Can International Organizations Shape Scientific Development?

Mengfan Cheng*

Zoe Xincheng Ge†

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June 10, 2024

Abstract

Scientific development is not neutral. One underlying source of the biased development is innovators' lack of information about the market demand for the new technology. We argue that IOs can provide the information about the priority of technology to convince innovators of a credible market demand for ignored technologies, which facilitates the R&D investment. We focus on the influence of the World Health Organization (WHO) on medical research on infectious diseases. Using disease characteristics to explore the informativeness of the market demand, we find that diseases with more unequal geographic distribution receive a higher priority from the WHO, while severe diseases are not listed as a high priority, confirming that the WHO's information provision substitutes for the lack of information about the market demand. Using a difference-in-differences specification, we show that the WHO priority can enhance R&D investment in ignored diseases. This paper highlights IOs' influence on the market as a new source of agenda-setting power in IOs.

*PhD Candidate, Department of Politics, New York University. Email: m.cheng@nyu.edu.

†Postdoctoral Fellow, Niehaus Center for Globalization and Governance, Princeton University. Email: zoe.ge@princetonc.edu.

1 Introduction

Scientific development is biased in favor of the interest of capital. Knowledge that contributes to a higher market return tends to receive more attention and funding for research and development (R&D), while areas lacking market implications may undergo a slower process of scientific development. For example, in the field of infectious diseases, despite the fact that malaria is deadlier than COVID-19 in Africa, malaria vaccine takes much longer to be developed than COVID-19 due to the concentration of malaria in poor regions (Wilkins and Paquette, 2021). The unequal scientific development may ignore the welfare of the less privileged population. Given their role in global public goods provision, can international organizations (IOs) facilitate the ignored area of scientific development?

We focus on the case of the World Health Organization's (WHO) impact on global health research. Studies on infectious diseases can contribute to the efficient control of disease outbreaks. The development of vaccine technology and treatment medicine can greatly alleviate the severity of disease outbreaks. Yet, not all infectious diseases receive the same attention and resources. One example is the development of an Ebola vaccine called rVSV-ZEBOV (Branswell, 2020). The vaccine delivery technology is called vesicular stomatitis virus (VSV) and has been available since 1994. Yet, even though the testing in animals proved to be effective against the virus and showed no sign of negative consequences, the vaccine did not receive any grants until 2014, which was given by a Canadian defense program as a tool to combat bioterrorism. Despite the great promise, there was still a lack of funding for this vaccine candidate to enter the clinical trial stage, leading to another 5 years' delay before the vaccine was finally approved. During this stalled development of the Ebola vaccine, there were two Public Health Emergency of International Concern (PHEIC) related to Ebola, one in West Africa in 2014 and another in the Democratic Republic of the Congo in 2019, causing an estimation of more than 13,000 deaths. Considering the consequence of such unequal scientific development and the WHO's role of facilitating disease control as a global public good, can the WHO facilitate the R&D investment in diseases that are ignored?

In this paper, we investigate how the WHO can shape the research on infectious diseases. One of the key reasons for the unequal R&D investment in different infectious diseases is informational. The market of medical products targeting infectious diseases is highly unpredictable, especially for those concentrated in low-income countries where the government's purchasing power is limited. Without the information on the market demand for specific medical products, pharmaceutical firms have a low expected return for their R&D investment in these diseases, which discourages such investment. In addition, as pharmaceutical firms tend to have multiple lines of R&D investment on different health issues, there is a high opportunity cost for firms to divert resources from a more stable and profitable market—such as seasonal flu—to ignored infectious diseases (Branswell, 2020). As a result, the unpredictability of the market demand is a big obstacle to R&D investment in diseases concentrated in low-income countries.

We argue that the WHO can leverage its influence on the market of medical products and provide information about the priority to convince pharmaceutical firms of a credible market for ignored diseases. To do so, the WHO publishes information about the priority of diseases and medical products to reduce the uncertainty in the demand for medical products. In addition, the WHO collaborates with other procurement agencies such as the United Nations International Children's Emergency Fund (UNICEF) and Gavi, the Vaccine Alliance (Gavi) to build a market for medical products targeting low-income countries. By pooling their financial resources together, these procurement agencies can create a large enough market, which addresses the problem of fragmented small markets that low-income countries have. Altogether, these efforts help facilitate the R&D invesetments in these ignored diseases.

