

The Unexpected Consequences of a Public Health Emergency Comparing West African and Indo-Pacific Maritime Crime during the COVID-19 Pandemic*

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The economic fallout from the COVID-19 pandemic has been devastating. Job losses, negative growth rates, and increased poverty have all followed rising infection rates. The economic costs have been especially challenging for many piracy-prone countries. The IMF anticipates sizable unemployment increases in the Philippines, Indonesia, and elsewhere in the Indo-Pacific. Deeper and more durable economic damage may materialize in some West African countries. Often, negative economic shocks produce surges in crime, both on land and at sea. The present study evaluates the effects of COVID-19 on maritime pirate attacks in two regions, West Africa and the Indo-Pacific. We employ monthly and quarterly data on government measures to prevent infection, sea-piracy incidents, and economic conditions to explore whether the subsequent economic fallout produced more maritime crime. We do not find clear evidence of this relationship in the Indo-Pacific. However, COVID-19 induced stringency measure does appear to have increased sea-piracy incidents in the Gulf of Guinea.

Introduction

The health consequences of the novel Coronavirus have been overwhelming. The World Health Organization (WHO) officially declared COVID-19 a pandemic on March 11, 2020. By the end of November 2021, the world totaled over 260 million officially recorded cases and 5.2 million deaths, although experts believe the true number is actually much higher on both counts (WHO). The SARS-CoV-2 virus, while less fatal than other respiratory viruses,

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such as SARS-CoV and MERS-CoV, remains highly transmissible, often spread by hosts that show no signs of illness. The virus appears to have jumped from bats to humans at an outdoor market in Wuhan, China, sometime in late 2019. It rapidly spread around the world in 2020, striking certain countries particularly hard, such as the United States, India, Brazil, Russia, and Peru.

In response to the pandemic, most countries went into some version of immediate lockdown beginning in March 2020 and instituted rules such as social distancing and later mask-wearing as a way to break the chain of infections and contain the spread of the disease. Pandemic mitigation measures led to a sizable slowdown in global economic activity as borders closed, consumers stayed home, and demand for many services plummeted. As a result, China was the only major economy to show a positive growth rate in 2020. The economies of most other countries contracted, some by more than 10%. Overall, the global economy shrank by nearly 4% in 2020 and the World Bank concludes that an additional 100 million people were pushed into poverty ([World Bank, N.d.](#)). The economic consequences of COVID-19 were felt most strongly in developing countries, especially those largely labor-intensive economies with weak worker protections. Significant unemployment increases were expected in Indonesia, Bangladesh, Venezuela, Brazil, Mexico, and the Philippines, among others, while longer lasting economic pain may befall countries in West Africa. Acute food insecurity is expected to increase and current research shows a relationship between famine and violence (Koren and Bagozzi 2021). The aquaculture sectors in the Indo-Pacific were also especially hard hit by the COVID-19 pandemic ([Wiradana et al., 2021](#)).

There is concern that the economic costs of COVID-19 may increase crime on land and at sea through its effects on joblessness, hunger, and poverty. Previous economic shocks, for example, have been followed by significant surges in maritime crime. The 1997-98 Asian financial crisis increased joblessness in the Indo-Pacific region at the same time as food prices shot up, both of which amplified poverty levels in many Southeast Asian countries. Maritime crime subsequently expanded. Pirate attacks jumped by 80% from 1998 to 1999 and another 50% from 1999 to 2000. The International Maritime Bureau (IMB) recorded 89 incidents in 1998. Only two years later, the number of incidents had increased to 247. Sea-piracy did not return to its pre-Asian financial crisis levels until 2006. The region was then rocked by

another economic recession that began in the United States in early 2007. Like before, pirate attacks surged in parts of the Indo-Pacific region, nearly quadrupling in Indonesian waters between 2008 and 2013 according to the IMB. Somali pirates also accelerated their seizure of commercial vessels in the Greater Gulf of Aden beginning in 2008, leading to the deployment of three multinational naval operations designed to deter this modern-day marauding.

While the relationship between COVID-19 and land-based crime has been examined, to our knowledge, the effects of the novel Coronavirus on crime at sea have been mostly ignored. But given the size of the maritime space and the absence of effective governance, illicit activity on the water may vary with government lock-down measures differently than crime on land. Indeed, recent studies on the relationship between COVID-19 and crime demonstrate that the pandemic significantly decreased terrestrial criminal behavior, although the size of the decrease varied by the type of crime (Nivette et al., 2021). Restrictions on movement appear to have reduced the rate of residential burglary but at the same time exposed commercial businesses to higher hazards of theft as families quarantined at home and businesses were closed and unoccupied. But, the effects of pandemic restrictions may be different for crime at sea. In fact, we find strong evidence that the relationship for piracy is different. Individuals, unable to make ends meet in the new locked-down and quarantined formal blue economy and without an adequate safety net to carry them over until it was safe to return to work, turned to illicit means to make ends meet. During the pandemic, piracy increased and clustered in the coastal waters of places such as Bangladesh, Indonesia, Malaysia, and Nigeria. In this article, we investigate the relationship between the economic consequences of the COVID-19 pandemic and the level of maritime piracy among littoral states. Our aim is to situate this study on piracy in the larger literature on the relationship between crime and the economy, how they affect each other, whether the relationship is possibly endogenous, and if so, how best to capture it.

