Empowered by Information: Disease Outbreak Reporting at the World Health Organization

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Abstract

Information provision by international organizations (IOs) contributes to international cooperation. However, scholars have rarely explored how political alignment moderates the effect of information. I argue that information dissemination by IOs increases cooperation, especially from politically isolated states. I investigate how the World Health Organization (WHO) induces states' reporting of disease outbreaks. States may conceal disease outbreaks to avoid border restrictions imposed by other states. To prevent disease concealment, the WHO was delegated the unilateral authority to disseminate information by the International Health Regulations reform. This reform allowed the WHO to trigger border restrictions, deterring states' attempts at disease concealment, especially for isolated states that receive stronger border restrictions. I find that the reform increased the disease outbreak reporting by states isolated from the US and its allies, but not those isolated from China or Russia. This paper reveals the political cleavage of the institutional design of information authority in IOs.

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> "It is wrong to be any 'country-centric.' I am sure we are not China-centric. The truth is, if we are going to be blamed, it is right to blame us for being US-centric."
>
> Dr. Tedros Adhanom Ghebreyesus, Director-General of the WHO

1 Introduction

Scholars of international cooperation have long argued that information disseminated by international organizations (IOs) contributes to cooperation by states (Keohane, 1984; Dai, 2005; Kelley and Simmons, 2015, 2020). While information triggers enforcement, scholars tend to assume that responses to information are homogeneous. This may not be the case in a highly interdependent world system where the political and economic ties among states shape the costs and benefits of enforcement and, as a result, who cooperates. In this paper, I argue that information provided by IOs interacts with the interdependent world system to induce cooperation by states, especially those isolated from the global system.

The surveillance of global health emergencies at the World Health Organization (WHO) is a relevant and important case to study. The WHO was established in 1948 as a specialized agency of the United Nations to monitor public health emergencies and provide evidence-based scientific policy advice to its member states. Despite its strengthened capacity to detect global health emergencies (Davies, 2012), the WHO relies on states' disclosure of the status of a disease outbreak to prescribe the appropriate policy recommendation to the international community (Creamer and Simmons, 2019). However, states are often reluctant to share outbreak information with the WHO for fear of the costly trade and travel restrictions imposed by other states (Carnegie and Carson, 2020). Delayed reporting is prevalent (Worsnop, 2019). The most salient case is the Chinese government's response during the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003, where the Chinese government barred the WHO experts from accessing the origin site of the illness to avoid the potential border restrictions (Altman and Bradsher, 2003; Huang, 2004).

To address this concealment problem, the WHO reformed the International Health Regulations (IHR), an agreement among all WHO member states to address global health security. One of the critical changes in the reform is that it authorized the WHO to disseminate outbreak information to its members without waiting for states to confirm first. Before the reform, the WHO did not have the authority to inform its members of a disease outbreak without the consent of the outbreak country, even if it was aware of the outbreak.

I developed a formal model to investigate how strengthening the authority of information dissemination at the WHO affects the strategic incentives of states to disclose information about disease outbreaks. In a highly interdependent global system, a disease outbreak in one country may directly spread to other countries and indirectly disrupt their political and economic activities (Zhang, 2022; Antràs et al., 2023). To minimize the negative impact of a disease outbreak, other countries may provide resources to mitigate the disease spread and impose border restrictions to shut the virus out of their territories. I argue that when the state with a disease outbreak is deeply integrated with the international system—defined as political and economic integration with other states—border restrictions become unappealing because the disruption caused by bans can backfire. Hence, states deeply integrated with the international system tend to receive more resources and face fewer bans upon a disease outbreak.

Knowing how other countries will respond to its disease outbreaks, a state's willingness to disclose is shaped by its integration with other states. Integrated states proactively report disease outbreaks to the WHO to benefit from the resource provision by other states without the concern for border restrictions. However, for isolated states, information dissemination of disease outbreaks may only trigger strong border restrictions without bringing in material support to mitigate the outbreak, reducing states' incentives to disclose proactively.

The model shows that when the WHO has greater authority over information dissemination, isolated states decide to disclose. Once the WHO can unilaterally inform its members of a disease outbreak, the isolated states anticipate costly border restrictions even if they refuse to share information with the WHO. Hence, these states become more forthcoming about disease outbreaks to avoid potential radical border restrictions due to the unilateral information dissemination by the WHO.

To examine this model, I use the number of Disease Outbreak News (DONs) reports as a proxy for state cooperation with disease outbreak reporting. The outbreak verification procedure at the WHO (Grein et al., 2000) suggests that only reports confirmed by the outbreak country can appear on the DONs web page. Hence, more DONs reports reflect states' active information sharing with the WHO. Using a difference-in-differences specification, I find that the IHR reform reduced the gap in reporting between states with deep versus shallow integration with the US, signifying increased reporting by isolated states.

Additional analyses examine states' integration with different major powerful countries in the world and reveal that the increase in disclosure after the IHR reform is specific to countries politically misaligned with the US and its allies, not those politically misaligned with other major powers, such as China or Russia. This suggests that outbreak countries' political alignment shapes the constraining power of the IHR reform, which granted indirect influence to major Western powers in IOs.

This paper contributes to the literature on the informational role of IOs (Keohane, 1984; Dai, 2005; Kelley and Simmons, 2015, 2020; Koliev et al., 2021). While it is commonly recognized that information provision by IOs contributes to deeper cooperation by states, one relatively ignored aspect is that information may trigger heterogeneous enforcement, especially in an interdependent world system where punishment is costly due to political and economic ties among states. I analyze how interdependence among states moderates the effect of information provision by IOs on state cooperation and show that information induces isolated states to cooperate more, especially for those politically misaligned states.

Related to the heterogeneous effect of IO information on state cooperation, this paper speaks to the literature on hegemonic power (Lake, 2009; Vreeland and Dreher, 2012; Dreher et al., 2022; Vreeland, 2019). Previous studies show that the US can influence IOs through indirect channels, such as exchanges between formal and informal power (Stone, 2011), institutional secrecy (Carnegie and Carson, 2019), bureaucrats' internalization of the US's preferences (Clark and Dolan, 2020), and membership selection in IOs (Davis, 2023). I present a new mechanism: the asymmetric interdependence in the world system. With interdependence shaping outbreak responses, the IHR reform has greater constraining power over states less aligned with the US and its allies. Such heterogeneity reveals how powerful actors can take advantage of the existing interdependence structure in the international system to shape the influence of the information IOs disseminate. Moreover, contrary to our traditional understanding that delegation to neutral IOs reduces the influence of main shareholders (Abbott and Snidal, 1998; Hawkins et al., 2006), I show that more information authority in IOs may enhance the influence of powerful actors.

Last, I contribute to the understudied literature on the politics of global health governance. One goal of the IHR reform is to enhance information sharing by governments. While various studies acknowledge this as one of the most critical changes in the IHR reform (Fidler, 2005; Katz and Fischer, 2010; Kamradt-Scott, 2015), a systemic examination of the reform's effect on states' outbreak reporting is needed, which could be due to the empirical challenge of measuring states' cooperation with information-sharing (Worsnop, 2019; Davies, 2012; Carlson et al., 2023). I overcome this challenge and provide a quantitative empirical evaluation of the effect of the IHR reform on states' information-sharing. I show that the IHR reform is most effective in inducing disclosure by states isolated from the international system, especially for non-allies of major Western powers.

2 Background

2.1 World Health Organization

Established in 1948, the WHO functions as one of the specialized agencies of the United Nations and the coordinating authority on international public health. It monitors public health risks, coordinates responses to health emergencies, and provides technical and material assistance to combat disease outbreaks. The WHO also sets international health standards and guidelines and collects data on global health issues.

Despite these numerous responsibilities, the WHO has limited resources to enforce cooperation. It has two primary sources of revenue (Kaiser Family Foundation, 2020). First, assessed contributions are set amounts expected to be paid by member state governments that are scaled by income and population. Accounting for less than 20% of the WHO's total budget, assessed contributions are often used to cover general expenses and program activities. Second, voluntary contributions include other funds from member states, private organizations, and individuals. Ninety percent of the voluntary contributions are earmarked by donors for certain activities. Only 3.9% of the voluntary contributions are subject to the WHO's discretion. Compared to the $7.4 billion discretionary budget[1] for the CDC of the US, only about 20% of its $6 billion total budget is at the WHO's discretion. Constrained by its limited resources, the WHO assists governments of outbreak countries mainly through providing technical support rather than material support.

2.2 Capacity of Information Collection at the WHO

The WHO has actively collected its own information on global health emergencies, and it has strengthened its capacity for information collection throughout the years. Since 1997, the WHO has established an electronic public health early warning system called the Global Public Health Intelligence Network (GPHIN), which collaborates with Canada's Public Health Agency. The GPHIN monitors internet media in several languages—one of the most important sources of non-governmental information—to detect potential events that are of public health concern. In 2000, the WHO formalized the use of non-official information by establishing the Global Outbreak Alert and Response Network (GOARN), a new disease surveillance

[1]This is based on the FY 2019 budget.

platform in collaboration with technical partners in epidemic alert and response. GOARN proved crucial in detecting the SARS outbreak in China (Fidler, 2005, 348).

Despite its capacity to detect disease outbreaks, the WHO did not have the authority to disseminate information collected by its intelligence. Constrained by this limited authority of information dissemination, the WHO could not provide timely updates or policy advice to its members if the government of the outbreak country refused to confirm the WHO's information.

This is what happened during the SARS outbreak in China in 2003. On November 27, 2002, the WHO received one of its earliest alerts from the GPHIN about a potential influenza outbreak in southern China. When the secretariat formally requested further information, the Chinese government dismissed the request. After a series of news reports by Hong Kong media about an epidemic of atypical pneumonia, the WHO issued a second formal request for information on February 10, 2003. The Chinese government confirmed the outbreak, which involved 305 individuals and 5 deaths, and stressed that the outbreak was under control. Out of respect, the WHO responded by closely monitoring the situation, but it continuously received reports from Hong Kong, Singapore, and Hanoi about hospital staff contracting atypical pneumonia. Until February 28, when Carlo Urbani, a WHO epidemiologist working in Vietnam, reported his suspicion about an ongoing new contagion, the WHO started to intensify the epidemiological intelligence gathering. On March 12, the secretariat issued the first global alert (Kamradt-Scott, 2015, 89-90). Since then, the WHO issued various recommendations and policy advice to contain the disease in real-time. However, due to the Chinese government's rejection of the WHO's request to send a team to the site (Altman and Bradsher, 2003), the WHO was uncertain about the adequacy of measures to control the disease and the rate of transmission.

The SARS outbreak proved that the capacity of information collection alone was insufficient for the WHO to effectively respond to global health emergencies, which gave rise to the reform of the International Health Regulations.

2.3 History of the International Health Regulations Reform

The International Health Regulations (IHR) is an agreement among 196 countries to work together for global health security. It was originally named the International Sanitary Regulations (ISR) and was first adopted on May 25, 1951, to prevent the international spread of diseases while minimizing disruptions to trade and commerce. Without significant adjustments, the ISR was renamed the IHR in 1969. Despite its long presence, the IHR "came to be viewed as ineffective and insipid, were openly derided, and were frequently ignored" (Kamradt-Scott, 2015, 101).

In the early 1990s, a series of disease outbreaks—such as the reappearance of cholera in Latin America in 1991, the outbreak of plague in India in 1994, and the Ebola outbreak in Zaire in 1995 (Kamradt-Scott, 2015, 106)—motivated states to reform the IHR. At the World Health Assembly (WHA) in 1995, states voted to revise and update the IHR. However, for various reasons, it took ten years to complete the revision.[2] It was not until 2003, when the SARS outbreak alerted the international community to the existing IHR's insufficient framework, that urgency to finalize the revision arose.

One of the key goals of the IHR reform is to enhance information sharing by governments. Four major substantive changes in the IHR reform are relevant to this goal. The first is an expansion in the scope of the new IHR. The previous regime applied to a list of chosen infectious diseases due to their close association with international trade and travel. The new regime expanded the scope of diseases to any public health risks of urgent international concern, which is defined by a "decision tree" (Fidler, 2005, 235). Second, states are obliged to notify the WHO of any event that may constitute a public health emergency of international concern in their territories and maintain disease surveillance and preparedness capacities.

[2]The reasons include technical problems in syndromic reporting, a lack of enthusiasm from member states, an interruption from the 2001 terrorist attacks, and so on.

Third, the IHR reform authorizes the WHO to report and act based on non-governmental sources of information if the disease outbreak country fails to cooperate. Paragraph 3 of Article 10 (2005) specifies that the WHO "shall offer to collaborate with the State Party" in on-site assessments, and paragraph 4 states that the WHO may share information about the disease outbreak with other States Parties "when justified by the magnitude of the public health risk." This change enhanced the WHO's authority of information dissemination, especially for the information collected by the WHO's own intelligence system.

Last, the reform grants the director-general the unilateral authority to declare a Public Health Emergency of International Concern (PHEIC). Such a declaration may trigger other states' restrictive measures and intervene in national sovereignty. It attracted resistance from member states and delayed the completion of the IHR revision for another year. As a compromise, the reform allowed more control in the declaration process from the state experiencing the outbreak, which pushed through the reform. Specifically, the IHR reform requires the director-general to convene an Emergency Committee composed of technical experts, with at least one expert nominated by the country with the disease outbreak. This gives the states with disease outbreaks some control over the PHEIC declaration.

The revised IHR framework was unanimously approved by the Inter-Governmental Working Group (IGWG) at the 58th WHA and has been in effect since June 15, 2007.[3]

The IHR reform is generally regarded as revolutionary (Fidler, 2005) due to its intervention in state sovereignty, especially for the third and fourth elements discussed above. Although all these changes may contribute to states' cooperation in outbreak reporting, the authority of information dissemination is crucial. As discussed, the WHO has a small budget at its discretion, which significantly constrains the devices of carrots and sticks it can wield over its members. However, the authority of information dissemination allows the WHO to

[3]Despite the prolonged negotiation process, I treat the year 2005 as the starting point of the agreement because the SARS outbreak revealed to the international community the possibility for the WHO to disseminate information without states' consent.

leverage outbreak responses—such as resources and border restrictions—from other countries. In this paper, I examine how the WHO can use its enhanced authority of information dissemination to induce states' proactive reporting of disease outbreaks.

3 A Model of Disease Outbreak Reporting

The model focuses on the early stage of disease outbreaks where the concealment of disease outbreaks is most likely. The model features three actors: the leader of the disease outbreak country (L), the agency or the WHO (A), and the international community (C).

