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

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Abstract

Can international organizations (IOs) facilitate deeper cooperation from states than what their material resources permit? The authority over information dissemination to their members empowers weak IOs. I investigate the role of the World Health Organization (WHO) in facilitating states' cooperation with the reporting of disease outbreaks. After the Severe Acute Respiratory Syndrome outbreak, the WHO was authorized by the International Health Regulations reform to disseminate outbreak information to the international community without waiting for states to confirm first. When states' attempt to conceal diseases leads to the WHO's information dissemination, states anticipate trade and travel restrictions imposed by the international community ex post. Those who might have been reluctant to disclose before the reform do so now more frequently. This is especially true for countries with weak linkages to the international community, where those restrictive measures might bind more tightly. Using the number of Disease Outbreak News to measure states' cooperation and linkages to different countries to proxy for linkages to the international community, I find that states with weak political alignment with the U.S. and its allies have fewer reports before the reform, confirming the presence of outbreak concealment. The reform increased reporting from those previously uncooperative states.

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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 U.S.-centric."
>
> Dr. Tedros Adhanom Ghebreyesus, Director-General of the WHO

1 Introduction

Can international organizations (IOs) facilitate cooperation from states? IOs are generally equipped with expertise but limited material resources to enforce cooperation. This is well illustrated during the Covid outbreak. Despite its expertise in public health, the World Health Organization's (WHO) appeal for information sharing and advice against trade and travel restrictions is frequently ignored by states (Maxmen, 2021), leading to uncoordinated efforts in managing the Covid outbreak (Rauhala, 2020). With a $1.2 billion budget at its discretion, which is equivalent to only one-sixth of the total discretionary budget at the Centers for Disease Control and Prevention (CDC) of the U.S.,[1] the WHO is constrained by the limited options in its toolbox. What institutional arrangement can empower the WHO in facilitating deeper cooperation from states than what its material resources permit?

The authority over information dissemination to its members empowers the WHO. States are reluctant to share outbreak information with the WHO in fear of the costly trade and travel restrictions imposed by the international community (Hollyer et al., 2015; Worsnop, 2019; Carnegie and Carson, 2020), leading to delayed responses to outbreaks and an even larger scale of damage. This is what happened during the Severe Acute Respiratory Syndrome (SARS) outbreak in China in 2003. After that, the WHO was authorized by the International Health Regulations (IHR) reform to disseminate outbreak information to its members without waiting for the outbreak state to confirm first. When their attempt to conceal diseases triggers the dissemination of outbreak information by the WHO to its mem-

[1] The calculation is based on the 2019 data in the WHO's Programme Budget Web Portal and the Office of Financial Resources report at the CDC.

bers, states anticipate those restrictive measures ex post. As such, those who might have been reluctant to disclose do so now more frequently. This is especially true for states with weak linkages to the international community, where the restrictive measures are stronger.

I develop a formal model to investigate the impact of this reform on the strategic incentives of states to share or withhold information on disease outbreaks. A global scale of interdependence among states means that an outbreak in one country can both directly spread to other countries and indirectly disrupt their political and economic activities. To minimize the negative impact of an outbreak, the international community provides resources to mitigate the outbreak and imposes border restrictions to shut the virus out of its territory. When the outbreak state is closely linked to the international community, border restrictions become less favorable than resource provision because the disruption caused by trade and travel bans may backfire. As such, states with strong linkages to the international community are likely to receive more resources and face fewer restrictions upon a disease outbreak.

Equipped with expertise in public health, the WHO can detect the presence of disease outbreaks but is constrained by its information authority. Before the IHR reform, the WHO cannot unilaterally disseminate the outbreak information to its members. States with weak linkages to the community can successfully conceal the outbreak to avoid those costly restrictions, while states with strong linkages to the community proactively report outbreaks to the WHO to benefit from the material support provided by the international community. Hence, before the IHR reform, states with strong linkages to the international community are more cooperative with the reporting of outbreaks than those with weak linkage.

After the IHR reform, those previously uncooperative states foresee that the information generated by the WHO can trigger costly restrictions ex post and hence become more forthcoming with outbreaks. Therefore, the IHR reform can induce cooperation from states with weak linkages to the international community.

To test these implications of the model, I use a difference-in-differences specification where I use the IHR reform as the treatment of the institutional change and explore the variation in states' linkages to the international community. I use the number of Disease Outbreak News (DONs) as a proxy for states' cooperation with disease outbreak reporting. This is because of the outbreak verification procedure at the WHO (Grein et al., 2000), where only reports confirmed by the outbreak country can appear on the DONs webpage, the most frequently visited webpage on the WHO website.

I take three steps to operationalize states' linkage to the international community. First, I measure linkage proximity using a state's linkages to the U.S. based on a set of political, economic, and geographic variables. I find that states with weak political alignment with the U.S. have fewer DONs reports before the IHR reform, confirming the existence of disease concealment. The reform reduced the gap in reporting between states with strong political alignment with the U.S. and those with weak alignment, signifying the increased reporting from those previously uncooperative states. As a placebo test, I use the number of outbreak events as the dependent variable and find that the previous patterns disappeared, suggesting that outbreak reporting is a politicized process. In addition, these results are specific to political linkage and do not apply to economic or geographic linkages.

Second, I examine a state's linkages to different major powers in the world. The analyses reveal that the increase in reporting is specific to countries with weak political alignment with the U.S. and its allies, not those with weak alignment with other major powers, such as China and Russia. This reveals that increasing the authority over information in IOs may not mitigate the political influence of powerful states but rather exacerbate it. Lastly, I consider states' economic linkages to the world and do not find a similar pattern as the model predictions, reinforcing that the outbreak reporting is politicized.

I make three contributions. First, I speak to the literature on states' compliance with their obligations under international treaties (Simmons, 2010). One canonical understanding is that states' compliance comes from the selection of which states opt into the institution (Downs et al., 1996; Stein, 2005) rather than the institution's constraining power. In contrast, I show that installing the authority over information into the institution makes it possible for IOs to play a proactive role in facilitating deeper cooperation from their members than what their resources permit.

Second, the heterogeneous effect of the IHR reform reveals a new mechanism of indirect influence of powerful actors over IOs (Stone, 2011; Dreher et al., 2019; Vreeland, 2019; Clark and Dolan, 2020). Previous studies show that the U.S. can influence the IOs through indirect channels, such as an exchange between formal and informal power (Stone, 2011) and bureaucrats' internalization of the U.S.'s preferences (Clark and Dolan, 2020). Due to the linkage strength that a country has to the international community, the IHR reform has more constraining power over states less politically aligned with the U.S. and its allies. Such heterogeneity suggests that the existing structure of interdependence in the international system is another mechanism of the indirect influence that powerful actors have over IOs.

Lastly, I contribute to the under-studied issue area of global health governance. Existing studies show how information dissemination can trigger radical responses (Worsnop, 2017b) and the domestic politics in ban impositions (Worsnop, 2017a; Kenwick and Simmons, 2020), which explains why states conceal disease outbreaks (Kamradt-Scott, 2015; Worsnop, 2019). Incorporating their insights, I examine the institutional design in infectious disease surveillance and reveal the heterogeneous impact of the IHR reform on states' cooperation with the reporting of disease outbreaks.

2 Background

2.1 World Health Organization

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

Despite the numerous responsibilities to fulfill, the WHO has limited resources to enforce cooperation. It has two primary components of revenues (Kaiser Family Foundation, 2020). One is the assessed contributions, which are set amounts expected to be paid by member state governments, scaled by income and population. Accounting for less than 20% of the total budget, assessed contributions are often used to cover general expenses and program activities. The other component is voluntary contributions, including other funds provided by member states, private organizations, and individuals. 90% of the voluntary contributions are earmarked by donors for certain activities. For example, as the biggest non-state donor, the Bill & Melinda Gates Foundation accounts for more than 10% of total voluntary contributions to the WHO, 60.59% of which are specified for polio eradication from 2018 to 2019.[2] Only 3.9% of all voluntary contributions are fully unconditional and subject to the WHO's discretion. Compared to the $7.4 billion discretionary budget[3] for the CDC of the U.S., the WHO has only about 20% of its $6 billion total budget at its discretion.

2.2 History of the International Health Regulations Reform

The International Health Regulations (IHR) is an agreement among 196 countries to work together for global health security. It was originally named the International Sanitary Regulations (ISR) and was first adopted on 25 May 1951 to prevent the international spread of diseases while minimizing disruption to trade and commerce. The recognized diseases under this framework were chosen particularly for their disruption to international trade, such as typhus, cholera, plague, yellow fever, smallpox, and relapsing fever. Without significant adjustments over time, ISR was renamed in 1969 as IHR. Despite its long presence, the IHR had been "viewed as ineffective and insipid, were openly derided, and were frequently ignored" (Kamradt-Scott, 2015, p. 101).

[2]The data is obtained from the WHO's Programme Budget Web Portal (http://open.who.int/2018-19/home).

[3]The number is based on the FY 2019 budget obtained from: https://www.cdc.gov/funding/documents/fy2019/fy-2019-ofr-snapshot-508.pdf

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, p. 106), motivated states to reform the IHR. At the WHA in 1995, states voted to revise and update the IHR. However, it took ten years to complete the revision due to various reasons.[4] It was until the SARS outbreak in 2003 that alerted the international community about the insufficiency of the existing IHR framework and the urgency to finish the revision.

The IHR reform is generally regarded as revolutionary due to its intervention in states' sovereignty. There are two substantive changes in the IHR reform (2005). First, the IHR reform authorized the WHO to report and act based on non-governmental sources of information if the disease outbreak country fails to cooperate. Paragraph 3 of Article 10 in IHR (2005) specifies that WHO "shall offer to collaborate with the State Party" in on-site assessments, and paragraph 4 states that WHO may share the disease outbreak information with other States Parties "when justified by the magnitude of the public health risk". 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 of different languages to detect potential events that are of public health concern, which is one of the most important sources of non-governmental information. However, before the IHR reform, the WHO did not have the authority to act on the information detected from the GPHIN until it obtained official confirmation from the affected state.

Second, the reform grants the director-general the unilateral authority to declare a Public Health Emergency of International Concern (PHEIC). Such declaration may trigger restrictive measures from other states and intervenes the national sovereignty. It attracted resistance from member states and delayed the completion of the IHR revision for another year. As a compromise, the reform incorporated more flexibility in the declaration process, which

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

pushed through the reform efforts. Specifically, the IHR reform requires the director-general to convene an Emergency Committee composed of a group of technical experts with at least one expert being nominated by the disease outbreak country. This gives the outbreak states some control over the PHEIC declaration.[5]

The revised IHR framework was unanimously approved by the Inter-Governmental Working Group (IGWG) at the 58th WHA and has been in effect since 15 June 2007.[6]

3 A Model of Disease Outbreak Reporting

I develop a model to demonstrate how the authority of information dissemination at the WHO affects states' incentive to share or withhold information on disease outbreaks. The model captures the early stage of disease outbreaks when the international community is not aware of the existence of an outbreak. The model features three actors: the leader of the disease outbreak country (L), the agency or the WHO (A), and the international community (C).

3.1 Sequence

Here is the sequence of the model:

1. Nature determines that the outbreak is severe with probability ψ: $Pr(\theta = 1) = \psi$.[7]

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

[5]This paper focuses on the first aspect of the IHR reform because the PHEIC declaration follows a different procedure and is a rare event since its inception. There are only seven PHEIC declarations: the H1N1 outbreak in 2009, the Polio outbreak in 2014, the Ebola outbreak in West Africa in 2014, the Zika outbreak in 2016, the Ebola outbreak in the Democratic Republic of the Congo in 2016, the Covid outbreak in 2020, and the ongoing Monkeypox outbreak in 2022.