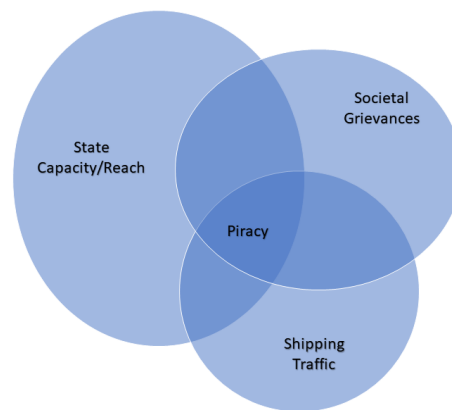
In what follows, we investigate the relationship between the COVID-19 pandemic, specifically the number of officially recorded cases, and the level of maritime piracy incidents in the territorial waters of Indo-Pacific and West African littoral states. First, we describe how the pandemic affected the aquaculture economies. Next, we hypothesize how the pandemic might lead to an increased number of piracy incidents through its effects on the economy.

Lastly, we conclude with our findings and provide a discussion.

Literature Review

Previous research suggests three important conceptual factors contribute to sea-piracy (see Figure 1). First, commercial vessels transiting the world’s maritime spaces provide rich targets of opportunity for potential pirates. Narrow channels and straits, such as the Bab el Mandab, only enhance these opportunities as cargo ships reduce speed as ship traffic increases. Second, state capacity strengthens formal control of maritime regions, deterring pirates through an increased risk of capture. Finally, poverty and joblessness associate with maritime crime as the labor pool for illicit activity expands.

Figure 1: Piracy prone area



According to [Hastings \(2009\)](#) and [Daxecker and Prins \(2021\)](#), weak governing capacity at the national level leads to increased piracy in a country’s waters. Other studies ([Murphy, 2007](#); [Weldemichael, 2019](#)) find poverty and political violence related to maritime marauding. Of course, attacks against ships can only arise where ships are located. Consequently, ports, anchorages, and busy shipping lanes all correlate with maritime pirate attacks ([Prins and Daxecker, 2017](#)). The surge in piracy in the greater Gulf of Aden beginning in 2008 illustrates the importance of governance voids, conflict, and geographic location. Yet, [Daxecker and Prins \(2013\)](#) argue that policymakers should also focus on root causes. According to the authors, while weak governance and target-rich environments lower the costs for potential

pirates, poverty and joblessness ultimately drive individuals towards illicit activities. [Tominaga \(2018\)](#) examines the relationship between economic conditions and maritime piracy by recording fluctuations in the fishing market and their effects on sea-crime.

Past studies use panel and aggregate data to show how permissive institutional environments can lead to increased piracy ([Daxecker and Prins, 2013](#)). However, consistent evidence supporting the economic drivers of piracy remains somewhat less clear. [Daxecker and Prins \(2013\)](#) use aggregate country and yearly data to show a link between fluctuations in fish values and sea-piracy. They find that lower fish values associate with increased piracy. However, as [Tominaga \(2018, p. 1058\)](#) indicates, the relationship may be endogenous; piracy may produce less fishing. Alternatively, an increase in piracy events might lead governments to invest more in the infrastructure of fisheries. Citing these shortcomings, [Tominaga \(2018\)](#) uses an instrumental variable approach to estimate the effects of fish values on piracy, and his empirical results provide only partial support for his position, casting doubt on the causal claim that piracy is connected to the local fishing sector. Despite [Tominaga's \(2018\)](#) critique, he too uses aggregate cross-country and yearly data.

Theory

In this section, we explain how an increase in COVID-19 cases might lead to more maritime piracy. The primary mechanism we propose is that the pandemic changed the structural opportunities for piracy when the aquaculture industry collapsed. The more stringent policies governments engaged in to mitigate the spread of the virus, the worse the economic impact on the fishing industry. The severe downturn in the fishing industry drove individuals, we hypothesize, to engage in piracy. Unlike crime on land, which mainly decreased around the world, piracy does not have the same opportunity structures. Many initial studies on the relationship between COVID-19 and crime on land find that the pandemic tended to decrease illicit activity (for instance, see [Ejrnæs and Scherg, 2022](#); [Demir and Park, 2021](#); [Estévez-Soto, 2021](#); [Payne, Morgan and Piquero, 2020](#)).

These studies use opportunity theory and routine activity theory, which emphasize three factors that together converge in time and space: the possible targets, capable guardians that can stop crime from occurring, and offenders from carrying out criminal activities

(Cohen and Felson, 1979). Simply put, the pandemic and its government-imposed restrictions reduced the number of possible offenders and targets and subsequently the number of criminal incidents. In a global analysis of stay-at-home restrictions in 27 cities across 23 countries in the Americas, Europe, the Middle East, and Asia, Nivette et al. (2021) find that government-mandated restrictions on movement led to a decline in urban crime. The average drop in metropolitan crime was approximately 37%, with robbery and theft decreasing even more. Nivette et al. (2021) conclude that the decline in urban crime resulted from large-scale changes in the opportunity structures and constraints faced by potential offenders rather than to any psychological and or social motivations. Similarly, Hou et al. (2022) investigate COVID-19 restrictions on four large cities, Washington DC, Chicago, New York City, and Los Angeles and find that while crime varies by the city and by what type of crime, most criminal activity decreased during the pandemic. Some crimes, such as theft, decreased significantly

Yet, opportunity is not the only contributing factor for crime. For illicit activities like maritime piracy, past studies have indicated that poverty and societal grievances are common and important root causes of illicit activity (Hastings, 2009; Daxecker and Prins, 2013). Unlike on land, the pandemic affected the opportunity structures on the maritime domain differently. Below we discuss how the pandemic has exacerbated economic grievances and hypothesize how that may lead to an increase in piracy events.

