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Concealing Disease: Trade and Travel Barriers and the Timeliness of Outbreak Reporting

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Abstract: Slow outbreak reporting by states is a key challenge to effectively responding to global health emergencies like Zika, Ebola, and H1N1. Current policy focuses on improving domestic outbreak surveillance capacity globally in order to reduce reporting lags. However, governments also face economic and political incentives to conceal outbreaks, and these incentives largely are ignored in policy discussions. In spite of the policy implications for outbreak response, the "capacity" and "will" explanations have not been systematically examined. Analysis of a dataset coding the timeliness of outbreak reporting from 1996–2014 finds evidence that states' unwillingness to report—rather than just their inability—leads to delayed reporting. The findings suggest that though building surveillance capacity is critical, doing so may not be sufficient to reduce reporting lags. Policy aimed at encouraging rapid reporting must also mitigate the associated economic and political costs.

Resumen: La lentitud en la notificación de brotes por parte de los estados es un desafío clave que impide responder de manera efectiva a las emergencias de salud globales como el zika, el ébola y la gripe A H1N1. La política actual se centra en mejorar la capacidad de vigilancia nacional de los brotes a nivel mundial para reducir los retrasos en la notificación. Sin embargo, los Gobiernos también enfrentan incentivos económicos y políticos para ocultar los brotes que son, en gran medida, ignorados en las discusiones sobre políticas. A pesar de las implicaciones políticas que subyacen a la respuesta a los brotes, las explicaciones relativas a la «capacidad» y la «voluntad» no se han examinado sistemáticamente. El análisis de un conjunto de datos sobre la prontitud de la notificación de brotes correspondiente al período comprendido entre los años 1996–2014 arroja evidencia de que es la falta de voluntad de los estados para notificar, más que su incapacidad, lo que genera demoras en la notificación. Si bien el fortalecimiento de la capacidad de vigilancia es fundamental, las conclusiones de este análisis sugieren que una política dirigida a fomentar la celeridad de la notificación también debe mitigar los costos económicos y políticos asociados.

Extrait: Le signalement lent des épidémies par les États est un défi majeur pour intervenir efficacement en cas d'urgences sanitaires mondiales, telles que Zika, Ebola et H1N1. La politique actuelle est axée sur l'amélioration de la capacité de surveillance nationale des épidémies au niveau mondial afin de réduire les délais de signalement. Cependant, les gouvernements sont également confrontés à des motivations économiques et politiques pour dissimuler les épidémies, qui sont largement ignorées dans les discussions politiques. En dépit des implications politiques pour l'intervention en cas d'épidémie, les explications liées à la « capacité » et à la « volonté » n'ont pas été systématiquement examinées. L'analyse

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d'un ensemble de données sur la rapidité des signalements d'épidémie de 1996 à 2014 démontre que la réticence des États à signaler (et non leur incapacité) entraîne un retard dans le signalement. Bien que le renforcement des capacités de surveillance soit essentiel, les résultats suggèrent que la politique visant à encourager le signalement rapide doit également atténuer les coûts économiques et politiques associés.

Keywords: international organizations, World Health Organization, compliance, disease outbreaks, global health

The World Health Organization (WHO) has verified nearly 500 infectious disease outbreaks in the past 20 years. Due to a multitude of social, political, economic, biological, and environmental factors, outbreaks have increased in recent decades, and this trend is expected to continue (Jones et al. 2008, 990; Morens, Folkers, and Fauci 2008, 710; Institute of Medicine 2010). Yet, global outbreak preparedness is lacking (National Academy of Medicine 2016; World Bank 2017a). The initial failure to stop the spread of Ebola in 2014 demonstrates that responding to these events poses a complex policy challenge for governments, international organizations, and nongovernmental actors. Part of this challenge is delayed outbreak reporting.

Early outbreak detection is key to launching an effective response because it increases the likelihood that outbreaks will be contained at the source and allows other potentially affected states to prepare internal response measures. Rapid reporting is a central goal of the WHO's International Health Regulations (IHR), the primary tool for coordinating the international response to outbreaks like Zika, Ebola, and H1N1 influenza, which states revised in 2005 in part to encourage timely reporting. Yet, reporting is often delayed. In 2009, it took an average of 13.5 days from the start of an outbreak for it to be discovered and 19 days until the outbreak was communicated publicly (Chan et al. 2010, 21702). Data through 2014 suggests that little additional progress has been made (Kluberg et al. 2016, e4).

The 2014 Ebola crisis is a case in point. It is estimated that the first case occurred in December 2013, but due in part to weak surveillance capacity the outbreak was not reported to WHO until March 2014. The outbreak of severe acute respiratory syndrome (SARS) in 2003 is another well-known example. Though the first cases of SARS emerged in China in December 2002, the government did not acknowledge the outbreak until February 2003. In fact, there is evidence that the Chinese government actively concealed the outbreak from the WHO, denying WHO experts access to Guangdong province where SARS first surfaced (Huang 2004, 121).

The cases of Ebola and SARS point to two potential explanations for reporting lags. On the one hand, a lack of surveillance capacity might prevent states that want to promptly report outbreaks from doing so (see, for example, Institute of Medicine 2009). Governments cannot report outbreaks that they do not know about. On the other hand, states have reasons to intentionally conceal outbreaks. Once an outbreak is made public, other states often react by imposing trade and travel restrictions that, according to the WHO, provide little additional protection from disease spread.[1] About 25 percent of states imposed such measures in response to H1N1 (2009) and Ebola (2014) (Rhymer and Speare 2017, 11; Worsnop 2017b, 366). The threat of being the target of other states' costly barriers (not to mention the myriad other economic costs associated with disease outbreaks) creates economic and political incentives for concealment. The political will and state-capacity perspectives lead to distinct policy recommendations for reducing reporting lags. Yet,

[1] For example, the WHO has not recommended trade or travel restrictions at points of entry during the four declared global health emergencies (World Health Organization 2009, 2014a, 2014b, 2016b).

there is little empirical examination of these alternatives in existing research and current policy largely ignores the potential political and economic disincentives to reporting.

What explains variation in the timeliness of reporting and continued delays across states and over time? Does a lack of surveillance capacity alone explain delays or is intentional concealment also to blame? Have the revised IHR had any impact on the timeliness of reporting since it entered into force in 2007? And, which policies have the best chance of encouraging rapid reporting?

To answer these questions, this article examines variation in the timeliness of infectious disease outbreaks reporting from 1996 to 2014 using data from Chan et al. (2010) and Kluberg et al. (2016).[2] I find that, while there is evidence that surveillance capacity is associated with faster reporting, there is also a cost-benefit calculation at work. Even controlling for surveillance capacity, duration analysis finds that states that are particularly vulnerable to being the target of others' trade and travel barriers are associated with longer reporting lags between 1996 and 2014. I also find no overall improvement in the timeliness of reporting after the new IHR enter into force—a finding that is consistent with other work examining outbreak reporting (Kluberg et al. 2016, e4).

These findings have implications for both policy and scholarship. From a policy perspective, the WHO has just named outbreak preparedness and response as one of three strategic priority areas for 2019–2023 (World Health Organization 2018a). Though disincentives to outbreak reporting have been noted in reviews of the international response to both the H1N1 and Ebola outbreaks (World Health Organization 2011, 2017b), current WHO policy focuses on building surveillance capacity to encourage rapid reporting with little attention paid to reducing the political and economic costs of outbreak reporting (World Health Organization 2016a, 2016c, 2018a). This article's findings suggest that enhancing domestic and global surveillance capacity through initiatives like the Joint External Evaluation, which assesses state progress toward meeting IHR core technical capacities for outbreak prevention, detection, and response, may not completely solve the problem of delayed outbreak reporting. This is problematic given that these technical capacities are the focus of WHO efforts in this area and also recently have been included as the indicator for Sustainable Development Goal target 3.D, which aims to "strengthen the capacity of all countries . . . for early warning, risk reduction, and management of national and global health risks" (United Nations 2017). Though meeting IHR core capacities is critical for many reasons, and surveillance capacity in particular is a prerequisite for timely reporting, the findings presented here provide evidence that even those states with the capacity to report quickly will be less likely to do so when they anticipate costs for that behavior.

As such, policy aimed at improving the timeliness of reporting must also include practical suggestions for lowering the costs of reporting or raising the costs of not reporting. Policy options include discouraging the use of excessive trade and travel barriers during outbreaks, setting up a financial mechanism to compensate national and local governments for economic losses associated with outbreaks, and legal protections for nonstate actors that report cases or outbreaks without government cooperation. The last section of this article discusses these and other policy options in more detail.

