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.

Keywords: global health governance; international organizations; information; interdependence

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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. With its strengthened capacity to detect global health emergencies (Davies, 2012a), the WHO is responsible for monitoring public health emergencies and relies on states' disclosure of the status of a disease outbreak to prescribe the appropriate policy recommendation. However, states are often reluctant to share outbreak information for fear of the costly border restrictions imposed by other states (Carnegie and Carson, 2020). Delayed reporting is prevalent (Worsnop, 2019).

To address this concealment problem, the WHO reformed the International Health Regulations (IHR), an agreement among its members to address global health security, which granted the WHO the authority to disseminate outbreak information without waiting for states to confirm first. Before the reform, even if it was aware of the outbreak, the WHO could not alert its members to disease outbreaks without the outbreak country's consent.

I developed a formal model to investigate how this strengthened authority affects states' strategic incentives to disclose disease outbreaks. In an interdependent global system, disease outbreaks may directly spread to other countries and indirectly disrupt their political and economic activities (Zhang, 2022; Antràs et al., 2023). To minimize such damages, other countries can provide resources to mitigate the disease spread and impose bans to shut the virus out of their territories. When the outbreak state is 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, integrated states tend to receive more resources and face fewer bans.

As such, a state's willingness to disclose is shaped by its integration with other states. Integrated states proactively report disease outbreaks to benefit from the resource provision without the concern for border restrictions. For isolated states, information dissemination of disease outbreaks only triggers strong border restrictions without material support, discouraging the outbreak reporting. When the WHO has greater authority over information dissemination, isolated states become forthcoming with outbreaks because they anticipate costly border restrictions even if they conceal. Hence, the IHR reform induced the outbreak reporting from isolated states.

Using the number of Disease Outbreak News (DONs) reports to measure state cooperation with disease outbreak reporting and states' isolation from the US to proxy for interdependence with the world, I compare the number of reports from isolated and integrated states before and after the reform. I find increased reporting by isolated states after the IHR reform. Additional analyses examine states' integration with different major powerful countries in the world and reveal that the increase in reporting 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, revealing an indirect form of influence that major Western powers have in IOs.

These findings have two contributions. While it is commonly recognized that information provision by IOs contributes to deeper cooperation by states (Keohane, 1984; Fang and Stone, 2012; Dai, 2005; Kelley and Simmons, 2015, 2020; Koliev et al., 2021), 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 show that interdependence among states moderates the effect of IO information on state cooperation, leading to more cooperation from isolated states, especially on the dimension of political alignment.

Such heterogeneity adds to our understanding of hegemonic power (Lake, 2009; Vreeland and Dreher, 2012; Dreher et al., 2022; Vreeland, 2019). Previous studies show that the US influences 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 preferences (Clark and Dolan, 2020), and membership selection in IOs (Davis, 2023). I present a new mechanism: the asymmetric interdependence in the world system. Because of the moderating role of interdependence, delegating more authority to IOs leads to deeper cooperation from politically misaligned states, which consequently suffer from sovereignty loss. However, states central to the interdependent world system benefit from a more transparent disease environment without a sovereignty loss. When crises lead to a greater demand for IO authority, the international order evolves in favor of these powerful states. This is contradictory to our traditional understanding that delegation to neutral IOs reduces the influence of main shareholders (Abbott and Snidal, 1998; Hawkins et al., 2006).

2 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.

Despite these responsibilities, the WHO has limited resources to enforce cooperation. It has two primary sources of revenue (Kaiser Family Foundation, 2020). Assessed contributions are set amounts paid by member states. Accounting for less than 20% of the WHO's total budget, assessed contributions are often used to cover general expenses and program activities. 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 at the WHO's discretion.[1] Constrained by its limited resources, the WHO assists governments mainly through technical rather than material support.

2.1 Capacity of Information Collection

The WHO collects information on global health emergencies and has strengthened its capacity for information collection over time. Since 1997, the WHO has established an electronic public health early warning system called the Global Public Health Intelligence Network (GPHIN) in collaboration with Canada's Public Health Agency. The GPHIN monitors internet media in several languages to detect potential events of public health concern. In 2000, the WHO formalized the use of non-official information with the Global Outbreak Alert and Response Network (GOARN), a new disease surveillance platform. GOARN proved crucial in detecting the SARS outbreak in China (Fidler, 2005, 348).

Yet, the WHO did not have the authority to disseminate information collected by its intelligence. Constrained by this limited authority, the WHO could not provide timely updates or policy advice to its members if the outbreak country refused to provide confirmation.

This is what happened during the SARS outbreak in China in 2003. On November 27,

[1]Compared to the $7.4 billion discretionary budget for the CDC of the US (based on the FY 2019 budget), only about 20% of its $6 billion budget is at the WHO's discretion.

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 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. On February 28, Carlo Urbani, a WHO epidemiologist working in Vietnam, reported his suspicion about an ongoing new contagion. The WHO then intensified the epidemiological intelligence gathering. On March 12, the secretariat issued the first global alert (Kamradt-Scott, 2015, 89-90). Later, 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 on on-site investigation (Huang, 2004), the WHO was uncertain about the rate of transmission and appropriate measures to control the disease.

The SARS outbreak proved that capacity for information collection alone was insufficient for the WHO to effectively manage global health emergencies, which led to the IHR reform.

2.2 History of the International Health Regulations

The International Health Regulations (IHR) is an agreement among 196 countries to address 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.

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.

The negotiation over the IHR revision started in 2004 and covered issues including the balance between sovereignty and the WHO Secretariat, the scope of reporting, domestic constraints in the designation of a single focal point, human rights, capacity building requirements, and so on (Whelan, 2008). One of the key goals of the IHR reform is to enhance information sharing by states. While the consensus on the need for disease reporting was reached early on (Davies, 2012b),[3] there was disagreement regarding the WHO authority over information because governments were concerned about the economic and other consequences that the WHO's information can trigger. As a compromise, consultative mechanisms were included to ensure the prudence in using the authority. The revised IHR framework was unanimously approved by the Inter-Governmental Working Group (IGWG) on May 23, 2005 and has been in effect since June 15, 2007.

The IHR reform is regarded as revolutionary (Fidler, 2005) due to its intervention in state sovereignty. There are four major substantive changes. The first is an expansion in scope. 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. 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. 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 4 of Ar-

[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.

[3]The WHO had been promoting the duty to report since 2001 (Fidler, 2004, 117-118).

ticle 10 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 its own intelligence system. Last, the reform grants the director-general the unilateral authority to declare a Public Health Emergency of International Concern (PHEIC). Such declarations can trigger other states' restrictive measures, intervening the national sovereignty. To address states' concern for their control over sovereignty, the new framework requires the director-general to convene an Emergency Committee composed of technical experts, with at least one expert nominated by the outbreak country.

I focus specifically on the aspect of the authority of information dissemination in the reform. Although other aspects can contribute to enhanced outbreak reporting, I regard the authority of information dissemination as the key driving force for states' behavior change. The WHO has a small budget at its discretion, significantly constraining the carrot and stick mechanisms it could wield over states. The authority of information dissemination allows the WHO to leverage outbreak responses—such as resources and border restrictions—from other countries, which changed states' calculus of reporting.

3 A Model of Disease Outbreak Reporting

I develop a model to illustrate how the WHO's strengthened information authority leads to enhanced reporting by states. 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). Both L and A can observe the severity of a disease outbreak θ, which takes two values, 0 and 1, while C does not. This setting implies that A has the capacity to detect outbreaks, which is the scope condition of the model.

The game begins with nature determining that a disease outbreak is severe ($\theta = 1$) with probability ψ.[4] After observing θ, L decides whether to report the outbreak ($r_L = 1$) or not ($r_L = 0$). After observing L's action, A decides whether to disseminate the outbreak information ($r_A = 1$) or not ($r_A = 0$). Last, after observing the actions of L and A, C provides resources $m \in [0, 1]$ and imposes bans $b \in [0, 1]$.

3.1 Payoffs

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, outbreak causes damages to L, and resources provided by C help mitigate the damage. Second, L suffers from the disruption caused by bans. Last, when L's reporting is inconsistent with A's information dissemination, L incurs a small reputation cost ϵ.

The following equation presents A's utility function:

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

A's goal of disease containment can be achieved through C's outbreak responses m and b.[5] Meanwhile, A incurs an overriding cost if it reports outbreaks to C without L's approval. As the WHO is a consensus-based IO, naming and shaming any country, even smaller ones, could lead to a reduction in autonomy in the long-run, let alone the short-term obstacle

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[4]Figure A.5 shows the game tree. I assume that $\psi < (\frac{\gamma(\gamma+\lambda)^2}{\lambda})^{\frac{1}{4}} - 1$ to ensure that C is not incentivized to respond without the reporting from the government or the WHO.

[5]Border restrictions are found to be effective in containing outbreaks in the early stage of a disease outbreak (Grépin et al., 2021).

that states may create to prevent its fact-finding missions (Fang and Stone, 2012, 554). $p \in [0,1]$ captures this overriding cost, which also represents the level of information authority delegated to A. The IHR reform is reflected as a decrease in p.

I consider C to be powerful states like the US, the UK, France, and Germany. C's major actions are resource provision and ban imposition. Given these countries' prominent role in aid provision and their economy size,[6] these countries' reaction to disease outbreaks summarizes what a country faces upon disease outbreaks.[7] Below is its 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 if the outbreak spreads into C's territory. C's resources and bans can mitigate the direct outbreak damage. Second, in an interdependence world system, disruptions caused by a disease outbreak in one country leads to disruptions in other countries if they are integrated (Antràs et al., 2023; Zhang, 2022). 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. $\alpha \in [0,1]$ captures L's integration with C.

Last, C incurs costs for resources and bans respectively: $k_m(m) = \frac{\gamma}{2}m^2 + \varepsilon_m \mathbb{1}\{m>0\}$ and $k_b(b) = \frac{\lambda}{2}b^2 + \varepsilon_b \mathbb{1}\{b>0\}$. γm^2 and λb^2 correspond to the material costs,[8] while $\varepsilon_m \mathbb{1}\{m>0\}$

[6]These countries accounted for 33% to 47% of global GDP between 1995 and 2019.