COVID-19 Restrictions, Economic Grievances and Increase in Piracy

Governments worldwide have responded to COVID-19 by introducing various social and economic restrictions such as school closures, public lockdowns, and business constraints.¹ While these measures were essential steps to prevent the spread of the virus, they also negatively affected national (Guerrieri et al., 2020) and local economies (Kanu, 2020; Rogerson and Rogerson, 2020; Susilawati, Falefi and Purwoko, 2020). According to Deb et al. (2020), after a month of containment measures, global imports and exports decreased by nearly 30% and the number of airline flights, domestic and international, fell by almost 99%, which

¹During the writing of this paper, the world was going through both the Delta and Omicron variants, more contagious strains of the COVID-19 virus.

of course adversely affected the tourism industry. Transit mobility further declined over 400 percentage points relative to country-specific paths in the absence of the government intervention.

The COVID-19 pandemic has been even more devastating for the countries in the Indo-Pacific, especially those that rely heavily on the blue economy (Bennett et al., 2020; Ferrer et al., 2021; Minahal et al., 2020; Sorensen, Echard and Weil, 2020). ASEAN countries, for example, saw significant declines in their overall growth, trade volume, as well as increases in unemployment. Indonesia's GDP growth in the last quarter of 2019 was 4.97%. In the first quarter of 2020 it dropped to 2.97% and turned negative in the second quarter, dropping to -5.32%. During the same period, the Philippines saw its GDP decrease from 6.7% in the last quarter of 2019 to -0.7% in the first quarter of 2020, and dropping a further -16.5% in the second quarter. For Malaysia, GDP growth went from 3.6% to 0.7% in the last quarter of 2019 to the first quarter of 2020, and dropped a further -17.1% in the second quarter (Chong, Li and Yip, 2021, p. 172-6).

Countries employed various policies to prevent, stop, contain, and mitigate the spread of the virus (Djalante et al., 2020; Haug et al., 2020). We find that these virus-mitigation measures affected the fishing industry in particular. In fact, economic lockdowns imposed by local and national governing bodies produced a recession in the aquaculture industry that has not been in over sixty years. There have been declines in the Fish Price Index and in the overall supply, production, and consumption of fish. The FAO anticipates that global fish production fell by 1.7% in 2020, which equated to a 1.4% decline in aquaculture output (FAO, 2021b). Decreased demand, especially where production relies on external markets, the lack safety and sanitary measures, and restrictions on movement, sometimes so severe fishermen are stranded for months, hurt the industry by decreasing fisheries production. Overall trade also suffered due to border restrictions and closures, health inspection delays, and production slowdowns driven by quarantined workers that subsequently demanded safer working conditions (FAO, 2021b).

Even before the onset of the pandemic, the aquaculture industry in the Indo-Pacific faced many hurdles. It is a labor-intensive and largely poorly regulated sector with few employment protections. Many countries in the region do not have adequate social safety

net protections. The industry itself is subject to pollution, IUU fishing, and downturns from climate change, for example, from flooding and storms. One study notes that in Thailand and Taiwan, workers faced employment disruptions, travel and mobility restrictions, and poor access to health and social services (Ferrer et al., 2021; Mardhia et al., 2020). In Thailand, for example, in March 2020, between 60,000 to 200,000 migrant workers in the fishing sector left to go back to their homes in Myanmar, Cambodia, and Laos. When fishing resumed, it was a perfect storm. There were worker shortages from the mostly migratory workforce being out of the country. Restrictions on transportation in Thailand made it difficult to fill in gaps where they were needed. There were restrictions on vessels moving between ports. Border restrictions led to the hiring of illegal workers, and workers faced exploitation (Marschke et al., 2021, p. 92). Similarly in Bangladesh, restrictions on transportation, coupled with less manpower, and production problems are seen as the main culprits causing the economic downturn in the aquaculture and fishery sector (Islam, Khan and Barman, 2021). While lower consumer demand reduced the price of fish, increased production, transportation, storage and marketing costs hurt the industry in Bangladesh even more.