3.1 Sequence

Figure 1 shows the game tree.

1. Nature determines that the outbreak is severe with probability ψ: $Pr(\theta = 1) = \psi$.[4]

2. L decides whether to report the outbreak to A ($r_L = 1$) or not ($r_L = 0$).

3. A decides whether to disseminate the outbreak information to C ($r_A = 1$) or not ($r_A = 0$).

4. C provides resources $m \in [0, 1]$ to L for disease mitigation and imposes trade and travel bans $b \in [0, 1]$ to prevent the disease from entering its territory.

[4] I assume that $\psi < (\frac{\gamma(\gamma+\lambda)^2}{\lambda})^{\frac{1}{4}} - 1$. This threshold ensures that C is not incentivized to respond when there is no reporting from the government or WHO. The solution to this threshold can be found in Appendix A.1.

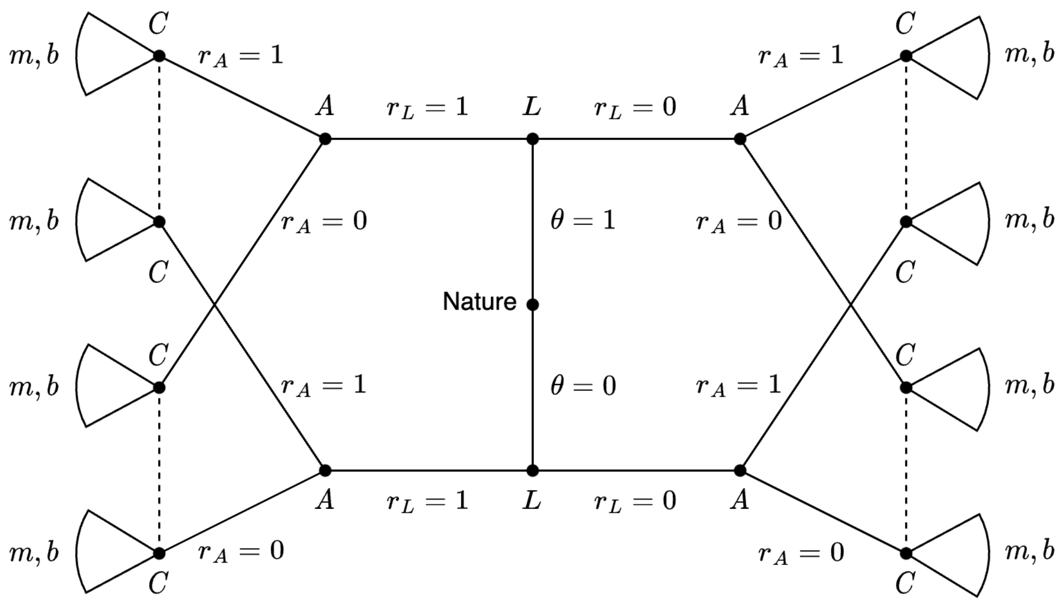

Figure 1: Game Tree

3.2 Payoffs

Knowing that C may respond to a disease outbreak by providing resources and imposing bans,[5] L decides whether to allow A to report the outbreak to C. L's utility function is as follows:

$$U_L(r_L) = -\underbrace{\theta(1-m)}_{\text{Disease damage}} - \underbrace{b}_{\text{Costs due to bans}} - \underbrace{\epsilon \mathbb{1}\{r_L \neq r_A\}}_{\text{Reputation costs}}$$

First, when there is an outbreak, L suffers from the damage caused by the outbreak. However, the resources provided by C can mitigate L's costs of outbreak damage. Second, since C may impose restrictive measures, L also suffers from the disruption caused by the bans. Last, when L's reporting is inconsistent with A's information dissemination, A incurs a small

[5]Worsnop (2017a) and Worsnop et al. (2022) show that the WHO's information dissemination can directly trigger outbreak responses, especially when the public is experiencing growing anxiety during a global health crisis (Kenwick and Simmons, 2020; Lipscy, 2020). Kobayashi et al. (2021), Gadarian et al. (2023), and Kobayashi et al. (2023) provide micro-foundations for such outbreak responses.

reputation cost ϵ.

As an agency specializing in public health, A aims to control the disease's spread and can use information dissemination to trigger outbreak responses by the international community. Its utility function is as follows:

$$U_A(r_A) = \underbrace{-\theta(1-m-b)}_{\text{Disease control goal}} - \underbrace{p\mathbb{1}\{r_L \neq r_A\}}_{\text{Overriding costs}}$$

Since both resources and bans have a constraining effect on disease spread, especially in the early stage of a disease outbreak (Grépin et al., 2021), the extent to which A can achieve disease control depends on the magnitudes of resources m and bans b. However, as information dissemination without states' consent is regarded as an intervention in states' sovereignty, A incurs an overriding cost if it reports outbreaks to C without L's approval. The parameter of interest is $p \in [0, 1]$, which captures the level of information authority delegated to A. We may use a decrease in p to represent the IHR reform, which granted the WHO the authority of information dissemination.

Suffering from the outbreak spillovers, C may provide resources and impose bans to minimize the damage, which is represented in the following utility function:

$$U_C(m, b) = -\underbrace{\theta(1-m-b)}_{\text{Disease spillovers}} - \underbrace{\alpha(\theta(1-m)+b)}_{\text{Disruption due to integration}} - \underbrace{(k_m(m)+k_b(b))}_{\text{Costs for resources and bans}}$$

First, the outbreak causes direct damages to C if the outbreak spreads outside of L's territory. C's outbreak responses of resources and bans can mitigate the direct damages of the outbreak. Second, with interdependence among states, disruptions caused by a disease outbreak in one country may lead to disruptions in other countries if they have deep integration with each other (Antràs et al., 2023; Zhang, 2022). For example, with the fragmented production mode, the temporary shutdown of firms in L can disrupt firms' operations in the same production chain in other countries. Conceptualizing interdependence as the mutual sensitivity in payoff structures, I assume that C internalizes the utility of L when considering the indirect damage of the outbreak. To measure how strongly C is affected by the disruption in L's territory, I use $\alpha \in [0, 1]$ to capture L's integration with C, the key parameter of interest.

Last, C incurs costs of resource provision and ban imposition, which are represented in the following cost functions, respectively:

$$k_m(m) = \frac{\gamma}{2}m^2 + \varepsilon_m \mathbb{1}\{m > 0\}$$

$$k_b(b) = \frac{\lambda}{2}b^2 + \varepsilon_b \mathbb{1}\{b > 0\}$$

γm^2 and λb^2 correspond to the material costs of resources and bans,[6] while $\varepsilon_m \mathbb{1}\{m > 0\}$ and $\varepsilon_b \mathbb{1}\{b > 0\}$) are the administrative costs once any resources or bans are provided.[7]

[6]I assume that $\gamma > \lambda$. This is consistent with the argument that ban imposition is less costly than resource provision and is a more domestically attractive option for political leaders (Kenwick and Simmons, 2020).

[7]As we are interested in the phenomenon where the international community reacts to the WHO's outbreak declaration (Worsnop, 2017b; Worsnop et al., 2022), I include these administrative costs to ensure that C have incentives to provide resources and impose bans upon A's reporting and that in the absence of A's reporting, C does not respond with a small amount of resource or bans due to its prior belief of the probability of outbreak severity ψ. To achieve this, I assume that

$$\frac{(1+\psi)^2}{2\gamma} < \varepsilon_m + \varepsilon_b < \frac{\gamma + \lambda}{2\sqrt{\gamma\lambda}}$$

$$\varepsilon_m > \frac{2\psi^2}{\gamma}$$

The first part of the first inequation ensures that $m = b = 0$ when C holds a prior belief about θ. The second part of the first inequation ensures that high administrative costs do not deter C's outbreak responses. The second inequation ensures that $m = b = 0$ when C holds a prior belief about θ and when the outbreak

3.3 Information Set

The model focuses on the early stage of a disease outbreak. I assume that L and A can observe θ, while C cannot for the following reasons. First, the direct interaction with early cases of the disease makes L more informed about the severity of an outbreak. Second, A's expertise in public health surveillance is reflected in A's capacity to collect its own information about worldwide disease outbreaks. The assumption that A can observe θ concentrates our attention on the circumstance where disease concealment results from states' reluctance to cooperate rather than the WHO's low capacity to detect outbreaks.[8] Last, I assume that C cannot observe θ and can only make its decision based on L and A's actions. All the other parameters are public information to the actors.

3.4 Equilibrium

Appendix A.1 shows the solution to the model. Here, I provide an intuitive illustration of actors' behaviors at the equilibrium under different parameter spaces.

When facing a disease outbreak, C responds with resource provision and ban imposition, the magnitude of which depends on the level of integration between L and C. Given C's posterior belief μ about the severity of an outbreak after observing the actions by L and A, C's best responses are as follows:

$$m(\mu) = \frac{\mu(1+\alpha)}{\gamma}$$

country does not face any bans. The calculation of these constraints is in Appendix A.1.

[8]This is a scope condition of this model. Suppose we assume that the WHO has partial knowledge about disease outbreaks. In that case, the analysis focuses on how changes in the WHO's capacity for disease surveillance affect states' disclosure. Although the WHO has indeed experienced a gradual improvement in its capacity of disease surveillance (Fidler, 2005; Davies, 2012), this focus does not correspond to the abrupt institutional change as a result of the IHR reform, which is the focus of the empirical analysis of this paper.

$$b(\mu) = max\{\frac{\mu - \alpha}{\lambda}, 0\}$$

which suggests that as the integration level between C and L increases, L is likely to receive more resources and face fewer bans.

Deeper integration between L and C means that C experiences more disruptions caused by the outbreak within L's territory. Resource provision helps control the outbreak from within, which reduces the disruptions to political and economic activities caused by disease outbreaks. As the integration between L and C deepens, C has incentives to provide more resources. Meanwhile, bans cut off C's interactions with L, causing more disruptions if L and C are more deeply integrated. Hence, deeper integration between L and C reduces the bans that C imposes.[9]

L's decision to disclose depends on C's outbreak responses and A's information authority. Figure 2 maps L's reporting strategy under the parameter spaces of its integration level with C and the information authority in A. The horizontal axis shows the costs A incurs to override L's decision. The higher the cost, the lower the information authority A has. The vertical axis demonstrates the integration level between L and C.

[9]The COVID-19 pandemic provides a good empirical setting to examine the pattern of border restrictions because it allows us to examine the border restrictions faced by all countries, while most disease outbreaks create a selective disease environment, making the inference difficult. Based on the pattern of border restriction imposition at the dyadic level between 2020 and 2021, I find that deeper integration between the dyad decreases the probability of border restrictions (Figure A.1). The result is mainly driven by political alignment measured by the UNGA voting similarity between the dyad and the geographic proximity measured by the distance between the capital cities. More details of this test can be found in Appendix A.2.

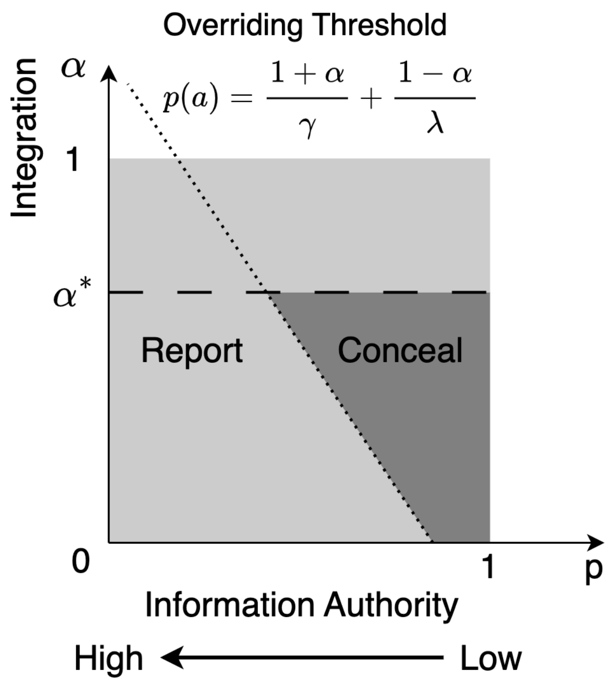

Figure 2: L's Reporting Strategy

I begin by analyzing L's incentives to disclose. The benefits of disclosure come from C's resource provision, while the corresponding costs are the border restrictions. When L is integrated with the international community, L tends to receive more resources and face fewer bans, making disclosure profitable. As a result, L with deep integration with C ($\alpha \geq \alpha^*$) do not have incentives to conceal regardless of A's information authority. This is shown in the light gray area above the horizontal dashed line α^*.

When L does not integrate deeply enough with C ($\alpha < \alpha^*$), the decision to disclose depends on A's information authority. When A incurs a high cost to override L's decision to conceal—suggesting that A has limited information authority—L is not concerned about being overridden by A and, hence, does not have incentives to disclose. This is represented by the dark gray area in Figure 2. When A has enough information authority, despite that L does not benefit from the disclosure, L may still share information with A because A will disseminate the outbreak information with the international community to trigger C's outbreak responses.[10]

Last, I analyze A's incentives for information dissemination. Given A's goal of disease control, the tradeoff that A faces is whether it is worth the cost to override L to achieve the benefit of disease control. When the resource provision and border restrictions are large enough, A is willing to override. This is especially true for L with shallower integration compared to moderate integration. These more isolated states tend to receive stronger bans upon information dissemination, while C's outbreak responses are moderate for those with moderate integration levels, making overriding less beneficial for A. The dotted line in Figure 2 characterizes the overriding threshold, below which A is willing to override L to obtain disease control from C's outbreak responses. This dotted line separates the spaces of L's reporting strategy at the equilibrium, with the space left to the line indicating induced disclosure.

3.5 Hypothesis

To understand the effect of the IHR reform on outbreak reporting, I examine the movement of p from 1 to 0, corresponding to the change from no information authority to complete information authority.[11]

[10]I assume that L can benefit from reporting consistently with A, which is characterized by ϵ in L's utility function. One potential benefit of proactive reporting is the first-mover advantage, which allows the outbreak state to control the contents of a report. Another potential benefit is to mitigate the international community's concern about disease severity. When C observes A's information dissemination despite L's concealment, C may interpret the outbreak as so severe that A is willing to incur the overriding cost to disseminate the outbreak information. As such, L may receive a greater amount of border restrictions.