[7]While China has become an increasingly important actor, its rise in the international arena, represented by the Belt and Road Initiative in 2013, was a relatively recently development, considering the period under study.

[8]I assume that $\gamma > \lambda$. This is consistent with the argument that ban imposition is less costly than resource provision and is domestically appealing (Kenwick and Simmons, 2020).

and $\varepsilon_b \mathbb{1}\{b > 0\}$) are the administrative costs once any resources or bans are provided.[9]

3.2 Equilibrium

I provide an intuitive illustration of players' behaviors at the equilibrium under different parameter spaces, with the solution shown in Appendix A.1.

Given C's posterior belief μ about disease severity after observing r_L and r_A, C's best responses are as follows:

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

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

As C and L's integration deepens, L tends to receive more resources and face fewer bans.

Deeper integration between L and C means that C experiences greater disease disruption due to integration with L. Resource provision contains the outbreak from within, which reduces both disease spillovers and disruptions due to connected political and economic activities. As integration between L and C deepens, C provides more resources. Meanwhile, bans cut off C's interactions with L, causing more disruptions if L and C are more deeply

[9]The administrative costs 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. I assume that $\frac{(1+\psi)^2}{2\gamma} < \varepsilon_m + \varepsilon_b < \frac{\gamma + \lambda}{2\sqrt{\gamma\lambda}}$ and $\varepsilon_m > \frac{2\psi^2}{\gamma}$. 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 country is integrated enough. The calculation is in Appendix A.1.

integrated. Hence, deeper integration between L and C discourages bans.

A's decision of information dissemination is shaped by the calculation of whether it is worth the cost to override L to achieve the goal of disease control. When resource provision and border restrictions are large, overriding pays off. This is especially true for the most isolated L because of the strong bans. However, overriding is not appealing for moderately integrated states due to the modest outbreak responses.

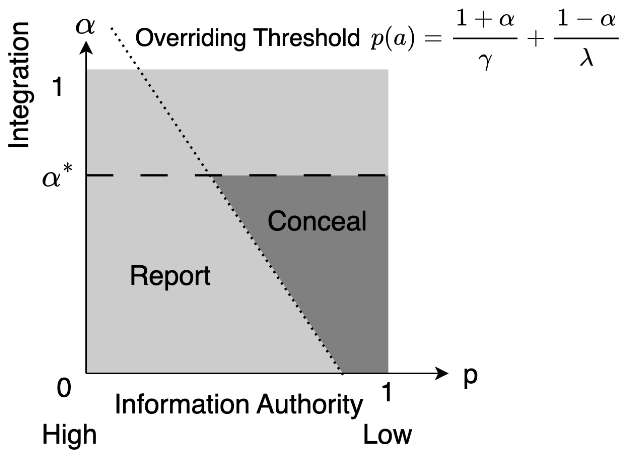

Figure 1: L's Reporting Strategy

L's decision to disclose depends on C's outbreak responses and A's information authority. Figure 1 maps L's reporting strategy under the parameter space of its integration with C and A's information authority. The horizontal axis represents the cost A incurs to override L's decision. The higher the cost, the less information authority A has. The vertical axis represents the level of integration between L and C. The dotted line characterizes A's overriding threshold, below which A is willing to override L.

When L is integrated, L receives more resources and faces fewer bans, making disclosure profitable. Hence, deeply integrated L ($\alpha \geq \alpha^*$) reports regardless of A's information authority. This is represented by 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 is not concerned about being overridden by A and does not disclose. This is represented by the dark gray area in Figure 1. When A has enough information authority, despite that L does not benefit from the disclosure, L may still disclose because of the outbreak responses triggered by A's information dissemination. The dotted line separates the spaces of L's reporting strategy at the equilibrium, with the left space indicating induced disclosure.[10]

3.3 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 movement from no information authority to complete information authority.[11]

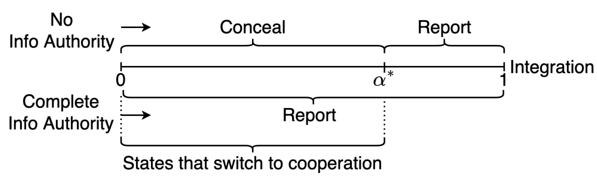

Figure 2: L's Strategy: Comparison Between $p = 1$ and $p = 0$

In Figure 2, when the WHO did not have information authority, only states with deep

[10]I assume that L can benefit from reporting consistently with A, which is characterized by ϵ in L's utility function. One benefit of proactive reporting is the first-mover advantage, which allows the outbreak state to control the report contents. Another 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 perceive the outbreak as so severe that A is willing to incur overriding costs to disseminate the outbreak information. As such, L may receive stronger border restrictions.

[11]It is empirically challenging to evaluate the degree of information authority granted by the IHR reform. The two extreme cases under examination capture the model prediction that the IHR reform is most capable of inducing cooperation from most isolated states.

enough integration disclosed. Once the WHO can disseminate information, those that would otherwise be reluctant to report became forthcoming.

Hypothesis 1. *The IHR reform induced more outbreak reporting by isolated states.*

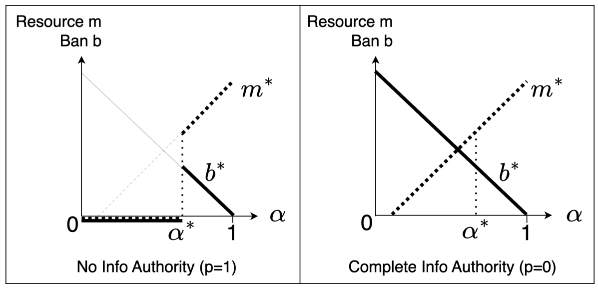

Figure 3: C's Strategy: Comparison Between $p = 1$ and $p = 0$

One result of the model is worth discussing. Figure 3 illustrates C's outbreak responses under the above two extreme scenarios. The dotted and solid lines correspond to the magnitude of resources and border restrictions at the equilibrium. In the pre-reform world on the left, only integrated states experience high resource provision and low border restrictions. Isolated countries do not receive bans or resources. In the right panel, after the reform, all countries receive bans and resources. However, isolated states are faced with strong restrictive measures along with limited resource provision. This comparison offers a comprehensive picture of the IHR reform. Arguably, the IHR reform is effective in facilitating information sharing on disease outbreaks. Yet, such benefits come at the cost of stronger restrictive measures, which may disrupt the efficient allocation of medical resources to contain outbreaks.

While the model emphasizes how IO information increases the cost of concealment, the IHR reform could also enhance disclosure by increasing the cost of ban imposition. The IHR reform granted the WHO the authority to make trade and travel recommendations. By naming and shaming states for imposing excessive border restrictions, the WHO could increase the reputation cost of ban imposition and deter these measures. Hence, isolated states would face lower costs of disclosure and become forthcoming. While empirical evidence does suggest that the WHO's guidance against bans weakens public support for such measures (Kobayashi et al., 2023), Worsnop (2017) shows that democratic political leaders with limited health capacity may go against the WHO's recommendation and use bans as political cover to prevent the loss of domestic support, suggesting the limited impact the WHO has over states' costs of ban imposition. Moreover, the examination of the WHO's recommendations on trade and travel measures during PHEICs—the most salient public health emergencies—by Worsnop et al. (2023) reveals the lack of clarity and consistency in the WHO's guidance. Given the vagueness, it is hard to imagine how the WHO could provide a focal point on the appropriate level of border restrictions.[12]

4 Data

4.1 Disease Outbreak News

To measure state cooperation with outbreak reporting, I use a country's annual total number of Disease Outbreak News (DONs) reports. The WHO publishes officially confirmed disease outbreaks of international importance through DONs, one of the most frequently accessed pages on the WHO website.

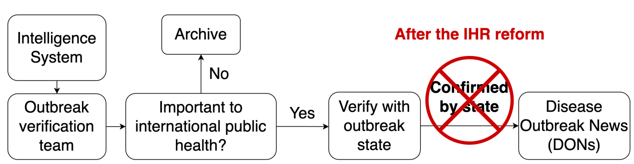

Figure 4: Disease Outbreak Verification System

Figure 4 illustrates the data-generating process of DONs reports (Grein et al., 2000). Based on the GPHIN and other intelligence, the system generates reports about events of potential concern, which are reviewed by a team at the WHO headquarters. Once an event is deemed important, an outbreak verification team will seek verification from the outbreak

[12]The WHO's reticence about border measures could be due to its concern for state retaliation, which may lead to decreases in autonomy (Kamradt-Scott, 2015, 147-148).

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 refused to confirm, there would not be a DONs report. After the reform, the WHO does not need to receive states' confirmation to post a report, which deters concealment efforts. Reports that would otherwise have been unconfirmed are now on the website. Due to this selection process, the number of DONs reports reflects states' cooperation with outbreak reporting.[13]

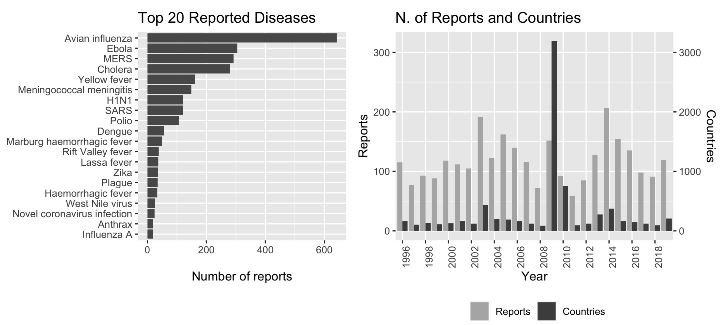

Figure 5: Major Disease Types in DONs and Number of Reports Overtime

After scraping the website, I obtained a dataset of 2,874 reports covering January 22, 1996 to May 14, 2020.[14] The left panel of Figure 5 shows the most frequently reported disease types. The right panel summarizes the over-time change in the number of reports and countries covered by DONs. For DONs reports, the spike in 2003 reflects the SARS outbreak, while the spike in 2014 reflects the Ebola outbreak in West Africa, the Middle

[13]One concern is that the number of reports reflects the agency's information dissemination instead of the state's cooperation. To address this concern, I coded each report based on the presence of any indications regarding government cooperation. Figure A.4 shows that the result holds after removing the reports without indication of government cooperation.