Turning to scholarship, this article speaks to the enduring question of why states do or do not abide by their institutional commitments (Martin and Simmons 1998; Simmons 2010). The "will or capacity" perspectives on outbreak reporting reflect a longstanding debate in the international organizations literature between the so-called "managerial" and "enforcement" approaches to compliance behavior. That is, the debate about whether noncompliance is due to a lack of capacity or to states'

[2] The dataset and code used for this analysis are available at https://doi.org/10.7910/DVN/YUSU8X.

intentional shirking of responsibilities (on the management approach, see Mitchell 1994; Chayes and Chayes 1998; Weiss and Jacobson 2000; Simmons 2002; Tallberg 2002; Cole 2015; examples of the enforcement approach include Downs, Rocke, and Barsoom 1996; Hafner-Burton, Tsutsui, and Meyer 2008). In the novel context of outbreak reporting, this article provides evidence that both mechanisms may be operating. Reducing reporting lags requires increasing both will and capacity. Further, universal membership makes the IHR a good case for examining institutional effects on state behavior (Von Stein 2005). As discussed here, the IHR seem not to have improved outbreak reporting overall; I discuss some reasons why in the final section.

The article proceeds as follows. The next section reviews the state capacity and political will perspectives on outbreak reporting outlined above. Then, I derive testable hypotheses based on the two perspectives. Following this, I discuss measuring the dependent variable—the timeliness of outbreak reporting—then I review the rest of the data and methodology. I then explain the empirical results, followed by alternative explanations and robustness checks. The final section concludes with policy implications.

Capacity or Concealment?

While global health issues have gained more attention in international relations scholarship of late (e.g., Chorev 2012; Kamradt-Scott and Rushton 2012; Graham 2014; Hanrieder 2014; Davies, Kamradt-Scott, and Rushton 2015; Kamradt-Scott 2015; Worsnop 2017b), little of this work directly examines variation in the timeliness of reporting. Existing global public health scholarship that does analyze this issue finds only a weak positive association between health capacity and reporting (McAlarnen et al. 2014). But, this work either does not examine variation across states (Chan et al. 2010; Mondor et al. 2012), or the empirical work on reporting delays does not theorize about *how* political factors might influence outbreak reporting or test these factors against alternative explanations like surveillance capacity (see Brownstein et al. 2008; Davies 2012; Kluberg et al. 2016).

Scholarship on state compliance behavior and treaty implementation offers insight into delayed outbreak reporting and incomplete compliance with IHR reporting requirements. Prevailing views of compliance behavior fall into two broad categories: the "managerial" approach argues that noncompliance is inadvertent and often due to a lack of state capacity to meet the terms of an agreement. Alternatively, the "enforcement" approach contends that compliance is based on a cost-benefit calculation—states will only comply when it is beneficial to do so and will shirk their commitments if they can do so with minimal cost.

Since many international agreements threaten limited international costs for noncompliance and evidence suggests that most states follow through with their international commitments most of the time, some suggest that a lack of domestic capacity prevents states from following through with their commitments (Mitchell 1994; Chayes and Chayes 1998; Weiss and Jacobson 2000; Simmons 2002; Tallberg 2002; Gray 2014; Cole 2015). Coined as the managerial approach by Chayes and Chayes (1998), this view argues that noncompliance is not the result of intentional shirking. Instead, states generally want to abide by their commitments, but doing so often requires legal, bureaucratic, economic, or other specialized expertise, not to mention absolute political control, that many states lack.

This approach contrasts with the enforcement perspective, which argues that the assumption that states would comply with their commitments if only they could paints too banal a picture of compliance decision-making. Compliance decisions can have political consequences for states at the international and domestic levels, and governments weigh these costs and benefits. Though capacity to comply is undoubtedly a prerequisite for doing so, those that are able to comply must also

consider the reaction of other states and the domestic consequences of complying or not complying. On the one hand, states might consider the geopolitical costs and benefits of compliance decisions and their behavior might be driven by fear of punishment from other states in the form of withholding aid, trade, or cooperation in other areas (Keohane 1984; Simmons 2000; Simmons and Elkins 2004). From this perspective, reputational interests and reciprocity matter most, and states base their compliance behavior on the likelihood of material or normative punishment.

On the other hand, compliance decisions also have domestic political consequences (Martin and Simmons 1998). For example, breaking international commitments, especially legalized ones, may be particularly costly for leaders of states with a strong commitment to domestic rule of law for normative reasons or because domestic constituents fear that the disregard of international law could translate into the domestic sphere (Finnemore and Sikkink 1998; Abbott and Snidal 2000; Kelley 2007). Some scholars focus on regime type and its influence on leaders' domestic political interests, finding that democracies are more likely to comply because constituents pressure their governments to follow through with their commitments (see, for example, Gaubatz 1996; Mansfield, Milner, and Rosendorff 2002; Neumayer 2002). Others argue that the public is not necessarily procompliance and show that the positive effect of participatory democracy is conditional on the presence of strong procompliance domestic interests (Dai 2006). Indeed, compliance with agreements dealing with politically charged issues like the environment, trade, human rights, territory, or arms control, for example, can have different domestic consequences in different types of states. In short, governments only comply when the benefits of doing so outweigh the international and/or domestic level costs, and noncompliance from this perspective is thus due to a failure of enforcement.

Bringing these arguments to bear on the IHR reflects the two explanations for lags in disease outbreak reporting already mentioned. States may want to report and may in fact quickly do so once an outbreak is discovered. But, weak surveillance capacity can delay outbreak discovery, which means that, in spite of the government's good intentions, significant time passes between the start of the outbreak and when it is publicly communicated. Alternatively, states may intentionally conceal an outbreak even after they are aware of it because reporting comes with costs—including unavoidable economic costs associated with outbreaks *and* the economic and political costs of being the target of other states' trade and travel barriers. From this perspective, states will only be likely to report and follow through with commitments to the IHR when they anticipate minimal costs for doing so.

Since its inception in 1951, the IHR have sought to encourage rapid reporting by addressing both of these issues. In terms of capacity, the regulations have always required that states meet minimum disease surveillance capabilities at points of entry. In terms of reducing the costs of reporting and ensuring that other states do not impose trade and travel barriers that have little public health rationale, the regulations have always laid out the maximum measures that other states can take in the name of protection from disease spread. But, the regulations originally only applied to three diseases (cholera, plague, and yellow fever), and even with respect to those diseases, states frequently imposed more restrictive measures than allowed by the regulations, and outbreak reporting was often delayed, if it happened at all (Carvalho and Zacher 2001). In 2005, states revised the IHR, and several of the changes aimed to further encourage outbreak reporting.

The new IHR contain the following seven key revisions:[3]

1. The regulations now apply to a broader range of public health events called "Public Health Emergencies of International Concern" (PHEIC);

[3] For in-depth reviews of the IHR revision, see von Tigerstrom (2005), Fidler and Gostin (2006), and Katz and Fischer (2010).

2. They allow the WHO to decide whether an event constitutes a PHEIC;
3. They require that states meet certain minimum domestic outbreak surveillance and response capacities in addition to capacities at points of entry;
4. They require states to notify the WHO of events that may constitute a PHEIC within 24 hours;
5. They allow the WHO to rely on nonstate sources of information about outbreaks;
6. They allow the WHO to issue recommendations to states about the appropriate response to outbreaks including whether states should impose trade and travel barriers;
7. And they allow the WHO to publicize states' failure to report outbreaks as well as the imposition of overly restrictive trade and travel barriers.

These changes not only aim to overcome the technical obstacles to compliance, but they also aim to decrease the costs of outbreak reporting relative to the benefits. On the one hand, requiring states to meet a set of domestic "core capacities" for outbreak preparedness is meant to ensure that all states have the capability to rapidly detect outbreaks. And, expanding the scope of the IHR lets states know that they should be reporting a wider range of health threats.

Other revisions aim at manipulating the costs of outbreak reporting. Allowing nonstate sources to report outbreaks and giving the WHO the ability to "name and shame" states that fail to report raises the reputational costs of outbreak concealment. And, giving the WHO the authority to issue recommendations about whether trade and travel barriers are warranted and the ability to publicize states' failure to follow these guidelines is meant to increase the costs of imposing unduly restrictive measures during an outbreak and reduce the costs of outbreak reporting.

In practice, however, these strategies are not completely effective. Though states agreed to meet the core health capacity requirements when they signed on to the new IHR in 2005, this commitment came with no funding attached. Most countries that lack these capacities are not able to build them alone. And, even self-reported assessments of progress toward meeting these capacities suggest limited improvement. In 2014, states had the opportunity to submit requests for a second extension to the deadline for meeting these core health capacities. At that time, only 64 states reported that they had met the capacities, while 81 states requested an additional two year extension, and 48 did not provide the WHO with any information (World Health Organization 2015a, 4; see also, Fischer and Katz 2013). In 2016, 76 states did not provide an update on progress and the majority of states have still not yet fully met the core capacities (World Health Organization 2017a, 3; see also Gostin and Katz 2016). The launch of an external evaluation process (called the Joint External Evaluation) to monitor progress on the core capacities is a promising step, but states voluntarily submit to these external evaluations (World Health Organization 2016a). As such, weak capacity may still play a role in reporting delays. The 2014 Ebola crisis offers an example. The slow response to the outbreak was due in part to weak surveillance capacity in Guinea, Liberia, and Sierra Leone. It is telling that Nigeria—a country with far greater resources than Guinea, Liberia, or Sierra Leone—was able to quash the spread of Ebola in the country by implementing several of the capacities recommended by the IHR, including contact tracing, monitoring of contacts, and rapid isolation of potentially infectious cases (Fasina et al. 2014).