To examine this argument, we look into one important agenda-setting tool of the WHO: the priority of vaccine prequalification. Vaccine is one of the most cost-effective interventions (World Health Organization, 2009). However, the efficacy and safety of vaccines require constant regulation. Equipped with its expertise in public health, the WHO was delegated the authority of vaccine quality control by other United Nations (UN) procurement agencies.

This procedure is called vaccine prequalification, which is a necessary condition for a vaccine to enter the UN procurement process. Hence, the WHO has the authority to give market access to vaccine products to a bigger market. By setting a higher priority for certain types of vaccines, the WHO can signal to pharmaceutical firms a higher probability that the product will enjoy a big market, which increases the marginal benefits of investing in the vaccine for firms.

Given the information problem of market demand, we examine how disease characteristics affect the credibility of market demand and, as a result, the vaccine priority set by the WHO. We hypothesize that the WHO sets a higher priority for diseases that are unequally distributed around the world because pharmaceutical firms may have more difficulty in predicting the outbreak trend and the market demand for such diseases. On the other hand, we hypothesize that diseases with greater severity may not necessarily receive a higher priority because it is more visible to the public when a disease outbreak affects multiple countries. The descriptive analysis confirms these hypotheses.

To examine the effect of vaccine priority on R&D investment, we employ a difference-in-differences specification. We use the publication of the vaccine priority list as the treatment and examine the treatment uptake by exploring the variation in the level of priority. To measure R&D investment in different diseases, we use the research funding data on the Research, Condition, and Disease Categorization (RCDC) provided by the National Institutes of Health (NIH) and an online database of clinical research studies around the world. Using regular expressions to detect diseases and the corresponding viruses, we categorize the funding and clinical trials into 38 types of vaccine-preventable diseases.[1] The results show that a higher priority set by the WHO does increase the R&D investment, but the effect is not statistically significant.

This paper contributes to the literature on the international determinants of scientific development. While existing work has shown the importance of economic factors (Acemoglu,

[1]Website: https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases

2002; Acemoglu et al., 2015) and domestic politics (Drezner, 2001) in the development of science and technology, an emerging literature is focusing on the role of international politics. Milner and Solstad (2021) shows that international competition accelerates the speed for states to adopt new technology, while Drezner (2019) highlights the importance of power distribution. Most closely related to this paper, Hai (2023) studies how states influence IOs' interpretation of scientific information to set the agenda in international negotiation. This paper shows how IOs can use their agenda-setting power to influence the direction of scientific development to achieve the goal of global public goods provision.

This paper also contributes to the understanding of the source of agenda-setting power in IOs. Existing studies have identified the influence of expertise (Haas, 1992; Pollack, 1997; Heinzel and Koenig-Archibugi, 2024), domestic audience (Bisbee et al., 2019; Kelley and Simmons, 2020), and bureaucrats (Arias, 2024) as the source for IOs' agenda-setting power. This paper adds to these studies by highlighting IOs' influence on the market as a new source for their ability to set the agenda.

2 Argument

2.1 Information Problem in Scientific Development

Scientific development is biased. While the direction of scientific development can be determined by the profitability of the price effect and the market size effect in the production output assisted by the technology (Acemoglu, 2002), we argue that one of the reasons for the biased directed technological change can be informational.

To illustrate the information problem, imagine a simple model with an innovator (F) and two states (P_1 and P_2) planning to purchase F's products with P_1 more well-resourced than P_2.

F can invest in two directions of the technology (d_1 and d_2) that targets the solution to a problem. The investment is costly. d_1 targets the market of P_1, while d_2 targets the market

of P_2. By optimizing its investments in d_1 and d_2, F aims to maximize its profits.

P_1 and P_2 purchases the product from F to solve their problem. Assume that P_1 always buys d_1 because it has a big budget, while P_2 is constrained by its budget, and its probability of purchasing d_2 is ϵ. To make it simple, let's assume that P_1 and P_2 can purchase 1 unit of d_1 and d_2, respectively, with the same price.

We assume that F faces an opportunity cost of investing in d_1 and d_2. For example, if F invests in d_2, but P_2 fails to purchase d_2, F will lose its investment in d_2, which could have been invested in the other product.

In this extremely simple model, due to the uncertainty that F faces in the market demand in P_2, F will only invest in d_2 if the probably for P_2 to purchase d_2 is greater than the investment. Considering the high cost of R&D investment, F only invests in d_1 to avoid the sunk cost in investing in d_2.

This simple model suggests that market uncertainty can prevent scientific development, especially for those technologies that target low-income countries.