[14]To identify outbreak countries, I use regular expressions to identify country names from the headline. For reports without country names in headlines, I use the same regular expressions to identify country names in the text and read them to verify.

East respiratory syndrome coronavirus (MERS) outbreak, and the avian influenza in China. For countries being covered in these reports, the spike in 2009 reflects the H1N1 outbreak, which affected 174 countries and territories.[15]

I transform reports into a country-year panel by totaling reports by country and year and coding missing entries as zero. The final dataset covers 151 countries from 1996 to 2019. On average, each country has one report 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, 74.4% have zero reports.[16]

4.2 Isolation from the International Community

The isolation measure aims to capture outbreak responses. During disease outbreaks, leaders of the international community need to respond under urgency and uncertainty (Lipscy, 2020), and one of the key considerations is to appease the anxious sentiment of the domestic audience (Kenwick and Simmons, 2020). Given the high visibility of outbreak responses during a public health emergency, I propose that political isolation between the outbreak country and the international community shapes outbreak responses. Resource provision to mitigate outbreak severity is a form of foreign aid, and scholars have shown that political alliance (Alesina and Dollar, 2000) plays a key role in determining who receives aid. Meanwhile, imposing border restrictions on politically misaligned countries is less costly for the alliance and more popular among the domestic audience. Given the lack of empirical evidence on border restrictions, I examine the case of COVID-19 pandemic, an ideal empirical setting where all countries are faced with infected cases, mitigating the concern for the selec-

[15]As the H1N1 outbreak leads to repeated updates for more than a hundred countries, the unusual reporting pattern may override the reporting pattern for other diseases. I exclude H1N1 in the main analysis. Figure A.6 shows the baseline results leaving one disease out.

[16]The summary statistics of all variables and their data sources are in Table A.1.

tion of outbreak events. I find that political misalignment between a dyad is correlated with stronger travel bans, while neither economic nor geographic isolation plays a prominent role in shaping bans.[17] Hence, to measure a country's isolation with the international community, I use a country's political misalignment with the US, measured by the absolute difference of ideal point estimates between a country and the US based on the voting records at the United Nations General Assembly (UNGA) (Bailey et al., 2017).

4.3 Regression Specification

I conduct a post-treatment analysis by exploring the variation in the effect of the IHR reform on isolated versus integrated states. Specifically, I compare the difference in cooperation between groups that are more sensitive to the treatment and groups that are less sensitive and identify the differences between these two groups.[18] My theory suggests that the IHR reform has a stronger effect on isolated states than on integrated states. I expect a positive difference in the effect of the IHR reform on cooperation between isolated and integrated states. The regression equation is shown below:

$$\begin{aligned} log(1 + DONs\ Report_{it}) =& \beta_1 Isolation_{i,t-1} + \beta_2 Isolation_{i,t-1} \times Post_t \\ & + \alpha_i + \gamma_t + \lambda_{it} + X_{i,t-1}\Gamma + \varepsilon_{it} \end{aligned}$$

where i and t indicate the country and year. The dependent variable is the number of DONs reports in the logarithm. $Post_t$ is a dummy variable indicating the post-reform

[17] Details of these analyses are in Appendix A.2.

[18] This identification strategy is based on the factorial DID design, where a clean control group unexposed to the event is lacking (Xu et al., 2024). Without additional assumptions compared to the canonical DID setting, the identified effect captures the difference in the causal effects of the reform across subgroups of different observed levels of isolation.

period. I consider 2005 as the starting point of the new IHR framework despite that the IHR reform came into effect in 2007. On the one hand, the consensus on the duty to report was established at the beginning of the negotiation (Whelan, 2008). On the other, the SARS outbreak was the first time that the WHO published information disregarding states' disapproval, which updated states' belief of the possibility that the WHO could override. Hence, the change in states' reporting patterns did not necessarily need to wait for the new framework to be legally binding and should take place at the onset of the reform.[19]

$Isolation_{i,t-1}$ is states' political isolation from the US. β_1 identifies the estimated effect of over-time changes in isolation. The coefficient of interest is β_2, which identifies the difference in the reporting gap between isolated and integrated states before and after the reform. β_2 should be positive to capture the increased reporting by isolated states after the reform.

One potential threat to this identification strategy is omitted variable bias. To address this concern, I control for country fixed effects α_i and year fixed effects γ_t. Specifically, α_i accounts for the time-invariant country-specific characteristics, such as climate and geographic conditions that are influential on the spread of infectious diseases. γ_t accounts for over-time changes in the WHO's DONs reporting strategy that is not specific to any country. Last, λ_{it} represents the country-specific time trends in the linear and quadratic terms, which captures the over-time shift in the disease environment in each country. For example, as the spread of meningococcal diseases in the meningitis belt is associated with higher dust concentration and lower temperatures, the region-specific climate change may shape the probability of outbreaks, causing omitted variable bias if the country-specific time trend is not accounted for. These terms also address the potential spurious correlation concern due to the long period. The quadratic term also captures the nonlinear trend due to the reform.

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[19]Documented by Davies (2012b) on East Asian states' reporting on H5N1 human infections immediately after the SARS outbreak, states had been providing information to the WHO, even before the reporting obligation became legally binding in 2007.

Additionally, I control for a vector of control variables $X_{i,t-1}$. 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 total GDP. I also control for global value chain (GVC) integration with the world (Casella et al., 2019), which captures how much value-added a country contributes to the production chain of the world. Infectious diseases disrupt international trade. Countries with greater openness and GVC integration may have incentives to withhold outbreak information. Second, I control for a country's engagement in international organizations. I control for whether a country is a member of the United Nations Security Council (UNSC). Previous research shows that being a temporary UNSC member 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 because democracies have a stronger domestic mechanism to induce compliance (Dai, 2005). I also control for GDP per capita and population size. All the independent variables are lagged for one year to avoid simultaneity bias.

5 Results

Table 1 reports the baseline results. Column (1) only controls for state-fixed effects and year-fixed effects. Column (2) and (3) add control variables and state-specific time trends. Column (4) includes state-specific quadratic time trends. The coefficient estimates of β_2 are statistically significant and positive. As a country's isolation from the US can be endogenous to the IHR reform, leading to post-treatment bias, I use the pre-treatment average of isolation as the treatment uptake after the reform. The last four columns in Table 1 shows the results, which are weaker but still statistically significant and positive in the full setting. Overall, these results confirm that isolated states increased their reporting after the IHR reform.[20]

Table 1: Isolation from the US and Disease Outbreak Reports

	Dependent variable:							
	log(1 + DONs reports)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Isolation from US	−0.013	−0.023	−0.031	-0.120^{*}				
	(0.049)	(0.053)	(0.057)	(0.068)				
Isolation from US * Post	0.073^{**}	0.078^{**}	0.261^{***}	0.325^{***}				
	(0.030)	(0.036)	(0.065)	(0.064)				
Isolation from US (Pretreatment)					0.092^{*}	0.098^{*}	−0.035	−0.114
					(0.049)	(0.051)	(0.084)	(0.076)
Isolation from US (Pretreatment) * Post					0.055^{*}	0.049	0.252^{***}	0.357^{***}
					(0.028)	(0.035)	(0.054)	(0.061)
State FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	N	N	Y	Y	N	N
Control	N	Y	Y	Y	N	Y	Y	Y
State-specific time trend	N	N	Y	Y	N	N	Y	Y
State-specific quadratic time trend	N	N	N	Y	N	N	N	Y
Observations	3,442	3,442	3,442	3,442	3,311	3,311	3,311	3,311
R^2	0.281	0.283	0.366	0.435	0.285	0.287	0.369	0.440
Adjusted R^2	0.243	0.243	0.299	0.344	0.246	0.247	0.300	0.348

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

[20] I further examine the heterogeneous effect of the IHR reform on different dimensions of isolation. Figure A.7 shows the coefficient estimates of a country's political, economic, and geographic isolation interacted with the post reform indicator using the specifications of the first four columns in Table 1. The mixed coefficient estimates for economic and geographic isolation suggests that political isolation plays a more important moderating role, which is consistent with the border restriction pattern shown in Appendix A.2.

5.1 Pre-Trend Analysis

Figure 6 presents the coefficient estimates of a vector of year dummies interacted with the isolation variable, with the same control variables in Column (4) of Table 1. I treat 2005 as the starting point of the IHR reform and use 2004 as the reference group. Figure 6 shows that before the IHR reform, there is not a significant difference in reporting between isolated and integrated states, indicating the absence of a pre-trend. Immediately after the initiation of the reform, DONs reports increased for states isolated from the US.[21]

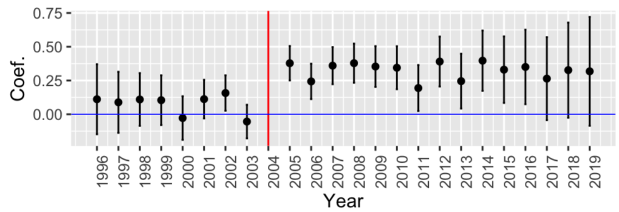

Figure 6: Pre-trend Analysis

[21]Following Hassell and Holbein (2024), this pre-trend analysis includes state-specific time trends and quadratic time trends to account for potential pre-trend in the dependent variable. However, as Strezhnev (2024) shows, including group-specific time trends in the DID setting does not identify the convex average of post-treatment ATTs without effect homogeneity assumption. Following his solution to this problem, Figure A.8 omits two and three pre-treatment periods to avoid perfect collinearity. The result suggests the absence of pre-trend when country-specific quadratic time trends are controlled for. Additionally, I used the counterfactual estimators (Liu et al., 2024) to further examine the parallel trend assumption. Figure A.9 shows that the matrix completion estimator is the more accurate model for counterfactual estimators and there is no evidence of pre-trend.