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

[7]I assume that ψ is a very small number, suggesting that severe diseases are rare events.

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

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

3.2 Payoffs

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

$$U_L(r_L) = -\underbrace{\theta(1-m)}_{\text{Disease damage}} - \underbrace{b}_{\text{Costs from ban}}$$

First, when there is an outbreak, L suffers from the damage caused by the outbreak, while the resources provided by C can mitigate L's costs of outbreak damage. Second, since C may impose restrictive measures, L also suffers from the disruption caused by the bans.

As an agency specializing in public health, A aims to control the disease's spread. Its utility function is as follows:

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

Given its limited resources, what A can do to control the outbreak is to use information dissemination to trigger outbreak responses by the international community. Since both resources and bans have a constraining effect on disease spread, the achievement of A's disease control goal depends on the magnitudes of resources m and bans b.[8] However, as information dissemination without states' consent is regarded as an intervention in states' sovereignty, A incurs an overriding cost if it reports outbreaks to C without L's approval. The parameter of interest is $p \in [0, 1]$, which captures the level of information dissemination

[8]To simply the math, I assume that resources and bans have an additive effect on disease control.

authority that the institutional design grants to A. As such, we may use a decrease in p to represent the IHR reform, which grants the WHO greater authority over information dissemination.

Suffering from the outbreak spillovers, C uses resource provision and ban imposition to minimize the outbreak damage, which is represented in the following utility function:

$$U_C(m,b) = -\underbrace{\theta(1-m-b)}_{\text{Disease damage}} - \underbrace{\alpha(\theta(1-m)+b)}_{\text{Damage due to linkage}} - \underbrace{(k_m(m)+k_b(b))}_{\text{Costs for resource and ban}}$$

First, the outbreak causes direct damages to C if the outbreak spreads outside of L's territory. By giving resources and imposing bans, C can reduce the direct damages of the outbreak. Second, with interdependence in political and economic activities among states, the disruption by an outbreak in one country may lead to disruption in other countries if they have strong linkages with each other. For example, due to the prevalence of fragmented production, the temporary shutdown of firms in L can disrupt the operations of firms in the same supply chain in other countries. Conceptualizing interdependence as the mutual sensitivity in payoff structures, I assume that C internalizes the utility of L when considering the indirect damage of the outbreak. To measure how strong C is affected by the disruption in L's territory, I use the parameter $\alpha \in [0,1]$ to capture the linkages between L and C, which is the key parameter of interest in this model.

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

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

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

γm^2 and λb^2 correspond to the material costs of resources and bans,[9] while $\varepsilon_m \mathbb{1}\{m > 0\}$

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

and $\varepsilon_b \mathbb{1}\{b > 0\}$) are the administrative costs once any resources or bans are provided.[10]

3.3 Information Set

The model focuses on the early stage of a disease outbreak. I assume that both L and A observe θ, while C does not. First, the direct interaction with early cases of the disease makes L more informed about the severity of an outbreak. Second, I assume that A's expertise in public health allows for complete information about the outbreak. This assumption focuses our attention on the institutional role of information dissemination and abstracts away from the informational component in A's message. Lastly, I assume that C cannot observe θ and can only make its decision based on L and A's actions. All the other parameters are public information to all three actors.

3.4 Equilibria

The equilibrium concept is weak Perfect Bayesian Equilibrium. The following proposition summarizes the equilibria of the model.[11]

Proposition 1 *Let* $\alpha^* = \dfrac{\gamma - \lambda}{\gamma + \lambda}$ *and* $\alpha^{**} = \dfrac{\gamma + \lambda - 2\gamma\lambda p}{\gamma - \lambda}$. *L's reporting strategy is* $r_L = \begin{cases} \theta & \text{if } \alpha \geq \alpha^* \text{ or } \alpha \leq \alpha^{**} \\ 0 & \text{otherwise} \end{cases}$. *A's reporting strategy is* $r_A = r_L$. *C provides resources* $m^* = \begin{cases} \dfrac{1+\alpha}{2\gamma} & \text{if } r_A = 1 \\ 0 & \text{otherwise} \end{cases}$ *and imposes bans* $b^* = \begin{cases} \dfrac{1-\alpha}{2\lambda} & \text{if } r_A = 1 \\ 0 & \text{otherwise} \end{cases}$. *C forms its belief about the outbreak severity* $Pr(\theta = 1 | r_A = 1) = 1$ *and* $Pr(\theta = 1 | r_A = 0) = \psi$, *where* $\psi = Pr(\theta = 1)$.

2020).

[10] To ensure a corner solution in C's equilibrium strategy, I include these administrative costs with certain constraints. $\varepsilon_m + \varepsilon_b \leq \dfrac{(1+\alpha)^2}{4\gamma} + \dfrac{(1-\alpha)^2}{4\lambda}$ ensures that C's outbreak responses are not deterred by high administrative costs, and $\varepsilon_m \geq \dfrac{(1+\alpha)^2\psi^2}{4\gamma}$ ensures that C does not choose a small amount of m and b when there is no sign of disease outbreak. The calculation of these constraints is in Appendix A.1.

[11] The solution to the game is in Appendix A.1.

From the equilibria, we can see that C's responses to outbreaks depend on its linkages with L. As L's linkages to C become stronger, C is likely to provide more resources and impose fewer restrictive measures. This result is crucial for our understanding of the decisions by L and A.

Figure 1 illustrates L's reporting strategy with different levels of linkage strength to C and information authority in A. The light grey area represents the truthful reporting by L, which contains two different situations. First, when L has strong linkages to C ($\alpha \geq \alpha^*$), L anticipates receiving a large number of resources and facing few restrictive measures once C becomes aware of the outbreak. As such, L benefits from A's dissemination of the outbreak information and proactively report the outbreak to A. Second, when L has weak linkages to C ($\alpha \leq \alpha^*$ and $\alpha \leq \alpha^{**}$), L knows that information dissemination can only lead to strong bans and few resources and wants to conceal the outbreak. However, since A knows that C's restrictive measures are strong enough to contain the outbreak within L's territory, A is willing to override A's reluctance in disclosure and make C aware of the outbreak. Foreseeing strong restrictive measures ex post, L becomes cooperative with the outbreak reporting.

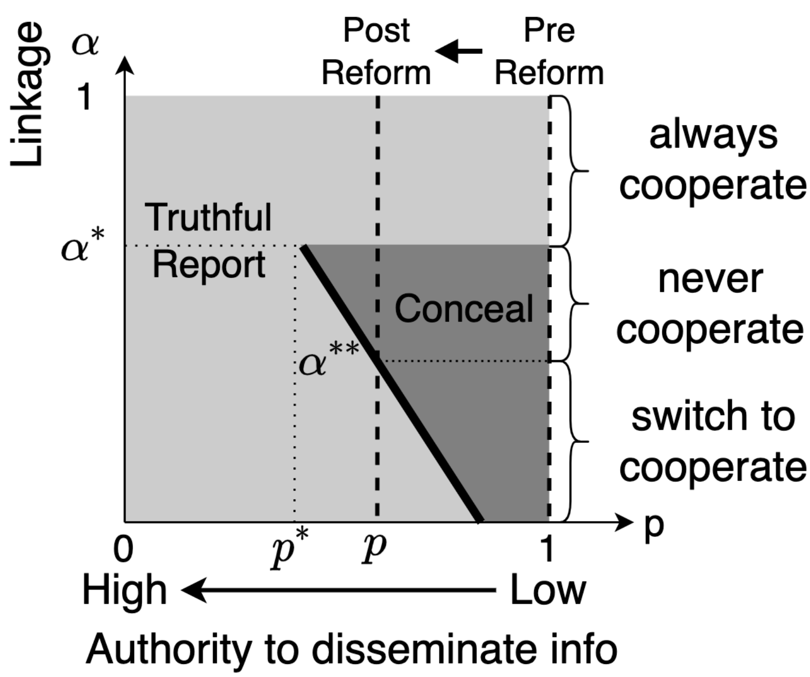

Figure 1: L's Reporting Strategy

The dark grey area in Figure 1 indicates the situation where L conceals the outbreak. When L does not have strong enough linkages with C ($\alpha < \alpha^*$), L does not benefit from the information dissemination and has incentives to withhold the outbreak information. Meanwhile, as L's linkages to C are not weak enough ($\alpha > \alpha^{**}$), C's responses to the outbreak are moderate. In A's calculation, it is not worth incurring the overriding costs only to generate a limited effect in outbreak containment. As such, L can successfully conceal the outbreak without the concern of A's information dissemination.

To understand how changes in A's information authority affect L's reporting strategy, the two vertical dashed lines in Figure 1 illustrate a decrease in the value of p, which corresponds to an increase in A's information authority. Moving the vertical dashed line towards the left, we start to see more truthful reporting from L with the weakest linkages to C first. As A is granted even more information authority, we expect more truthful reporting by L with moderate but still relatively weak linkages to C. These changes in L's reporting strategy suggest that granting more authority of information dissemination to A is most effective in inducing cooperation from L with the weakest linkages to C.

3.5 Hypotheses

To intuitively demonstrate the testable hypotheses, I assume that the IHR reform moves p from 1 to 0.[12] Figure 2 and Figure 3 demonstrate L and C's strategies under these two extreme scenarios, where A either has zero or complete authority of information dissemination.

As Figure 2 shows, before the IHR reform when the WHO cannot unilaterally disseminate the outbreak information, only states whose linkages to the international community is strong enough report the outbreak. This explains the concealment efforts by the Chinese government during the SARS outbreak in 2003 (Huang, 2004). After the IHR reform allows the WHO to disseminate the outbreak information at its own discretion, those who would otherwise be reluctant to disclose become more forthcoming with the outbreaks, which ex-

[12] This assumption is only for illustrative purposes and does not affect the substances in the hypotheses.

plains the timely reporting by the Chinese government during the Covid outbreak in 2020 (Horton, 2020).