The aquaculture sector in Indonesia, which is dominated by small-scale fishers, was also hit hard. The Indonesian government implemented lockdowns and transportation restrictions by closing port facilities early on during the pandemic. The lockdowns, restrictions on transportation, business closures where fish are sold, and fishers being forced to sell at lower prices all had a major negative effect on the fishing industry in Indonesia (Ferrer et al., 2021; Mardhia et al., 2020). By April 2020, fish exports in Indonesia fell by 70% (Maulana and Zahro, 2021; Mubarok and Ambari, 2020). In an example of how hard things were, in Southeast Sulawesi, Indonesia, the number of active fishers and traders declined by over 90% because of the pandemic. Interviewing small-scale fishermen and traders in Southeast Sulawesi, Campbell et al. (2021) find that they, “believed that the primary impacts to their fishing practices during the pandemic were a lack of fish traders and a low/reduced fish value” (2021: 6-7).²

Further, while the fishing sector stagnated, opportunities for piracy provided by maritime

²Campbell et al. (2021, p. 6) also find: “97% of men and 83% of women believed that their businesses were impacted or severely impacted by the pandemic. Of the 114 fishers interviewed, approximately 99% of men and 75% of women stated that their fishing practices were impacted or severely impacted”.

traffic in the region seemed unaffected. A study suggests that the volume of maritime traffic varied by regions. In a global analysis of the marine traffic during the pandemic, researchers found a downturn in activity similar to economic activities on land, mainly between January and June 2020 (March et al., 2021). However, they also found the marine activities varied by region. The Mediterranean Sea saw a systematic decrease, but activities in East Asia had a mixture of decreases and increases. The traffic in China's EEZ declined (March et al., 2021). In contrast, the Strait of Malacca saw an increase in vessel traffic during January, February, and March of 2020 followed by a decline in April and May, which correlated with the number of cases observed in Southeast Asia. Commercial traffic in the Strait climbed up again in June 2020 (March et al., 2021, p. 8). These changes were also associated with the counts of piracy events in the region. The IMB recorded 23 attacks in Singapore Strait, nearly doubling the number of incidents from 2019 and reaching the highest level of sea-piracy activity recorded by the IMB in the Singapore Straits since data collection began.

The COVID-19 pandemic, by hurting the fishing sector, especially its small-scale fisheries, sharply increased the likelihood that individuals would turn to crime. Maritime piracy is closely related to economic opportunities in the fishing sector (Daxecker & Prins, 2013; Tominaga, 2018). When the market declines, former fishermen sometimes turn to piracy. This occurs when restrictions are implemented, fishing is not available, prices fluctuate, production declines, and illegal fishing activity competes with regulated fishing. Negative economic shocks, for example, lead to an increase in piracy incidents (Flückiger & Ludwig, 2015). The COVID-19 pandemic was a major exogenous shock that led governments to impose restrictions on movement and commerce to combat the virus. Many of these policies exacerbated the labor-intensive characteristics of the aquaculture industry in developing countries where piracy is already located. Small-scale fishermen, for instance, caught in poverty traps, are especially hurt during economic downturns. When the economy falls off, the poor are more likely to cling to their job, but are also more likely to walk away as fish catch declines or if they have a higher level of material wealth (Cinner et al., 2009). Tominaga (2018) argues that there are different mechanisms explaining why small-scale artisanal fishermen are more willing to engage in piracy when the maritime economy worsens as opposed to when fishermen who work in large, industrial/commercial fishing engage in

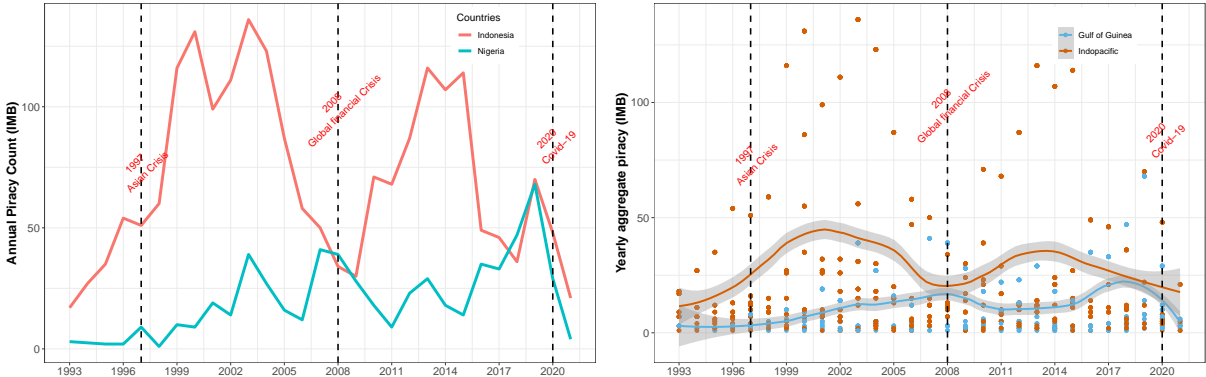
piracy. He argues that small-scale fishermen, which are deeply reliant on the industry for their own food consumption, and have little material ability to engage in large-scale pirate attacks (attacking large vessels and hostage-taking), are more likely to commit small-scale unsophisticated attacks when fish production declines. In contrast, for fishermen working in industrial fishing, declines in fish production and value, alongside their greater capabilities, are more likely to commit larger, more sophisticated pirate attacks. The above discussion leads to our main hypothesis:

H1: Piracy events are more likely to increase in the months following government restrictions on movement and commercial activity.

Descriptive Stats

One identification strategy to examine the effects of economic hardships on piracy events is to compare the the number of events before and after a country implements a harsh stringency measure. In this study, we look at two piracy-prone country cases, Indonesia and Nigeria. The two countries are the two highest piracy prone countries but in different regions of the world. Figure 2 shows the piracy events in the two countries and regions since 1993.