[11]It is difficult to empirically evaluate how much information authority the IHR reform delegated to the WHO. I examine the two extreme cases of zero and complete information authority. Despite the simplification, this comparison captures the model prediction that the IHR reform is most capable of inducing

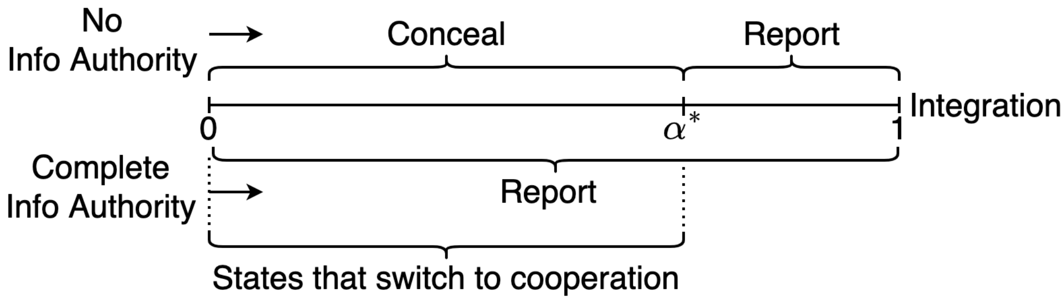

Figure 3: L's Strategy: Comparison Between $p = 1$ an $p = 0$

As Figure 3 shows, before the IHR reform, when the WHO could not unilaterally disseminate the outbreak information, only states with deep enough integration with the international community reported the outbreak. After the IHR reform allows the WHO to disseminate the outbreak information at its own discretion, those who would otherwise be reluctant to disclose become more forthcoming with the outbreaks. We obtain the following hypothesis from this comparison.

Hypothesis 1. *The IHR reform induced more outbreak reporting by shallowly integrated states, which would otherwise be reluctant to disclose.*

Before moving to the empirical test of the hypothesis, one result of the model is worth discussing. Figure 4 illustrates the international community's outbreak responses given an outbreak under two extreme scenarios, where the WHO has zero and complete authority of information dissemination. The dotted and solid lines correspond to the magnitude of resources and border restrictions at the equilibrium. The left panel shows the pre-reform world, which is characterized by high resource provision and low border restrictions for integrated countries only. For isolated countries, as a result of their disease concealment, they do not face the costly bans and limited resources before the reform. In the post-reform world in the right panel, the international community is responsive to disease outbreaks in all countries, but restrictive measures with limited resource provision for isolated states

cooperation from states that are least integrated with the global system.

dominate their additional reactions. This comparison offers a comprehensive picture of the IHR reform. Arguably, the IHR reform is effective in facilitating cooperation with reporting disease outbreaks. However, such benefits come at the cost of stronger restrictive measures,[12] which may disrupt the efficient allocation of medical resources to contain the outbreak.

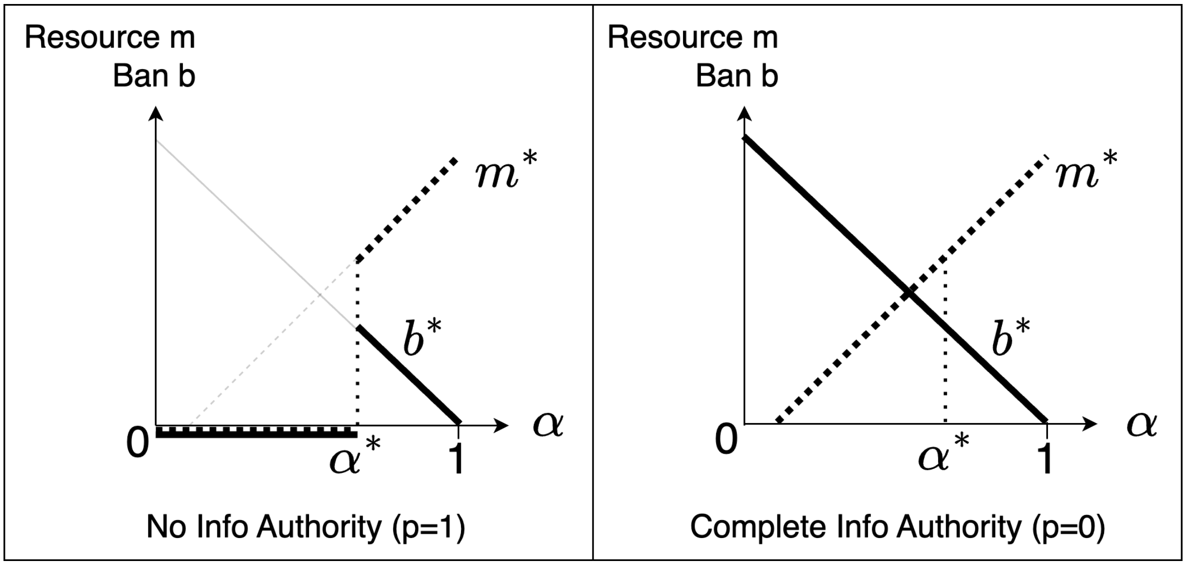

Figure 4: C's Strategy: Comparison Between $p = 1$ and $p = 0$

4 Data

4.1 Disease Outbreak News (DONs)

To measure state cooperation with outbreak reporting, I construct a variable based on the number of Disease Outbreak News (DONs) reports per country annually. I obtained the data from the WHO's DONs web page, which is the most frequently accessed page on the WHO website and is a platform where the WHO disseminates officially confirmed information about disease outbreaks of international importance. The number of DONs reports can measure

[12]This result is consistent with Worsnop et al. (2022), who argue that information dissemination by the WHO triggers border restrictions. However, they did not explore the heterogeneous effect of information provision by the WHO.

cooperation because of the outbreak verification process at the WHO.

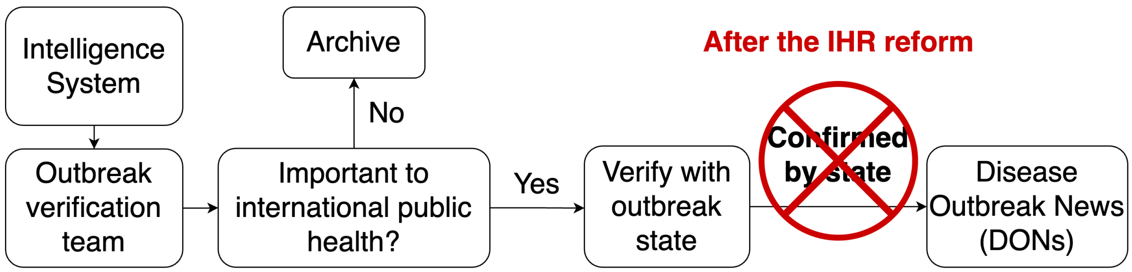

Figure 5: Disease Outbreak Verification System

Figure 5 illustrates the data-generating process of DONs reports (Grein et al., 2000). Based on the GPHIN and other information sources, the system generates reports of events that might be of concern. Every morning, a team at the WHO headquarters evaluates the importance of each event. Once an event is deemed important, an outbreak verification team will seek verification from the outbreak country. Before the reform, the WHO could only post a report on the DONs web page upon receiving official confirmation from the country. In other words, if a state did not provide confirmation, there would not be a report in the data set. After the reform, the WHO does not need to receive confirmation from the state to post a report, which deters the withholding of reports that would otherwise have been missing from the data set. Due to this selection process, changes in the number of DONs reports can reflect changes in states' cooperation with outbreak reporting.[13]

With variations in the content over time, all DONs reports include outbreak information, such as the region of a disease outbreak, disease type, and sometimes the number of cases. After scraping the website, I obtained a data set of 2,874 reports covering January 22, 1996,

[13] One potential concern with this measure is that the number of reports reflects the agency's information dissemination instead of the state's cooperation. To empirically examine this concern, I coded each report based on whether a report identifies the government as the source of information or whether a report has any indications of cooperation from the government of the outbreak country. As Table A.1 shows, the result is robust after removing the DONs reports without indicating government cooperation. More details about the coding criteria and the empirical analysis can be found in Appendix A.3.

to May 14, 2020.[14] The left panel of Figure 6 summarizes the over-time change in the number of reports. The spike in 2003 reflects the SARS outbreak, while the spike in 2014 reflects the Ebola outbreak in West Africa and the Middle East respiratory syndrome coronavirus (MERS) outbreak. The right panel shows the most frequently reported disease types.

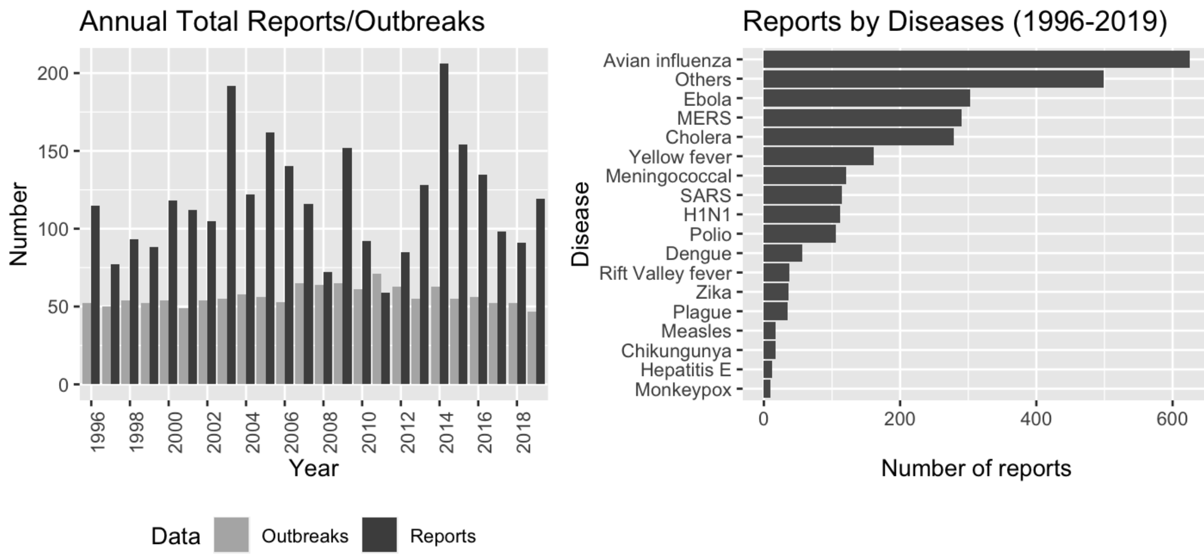

Figure 6: Number of Reports Overtime and Major Disease Types in DONs

I also collect the disease outbreak event data from a third-party source: the Global Infectious Diseases and Epidemiology Online Network (GIDEON),[15] a platform mainly used by health professionals and educators for infectious disease diagnosis and reference purposes

[14]To code the disease outbreak countries in each report, I use regular expressions to identify the country name from the headline. For reports that do not identify country names in headlines, I use the same regular expressions to identify the country names from the report content. Then, I read the contents to verify that the identified countries were the ones that experienced outbreaks. Figure A.4 shows the distribution of the number of countries in each report. Figure A.5 presents the over-time coverage of countries. Figure A.6 shows the most frequently reported countries before 2005 and after 2005.

[15]GIDEON builds its data set through real-time search based on keywords and ex-post collection of official documents and peer-reviewed publications. The fact that GIDEON collects data ex-post alleviates the concern that the number of outbreaks detected by GIDEON is driven by governments' reporting willingness

in hospitals and universities. Due to its functional nature, the GIDEON data set provides a relatively less politicized source of the severity of disease outbreaks. We can see from the left panel of Figure 6 that the number of outbreaks is stable over time, while the number of reports varies. This is partly because, for the same outbreak in the same country, multiple reports are published to provide updates on the situation of the outbreak. This offers another reason why the number of DONs reports is a useful measure of government cooperation, as frequent updates during an outbreak reflect governments' effort to share information with the WHO.

To transform the report data set into a country-year panel, I sum the reports by country and year and balance the panel by coding the missing country-year entries as zero. The final data set covers 152 countries from 1996 to 2015.[16] On average, each country has two reports every year. The maximum number of reports a country receives in a year is 75, corresponding to the SARS reports for China in 2003. Of the country-year pairs, 69.3% have zero reports.[17]

4.2 Integration with International Community

I use a country's integration with the US to measure integration with the international community. Since the US and its allies are the largest shareholders in the WHO, have great influence in international organizations (Copelovitch, 2010; Dreher et al., 2009b; Stone, 2008, 2011), and are major aid providers, treating the US as the representative of the international community can be a good summary of the international community's responses to disease outbreaks. I construct an integration index based on a country's political, economic, and

or capacity.

[16]The reduction in the number of countries and years is due to the availability of the integration measures and other control variables.

[17]The summary statistics of all variables and their data sources are in Table A.2.

geographic integration with the US. First, I use the ideal point estimates based on the voting records at the United Nations General Assembly (UNGA) (Bailey et al., 2017) to measure the political integration. I use the absolute difference of the ideal point estimate between a country and the US to measure political integration. The larger the magnitude, the shallower the integration.[18] Second, I use total imports from the US to measure economic integration. Third, to measure the geographic integration, I use the number of seats on direct flights to the US because it captures the capacity of population movement and reflects geographic integration in the era of globalization. To harmonize the magnitude of these variables, I create the Z-score index by first standardizing these three integration dimensions and then taking the average of the standardized integration scores.

4.3 Regression Specification

I employ the difference-in-differences (DID) specification with the IHR reform as the treatment and explore the variation in the depth of state integration with the US. Unlike the standard DID approach, where the control group is not treated and serves as the counterfactual, the treatment in this paper affects all countries, but the magnitude of influence varies with the depth of integration with the US. The intuition of this identification strategy is to compare the difference in cooperation between groups that are more sensitive to the treatment and groups that are less sensitive and to identify the differences between these two groups. Assuming that the treatment has a one-directional impact on all groups—meaning that the IHR reform does not reduce the level of cooperation from states with deep integration with the US—the identified effect is a conservative estimate of the effect of the IHR

[18]In the regression below, I take the negative value of the ideal point distance to harmonize the signs of the coefficients of different integration variables.

reform on state cooperation. The regression equation is shown below:

$$\begin{aligned} log(1 + DONs\ Report_{irt}) =& \beta_1 Integration_{i,t-1} + \beta_2 Integration_{i,t-1} \times Post_t \\ & + \alpha_t + \gamma_i + \delta_{rt} + \lambda_{it} + X_{i,t-1}\Gamma + \varepsilon_{idt} \end{aligned}$$

where i, r, and t indicate the country, regional office, and year. The dependent variable is the number of DONs reports in the logarithm. $Integration_{i,t-1}$ represents the integration index based on states' political, economic, and geographic integration with the US. The coefficient β_1 identifies the difference in DONs reports between integrated and isolated states before the IHR reform. Ideally, β_1 may inform us who concealed outbreaks before the IHR reform. However, due to the lack of data on the disease environment, making inferences about state cooperation from β_1 is empirically challenging. As the global disease burden is unequally distributed around the world, more DONs reports do not reflect states' cooperation without accounting for disease environment. Moreover, we cannot use the observed disease incidents to proxy for the disease environment as this variable is endogenous to states' reporting decisions.