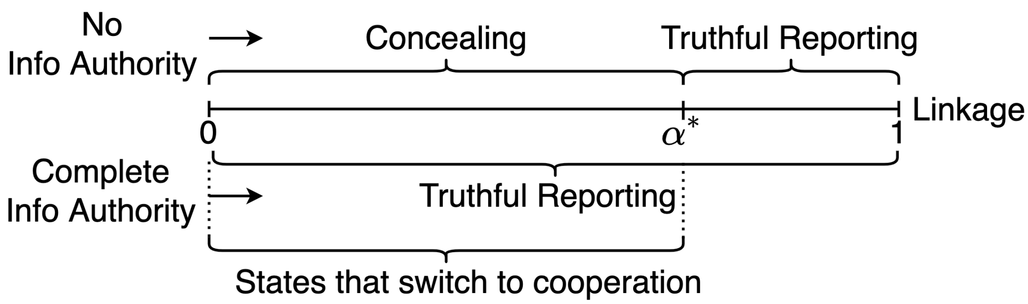

Figure 2: L's Strategy: Comparison Between $p = 1$ an $p = 0$

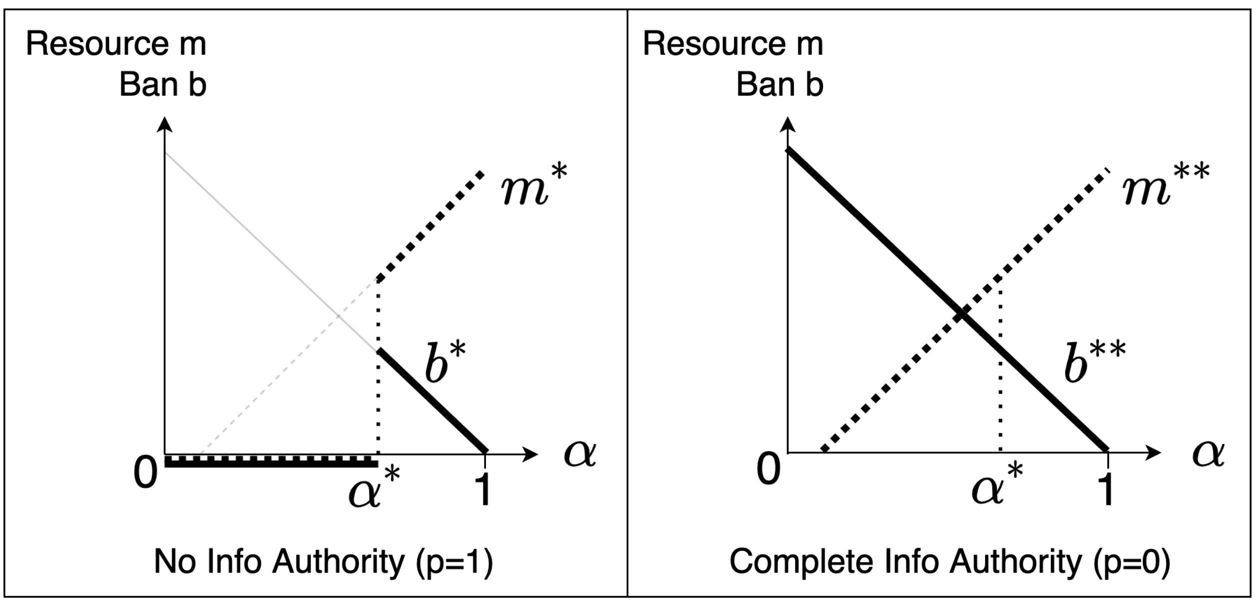

Figure 3: C's Strategy: Comparison Between $p = 1$ and $p = 0$

Figure 3 illustrates how the IHR reform affects resource provision and ban imposition by the international community. The dotted and solid lines correspond to the magnitude of resources and restrictive measures respectively. The left panel shows the pre-reform world, which is characterized by high resources and low bans. In the post-reform world in the right panel, the international community is more responsive to disease outbreaks, but their reactions are dominated by restrictive measures with limited resource provision. This comparison provides us with a comprehensive picture of the IHR reform. Arguably, the IHR reform is effective in facilitating cooperation with the reporting of disease outbreaks. However, such benefits come at the cost of stronger restrictive measures, which disrupts the efficient allocation of medical resources to contain the outbreak.

In the following sections, I describe the empirical test on the following hypotheses:

Hypothesis 1 *Before the IHR reform, states with weak linkages to the international community are less cooperative with the reporting of outbreaks.*

Hypothesis 2 *The IHR reform induces more outbreak reporting by weaker linkage states, which would otherwise be reluctant to disclose.*

4 Data

4.1 Disease Outbreak News (DONs)

To measure states' cooperation with outbreak reporting, I construct a variable based on the number of disease outbreak news a country has every year. I obtain the data from the WHO's Disease Outbreak News (DONs) webpage[13], which is the most frequently accessed webpage on the WHO website and is a platform where the WHO disseminates officially confirmed information about disease outbreaks of international importance. Because of the outbreak verification process in the WHO, we can use the number of DONs reports to measure cooperation. Figure 4 illustrates the data generating process of each report on the DONs website (Grein et al., 2000). Based on the GPHIN and other information sources, the system generates reports of events that might be of concern. Every day in the morning, a team at the WHO headquarters evaluates the importance of the events. Once an event is deemed important, the outbreak verification team will seek verification from the disease outbreak country. Only upon the receipt of official confirmation will the WHO post a report on the DONs webpage. In other words, if a state refuses to confirm the outbreak, we will not

[13]Website: https://www.who.int/csr/don/en/

see the report in the data set. Thus, the number of DONs reports can be a good indicator to capture states' cooperation with the reporting of outbreaks before the reform in 2005.[14]

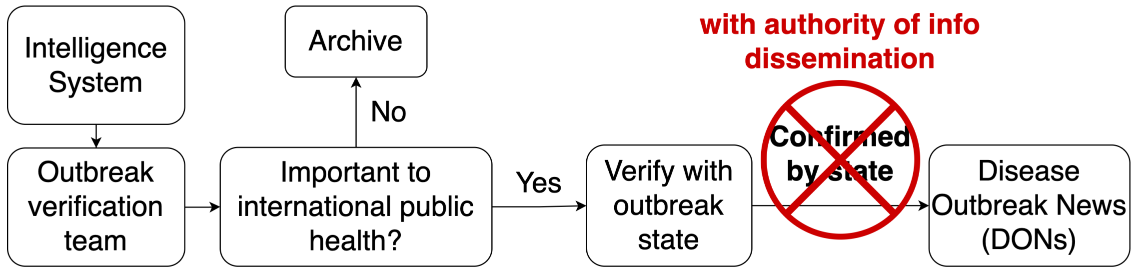

Figure 4: Disease Outbreak Verification System

With variations in the contents over time, all reports in the DONs include basic information such as the reporter, disease type, region of the outbreak, and the number of cases. After scraping the website, I obtained a dataset of 2874 reports covering dates from 1996 to May 14, 2020.[15] The left panel of Figure 5 summarizes the over-time change in the number of reports. The spike in 2003 reflects the SARS outbreak, while the spike in 2014 reflects the Ebola outbreak in West Africa and the Middle East respiratory syndrome coronavirus (MERS) outbreak. The right panel shows the most frequently reported disease types.

I also collect the disease outbreak event data from a third-party source: the Global Infectious Diseases and Epidemiology Online Network (GIDEON),[16] a platform mainly used by health professionals and educators for infectious disease diagnosis and reference purposes in hospitals and universities. Due to its functional nature, the GIDEON dataset provides a relatively less politicized source of the severity of disease outbreaks. We can see from the left panel of Figure 5 that the number of outbreaks is stable over time, while the number of reports varies.

[14] One potential concern with this measure is that the number of reports reflects the agency's information dissemination r_A instead of the state's cooperation r_L. However, as the model shows, $r_A = r_L$ at the equilibrium, suggesting that the number of reports can indirectly represent states' cooperation.

[15] To code the disease outbreak countries in each report, I use regular expressions to identify the country name from the headline. For reports that do not identify country names in headlines, I first use the same regular expressions to identify the country names from the report content. Then, I read the contents to verify that the identified countries are the ones that experienced outbreaks. Figure A.1 shows the histogram of the number of countries in each report. Figure A.2 presents the coverage of countries over time. Figure A.3 shows the most frequently reported countries before 2005 and after 2005.

[16] Website: https://www.gideononline.com/. Figure A.5 shows the interface of this database.

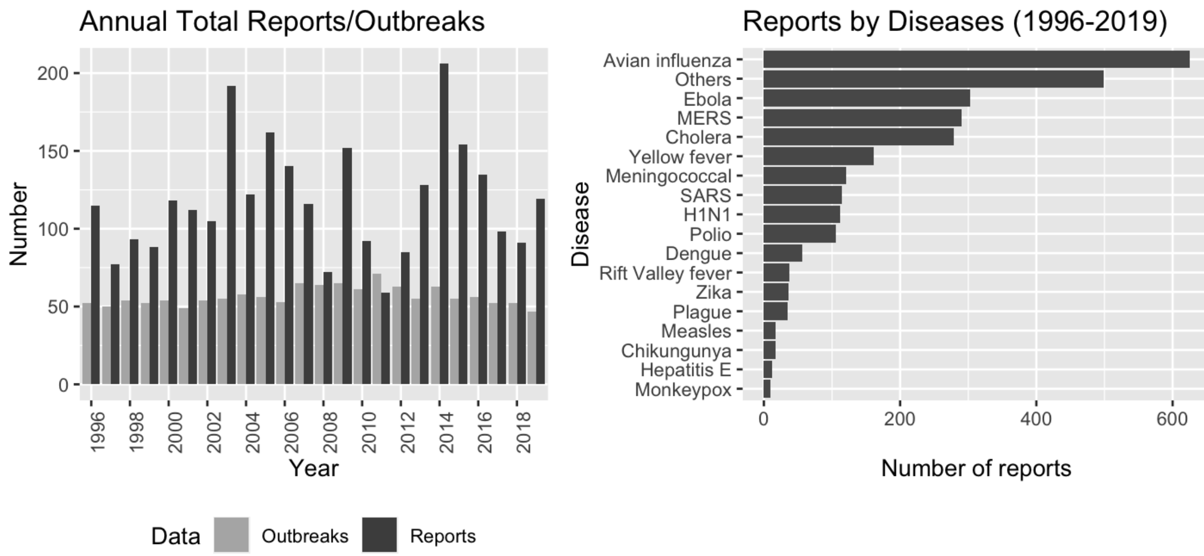

Figure 5: Number of Reports Overtime and Major Disease Types in DONs

To transform the report dataset into a country-year panel, I sum the reports by country and year and balance the panel by coding the missing country-year entries as zero. The final dataset covers 152 countries in the period from 1996 to 2015.[17] As is shown in Table 1, each country has on average 2 reports every year. The maximum number of reports a country receives in a year is 75, which corresponds to the reports on SARS for China in 2003. 69.3% of the country-year pairs have zero reports.

4.2 Linkage Proximity

I use a state's linkage to the U.S. to measure linkage proximity with the international community. Since the U.S. and its allies have the greatest influence in the international arena and are the major aid providers, treating the U.S. as the representative of the international community can well capture the international community's responses to disease outbreaks. I construct political, economic, and geographic linkages. First, I use the ideal point estimates ($IdealDistance_{it}$) based on the voting records at the United Nations General Assembly

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

(UNGA) (Bailey et al., 2017) to measure the political linkage.[18] I use the absolute difference of the ideal point estimate between a country and the U.S. to measure the political alignment. The larger the magnitude, the weaker the linkage is.[19] Second, I use the total imports from the U.S. to measure economic linkages. I also examine economic linkage based on total trade volume with the U.S. and total exports to the U.S. Third, to measure the geographic linkage, I use the number of seats on direct flights to the U.S.[20] because it captures the capacity of population movement and reflects the geographic linkage in the age of extensive international travel.

The summary statistics of these three variables are shown in Table 1.

Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Median	Max
N. of DONs reports	2,922	2.163	7.485	0	0	75
Ideal Point distance with US	2,922	2.884	0.846	5.175	3.091	0.114
log(1+total trade volume with US)	2,922	20.756	3.161	0.000	20.919	27.225
log(1+total imports from US)	2,922	19.834	3.071	0.000	19.848	26.467
log(1+total exports to US)	2,922	19.758	3.831	0.000	20.090	26.910
log(1+seats on direct flights to US)	2,922	6.669	6.615	0.000	5.849	17.342
Polity IV	2,922	3.624	6.294	−10	6	10
UNSC membership	2,922	0.094	0.292	0	0	1
log(1+GDP per capita)	2,922	8.296	1.512	5.218	8.216	11.425
log(1+population)	2,922	16.163	1.523	12.792	16.118	21.034
IMF participation	2,922	0.332	0.471	0	0	1
Openness	2,922	0.545	0.421	0.000	0.485	3.454
N. of desease outbreaks (GIDEON)	2,922	1.743	2.662	0	1	24

[18] This measure accounts for the agenda change over time at the UNGA and allows for the inter-temporal comparison of alignment. Thus, it is an improvement to the measurement based on disagreement vote share.

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

[20] The data is obtained from the U.S. Department of Transportation website: https://www.transportation.gov/policy/aviation-policy/us-international-air-passenger-and-freight-statistics-report.