5.2 Role of Disease Severity

While I use the number of DONs reports to proxy for states' willingness to report, disease severity may conflate the quantity of reports. Isolated state might have experienced more severe outbreaks after the reform. They could also provide more updates on unimportant outbreaks. These possibilities could invalidate the above results as evidence for my theory.

To alleviate the concern that more reports reflect disease severity rather than willingness to report, I control for disease severity in different ways. First, I collect the disease outbreak event data from a third-party source: the Global Infectious Diseases and Epidemiology Online Network (GIDEON), a platform used by health professionals and educators for infectious disease diagnosis and reference purposes in hospitals and universities. GIDEON builds its dataset through keyword-based real-time search and ex-post collection of official documents and peer-reviewed publications. The ex-post nature of data collection alleviates the concern that outbreaks detected by GIDEON are only driven by governments' reporting willingness or capacity. Hence, the GIDEON database provides a relatively less politicized source of disease severity. One empirical challenge is that GIDEON and DONs have different criteria of outbreak selection and disease definition.[22] I alleviate this challenge by manually coding diseases in DONs reports and matching them to the GIDEON diseases. Among the 78 diseases or conditions reported by DONs, 58 diseases have a match in GIDEON, which account for 96% of DONs reports. Given the high matching rate, I keep GIDEON outbreak events with diseases matched in DONs. In Column (1) and (2) in Table A.2, the baseline results hold after controlling for outbreak events. One caveat with these results is that outbreak events is a post-treatment control and may bias the coefficient estimates. To address this concern, I consider the growing understanding on the relationship between climate change and infectious diseases and control for air temperature to capture a country's vulnerability to infectious diseases. Specifically, I use 5 to 15°C as the ideal range for respiratory diseases

[22]Figure A.10 shows the screenshots of outbreak selection criteria of these two databases.

(Huang et al., 2020), which is based on COVID-19 studies, and 20 to 30°C for vector-borne diseases (McMichael and Githeko, 2001). Absent of a precise prediction of the ideal temperature range for different infectious diseases, I also control for annual mean of temperature and its quadratic term. Column (3) and (4) in Table A.2 show that the baseline results hold.

Next, I examine whether increased reporting is due to repeated updates on severe outbreaks. If isolated states experience more severe outbreaks after the reform and provide updates on outbreaks that are already known, this may undercut the disclosure-enhancing effect of IHR reform. Empirically, with the assumption that each disease type in the same country in the same year corresponds one outbreak, I examine whether isolated states experienced an increase in average number of reports per outbreak, which reflects efforts to update known outbreaks rather than disclosure of new outbreaks. In the last four columns in Table A.2, isolated states have fewer reports on the same outbreak after the IHR reform, failing to confirm that increased reporting is driven by frequent updates on severe diseases.

5.3 Alternative Explanations

Multiple alternative explanations could explain the same pattern. One explanation is the norm shift. The SARS outbreak was the first time that the WHO alerted other states about the outbreak and issued travel recommendation without the state's consent, which updated state's understanding about the WHO's practice during public health crisis. As a result, prompt reporting became the new norm (Davies, 2012b), and states not supportive of the US-led liberal international order became more forthcoming. To test this argument, I use states' rule of law index (Coppedge et al., 2023), which measures a country's judicial independence and compliance in the domestic arena, to proxy for a states' support for liberal international order. The logic is that the quality of a country's domestic legal institutions should be correlated with a country's respect for international law, while domestic legal institutions should not be relevant to other countries' decisions on border restrictions. The first three columns in Table A.3 shows that the gap in reporting between countries with strong versus weak rule of law shrank after the IHR reform, indicating increased reporting from countries with weak rule of law.[23] Still, the moderating effect of isolation holds after controlling for the effect of norms.

Another alternative explanation is that the IHR reform may have a stronger effect on autocracies because democracies are more cooperative (Mansfield et al., 2002) and have a stronger domestic enforcement mechanism of compliance (Dai, 2005). Columns (4)-(5) in Table A.3 examine the heterogeneous effect of the IHR reform regarding regime types and present mixed effects of democracy on reporting. The effect of isolation holds after accounting for the heterogeneous effect of democracy.

Third, 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 (6)-(7) in Table A.3 use the HRV transparency index to measure a country's transparency (Hollyer et al., 2014) and fail to find strong support for this explanation.

Last, states may have enhanced their capacity for outbreak surveillance and preparedness after the IHR reform, which is part of state obligations under the IHR reform. The enhanced reporting may reflect states' health capacity improvement rather than a greater willingness to cooperate. Two reasons suggest that this explanation may not be plausible. First, improving health capacity takes time, which is inconsistent with immediate behavior changes by states in Figure 6. 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 and their interactions with the post-reform indicator. As is shown in Table A.4, the effect of isolation hold.

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[23]Figure A.12 examines the pre-trend analysis related to rule of law. There exists a pre-trend in the effect of rule of law on reporting and the pattern in Figure 6 holds after controlling for the time-varying effect of rule of law.

Last, to ensure the results are not driven by the outbreak of MERS in Saudi Arabia or other disease outbreaks in China, I conduct a Jackknife test, where I drop one country from of the analysis at a time using the specification of Column (4) in Table 1. Figure A.13 shows that the main results are not driven by any single country.

5.4 Mechanism Check

In my theory, the driving force of states' behavior change comes from outbreak responses triggered by the WHO's information. To examine the mechanism of outbreak responses, I explore disease characteristics. Diseases with high transmissibility may receive more radical responses, while the availability of effective vaccines may reduce the concern for a disease.

To explore the variation in disease characteristics, I look into the book *International Travel and Health* published by WHO (2012), which provides information on potential risks to travelers' health and the prevention and treatment against these risks. One unique thing about this book is that it categorizes a set of infectious diseases of potential risk for travelers, along with the criteria of disease selection, shown in Figure A.11. The criteria focus not only on a disease's direct damage to travelers' health but also on the perceived risk and anxiety a disease may cause, which aligns with my search for diseases that could trigger radical responses. This book also lists vaccine-preventable diseases, some of which are routine vaccines as part of the childhood immunization program. Leveraging these different categories, I expect a stronger pattern of increased reporting by isolated countries on diseases with high travel risk than on vaccine preventable diseases after the IHR reform.

Figure 7 shows the most frequent diseases in DONs reports based on the above categorization. The majority of DONs reports fall under the category of travel risk diseases. Some diseases are both of high risk and can be prevented by vaccines, such as yellow fever and dengue. To disentangle the mechanism of border restrictions, I keep these diseases only in the category of travel risk diseases. Cholera, meningococcal meningitis, and polio are the most frequent vaccine-preventable diseases without highlighted travel risk. Both cholera and meningococcal meningitis are endemic due to their mode of transmission.[24] As for polio, despite the PHEIC declaration due to documented exported case of wild poliovirus, global polio cases have decreased over 99% thanks to the global efforts of polio eradication. Many diseases in the last category are syndromes and conditions and appear in DONs due to the uncertainty countries face when clustered unidentified conditions occur. Given such uncertainty, I expect no increase in reporting by isolated states on this category.

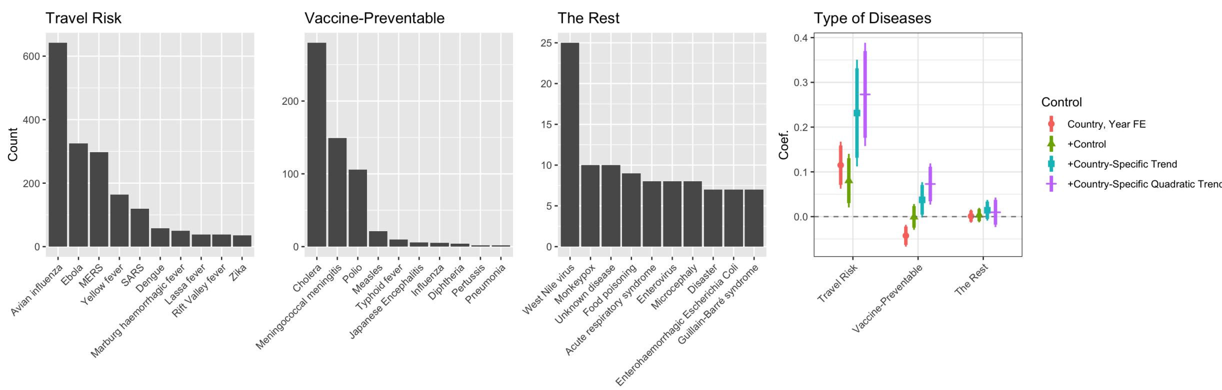

Figure 7: Mechanism Check: Disease Type

Using reports in each category at the country-year level as dependent variables, the last panel in Figure 7 shows the coefficient estimates of β_2 under different regression specifications. Results related to diseases with travel risks are more significant and of a greater magnitude than those related to vaccine-preventable diseases, while the results related to the rest of diseases are insignificant. This pattern suggests that when border restriction is more likely, states are more likely to disclose, confirming the mechanism of outbreak responses.

5.5 Is This About the US?

I further investigate the heterogeneity of isolation by expanding the center of the international community to other powerful states. The first group comprises powerful Western countries:

[24]Cholera is mostly transmitted through contaminated food and water, while the transmission of meningococcal disease requires specific climate environment.

the UK, France, and Germany. The second group includes other major powers: China and Russia. I examine a country's isolation from these countries using the ideal point distance based on the UNGA voting records and the inter-governmental organization (IGO) portfolio distance (Voeten, 2021). The former captures a country's ideological distance with these states, while the latter is a behavioral measure and captures the divergence in the commitment to international cooperation (Copelovitch and Powers, 2021).

