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THE RELATIONSHIP BETWEEN THE STRINGENCY INDEX, EXCESS DEATHS AND GDP DURING THE COVID-19 PANDEMIC

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INTRODUCTION

In the following pages, we will look at the global economic impact of COVID-19 containment measures, as well as their effectiveness in reducing mortality in a cross-country comparison. Our analysis variables are stringency, as a measure of the extent of containment efforts, excess deaths, as a measure of health impact, and GDP, as a measure of economic performance. In general, tighter stringency measures are associated with fewer excess fatalities and greater GDP loss.

However, this is not always the case, as most linkages are determined by a country's beginning socio-economic condition. Results are highly influenced by international spillovers and biases due to reverse causality. As a consequence, we divide the analysis considering high-income and middle-low-income countries separately to examine the outcomes. The data on advanced economies is quite rich, but this is not the case for the other two types of countries, especially for low-income regions availability of data is scarce due to lack of transparency and difficulty of tracking for local governments. Below, we provide a presentation of our main variables.

1.1 THE OXFORD STRINGENCY INDEX

The COVID-19 pandemic, spurred governments around the world to develop a variety of policies to combat the virus's spread. To systematically evaluate these measurements across nations and over time, researchers at the University of Oxford's Blavatnik School of Government created the Oxford COVID-19 Government Response Tracker (OxCGRT). The Oxford Stringency Index, which measures the severity of government reactions to the pandemic, is a critical component of this tracker.

Development of the Oxford Stringency Index

The Oxford Stringency Index was designed to give a comprehensive and comparative assessment of government reactions to COVID-19. The initial aim for its development was to address the need for a consistent mechanism for tracking and comparing the intensity and severity of policy actions across countries and regions. The index enables researchers, politicians, and the general public to examine the link between government initiatives and a variety of outcomes, including pathogen propagation, economic effect, and public health.

The OxCGRT team, led by Thomas Hale, quickly created the index in early 2020. The team gathered publicly available information about government replies from official sources such as press announcements, news stories, and public databases. They constructed a dataset by methodically coding this information, which includes a wide range of policy actions enacted by governments around the world.

Variables of the Oxford Stringency index

The Oxford Stringency Index is calculated using a collection of 20 indicators representing various government policies. These indicators are divided into four categories: containment and closure policies, economic policies and health-care policies. Each indicator is awarded a score depending on the measure's intensity or strictness, and these scores are combined to create the overall stringency index. The main variables are listed below:

-Containment and Closure Policies

School Closures (C1): Determines the level of school closures, which ranges from no measures to the entire closure of all educational facilities.

<u>Workplace Closures (C2)</u>: Determines the extent of workplace closures, ranging from no measures to the forced closure of all non-essential workplaces.

<u>Cancel Public activities (C3)</u>: Assesses the cancellation of public activities, ranging from no measures to all events.

<u>Restrictions on Gatherings (C4)</u>: Determines the level of restriction on private and public gatherings, ranging from none to complete prohibition.

<u>Close Public Transport (C5)</u>: Evaluates the closure of public transportation services, ranging from minimal steps to total shutdown.

<u>Stay-at-Home Requirements (C6)</u>: Assesses the use of stay-at-home orders, ranging from no measures to required orders except for vital activities.

<u>Internal Movement Restrictions (C7)</u>: Measures that limit movement within the country, ranging from no restrictions to severe ones.

<u>International Travel Controls (C8)</u>: Evaluates the strictness of international travel controls, ranging from no measures to full border closure.

-Economic policies

<u>Income Support (E1)</u>: Indicates the level of government income support, ranging from no help to significant support that covers the majority or all lost income.

<u>Debt/Contract Relief (E2)</u>: Evaluates the availability of debt or contract relief for households, ranging from no measures to extensive relief measures.

<u>Fiscal Measures (E3)</u>: Assesses the government's spending on fiscal measures to mitigate the economic impact of COVID-19.

<u>foreign Support (E4)</u>: This metric assesses foreign financial assistance supplied to other countries.

-Health System Policies

<u>Public Information Campaigns (H1)</u>: Determines the frequency and intensity of public information campaigns.

<u>Testing Policy (H2)</u>: Evaluates the extent of testing policies, ranging from no testing policy to open public testing.

<u>Contact Tracing (H3)</u>: Assesses the level of contact tracing, ranging from no tracing to complete tracing of all contacts.

<u>Emergency Investment in Healthcare (H4)</u>: Quantifies emergency investment in healthcare infrastructure and systems.

<u>Investment in Vaccines (H5)</u>: Evaluates vaccine development investments.

<u>Facial Coverings (H6)</u>: Tracks the number of mandates requiring the usage of facial coverings, ranging from none to mandatory in all public venues.

<u>Vaccination Policy (H7):</u> Assesses the policy for vaccine rollout, from non-availability to availability for most or all citizens.

Protection of senior People (H8): Policies designed expressly to protect senior populations.

Computation of the Index
To compute the Oxford Stringency Index, the scores for each relevant indicator are combined. Each indication is normalized to a 0–100 scale, with higher scores indicating stricter rules. The overall stringency index is then calculated as the average of these normalized scores, yielding a composite statistic that represents the severity of government reactions at any particular period.