We focus on the biased development of medical technology that addresses infectious diseases. While pharmaceutical firms can develop medicines targeting all infectious diseases around the world, the opportunity cost of focusing on any disease can be high if there is not a healthy market demand for that disease. Hence, pharmaceutical firms have to be strategic in their investment choice in infectious diseases. As most pharmaceutical firms are located in rich countries with well-developed health systems, the product profiles of these firms mainly target the market in rich countries. In addition, due to the disparity of infectious disease distribution between rich and low-income countries, as is shown in Figure 1, some of the outbreaks of infectious diseases that are common in low-income countries, such as Dengue and Cholera, are rare events in high-income countries. Due to such geographic mismatch, it is difficult for pharmaceutical firms to predict the trend of disease outbreaks in low-income countries and the specific features of vaccines and treatment medicines to address the disease outbreaks, leading to more resources allocated to health research focus more on

diseases concentrated in rich countries (Adam et al., 2023).

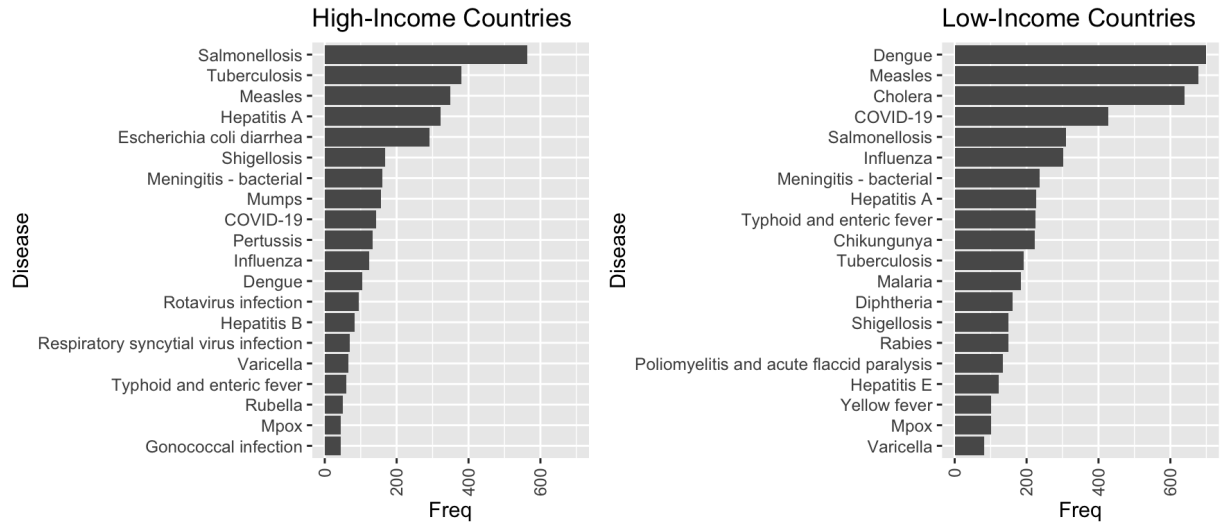

Figure 1: Top Disease Outbreaks in High and Low-Income Countries (1990-2023)

Note: High and low-income countries are defined based on whether a country is in the first and last quantile based on GDP per capita.

As a global public goods provider, can the WHO shape the R&D investment in ignored infectious diseases?

2.2 How Can the WHO Shape R&D investment?

We argue that the WHO can provide information about the priority of diseases and medical products to shape R&D investment in infectious diseases. Such priority information can serve as an agenda-setting tool and increase the salience of certain technologies. Bisbee et al. (2019) show that, as an international assessment mechanism of government performance, global performance indicators (GPIs) induced governments to move the investment in social developments that are not calculated in GPIs to targets that are measured in GPIs. The same logic may apply to firms' investment decisions. Once IOs categorize certain technologies as of higher priority than other related technologies, profit-driven firms speculate a higher probability of credible market demand for the product, which increases firms' expected return from investment and motivates firms to channel investment in other technologies to the more

salient ones.

In addition, to enhance the credibility of its information provision, the WHO can connect the technology of higher priority to market access. With its close connection to other IOs and non-governmental organizations (NGOs), the WHO can create a sizeable market that pools resources from these organizations. Figure 2 shows a pathway through which the WHO can shape R&D investment.

Figure 2: How Does the WHO Shape R&D Investment?

3 Background

This section lays out the empirical context, which will be followed by the discussion of the hypotheses for empirical test in the next section.