At the same time, however, the relationship between weak capacity and reporting may be more complicated in some cases. For example, in the aftermath of the 1994 outbreak of plague in Surat, India, a WHO team of investigators "concluded that the lack of adequate diagnostic equipment in the affected area led to overreporting and subsequent panic" (Cash and Narasimhan 2000, 1361). It is therefore possible that weak surveillance capacity sometimes leads to underreporting and sometimes leads

to jumping the gun and overreporting. This possibly indeterminate relationship raises the possibility that other factors may also play a role in reporting lags.

Furthermore, during recent outbreaks including the 2014 outbreak of Ebola and the 2009 H1N1 pandemic, close to 25 percent of states imposed trade and travel barriers that went beyond WHO recommendations, largely for domestic political reasons (Rhymer and Speare 2017, 11; Worsnop 2017b, 366). During these outbreaks, the WHO did not take advantage of its authority to name and shame states for not following its guidance. As such, states that discover outbreaks also continue to face incentives to conceal them in order to avoid other states' costly reactions.

So, is it primarily a capacity issue, or is intentional concealment also at work? The answer to this question is critical for identifying strategies to ensure that outbreaks are reported—and responded to—quickly. Capacity to detect outbreaks is of course necessary to follow through with commitments to the IHR to report outbreaks quickly and accurately—states cannot quickly inform the international community of potential public health emergencies if they do not know that an outbreak is occurring. But, I argue that weak capacity is not the whole story—states also intentionally conceal outbreaks to avoid economic and political harm.

Trade and Travel Barriers, Outbreak Concealment, and the IHR

Though surveillance capacity may be a prerequisite for rapid reporting, states face real incentives to intentionally conceal an outbreak after it is discovered. Evidence of outbreak concealment due to fear of economic harm dates back to the plague epidemics in medieval Europe. To prevent economic damage from quarantine and trade route closures, local health authorities often downplayed the severity of outbreaks (Porter 1999; see also von Tigerstrom 2005, 42). The 1991 outbreak of cholera in Peru, the 1994 outbreak of the plague in India, the 2003 outbreak of SARS in China, the 2009 H1N1 pandemic, and the 2014 Ebola outbreak reveal a similar dynamic.

In January 1991, an epidemic of cholera broke out in Peru, spreading to other countries in the region including Chile, Colombia, and Ecuador. A number of states immediately imposed barriers against Peruvian travel and goods that went beyond the measures recommended by the WHO. Examples include bans of perishable foods enacted by Bolivia, Chile, and Ecuador, along with a ban of all imports from Peru imposed by the European Community. As a result, Peru's tourism and trade sectors lost more than US $770 million (Cash and Narasimhan 2000, 1363).

During the 1994 outbreak of the plague in Surat, India, the Indian government "reluctantly reported the outbreaks to WHO" (WHO Archives, n.d.), and before the outbreak was even confirmed a number of states—including Canada, France, Germany, Italy, Sweden, the United Kingdom, the United States, Bangladesh, Oman, the United Arab Emirates, and Qatar—had imposed trade and travel restrictions or warnings. The WHO had recommended against such actions (Cash and Narasimhan 2000, 1361). Losses to India's economy associated with the outbreak, including the cost of trade and travel barriers imposed against it by other states, totaled more than US $2 billion (Cash and Narasimhan 2000, 1362).

In its handling of the 2002 outbreak of SARS, China took its cue from the experience of states like Peru and India and did not make the outbreak public. It is widely acknowledged that fear of economic and political costs in part motivated China's behavior and that SARS would have been better contained had China reported the outbreak earlier (Mackey and Liang 2012; Huang 2013).

During the 2009 H1N1 pandemic, countries again imposed measures that went beyond WHO recommendations. On April 26, 2009, the WHO declared the H1N1 influenza pandemic a public health emergency (the first such declaration since the entry into force of the new IHR in 2007). That same day, the WHO recommended that states not impose trade and travel restrictions because these barriers would

not prevent the spread of the disease (World Health Organization 2009). Despite these recommendations, 47 states went ahead and imposed barriers against H1N1-affected states anyway (Worsnop 2017b, 366). Interestingly, most of these trade barriers targeted the United States as it was one of the states most affected by H1N1.

The 2014 Ebola outbreak offers a recent example of states imposing restrictions that go against WHO guidance. After declaring the Ebola outbreak a public health emergency on August 8, 2014, the WHO recommended against a "general ban on international travel or trade" (World Health Organization 2014b). In spite of this guidance, the WHO received close to 600 complaints citing overly restrictive trade or travel barriers related to Ebola and followed up with 47 states in cases where the WHO considered the measures to be excessive (World Health Organization 2015b, 4). There is evidence that even at the local level communities concealed cases of Ebola for fear of the human and economic costs of the public health response, which too often included *cordons sanitaires* that cut the community off from access to food and medical care (Onishi 2014).

These examples illustrate that a government that discovers an outbreak can expect to be the target of other states' trade and travel restrictions once the outbreak is made public. Not surprisingly, then, states may not be eager to rapidly and transparently report outbreaks. Disease outbreaks impose many costs on affected states including loss of productivity due to illness and death. Additionally, outbreaks are followed by changes in consumer behavior domestically and in tourist and business activity internationally due to both fear of disease and to disease control measures that can have a public health rationale, like temporary school and business closures (Lempel, Epstein, and Hammond 2009; Copeland et al. 2013). Overly restrictive trade and travel barriers imposed by other states inflict additional costs that are often unnecessary from a public health perspective, according to the WHO and other health experts (see, for example, Cooper et al. 2006; Ferguson et al. 2006; Colizza et al. 2007; Vincent et al. 2009; World Health Organization 2009; Cowling et al. 2010; Poletto et al. 2014; Selvey, Antão, and Hall 2015).

The economic costs extend beyond the direct economic impact of the barriers themselves. In imposing barriers, governments send a signal to private actors that they should alter their behavior as well, thus exacerbating the range of costs associated with outbreaks mentioned above. In the case of Ebola, for example, private companies pulled employees out of the region and stopped operations—especially in the mining and agricultural sectors—and airlines like British Airways and Emirates halted flights to the region (Economist 2014; World Bank 2014). This behavior by private actors is encouraged by the fact that governments themselves imposed barriers against Ebola-affected countries. Barriers levy economic costs on target states, and these economic costs, not surprisingly, can have political costs for governments as well. The direct and indirect costs of trade and travel restrictions, then, incentivize governments to conceal outbreaks.

If this dynamic is operating in the aggregate—if some states do intentionally conceal outbreaks to avoid being the target of trade and travel restrictions—then there should be evidence that states are weighing the costs and benefits of reporting an outbreak against concealing it. As such, those states that stand to lose more from publicizing an outbreak should be slower to report.

I identify two types of states that may be particularly vulnerable to trade and travel barriers after reporting an outbreak and so face strong incentives to conceal in order to not provoke those barriers: states that are economically vulnerable and states that are politically vulnerable. First, the specter of international economic costs might influence state behavior. In this case, states that are more enmeshed in the global trading system face higher potential costs for reporting an outbreak because there are more states that can impose barriers in response—and more opportunities for those states to do so. Highly trade-exposed states, then, may choose to delay reporting and try to contain the outbreak themselves first, away from the public eye.

Alternatively, if the state is less trade-exposed in the first place, then, all else being equal, it stands to lose less from reporting an outbreak. Another way to get at this relationship is to focus on the value added of the agricultural sector since previous outbreaks have demonstrated that import restrictions during an outbreak often target agricultural products (Cash and Narasimhan 2000, 1362; Johnson 2009). International import restrictions could also spill into the domestic market because consumers tend to seek substitutes for the supposedly affected products even in markets that are not affected by the outbreak, which leads to decreased demand across the board and could further harm international competitiveness (Blayney 2005; Moore and Morgan 2006, 6). Beyond the international costs, harm to domestic agricultural producers could translate into a loss of political support for the government. To avoid or delay this outcome, a government may try to conceal the outbreak.

Of course, *not* reporting an outbreak could also come with international costs. If it becomes clear that a country concealed an outbreak, it could face punishment from the international community as well. China's experience during the SARS outbreak is a case in point. The government was publicly criticized by the WHO and other states for concealing the scope of the outbreak, and some officials lost their posts. But, states are shortsighted. The more immediate international costs to worry about are the overreactions of other states once the outbreak is reported. Punishment for concealment comes later, if at all, and would most likely be in the form of rhetorical admonishment rather than immediate material costs. WHO has limited power to enforce reporting requirements and, furthermore, aside from the SARS case, has been reluctant to name and shame states for being slow to report (Kamradt-Scott 2016, 411). In any case, this is an empirical question. If states worry more about the international costs of not reporting than they do about the economic harm of reporting, then we might expect highly trade-exposed states to be *more* likely to report rather than less likely.