Due to this empirical challenge, we can only infer the change in states' reporting behaviors by taking the difference in reports before and after the reform, which allows us to account for disease environments. The coefficient of interest is β_2, corresponding to the interaction term $Integration_{i,t-1} \times Post_t$. $Post_t$ is a dummy variable indicating the post-reform period. β_2 identifies the causal effect of the authority of information dissemination on state cooperation with outbreak reporting, which is interpreted as the difference in the reporting gap between integrated and isolated states before and after the reform. As we expect the isolated states to increase their reporting after the reform, β_2 is expected to be negative to capture the shrinkage in the gap.

One potential threat to this identification strategy is omitted variable bias. To address this concern, I control for year fixed effects α_t, country fixed effects γ_i, and regional office-year fixed effects δ_{rt}. Specifically, α_t accounts for the over-time change in the WHO's DONs reporting strategy that is not specific to any country. γ_i accounts for the time-invariant country-specific characteristics, such as geographic conditions that are sensitive to the influence of infectious diseases. δ_{rt} controls for the over-time change in the six regional offices each country is assigned to. For example, since the regional office plays a critical role in on-site disease verification, a leadership change in a specific regional office may affect the reporting pattern for all countries in that region. Last, λ_{it} represents the country-specific and the country-specific quadratic time trends. These terms address the potential spurious correlation concern due to the long period. Including the quadratic term captures the nonlinear trend due to the reform.

I also control for a vector of control variables X_{it}. First, as infectious diseases have a close relationship with international trade and travel, I control for the openness of the economy, which is measured as the total import and export volume over the total GDP. As infectious diseases disrupt international trade, countries with greater openness may have incentives to withhold outbreak information.

Second, I control for a country's engagement in other international organizations. I control for whether a country is a member of the United Nations Security Council (UNSC). Previous research shows that being on the UNSC creates space for vote-buying (Dreher et al., 2022), which generates not only preferential treatment from the International Monetary Fund (IMF) (Dreher et al., 2009a) and the World Bank (Dreher et al., 2009b) but also pernicious consequences on economic growth and press freedom (Bueno de Mesquita and Smith, 2010). Hence, UNSC membership reduces a country's incentive to obtain support from the WHO in dealing with a disease outbreak and may harm cooperation in the public health arena. In addition, I control for whether a country participates in any IMF programs. Stubbs et al. (2017) argue that IMF conditionality reduces the fiscal space for investment in health systems, which may undermine the ability to cope with infectious disease outbreaks (Kentikelenis et al., 2015). The number of DONs reports may increase due to a low capacity to deal with the outbreak.

Last, I control for regime types to account for the fact that democracies have a stronger domestic mechanism to induce compliance (Dai, 2005). I also control for GDP per capita and population size to account for the general conditions in the country. All the independent variables are lagged for one year to avoid simultaneity bias.

5 Results

5.1 Baseline Results

Table 1 reports the baseline results. Column (1) only controls for state-fixed effects and state-specific time trends. Column (2) adds the control variables mentioned in the previous section. Column (3) includes the regional office-year fixed effects and state-specific quadratic time trends. Across all these specifications, the coefficient estimates are statistically significant negative for β_2. This suggests that after the IHR reform, states less integrated with the US increased their reporting, shrinking the gap in reporting with integrated states.

Table 1: Integration with US and Disease Outbreak Reports/Events

	Dependent variable:					
	log(1 + DONs reports)			log(1 + Outbreak Events)		
	(1)	(2)	(3)	(4)	(5)	(6)
Integration with US	−0.009	−0.002	0.093	−0.038	−0.020	0.001
	(0.064)	(0.066)	(0.094)	(0.050)	(0.049)	(0.062)
Integration with US * Post2005	-0.158^{**}	-0.182^{***}	-0.317^{***}	0.035	0.036	0.053
	(0.065)	(0.065)	(0.111)	(0.036)	(0.036)	(0.055)
State FE	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y
Control	N	Y	Y	N	Y	Y
Office-Year FE	N	N	Y	N	N	Y
State-specific quadratic time trend	N	N	Y	N	N	Y
Observations	2,922	2,845	2,845	2,922	2,845	2,845
R^2	0.487	0.496	0.657	0.711	0.711	0.749
Adjusted R^2	0.424	0.432	0.570	0.675	0.674	0.685

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
Standard errors are clustered at the country level in parentheses.

To examine the heterogeneous effect of IO information on different dimensions of interdependence, the first column of Figure 7 shows the coefficient estimates of a country's political, economic, and geographic integration using the specification in Column (3) of Table 1. As my theory suggests, post-reform cooperation comes from the deterrence of outbreak responses, which is triggered by information dissemination by the WHO. Stronger result in the political dimension implies that outbreak responses to IO information are stronger if the outbreak country is politically misaligned with other countries. This is consistent with the pattern of border restrictions during the Covid-19 pandemic. As Figure A.1 shows, countries tend to impose border restrictions on countries that are not politically aligned. In addition, among different types of border restrictions, the results related to citizenship-based bans—the most political border restriction among others—are the strongest. These results suggest that information provision by IOs may have a stronger constraining power over states' behaviors based on their political alignment.

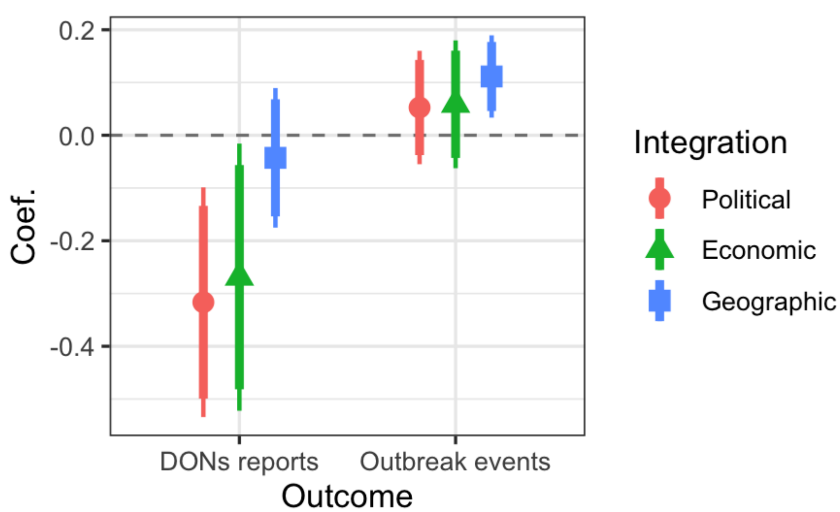

Figure 7: Which Dimensions of Integration Matter?

5.2 Placebo Test

One potential threat to the above results is that disease severity could drive the pattern rather than states' willingness to cooperate. A state's integration level may correlate with other factors influencing how much a country invests in public health facilities and, hence, how likely a country is to experience disease outbreaks. To address this concern, I conduct a placebo test using the number of outbreak events as the dependent variable. If DONs reports only reflect the severity of disease outbreaks, we expect a pattern similar to the first three columns of Table 1.

Using the number of disease outbreak events from the GIDEON database as the dependent variable,[19] the last three columns in Table 1 present the result. The IHR reforms increased the number of outbreak events for states that are more deeply integrated with the US. This is different from the previous pattern, suggesting that the disease outbreak reporting process might be politicized.[20] The second column in Figure 7 shows the placebo test using the breakdown of the integration index.

5.3 Mechanism Check

To further examine the mechanism, I explore the variation of disease types in DONs reports. I argue that the driving force of states' behavior change comes from disease outbreak responses triggered by the WHO's information dissemination. Hence, greater cooperation in reporting should only exist for outbreaks that can potentially trigger other countries' outbreak responses. For example, diseases with high transmissibility may receive more radical responses, while the availability of vaccines may reduce the concern for a disease. Therefore, we expect the reform to induce cooperation in reporting from isolated states only for

[19] Although the GIDEON database covers the number of cases for each outbreak, there is a severe missing data issue, making it difficult to verify the actual level of severity. As a compromise, I use the number of outbreaks to capture the baseline severity of disease outbreaks.

[20] As the number of disease outbreak events is a post-treatment control, I do not control for it in the baseline setting. However, as is shown in Table A.3, the baseline results hold after controlling for this variable.

outbreaks with high transmissibility or without a vaccine.

However, the empirical challenge is the lack of a measurement to capture these features of diseases. As a compromise, I use the list of diseases published on the Traveler's Health web page on the CDC website, which aims to provide citizens with information about diseases that are relevant to travel. I use travel-related diseases to indicate the diseases listed on this web page. After categorizing the disease in each DONs report into travel-related and other diseases, I aggregate the reports to the country-year level. If outbreak responses drive states' behavior changes, we expect increased reporting by isolated countries only for travel-related diseases and not other diseases.

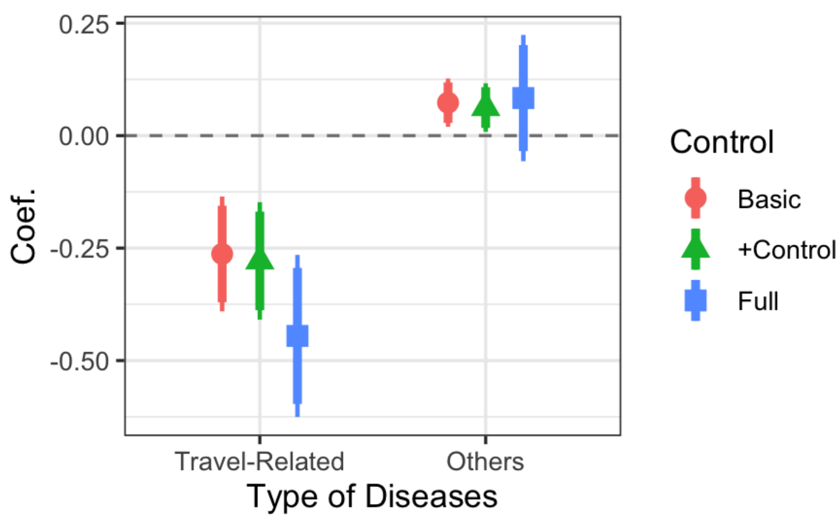

Figure 8: Mechanism Check

Figure 8 shows the results with two different sets of DONs reports as the dependent variable. The first column shows the coefficient estimate of the interaction term β_2 using DONs reports on travel-related diseases. The coefficient estimates are significantly negative and become stronger as more controls are included. In addition, there is no similar pattern for other types of diseases. Instead, the gap in reporting on other diseases increased between integrated and isolated states. These results confirm that the deterrent effect of the WHO's information dissemination depends on the presence of outbreak responses as an enforcement mechanism. For the rest of the paper, I use DONs reports on travel-related diseases as the dependent variable, as this outcome is a more precise test for the model.

5.4 Pre-Trend Analysis and Robustness Checks

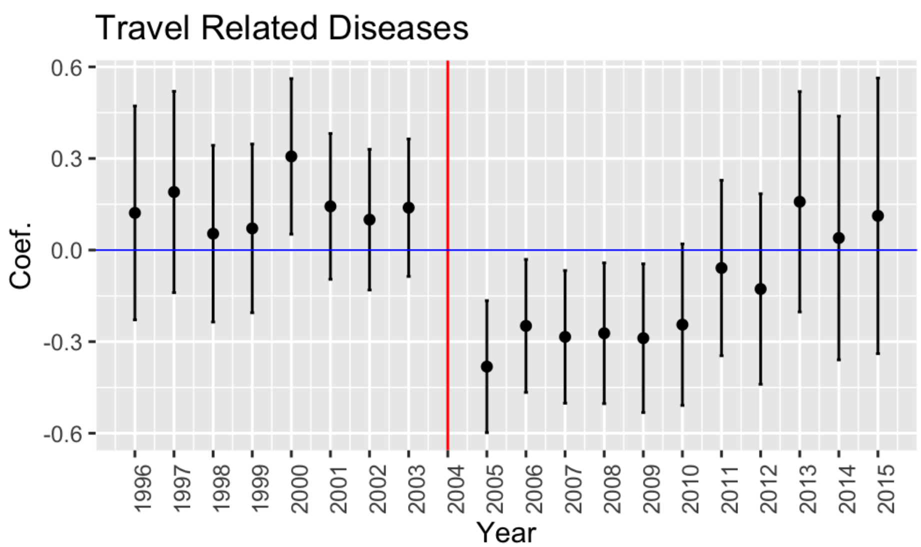

Figure 9: Pre-trend Analysis

To test the parallel trend assumption, Figure 9 presents the coefficient estimates of a vector of year dummies interacted with the integration index. As the negotiation over the IHR reform began in 2005, I used 2004 as the reference group. The results show that before the IHR reform, more integrated countries tend to have more DONs reports,[21] indicating the absence of a pre-trend. Immediately after the initiation of the reform, the number of DONs reports from states less integrated with the US started to increase until 2010.[22]

[21] The spike in 2000 is driven by the ebola outbreak in Uganda, which is politically distant from the US.

[22] There are two potential explanations for why the effect dissipated. One could be due to the H1N1 outbreak in 2009 and 2010, which originated in Mexico and had large exposure in the US and countries closely integrated, crowded out the health capacities dealing with other disease outbreaks. Another explanation could be that states learned over time that the WHO would not easily override its member states due to

I conduct the following robustness checks. First, one alternative explanation is that the IHR reform may have a heterogeneous effect on different regime types. As democracies are more cooperative (Mansfield et al., 2002) and have a stronger domestic enforcement mechanism of compliance (Dai, 2005), the reform may have had a greater impact on autocrats' behavior. Columns (1) and (2) in Table A.4 examine the heterogeneous effect of the IHR reform regarding regime types and find that the reform increased the number of DONs reports in democracies after the reform, which is inconsistent with the model prediction. Still, the baseline results become stronger after controlling for the heterogeneous effect of democracy.

Second, a country's transparency level may affect the detection of outbreaks. The reform may have a ceiling effect on states with high transparency and may have increased the reporting by states with low transparency. Columns (3) and (4) in Table A.4 use the HRV transparency index to measure a country's transparency level (Hollyer et al., 2014) and confirm that states with low transparency became more forthcoming after the reform. Meanwhile, the baseline results hold after controlling for transparency.