3.1 World Health Organization and Scientific Development

The WHO is a specialized agency of the United Nations (UN) in charge of promoting international public health. Prior to the creation of the WHO, the first effort of international coopration on global health started from the International Sanitary Conference in 1851. The priorities of the International Sanitary Conference in the late nineteenth and early twentieth centuries focused on preventing the spread of a limited list of diseases—cholera, plagure, and yellow fever—from Asia and the Middle East to Europe and North America (Fidler, 2005). The establishment of the WHO expanded the narrow scope in this old regime and embraced new goals, policy orientation, and strategy to address global health. More specifically, the WHO embraced the goal of Health for All, which covers not only the eradication and containment of infectious diseases, but also the improvement of overall health outcomes,

especially in the developing world. Meanwhile, the WHO's policy orientation transformed from old regimes' focus on balancing economic interests of great powers with health risks to the pure focus on improving health outcomes through disease eradicaton and universal primary health care. Lastly, the WHO's strategy compared to the old regime involves active application and dissemination of scientific advancements, such as antibiotics and vaccines.

The WHO focuses on three aspects to guide, develop, and deliver health policies based on scientific evidence. The first is to set the agenda to guide the research focus to gaps and priorities that are responsive to local contexts. The second is to evaluate the quality of new scientific advancements by developing and disseminating the appropriate norms and standards for practice. The last is to translate the latest data, research, and evidence into real-world adoption. Therefore, the WHO plays a critical role in connecting the scientific community to real-world practitioners for the promotion of health for all populations around the world.

3.2 Vaccine Prequalification at the WHO

We focus on one agenda-setting power at the WHO: vaccine prequalification.

Vaccines are one of the most successful and cost-effective health interventions (World Health Organization, 2009). Different from chemical pharmaceuticals, vaccines are biological products and are derived from living organisms. Due to the inherent variability of living organisms, vaccines could be damaged from the contamination of materials or changing environments. Constant qualitiy control and assessment are necessary to ensure the safety and efficacy of vaccine products.

As a result of constant demand for quality control by the United Nations Children's Fund (UNICEF) and other UN procurement agencies, the vaccines prequalification programme was established in 1987. The programme started as a modest project which involved the testing of vaccine lots, review of summary lot protocols, and the inspection of manufacturing sites. As the demand, diversity, and complexity of vaccine products submitted for prequalification

continued to grow, the WHO revised its prequalification procedure. Since 2002, the WHO has required the national regulatory authority (NRA) of the vaccine producing country to be functional—defined as the establishement of appropriate capacity for vaccine regulation—as a prerequisite for accepting submissions of vaccine prequalification by manufacturers from that country. This requirement has a great impact on strengthening vaccine regulation capacity in developing countries. In 2012, in reponse to the increased volume and cost of new vaccines, the WHO developed a streamlined prequalification procedure to reduce the timeline and resources for assessment. For example, the assessment reports by certain NRAs are recognized to avoid duplicative regulatory efforts.[2]

In addition to quality control, the WHO also collaborates with the UNICEF and Global Alliance for Vaccines and Immunization (GAVI) to predict, maintain, and create the market for vaccines. The vaccine market is small and concentrated from both the supply and demand perspective. More specifically, on the supply side, manufacturers of vaccines are mainly located in developed countries. On the demand side, however, many diseases are concentrated in low- and middle-income countries (LMICs). While vaccine sales to high-income countries generate more revenue, sales to LMICs are of much larger volume. Due to the geographic mismatch in the demand and supply of vaccines, it is challenging for manufacturers to predict which vaccine product to prioritize. Moreover, given that each vaccine product—even for the same type of disease—has its specificities, individual vaccines or vaccine types have their own individual markets, making the prediction of the pricing and procurement a complex task. Given the complex nature of vaccine market, the WHO's function of connecting vaccine manufacturers with the procurement agencies and donors in these agencies plays a critical role in ensuring a healthy vaccine market.

[2]The recognizaed NRAs include Australia, Belgium, Canada, France, Italy, the United States, and the European Medicines Agency.

3.3 Procedure of Vaccine Prequalication

For a vaccine product to be eligible for prequalification, the vaccine has to be on the Vaccines Prequalification Priority List,[3] which categorizes the priority of vaccines that are anticipated to be available for supply. The list is made every two years by the WHO in consultation with the UNICEF and the Revolving Fund of the Pan American Health Organization, a mechanism that provide technical suport to national immunization programs through overcoming the barriers of price and access. Four criteria determine the priority of a vaccine: market demand, programmatic needs of the WHO, recommendation by the WHO's Strategic Advisory Group of Experts on immunization (SAGE), and supply security due to shortage.