The Oxford Stringency Index has been widely utilized in research to assess the efficacy of various policy strategies for preventing the spread of COVID-19 and minimizing its effects. It allows for cross-country comparisons and the identification of best practices in pandemic response, policymakers use the index to assess the stringency of their measures in comparison to other nations and to inform future policy decisions.

The Index also contributes significantly to the field of pandemic response studies. Providing a consistent and comparable assessment of government initiatives helps to better understand the relationship between policy measures and pandemic outcomes. As the world deals with COVID-19 effects and prepares for future public health catastrophes, the Oxford Stringency Index will continue to be an invaluable resource for scholars and governments alike.

1.2.EXCESS DEATHS

The COVID-19 epidemic has presented significant problems to public health systems globally. Measuring its health impact accurately is critical for understanding the entire scope of the situation and guiding governmental solutions. One of the most dependable measurements of COVID-19's health impact is the concept of "excess deaths."

Excess deaths are those that occur within a certain period and exceed the predicted number of deaths based on previous data. The measure includes not just the direct mortality caused by COVID-19, but also the indirect deaths stemming from the pandemic's broader impact on health systems and society. Indirect deaths can occur as a result of overburdened healthcare systems, delayed treatments for other ailments, and behavioral changes.

Methods to Measure Excess Deaths
There are various methods for calculating excess fatalities, each with advantages and drawbacks. The primary methods are:

-Simple Historical Average: This method compares the number of deaths during the epidemic to the average number of deaths over the same period in previous years, usually spanning five to ten years. The extra deaths are represented by the difference between the observed and historical averages. Seasonal Adjustments: To account for seasonal differences in mortality, this approach modifies historical averages to match anticipated seasonal changes, resulting in a more realistic baseline for comparison.

-Regression models employ statistical techniques to forecast predicted fatalities based on past data, taking into account trends, seasonal patterns, and demographic changes. The anticipated figures are then compared to the actual deaths during the pandemic.

-Time Series Models: These models, such as autoregressive integrated moving average (ARIMA) models, evaluate past death data to estimate future deaths, which are then used to quantify excess deaths.

-<u>Cause-Adjusted Models</u>: This method examines fatalities by specific causes, distinguishing COVID-19 deaths from other causes, and evaluating changes in non-COVID-19 mortality rates. This approach helps in understanding the pandemic's larger health consequences.

Benefits of using Excess Deaths as a Measure

Excess deaths provide several benefits as a measure of the health impact of COVID-19. Unlike confirmed COVID-19 death statistics, which may be constrained by testing capability and reporting methods, excess deaths include all pandemic-related deaths, including those caused indirectly by the crisis. Excess deaths are also less prone to underreporting or misclassification biases, which can impact COVID-19 death estimates. They provide a more complete picture by including unreported or incorrectly identified COVID-19 deaths.

These rates provide more precise cross-country comparisons by standardizing the measure across various health systems and reporting techniques. Standardization is critical for assessing the pandemic's global impact. Finally, Excess deaths, including indirect mortality, shed light on the pandemic's broader impact on public health, including the implications on healthcare access, mental health, and social determinants.

Understanding excess fatalities can help guide public health policies and initiatives. For example, finding increases in excess deaths might show locations where healthcare systems are overburdened or where greater resources are required.

Challenges of using Excess Deaths as a Measure

While extra fatalities are a powerful statistic, there are certain problems to keep in mind.
The accuracy of excess death estimates is dependent on the quality and availability of mortality data, inconsistent or inadequate data can result in erroneous estimates. Setting a suitable baseline for projected fatalities can be difficult due to variations in previous mortality rates and demographic shifts. It is difficult to distinguish between the pandemic's direct and indirect effects on mortality. COVID-19 may not be the main cause of extra deaths due to temporal lag .This is because there may be a temporal lag in reporting mortality data, which could delay the assessment of excess deaths and the timely implementation of policy solutions.

In conclusion, excess deaths are a reliable and complete indicator of the health impact of the COVID-19 pandemic. By including both direct and indirect deaths, they provide a more complete and less biased picture than confirmed COVID-19 death statistics. Despite issues with data quality and baseline establishment, using excess fatalities is critical for understanding the pandemic's entire effects and driving successful public health strategies.

1.3 GROSS DOMESTIC PRODUCT

The COVID-19 pandemic has precipitated a global economic crisis, resulting in enormous interruptions in economic activity. To assess the pandemic's economic impact, robust and comprehensive measures are required. One of the most commonly utilized indicators for this purpose is Gross Domestic Product (GDP).

Gross Domestic Product (GDP) is the total monetary worth of all final goods and services produced inside a country's borders over a set time period, usually a year or a quarter. It provides a complete assessment of a country's total economic activity and health. GDP can be computed using three methods: the production, income, and expenditure techniques.

<u>Production Approach</u>: This method adds the value added at each stage of production to arrive at the final output. GDP is calculated by summing the gross value of output from all economic sectors and removing the value of intermediate products in order to avoid double counting.

<u>The Income Approach</u>: This method calculates GDP by adding all incomes earned by individuals and firms in the economy, including wages, earnings, rents, and taxes, less subsidies. It focuses on the allocation of profits from output.

<u>The expenditure approach:</u> This method estimates GDP by adding all expenditures made in the economy, including consumption, investment, government spending, and net exports (exports minus imports). It indicates the entire amount spent on final goods and services.