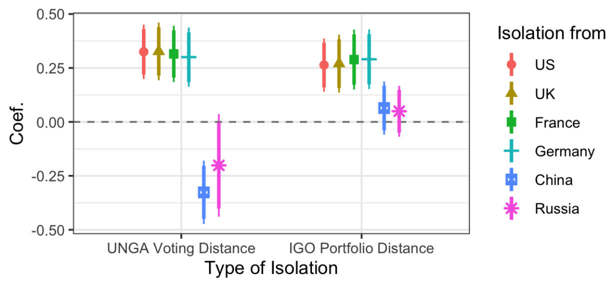

Figure 8: Isolation from Powerful Countries

Figure 8 shows the coefficient estimates of β_2 using the specification in Column (4) of Table 1. Figure 8 shows that the increase in reporting induced by the IHR reform is specific to countries isolated from the US and its allies, not those isolated from China or Russia. Such heterogeneity concerning different anchors as the center of the international community implies that IO information leads to stronger border restrictions on non-allies of major Western powers, but not non-allies of China or Russia. This is consistent with the border restriction patterns during COVID-19 in Figure A.1.[25]

[25]In Figure A.14, I examine the effect of economic isolation and find that states' economic interdepenence with the world system matters more than economic dependence, confirming the role of mutual dependence on outbreak responses.

5.6 Discussion

This heterogeneous pattern along political alignment has implications for the architecture of international institutions. When the WHO information triggers stronger border restrictions as enforcement for politically isolated states and induces more disclosure from them, granting information authority to the WHO favors Western powerful states. This is because these states can benefit from a more transparent disease environment without suffering the sovereignty loss due to the responses IO information can trigger. As the threat from public health crises leads to a greater demand of information sharing on diseases and more delegation to the WHO, the international order evolves in the favor of these powerful countries. Therefore, interdependence grants major Western powers an indirect form of influence in IOs (Stone, 2011; Carnegie and Carson, 2019; Clark and Dolan, 2020; Davis, 2023).

Then, why did countries isolated from the US and its allies agree to the IHR reform? Two reasons may explain the absence of withdrawals. One is reciprocity. Given the risk of future disease outbreaks in other countries, states isolated from the US expect other countries to share information with the WHO (Fidler, 2005, 377), which generates long-term benefits of disease 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. When the overall benefits of WHO membership exceed the costs of the IHR reform, isolated states may choose to stay even though the IHR reform requires more cooperation from them.

Such dynamics imply the presence of political cleavages over the institutional design of information authority at the WHO. This is illustrated in the post COVID-19 negotiation at the WHO. The US proposal on the amendment to the IHR emphasizes expanding the scope of information sharing and strengthening the information dissemination at the WHO (Ramakrishnan, 2021), while some African countries are concerned about their sovereignty related to border restrictions (Ravelo, 2021). Such tension reveals the central role of interdependence in shaping cleavages of institutional design in IOs.

6 Conclusion

This paper reveals the role of political isolation in moderating the effect of IO information on international cooperation. I examine the role of the WHO in facilitating states' outbreak reporting and find that enhanced authority of information dissemination induced proactive reporting of disease outbreaks, especially by countries politically misaligned with the US and its allies. Such heterogeneity along political alignment implies an indirect form of influence that powerful countries have in IOs.

While I test my argument in the realm of global health governance, the theory has broader applicability in international relations. Two key scope conditions are crucial for my theory. First, the IO must have the capacity to collect information. The ability to detect private information grants the IO the authority in its issue area and makes its information dissemination credible. Second and more importantly, IO information must have the ability to manipulate the incentive structure of cooperation for states (Barrett, 2005) through the channel of interdependence. In the global health arena, due to the disease spillover and disruptions through political and economic ties among states, information disseminated by the WHO triggers border restrictions, making concealment more costly.

Yet, these conditions are not unique to the WHO. On the one hand, data collection and publication are common tasks that most IOs are engaged with. On the other, in a highly interdependent global system, information about one country has implications for connected parties and triggers their reactions, reshaping the cost and benefit of cooperation for states. In the financial arena, information about a country's financial stability has implications for connected countries' financial profiles. The IO's ability to release such information could shape the debt restructuring efforts during sovereign debt crisis, deterring unaccountable borrowing decisions. In the developmental arena, information about a country's labor standards may influence the investment decision of firms along the supply chain, especially for those facing consumers (Malesky and Mosley, 2018). As such, IO information could lead to labor standard upgrade for countries aiming to attract international investment.

While my theory is relevant to different issue areas, it requires future work to understand its implications in different empirical realms. IO information may trigger different responses depending on the type of interdependence. As is illustrated in the case of global health surveillance, while the WHO can use its information authority to induce a more transparent disease environment, such information triggers enforcement based on political alignment and highlights the geopolitical divergence over the international order. If the heterogeneous enforcement triggered by IO information consistently lies along political alignment in different domains, one may be concerned about the sustainability of such institutional design. These implications for the international order, along with the diverse manifestation in other empirical domains, constitute promising space for future research.

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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 $m(\mu) = \dfrac{\mu(1+\alpha)}{\gamma}$ and $b(\mu) = max\{\dfrac{\mu - \alpha}{\lambda}, 0\}$*

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

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

□

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 $\alpha < \dfrac{\gamma - \lambda}{\lambda}$, 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 $r_A = 1$.[26]

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 $r_L = \theta$.

[26]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 $r_L = 0$.

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

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

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

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

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

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

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

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

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

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

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

Therefore, we need $\dfrac{(1+\psi)^2}{2\gamma} < \varepsilon_m + \varepsilon_b < \dfrac{\gamma + \lambda}{2\sqrt{\gamma\lambda}}$, $\varepsilon_m > \dfrac{2\psi^2}{\gamma}$, and $\psi < (\dfrac{\gamma(\gamma + \lambda)^2}{\lambda})^{\frac{1}{4}} - 1$ 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 political ties with the international community determines the amount of resources and bans this country faces upon disease outbreaks, illustrated in Figure 3. This section empirically examines whether isolation between two countries leads to ban imposition.[27]

[27]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.,

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 me to have a relatively similar benchmark of disease environment. In contrast, for most disease outbreaks, only a subset of countries experience infected cases. Hence, 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.[28] For other disease outbreaks, there do not exist as comprehensive data sources to examine the proposition.

Among all the datasets 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 datasets contain domestic policies and may increase the probability of coding errors if the coder mixes domestic policies with international ones.[29] 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

2019), making it impossible to measure the amount of aid given to the target country.

[28]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.

[29]This is the case for CoronaNet dataset.

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 directed dyad dataset to examine how isolation 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 these 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. Last, travel-based restrictions ban travelers who have recently traveling through or from a specific country. In the regression analysis, I first differentiate these different types of restrictions and then create two aggregate 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.

The sample of the analysis is a cross-sectional directed dyad between 2020 and 2021. The key independent variables is the isolation in three dimensions. To measure political isolation, I use the difference in the ideal point estimates based on UNGA voting records between the dyad. To measure economic isolation, I use the total trade volume between the dyad and flip the sign of it. To measure geographic integration, I use the geographic distance between the capital cities.

To account for characteristics that may affect both the degree of isolation between the dyad and 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.

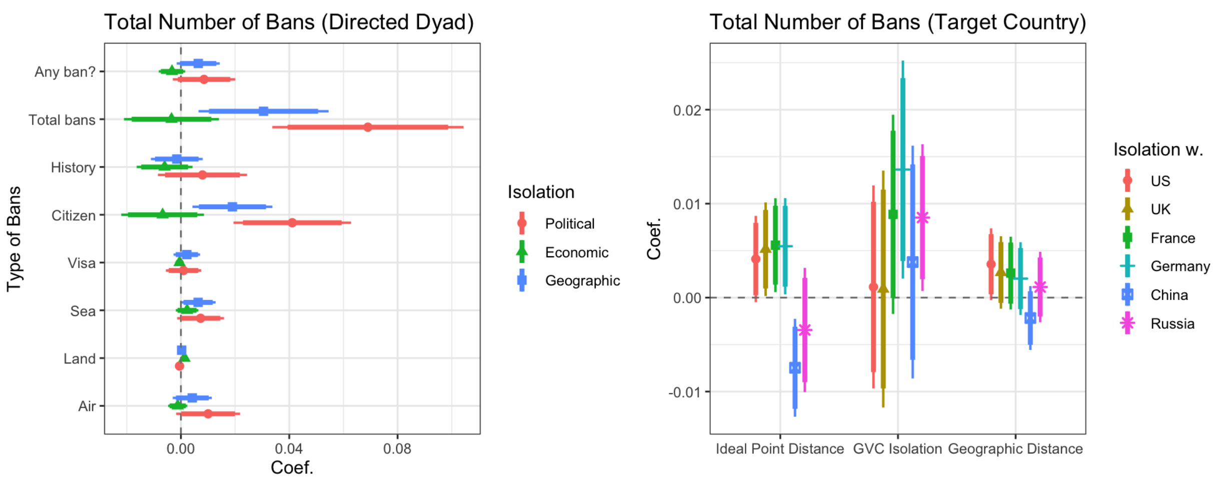


Figure A.1: Isolation and Border Restrictions

The left panel of Figure A.1 shows the results. The colors represent different types of isolation. 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 countries are more likely to impose border restrictions on isolated countries, especially for citizenship ban. In addition, the results are stronger for political and geographic isolation. Economic isolation has a mixed effect on border restriction. Overall, these results confirm that border restrictions tend to target isolated states.

As my theory focus on the aggregate level of border restrictions that a country face, a more direct test of this assumption should be at the target country level, which is shown in the right panel of Figure A.1.[30] Using ideal point distance to measure political isolation, the first column shows that countries politically isolated from the US and its allies experienced more bans, while the effect flipped for isolation with China and Russia. This result presents the heterogeneity in the enforcement mechanism, which explains where states' behavior change came from and is consistent with the pattern in Figure 8.

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 examine how DONs reports were written to identify government cooperation.