To start the prequalification process, manufacturers have to initiating the process by submitting an application to the WHO. However, for a manufacturer to be eligible, the corresponding NRA of the manufacturer must be classified as a functional NRA or WHO-listed authority operating at maturity level 3. This is to ensure the regulatory oversight of the product. After the submission, the WHO will screen the application based on the programmatic suitability (World Health Organization, 2014), which evaluates the characteristics of the vaccine candidate, such as heat stability, presentation, labeling, and shipping conditions. Only when the vaccine candidate is compliant with the complusory characteristics can the product start the prequalification assessment.[4] The assessment includes a scientific evaluation of evidence, sample testing, and inspection of the manufacturing site. Once a vaccine product is considered to meet all the requirements, it will be included in the WHO List of Prequalified Vaccines.[5]

After a vaccine product passes the prequalification requirements, there is an annual evaluation to ensure the quality and continued compliance with the required standards of the

[3]Website: https://extranet.who.int/prequal/vaccines/vaccines-eligible-who-prequalification

[4]There are two categories of characteristics: mandatory and critical characteristics. Both categories are compulsory, but if a product deviates from the critical characteristics, the screening procedure will go through a review process involving the manufacturer and procurement agencies to determine whether to accept the application.

[5]Website: https://extranet.who.int/prequal/vaccines/prequalified-vaccines

product. If a product fails to meet the post-prequalification testing and reporting requirements, the WHO can withdraw the product from its list of prequalified vaccines. Manufacturer can also withdraw their product from the list due to discontinued production or commercialization.

4 Hypotheses

To test the argument of how the WHO uses information provision to shape R&D investment, we propose the following testable hypotheses, which examines the determinants and effect of the WHO's agenda-setting on the priority of scientific development.

The key function that the WHO serves to shape the R&D investment in infectious diseases is its ability to convince pharmaceutical firms of a credible market demand. This suggests that the information provision on the priority of vaccines should substitute for the lack of information about the market demand for pharmaceutical firms.

To explore the variation in the information environment that pharmacerutical firms face, we investigate disease characteristics. One of the key factors for the lack of information for firms is the geographic mismatch between where disease outbreaks occur and where the technology owner is located. Hence, if a disease is more concentrated in low-income countries, it may be more challenging for firms to predict the market demand for products targeting that disease. However, if a disease is equally likely to occur to many countries, it is become easier to understand the market demand for firms. Hence, the inequality in disease distribution creates a more opaque market demand for firms, which motivates the WHO to set a higher priority for these diseases.

Another important disease characteristics is disease severity. The market demand is more observable if a disease outbreak influences multiple countries and large populations. In that case, it is not necessary for the WHO to provide more information about the market demand for products targeting the disease. Hence, the severity of a disease may not necessarily

increase the priority set by the WHO.

The following two hypotheses summarize the determinants of the WHO's priority-setting.

Hypothesis 1. *Diseases with more unequal distribution receive a higher priority.*

Hypothesis 2. *Disease severity does not necessarily affect WHO priority.*

Lastly, to examine the effect of the WHO's priority-setting on R&D investment, the following hypothesis lays out the theoretical prediction.

Hypothesis 3. *Diseases with a higher priority receive more research funding and have more clinical trials.*

5 Data

5.1 Disease Inequality

Our theory suggests that the WHO should prioritize vaccines based on whether the diseases they target are unequally distributed in developing countries. For empirical examination of the theory, we start by constructing a sample of diseases from the GIDEON. The program reports the number of cases of communicable diseases across the world each year. We then construct an inequality index for each disease in a given year based on the number of countries reported a threat or the population of threatened countries. The index is measured using the Gini index approach and ranges between 0 and 1. We construct the index by replacing the income distribution of traditional Gini coefficient with the distribution of affected population. When a disease receive an inequality index of 0, such as COVID-19, it suggests that this disease is equally distributed across all countries. Diseases that are concentrated in a small number of countries, such as Ebola, receive an inequality index closer to 1.

When constructing this index, we assume that countries that did not report an outbreak are not affected by the disease in a given year after the first reporting. An implicit assumption for using GIDEON data is that governments always choose to report the outbreaks.

Although governments have incentives to hide outbreaks, we believe that under-reporting does not significantly affect our results for two reasons. First of all, The International Health Regulations (IHR) reform in 2005 authorized the WHO to act on behalf of local governments using non-governmental sources of information when governments do not cooperate. Hence under-reporting should not significantly reduce the number of diseases reported. Secondly, one may be concerned that a disease receives a higher inequality score when governments hide the outbreaks. Since our theory focuses on how the WHO prioritizes certain diseases, the inequality measurement should capture the level of inequality perceived by the WHO, which is captured by government reports. Hence outbreaks undisclosed by governments should not affect the WHO priority in the first place and thus should not affect the downstream firm behaviors.