The components of GDP
GDP consists of four basic components, each representing a distinct form of economic activity:

<u>Consumption (C)</u> refers to the total value of all products and services consumed by households. This is frequently the largest component of GDP, encompassing spending on durable goods, nondurable items, and services.

<u>Investment (I)</u> refers to expenditures on capital goods for future production. This comprises commercial investments in equipment and structures, residential construction, and inventory adjustments.

<u>Government spending (G)</u> refers to the total amount spent by the government on goods and services. It covers funding for defense, education, public safety, and infrastructure but excludes transfer payments like as pensions and unemployment benefits.

<u>Net exports (NX)</u> are the value of a country's exports less its imports. Positive net exports indicate a trade surplus; negative net exports indicate a trade deficit.

GDP as a strong measure of economic impact.
GDP is an important indicator in measuring the economic impact of COVID-19 for various reasons. Firstly, GDP refers to a country's total economic activity and provides a broad picture of the economy's health. It captures the production, revenue, and expenditure aspects, providing a multidimensional view of economic performance. This variable enables comparative study between countries and throughout time. By standardizing economic activity into a single indicator, it makes it easier to compare the economic impact of COVID-19 across countries and regions, emphasizing the relative severity of the slump.

A decrease in GDP growth or a reduction in GDP indicates an economic recession, which has been a common result of the epidemic. Tracking GDP changes assists in determining the magnitude and duration of the economic impact, policymakers use GDP data to create and implement economic policies. During the COVID-19 epidemic, governments used GDP predictions to assess the efficacy of fiscal and monetary actions targeted at minimizing economic consequences. Understanding GDP trends is useful in developing targeted stimulus packages and recovery plans.

In a more precise way, GDP statistics can be broken down to assess the performance of various economic sectors. The pandemic has had an unequal impact on sectors such as tourism, hospitality,

and retail, while others such as technology and healthcare have proven resilient. Sectoral GDP analysis identifies fragile and robust sectors, guiding resource allocation and assistance measures. International Aid and Support. International organizations and development agencies use GDP measures to allocate aid and support to pandemic-affected countries. Lower GDP growth or contractions indicate a larger need for foreign help to stabilize economies and promote recovery.

While GDP is a helpful indicator, there are certain constraints to consider:
GDP does not account for non-market activities such as family labor and volunteer work, which can be considerable, particularly during a crisis like COVID-19, when informal support networks are critical. Considering income distribution GDP measures total economic output but does not reveal information about it.The epidemic has exacerbated disparities, and GDP cannot fully capture the distributional consequences.
Other items such as environmental and social factors are also neglected as GDP prioritizes economic output over environmental deterioration and social well-being. The pandemic has underlined the significance of comprehensive policies that address both health and environmental sustainability.
GDP data is also frequently released with a delay, making real-time analysis difficult. During quickly growing emergencies such as COVID-19, timely data is critical for effective policymaking.

 Despite its shortcomings, GDP remains a cornerstone of economic analysis and an important statistic for guiding recovery efforts in the aftermath of COVID-19.
It is an important measure for assessing the economic impact of COVID-19 on countries. It's comprehensiveness, ability to assist comparative research, and importance in policy development make it an essential instrument for understanding the economic effects of the epidemic.

OVERVIEW

The purpose of this thesis is to look at how stringent regulations established during the COVID-19 crisis affected global economic systems and mortality rates. To do this, we use the Oxford Stringency Index as a key indicator of policy strictness, GDP as a measure of economic activity, and excess deaths as a measure of mortality impact.

The COVID-19 epidemic drove governments around the world to implement a number of rigorous laws aimed at limiting the virus's spread. The Oxford Stringency Index gives a comprehensive measure of these policies by combining numerous government response indicators into a single score that represents a country's overall stringency of measures.

Our primary goal is to determine how these stringent restrictions impacted economic performance and public health outcomes. GDP is an important indicator for measuring economic impact, as it provides information about how restrictions affect economic activity, production, and general economic health. Simultaneously, excess fatalities give a more comprehensive estimate of the mortality impact, including not only COVID-19-related deaths but also those induced indirectly by the pandemic.

2.1 RESEARCH MATERIAL

Our research relies on prior studies completed between 2020 and 2024 that primarily use regression analysis to evaluate the correlations between our variables of interest. Specifically, we look at the key relationships between policy stringency and excess deaths, as well as between policy stringency and GDP. We also analyze the relationship between excess deaths and GDP as it was proven to be a key factor in governments' decisions on which measures to implement. The literature on these relationships is substantial and mostly uses cross-country comparisons.

Cross-country comparisons provide various advantages. For starters, they provide a broader context by incorporating a variety of policy responses and outcomes, which can improve the generalizability of findings. This diversity enables researchers to find patterns and linkages that may not be visible in single-country studies. Second, cross-country comparisons can account for country-specific effects and provide a more complete picture of how various factors influence the outcomes of interest. This is especially valuable for distinguishing the impact of policy stringency from other variables that may skew results in a single-country research.