4.3 Regression Specification

I employ the difference-in-differences (DID) specification with the IHR reform as the treatment and explore the variation in a country's linkage to the U.S. Unlike the standard DID approach, where the control group is not treated and serves as the counterfactual, the treatment in this paper affects all countries but the magnitude of influence varies with the degree of linkage to the U.S. Hence, the intuition of this identification strategy is to compare the difference in compliance between groups that are more sensitive to the treatment with the groups that are less sensitive and to identify the differences between these two groups. By assuming that the treatment has a one-directional impact on all groups, meaning that the IHR reform does not reduce the level of cooperation from states with a strong linkage to the U.S., the identified effect is a conservative estimate of the effect of the IHR reform on states' cooperation. The identification assumption is that the trend in the relationship between the linkage to the U.S. and the number of DONs reports is the same in the absence of the reform. The regression equation is shown below:

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

where i, r, and t indicate the country, regional office, and year respectively. The dependent variable is the number of DONs reports in the logarithm. $Linkage_{i,t-1}$ represents the measures of states' political, economic, and geographic linkage proximity to the U.S. The coefficient β_1 identifies the relationship between linkage to the U.S. and the level of states' cooperation before the IHR reform, which is expected to be positive if Hypothesis 1 holds. $Post_t$ is a dummy variable indicating the post-reform period. The coefficient β_2 of the interaction term $Linkage_{i,t-1} * Post_t$ identifies the causal effect of the authority of information dissemination on states' cooperation with outbreak reporting, which is expected to be negative according to Hypothesis 2.[21]

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

In addition to the above specifications, I control for a vector of country-year specific control variables X_{it}. First, as infectious diseases have a close relationship with international trade and travel, I control for the openness of the economy, which is measured as the total import and export volume over total GDP. As infectious diseases are disruptive to international trade, countries with greater openness are less willing to disclose their outbreak information. Hence, states with greater openness should have fewer DONs reports.

Second, I control for a country's engagement in other international organizations. I control for whether a country is a member of the United Nations Security Council (UNSC). Previous research shows that being on the UNSC creates space for vote-buying (Dreher et al., 2019), 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

[21] As the ideal point distance measure has an opposite sign to the linkage variable, I will flip the sign of the measure to make the coefficient estimates have consistent signs.

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 participated 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 amount of DONs reports may increase as a result of the low capacity to deal with the outbreak.

Lastly, I control for the regime type to account for the fact that democracies have a stronger domestic mechanism to induce compliance (Dai, 2005). I also control for GDP per capita and population size to account for the general conditions. The summary statistics of these control variables are in Table 1.[22] All the independent variables are lagged for one year to avoid simultaneity bias.

5 Results

Table 2 reports the baseline results. Column (1), (3), (5), and (7) examine how the linkage to the U.S. affects the number of DONs reports, while Column (2), (4), (6), and (8) test the first two hypotheses of the paper. None of the linkage variables has a significant impact on the number of reports. However, linkage plays an important role once we take into consideration the IHR reform. For political linkage, one standard deviation increase in the ideal point proximity with the U.S. leads to about an 8% increase in DONs reports before the reform (Row 1). After the IHR reform, one standard deviation further away from the U.S.'s ideal point estimate significantly increases the number of DONs reports by about 21% (Row 2). The results with economic linkage exhibit a similar pattern, but the effect is not statistically significant. Fewer imports from the U.S. do not reduce the DONs reports before the reform (Row 3), but they do increase the number of DONs reports after the reform (Row 4), which is consistent with Hypothesis 2. However, the results with geographic linkage do not display

[22] Table A.11 presents the data sources of these variables.

a consistent pattern as the model predicts. More seats on direct flights to the U.S. reduce the number of DONs reports, and the IHR reform seems to impose a negligible impact on DONs reports. Column (8) includes all three of the linkage variables. The previous results hold. To further explore the economic linkage, I replicate the results in Column (4) with the economic linkage measured as total trade volume with the U.S. and exports to the U.S. in Table A.1. The impact of economic linkage is mainly driven by imports from the U.S.

One potential threat is that the results could be driven by the actual disease severity instead of states' cooperation with outbreak reporting. The linkage variables may correlate with other factors that influence how much resources a country invests in public health facilities and hence how likely a country experiences disease outbreaks. To address this concern, I conduct a placebo test using the number of outbreak events as the dependent variable. If the DONs reports reflect the actual severity of disease outbreaks, we should observe a similar pattern as Table 2 shows.

Using the number of outbreak events from the GIDEON database as the dependent variable,[23] Table 3 presents the result. The patterns in Table 2 disappear. For political and economic linkages, the coefficients of the interaction terms flip the signs and become statistically insignificant. The results with geographic linkage present an opposite pattern to the model prediction: stronger geographic linkage reduces the disease outbreaks before the reform, but it significantly alleviates the negative correlation after the reform. These results suggest that the disease outbreak reporting process is politicized.[24]

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

[24]As the number of disease outbreak events is a post-treatment control, I do not control for it in the baseline setting. However, as is shown in Table A.2, the baseline results still hold after controlling for this variable.

Table 2: Economic and Political Links and Disease Outbreak Report

	Dependent variable:							
	log(1 + DONs reports)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ideal point proximity with US	−0.085	0.105					−0.089	0.074
	(0.092)	(0.107)					(0.092)	(0.102)
Ideal point proximity * Post2005		−0.359***						−0.324**
		(0.126)						(0.130)
Total imports from US			−0.013	−0.009			−0.012	0.096*
			(0.013)	(0.014)			(0.013)	(0.049)
Total imports from US * Post2005				−0.064**				−0.068**
				(0.031)				(0.031)
Seats on Direct Flight to US					−0.014*	−0.011	−0.012*	−0.018**
					(0.008)	(0.010)	(0.007)	(0.009)
Seats on Direct Flight * Post2005						−0.007		0.014
						(0.010)		(0.011)
Control	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,845	2,845	2,875	2,875	2,875	2,875	2,845	2,845
R^2	0.655	0.657	0.652	0.654	0.653	0.653	0.655	0.659
Adjusted R^2	0.568	0.570	0.566	0.567	0.566	0.566	0.568	0.572

Note: *p<0.1; **p<0.05; ***p<0.01

Standard error clustered at the country level in parentheses.

Table 3: Economic and Political Links and Disease Outbreak Events

	Dependent variable: log(1 + number of disease outbreaks) (GIDEON)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ideal point proximity with US	0.033	0.001					0.031	0.025
	(0.064)	(0.070)					(0.064)	(0.073)
Ideal point proximity * Post2005		0.060						0.019
		(0.062)						(0.072)
Total imports from US			−0.016*	−0.017*			−0.016*	0.014
			(0.009)	(0.009)			(0.010)	(0.028)
Total imports from US * Post2005				0.014				−0.023
				(0.015)				(0.020)
Seats on Direct Flight to US					−0.003	−0.012*	−0.002	−0.012*
					(0.005)	(0.007)	(0.005)	(0.007)
Seats on Direct Flight * Post2005						0.017***		0.020**
						(0.006)		(0.008)
Control	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,845	2,845	2,875	2,875	2,875	2,875	2,845	2,845
R^2	0.749	0.749	0.746	0.746	0.746	0.747	0.749	0.750
Adjusted R^2	0.685	0.685	0.682	0.682	0.682	0.683	0.685	0.686

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

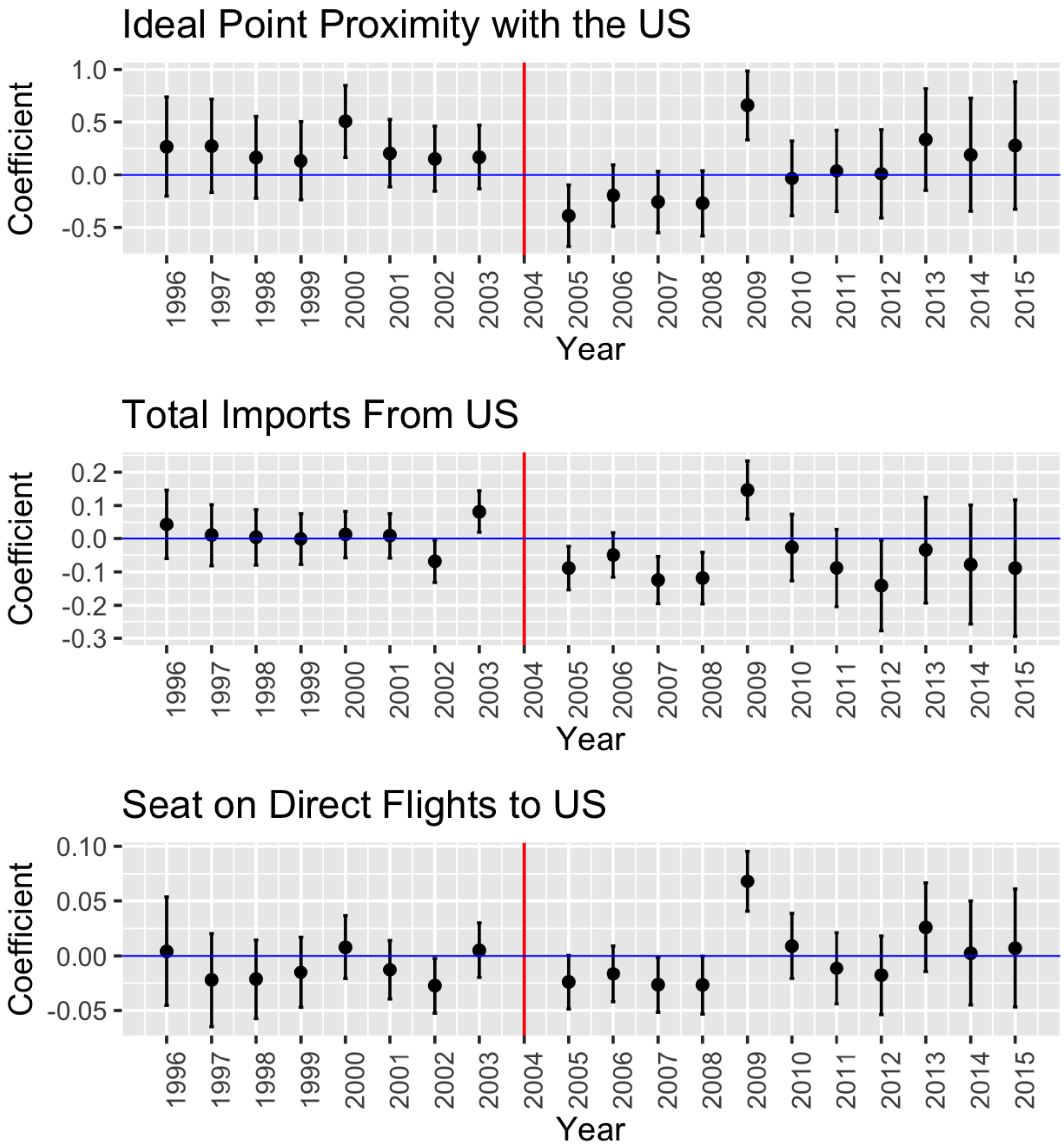

Figure 6: Pre-trend Analysis

To test the parallel trend assumption, Figure 6 presents the coefficient estimates of a vector of year dummies interacted with the three linkage variables. For political and economic linkages, the pre-trend does not seem to exist before the reform: the coefficients of the linkage variable are mostly non-negative and statistically insignificant before 2004. As the negotiation over the IHR reform started in 2005, the reports from states with a weaker linkage started to increase until 2009. The two big spikes in 2009 are likely due to the

H1N1 pandemic, which started in Mexico and was later spread to the U.S. As the disease is more likely to spread to states with a closer linkage to the U.S., the significantly positive coefficients reflect this tendency. For geographic linkages, no significant changes exist before and after 2004, and the only spike is also due to the H1N1 pandemic in 2009, which seems consistent with the null results in Table 3.