After reading through the 2,874 DONs reports, I identify a report as a result of government cooperation based on 5 conditions. 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. Third, a report is from the Early Warning Alert and

[30]The dependent variable is in the logarithm. I control for regime type, GDP per capita, total population, whether a country is a UNSC temporary member, IMF participation, and openness. Given the cross-sectional nature, I do not control for any fixed effects.

Response System (EWARS) or from the IHR National Focal Point. Both are institutional systems that the WHO established with governments to more efficiently and timely identify potential disease outbreaks. Hence, it is reasonable to assume that the government is aware 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 the term "mass reporting" to refer to reports on a disease outbreak that involves three or more countries. Such reports are often related to epidemics that spread to multiple countries and do not necessarily identify the source of information. It is difficult for governments to hide outbreaks that have spread to multiple countries, it is reasonable to believe that the government is cooperating with the WHO.

If a report does not fall in any of the above conditions, the report has no indication of government cooperation. 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. Sometimes, a disease is 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. As writers have different writing styles, the way a report is written may not reflect government behaviors. Still, it is safe to assume that the WHO cannot claim that the government provided the information when it was not the case. Positive cases imply government cooperation, while negative cases does not necessarily confirm the lack government cooperation. Hence, this coding scheme provides a strong case as the robustness check.

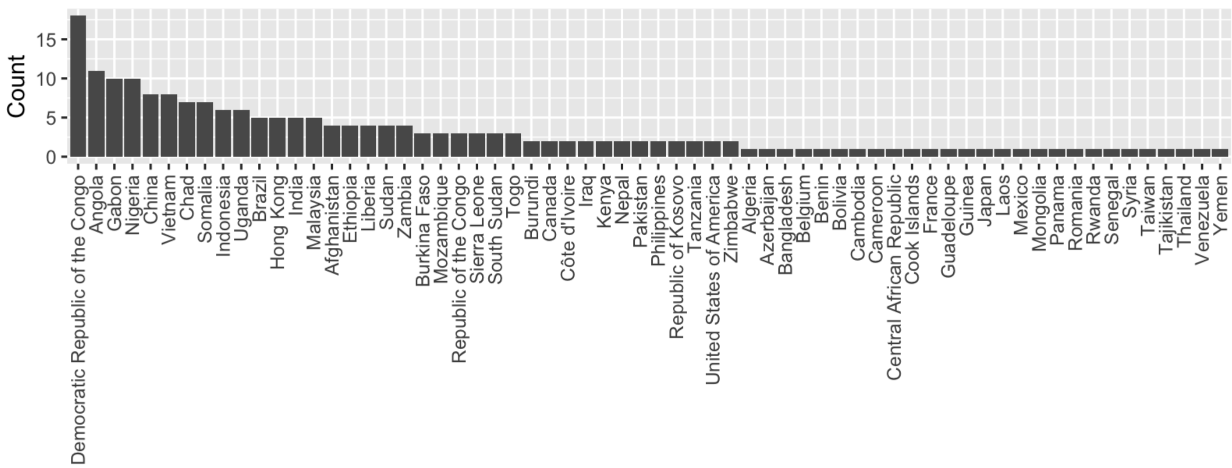


Figure A.2: Number of Reports Without Indication of Government Cooperation

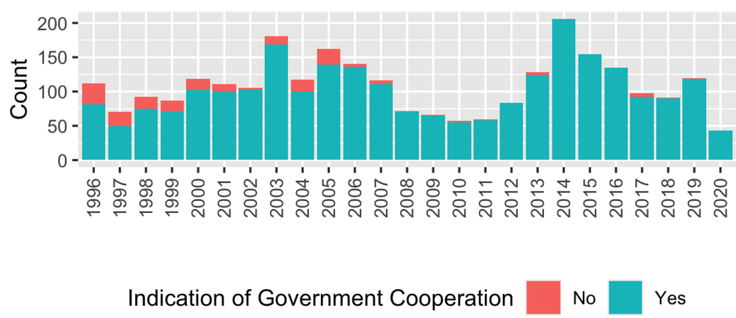


Figure A.3: Proportion of DONs Reports by Government (1996-2020)

Figure A.2 shows the countries with reports without any indication of government cooperation. Figure A.3 shows the over-time change in the proportion of DONs reports with and without government cooperation. 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. Moreover, the majority of the reports present indication of government cooperation, alleviating the concern that DONs reports only measures the information dissemination by the WHO rather than government cooperation.

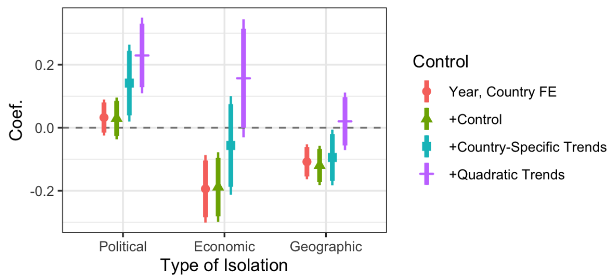


Figure A.4: Robustness Check: DONs Reports by Governments

To examine whether the main results hold with this refined measure of government cooperation, I remove all the reports without any indication of government cooperation and aggregate the rest reports to the country-year level. Using Table 1's specifications, Figure A.4 reports the results. The pattern of coefficient estimates are similar to results in Table 1 and Figure A.7, alleviating the measurement concern with DONs reports.

A.4 Figures and Tables

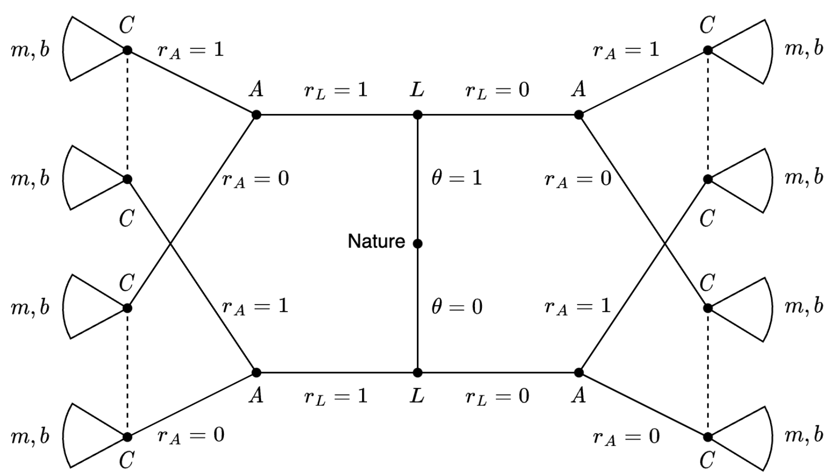
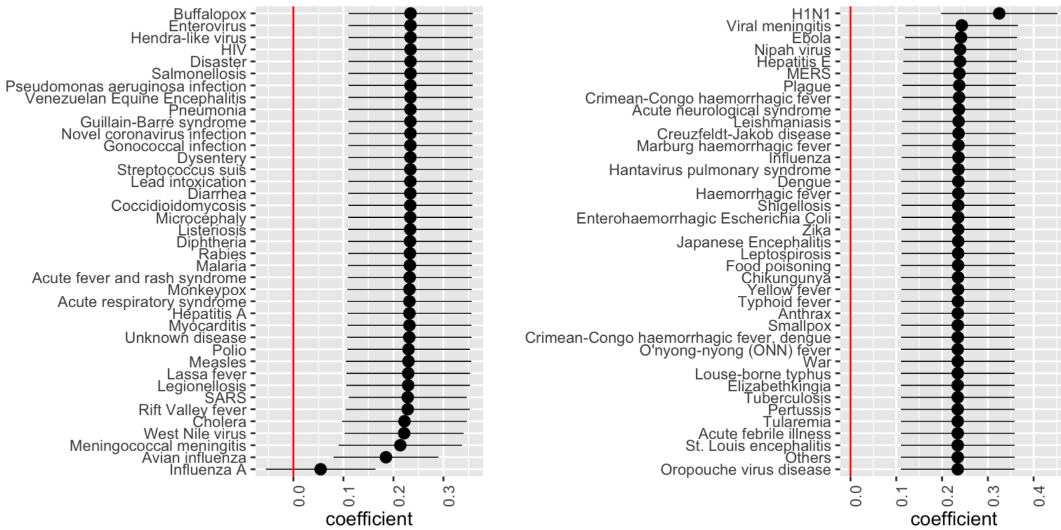


Figure A.5: Game Tree

Figure A.6: Jackknife Test for Diseases



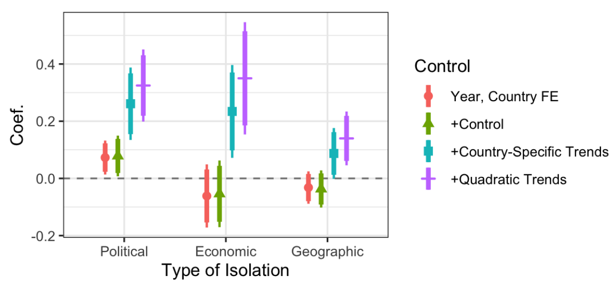


Figure A.7: Which Dimensions of Isolation Matter?

Note: I use total imports from the US to measure economic isolation. The measure of geographic isolation is based on the number of seats on direct flights to the US because it captures the capacity of population movement and reflects geographic isolation in the era of globalization. To harmonize the sign of coefficient estimates, I flipped the signs of total imports and flight seats variables.