Figure 2: Count of piracy events.



Note: The left panel in the figure shows yearly counts of piracy in Indonesia and Nigeria. The right panel shows the regional trend with IMB data. The figures depict the increase of piracy events in the aftermath of the economic crises.

Government Stringency measures as proxy for economic disruption

The number of COVID-19 cases rapidly increased worldwide after it was first seen towards the beginning of 2020. But countries differed in the rate of transmission and intensity. Even at the height of the pandemic, the severity was not uniform. Consequently, the government response in restricting movements and business activities to curb the spread also varied across countries. This seemingly random restrictive measure has opened up an opportunity for researchers to examine the effect of restrictions and their disruption to local economies on events like crime or piracy.

The COVID-19 mitigation measures also had a significant impact in West and Sub-Saharan Africa. The pandemic and subsequent restrictions led to the greatest negative impacts on demand for domestic markets, increases in the price of inputs and lack of access to raw materials, and state policies regarding the movement of people (Oman et al., 2022, p.xv). Businesses in Sub-Saharan Africa were hit hard. The FAO reports that:“Companies were severely affected in terms of revenues, capacity and cash flow, with 41 percent of firms in Ethiopia, 52 percent in Nigeria, 75 percent in Madagascar, 60 percent in Ivory Coast, 62 percent in Zambia, and 6 percent in Kenya expecting over a 25 percent decrease in turnover” (Oman et al., 2022, p.xv).

In the Ivory Coast, the pandemic affected the aquaculture industry by cancelling orders leading to rotting stock and blocked working capital from fishing boats not going out to sea (Oman et al., 2022, p.14). In a survey conducted during the initial lockdown in the rural coastal village of Bureh Town in Sierra Leone, where fishing and tourism comprise the town’s main occupations, every household in the survey but one reported that their weekly income decreased by a category of 51% to 100% in contrast to the pre-lockdown period. Similarly, 82% of respondents reported having difficulty proving food for their family (Buonsenso et al., 2020, p.25).

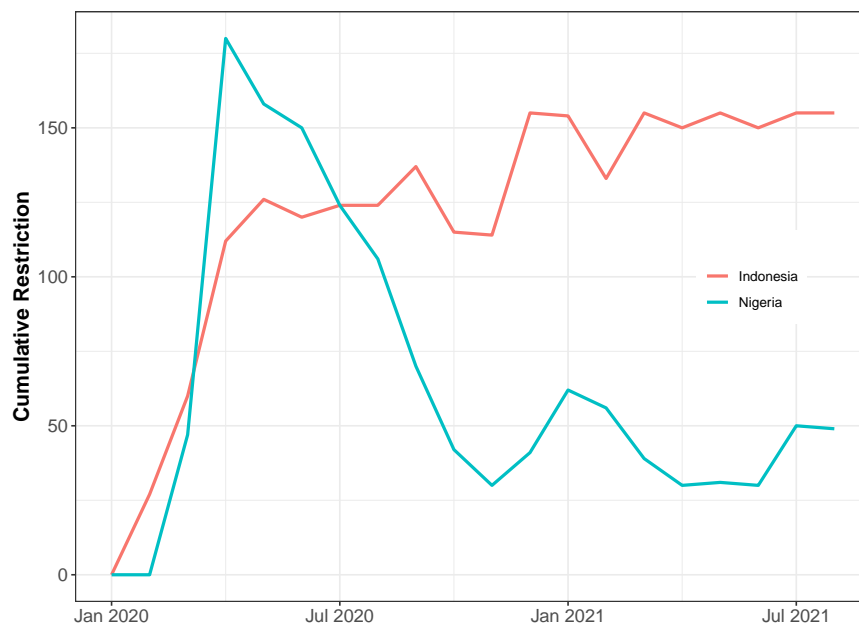
Similar to other countries, Nigeria responded to COVID-19 with an array of restrictions: home lockdowns, nighttime curfews, travel bans, a ban on domestic interstate travel, closure of schools, closing restaurants and bars, and a ban on public gatherings (FAO, 2021b). When the pandemic hit the country, there was an ongoing insurgency in the northeastern

part of the country and the planting season in the southern part. In addition to weathering violence from Boko Haram in the northeast, while millions of Nigerians were already facing food insecurity, recovering from the pandemic has been made more difficult due to “income losses, trade disruptions, and rising food prices”. In Northeastern Nigeria, recovering from the pandemic was also made more difficult from pests and diseases, leading to low crop yields and livestock productivity (FAO, 2021a) The southern part of Nigeria saw disruptions in the agricultural labour supply and the disruption of migrant labour because of an interstate travel ban (Oman et al., 2022, p.13). During the initial 8-week period of Nigeria’s lockdown during 2020, their GDP dropped by \$11 billion USD or 23% (Andam et al., 2020), experiencing its worst depression in two decade, but began to recover and grow in 2021.] In a study of how the pandemic affected food insecurity, Amare et al. (2021) find that lockdown measures are associated with 6–15 percentage points increase in households’ experience of food insecurity 12 percentage points reduction in the probability of participation in non-farm business activities (Amare et al., 2021). In Lagos, Nigeria, Africa’s largest city, respondents in a survey reported that transportation restrictions impacted their social, religious, and economic life. The pandemic impacted transportation in Lagos by increased costs, shortage and the lack of options, and congestion (Mogaji, 2020, p.3).