In addition to international costs, reporting an outbreak can have domestic political consequences. Not only can admitting to a serious outbreak reduce public confidence in the government's ability to protect the population, but being the target of other states' trade and travel barriers can also have this effect—not to mention the real domestic economic harm that barriers can cause. All governments depend on some level of popular support to stay in office and govern effectively; they take the reaction of the public and other domestic actors into account when making policy. Governments that face strong domestic political opposition are particularly vulnerable to policy failures (Allee and Huth 2006, 225), and so they may view outbreak reporting as a costly decision. "Allowing" an outbreak to occur and provoking barriers will undoubtedly not be well received by the population and can provide fodder to domestic political opposition that can be used to either remove leaders from office or simply make governing difficult. Thus, trying to get the outbreak under control before having to disclose fully the situation to domestic constituents can seem like an attractive strategy for those governments facing opposition at home.[4]

At the same time, however, there are some states for which *not* reporting is the costlier strategy. Noncompliance with international legal commitments, and even behavior that undermines the spirit of international legal commitments, can be particularly costly for states with a high level of commitment to rule of law domestically. Domestic constituents in these states may fear that the disregard of international law could translate into the domestic sphere, or disregard of international law may cost a leader support at home simply because the population values keeping commitments (Fearon 1994; Slaughter 1995; Finnemore and Sikkink 1998; Kelley 2007;

[4] Again, it could be possible that governments worry more about the domestic political costs of unsuccessfully trying to conceal an outbreak. If this is true on aggregate, then we would expect governments facing domestic political opposition to be more likely than others to report quickly.

Tomz 2007). Either way, governments in high rule-of-law states are more likely to follow through with institutional commitments because not doing so could result in a loss of domestic political support. These states should see outbreak concealment as costly because it undermines a key goal of the IHR, and it would mean disregarding a formal international legal commitment. Importantly, these states should see concealment as particularly costly *after* the new IHR enter into force because the new regulations strengthen the obligation on states to quickly report outbreaks.

Importantly, if high rule-of-law states are more likely to report outbreaks after the IHR revision, then this would not only support the contention that governments consider domestic political consequences when making compliance decisions, but would also provide evidence of institutional effects—at least for one group of states. Kelley (2007) makes a similar institutional effects argument in her study of which states uphold their commitments to the International Criminal Court (ICC). She finds that high domestic rule of law encourages states to uphold their commitments to the International Criminal Court, but only for those states that have ratified the ICC statute. Rule of law actually had a negative influence on the behavior of states that had not ratified. This study cannot compare state parties to the IHR to states that are not because the IHR have universal membership. Instead, I compare behavior before and after the revised IHR enter into force.

This logic produces the following hypotheses:

Hypothesis One: *High economic vulnerability should increase reporting lags.*

Hypothesis Two: *High political vulnerability should increase reporting lags.*

Hypothesis Three: *High domestic commitment to rule of law should make states report more quickly, particularly after the revised IHR enter into force.*

I test these hypotheses against the alternative that would expect capacity to drive state behavior:

Hypothesis Four: *Strong surveillance capacity should reduce reporting lags.*

Measuring the Timeliness of Outbreak Reporting[5]

Following Chan et al. (2010), the dependent variable is the time in days between the outbreak start date and the first public communication about the outbreak. I use this measure because reducing the number of days between the start of the outbreak and the first public report is key to improving outbreak response. The shorter the amount of time between the start of the outbreak and when it is reported, the less time the outbreak has to spread, and the more time the locality, state, and international community have to put in place preparedness measures at clinics and hospitals, procedures for contact tracing and monitoring, and plans for vaccine and treatment development before the outbreak escalates.

The central critique of this measure is that in the Chan et al. (2010) data, the first public communication about the outbreak can be from a variety of sources: the government itself, the WHO, or nonstate actors including internet surveillance response programs (ISRPs) like HealthMap, PubMED, and the Global Public Health Intelligence Network (GPHIN) (again, see Chan et al. 2010, 21701). That the dependent variable may not be measuring state behavior in some cases, but could instead be capturing the behavior of private actors raises the question of whether this measure is really appropriate for testing the theoretical argument put forward in the third section, which is about the incentives that *governments*—not private actors—face to report or conceal an outbreak.

[5] The dataset and code used for this analysis are available at https://doi.org/10.7910/DVN/YUSU8X.

For three reasons, however, the first public communication about the outbreak from any source remains well-suited to the analysis. First, the incentives that governments face condition not only their behavior, but also the behavior of private actors within the state. Davies (2012, 102) points out that ISRPs often depend on government information and notes that 50 percent of all ISRP outbreak reports are based on information from government public health officials. Indeed, ISRP reports may reflect the government's own information that just might not yet have been officially reported. Furthermore, the government itself is often able to structure the environment in which ISRPs operate. In many cases the government retains considerable control over information flow within the country—even by nonstate actors—and it can clamp down on information access if it so desires (Madoff and Woodall 2005; Lynch 2011; Searcey and Essomba 2017). And, in cases when the government is trying to conceal an outbreak, nongovernmental organizations (NGOs) that report face potential backlash for doing so. The 2008 cholera outbreak in Zimbabwe is a case in point. After the Zimbabwean government tried to conceal the extent of the outbreak, several NGOs reported it anyway and were then "denied access [to the country] and experienced harassment in part as a result of their reporting" (Davies 2012, 105). This threat of punishment gives the government leverage over nonstate actors that would report against the government's wishes. In many ways, then, ISRP reports may reflect the government's own capacity and/or willingness to report.

Second, to the extent that internet-based surveillance systems are not reliant on government information, they are often a key part of a state's disease surveillance capacity (Brownstein et al. 2008; Katz et al. 2017). Excluding outbreaks reported by these nonstate sources that the government might actually be relying on to fill surveillance gaps could bias the findings against the state capacity perspective and in favor of my argument. In fact, including these nonstate reported outbreaks in the analysis provides a hard test for my argument in that finding empirical support requires showing that the state-level incentives I identify in the third section have an impact on the timing of outbreak reporting by not only directly influencing state behavior, but also by creating a structural environment that indirectly influences nonstate actors.

Finally, and perhaps most importantly, as noted above, the time between the start of the outbreak and the first public report—whatever the source—is what matters from the perspective of improving outbreak response, especially since information often flows faster through unofficial nongovernmental than governmental sources (Katz et al. 2017). The goal is to reduce reporting time in order to facilitate a more effective response. The sooner the outbreak is made public by *any* actor, the more quickly the response can begin.

Timeliness as Compliance

I also consider the time from the start of the outbreak to the first public report a good approximation of state compliance with the IHR. The revised IHR require states to report "all events which may constitute" a Public Health Emergency of International Concern (PHEIC) to the WHO through a specified contact point—the National IHR Focal Point—within 24 hours (World Health Organization 2005, Article 6). On its face, then, compliance seems easy to identify. In reality, there is room for subjective interpretation. Though the WHO has the final say on which events constitute a PHEIC, it is less clear which events "may constitute" a PHEIC and thus require reporting to the WHO. The IHR contain a decision instrument to help states make this determination (World Health Organization 2005, Annex 2). The decision instrument does contain a list of diseases that must always be notified to the WHO, but, this list is not exhaustive. In two other sets of circumstances, states must use an algorithm to determine whether an event should be reported to the WHO. A second list identifies certain diseases that should always lead states to use the

algorithm. States should also use the algorithm for "any event of potential international public health concern, including those of unknown causes or sources and those involving other events or diseases" (World Health Organization 2005, Annex 2). Once the decision is made to use the algorithm, states are asked to consider whether the event is serious, unusual, or unexpected, the risk of international spread, and the risk of international trade or travel restrictions being imposed. There is room for interpretation here. Even though the WHO has issued guidance for how to use the decision instrument (World Health Organization 2008), in some cases, it might not be clear whether a failure to report is a case of noncompliance, or just a reasonable difference of opinion about whether the event should have been reported according to the algorithm. Further, it might not be clear when the government actually became aware of the outbreak and when the 24-hour count down should start.

Therefore, defining legal compliance in this case is difficult; even if it were possible doing so might result in missing the forest for the trees. For example, say a state reports an outbreak within 24 hours of detecting it, but does not do so through the official National IHR Focal Point. Considering that a case of "noncompliance" would ignore the fact that the outbreak was still quickly publicly communicated, which is the overall goal behind the specific requirements of the IHR. As such, given the difficulty of identifying compliance and noncompliance with IHR outbreak reporting requirements, focusing instead on effectiveness as scholars have done in other contexts can be a good way to think about compliance (see, for example, Victor 1998; McNamara 2004). In this case, if states are generally complying with their outbreak reporting commitments under the IHR, then we would expect to see shorter reporting lags. If states are generally not complying, then we would expect to see longer reporting lags.