Third, another alternative explanation is that states may have enhanced their capacity for outbreak surveillance and preparedness after the IHR reform, which is one of the state obligations of the IHR reform. Hence, the enhanced reporting may reflect states' health capacity improvement rather than a greater willingness to cooperate. There are two reasons why this explanation may not be plausible. First, improving health capacity takes time, which is inconsistent with immediate behavior changes by states in Figure 9. Second, to systematically examine the plausibility of this explanation, I control for the percentage of the population using basic sanitation services and the number of hospital beds per 1000 people[23] and their interaction with the post-reform indicators. Table A.5 shows that the

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the need for collaboration by the governments of these countries to investigate a disease outbreak. Hence, countries adjusted their reporting decisions accordingly. Despite potential adjustments due to the learning mechanism, the cooperation-enhancing effect of the IHR reform still lasted for six years.

[23]The data is collected from the World Bank WDI Database. A more direct measure of states' health

gap in reporting between isolated and integrated states remains significantly negative after controlling for health capacity. In addition, better health capacity is generally correlated with fewer DONs reports, implying that countries with good health capacity may suffer less from disease outbreaks.

Last, to ensure the results are not driven by the outbreak of MERS in Saudi Arabia or other disease outbreaks in China, I exclude Saudi Arabia and China—separately and altogether—from the regression. The results hold, as is shown in Table A.6.[24]

5.5 Is This About the US?

To further investigate different measures of a country's interdependence with the world system, I expand the center of the international community to other powerful states in the international arena. The first group comprises powerful Western countries like the UK, France, and Germany. The second group includes other major powers, such as China and Russia. Regarding the political dimension, I examine a country's integration with these countries using the ideal point similarity based on the UNGA voting records and the inter-governmental organization (IGO) portfolio similarity (Voeten, 2021). The former captures a country's ideological similarity with these powerful states, while the latter is a behavioral measure and

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capacity is states' compliance with their capacity building. However, as Tsai and Katz (2018) and Razavi et al. (2021) show, the state self-reporting score in the Electronic States Parties Self-Assessment Annual Reporting Tool (e-SPAR) may not reflect the true level of compliance. Also, this data is only available after 2010, making it unsuitable for the test.

[24]To examine which observations drive the results, I conduct a Jackknife test, where I drop one country out of the analysis at a time using the specification in Column (3) of Table 1. Figure A.7 presents the results, where each dot represents the coefficient estimate dropping the corresponding country, and the bar is the confidence interval at the 95% level. Major countries that drive the results include Canada, Egypt, Indonesia, Cambodia, the UK, and so on.

captures the shared commitment to international cooperation among states (Copelovitch and Powers, 2021). Regarding the economic dimension, I use the dyadic global value chain (GVC) integration collected from the UNCTAD-Eora Global Value Chain Database (Casella et al., 2019) to measure a country's engagement with each other in the globally fragmented production process. This measure captures how much value-added a country contributes to the production chain with the other country.

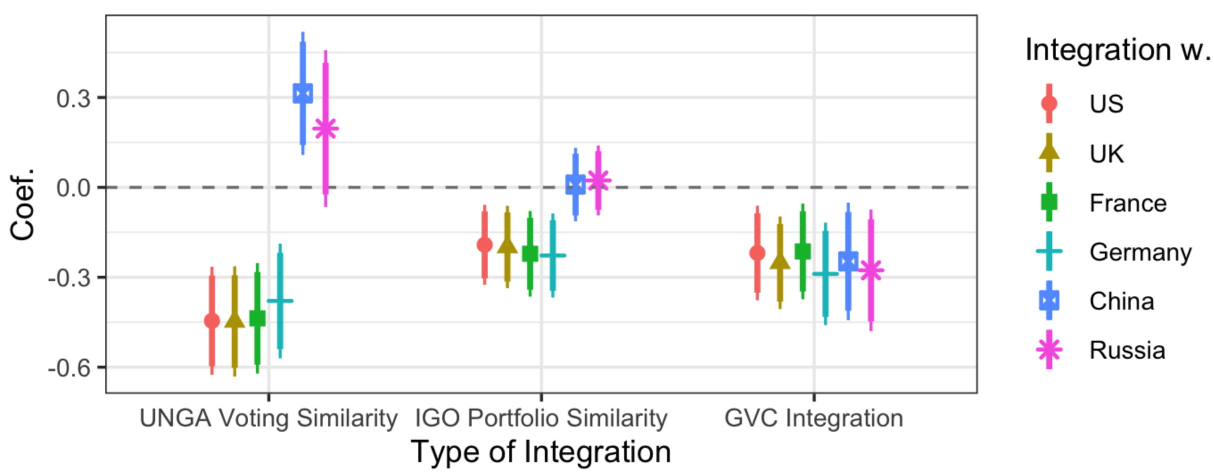

Figure 10: Integration with Powerful Countries

Figure 10 shows the coefficient estimates of β_2 based on the regression specification in Column (3) of Table 1 using DONs reports related to travel as the dependent variable. Regarding the political dimension, the first two columns in Figure 10 show that, using both the ideological and the behavioral measures, the increase in reporting induced by the IHR reform is specific to countries less integrated with the US and its allies, not those less integrated with China or Russia. Given outbreak responses as the enforcement mechanism, such heterogeneity concerning different anchors as the center of the international community suggests that non-allies of major Western powers are facing stronger border restrictions. Hence, the WHO has greater constraining power over these countries' reporting behavior after the IHR reform.

These results add to our understanding of IOs in two aspects. First, they reveal an indirect form of influence that major Western powers have in the WHO. More specifically, located in a more central position in the interdependent world system, Western powers can benefit from the heterogeneous effect of information dissemination by IOs to make politically isolated states cooperate more. Hence, the existing interdependent structure in the international system is a new mechanism of how powerful states can exert indirect influence in IOs (Stone, 2011; Carnegie and Carson, 2019; Clark and Dolan, 2020; Davis, 2023).

Second, these results contradict the conventional wisdom that independence in IOs reduces the influence of powerful actors (Abbott and Snidal, 1998; Hawkins et al., 2006). The presence of the indirect influence of powerful actors at the WHO shows that delegating the authority of information dissemination to IOs may instead enhance the influence of powerful states.

The last column in Figure 10 examines economic integration. The results show that the IHR reform increased the outbreak reporting by states that were not integrated with all these six countries through GVCs. The results related to economic integration differ from those of political integration because all these six countries were among the countries with the deepest GVC integration with other countries, making all of them more central in the global economic system.

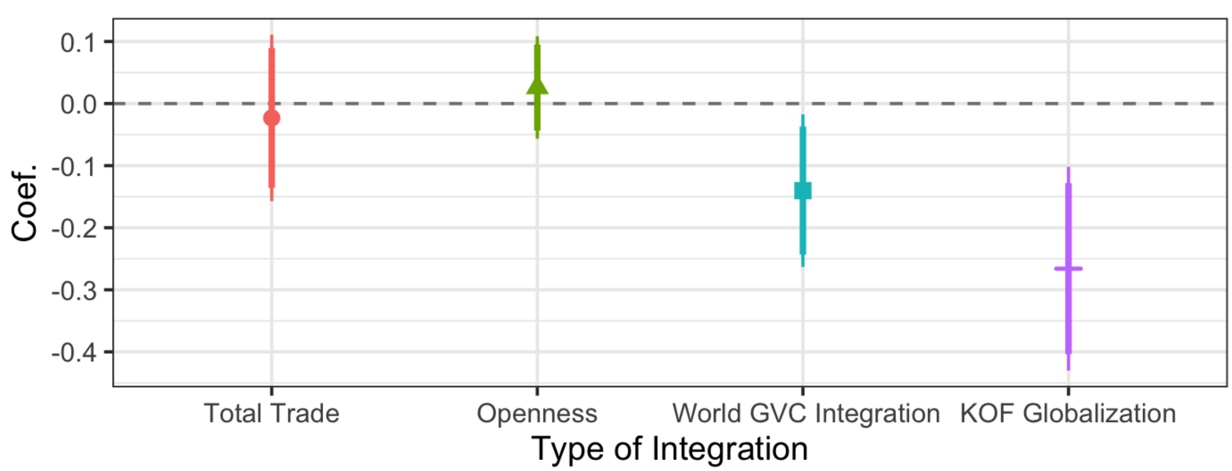

Figure 11: Integration with the World

Last, I conduct a similar test using different types of economic integration with the world to examine further what type of economic integration matters. I consider states' dependence on the world economy measured by total trade volume and openness. I also examine a state's interdependence with the global system, which is measured by GVC integration with the world and the KOF globalization index (Gygli et al., 2019). Figure 11 presents the coefficient estimates of β_2. There is no consistent or significant pattern for economic dependence, suggesting that economic dependence may not be necessary for triggering outbreak responses as the enforcement mechanism. Regarding economic interdependence, we find statistically negative coefficient estimates. States with low interdependence became more forthcoming after the reform, revealing the critical role of interdependence in shaping heterogeneous outbreak responses.

6 Conclusion

Information provision by IOs induces state cooperation, especially for those politically misaligned with major Western powers. I examine the role of the WHO in facilitating state cooperation with outbreak reporting. Information dissemination about disease outbreaks may trigger border restrictions. Hence, states with disease outbreaks have incentives to withhold outbreak information. Once authorized to disseminate information to its members, the WHO could leverage outbreak responses as ex-post cost on disease concealment. More importantly, in an interdependent world system, information dissemination by the WHO triggers heterogeneous outbreak responses, with integrated states receiving more resources and facing fewer bans. Hence, the WHO can use information dissemination to trigger stronger enforcement on isolated states, deterring their concealment attempts.

I show that the IHR reform increased the reporting from states with isolated from the US. Additionally, the increase in cooperation is specific to countries politically misaligned with the US and its allies, suggesting that the existing interdependence structure determines the scope that information dissemination can empower the WHO. Such scope is where powerful countries gains indirect influence in IOs.

Why did countries less integrated with the US and its allies agree to the IHR reform? As the IHR reform forces these states to change their behavior and become more cooperative, they may have had incentives to withdraw from the WHO. Two reasons may explain the absence of withdrawals. One is reciprocity. Given the risk of future disease outbreaks in other countries, states with shallow integration with the US expect other countries to share information with the WHO (Fidler, 2005, 377), which generates long-term benefits of disease outbreak containment and may compensate for the short-term costs of cooperation. The second reason is the lack of exit options. In addition to its role in infectious disease surveillance, the WHO plays an important role in harmonizing medical standards and health-related research. As the overall benefits of being a member of the WHO may exceed the costs of the IHR reform, isolated states may choose to stay even though the IHR reform requires more cooperation from them.

Despite these optimistic findings, deeper cooperation comes at the cost of greater politicization at the WHO. The political dimension of the heterogeneous effects of the IHR reform may generate tensions among member states with different ideologies, which makes the WHO—a technical IO with a neutral stance—an arena where powerful states can shape the international order in their favor. This may explain why the WHO is faced with increasing criticism for its collaboration with the Chinese government during the Covid outbreak. Understanding the political tension created by the IHR reform will be crucial for the next round of the IHR reform and the negotiation over a pandemic treaty in the post-Covid era.

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A Appendix

Contents

A.1 Model Equilibrium and the Proof

The equilibrium concept is weak Perfect Bayesian Equilibrium (wPBE), which requires that (1) each actor's action at each decision node is sequentially rational given the belief at that decision node and the strategy of other actors, and (2) beliefs are updated based on Bayes' rule and the strategy profile whenever possible. I begin by stating some general properties that hold in any wPBE of the game.

Lemma 1. *Define C's posterior belief about θ as $\mu = Pr(\theta = 1|r_L, r_A)$. C's best response, given the belief at each decision node, is $m(\mu) = \frac{\mu(1+\alpha)}{\gamma}$ and $b(\mu) = max\{\frac{\mu - \alpha}{\lambda}, 0\}$*

Proof. Given C's posterior belief about θ, we know that $EU_C(m, b|\mu) = -\mu(1+\alpha)(1-m) + \mu b - \alpha b - \frac{\gamma m^2}{2} - \frac{\lambda b^2}{2} - \varepsilon_m - \varepsilon_b$

F.O.C. w.r.t. m and b, we obtain $m(\mu) = \frac{\mu(1+\alpha)}{\gamma}$ and $b(\mu) = max\{\frac{\mu - \alpha}{\lambda}, 0\}$

□

Lemma 1 characterizes C's best responses as a function of its posterior belief about θ. C's responses to disease outbreaks depend on its integration with L. As L's integration with C deepens, C is likely to provide more resources and impose fewer restrictive measures. This is because restrictive measures like trade and travel bans have two effects. One is to constrain the virus movement across country borders. Meanwhile, they also cause disruptions in the countries that impose the bans, especially when the ban imposing country has intense cross-border activities with the outbreak country.

Lemma 2. *Using the property of weak dominance, we can eliminate certain actions of L and A. If $\theta = 0$, $r_L = 0$ and $r_A = 0$. If $\theta = 1$, L does not have incentives to increase C's belief that $\theta = 1$ when $\alpha < \frac{\gamma - \lambda}{\lambda}$, while it is always in A's interest to do so.*

Proof. Given C's best response, L and A's expected utility are

$$EU_L(r_L|\theta) = -\theta(1 - \frac{\mu(1+\alpha)}{\gamma}) - max\{\frac{\mu - \alpha}{\lambda}, 0\} - \epsilon \mathbb{1}\{r_L \neq r_A\}$$

$$EU_A(r_A|\theta, r_L) = -\theta(1 - \frac{\mu(1+\alpha)}{\gamma} - max\{\frac{\mu - \alpha}{\lambda}, 0\}) - p\mathbb{1}\{r_L \neq r_A\}$$

When $\theta = 0$, we know that $\frac{dEU_L(r_L|\theta)}{d\mu} \leq 0$ and $\frac{dEU_A(r_A|\theta, r_L)}{d\mu} = 0$. This suggests that when $\theta = 0$, neither L nor A can benefit from increasing C's belief that $\theta = 1$. Neither L nor A has incentives to report an outbreak when there is none. As such, by the property of weak dominance, we have $r_L(\theta = 0) = 0$ and $r_A(\theta = 0, r_L) = 0$.