However, there are some disadvantages to doing cross-country comparisons. One significant drawback is the possibility of inconsistency in data quality and reporting standards across countries. This inconsistency can introduce biases and compromise the dependability of the results. Furthermore, cultural, economic, and political differences between countries can complicate the interpretation of results. Contextual differences may prevent what works in one country from being applicable or successful in another. Furthermore, cross-country studies frequently encounter difficulties in accounting for the timing and execution of policies, which can vary greatly and influence the outcomes examined.

2.2 STRUCTURE AND ADJUSTMENTS

To provide a clearer and more accurate analysis, we employ a variety of ways to address the challenges of cross-country comparison. Mainly, we must account for foreign spillovers and reversal casualties.

International spillovers are the economic, social, and political consequences that actions or events in one country might have on other ones. For example, severe lockdowns in big economies can interrupt global supply networks, disrupting economic activity in other countries. Similarly, travel restrictions can have an impact on tourism-dependent economies, even in nations with less rigorous policies.

Reverse causality arises when the cause-and-effect relationship is unclear. In the context of our study, while we want to investigate how rigorous policies affect economic activity and mortality, it is also feasible that rising mortality rates or declining economic activity lead governments to impose stricter policies. This bidirectional link might hinder data analysis and interpretation.

Our initial tactic is to categorize countries based on their economic conditions. We classify countries with similar economic conditions into two groups: advanced economies and emerging economies. We also provide insights on low-income countries, recognizing the limited data accessibility in these places. This grouping helps to adjust for biases caused by differing initial economic situations and provides a more detailed understanding of the effects among more homogeneous groups.

While cross-country comparisons confront inherent obstacles due to cultural and political variations, our grouping strategy reduces these biases. This method works especially well in advanced economies, where data quality and reporting standards are more uniform, allowing for more meaningful comparisons.

We divide our research into two phases of the pandemic: the first, from January 2020 to July 2021, and the second, from July 2021 to December 2022. This segmentation is based on the introduction of mass vaccination, a watershed moment that profoundly affected the variables we are studying. By distinguishing between these eras, we may more precisely measure the impact of stringent regulations before and after vaccinations became widely available, taking into account the various outcomes across different countries.

To address reverse causality, we consider research that uses instrumental variable approaches and lagged variables in their regression models. These strategies contribute to a clearer direction of causality by employing external elements as instruments that influence policy stringency but are unaffected by GDP or mortality rates. These studies frequently incorporate controls for global economic indicators and regional dummy variables to account for the effects of international spillovers. This helps to separate the influence of a country's stringency policy from the larger international background. Nevertheless, we will try to describe the role of spillovers in some situations as they play a fundamental role in the economic situation, especially in emerging countries.

MAIN FINDINGS

2.3 ADDRESSING EXCESS DEATH-GDP TRADE OFF
During the initial period of the pandemic, both developing and advanced economies faced significant challenges in balancing public health and economic stability, but their experiences differed due to structural and policy disparities.

In emerging economies, there was a substantial link between the severity of lockdown measures and GDP contraction. The economic structure of these countries, which frequently rely on informal sectors and socially engaging employment, exacerbated the economic impact of strict stringency rules. Despite the installation of tight controls, the relationship between excess deaths and stringency was negative but weak. This shows that, despite maintaining rigorous rules in the face of excess mortality, emerging economies struggled to dynamically alter these policies due to demographic dynamics and limited resources.

In contrast, in advanced economies, the number of deaths was strongly related to economic openness. To manage the epidemic, these countries implemented strong measures, resulting in large GDP losses, particularly in the early months of 2020. The link between economic openness and mortality was strong early on, but it became less obvious as the pandemic advanced into the second and third semesters. This trend is likely due to evolving understanding of the virus, advancements in healthcare interventions, and changes in policy approaches over time.

Advanced economies, such as Taiwan, Korea, and Germany, were able to achieve reasonably positive results on both fronts: reducing mortality and limiting GDP losses. These countries established proactive and effective health policies early on, taking advantage of improved healthcare infrastructure and increased government resource availability. Despite initial challenges, their strategic countermeasures included extensive testing, contact tracing, and efficient lockdown procedures, which helped contain the virus's spread without significantly damaging the economy.

However, not all advanced economies performed equally well. Countries such as France, Italy, and the United Kingdom saw high death rates and considerable economic losses. These results were attributed to a combination of inadequate government interventions and bad luck, specifically the timing and preparation of their responses to the infection. For example, delayed lockdowns and contradictory procedures contributed to more excess deaths and economic hardship. Sweden's approach, which sought for herd immunity with fewer restrictions, yielded an intermediate result, with high mortality but a lower GDP loss than more stringent countries.

Emerging economies, saw a greater trade-off between GDP and excess fatalities. These economies were heavily harmed due to their economic frameworks, which included large informal sectors and limited state aid programs. Titan Alon's 2022 analysis indicated that GDP per capita in emerging markets declined by an average of 6.7% between 2019 and 2020, compared to 2.4% in mature nations. Excess mortality was significantly higher, with developing markets having a 75% greater excess mortality rate than developed economies.

These countries followed tight lockdown tactics similar to the developed nations, but the results were less effective because of limited resources and structural constraints. For example, Peru quickly implemented stringent restrictions like as border closures and curfews. Despite these efforts, the country's healthcare system was overburdened, and the massive informal sector suffered greatly from economic disturbances. The rigorous measures failed to appreciably reduce excess mortality, illustrating the challenges of implementing effective regulations in resource-constrained environments.