Data

As noted, I use data from Chan et al. (2010), which was expanded by Kluberg et al. (2016) to cover additional years. Using WHO Disease Outbreak News reports from 1996 to 2014, the dataset codes the timeliness of outbreak reporting for 463 outbreaks verified by the WHO during that period. The dataset includes only distinct outbreaks and excludes outbreaks that have spread from other countries. As such, in cases of outbreaks that eventually spread across countries (like H1N1 in 2009, for example), only the country where the outbreak originated is included.[6] The dependent variable measures the time in days between the outbreak start date and the first public communication about the outbreak from a public or private source, where the unit of observation is country-outbreak. The range of this variable is zero days to 365 days between outbreak start and public communication. I drop 17 outbreaks from the analysis due to missing data about the country of origin, so the dataset used in this paper includes 446 outbreaks. Additional coding details and sources for outbreak start and public communication can be found in the supporting information for Chan et al. (2010).

A potential concern is that there is no information on the outbreak start date for 25 percent of observations, which further reduces the number of observations to 336 outbreaks. I considered using multiple imputation to account for this, but 25 percent missingness on the dependent variable is relatively high for multiple imputation to be effective. More importantly, it is possible that the missing at random assumption required for multiple imputation does not hold in this case

[6] Including only the country of origin gets around potential issues related to sequencing and the possibility that in cases of outbreaks that spread across countries, governments base reporting decisions on the behavior of states where the outbreak spread first. These dynamics are important to understand as well, but the data do not allow me to address them here.

(King et al. 2001). One possibility is that the outbreaks with missing outbreak start information were more likely to occur in countries with weaker surveillance capacity. Bivariate regression of a binary variable coding whether observations had a missing outbreak start date and internet coverage show that the two are negatively correlated. This suggests that the observations left in the dataset may have generally stronger surveillance capacity. It is therefore possible that the outbreaks I examine here occur in states with stronger surveillance capacity on average, which should be the states most likely to report quickly according to the capacity perspective. To the extent that this bias exists, it should bias against finding support for my argument that intentional concealment also plays a role. As such, finding that political and economic vulnerability is associated with slower reporting even in this set of outbreaks would be strong evidence for the argument. However, though the outbreaks without a missing start date *on average* might occur in states with stronger surveillance capacity, many outbreaks remain in the dataset from low capacity countries (for a list, see Tables S5 and S6 in the supplementary files online). Thus, the findings are not limited to higher capacity countries. The rest of this section describes key explanatory variables and controls used in the analysis.

Key Explanatory Variables

I expand on the Chan et al. (2010) and Kluberg et al. (2016) data with a number of explanatory variables and controls. I examine the following key independent variables: surveillance capacity (health expenditures as a percentage of gross domestic product [GDP] and internet coverage), trade exposure, dependence on the agricultural sector, domestic political opposition, domestic commitment to rule of law, and whether the new IHR were in force at the start of the outbreak.[7] As a measure of surveillance capacity, I use total (private + public) health expenditures as a percentage of GDP (World Bank 2016). Because health spending is a broad measure that does not necessarily capture outbreak surveillance capacity, I also include internet coverage. Access to the internet has been associated with reduced outbreak reporting lags (Wilson and Brownstein 2009; McAlarnen et al. 2014; Smith et al. 2014), and the proliferation of internet-based surveillance systems for health-related events makes this an important variable to consider (Brownstein et al. 2008; Davies 2012; Katz et al. 2017). I use data from the World Bank (2016) coding the number of individuals (per 100 population) that have used the internet over the past year.

To measure the level of trade exposure and dependence on the agricultural sector, I use the sum of exports and imports of goods and services as a share of gross domestic product (GDP) and the value added of the agricultural sector as a percentage of GDP, respectively (World Bank 2016). To measure domestic political opposition, I follow Allee and Huth (2006). They use the following coding to define a government as facing strong domestic political opposition:

> Executives in democratic countries are considered to face strong domestic political opposition when their governing coalition does not control a majority of seats in the primary legislative or parliamentary body. Executives in nondemocratic countries are said to face significant domestic political opposition if there has been an attempted or actual coup within the country in the past year (Allee and Huth 2006, 226).

To get the year coverage that I need for this variable, I use slightly different data sources than Allee and Huth (2006). As they do, I define a democracy as a state

[7] Unless otherwise noted, all explanatory variables and controls are lagged by one year. Full description of data and summary statistics are available in the supplementary files (see Table S3).

that scores a 6 or above on the Polity IV data project's 21-point Polity scale, which captures the competitiveness and regulation of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive, and ranges from –10 (strongly autocratic) to 10 (strongly democratic) (Marshall, Jaggers, and Gurr 2014). Democratic governments are coded as facing strong domestic opposition if they do not control a majority of votes in the legislature. I use the Numvote variable coding the total vote share in the legislature of government parties from the Database of Political Institutions (Beck et al. 2001). Nondemocratic governments are coded as facing strong domestic opposition if in the past year a change in the chief executive occurred through a "forceful seizure of power"—a "1" in the Polity IV data project's Xrreg (Regulation of Chief Executive) variable. The final variable is binary, coding a state as a "1" if either of the previous conditions are true, and "0" otherwise.

To code domestic commitment to rule of law, I use data from the Worldwide Governance Indicators Dataset, which ranges from –2.5 (weak) to 2.5 (strong) (Kaufmann, Kraay, and Mastruzzi 2010). Lastly, to code whether the IHR were in force when the outbreak started, I create a binary variable for whether the outbreak start date was after June 15, 2007, the date the IHR enter into force.

Controls

I include several other controls. Though previous studies of outbreak reporting have not found a relationship between regime type and reporting (Kluberg et al. 2016), scholars associate regime type with compliance behavior generally, and some have argued that democracies are more open about information during disease outbreaks (Vu 2011, 4–5). As such, I include a measure of democracy using the Polity score (Marshall, Jaggers, and Gurr 2014).

General level of development measured through economic wealth could also affect behavior, so I include GDP per capita data from the World Bank (2016). And, as an alternative to trade exposure and dependence on the agricultural sector for capturing potential economic costs of reporting, I include the total contribution of travel and tourism to GDP (as a percentage of GDP) from the World Bank (2017b). Lastly, existing studies show that reporting lags have decreased over time (Chan et al. 2010; Mondor et al. 2012), so to account for potential time trends, I include the year the outbreak started.

Analysis and Results

I use a set of Cox proportional hazards models to investigate the duration of time between the start of the outbreak and the first public communication about the outbreak. Note that both health spending and internet coverage are included in all models in order to examine whether other variables have an influence on outbreak reporting, even when controlling for surveillance capacity.

The Cox model takes the following form:

$$h_i(t) = h_0(t) * e^{\left(\begin{array}{c}\beta_1 * ln(\text{HEALTH SPENDING}) + \beta_2 * ln(\text{INTERNET COVERAGE}) + \beta_3 * ln(\text{TRADE EXPOSURE}) \\ + \beta_4 * \text{DOMESTIC OPPOSITION} + \gamma Z_i + \epsilon_i\end{array}\right)}$$

Where $h_i(t)$ is the probability of country i reporting an outbreak conditional on having not reported until time t, $h_0(t)$ represents the baseline hazard of reporting, and Z is a vector of control variables (for further details see Box-Steffensmeier and Jones 2004). I use the Cox model because I do not have a strong expectation about the shape of the survival curve. In contrast to parametric duration models like the exponential or the Weibull models, the Cox model is semiparametric—it does not

Table 1. Hazard models explaining days to outbreak report

	Surveillance (1)	*Costs* (2)	*Full* (3)	*IHR* (4)
ln(Health Exp.)	0.874	0.787	0.984	0.926
	(0.135)	(0.157)	(0.242)	(0.231)
ln(Internet)	1.073***	1.092*	1.063	1.093*
	(0.027)	(0.045)	(0.053)	(0.047)
ln(Trade Exposure)		0.812**	0.765**	0.775**
		(0.094)	(0.116)	(0.115)
Domestic Opposition		0.753***	0.840***	0.808***
		(0.110)	(0.058)	(0.077)
IHR	0.812	0.850	0.841	1.056
	(0.127)	(0.152)	(0.194)	(0.189)
Outbreak Year	1.009	0.999	1.011	0.996
	(0.017)	(0.028)	(0.036)	(0.033)
ln(Agriculture)			0.607***	0.650***
			(0.136)	(0.108)
ln(Travel and Tourism)			1.934***	1.876***
			(0.196)	(0.202)
Rule of Law			0.812**	0.730***
			(0.085)	(0.101)
Democracy			0.996	1.002
			(0.016)	(0.014)
ln(GDP per capita)			0.731***	0.747***
			(0.105)	(0.097)
IHR x Rule of Law				1.306**
				(0.109)
Observations	298	252	207	207

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Robust standard errors clustered by WHO region in parentheses.

make an assumption about the shape of the baseline hazard (Box-Steffensmeier and Zorn 2001). To account for established regional patterns in outbreak reporting (see, for example, Kluberg et al. 2016), all models cluster standard errors by WHO region.[8]

The Duration in Days from Outbreak Start to Public Communication

Results support the argument that a cost-benefit calculation, rather than capacity alone, influences state behavior. Table 1 presents a set of Cox proportional hazards models examining the timing of reporting. The results are shown as hazard rates, which indicate the impact of a given variable on the rate of outbreak reporting relative to a baseline hazard of 1.00. Coefficients greater than one proportionately increase the rate while coefficients less than one proportionately reduce the rate.