Figure A.8: Pre-trend Analysis: Correcting for Group-Specific Time Trends

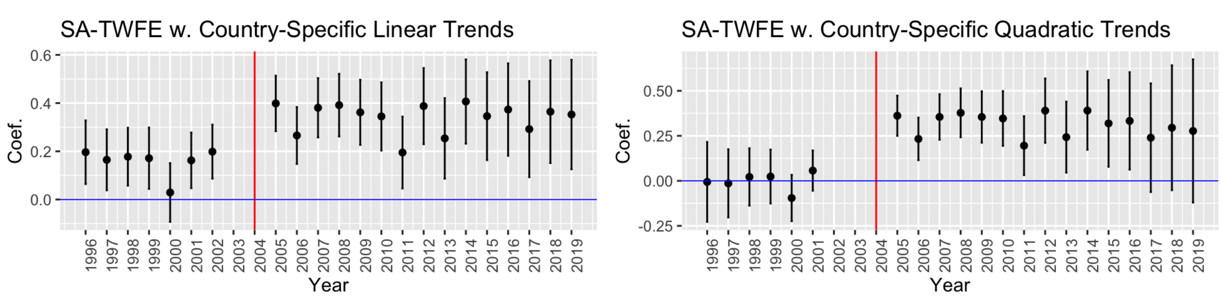
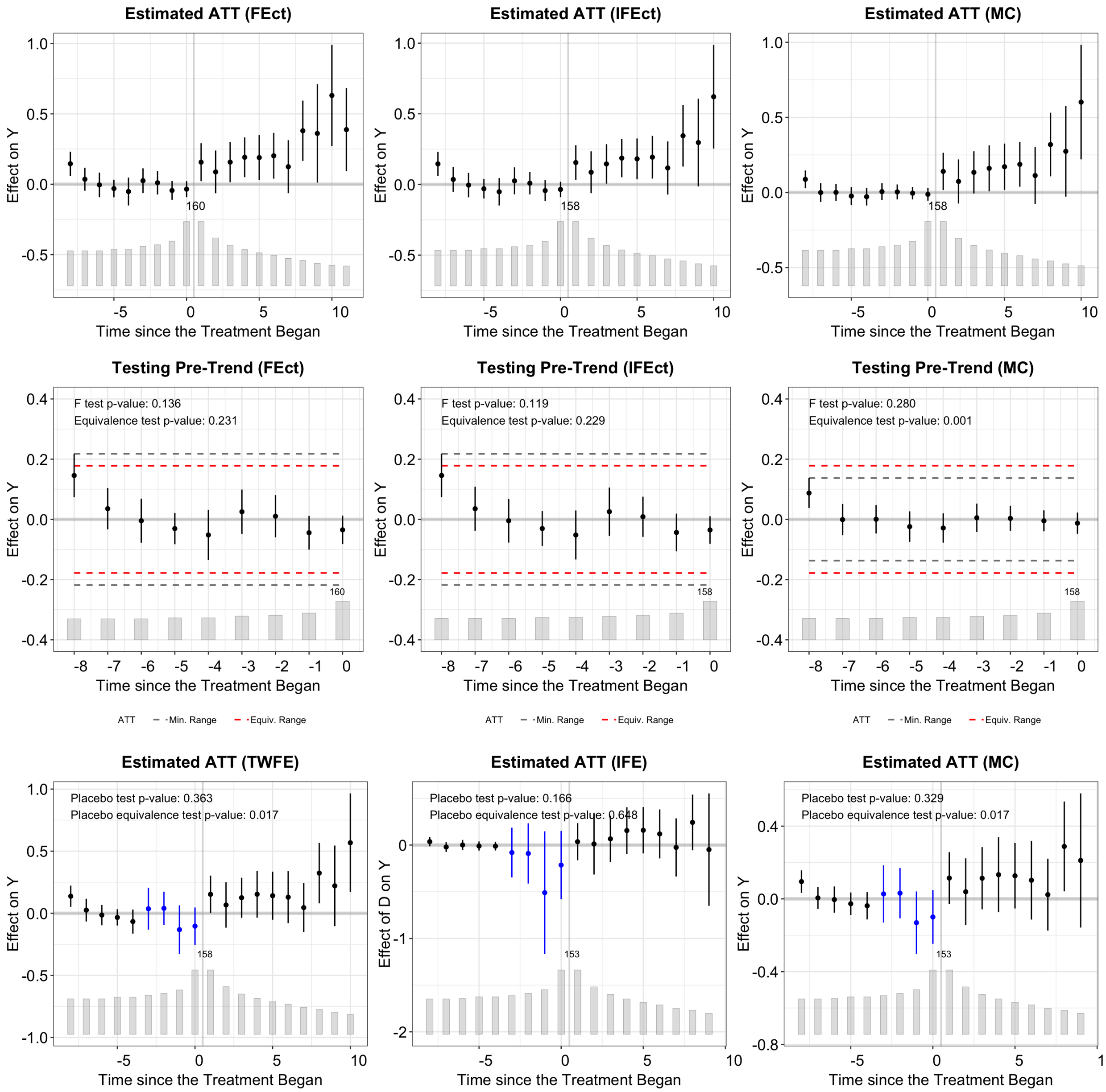


Figure A.9: Pre-trend Analysis: Counterfactual Estimators



Note: To create the binary measure of treatment uptake, I used the median of the isolation variable as the threshold and treated the observations with high isolation as the treated group.

Figure A.10: Criteria of Outbreak Selection: DONs vs. GIDEON

The criteria for Disease Outbreak News

Disease Outbreak News (DONs) are published relating to confirmed or potential public health events, of:

- Unknown cause with a significant or potential international health concern that may affect international travel or trade;
- A known cause which has demonstrated the ability to cause serious public health impact and spread internationally;
- High public concern which may lead to disruption of required public health interventions, or could disrupt international travel or trade.

How are outbreaks defined in GIDEON®?

Find out how GIDEON® defines outbreaks for monitoring purposes

In GIDEON®, an entry qualifies as an outbreak if:

- An event is specifically reported as an outbreak in source literature.
- It is a high-profile, notifiable disease in a non-endemic area e.g. Ebola in Italy
- ≥2 local cases appear unusual
- Citations of animal disease are denoted as outbreaks – even when only one animal is involved – in keeping with OIE definitions. Thus, a report of anthrax in a single goat is considered an outbreak in their reporting system.
- In general, any grouping of cases – including family clusters and epidemics – will be listed as an outbreak for the purpose of consistency. The term ***outbreak*** is generic here, and much will depend on the nature of the disease itself as there is no numerical cutoff.

Figure A.11: Criteria of the Selection of Diseases of Potential Risk for Travellers

The infectious diseases described in this chapter have been selected on the basis of the following criteria:

— diseases that have a sufficiently high global or regional prevalence to constitute a significant risk for travellers;
— diseases that are severe and life-threatening, even though the risk of exposure may be low for most travellers;
— diseases for which the perceived risk may be much greater than the real risk, and which may therefore cause anxiety to travellers;
— diseases that involve a public health risk due to transmission of infection to others by the infected traveller.

Figure A.12: Pre-trend Analysis: The Role of Norms

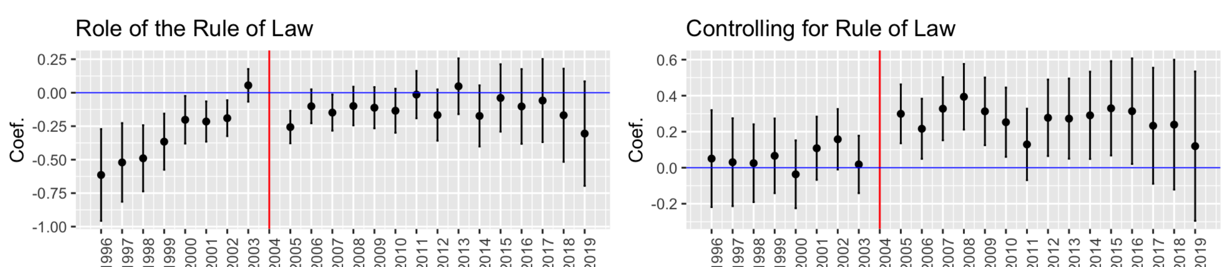
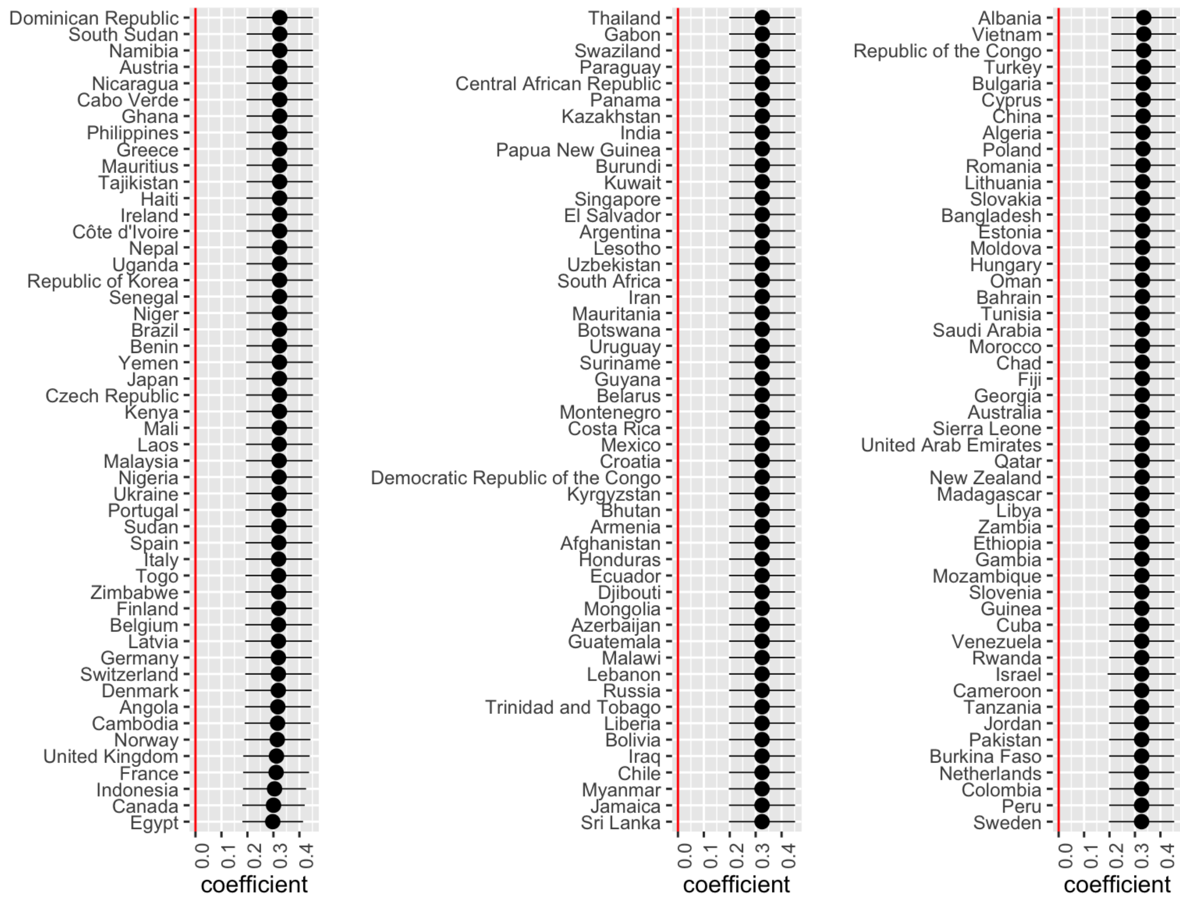
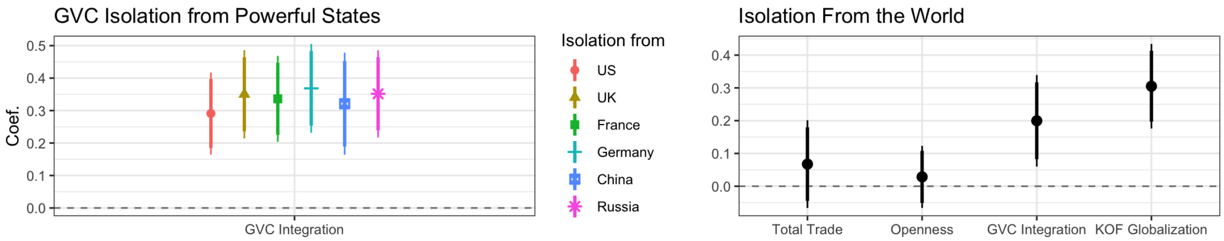