In general, advanced economies typically had the infrastructure and resources to enact and enforce good health programs. Emerging Economies faced more difficulties in policy execution due to low

resources and a greater reliance on informal sectors, strict regulations frequently caused severe economic disruption without corresponding reductions in mortality.

The effect was that while advanced economies saw a range of outcomes, emerging economies generally saw higher excess mortality and larger GDP reductions. The economic structure and the lack of strong social safety nets worsened the pandemic's effects.

From an adaptation and resource allocation point of view, advanced economies had greater flexibility in reallocating resources and altering policy dynamically. Redistributive measures and social insurance programs served to soften the economic shock whereas. Emerging economies on the other hand, have struggled to adapt due to structural constraints and inadequate government resources. Targeted solutions were complicated by multigenerational cohabitation and the need for job relationships.

In conclusion, while both advanced and emerging economies experienced considerable obstacles during the COVID-19 epidemic, the results differed greatly depending on the effectiveness of policy responses, resource availability, and economic structures. Advanced economies fared better thanks to proactive health initiatives and larger social safety nets, whereas emerging markets faced a more severe trade-off between economic activity and public health, which was compounded by structural and resource constraints.

2.4 THE IMPACT OF THE STRINGENCY INDEX

The COVID-19 epidemic prompted strong government responses around the world, with different effects on GDP and excess mortality in advanced and emerging nations. These distinctions stem from the timing, harshness, and socioeconomic conditions in which the policies are enacted.

Stringency and GDP

The pandemic's impact on advanced economies varied depending on the timing and severity of actions implemented. Countries such as Italy, Spain, and France enacted stringent lockdowns early on, resulting in significant economic cutbacks but effective control of excess mortality. On the other hand, the United States and the United Kingdom were first cautious, resulting in higher mortality rates and long-term economic consequences.

According to studies conducted by Michael König and Adalbert Winkler, the association between stringency and mortality was positive in the first quarter of 2020, indicating that countries with tougher policies saw greater mortality rates at first due to delayed reactions. By the second quarter, the economic impact had become clear, with strict measurements demonstrating a strong negative association with GDP growth.

The economic impact of tight restrictions was shown in substantial GDP declines throughout advanced economies. However, the presence of strong social safety nets and redistributive policies mitigated some of the negative consequences. Countries with strict and effective early responses, such as Germany, were able to keep mortality and economic decline to a manageable level.

Cross-country influences included geographic and economic interdependence among advanced economies. For example, in the European Union, adjacent countries' policies influenced one another, resulting in a compounded effect on economic growth and health results. Travel restrictions and voluntary trip cancellations harmed tourism-dependent economies, worsening economic downturn.

Emerging economies confront more difficulty in balancing rigorous measures and economic stability. The socioeconomic context, which included high levels of informal employment and

insecure labor markets, had a substantial impact on their reactions. Stringent lockdowns in nations such as India resulted in significant mobility restrictions and economic recession, especially in the informal sector.

Therefore these countries saw more severe economic impacts also due to limited fiscal capacity and poor social safety nets. In Latin America, strong lockdown measures combined with a high prevalence of precarious work resulted in catastrophic economic downturns and rising poverty rates. Countries like as Peru suffered significant GDP losses despite strict virus control methods.

Emerging economies showed a lower correlation between stringency and excess deaths compared to advanced ones. Factors such as poor healthcare infrastructure, larger population densities, and socioeconomic disparities have a greater impact on death rates than the stringency of interventions. The effectiveness of harsh measures was frequently undermined by noncompliance and the need for many workers to continue working despite constraints.

Stringent policies in South Asia had a severe economic impact, with major decreases in consumption and investment growth. East Asia, with fewer severe regulations and active testing, achieved better economic results with lower GDP losses.

Latin America's high percentages of informal employment and fragile labor markets meant that strict lockdowns had terrible economic consequences. Fiscal stimulus measures aimed at formal employment failed to reach a sizable proportion of the workforce, worsening economic disparities and poverty.

Overall, in Advanced Economies the negative link between stringency and GDP was strong, particularly in the second quarter of 2020. Stringent measures directly restricted economic activity while also mitigating long-term health hazards, so indirectly promoting economic recovery. In emerging Economies the economic impact was more severe due to structural flaws and restricted policy options. Stringent measures resulted in significant GDP losses, particularly in nations with extensive informal economies and insecure labor markets.

Stringency and excess deaths

In advanced economies Stringency reduced extra fatalities significantly, especially when implemented on schedule. Countries that delayed tough measures experienced greater death rates, emphasizing the significance of prompt and decisive action. In Emerging Economies the link between stringency and excess fatalities was less obvious. The effectiveness of measures was frequently hindered by socioeconomic issues, such as noncompliance and the need for informal laborers to continue working.

This is because, Strong healthcare systems, increased resource availability, and strong social safety nets improved the efficacy of rigorous measures. Cross-country influences and coordinated responses also played an important role in Advanced economies. Structural constraints, limited fiscal capacity, and socioeconomic differences hampered the effectiveness of strict measures in emerging economies. The high rate of informal employment and insecure labor markets worsened the economic impact of lockdowns.