In the following, we systematically examine the effect of covid on piracy using monthly data in two countries, Indonesia and Nigeria where COVID-19 cases peaked at different periods. Rather than just the actual pandemic, we expect government-imposed restrictions to curb the pandemic will have a more severe effect on the local economy and individual poverty level. This pandemic-induced poverty, in turn, should affect monthly piracy incidents. To test our hypotheses, we use interrupted time series analysis, which tracks the trend over time, before and after an intervention, which in our case is the stringent measures from Hale et al. (2021). We modify the daily stringency measures from the dataset into monthly cumulative measure by aggregating the following government responses each month: school closures, workplace closures, canceled public events, gathering restrictions, public transport closures, stay at home orders, internal movement restrictions, and international travel controls. Each of these responses is coded as 1 if the government declared restriction on that criteria and 0 otherwise. For instance, if a country imposed all eight types of restrictions every day for

a month, the cumulative restriction for the month is calculated as $8 \times 30 = 240$. We consider months following the highest level cumulative restriction as the post-intervention period.

Figure 3: Stringency measures in response to COVID-19



Note: Figure above shows monthly cumulative restrictions imposed by the government in Indonesia and Nigeria, in response to rising COVID-19 cases. As shown in the figure the restrictions peaked in Nigeria in April 2020, and in Indonesia in December 2020.

There was a substantive variation on how countries imposed stringency measures. While many factors may have led the governments to impose restrictions, the main driving factor was the reported Covid cases in the country. Figure 3 shows the 30-day cumulative stringency measures of Nigeria and Indonesia based on the eight factors discussed above. As shown in the figure, Nigeria, and some other countries in the Gulf of Guinea (not shown), imposed heavier restrictions early on, whereas countries in Southeast Asia were less affected early on. Indonesia saw the surge in covid cases only during the second wave of the Delta variant. As a result, Nigeria has the intervention in April 2020 while Indonesia has intervention much later, in December 2020. As discussed earlier, these restrictions had significant effect on the local economy. For instance, a study in Indonesia shows that the coastal areas in the country suffered significantly due to the pandemic (Teniwut, 2021). Towards the beginning of 2020, although Indonesia's number of Covid cases was relatively low, the impact on the local economy was palpable due to the decrease in overseas demand for local aquaculture and

farming products and limited shipping access. According to the author, even the “perception of declining fishery conditions” was found to aggravate social problems like inter-village conflicts (p. 186). But as the number of Covid cases in the country started to increase steadily around November 2020 and the government response peaked in December of that year, bringing the local economy to grinding halt.

Empirical Approach

How does economic hardship affect the number of piracy events? Understanding the causal effects of poverty at the societal level is difficult since the variable is intertwined with many other factors such as governance, geographical dispersion, population, and other demographic factors. Ideally, a randomized control trial would be the most helpful design to scientifically study how an externally induced poverty and economic hardship in society might impact piracy activities (Hudson, Fielding and Ramsay, 2019). Alternatively, evaluating variation in piracy activities due to pandemic-related stringency measures and the dip in the local economy is close to a natural experiment. Comparison of immediate pre- and post-crises of even a single case can reveal the effect of economic disruption at the local level on outcomes like crime or piracy. For identification, the immediate pre- or post-effect is preferable to data spanning a longer time frame since the effect of other factors tends to dilute the result as we increase the time. Therefore, we use an interrupted time series (ITS) design, a strong quasi-experimental design, to identify whether economic grievance impacts piracy events. According to Reichardt (2019), “the ITS design can be implemented with a single unit or multiple units. Indeed, the design can be implemented with an entire population so that no participant goes without the treatment” (p. 202).

The start of the global COVID-19 pandemic and the government-imposed restrictions at the country level is akin to a natural experiment, as the population in these countries had to respond quickly to the external intervention. With the onset of the pandemic, governments worldwide started to impose restrictions, causing a decline in trade and commerce. Yet, for an individual country, we should be able to observe the local effect of the government restriction on events like maritime crime by comparing the trend before and after the measure. An approach to understanding the impact of an intervention is by using the interrupted time

series (ITS) design, which estimates the trend difference of outcome events before and after the intervention. This method is particularly relevant for policy evaluation in the short term, narrowing the study timeframe to immediately before and after the intervention so that other unrelated shocks do not complicate the results as we extend the pre and post-time periods (see [Abadie, 2021](#), p. 293). We, therefore, limit our study by focusing on months since the onset of the global pandemic, around January 2020. We then compare the trends in piracy before and after the government-imposed restriction using the ITS model.