I conduct the following robustness checks. First, one alternative explanation is that the IHR reform may have a heterogeneous effect on different regime types. As democracies are more cooperative (Mansfield et al., 2002) and have a stronger domestic enforcement mechanism of compliance (Dai, 2005), the reform may have a greater impact on autocrats' behavior. Table A.3 examines the heterogeneous effect of the IHR reform on regime types and finds that the reform increases democracies' number of DONs of reports after the reform, which is inconsistent with the model prediction. Still, the baseline results become stronger after controlling for the heterogeneous effect of democracy. Second, the transparency level may affect how states respond to the IHR reform. As the reform may have a ceiling effect on states with high transparency levels, the reform may increase the reporting by states with a relatively low transparency level. Using the HRV transparency index (Hollyer et al., 2014), Table A.4 shows that transparency has no effect on the number of DONs reports, and the baseline results still hold after controlling for transparency. Lastly, to make sure the results are not driven by the outbreak of MERS in Saudi Arabia and other outbreaks in China, I exclude Saudi Arabia and China, both separately and altogether, from the regression, and the results still hold.[25]

5.1 What Does the Linkage Mean?

To explore further what the linkages variables are measuring, I use the bilateral treaty portfolio similarity (Lupu, 2016) and the IGO portfolio similarity (Voeten, 2021) to measure political linkage. While the UNGA voting similarity better captures governments' ideology

[25]The results are shown in Table A.5.

and policy positions, the treaty and IGO portfolio similarity may reflect governments' shared commitment to international cooperation (Copelovitch and Powers, 2021). For economic linkage, I use dyadic GVC integration collected from the UNCTAD-Eora Global Value Chain Database (Casella et al., 2019). To investigate whether the results are specific to the U.S., I examine states' linkages to the U.K., France, Germany, China, and Russia.

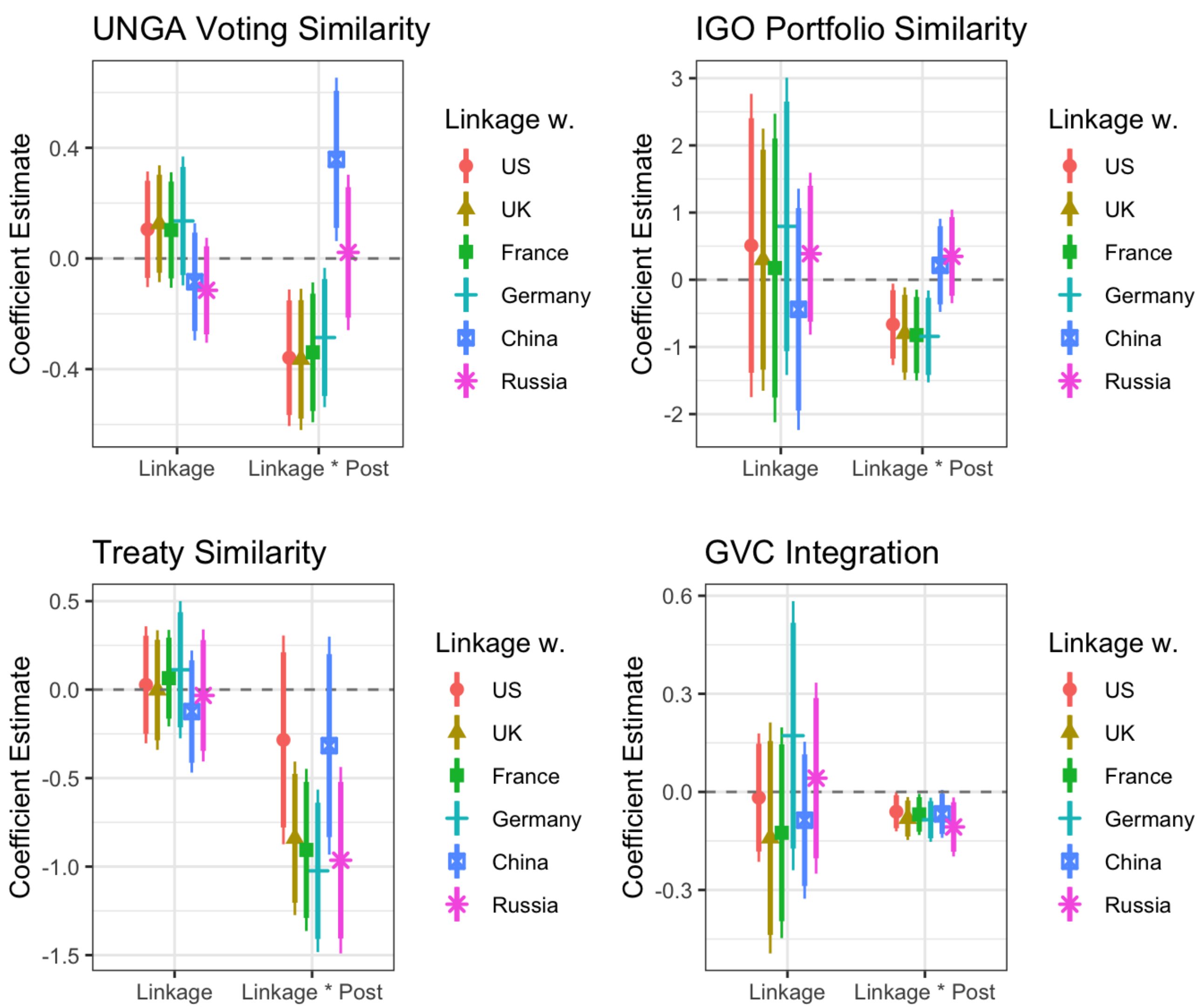

Figure 7: Other Measures of Linkages

Figure 7 shows the coefficient estimates based on the regression specification in Column (2) in Table 2. We can see that both UNGA voting similarity and the IGO portfolio similarity exhibit a similar pattern: the IHR reform increased cooperation from states with weak linkages to the U.S., the U.K., France, and Germany, all of which are the main shareholders of the WHO. Countries with close linkages to China or Russia were less cooperative before the IHR reform and became more cooperative after the IHR reform. For treaty similarity, the pattern applies to the U.K., France, Germany, and Russia. This is different from the model prediction.[26] For GVC integration, the IHR reform increased cooperation from states with closer linkages to all these six countries, which could be because all these six countries are well integrated into GVCs. Overall, these pattern suggests that the IHR reform has a constraining influence on cooperation with outbreak reporting for states with weak political linkages with the U.S. and its allies.

Lastly, I conduct a similar test using different measures of economic linkages to the world. I consider states' total trade volume, openness, and GVC integration with the world. Figure 8 presents the results. None of the measures exhibits a similar pattern as the model prediction. This suggests that economic linkage is not as important in facilitating states' incentives to cooperate as political linkage does.

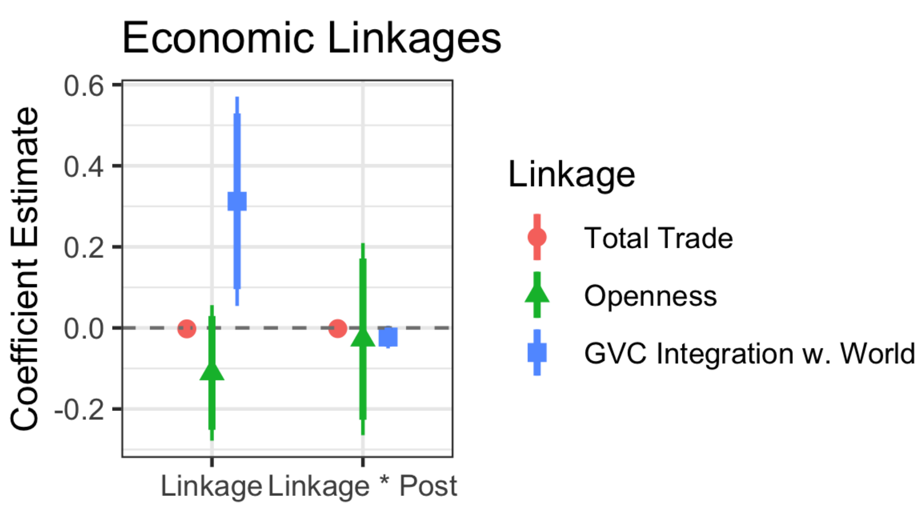

Figure 8: Economic Linkages with the World

[26] One reason why the measure of treaty similarity produces a different pattern could be due to the different time span. The measure of treaty similarity only exists from 1996 to 2009, while the other linkages measures are available from 1996 to 2015.

6 Conclusion

Can IOs facilitate deeper cooperation from their states than what their material resources permit? I provide an institutional solution to this problem. Specifically, the authority over information dissemination to their members empowers IOs to facilitate deeper cooperation from states.

I examine the WHO's role in facilitating states' cooperation with the reporting of outbreaks. As information dissemination of disease outbreaks may trigger trade and travel bans imposed by the international community, the outbreak state has incentives to conceal the outbreak. Once authorized to disseminate outbreak information to the international community, the WHO can leverage responses from the community, which serves as ex-post cost on information withhold and deters noncompliance. More importantly, such enforcement depends on the outbreak state's linkage to the community. Stronger linkage means that the international community is better off providing resources than imposing border restrictions. As such, the WHO can trigger strong restrictions on states with weak linkages to the community, which effectively deters their attempt to conceal outbreaks.

The empirical results support the argument. Before the IHR reform, states with weak linkages to the U.S. are less cooperative with outbreak reporting, confirming the presence of outbreak concealment. The IHR reform increased reporting from states with weak linkage to the U.S. This pattern disappears using the number of disease outbreak events as the dependent variable, suggesting that the disease outbreak reporting process is politicized. In addition, the theoretically consistent patterns only hold for linkages measured by political linkages to the U.S. and its allies and do not apply for political linkages to China or Russia, suggesting that the existing interdependence structure determines the scope of cooperation that information dissemination allows the IO to facilitate.

Given the difficulty in delegating more power to multilateral IOs (Hawkins et al., 2006), why did countries with weak linkages to the U.S. and its allies agree to the IHR reform? As the IHR reform forces these states to change their behavior and cooperate more, these states may have incentives to withdraw from the WHO. Two reasons might explain why the withdrawal did not happen. The first reason is reciprocity. Given the risk of future disease outbreaks in other countries, states with weak linkages to the U.S. expect other countries to share information with the WHO, the long-term benefits of which may cancel out 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 also plays an important role in the harmonization of medical standards and health-related research. As the overall benefits from being a member of the WHO may still exceed the costs of the changes in the IHR reform, states with weak linkages choose to stay even though the IHR reform requires more cooperation from them.

Despite the optimistic findings of this paper, there are some costs of using information dissemination to achieve cooperation in outbreak reporting. As is demonstrated in the Covid outbreak, the WHO's alert about new Covid variants has frequently triggered massive trade and travel bans, making it difficult to distribute personal protective equipment to regions that needed them the most. As the negotiation over a pandemic treaty is still ongoing, understanding how to prevent countries from adopting restrictive measures upon information dissemination will be crucial to achieving welfare-enhancing cooperation in global health governance.

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A Appendix

A.1 Solution to the Model

For C, FOC:

$$Im = \frac{dU_C(m,b)}{dm} = \theta + \alpha\theta - 2\gamma m = 0$$

$$Ib = \frac{dU_C(m,b)}{db} = \theta - \alpha q - 2\lambda b = 0$$

$$m = \frac{\theta(1+\alpha)}{2\gamma}$$

$$b = \frac{\theta - \alpha}{2\lambda}$$

Therefore, m is increasing in α, and b is decreasing in α.