When $\theta = 1$, we know that $\frac{dEU_L(r_L|\theta)}{d\mu} = \begin{cases} \frac{1+\alpha}{\gamma} - \frac{1}{\lambda} & \text{if } \mu > \alpha \\ \frac{1+\alpha}{\gamma} & \text{if } \mu \leq \alpha \end{cases}$ and $\frac{dEU_A(r_A|\theta, r_L)}{d\mu} > 0$. Hence, it is always in A's incentives to increase C's belief that $\theta = 1$. However, it is only in L's incentives to do so when $\alpha \geq \frac{\gamma - \lambda}{\lambda}$. When $\alpha < \frac{\gamma - \lambda}{\lambda}$, L has incentives to conceal the outbreak from C. □

Lemma 2 states that any outbreak reporting by either L or A comes from the cases when $\theta = 1$. As such, it is reasonable to assume C's belief about θ whenever off the path of play to be 1 if $r_L = 1$ or $r_A = 1$.[25]

Given this restriction on off-path beliefs, the following proposition summarizes the equilibrium of the model.

Proposition 1. *Let* $\alpha^* = \frac{\gamma - \lambda}{\gamma + \lambda}$.

1. *When* $\alpha \geq \alpha^*$ *and* $p \geq \frac{1+\alpha}{\gamma} + \frac{1-\alpha}{\lambda}$,

   L's reporting strategy is $r_L = \theta$.

[25]See Banks (2001).

$$A\text{'s reporting strategy is } r_A = \begin{cases} 1 & \text{if } \theta = 1, r_L = 1; \text{ or } \theta = 0, r_L = 1 \\ 0 & \text{if } \theta = 1, r_L = 0; \text{ or } \theta = 0, r_L = 0 \end{cases}.$$

$$C\text{'s outbreak responses are } m = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1+\alpha}{\gamma} & \text{Otherwise} \end{cases} \text{ and } b = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1-\alpha}{\lambda} & \text{Otherwise} \end{cases}.$$

$$C \text{ forms its belief about the outbreak severity } \begin{cases} Pr(\theta = 1 | r_L = 1, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 1, r_A = 0) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 0) = 0 \end{cases}.$$

2. *When* $\alpha \geq \alpha^*$ *and* $p < \dfrac{1+\alpha}{\gamma} + \dfrac{1-\alpha}{\lambda}$,

   L's reporting strategy is $r_L = \theta$.

$$A\text{'s reporting strategy is } r_A = \begin{cases} 1 & \text{if } \theta = 1, r_L = 1; \text{ or } \theta = 0, r_L = 1; \text{ or } \theta = 1, r_L = 0 \\ 0 & \text{if } \theta = 0, r_L = 0 \end{cases}.$$

$$C\text{'s outbreak responses are } m = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1+\alpha}{\gamma} & \text{Otherwise} \end{cases} \text{ and } b = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1-\alpha}{\lambda} & \text{Otherwise} \end{cases}.$$

$$C \text{ forms its belief about the outbreak severity } \begin{cases} Pr(\theta = 1 | r_L = 1, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 1, r_A = 0) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 0) = 0 \end{cases}.$$

3. *When* $\alpha < \alpha^*$ *and* $p \geq \dfrac{1+\alpha}{\gamma} + \dfrac{1-\alpha}{\lambda}$,

   L's reporting strategy is $r_L = 0$.

$$A\text{'s reporting strategy is } r_A = \begin{cases} 1 & \text{if } \theta = 1, r_L = 1; \text{ or } \theta = 0, r_L = 1 \\ 0 & \text{if } \theta = 1, r_L = 0; \text{ or } \theta = 0, r_L = 0 \end{cases}.$$

$$C\text{'s outbreak responses are } m = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \frac{1+\alpha}{\gamma} & \text{Otherwise} \end{cases} \text{ and } b = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \frac{1-\alpha}{\lambda} & \text{Otherwise} \end{cases}.$$

$$C \text{ forms its belief about the outbreak severity } \begin{cases} Pr(\theta = 1 | r_L = 1, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 1, r_A = 0) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 0) = \psi \end{cases}.$$

4. *When* $\alpha < \alpha^*$ *and* $p < \frac{1+\alpha}{\gamma} + \frac{1-\alpha}{\lambda}$,

   L's reporting strategy is $r_L = \theta$.

$$A\text{'s reporting strategy is } r_A = \begin{cases} 1 & \text{if } \theta = 1, r_L = 1; \text{ or } \theta = 0, r_L = 1; \text{ or } \theta = 1, r_L = 0 \\ 0 & \text{if } \theta = 0, r_L = 0 \end{cases}.$$

$$C\text{'s outbreak responses are } m = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \frac{1+\alpha}{\gamma} & \text{Otherwise} \end{cases} \text{ and } b = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \frac{1-\alpha}{\lambda} & \text{Otherwise} \end{cases}.$$

$$C \text{ forms its belief about the outbreak severity } \begin{cases} Pr(\theta = 1 | r_L = 1, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 1, r_A = 0) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 1) = 1 \\ Pr(\theta = 1 | r_L = 0, r_A = 0) = 0 \end{cases}.$$

Proof. From Lemma 2, we know that on the path of play, $r_L(\theta = 0) = 0$ and $r_A(\theta = 0, r_L = 0) = 0$. We can also infer from A's utility function that $r_A(\theta = 0, r_L = 1) = 1$.

Case 1 $\alpha \geq \alpha^*$ and $p \geq \dfrac{1+\alpha}{\gamma} + \dfrac{1-\alpha}{\lambda}$

Based on Bayes' rule, $Pr(\theta = 1|r_L = 1, r_A = 1) = 1$ and $Pr(\theta = 1|r_L = 0, r_A = 0) = 0$. According to the restrictions on C's off-path belief, $Pr(\theta = 1|r_L = 1, r_A = 0) = 1$ and $Pr(\theta = 1|r_L = 0, r_A = 1) = 1$. Hence, C's best responses are $m = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1+\alpha}{\gamma} & \text{Otherwise} \end{cases}$ and $b = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1-\alpha}{\lambda} & \text{Otherwise} \end{cases}$.

To simplify the notation, for the rest of the proof, let $m^* = \dfrac{1+\alpha}{\gamma}$ and $b^* = \dfrac{1-\alpha}{\lambda}$.

L does not have incentives to deviate because $EU_L(r_L = 1|\theta = 1) = -(1 - m^*) - b^* > -1 = EU_L(r_L = 0|\theta = 1) = -1$

A has no incentives to deviate because

$$\begin{cases} EU_A(r_A = 1|\theta = 1, r_L = 1) = -(1 - m^* - b^*) > -1 - p = EU_A(r_A = 0|\theta = 1, r_L = 1) \\ EU_A(r_A = 1|\theta = 1, r_L = 0) = -1(1 - m^* - b^*) - p < -1 = EU_A(r_A = 0|\theta = 1, r_L = 0) \end{cases}$$

Case 2 $\alpha \geq \alpha^*$ and $p < \dfrac{1+\alpha}{\gamma} + \dfrac{1-\alpha}{\lambda}$

Based on Bayes' rule, $Pr(\theta = 1|r_L = 1, r_A = 1) = 1$ and $Pr(\theta = 1|r_L = 0, r_A = 0) = 0$. The off-path beliefs are $Pr(\theta = 1|r_L = 1, r_A = 0) = 1$ and $Pr(\theta = 1|r_L = 0, r_A = 1) = 1$. As such, C has the same best responses as in Case 1.

L has no incentives to deviate because $EU_L(r_L = 1|\theta = 1) = -(1 - m^*) - b^* > -(1 - m^*) - b^* - \epsilon = EU_L(r_L = 0|\theta = 1)$

A has no incentives to deviate because $EU_A(r_A = 1|\theta = 1, r_L = 0) = -1(1 - m^* - b^*) - p > -1 = EU_A(r_A = 0|\theta = 1, r_L = 0)$

Case 3 $\alpha < \alpha^*$ and $p \geq \dfrac{1+\alpha}{\gamma} + \dfrac{1-\alpha}{\lambda}$

Based on Bayes' rule, $Pr(\theta = 1|r_L = 0, r_A = 0) = \psi$. The off-path beliefs are $Pr(\theta = 1|r_L = 1, r_A = 0) = 1$, $Pr(\theta = 1|r_L = 0, r_A = 1) = 1$, and $Pr(\theta = 1|r_L = 1, r_A = 1) = 1$. To ensure a connor solution in C's responses when $r_L = r_A = 0$, we need to impose restrictions on the administrative costs ε_m and ε_b, which requires the following conditions

$$\begin{cases} EU_C(m^*, b^*|\mu = 1) > EU_C(m = 0, b = 0|\mu = 1) \\ EU_C(m(\mu = \psi), b(\mu = \psi)|\mu = \psi) < EU_C(m = 0, b = 0|\mu = \psi) \end{cases}$$

where $\mu = Pr(\theta = 1|r_L, r_A)$ is the posterior belief.

Hence, we have $\begin{cases} \varepsilon_m + \varepsilon_b < (1+\alpha)m^* + (1-\alpha)b^* - \frac{\gamma}{2}m^{*2} - \frac{\lambda}{2}b^{*2} \\ \varepsilon_m + \varepsilon_b > \psi(1+\alpha)m(\psi) + (\psi - \alpha)b(\psi) - \frac{\gamma}{2}m^2(\psi) - \frac{\lambda}{2}b^2(\psi) \end{cases}$

With $\begin{cases} m^* = \dfrac{1+\alpha}{\gamma} \\ b^* = \dfrac{1-\alpha}{\lambda} \end{cases}$ and $\begin{cases} m(\psi) = \dfrac{\psi(1+\alpha)}{\gamma} \\ b(\psi) = \dfrac{\psi - \alpha}{\lambda} \end{cases}$, we have

$$\begin{cases} \varepsilon_m + \varepsilon_b < \dfrac{(1+\alpha)^2}{2\gamma} + \dfrac{(1-\alpha)^2}{2\lambda} \\ \varepsilon_m + \varepsilon_b > \dfrac{\psi^2(1+\alpha)^2}{2\gamma} + \dfrac{(\psi-\alpha)^2}{2\lambda} & \text{if } \alpha \leq \psi \\ \varepsilon_m > \dfrac{\psi^2(1+\alpha)^2}{2\gamma} & \text{if } \alpha > \psi \end{cases}$$

With $min(\frac{(1+\alpha)^2}{2\gamma} + \frac{(1-\alpha)^2}{2\lambda}) = \frac{\gamma+\lambda}{2\sqrt{\gamma\lambda}}$, we have $\varepsilon_m + \varepsilon_b < \frac{\gamma+\lambda}{2\sqrt{\gamma\lambda}}$.

Given that $\alpha \leq \psi$, $max(\frac{\psi^2(1+\alpha)^2}{2\gamma} + \frac{(\psi-\alpha)^2}{2\lambda}) = max\{\frac{\gamma+\lambda}{2\gamma\lambda}\psi^2, \frac{(1+\psi)^2}{2\gamma}\} = \frac{(1+\psi)^2}{2\gamma}$. Hence, $\varepsilon_m + \varepsilon_b > \frac{(1+\psi)^2}{2\gamma}$.

Given that $\alpha > \psi$, $max(\frac{\psi^2(1+\alpha)^2}{2\gamma}) = \frac{2\psi^2}{\gamma}$. Hence, $\varepsilon_m > \frac{2\psi^2}{\gamma}$.

Therefore, we need $\frac{(1+\psi)^2}{2\gamma} < \varepsilon_m + \varepsilon_b < \frac{\gamma+\lambda}{2\sqrt{\gamma\lambda}}$, $\varepsilon_m > \frac{2\psi^2}{\gamma}$, and $\psi < (\frac{\gamma(\gamma+\lambda)^2}{\lambda})^{\frac{1}{4}} - 1$ to support C's best responses $m = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1+\alpha}{\gamma} & \text{Otherwise} \end{cases}$ and $b = \begin{cases} 0 & \text{if } r_L = r_A = 0 \\ \dfrac{1-\alpha}{\lambda} & \text{Otherwise} \end{cases}$.

L has no incentives to deviate because $EU_L(r_L = 1|\theta = 1) = -(1 - m^*) - b^* < -1 = EU_L(r_L = 0|\theta = 1)$

A has no incentives to deviate because

$$\begin{cases} EU_A(r_A = 1|\theta = 1, r_L = 1) = -(1 - m^* - b^*) > -1 - p = EU_A(r_A = 0|\theta = 1, r_L = 1) \\ EU_A(r_A = 1|\theta = 1, r_L = 0) = -1(1 - m^* - b^*) - p < -1 = EU_A(r_A = 0|\theta = 1, r_L = 0) \end{cases}$$

Case 4 $\alpha < \alpha^*$ and $p < \dfrac{1+\alpha}{\gamma} + \dfrac{1-\alpha}{\lambda}$

Based on Bayes' rule, $Pr(\theta = 1|r_L = 1, r_A = 1) = 1$ and $Pr(\theta = 1|r_L = 0, r_A = 0) = 0$. The off-path beliefs are $Pr(\theta = 1|r_L = 1, r_A = 0) = 1$ and $Pr(\theta = 1|r_L = 0, r_A = 1) = 1$. As such, C has the same best responses as in Case 1 and 2.

L has no incentives to deviate because $EU_L(r_L = 1|\theta = 1) = -(1 - m^*) - b^* > -(1 - m^*) - b^* - \epsilon = EU_L(r_L = 0|\theta = 1)$

A has no incentives to deviate because

$$\begin{cases} EU_A(r_A = 1|\theta = 1, r_L = 1) = -(1 - m^* - b^*) > -1 - p = EU_A(r_A = 0|\theta = 1, r_L = 1) \\ EU_A(r_A = 1|\theta = 1, r_L = 0) = -(1 - m^* - b^*) - p > -1 = EU_A(r_A = 0|\theta = 1, r_L = 0) \end{cases}$$

□

A.2 How Does Integration Shape Border Restrictions?

One of the key propositions in the model is that a country's integration level with the international community determines the amount of resources and bans this country faces upon disease outbreaks, illustrated in Figure 4. This section empirically examines whether integration between two countries affects ban imposition.[26]

[26] It is empirically challenging to examine the resource aspect of the proposition because a good proportion of global health responses take the form of military aid (Michaud et al., 2019), making it impossible to

COVID-19 pandemic provides a unique empirical environment to examine the proposition from the ban imposition perspective. First, since every country experienced COVID-19 cases between 2020 and 2021, this allows us to have a relatively similar benchmark of disease environment. In contrast, only a subset of countries experience infected cases for other disease outbreaks. As such, we can only examine ban imposition on these countries as the target, which may bias the results, especially when certain countries are more likely to face disease outbreaks. Second, multiple institutions and research groups invested great efforts in data collection on COVID-related policies.[27] For other disease outbreaks, there do not exist as comprehensive data sources to examine the proposition.