[8] As robustness checks, I include region as a control and also cluster standard errors by country (see Models 1 and 2 in Table S2 in the supplementary files). The substantive findings remain largely consistent in these models. The only difference is that the trade exposure variable is not significant when I cluster standard errors by country ($p = 0.13$, though the negative substantive relationship remains consistent). But, the alternative measure for economic vulnerability—the size of the agricultural sector—remains significantly negatively associated with reporting ($p < 0.01$).

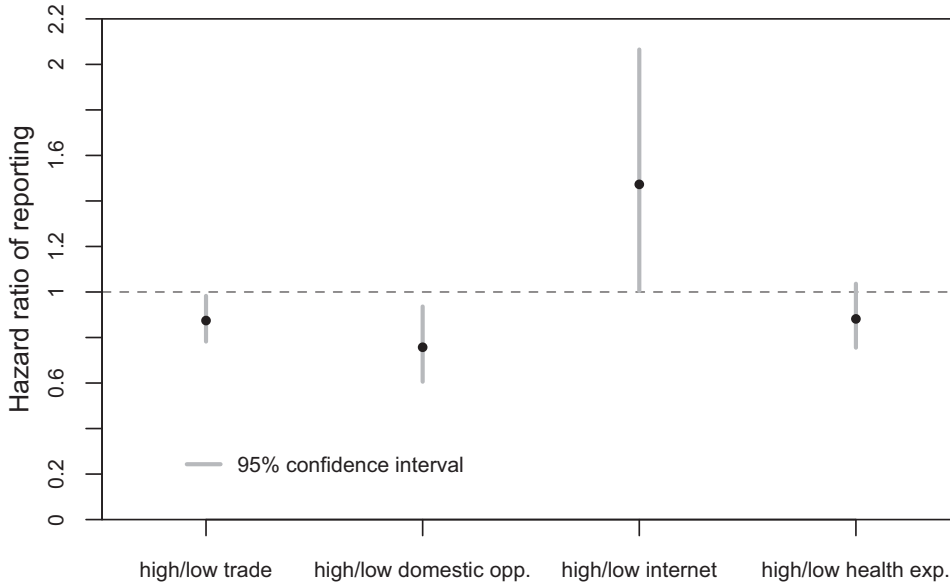

Figure 1. Ratios of simulated hazard rates of reporting for states with high trade exposure to those with low exposure, states facing domestic political opposition to those not facing opposition, states with high internet coverage to those with low coverage, and states with high health spending to those with low spending. In the case of domestic political opposition, "low" and "high" refer to 0 and 1. For all of the other variables, "low" and "high" refer to the first and third quartiles.

As an example, a hazard rate of 0.5 would mean that the rate at which countries report is cut in half and they would be two times less likely to report.

The results show that health spending (Model 1) is not significantly associated with reporting, and in fact the substantive effect is negative—the opposite of what would be expected. Internet coverage, however, increases the speed of reporting in Models 1, 2, and 4 (it is not significant in the full model, Model 3). Yet, even controlling for surveillance capacity with health spending and internet coverage, both trade exposure and domestic political opposition are significantly associated with increases in reporting lags (Model 2). States that face higher potential economic and political costs for reporting are less likely to report on any given day than states facing lower costs for doing so.

Model 3 is the full model; it shows that the findings about trade exposure and domestic political opposition are robust to the inclusion of other variables. In terms of the other controls, four are significantly associated with reporting: a larger agricultural sector is negatively associated with reporting, which is consistent with the finding about trade exposure. In addition, GDP per capita is negatively associated with reporting, as is a higher level of domestic rule of law, while a higher percentage of GDP made up by travel and tourism encourages reporting. These last two findings are somewhat surprising, and I return to them below.

Figure 1 displays the key findings graphically.[9] The figure compares the reporting behavior of: (1) states with high and low trade exposure, (2) governments facing domestic political opposition and those not facing opposition, (3) states with high and low internet coverage, and (4) states with high and low health spending. To compare each group of states, I present the ratios of simulated hazard rates: each point in the figure represents how much more or less likely a state with a high level on

[9] Simulated hazard ratios and Figure 1 based on Model 2. All simulations in the article produced using the Zelig package in R (a free software environment for statistical computing) (Imai, King, and Lau 2007, 2008).

each variable is to report on any given day than a state with a low level on each variable. In the case of domestic political opposition, "low" and "high" refer to 0 and 1. For all of the other variables, "low" and "high" refer to the first and third quartiles.[10]

The figure shows that a highly trade-exposed state is 1.14 times less likely to report (hazard ratio of 0.87) than a state that has a low level of trade exposure ($p < 0.05$). And, a state facing domestic political opposition is 1.32 times less likely to report (hazard ratio of 0.76) than a state that is not facing political opposition ($p < 0.05$). Importantly, these relationships hold even while controlling for the influence of surveillance capacity. The figure shows that there is no significant difference in the reporting behavior of states that spend a little or a lot on health. But, a state with widespread internet coverage is 1.47 times more likely to report on any given day than a state with limited coverage ($p < 0.05$). These findings provide evidence that, even accounting for surveillance capacity, political and economic incentives are associated with increased reporting lags.

IHR Effects

Interestingly, Model 3 also shows that there is no significant association between the new IHR being in force and reporting. In fact, the substantive relationship is negative—the opposite of the intended effect of the new IHR, which was to encourage reporting. Interestingly, Model 3 also shows that rule of law is negatively associated with reporting. To further examine this relationship, Model 4 includes an interaction between rule of law and IHR. Though rule of law is negatively associated with reporting in Model 3, when interacted with the IHR entering into force in Model 4, this relationship changes. Before the new IHR enter into force in 2007, a state with a high level of domestic rule of law (third quartile) was 1.36 times less likely to report (hazard ratio of 0.74, $p < 0.05$) than a state with a low level of domestic rule of law (first quartile), whereas after the IHR entered into force, the substantive effect became quite small (hazard ratio of 0.96) and was no longer significant.[11] Although the expectation was that rule of law would encourage reporting and this should have been even more so after the new IHR entered into force, the finding that the negative effect diminishes and is no longer significant post-IHR provides some evidence that the strengthened legal obligation on states to report quickly in the new IHR may have affected the behavior of high rule-of-law states that could suffer costs for not following through international commitments.

Travel and Tourism

One finding worth returning to is the positive association between tourism and reporting. Model 3 shows that states with larger travel and tourism sectors are more likely to report quickly. At first glance, this finding does not seem to fit in with the central argument in this article. Like trade-exposed states and states facing domestic political opposition, states with large travel and tourism sectors stand to face costs if they report an outbreak and other states impose travel restrictions or individuals change their travel plans. As such, we might expect states with large travel and tourism sectors to delay reporting. What explains the surprising outcome we do observe?

One possibility is that states with large travel and tourism sectors face a different cost-benefit analysis when it comes to reporting than trade-exposed states or those facing domestic political opposition. Disease outbreaks can certainly have negative effects on a state's tourism industry. But, crisis management researchers argue that, while tourism losses may be inevitable during and after an outbreak and other

[10] Defining high and low as the maximum and mean, mean and minimum, or maximum and minimum does not change the substantive findings.

[11] Simulation based on Model 4.

natural disasters, government transparency and assurances can increase visitor confidence in the government's handling of the situation and minimize longer term losses (Laws, Prideax, and Chon 2006; Henderson 2007; Beirman 2012). Tourism-reliant countries must weigh the tourism losses that come from rapid reporting against those that come from concealing now with the risk of discovery later. In other words, these governments have to weigh a short-term loss in tourism against a longer term hit to their reputation, which could in turn have a long-term negative impact on tourism. Visitor trust is an important determinant of travel destination selection (see, for example, Jang and Cai 2002; Rahmani, Gnoth, and Mather 2018), and trust is based on individuals' feelings about a location's reputation (see Artigas et al. 2017). Therefore, it is likely that feelings of *distrust* could persist after the precipitating event has ended, thus affecting visitor behavior in the longer term (Beirman 2017).

The experience of Vietnam during the 2003 SARS outbreak illustrates this dynamic. As the outbreak spread, the WHO issued travel advisories for a number of countries, which impacted tourism and other travel (World Health Organization 2003a). Though Vietnam was on the WHO's list of countries with local transmission of SARS, the WHO never issued a travel advisory for the country because of its rapid and open response to the outbreak. In late April 2003, Vietnam became the first country to contain the outbreak (World Health Organization 2003b). Aileen Plant, WHO's lead in Vietnam for the outbreak, noted that this rapid containment was due to "the speed, the leadership, the transparency, the flexibility, the intensity with which they [the Vietnamese government] educated people what to do" (Mydans 2003, A00001). As such, Vietnam, which falls in the top 25 percent of countries for percent GDP made up by travel and tourism, was rewarded for openness during the SARS outbreak.