When C believes that $\theta = 0$, $m = b = 0$.

When C believes that $\theta = 1$, $m = m^* = \frac{1+\alpha}{2\gamma}$ and $b = b^* = \frac{1-\alpha}{2\lambda}$.

Knowing how C behaves, we now turn to A's decision-making process, which includes two situations.

A.1.1 A Does Not Incur the Overriding Cost

When L allows A to disseminate information, A does not incur the overriding cost and only transmits a message from L to C.

- Separating equilibrium: $r_L = \begin{cases} 1 & \theta = 1 \\ 0 & \theta = 0 \end{cases}$

$$\begin{cases} E(r_L = 1|\theta = 1) \geq E(r_L = 0|\theta = 1) \\ E(r_L = 1|\theta = 0) \leq E(r_L = 0|\theta = 0) \end{cases}$$

$$\begin{cases} -(1-m^*) - b^* \geq \mu(-(1-m^*) - b^*) + (1-\mu)(-1) \\ -b^* \leq \mu(-b^*) + (1-\mu)0 \end{cases}$$

  Simplify the equations, we have $(1-\mu)(m^* - b^*) > 0$.

  Plug in m^* and b^*, we get $\alpha \geq \frac{\gamma - \lambda}{\gamma + \lambda} = \alpha^*$ and $\mu = 0$.

- Pooling equilibrium: $r_L = 0$

$$\begin{cases} E(r_L = 1|\theta = 1) \leq E(r_L = 0|\theta = 1) \\ E(r_L = 1|\theta = 0) \leq E(r_L = 0|\theta = 0) \end{cases}$$

In this case, $\alpha < \alpha^*$ and $\mu = \psi$, where $\psi = Pr(\theta = 1)$.

- Pooling equilibrium $r_L = 1$ does not exist.
- Separating equilibrium $r_L = \begin{cases} 0 & \theta = 1 \\ 1 & \theta = 0 \end{cases}$ does not exist.

Therefore, we obtain that when $\alpha \geq \alpha^*$, A does not incur any overriding costs and can simply act based on what is the best for the disease control: $r_A = \begin{cases} 1 & \theta = 1 \\ 0 & \theta = 0 \end{cases}$.

A.1.2 A Incurs the Overriding Cost

When $\alpha < \alpha^*$, L will not allow A to disseminate the information. A has to balance the tradeoff between the disease relief provided by C if it disseminates the information and the overriding costs of ignoring L's disapproval. Only when A's report can induce enough m and b to contain the disease will A be willing to suffer the overriding cost p, which has a flavor of the signaling game.

When $\theta = 0$, $r_L = 0$. A does not need m or b: $r_A = 0$. Thus, when $r_A = 1$, C can infer that $\theta = 1$.

- Separating equilibrium: $r_A = \begin{cases} 1 & \theta = 1 \\ 0 & \theta = 0 \end{cases}$

$$\begin{cases} E(r_A = 1|\theta = 1) \geq E(r_A = 0|\theta = 1) \\ E(r_A = 1|\theta = 0) \leq E(r_A = 0|\theta = 0) \end{cases}$$

$$\begin{cases} -(1 - m^* - b^*) - p \geq \mu[-(1 - m^* - b^*)] + (1 - \mu)(-1) \\ -p \leq \mu(0) + (1 - \mu)0 \end{cases}$$

After simplifying the equations, we get $(m^* + b^*)(1 - \mu) \geq p$

Based on Bayes' rule, $\mu = \dfrac{0 * \psi}{0 * \psi + 1 * (1 - \psi)} = 0$

After plugging m^* and b^*, we have

$$\frac{1 + \alpha}{2\gamma} + \frac{1 - \alpha}{2\lambda} \geq p$$

We got $\alpha \leq \dfrac{\gamma + \lambda - 2\gamma\lambda p}{\gamma - \lambda} = \alpha^{**}$.

- Pooling equilibrium: $r_A = 0$

$$\begin{cases} E(r_A = 1|\theta = 1) \leq E(r_A = 0|\theta = 1) \\ E(r_A = 1|\theta = 0) \leq E(r_A = 0|\theta = 0) \end{cases}$$

In this case, $\alpha > \alpha^{**}$ and $\mu = \psi$, where $\psi = Pr(\theta = 1)$.

- Pooling equilibrium $r_A = 1$ does not exist.

- Separating equilibrium $r_A = \begin{cases} 0 & \theta = 1 \\ 1 & \theta = 0 \end{cases}$ does not exist.

Therefore, we know that when $\alpha \geq \alpha^*$ and $\alpha \leq \alpha^{**}$, A disseminates the information. When $\alpha \geq \alpha^*$, $r_L = 1$. When $\alpha \leq \alpha^{**}$, A's information dissemination leads to the same utility to L regardless of L approval, L approves.

Now, we go back to C's decision. When $r_A = 1$, C believes that $\theta = 1$ and chooses $m = m^* = \dfrac{1+\alpha}{2\gamma}$ and $b = b^* = \dfrac{1-\alpha}{2\lambda}$. To make sure that C's outbreak responses are not deterred by the administrative costs, we need $EU_C(m^*, b^*) \geq EU_C(m = 0, b = 0)$ when $r_A = 1$, which generates $\varepsilon_m + \varepsilon_b \leq \dfrac{(1+\alpha)^2}{4\gamma} + \dfrac{(1-\alpha)^2}{4\lambda}$.

When $r_A = 0$, C makes decision based on its belief about the probability that $\theta = 1$.

$$\begin{aligned} EU_C(m > 0, b > 0) &= \psi[-1 + m + b - \alpha(1 - m + b) - \gamma m^2 - \lambda b^2 - \varepsilon_m - \varepsilon_b] \\ &\quad + (1-\psi)[-\alpha b - \gamma m^2 - \lambda b^2 - \varepsilon_m - \varepsilon_b] \\ &= \psi[-(1+\alpha) + (1+\alpha)m + \alpha b] - (\alpha b + \gamma m^2 + \lambda b^2 + \varepsilon_m + \varepsilon_b) \end{aligned}$$

FOC w.r.t m and b respectively, we get $m^{**} = \dfrac{1+\alpha}{2\gamma}\psi$ and $b^{**} = 0$. Hence,

$$EU_C(m^{**}, b^{**}) = -(1+\alpha)\psi + \frac{(1+\alpha)^2\psi^2}{4\gamma} - \varepsilon_m$$

$$EU_C(m = 0, b = 0) = -\psi(1+\alpha)$$

To make sure that $EU_C(m^{**}, b^{**}) \leq EU_C(m = 0, b = 0)$, we have $\varepsilon_m \geq \dfrac{(1+\alpha)^2\psi^2}{4\gamma}$. This ensures that when ψ is a very small number, C chooses $m = b = 0$ rather than impose a small number of resources or bans.

A.2 Figures and Tables

Figure A.1: Number of Countries of Disease Outbreak in One Report

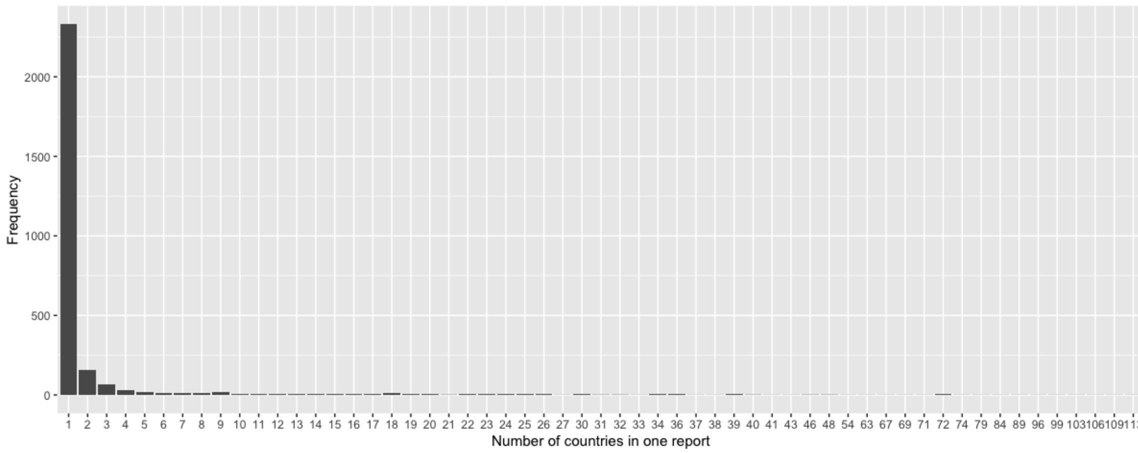

Figure A.2: Share of Countries Being Covered by DONs (1996-2019)