Figure A.13: Jackknife Test for Countries



Note: Each dot represents the coefficient estimate of β_2 after removing the corresponding country. The bar is the confidence interval at the 95% level.

Figure A.14: Economic Isolation



Note: For the left panel, I use 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. For the right panel, I use total trade volume and openness to measure states' dependence on world economy. I examine a state's interdependence with the global system using GVC integration with the world and the KOF globalization index (Gygli et al., 2019). I flip the signs of these economic measures to capture the economic isolation, which provides consistent interpretation of the coefficient signs with the rest of the paper. The left panel shows that the IHR reform increased the outbreak reporting by states disintegrated with all these six countries through GVCs. The different pattern presented by economic isolation is because all these six countries have the deepest GVC integration with other countries, making them central to the global economic system. The right panel presents stronger results related to economic interdependence than economic dependence, which is consistent with the role of mutual dependence on outbreak responses.

Table A.1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Median	Max	Data Source
Outcomes							
N. of DONs reports	3,442	0.983	3.974	0	0	75	WHO DONs
N. of DONs reports: travel risk	3,442	0.699	3.826	0	0	75	WHO DONs & WHO (2012)
N. of DONs reports: vaccine-preventable	3,442	0.239	0.884	0	0	15	WHO DONs & WHO (2012)
N. of DONs reports: the rest	3,442	0.044	0.372	0	0	10	WHO DONs & WHO (2012)
N. of outbreak events: DONs related	3,442	2.234	2.603	0	1	21	GIDEON
Isolation (all standardized)							
Ideal point distance to US	3,442	0.022	0.967	−3.088	0.276	2.649	Bailey et al. (2017)
Imports from US	3,442	−0.257	0.674	−1.719	−0.260	4.298	UN Comtrade
Seats on direct flights to US	3,442	−0.091	1.015	−1.712	−0.021	0.964	US Department of Transportation
IGO portfolio distance with US	2,838	−0.067	0.970	−2.041	0.025	3.092	Voeten (2021)
GVC integration with US	3,165	−0.158	0.967	−2.420	−0.151	1.791	UNCTAD-Eora GVC Database
Total trade with world	3,442	−0.217	0.864	−1.081	−0.496	1.891	UN Comtrade
Openness	3,442	−0.098	1.004	−6.997	0.055	1.230	UN Comtrade & World Bank WDI
GVC integration with world	3,442	−0.073	1.021	−1.591	−0.209	2.890	UNCTAD-Eora GVC Database
KOF globalization index	3,292	−0.156	0.989	−2.182	−0.085	2.183	Gygli et al. (2019)
Other controls							
Polity IV	3,442	3.795	6.246	−10	6	10	Center for Systemic Peace
HRV transparency index	1,860	1.902	2.427	−1.738	1.317	9.981	Hollyer et al. (2014)
Rule of Law	3,442	0.553	0.306	0.026	0.547	0.999	Coppedge et al. (2023)
N. of hospital beds per 1000 people	1,587	4.154	2.957	0.100	3.500	15.400	World Bank WDI
% of pop. w/ basic sanitation services	2,598	−0.035	1.026	−2.234	0.439	0.959	World Bank WDI
UNSC membership	3,442	0.094	0.292	0	0	1	Dreher et al. (2009a)
IMF participation	3,442	0.391	0.488	0	0	1	Kentikelenis and Stubbs (2023)
log(1+GDP per capita)	3,442	8.359	1.508	5.218	8.293	11.431	World Bank WDI
log(total population)	3,442	16.252	1.483	12.864	16.147	21.055	World Bank WDI
Months (5-15C)	3,416	2.031	2.584	0	0	12	Berkeley Earth
Months (20-30C)	3,416	6.511	4.674	0	6	12	Berkeley Earth
Annual Average Temperature	3,442	18.949	8.145	−5.230	22.100	29.750	Climage Change Knowledge Portal

Table A.2: Role of Disease Severity

	Dependent variable:							
	log(1 + DONs reports)				Average Reports Per Outbreak			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Isolation from US	-0.122^{*}	-0.098	-0.125^{*}	-0.121^{*}	0.055	0.058	0.216	0.217
	(0.065)	(0.064)	(0.068)	(0.068)	(0.087)	(0.088)	(0.146)	(0.190)
Isolation from US * Post	0.316^{***}	0.290^{***}	0.332^{***}	0.327^{***}	-0.045	-0.046	-0.253^{**}	-0.117
	(0.064)	(0.062)	(0.065)	(0.065)	(0.053)	(0.061)	(0.110)	(0.146)
Outbreak events (DONs)	0.216^{***}	0.312^{***}						
	(0.034)	(0.055)						
Outbreak events (DONs) * Post		-0.158^{***}						
		(0.053)						
Number of months (5-15C)			-0.026^{*}					
			(0.014)					
Number of months (20-30C)			0.014					
			(0.020)					
Mean annual temperature				-0.039				
				(0.041)				
Mean annual temperature (squared)				0.001				
				(0.001)				
Control	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	N	N
State-specific time trend	Y	Y	Y	Y	N	N	Y	Y
State-specific time quadratic trend	Y	Y	Y	Y	N	N	N	Y
Observations	3,442	3,442	3,416	3,442	1,081	1,081	1,081	1,081
R^2	0.451	0.453	0.434	0.435	0.455	0.458	0.544	0.647
Adjusted R^2	0.362	0.365	0.343	0.344	0.351	0.350	0.349	0.391

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

Table A.3: Robustness Check: Norms, Democracy, and Transparency

	Dependent variable:						
	log(1 + DONs reports)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Isolation from US		-0.082	-0.069		-0.164^{**}		-0.170^{**}
		(0.066)	(0.067)		(0.066)		(0.077)
Isolation from US * Post		0.259^{***}	0.244^{***}		0.400^{***}		0.369^{***}
		(0.072)	(0.070)		(0.077)		(0.083)
Rule of Law	0.045	-0.027	-0.571^{**}				
	(0.116)	(0.116)	(0.242)				
Rule of Law * Post	-0.246^{***}	-0.099	0.268				
	(0.060)	(0.064)	(0.285)				
Polity IV	0.043	0.049	0.072	0.078	-0.026	0.068	0.083
	(0.056)	(0.055)	(0.057)	(0.065)	(0.064)	(0.058)	(0.058)
Polity IV * Post				-0.091^{*}	0.115^{*}		
				(0.054)	(0.061)		
HRV Transparency						0.021	-0.102^{*}
						(0.052)	(0.052)
HRV Transparency * Post						-0.091^{*}	0.075
						(0.048)	(0.053)
Control	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y
Rule of Law * Year FE	N	N	Y	N	N	N	N
Observations	3,442	3,442	3,442	3,442	3,442	2,873	2,873
R^2	0.431	0.436	0.448	0.424	0.436	0.434	0.447
Adjusted R^2	0.339	0.345	0.353	0.331	0.345	0.330	0.344

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

Table A.4: Robustness Check: Health Capacity

	Dependent variable: log(1 + DONs reports)				
	(1)	(2)	(3)	(4)	(5)
Isolation from US		−0.048		−0.143	−0.074
		(0.107)		(0.107)	(0.140)
Isolation from US * Post		0.210***		0.359***	0.321***
		(0.073)		(0.092)	(0.088)
Basic sanitation services	−1.127	−1.227			−8.712
	(1.640)	(1.684)			(6.812)
Basic sanitation services * Post	−0.296***	−0.204***			−0.115
	(0.070)	(0.072)			(0.139)
Hospital bed			0.278***	0.175*	0.312*
			(0.100)	(0.091)	(0.167)
Hospital bed * Post			−0.205***	−0.031	−0.074
			(0.075)	(0.071)	(0.116)
Control	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y
Observations	2,598	2,598	1,587	1,587	1,284
R^2	0.493	0.497	0.575	0.591	0.654
Adjusted R^2	0.381	0.385	0.413	0.433	0.477

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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