2.5 LOW INCOME COUNTRIES

The COVID-19 pandemic has highlighted low-income countries' specific vulnerabilities, since the relationship between GDP, stringent measures, and excess mortality has materialized differently

than in more advanced ones. This unique predicament is the result of a number of socioeconomic and demographic factors that influence how the epidemic affects certain areas.

In low-income nations, the economic impact of COVID-19 frequently diverged significantly from the health effect. Countries such as Seychelles and Fiji, which recorded relatively few cases and no deaths, had severe economic downturns due to their reliance on tourism and limited fiscal resources to combat the slump. Exposure, vulnerability, and resilience posed a greater economic danger in many countries than the virus's direct spread. This approach, which is based on hazard, exposure, vulnerability, and resilience, demonstrates how economic risk can be substantial even in areas with moderate virus frequency.

The pandemic's economic impact in low-income countries includes both direct and indirect losses. Direct losses have immediate consequences, such as decreased income and output and higher healthcare costs. However, indirect losses are more significant, particularly in nations that were not directly hit by the virus but suffered as a result of the global economic shock. Globalization, increased tourism, labor flows, and social media have heightened behavioral responses and vulnerabilities, worsening economic losses even in areas with lower infection rates.

Stringent measures, while necessary to control the virus's spread, have far-reaching economic consequences in low-income countries. Countries in Sub-Saharan Africa, such as South Africa, Burkina Faso, and Nigeria, have imposed a variety of draconian measures, including travel bans, limits on public meetings, and school closures. These measures, combined with a drop in global demand, caused substantial economic disruptions, disproportionately hurting the poor and vulnerable people that rely on informal sectors and agricultural production for a living.

The high prevalence of economic informality in low-income nations has hampered effective government initiatives. Informal employment made it difficult to implement lockdowns and give targeted economic assistance. Social capital, on the other hand, through mutual aid and community support, contributed to the reduction of some health and economic costs. However, these regions' overall economic resilience remained poor, emphasizing the need for stronger social safety nets and economic support measures.

In the case of sub-Saharan Africa for example, despite its late arrival, COVID-19 spread quickly, with major outbreaks in South Africa, Nigeria, and Kenya. Governments enacted strict regulations, but the economic consequences were devastating. The fall in global demand and domestic control efforts resulted in income losses that disproportionately impacted the poor. Agricultural productivity has fallen, lowering rural incomes and food consumption. The economic effects highlighted the importance of appropriate governmental actions in containing the pandemic and facilitating recovery.

To conclude we can state that in low-income nations, the relationship between stringency measures and economic outcomes is overwhelmingly negative, with strict policies resulting in severe economic contractions. The association between stringency and excess fatalities is less prominent due to factors such as demographic features, smaller population density, and poor healthcare facilities. These countries faced a conundrum: strict measures were required to contain the virus, but they also resulted in considerable economic hardships. Effective international collaboration and customized policy responses are required to reduce these effects and facilitate recovery in low-

income countries. These countries' experiences show the importance of strong social safety nets and economic resilience policies for dealing with future shocks.

2.6 THE INTRODUCTION OF VACCINES

The launch of COVID-19 vaccines in mid-2021 was a watershed point in the global fight to combat the pandemic, altering major economic and health metrics in both emerging and developed economies. However, the impact of vaccines on GDP, stringency index, and excess fatalities varied dramatically among different locations due to disparities in vaccine distribution, healthcare facilities, and government policy.

Vaccines and Excess Deaths

Vaccines performed an important influence in lowering excess fatalities in both emerging and developed nations. Most countries saw a large drop in deaths after launching widespread immunization campaigns. This effect became especially noticeable after the summer of 2021, demonstrating the effectiveness of immunizations in reducing serious sickness and death. However, the magnitude of this decline varied, indicating differences in immunization coverage and healthcare capability. Advanced economies, with superior healthcare systems and early availability to vaccines, witnessed more immediate and significant reductions in mortality rates. Emerging economies, on the other hand, fell more slowly when vaccine rollouts were delayed and logistical obstacles arose.

Vaccines and GDP

The economic consequences of vaccination efforts were significant, however they differed by country. As vaccination rates rose, advanced economies started to recover economically. Governments steadily eased restrictions, boosting economic activity and consumer spending. This upward trend in GDP growth was especially noticeable in nations with strong healthcare systems and high vaccination rates, such as France and Italy. The confidence in obtaining herd immunity through vaccinations stimulated more investment and expenditure, which fueled economic recovery.

In emerging nations, vaccination availability provides critical support to pressured public health systems while also facilitating economic recovery. Vaccination initiatives served to restrict virus transmission, lower infection rates, and reduce hospital admissions and deaths. This reduced the pressure on healthcare institutions, allowing resources to be redirected to more pressing health issues.

Economically, the effective deployment of vaccinations in emerging economies prepared the path for a progressive reopening of markets. Lockdowns and travel bans had a significant impact on businesses and employment, but universal vaccination facilitated the return of economic activity. This revival bolstered consumer and investor confidence, resulting in higher spending, investment, and overall economic growth.

However, vaccination delivery in emerging economies presented considerable problems. Vaccine skepticism, logistical challenges, and insufficient healthcare infrastructure hampered the achievement of universal immunization coverage. Overcoming these challenges necessitated targeted public health campaigns, distribution facility investments, and healthcare system upgrades.