5.2 Vaccine Priority

The empirical implication of our theory suggests that we should observe a positive relationship between inequality index and priority status, meaning that WHO is more likely to prioritize the approval of vaccines for unequally distributed diseases to facilitate investments in under-invested areas. The WHO may endorse vaccines mainly in two ways. First of all, the WHO publishes a list of vaccine priority where they put vaccines into the priority categories from high to low and to no priority. The list signals credible demand of certain vaccines and hence facilitate investments. We construct binary variable which takes the value of one if a vaccine makes it to the high or medium priority category.

Once the priority list is announced, the WHO also prequalifies vaccines that are on the list. Only prequalified vaccines may be procured by GAVI and UNICEF programs, which further strengthen the signal of market demand. Ideally we would like to obtain a full list of vaccines submitted for pre-qualification and examine whether vaccines targeting unequally distributed diseases are more likely to be pre-qualified. However, WHO does not publish the universe of vaccines for which firms have submitted a pre-qualification application. Estimates

based on pre-qualification results may capture application instead of WHO priority.

5.3 Investment Response to Vaccine Priority

The WHO also prioritizes unequally distributed diseases by signaling credible market demand. Our theory predicts that the WHO may facilitate further investments by prioritizing the endorsement of vaccines targeting unequally distributed diseases. It implies that firm investments should be positively associated with WHO prioritization. When vaccines for certain diseases are prioritized, firms, especially development agencies, expect increasing demand for such vaccines, which further encourages investments. Due to lack of information on firm investments at the vaccine level,, we measure investments in diseases by the number of registered clinical trials and the amount of research funding issued.

We source clinical research trials data from ClinicalTrials.gov, a website maintained by the National Library of Medicine (NLM) in the USA. The website publishes self-reported clinical trials from over 200 countries. The NLM does not approve or review any of the registered trials. Investigators may choose to publish their studies for different reasons. They may be required by domestic law and academic journal submission rules to publish their clinical studies on a public database. The WHO also stated in 2006 that clinical trials happening anywhere around the world must have some information available on ClinicalTrials.gov or other similar databases. They are also incentivized to publish their information because patients who have no access to fully grown treatment may actively search and sign up for on-going clinical trials on this website. The registration reports date and location of trials as well as the conditions under study. We leverage these information and matched 26,472 trials from 2000 to 2023 to GIDEON disease outbreak data.

We estimate research funding investment through funding issuance records published by National Institute of Health (NIH). The NIH awards funding to organizations mostly within the US with a small proportion of foreign awardees. We identify the disease under study by the research category reported by NIH.

One empirical challenge with both of the data sets is that they do not report the record based on the exact disease category we have from the GIDEON data set. To overcome this challenge, we use regular expression to identify disease names and the corresponding virus related to each disease from the title of the project that are granted the funding and the conditions of the clinical trial. This allows us to match 38 vaccine-preventable diseases based on the WHO definition.[6]

6 Results

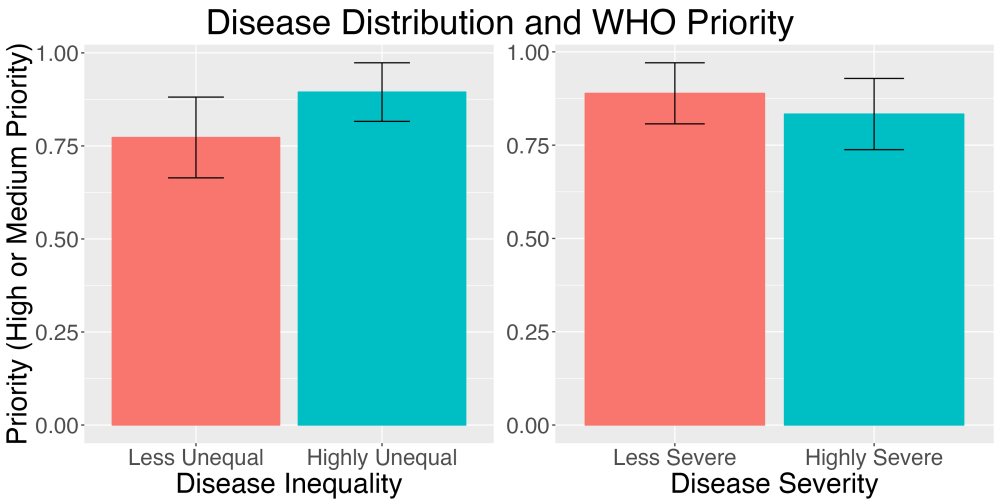

Figure 3: Disease Distribution and WHO Priority

Note: Y axis indicates the proportion of diseases covered by high or medium priority in the WHO priority list.