Table 1 displays results from interrupted time series analysis where the models compare piracy trends pre- and post-COVID-induced stringency in Nigeria and Indonesia. We use piracy activity data since the start of the year 2020, around the time when COVID-19 pandemic started, until June 2021. Intervention in the two countries start when monthly cumulative restriction peak in the countries, which are April 2020 for Nigeria and December 2020 for Indonesia, as shown in [Figure 3](#). We start by estimating single-group ITSA using the ITSA package written for Stata, before running the multi-group ITSA, where we include three neighboring countries as controls. To compare the piracy trends before and after interventions in the treatment countries, using single and multi-group design, we use regression model that includes the seven terms as represented in the following equation ([Linden, 2015](#)):

$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \epsilon_t$$

where Y_t is the aggregate piracy at month t , T_t is time since start of the study, and X_t represents a dummy variable representing pre- or post-intervention (0, 1). Z is a dummy variable indicating the cohort assignment (treatment or control countries), and $Z T_t$, $Z X_t$ and $Z X_t T_t$ are the respective interaction terms. β_4 in the equation captures the intercept difference at the beginning of the study, β_5 is the difference in the slope of outcome variable between treatment and controls, and β_6 indicates the mean level difference between treatment and control groups for months immediately following the intervention. Lastly, β_7 is the key coefficient, which estimates the impact of intervention as represented by the difference between treatment and control groups in the slope of the outcome after the intervention, compared to pre-intervention and control group trend. Newey-West standard errors were

specified to account for autocorrelation at lag 1. In the table, models (1) and (3) are single-group ITSA models for Nigeria and Indonesia respectively. Models (2) and (4) are multi-group ITSA models for the two countries including the neighbouring countries. Variable of interests are $x_t_Country$ (β_3) for single group models and $_z_x_t_Country$ (β_7) for multi-group models.

For the Nigeria multi-group ITSA, we include Ghana, Sierra Leone and Angola as controls, and for Indonesia, we include Malaysia, Thailand and Philippines. Introducing other neighboring countries as controls in a multi-group ITS further refines the result. Since the timing and intensity of government restrictions in the countries varied significantly, comparing piracy as an outcome of intervention in the treatment country with piracy cases in neighboring countries provides an estimate of the intervention effect (Linden, 2015, p. 483-84). For instance, Indonesia had the highest cumulative stringency measure of 155 in December 2020, much later compared to other countries in the region. The cumulative stringency for Thailand (155) was highest in May 2020, and in April 2020 for Malaysia (176) and the Philippines (210). As for Nigeria, the timing of the stringency was similar to nearby countries in the control group (April 2020) but the intensity of stringency was much higher for Nigeria (180), compared to Sierra Leone (149), Ghana (146), and Angola (172).

In the table, a positive coefficient for these variables in the table indicates that COVID-19 restrictions increased piracy activities. As expected, both variables in the models, $x_t_Country$ and $_z_x_t_Country$, are positive for all four models, indicating a positive piracy trend in the aftermath of severe restrictions. However, we find statistical significance only for Nigeria. Substantive results of the models are represented in Figure 3. The left panel figures represent single-group models 1 and 3, for Nigeria and Indonesia, whereas the right panels show the pre- and post-restrictions of the two countries compared with their neighbors. As the coefficients in the models and the slopes in the figures suggest, piracy trend tends to rise following the peak of the COVID-19 restrictions. While the slope is more distinct for Indonesia, the timing of the restrictions was much later than in Nigeria. Therefore, the trend is statistically significant in Nigeria in both models, but not for Indonesia. The number of data points for the analysis is not adequate for the post-restriction trend to reach traditional statistical significance ($p < 0.05$). We believe that the trend in Indonesia becomes clearer as

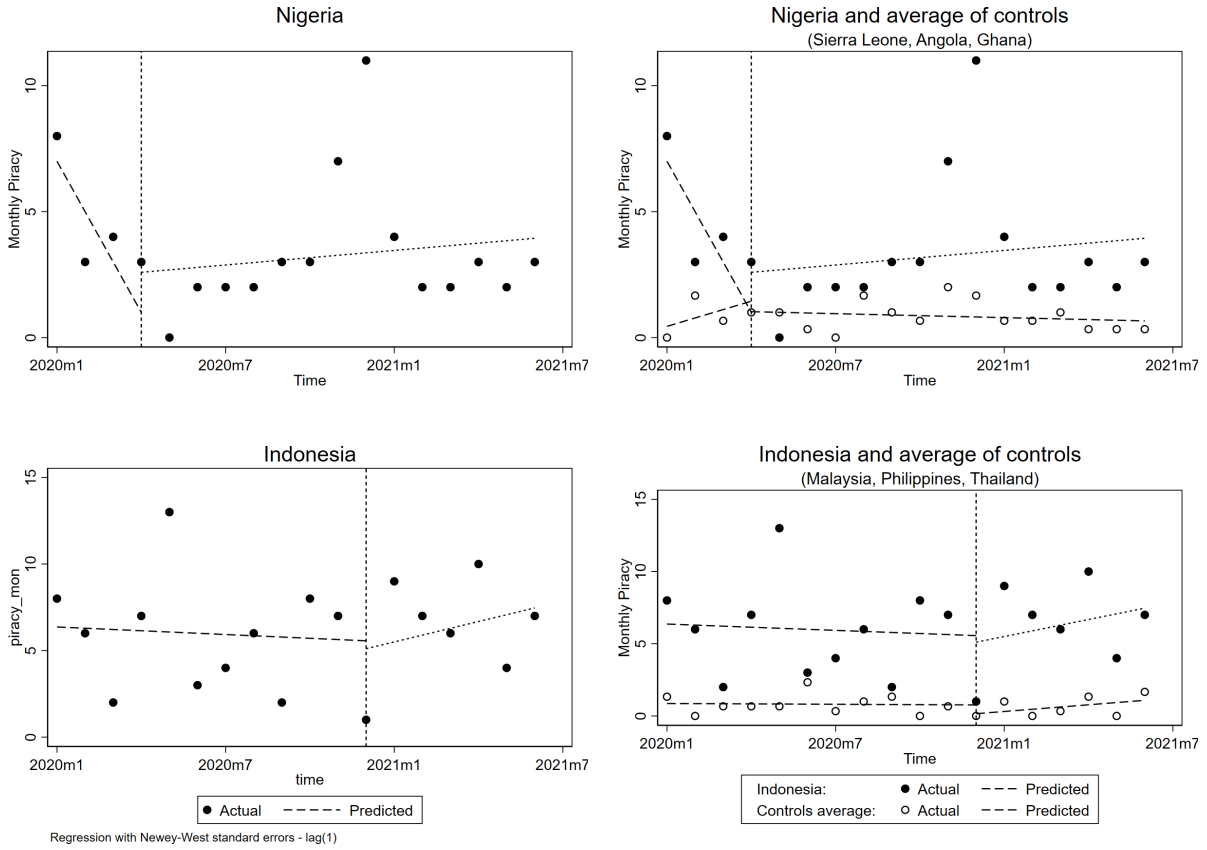
Table 1: Interrupted time series analysis