Impact on the Stringency Index.

Rising vaccination rates in both emerging and advanced economies resulted in a progressive relaxation of restrictions. Governments modified public health policy in response to the epidemiological situation, indicating the effectiveness of vaccination campaigns in mitigating the threat of COVID-19.

In advanced economies, the adjustment was more methodical and coincided with increased vaccine coverage. Although the lifting of limitations followed a similar pattern in emerging nations, it was frequently delayed due to slower vaccination rollouts and other logistical issues. Nonetheless, as vaccination campaigns continued, stringency index ratings fell, indicating a strategy shift toward balancing public health concerns and economic recovery.

In conclusion, vaccines have had a considerable and multifaceted impact on GDP, the stringency index, and excess fatalities in both emerging and developed nations. While rich economies saw more immediate benefits in terms of fewer deaths and economic recovery as a result of earlier and wider vaccination distribution, emerging economies saw a slower but equally significant improvement. Effective vaccination efforts have been critical in mitigating the pandemic, regenerating economies, and altering public health policies. The experience emphasizes the need for fair vaccine access and strong international cooperation to maintain a resilient global response to health crises.

ADVANCED ECONOMIES

This chapter will look at the impact of COVID-19 government initiatives, measured by the Oxford Stringency Index, on excess deaths and national GDP in advanced economies. When considering the relationship between those factors, we know it is important to note the difficulty in isolating the effects without them being affected by other items. It has been found that international spillovers play a significant role, with a country's exposure to the global economy influencing its vulnerability to the pandemic's economic effects. As a result, we consider economies with similar starting conditions: a high per capita income, a diverse export base, and a financial sector that is integrated into the global financial system. By doing so, we reduce the likelihood of bias and reverse casualty.

FIRST PHASE OF THE PANDEMIC

During the first phase of the pandemic (March 2020- June 2021) the number of deaths was highly correlated with the openness of the economies. In order to keep the situation under control, governments introduced strict stringent policies in most advanced economies, suffering great losses from a GDP standpoint. This is particularly true for the first months of 2020, the mentioned causal effect relationship becomes less definite towards the second and third semester of the pandemic.

3.1 THE DILEMMA REGARDING GDP AND EXCESS DEATHS

To correctly examine the relationship between excess fatalities and GDP during the time under consideration, we must first identify the various elements that may have influenced their correlation. According to a study by Jesús Fernández-Villaverde and Charles I. Jones published in October 2020, there are two main relationships regarding excess deaths: a negative correlation between COVID deaths and the openness of the economy, and a positive correlation between high deaths and unsuccessful policy or 'bad luck', where luck refers to the timing and preparation of the government at the moment in which the country came in contact with the virus. These relationships are summarized in Figure 1. The dilemma with which these countries were brought upon during the first phase of the pandemic was either abruptly shutting down the economy to save lives while suffering major economic losses, or keeping the economy active to limit GDP loss at the risk of more pandemic-related deaths.
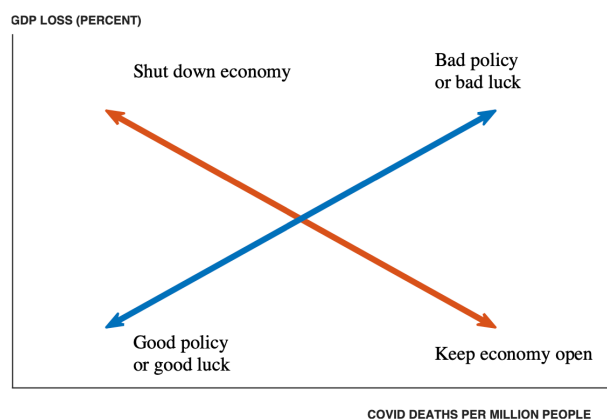

FIGURE 1: Economic Activity, Covid Deaths, Health Policy, and Luck

The 'luck' and time problem highlights the importance of incorporating control variables into cross-country comparative research. This is frequently accomplished by employing the timing component as an explicit variable, whereas luck complicates the situation because elements of interest are more difficult to identify. However, some attempts have been made to incorporate control variables associating luck with social support and successful population responses to programs., by doing so we are able to try and address in a clearer way the effects of bad policies from the ones of bad luck. However it must be said that completely isolating the effects of these factors is highly challenging and rarely brings to definite results.

As we can see in the image below, during the first year of the pandemic countries' performance can be divided into 2 main subgroups:

   -Those like Taiwan, Korea, and Germany demonstrate the possibility of obtaining positive outcomes on both fronts, with minimal mortality and small GDP losses. Despite initial hurdles, Greece has fared rather well thanks to proactive actions and geographical circumstances.

   -Other countries have had high fatality rates and huge GDP losses due to a combination of bad luck and ineffective governmental responses. This is the case for France, Italy, and the United Kingdom.