Figure 3 shows the descriptive analysis of the relationship between disease characterisitcs and the WHO priority. We can see that the level of priority is higher for diseases that are more unequally distributed, while more severe diseses have a lower priority than less severe diseases. These descriptive analysis is consistent with the first two hypothesis of the paper.

Before moving to the examination of the effect of the WHO priority on R&D investment, we conduct a test to check whether higher priority leads to market access. To measure

[6]Website: https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases

market access, we use the number of vaccines being prequalified in a certain year. Table 1 shows the results. We can see that diseases with higher priority have more vaccines being prequalified. However, the results are not statistically significant.

	Dependent variable:				
	Any Vac. Prequalified				
	(1)	(2)	(3)	(4)	(5)
Priority (High or medium)	0.132			0.125	0.130
	(0.243)			(0.244)	(0.244)
Inequality (country)		0.001		0.006	
		(0.053)		(0.049)	
Inequality (pop.)			0.024		0.017
			(0.038)		(0.045)
Severity (country)				0.002**	
				(0.001)	
Severity (pop.)					0.000
					(0.000)
Disease Fixed Effects	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y
Observations	1,026	1,031	1,031	1,031	1,031
R^2	0.396	0.394	0.394	0.402	0.395
Adjusted R^2	0.357	0.354	0.355	0.361	0.354

Note: Severity and inequality measures are lagged by one year. Standard errors are clustered at disease level. *p<0.1; **p<0.05; ***p<0.01

Table 1: WHO Priority and Market Access

To examine how the WHO priority shape R&D investment in infectious diseases, we use a difference-in-differences specification, which is shown in the following equation.

$$Investment_{it} = \gamma_i + \lambda_t + \beta_2 Priority_i \times Post_t + \epsilon$$

$Investment_{it}$ refers two measures of the R&D invesment. One is the annual total amount of grants invested in disease i in year t. The other is the total number of clinical trials on disease i in year t. $Post_t$ indicates whether a year is after 2017, which is the year when the Vaccine Prequalification Priority List was first published.[7] $Priority_i$ is the disease-level

[7]There have been two published list of Vaccine Prequalification Priority. One was published in 2017 after

priority index as is discussed in Section 5.2. γ_i is the disease fixed effect, which captures the disease-specific characteristics that may affect the overall level of R&D investment. λ_t is the year fixed effects and captures the time-specific factors that contributes to the R&D investment. For example, due to the American Recovery and Reinvestment Act of 2009 (ARRA), there were extra funding for health research in year 2009 and 2010. The year fixed effect can control for such changes in funding.

	Dependent variable:							
	log(1+NIH funding)				N. Clinical Trials in 1 year			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Priority Index	−0.531				−1.081			
	(0.488)				(8.248)			
Priority Index * Post	0.733*	0.733*	0.215	0.723	2.810	2.810	10.914	7.140
	(0.399)	(0.393)	(0.811)	(1.747)	(4.774)	(4.709)	(10.606)	(8.474)
Disease Severity (lagged average)			0.019	0.021*			−0.001	−0.297***
			(0.011)	(0.012)			(0.029)	(0.033)
Disease Inequality (lagged average)			4.814	8.410			3.239	22.630
			(3.070)	(6.189)			(18.452)	(17.254)
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Disease FE	N	Y	Y	Y	N	Y	Y	Y
Disease-specific trend	N	N	N	Y	N	N	N	Y
Observations	481	481	292	292	481	481	292	292
R^2	0.025	0.698	0.725	0.772	0.003	0.914	0.746	0.875
Adjusted R^2	−0.005	0.664	0.685	0.714	−0.027	0.904	0.709	0.843

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

Table 2: How Does the WHO Priority Affect R&D Investments in Diseases?

Table 2 shows the results. The first four columns examine the effect of the WHO priority on research funding, while the last four columns look into the effect on clinical trials. Column (1) and (5) only control the year fixed effect. Column (2) and (6) controls for the disease fixed effect. We can see that higher priority leads to more research funding and more clinical trials, although the statistical significance is low.