Other governments have also learned the importance of open communication for minimizing an outbreak's impact on tourism; the British government in the wake of the 2001 outbreak of foot and mouth disease is a case in point. As the outbreak unfolded, the British Tourism Authority found that "perceptions of the way that Britain was handling the outbreak" was a deterrent to visiting the countryside (Frisby 2003, 90). In response, the British Tourism Authority, with the support of the government, launched a media and messaging campaign to provide factual information to travelers about the outbreak and ensure that plans were only changed when absolutely necessary (Frisby 2003, 91; see also McConnell and Stark 2002).

However, the benefits of transparency do not appear to apply to questions of trade. Illustratively, at the outset of the 2009 H1N1 pandemic, Mexico and the United States quickly reported outbreaks and were rewarded for doing so with almost 25 percent of countries imposing pork import restrictions on the two countries. As such, high-profile events like H1N1 show little benefit to reporting quickly if a country is worried about trade restrictions. Further, the actors primarily responsible for trade losses include industry and other governments rather than the individuals who are primarily responsible for tourism losses. The latter may be more driven by emotions and feelings of trust and comfort whereas the former may be more concerned about the bottom line and so may be less likely to maintain changes in investment or trade behavior after the outbreak has ended, regardless of whether or not a government was transparent at outset (for example, most pork import restrictions during H1N1 were removed after the outbreak dissipated). Individuals, however, may maintain an image of a destination as dangerous and untrustworthy long into the future.

As such, countries reliant on tourism may see benefits to reporting quickly in order to maintain visitor confidence, whereas trade-dependent countries may be more worried about the short-term negative impacts on trade and try to conceal to avoid those. This should be particularly true for tourism-reliant countries that also have high surveillance capacity because information about the outbreak is more

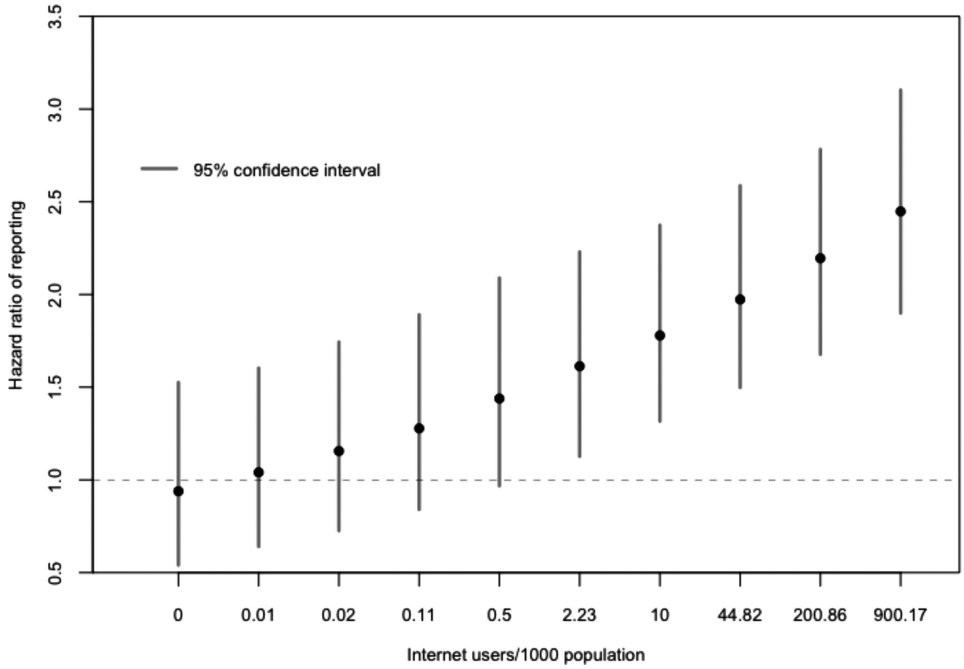

Figure 2. Ratios of simulated hazard rates of reporting for states with large tourism sectors (third quartile) to those with small tourism sectors (first quartile) at increasing levels of internet coverage.

likely to become public in those cases and a lack of transparency could actually further harm the tourism sector because individuals considering a visit may fear that the government is not trustworthy. Tourism-dependent countries that also have high surveillance capacity may be transparent in the hope that doing so will lessen harm to tourism relative to attempting to conceal and being exposed for that behavior when the outbreak becomes public anyway.

To further probe whether these different logics are operating for tourism-reliant and trade-reliant countries, I interact internet coverage with the share of GDP made up by the travel and tourism sectors. As expected, there is a positive interaction between the two. Figure 2 displays the findings graphically (see Model 3 in Table S2 in the supplementary files for full regression results). The figure presents the ratios of simulated hazard rates to compare states with a large tourism sector (third quartile) to those with a small tourism sector (first quartile). While at higher levels of internet coverage, a large tourism sector is associated with faster reporting, at lower levels the substantive relationship is much smaller and no longer statistically significant. Indeed, 25 percent of the outbreaks in the dataset occur in countries with lower internet coverage where the relationship between a large tourism sector and rapid reporting is not significant (the relationship is insignificant at about 0.7 users/1000 population or fewer). These findings are consistent with the argument that governments pay attention to the costs and benefits of reporting. Where the outbreak is more likely to be made public because of strong surveillance capacity, having a large tourism sector encourages governments to transparently report the outbreak rather than risk looking untrustworthy (in contrast and as expected, the negative effect of trade dependence on reporting is not conditional on surveillance capacity). If the cost-benefit analysis shifted in favor of reporting for states other than those with large tourism sectors and strong surveillance capacity, then we could expect more rapid reporting in general.

Alternative Explanations and Robustness Checks

Several alternative explanations and robustness checks are worth considering. First, perhaps the type of disease has an influence on the timing of reporting. It could be that governments expect fewer barriers to be imposed in response to diseases that tend not to be spread through direct human-to-human transmission. For example, the outbreak of Zika in 2016, which is primarily spread through mosquitos and produces only mild symptoms for the vast majority of those infected, provoked few trade or travel barriers. Therefore, in the supplementary files I control for whether, according to the WHO and/or the Centers for Disease Control and Prevention, the disease spreads through direct human-to-human transmission (see Model 1 in Table S1). Direct human-to-human transmission is negatively correlated with reporting, but the relationship is not statistically significant. I also include a binary variable for whether the country experienced an outbreak previously in the dataset, which is not significantly associated with reporting (Model 2 in Table S1). Importantly, controlling for these factors does not alter the substantive findings presented in Section 6.

A second issue has to do with the measure of surveillance capacity. Because health spending measures the amount of money spent rather than *how* it is spent, it may not accurately capture surveillance capacity. This is why I include internet coverage in the analysis. Though internet coverage gets at communication networks and a possible pathway for surveillance, it is a noisy indicator. The extent of internet coverage could be a product of how transparent the state is generally—a government that is transparent and likely to report outbreaks may also be likely to have wide internet coverage. Or, in some cases, internet coverage may not actually reflect surveillance capacity, but instead could reflect the likelihood that nonstate actors might make an outbreak public and hold a government accountable for not reporting itself. Therefore, in the supplementary files, I exclude internet coverage and use only health spending as a measure of surveillance capacity. The substantive results remain unchanged (see Model 3 in Table S1).

As an additional robustness check, I use the Human Development Index (HDI) as a measure of surveillance capacity (see Model 4 in Table S1). In their study of the timeliness of outbreak reporting, Kluberg et al. (2016, e2) include the HDI because existing "studies have found associations between HDI and health system quality, health outcomes, disease prevalence, and health-seeking behavior" and find that higher scores on the HDI are associated with shorter reporting delays. The HDI is a composite measure of development that includes life expectancy, years of schooling, and gross national income per capita (United Nations Development Program 2016). I find that the relationship between HDI and reporting is positive but not statistically significant. Including it instead of health spending and internet coverage does not change the key substantive results.

Finally, to account for potential within-cluster homogeneity in outcomes, I include two multilevel models by using a random effects cox model (otherwise known as a shared frailty model, see Table S3 in the supplementary files). The first includes region random effects and the second includes country random effects. The substantive findings remain largely consistent in these models. The only difference is that the trade exposure variable is not significant in either model ($p = 0.12$ in the former and 0.17 in the latter, though the negative substantive relationship remains consistent). But, the alternative measure for economic vulnerability—the size of the agricultural sector—remains significantly negatively associated with reporting ($p < 0.01$).