Among all the data sets on COVID-related policies, I use the COVID Border Accountability Project (COBAP) (Shiraef et al., 2021) for the following reasons. First, COBAP is directly related to border restrictions, while other data sets contain domestic policies and may increase the probability of coding errors if the coder mixes domestic policies with international ones.[28] COBAP has two categories of border restrictions: complete closure and partial closure. Complete closure refers to policies where all newcomers are banned from all ports of entry—air, land, and sea—with limited exceptions. Partial closure restricts access to specific groups of people based on their citizenship, travel history, visa application, or types of border entry, such as air, land, or sea. Second, the COBAP dataset has relatively straightforward information on the target of border restrictions. This allows me to create a

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measure the amount of aid given to the target country.

[27]The available data sources include COVID Border Accountability Project (https://covidborderaccountability.org/), CoronaNet (https://www.coronanet-project.org/index.html), WHO's Public Health and Social Measures (PHSMs) dataset (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/phsm), Citizenship, Migration and Mobility in a Pandemic (CMMP) (https://cadmus.eui.eu/handle/1814/68359), ACAPS (https://www.acaps.org/), among others.

[28]This is the case for CoronaNet dataset.

directed dyad dataset to examine how the integration level between a dyad affects border restrictions.

To code the border restriction variable, I take a conservative approach and create a binary variable of whether the initiator country has imposed a certain type of border restriction on the target country in 2020 and 2021. Although the COBAP dataset contains information on the start and end dates of a policy, there are coding errors and missing data issues with the end dates of a policy. In addition, when there is a policy change, it is unclear how to quantify it. Hence, a binary variable indicating the existence of a certain type of border restriction can tolerate such data coding concerns and reduce measurement errors in the dataset.

There are four types of border restrictions. First, border closure refers to the restrictions on travel through a specified land, sea, or air border. Second, visa-based ban refers to restrictions on new visa applications. Third, a citizenship-based ban refers to bans against foreign nationals from a specified country. Lastly, travel-based restrictions ban travelers recently traveling through or from a specified country. In the regression analysis, I first differentiate these different types of restrictions and then create two aggregate levels of measures of border restrictions. The first is the total number of these 4 types of restrictions. The second is a binary variable indicating whether at least one of these types of restrictions exists. Since complete closure refers to bans against all kinds of borders, once a country initiated complete closure, I code all dyads with this initiator as having border closure in the forms of air, land, and sea.[29]

The sample of the analysis is a cross-sectional directed dyad between 2020 and 2021. The key independent variable is an integration z-score index calculated based on the average of the standardized index in three dimensions. To measure political integration, I use the difference in the ideal point estimates based on UNGA voting records between the dyad. To measure economic integration, I use the total trade volume between the dyad. To measure geographic integration, I use the geographic distance between the capital cities of the dyad.

[29]The results are robustly removing complete closures.

To account for characteristics that may affect both the integration level between the dyad and the border restrictions, I control for the gaps in GDP per capita, population, and polity IV between the dyad, and whether the dyad has contingent territory. I also control for initiator fixed effects and target fixed effects to control for the domestic conditions of the initiator and target countries, such as disease severity of both the initiator and target countries, political conditions that may lead to radical responses, and so on. Standard errors are clustered at the initiator and target levels.

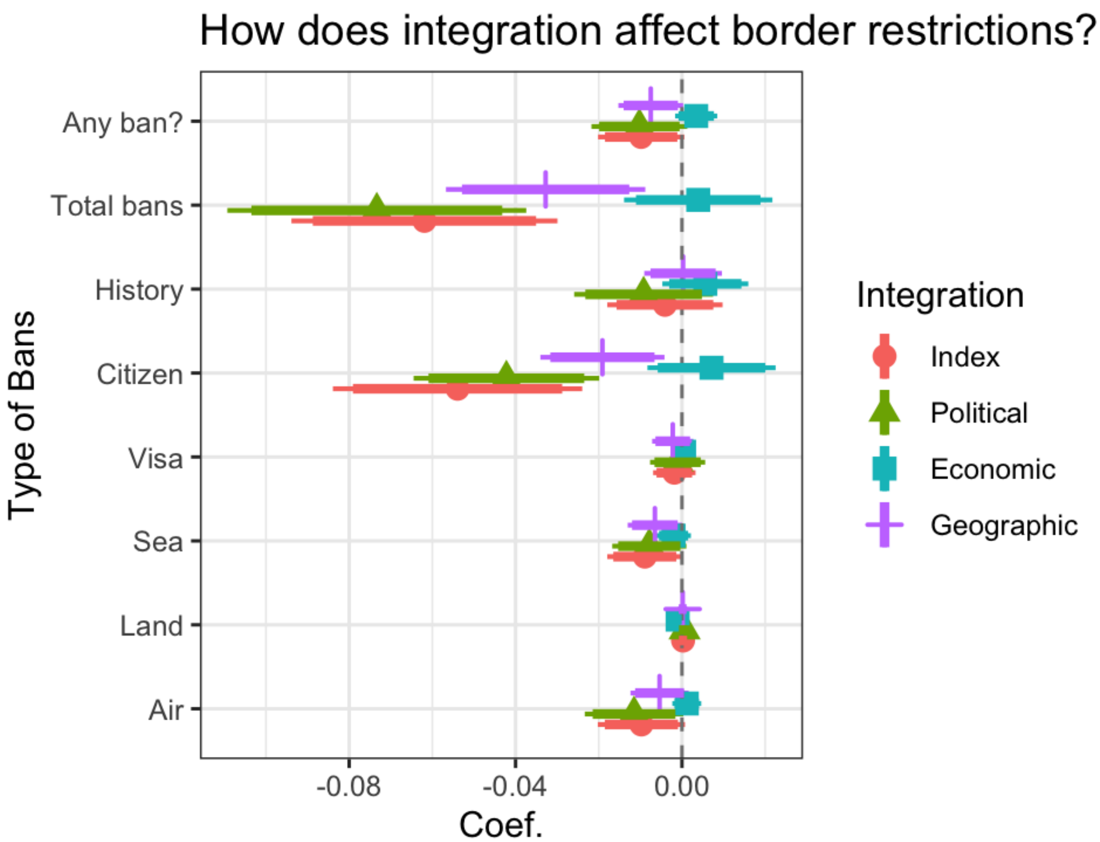

Figure A.1: Integration and Border Restrictions

Figure A.1 shows the coefficient estimates of the analysis. Different colors represent different types of integration. The dependent variable in the first row is whether there is at least one type of border restriction. For the second row, the dependent variable is the total number of border restrictions of different types. The dependent variables in the rest rows are whether a certain type of border restriction existed. We can see that deeper integration between the dyad reduces the probability of border restrictions, especially for the citizenship ban. In addition, the results are mostly driven by political alignment and geographic proximity. Greater trade volume between the dyad seems to increase the probability of border restrictions, but the results are not significant. Overall, these results support the proposition that greater integration reduces the probability of border restrictions.

A.3 DONs Reports and Government Cooperation

This section examines whether the number of DONs reports represents government cooperation. If DONs reports only reflect the cases where the WHO overrides the states and unilaterally disseminates information to the international community, the empirical results would not be consistent with the theory, which suggests that the authority of information dissemination at the WHO deters disease concealment. To address this concern, I looked into how DONs reports were written to see whether the contents help us identify government cooperation.

After reading through the 2,874 DONs reports, I made the following coding decisions. There are 5 cases where a report is coded as from governments. First and most straightforwardly, the report mentions that a governmental department—often the Ministry of Health—provided information about cases of a certain disease. Second, a report mentions the collaboration between the WHO and the local authorities, using phrases like "the WHO is supporting local authorities". In this case, even if the outbreak information does not necessarily come from the government, it is crucial for the government not to deny the cases and actively work with the WHO to deal with the disease outbreak. In that sense, collaboration reflects government cooperation. Third, a report is from the Early Warning Alert and Response System (EWARS) or from the IHR National Focal Point.[30] These are institutional

[30]EWARS Website: https://www.who.int/emergencies/surveillance/early-warning-alert-and-response-system-ewars. IHR National Focal Point Website: https://www.who.int/teams/ihr/national-focal-points.

systems that the WHO established with governments to more efficiently and timely identify potential disease outbreaks. As such, it is reasonable to think that the government is award of the outbreak and does not conceal the outbreak. Fourth, a report mentions national efforts to address the outbreak. For example, for poliovirus outbreaks, a common strategy to control the outbreak is through vaccine campaigns. If a report mentions a nationwide polio vaccine campaign, it is reasonable to think that the government is actively mobilizing efforts to address the outbreak. Last, a report provides outbreak status information of multiple countries. I use th term "collective reporting" to refer to reports on a disease outbreak that involves three or more countries. Such reports are often about a pandemic that spreads to multiple countries and do not necessarily identify the source of information. As it is difficult for governments to hide outbreaks that have spread to multiple countries, it is reasonable to think that the government is cooperating with the WHO. However, as this situation is more ambiguous than other cases, I will conduct regression analyses excluding and including the collective reporting cases.

I treat the rest of the reports as not from the government. In some cases, the report suggests that the WHO is awaiting or seeking confirmation from the government. In other cases, the report does not mention any official entities. Two scenarios may explain such cases. The first case is the absence of state capacity. For example, the disease might be confirmed by Doctors without Borders or the WHO collaborating laboratories in the region. This is common for countries with conflicts or limited resources to conduct laboratory tests. Second, the WHO received the outbreak report from its own source of information. As the WHO needs cooperation from the government to investigate the outbreak further, it is diplomatic to intentionally leave government entities out of the report to avoid tension with the government.

There is one caveat with this coding strategy. It could be the case that different writers have different writing styles. Hence, the way the reports were written does not reflect government behaviors. Still, it is safe to assume that the WHO cannot say that the government provided the information when it was not involved. As such, positive cases imply government cooperation, while there is a chance for negative cases to have omitted government cooperation. Therefore, these coding criteria are a conservative strategy for the robustness check.

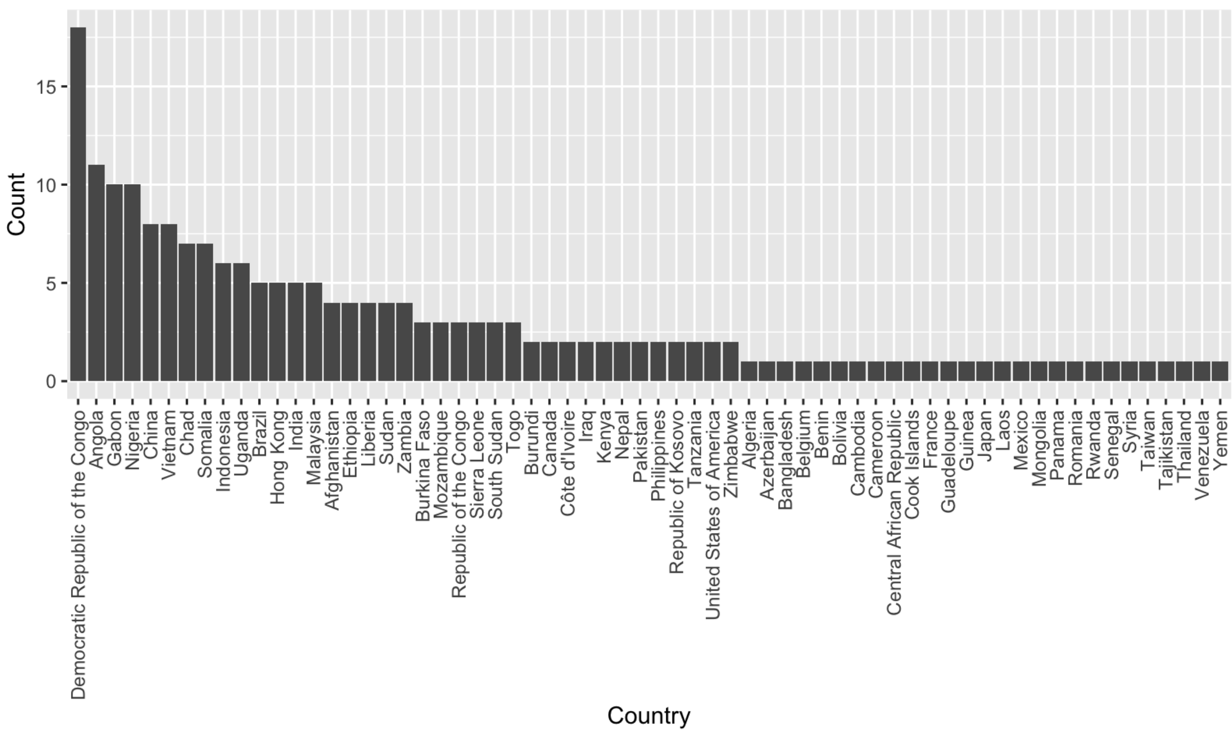

Figure A.2: Countries With Reports Not From the Government

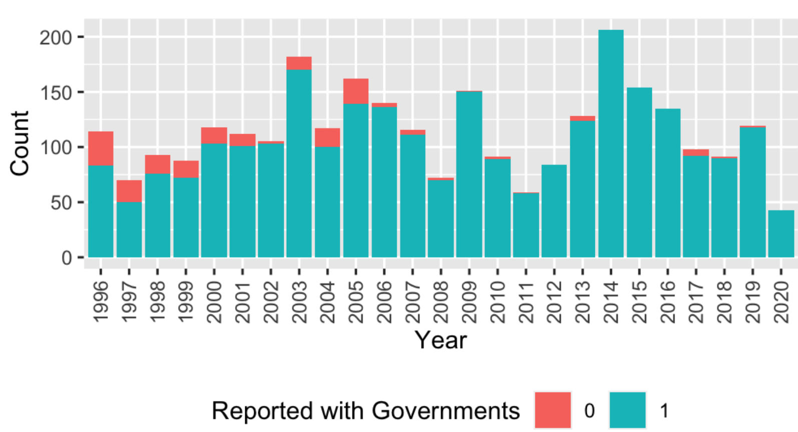

Figure A.3: Proportion of DONs Reports by Government (1996-2020)

After coding all the reports, Figure A.2 shows the countries with reports without any indication of government cooperation. Most countries are developing countries. I then aggregate the reports to the year level. Figure A.3 shows the over-time change in the proportion of DONs reports from and not from governments.[31] The red bars represent the reports without government cooperation, which were more frequent before 2005 and have sharply declined since 2006. This change is consistent with the theory that information dissemination has a deterrence effect on disease concealment. This helps address the concern that the number of DONs reports only measures the information dissemination by the WHO rather than government cooperation.