One potential concern is that this relationship could be driven by the fact that both the WHO and firms prioritize disease with higher burdens. In Column (3) and (7), we control for disease severity and inequality. Both measures are the average of the past three years,

the First Annual review of diseases prioritized under the Research and Development Blueprint. It covers the period from 2018 to 2020. The other one was published in 2023 after the WHO launced a global scientific process to update the list of priority pathogens and covers the period from 2024 to 2026. As the R&D invesment may have a delay in the response to the publication of the priority list, we only examine the effect of the first list.

which address the concern that the R&D investment may respond to the disease situation with a delay. In Column (4) and (8), we control for disease-specific time trend to control for the time-dependency in the R&D investment over time. Throughout these specification, we see weak but consistent positive coefficient estimates for the interaction term, suggesting that there is a slight increase in the R&D investment on diseases with a higher priority after the publication of the WHO priority list.

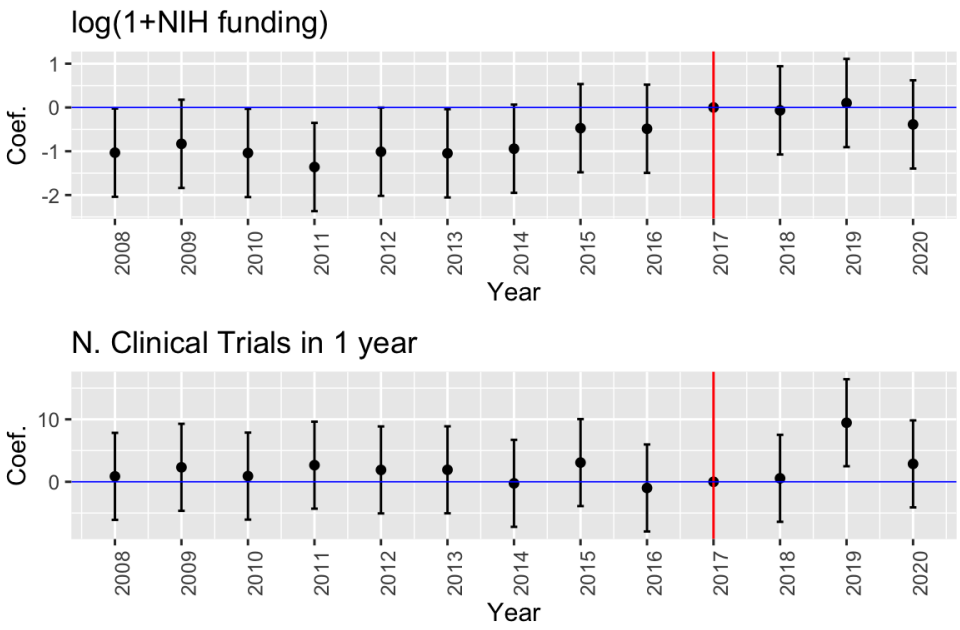

Figure 4: Pretrend Analysis

Figure 4 shows the pretrend analysis. We treat the year 2017 as the reference group and examine the coefficient estimates of the year dummy interacted with the priority index using the specification in Column (4) and (8) in Table 2. The uppder panel shows that, for NIH funding, there is an increasing trend before the treatment, suggesting the violation of the parallel trend assumption. For the results of clinical trials in the lower panel, there does not exist a pretrend and the effect of the priority list starts to take effect after 2 years of the publication of the list, which may be due to the time needed to obtain the research funding and prepare for the testing with subjects.

7 Discussion

Can IOs use its agenda-setting power to shape scientific development? We argue that IOs can provide information to substitute for the lack of market demand for ignored technologies to induce R&D investment in these technologies.

Empirically, we examine how the WHO's agenda-setting on vaccine technology can shape R&D investment in infectious diseases. The empirical test supports the argument that the WHO's information provision aims to substitute for the lack of market information. However, we find weak suggestive evidence of a positive relationship between the WHO priority and R&D investment. One potential reason for the lack of empirical evidence could be due to the mismatch between the goal of vaccine priority and other WHO practice to shape R&D investment. One of the key determinants of the vaccine priority is the supply security, which aims to monitor and respond to factors that may lead to vaccine shortages. Since many of the vaccine types listed in the priority list are routine and well-established vaccines targeting disease like diphtheria, tetanus, measles, and mumps among others, there is not much need to further develop these vaccines. To address this mismatch, we will examine the other priority lists published by the WHO, which include the Bacterial Priority Pathogens List and the list of Diseases Prioritized Under the R&D Blueprint.

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