	(1)	(2)	(3)	(4)
	Nigeria	Nigeria	Indonesia	Indonesia
_t	-2.000** (0.802)	0.333 (0.241)	-0.073 (0.229)	-0.009 (0.060)
_x_Nigeria	1.592 (1.925)	-0.417 (0.773)		
_x_t_Nigeria	2.096** (0.814)	-0.360 (0.246)		
_z		6.556*** (0.988)		5.500*** (1.582)
_z_t		-2.333*** (0.788)		-0.064 (0.222)
_z_x_Nigeria		2.008 (1.960)		
_z_x_t_Nigeria		2.456*** (0.801)		
_x_Indonesia			-0.456 (2.775)	-0.609 (0.578)
_x_t_Indonesia			0.466 (0.533)	0.164 (0.149)
_z_x_Indonesia				0.152 (2.659)
_z_x_t_Indonesia				0.302 (0.520)
Constant	7.000*** (0.964)	0.444 (0.406)	6.364*** (1.645)	0.864** (0.367)
Observation	18	72	18	72

Note: The table above shows the effect of covid stringency on piracy in Nigeria and Indonesia, using single and multi-group models, including in the latter nearby littoral countries for comparison. The peak intervention started in Indonesia in December 2020 and in Nigeria in April 2020.

we gather more data, but these preliminary results suggest that the COVID-19 restrictions and their societal impact led to increased piracy in the two countries.

Figure 4: Stringency measures in response to COVID-19



Note: Panels in the figure above are from ITSA models in Table 2. They show patterns of piracy after highest monthly cumulative restrictions imposed by the government in Indonesia and Nigeria.

Conclusion

This study highlights the effect of the COVID-19 pandemic on maritime piracy. Although the pandemic is ongoing while writing this paper, it has been two years since it started. In an attempt to slow or stop the contagion, governments worldwide implemented a variety of stringency measures that directly affected the social economy by increasing local-level poverty and widening inequality (Deaton, 2021; Kong and Prinz, 2020; Bank, 2020). As discussed in the earlier section, past studies have indicated that three structural factors influence the number of piracy: shipping traffic, state capacity to deter pirates, and the prevalence of root causes like economic inequality and grievances.

By exploring the relationship between pandemic and piracy, this research provides evidence supporting the root cause argument. Results indicate increased piracy activities in the months following strict stringency measures by governments, suggesting that the spiking of societal grievances from such measures lowered opportunity cost for individuals to engage in such illegal activities. We find strong evidence for this trend in Nigeria within the Gulf of Guinea. The trend in Indonesia seems to be going in that direction, but the results are not statistically significant. The larger confidence interval for results in Indonesia is likely due to the fewer data points since the country's restrictive measures peaked much later than Nigeria. Moreover, COVID-19 situation and restrictive measures were being re-introduced due to the emergence of the new Delta variant. From these initial results, we are likely to witness a further spike in piracy activities as a direct consequence of the economic hardship.

Our research demonstrates that significant health-related events and the restrictive government policies instituted to deal with them can have a major effect on the local fishing industry, which can increase individual hardship and grievance and ultimately lead to an increase in maritime piracy. Governments not only responded to the pandemic with a range of restrictions, they also responded with a collection of fiscal policies aimed at increasing demand and compensating industries and workers that were hurt. Perhaps one implication of our research is that these policies were not enough to keep the fish industry afloat and support workers who suddenly found themselves out of a job. Lastly, while our focus in this article was on the COVID-19 pandemic, other large-scale events, from extreme weather to another global recession, might also lead to substantial downturns in the economy and with it increases in maritime piracy. Just as the 1997-1998 Asian Financial Crisis led to increased joblessness and poverty, and maritime crime, so too did the COVID-19 pandemic; future economic recessions, if not properly addressed, might lead to the same increase in maritime violence.

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