Table A.1: Robustness Check: DONs Reports by Governments

	Dependent variable:					
	Exclude Collective Reporting			Include Collective Reporting		
	(1)	(2)	(3)	(4)	(5)	(6)
Integration with US	−0.032	−0.032	0.077	0.005	0.010	0.110
	(0.062)	(0.063)	(0.090)	(0.062)	(0.064)	(0.092)
Integration with US * Post2005	−0.062	−0.085	-0.247^{**}	-0.156^{**}	-0.179^{***}	-0.318^{***}
	(0.061)	(0.062)	(0.100)	(0.064)	(0.065)	(0.108)
State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	N	N
State-specific time trend	Y	Y	Y	Y	Y	Y
Control	N	Y	Y	N	Y	Y
Office-Year FE	N	N	Y	N	N	Y
State-specific quadratic time trend	N	N	Y	N	N	Y
Observations	2,922	2,845	2,845	2,922	2,845	2,845
R^2	0.492	0.501	0.661	0.486	0.496	0.658
Adjusted R^2	0.429	0.438	0.576	0.423	0.432	0.572

Note: *p<0.1; **p<0.05; ***p<0.01
Standard error clustered at the country level in parentheses.

To systematically examine how this refined measure of government cooperation affects the results, I remove all the reports without indications of government cooperation and aggregate the rest of the reports to the country-year level. Using the empirical specification in Columns (1) to (3) in Table 1, Table A.1 reports the results. The first three columns exclude collective

[31] Both Figure A.2 and Figure A.3 treat the collective reporting as goverment cooperation.

reporting from reports with government cooperation, while the other three columns include this category.

Excluding collective reporting, the coefficient estimates of the interaction term become weaker compared to Table 1. Still, the coefficient estimate becomes significant after controlling for the regional office-year fixed effects and the country-specific quadratic time trend. The results including collective reporting are consistent with Table 1. Overall, this table suggests that the results in the paper are robust to the measurement concern with the number of DONs reports.

A.4 Figures and Tables

Figure A.4: Number of Disease Outbreak Countries in One Report

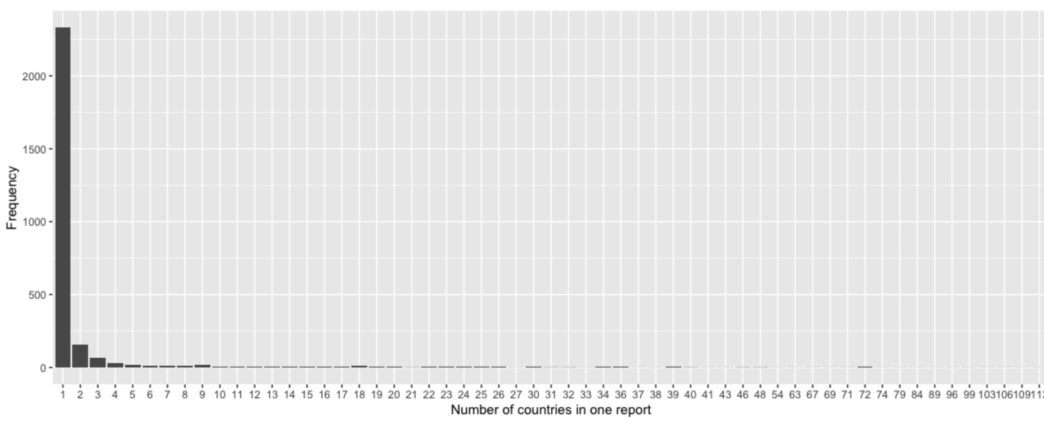

Figure A.5: Share of Countries Being Covered by DONs (1996-2019)

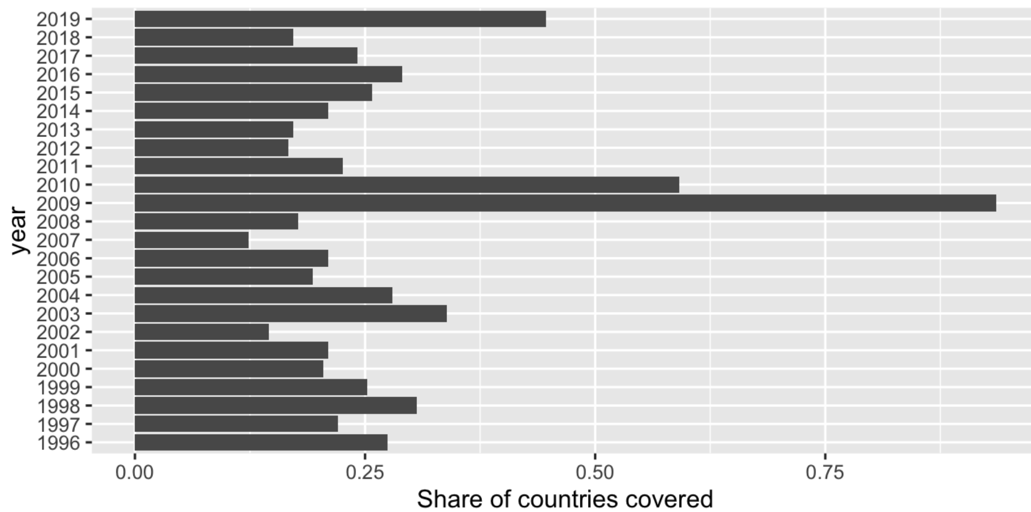

Figure A.6: Most Frequently Reported Countries: Pre 2005 vs. Post 2005

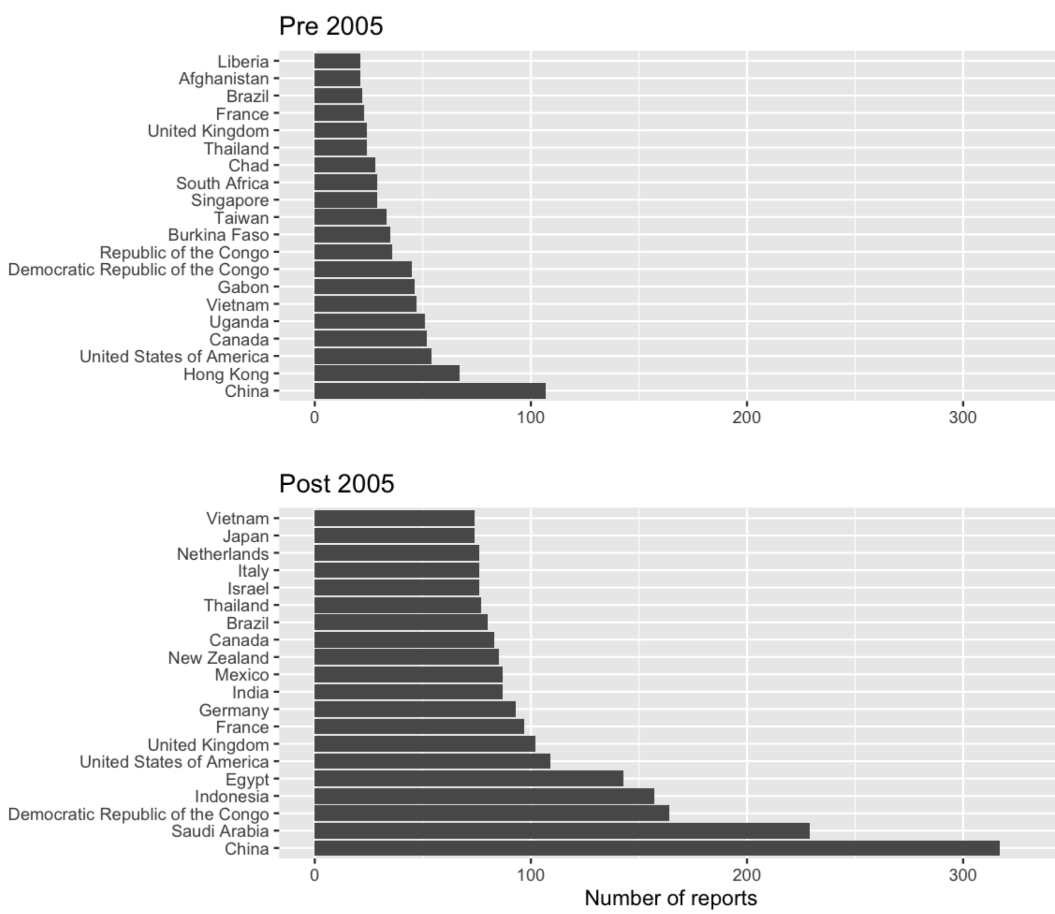

Figure A.7: Jackknife Test

Table A.2: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Median	Max	Data Source
Outcomes							
N. of DONs reports	2,922	2.163	7.485	0	0	75	WHO DONs web page
N. of DONs reports (travel)	2,922	0.828	3.508	0	0	67	WHO DONs web page
N. of DONs reports (the rest)	2,922	1.334	6.601	0	0	73	WHO DONs web page
N. of outbreak events (GIDEON)	2,922	1.743	2.662	0	1	24	GIDEON
Integration (all standardized)							
Integration index (Z-score)	2,922	−0.052	0.958	−2.649	−0.287	3.088	
Ideal point proximity to US	2,922	−0.052	0.958	−2.649	−0.287	3.088	Bailey et al. (2017)
Imports from US	2,922	0.198	0.734	−4.541	0.201	1.783	UN Comtrade
Seats on direct flights to US	2,922	0.143	1.020	−0.885	0.016	1.788	US Department of Transportation
IGO portfolio similarity with US	2,902	0.038	0.970	−1.959	−0.062	2.041	Voeten (2021)
GVC integration with US	2,612	0.138	0.966	−1.791	0.132	2.420	UNCTAD-Eora Global Value Chain Database
Total trade with world	2,922	0.172	0.886	−1.914	0.469	1.071	US Department of Transportation
GVC integration with world	2,845	0.048	1.021	−2.890	0.184	1.591	UNCTAD-Eora Global Value Chain Database
Openness	2,922	0.063	1.003	−1.237	−0.080	7.000	UN Comtrade & World Bank WDI Database
KOF globalization index	2,922	0.061	1.009	−2.183	−0.006	2.169	Gygli et al. (2019)
Other controls							
Polity IV	2,922	3.624	6.294	−10	6	10	Center for Systemic Peace
HRV transparency index	2,922	0.389	0.965	−0.901	1.105	1.126	Hollyer et al. (2014)
UNSC membership	2,922	0.094	0.292	0	0	1	Dreher et al. (2009a)
log(1+GDP per capita)	2,922	8.296	1.512	5.218	8.216	11.425	World Bank WDI Database
log(total population)	2,922	16.163	1.523	12.792	16.118	21.034	World Bank WDI Database
IMF participation	2,922	0.332	0.471	0	0	1	Replication file from Clark and Dolan (2020)

Table A.3: Integration with US and Disease Outbreak Reports/Events

	Dependent variable:		
	log(1 + DONs reports)		
	(1)	(2)	(3)
Integration with US	−0.004	0.001	0.093
	(0.062)	(0.065)	(0.093)
Integration with US * Post2005	−0.162**	−0.187***	−0.323***
	(0.065)	(0.065)	(0.110)
log(1 + Outbreak Events)	0.128***	0.122***	0.119***
	(0.035)	(0.036)	(0.035)
State FE	Y	Y	Y
Year FE	Y	Y	Y
State-specific time trend	Y	Y	Y
Control	N	Y	Y
Office-Year FE	N	N	Y
State-specific quadratic time trend	N	N	Y
Observations	2,922	2,845	2,845
R^2	0.490	0.499	0.660
Adjusted R^2	0.427	0.435	0.573

Note: *p<0.1; **p<0.05; ***p<0.01
Standard error clustered at the country level in parentheses.

Table A.4: Robustness Check: Polity IV and HRV Transparency Index

	Dependent variable:			
	log(1 + DONs reports) (Travel-Related)			
	(1)	(2)	(3)	(4)
Integration with US (Z-score)		0.227**		0.173*
		(0.092)		(0.088)
Integration with US (Z-score) * Post2005		−0.504***		−0.413***
		(0.111)		(0.094)
Standardized Polity IV	0.060	0.028	0.046	0.078
	(0.065)	(0.065)	(0.062)	(0.060)
Standardized Polity IV * Post2005	−0.017	0.119*		
	(0.058)	(0.065)		
Standardized HRV			0.071	−0.004
			(0.077)	(0.079)
Standardized HRV * Post2005			−0.101*	−0.030
			(0.057)	(0.058)
Control	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y
Observations	2,954	2,922	2,954	2,922
R^2	0.480	0.495	0.481	0.494
Adjusted R^2	0.352	0.368	0.353	0.366

Note: *p<0.1; **p<0.05; ***p<0.01
Standard error clustered at the country level in parentheses.

Table A.5: Robustness Check: Health Capacity

	Dependent variable:			
	log(1 + DONs reports) (Travel-Related)			
	(1)	(2)	(3)	(4)
Integration with US (Z-score)		0.054		0.233*
		(0.138)		(0.119)
Integration with US (Z-score) * Post2005		−0.236*		−0.571***
		(0.123)		(0.102)
Standardized basic sanitation services	−3.911	−4.097		
	(3.749)	(3.855)		
Standardized basic sanitation services * Post2005	−0.210**	−0.186**		
	(0.084)	(0.076)		
Standardized hospital bed			0.161	0.140
			(0.104)	(0.099)
Standardized hospital bed * Post2005			−0.120	−0.145
			(0.104)	(0.089)
Control	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y
Observations	2,162	2,148	1,564	1,558
R^2	0.570	0.576	0.629	0.652
Adjusted R^2	0.427	0.433	0.439	0.472
Note:	*p<0.1; **p<0.05; ***p<0.01			
	Standard error clustered at the country level in parentheses.			

Table A.6: Exclude China and Saudi Arabia from the Sample

	Dependent variable:		
	log(1 + DONs reports) (Travel-Related)		
	Exclude China	Exclude Saudi Arabia	Exclude Both
	(1)	(2)	(3)
Integration with US (Z-score)	−0.036	−0.056	−0.060
	(0.098)	(0.094)	(0.095)
Integration with US (Z-score) * Post2005	−0.226***	−0.216***	−0.212***
	(0.076)	(0.076)	(0.076)
Control	Y	Y	Y
State FE	Y	Y	Y
Office-Year FE	Y	Y	Y
State-specific time trend	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y
Observations	2,902	2,902	2,882
R^2	0.471	0.482	0.461
Adjusted R^2	0.338	0.352	0.325
Note:	*p<0.1; **p<0.05; ***p<0.01		
	Standard error clustered at the country level in parentheses.		

References for Appendix

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