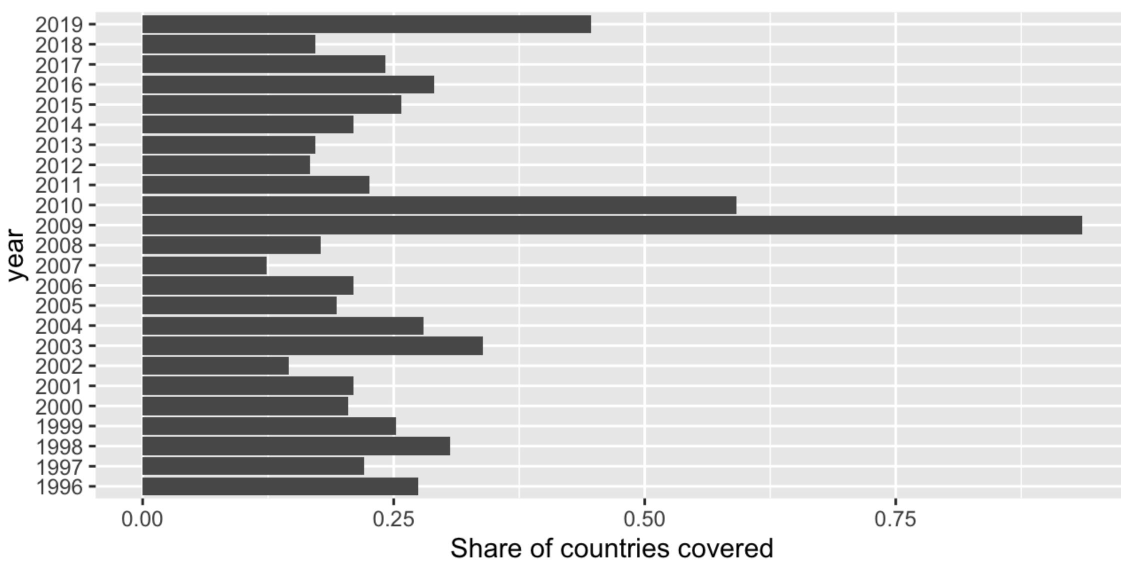

Figure A.3: Most Frequently Reported Countries: Pre 2005 vs. Post 2005

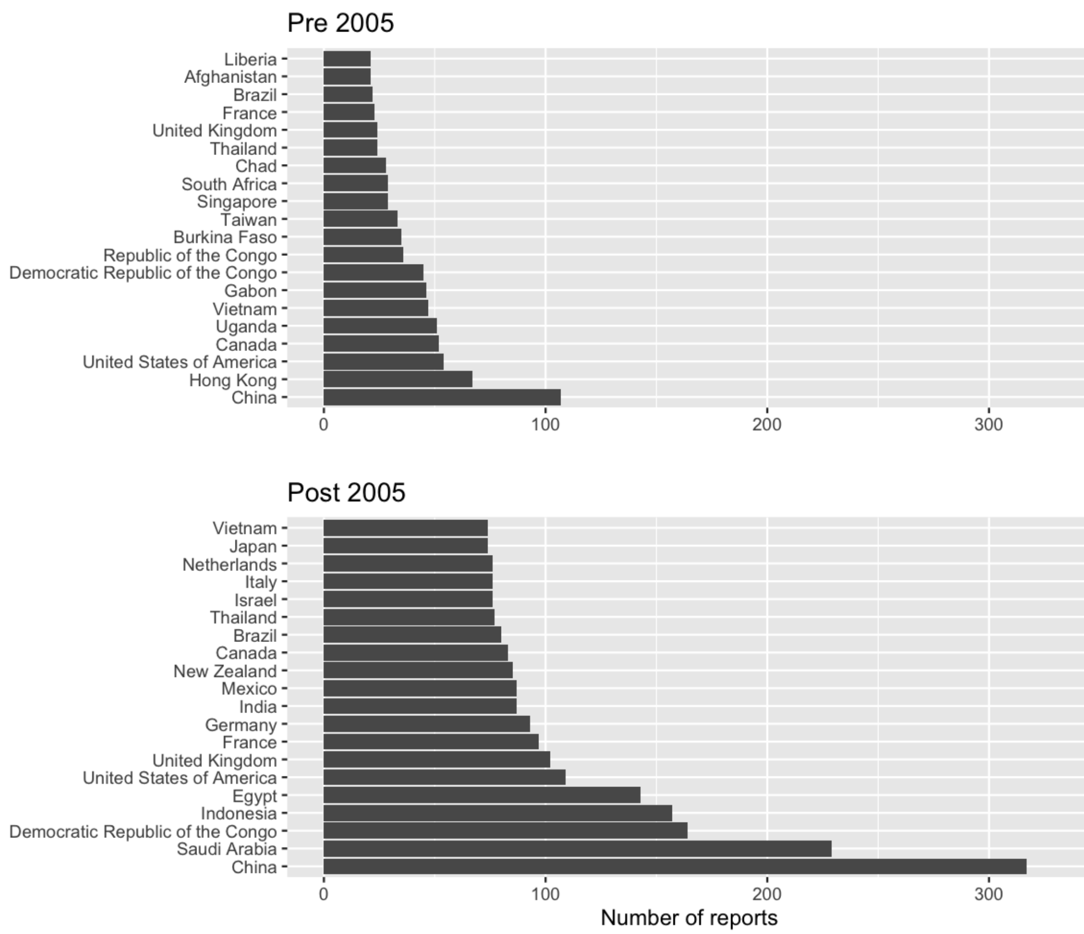

Figure A.4: Disease Information Verification System

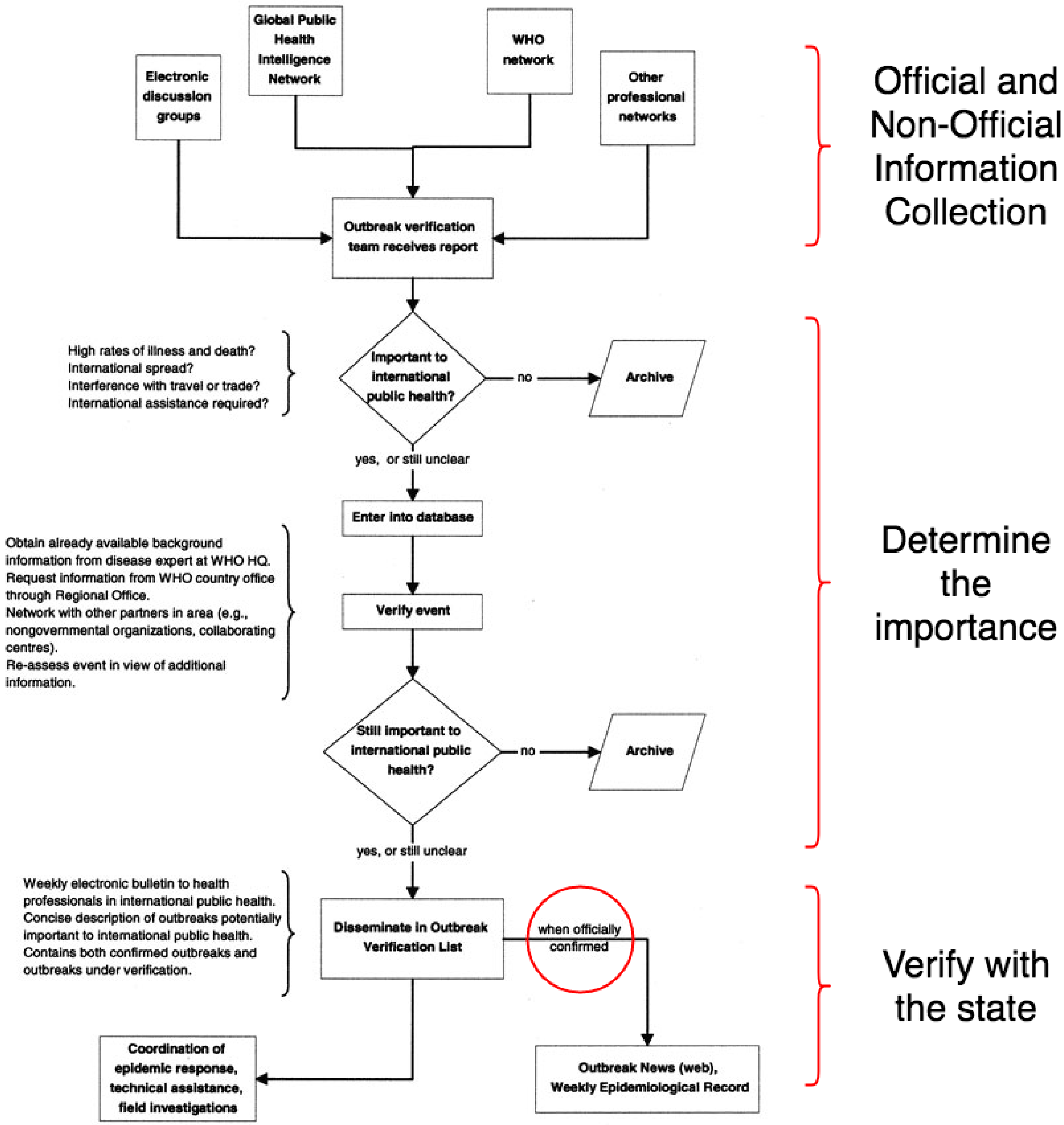

Figure A.5: Interface of GIDEON Informatics

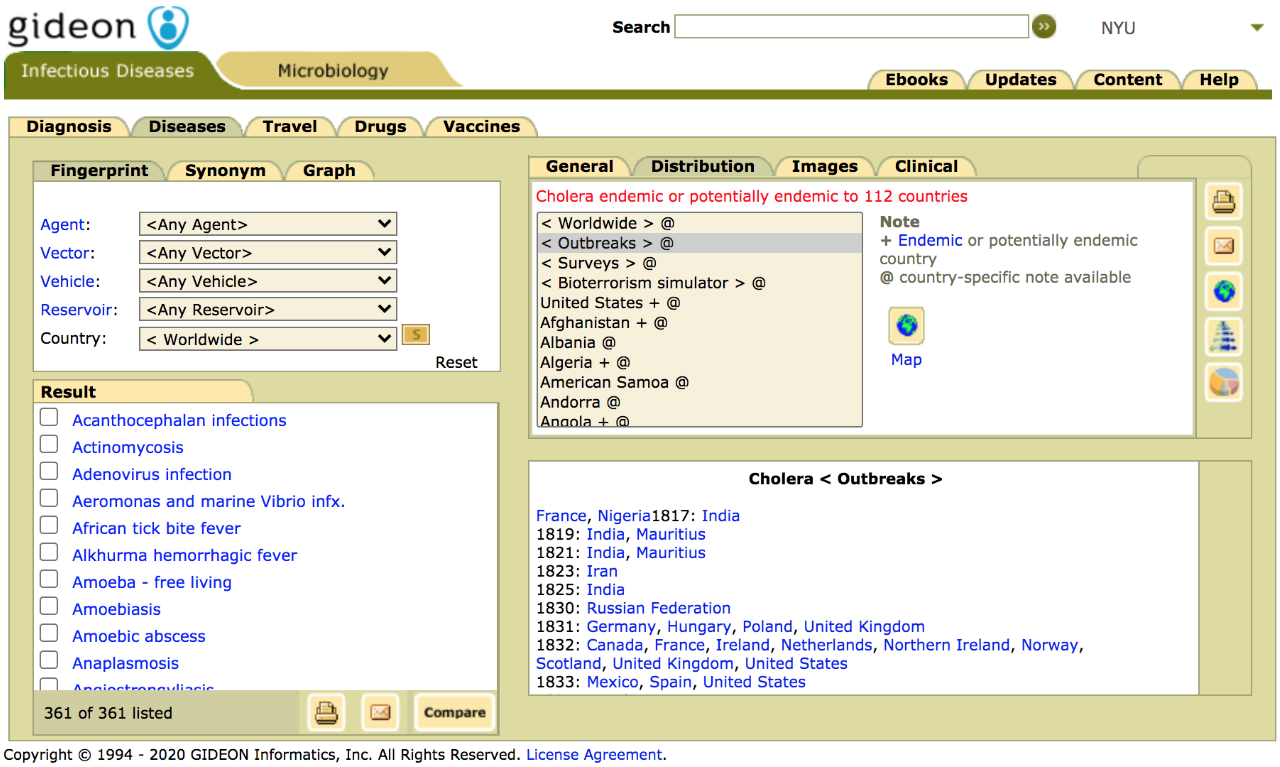

Table A.1: Trade Volume with the US and Disease Outbreak Report

	Dependent variable:					
	log(1 + DONs reports)					
	(1)	(2)	(3)	(4)	(5)	(6)
Total trade volume with US	−0.023*	−0.019				
	(0.013)	(0.013)				
Total trade volume with US * Post2005		−0.069**				
		(0.032)				
Total exports to US			−0.014	−0.001		
			(0.010)	(0.013)		
Total exports to US * Post2005				−0.033*		
				(0.020)		
Total imports from US					−0.010	−0.006
					(0.013)	(0.014)
Total imports from US * Post2005						−0.065**
						(0.031)
Control	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y
Observations	2,845	2,845	2,845	2,845	2,845	2,845
R^2	0.655	0.657	0.655	0.656	0.655	0.656
Adjusted R^2	0.568	0.570	0.568	0.568	0.567	0.569

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

Table A.2: Controlling for Disease Outbreak Events

	Dependent variable: log(1 + DONs reports)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ideal point proximity with US	−0.089	0.105					−0.093	0.072
	(0.091)	(0.106)					(0.091)	(0.101)
Ideal point proximity * Post2005		−0.366***						−0.326**
		(0.125)						(0.129)
Total imports from US			−0.008	−0.004			−0.010	0.095*
			(0.013)	(0.014)			(0.013)	(0.048)
Total imports from US * Post2005				−0.067**				−0.065**
				(0.031)				(0.030)
Seats on Direct Flight to US					−0.012*	−0.007	−0.012*	−0.017*
					(0.007)	(0.009)	(0.007)	(0.009)
Seats on Direct Flight * Post2005						−0.010		0.011
						(0.010)		(0.011)
N. of diseases (GIDEON)	0.117***	0.119***	0.116***	0.118***	0.116***	0.119***	0.116***	0.116***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.036)	(0.035)	(0.035)
Control	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,845	2,845	2,845	2,845	2,845	2,845	2,845	2,845
R^2	0.657	0.660	0.657	0.658	0.657	0.657	0.657	0.662
Adjusted R^2	0.570	0.573	0.570	0.572	0.571	0.571	0.570	0.575

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

Table A.3: Alternative Explanation: Regime Type

	Dependent variable:			
	log(1 + DONs reports)			
	(1)	(2)	(3)	(4)
Ideal point proximity with US			−0.089	0.134
			(0.092)	(0.105)
Ideal point proximity * Post2005				−0.439***
				(0.143)
Total imports from US			−0.012	0.093*
			(0.013)	(0.048)
Total imports from US * Post2005				−0.071**
				(0.028)
Seats on Direct Flight to US			−0.012*	−0.017*
			(0.007)	(0.009)
Seats on Direct Flight * Post2005				0.010
				(0.010)
Polity IV	0.006	0.004	0.006	−0.006
	(0.011)	(0.012)	(0.011)	(0.012)
Polity IV * Post2005		0.005		0.026**
		(0.009)		(0.011)
Control	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y
Observations	2,845	2,845	2,845	2,845
R^2	0.655	0.655	0.655	0.661
Adjusted R^2	0.568	0.567	0.568	0.574

Note: *p<0.1; **p<0.05; ***p<0.01

Standard error clustered at the country level in parentheses.