Policy Implications and Conclusions

This research was motivated by the consistent pattern of delays in outbreak reporting that continues to prove costly in terms of lives and resources. The findings provide evidence that governments are sensitive to the political and economic consequences of outbreak reporting. While I focus on the threat of trade and travel barriers as disincentives to reporting, it is likely that the many additional costs associated with disease outbreaks also motivate outbreak concealment (or at least intentional downplaying of outbreak severity). In short, in addition to the issue of weak capacity, governments also face a potential wide range of costs when deciding to report outbreaks in a timely manner. Thus, it is important that the WHO has recently emphasized outbreak preparedness and response as one of three strategic priority areas for 2019–2023 (World Health Organization 2018a, 20). Further, the Sustainable Development Goals explicitly include meeting the IHR outbreak response capacities as an indicator under target 3.D, which aims to promote global health security (United Nations 2017). However, as outbreak preparedness gets a higher profile, it is necessary to ensure that both technical capacity *and* political and economic factors are taken into account.

Existing policy aimed at encouraging rapid reporting focuses on surveillance capacity building even though, as this article shows, political and economic incentives also contribute to delayed reporting. The WHO's most recent draft program of work, its plan for the new Health Emergencies Program, and its recently released draft five-year strategic plan for implementing the IHR all focus heavily on capacity building through the IHR core capacity requirements with little attention given to practical suggestions for mitigating the political and economic costs of reporting (World Health Organization 2016c, 2018a, 2018b). Capacity building is critical, but ignoring other factors that also lead to reporting delays could mean that technical capacity improvements will not have the desired effect on reporting. Making progress requires both technical capacity building and addressing the economic and political disincentives to reporting.

The article's findings point to several pathways for doing so. The first set of strategies aim to lower the costs of reporting. First, effectively discouraging the imposition of trade and travel barriers that go against WHO guidance during an outbreak could reduce the anticipated costs of reporting. That so many countries have imposed excessive barriers during recent global health emergencies, with little consequence for ignoring WHO guidelines, suggests that convincing states not to do so is no easy task. The WHO, NGOs, and/or other states must at least threaten reputational costs for this behavior that goes against state commitments to the IHR. On paper, the WHO has the authority to name and shame states that disregard its recommendations, but it has not exercised this authority during recent outbreaks (Kamradt-Scott 2016, 411). This caution is not surprising given the WHO's continued reliance on member countries for financial support and cooperation, but it is a missed opportunity to lower the costs of outbreak reporting. States and interested NGOs could fill the gap, but both have their own reasons for not wanting to name and shame countries for bad behavior. In its five-year strategic plan to improve public health preparedness and response presented at the World Health Assembly in May 2018, WHO emphasized that the organization should systematically collect and report on additional health measures imposed by states and coordinate with the World Trade Organization (WTO) to address trade-related issues during public health emergencies of international concern (World Health Organization 2018b, 8–9). Further, WHO (with the University of Sydney, New South Wales, Australia), recently launched a new tool to monitor state compliance with IHR requirements regarding additional health measures (Kamradt-Scott et al. 2018). These are important, and positive, developments. But, it remains to be seen how the tool will be used during a public health emergency. The structural constraints that have made WHO

hesitant to criticize, let alone directly oppose, its member countries remain—and may actually intensify over time given the increasing role of voluntary contributions in the organization's budget (Graham 2017).

Particularly troubling is evidence that the declaration of a public health emergency by the WHO (one of its new powers under the revised IHR), which is meant to warn and prepare the international community, might actually provoke states to impose trade and travel barriers. During the 2014 Ebola outbreak, for example, the number of states imposing travel barriers was highest immediately following the WHO's declaration that the outbreak constituted a public health emergency, and, interestingly, state behavior was not related to the severity of the outbreak (Worsnop 2017a). In the absence of anticipated costs for disregarding WHO guidance during an outbreak, the declaration of a public health emergency signals that a serious outbreak is underway and that states should go ahead and impose restrictive border measures. This relationship may actually explain my finding that the new IHR have not had an overall positive influence on the timeliness of reporting. If states that discover outbreaks know, or think, that the WHO's formal declaration of a public health emergency might actually provoke barriers, then they will not be eager to report post-IHR. Naming and shaming states that ignore WHO guidance by imposing barriers could disrupt this dynamic.

Interestingly, for the first few decades of the WHO's existence, its Committee on International Quarantine regularly discussed and published in its reports cases of excessive measures and actively followed up with states that imposed such measures reminding them of their commitments under the then-named International Sanitary Regulations (see, for example, World Health Organization 1962, 1964, 1965, 1966, 1967). Research into why the WHO was willing to name and shame states then and why it stopped could identify factors that might make the organization willing to do so once more.

A second option would be to set up a mechanism to help states recover from the economic losses associated with reporting an outbreak—including the costs of being the target of other states' trade and travel barriers and unavoidable costs like loss of productivity. The World Bank recently launched the Pandemic Emergency Financing Facility in order to make funds available to poorly resourced countries at the start of an outbreak to help with rapid response (Stein and Sridhar 2017). There have been some implementation issues with the fund, but a mechanism should also be set up to compensate for economic losses during outbreaks. Providing some assurance of financial compensation might convince governments to report and risk the associated economic costs. This type of mechanism has been suggested before (Cash and Narasimhan 2000, 1365) and was even supported by some states during negotiations of the revised IHR in 2004 (World Health Organization 2004, 2), yet it has neither been implemented nor seriously discussed as a policy option since then.

Third, at the domestic level, countries should be encouraged to pass legislation for a local financial compensation and support scheme as a part of the IHR core capacity requirements. Disincentives to reporting also exist at the local level during an outbreak, which can then delay reporting at the national level. For example, underreporting of cases of avian flu among poultry has been suspected in China due to insufficient compensation for the culling of birds after an outbreak is made public (Kaufman 2008, S11; Huang, Wang, and Zuo 2017, 67). The United Nations recommends compensation to encourage local reporting of avian influenza, and it has been implemented with some success in some cases of disease outbreaks among livestock and poultry, including the 2001 outbreak of foot and mouth disease in Britain (Donaldson et al. 2006; UNSIC Office 2017). Incentives for concealment at the local level exist during outbreaks that affect humans as well. Local officials and family members may conceal cases because of the sometimes draconian public health measures that are adopted in response. For example, Liberia's West Point neighborhood in the capital Monrovia was sealed off by the government during

the Ebola outbreak and the community was isolated from needed food and other supplies (Onishi 2014). Short of official quarantine, local reporting may have other economic repercussions as well if people and businesses avoid affected areas.

As such, some guarantee of support in the form of financial compensation for losses or access to food, water, and medical supplies in the case of a quarantine could shift incentives in favor of reporting at the local level during a range of types of outbreaks. Of course, financial compensation must be set at a level that is high enough to encourage reporting but not so high that it creates a moral hazard. In the case of avian influenza, the United Nations recommends that rates be "no less than 50 percent of the reference market value of suspected birds at the farm gate, and no more than 100 percent" (UNSIC Office 2017). The rate and type of compensation may have to be tailored to different outbreak scenarios, but rapid national reporting also relies on mitigating disincentives to reporting at the local level.

The first three strategies would lower the costs of reporting. Another option is to raise the costs of not reporting. The WHO could name and shame states that delay reporting. But, this is often difficult to ascertain in real time, and, as discussed above, criticizing member countries does not come easily to the organization. A more promising strategy would be to incorporate domestic legal protections for nonstate actors that independently report outbreaks into the IHR core capacity requirements. Currently, the WHO can use outbreak information from nonstate sources without state permission, but in certain scenarios these actors may be hesitant to report such information without state sign-off. Stronger legal protections could empower nonstate actors to share information and therefore raise reputational costs for governments that do not cooperate.

These policy options will not be easy to implement—but, neither are the technical capacities required to improve outbreak preparedness that are the current focus of policy initiatives. Mitigating the political and economic disincentives to reporting is just as critical for rapid reporting and outbreak response as technical capacity. These factors must have a more central role in policy discussions, especially given the increased attention on outbreak preparedness at the WHO and the United Nations generally; the policy options laid out here offer a starting point.

Finally, it is worth returning to the issue of outbreak data availability and quality. Quality and detailed data on outbreaks are critical for fully understanding reporting lags and other aspects of outbreak response. Existing data illustrate that we need to engage in a more concerted and sophisticated global data collection effort. As noted above, about 25 percent of the outbreaks verified by the WHO are missing information on the start date; it could be that the outbreaks with start date information occur in countries that, on average, have higher surveillance capacity. Other possibilities exist as well, including that certain types of diseases may be harder to surveil and thus may be less likely to have a recorded start date. Furthermore, the outbreaks verified by the WHO only represent a subset of outbreaks that actually occur. Therefore, as others have emphasized (see, for example, Smolinski, Crawley, and Olsen 2017), more comprehensive outbreak data collection efforts are needed in order to further investigate, and improve, trends in outbreak reporting. Though such efforts will not necessarily help to fill in historical outbreak records, improving data collection now can help us to derive better lessons from future outbreaks.

Supplementary Information

Supplementary information is available at the *ISAISP* data archive.

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