Table A.4: Alternative Explanation: Transparency

	Dependent variable:			
	log(1 + DONs reports)			
	(1)	(2)	(3)	(4)
Ideal point proximity with US			−0.126	0.071
			(0.115)	(0.126)
Ideal point proximity * Post2005				-0.439^{***}
				(0.158)
Total imports from US			0.005	0.125^{*}
			(0.017)	(0.069)
Total imports from US * Post2005				-0.119^{***}
				(0.037)
Seats on Direct Flight to US			−0.006	−0.017
			(0.009)	(0.010)
Seats on Direct Flight * Post2005				0.031^{**}
				(0.015)
HRV Transparency Index	−0.007	0.020	−0.008	0.009
	(0.040)	(0.041)	(0.040)	(0.041)
HRV Transparency Index * Post2005		−0.038		0.020
		(0.024)		(0.032)
Control	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y
Observations	1,860	1,860	1,860	1,860
R^2	0.716	0.716	0.716	0.722
Adjusted R^2	0.621	0.622	0.621	0.628

Note: *p<0.1; **p<0.05; ***p<0.01

Standard error clustered at the country level in parentheses.

Table A.5: Exclude China and Saudi Arabia from the Sample

	Dependent variable:		
		log(1 + DONs reports)	
	Exclude China	Exclude Saudi Arabia	Exclude Both
	(1)	(2)	(3)
Ideal point proximity with US	0.071	0.090	0.087
	(0.107)	(0.101)	(0.106)
Ideal point proximity * Post2005	−0.350***	−0.322**	−0.348***
	(0.132)	(0.130)	(0.131)
Total imports from US	0.097*	0.092*	0.092*
	(0.049)	(0.049)	(0.049)
Total imports from US * Post2005	−0.060*	−0.067**	−0.059*
	(0.030)	(0.031)	(0.031)
Seats on Direct Flight to US	−0.019**	−0.021**	−0.021**
	(0.009)	(0.009)	(0.009)
Seats on Direct Flight * Post2005	0.014	0.015	0.016
	(0.011)	(0.011)	(0.011)
Control	Y	Y	Y
State FE	Y	Y	Y
Office-Year FE	Y	Y	Y
State-specific time trend	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y
Observations	2,825	2,825	2,805
R^2	0.653	0.657	0.650
Adjusted R^2	0.564	0.569	0.561
Note:			*p<0.1; **p<0.05; ***p<0.01
			Standard error clustered at the country level in parentheses.

Table A.6: Economic and Political Links and Disease Outbreak Report

	Dependent variable:											
	log(1 + DONs reports)											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
US Poli Linkaage	−0.085	0.105										
	(0.092)	(0.107)										
US Poli Linkaage * Post2005		−0.359***										
		(0.126)										
UK Poli Linkaage			−0.064	0.125								
			(0.091)	(0.108)								
UK Poli Linkaage * Post2005				−0.365***								
				(0.130)								
FR Poli Linkaage					−0.075	0.103						
					(0.092)	(0.106)						
FR Poli Linkaage * Post2005						−0.339***						
						(0.129)						
DEU Poli Linkaage							−0.004	0.136				
							(0.103)	(0.119)				
DEU Poli Linkaage * Post2005								−0.286**				
								(0.128)				
CN Poli Linkaage									0.098	−0.084		
									(0.081)	(0.108)		
CN Poli Linkaage * Post2005										0.358**		
										(0.151)		
RUS Poli Linkaage											−0.099	−0.115
											(0.088)	(0.097)
RUS Poli Linkaage * Post2005												0.022
												(0.143)
Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,845	2,845	2,845	2,845	2,845	2,845	2,845	2,845	2,845	2,845	2,845	2,845
R^2	0.655	0.657	0.656	0.659	0.655	0.657	0.654	0.656	0.648	0.651	0.654	0.655
Adjusted R^2	0.568	0.570	0.570	0.573	0.568	0.571	0.567	0.568	0.559	0.563	0.567	0.568

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

Table A.7: Interdependence with US and Disease Outbreak Report

	Dependent variable:											
	log(1 + DONs reports)											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IGO Similarity with US	0.234	0.510										
	(1.107)	(1.152)										
IGO Similarity w. US * Post2005		−0.665**										
		(0.309)										
IGO Similarity with UK			−0.109	0.298								
			(0.923)	(0.995)								
IGO Similarity w. UK * Post2005				−0.802**								
				(0.351)								
IGO Similarity with France					−0.225	0.175						
					(1.131)	(1.172)						
IGO Similarity w. France * Post2005						−0.824**						
						(0.345)						
IGO Similarity with Germany							0.429	0.795				
							(1.077)	(1.129)				
IGO Similarity w. Germany * Post2005								−0.844**				
								(0.349)				
IGO Similarity with China									−0.351	−0.441		
									(0.901)	(0.916)		
IGO Similarity w. China * Post2005										0.215		
										(0.354)		
IGO Similarity with Russia											0.431	0.388
											(0.613)	(0.615)
IGO Similarity w. Russia * Post2005												0.347
												(0.356)
Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,855	2,855	2,855	2,855	2,855	2,855	2,855	2,855	2,855	2,855	2,855	2,855
R^2	0.652	0.654	0.654	0.656	0.653	0.655	0.652	0.654	0.646	0.646	0.652	0.652
Adjusted R^2	0.566	0.567	0.568	0.570	0.566	0.569	0.565	0.568	0.558	0.558	0.565	0.565

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

Table A.8: Interdependence with US and Disease Outbreak Report

	Dependent variable: log(1 + DONs reports)											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Treaty similarity with US	−0.029	0.027										
	(0.171)	(0.169)										
Treaty similarity w. US * Post2005		−0.284										
		(0.301)										
Treaty similarity with UK			−0.192	−0.002								
			(0.174)	(0.172)								
Treaty similarity w. UK * Post2005				-0.840^{***}								
				(0.221)								
Treaty similarity with France					−0.094	0.065						
					(0.142)	(0.139)						
Treaty similarity w. France * Post2005						-0.906^{***}						
						(0.234)						
Treaty similarity with Germany							−0.170	0.112				
							(0.202)	(0.198)				
Treaty similarity w. Germany * Post2005								-1.024^{***}				
								(0.234)				
Treaty similarity with China									−0.205	−0.124		
									(0.183)	(0.176)		
Treaty similarity w. China * Post2005										−0.316		
										(0.314)		
Treaty similarity with Russia											−0.228	−0.033
											(0.193)	(0.190)
Treaty similarity w. Russia * Post2005												-0.964^{***}
												(0.269)
Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
State FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Observations	2,001	2,001	2,001	2,001	2,001	2,001	1,929	1,929	2,001	2,001	2,001	2,001
R^2	0.721	0.721	0.723	0.729	0.722	0.727	0.723	0.730	0.718	0.718	0.722	0.727
Adjusted R^2	0.621	0.621	0.624	0.631	0.622	0.630	0.621	0.631	0.617	0.617	0.623	0.630

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

Table A.9: Interdependence with US and Disease Outbreak Report

	Dependent variable:											
	log(1 + DONs reports)											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
GVC integration with US	−0.014	−0.018										
	(0.098)	(0.100)										
GVC integration w. US * Post2005		-0.061^{*}										
		(0.031)										
GVC integration with UK			−0.244	−0.141								
			(0.172)	(0.180)								
GVC integration w. UK * Post2005				-0.081^{**}								
				(0.034)								
GVC integration with France					−0.241	−0.125						
					(0.163)	(0.164)						
GVC integration w. France * Post2005						-0.069^{**}						
						(0.032)						
GVC integration with Germany							0.054	0.172				
							(0.200)	(0.210)				
GVC integration w. Germany * Post2005								-0.085^{**}				
								(0.034)				
GVC integration with China									−0.087	−0.087		
									(0.120)	(0.122)		
GVC integration w. China * Post2005										-0.067^{*}		
										(0.037)		
GVC integration with Russia											−0.108	0.042
											(0.137)	(0.149)
GVC integration w. Russia * Post2005												-0.107^{**}
												(0.046)
Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
State FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Office-Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
State-specific time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Observations	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642
R^2	0.674	0.675	0.676	0.678	0.674	0.676	0.673	0.676	0.667	0.669	0.673	0.676
Adjusted R^2	0.590	0.592	0.593	0.596	0.591	0.593	0.590	0.593	0.582	0.584	0.590	0.593

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

Table A.10: Economic and Political Links and Disease Outbreak Report

	Dependent variable: log(1 + DONs reports)					
	(1)	(2)	(3)	(4)	(5)	(6)
Total trade volume	−0.003	−0.002				
	(0.005)	(0.005)				
Total trade volume * Post2005		−0.002				
		(0.006)				
GVC integration	0.219*	0.220*	0.221*	0.312**	0.221*	0.222*
	(0.115)	(0.115)	(0.116)	(0.132)	(0.116)	(0.116)
GVC integration * Post2005				−0.023		
				(0.014)		
Openness	−0.060	−0.060	−0.124	−0.127	−0.124	−0.111
	(0.131)	(0.130)	(0.077)	(0.078)	(0.077)	(0.085)
Openness * Post2005						−0.028
						(0.121)
Control	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y
Office-Year FE	Y	Y	Y	Y	Y	Y
State-specific time trend	Y	Y	Y	Y	Y	Y
State-specific quadratic time trend	Y	Y	Y	Y	Y	Y
Observations	2,895	2,895	2,895	2,895	2,895	2,895
R^2	0.652	0.652	0.652	0.653	0.652	0.652
Adjusted R^2	0.566	0.566	0.566	0.567	0.566	0.566

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

Table A.11: Data Sources

Variable	Source	Notes
Dependent Variable		
Disease Outbreak News Report	WHO DONs	
Disease outbreak events	Global Infectious Diseases and Epidemiology Online Network (GIDEON)	
Independent Variable		
Ideal point estimate (UNGA)	Bailey et al. (2017)	
Trade volume with the US	UN Comtrade	
Seats on direct flights to the US	U.S. Department of Transportation	
Control Variable		
UNSC Membership	Dreher et al. (2009a)	
GDP per capita	World Bank WDI Database	
Total population	World Bank WDI Database	
Polity IV	Center for Systemic Peace	
Openness (Total import and export over GDP)	UN Comtrade	
IMF participation	Replication file from Clark and Dolan (2020)	
HRV Transparency Index	Hollyer et al. (2014)	