   Sweden represents the intermediate position, with relatively modest GDP loss and high mortality. Sweden's approach, which aimed for herd immunity with fewer restrictions, resulted in a smaller GDP loss than countries with stronger controls. This is because several factors, ranging from early virus exposure to social differences, which influence outcomes.It has also been discovered that delayed responses in one country have an impact on others, and that worldwide economic implications influence even successful virus management.
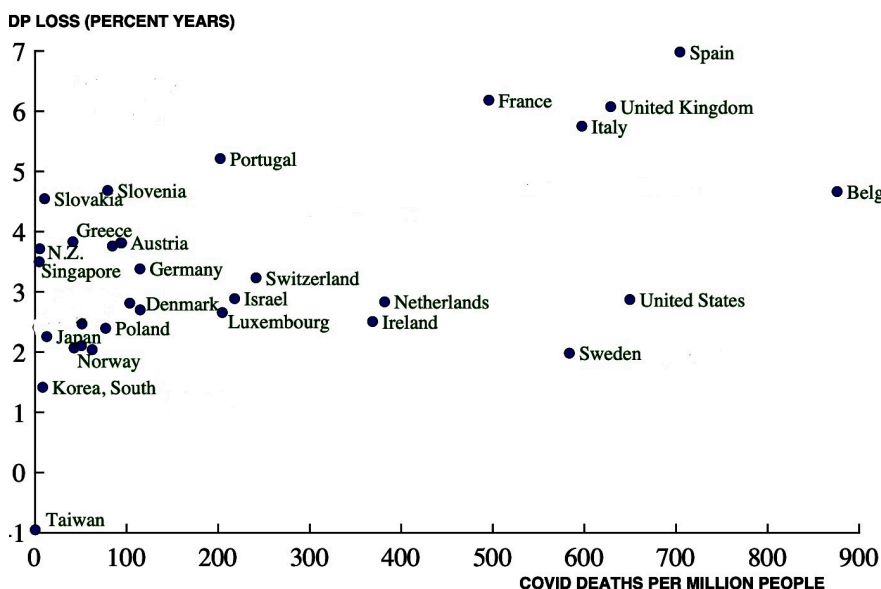

   FIGURE 2: International Covid Deaths and Lost GDP (GDP Loss" is the *cumulative* loss in GDP in 2020)

3.2 GDP FORECASTS

Even if with different severity, the results available by the end of 2020 were not encouraging. Pradyot Ranjan Jena et al.'s December 2020 prediction shows severe GDP decreases for all countries for the quarter April-June 2020, with annualized GDP growth predicted to be negative in double digits. The strictness of preventative measures during the first phase of the pandemic, including local and national lockdowns produced enormous disruptions to global supply networks and economic activities, increasing pre-existing economic issues such as the trade dispute between the US and China and falling consumer spending. To provide a more detailed analysis, we look at the instances in which the pandemic had a great impact on countries' GDP in the first quarter of 2020. The United States' GDP growth fell by 1.3%, while European countries, notably those largely reliant on tourism and services, such as France, Spain, Italy, and Germany, saw even sharper contractions ranging from 2.2% to 5.34%. Japan experienced a 0.5% fall, owing to lower exports and the trade dispute between the US and China. Forecasts for the second quarter of 2020 projected a further sharp drop in GDP growth across major economies, with the United States expecting double-digit negative growth rates. The eurozone recovery was predicted to be gradual, and Japan's GDP downturn was expected to continue due to global trade issues.

3.3 THE IMPACT OF STRINGENCY POLICIES

The research on the association between the stringency index, excess deaths, and GDP before the introduction of mass vaccination is considerable. Michael König and Adalbert Winkler's 2020 analysis shows that nations with efficient government responses face fewer significant changes to growth estimates. However, also in this case, it should be recognized that in several cases, the pandemic's global influence overshadowed individual government actions.

The fundamental role of timing to control excess deaths and the influence of neighboring countries

The timeliness of establishing strict stringency policies has emerged as a critical aspect in determining the success of operations for lowering death rates. Kaçak and Yıldız made the initial observation in 2020, which was later supported by Koç and Saraç. Taşdoğan's 2020 study found that implementing measures within the first two and a half months of the pandemic led to the greatest success. At the beginning, the responses to the disease in the United States, United Kingdom, and Spain have been limited, whereas Turkey, Italy, and, especially, France have taken considerable measures. However, once the number of cases hits 10,000, all countries take more severe action. According to the study, countries' initial reactions may be due to economic or political weakness. When the number of cases became out of hand, the UK lobbied for herd immunity, which was eventually repealed due to public opposition. Similarly, the United States did not take the pandemic seriously enough, despite the fact that social (physical) distance was the only appropriate measure. These underestimation of the gravity of the virus caused severe consequences for negligent countries that have faced higher excess deaths attributed to COVID-19 for a prolonged period of time as a result of their actions.

UK	January 31	February 2	After 2 days
Spain	February 1	January 31	Before 1 day

USA	January 21	February 2	After 12 days
S.Korea	January 20	January 31	After 11 days
France	January 25	January 23	Before 2 days
Germany	January 28	January 24	Before 4 days
Japan	January 15	January 7	Before 8 days
Italy	January 31	January 23	Before 8 days

FIGURE 3: the timing of governments responses

Çelik (2021) conducted a different analysis analyzing data from 27 European Union countries from January 2020 to March 2021. The study highlights favorable geographical interactions among EU members while highlighting the negative effects of COVID-19 stringency measures on economic growth. Furthermore, policies implemented by adjacent countries were found to have a stronger detrimental impact on economic growth.

Differences between the first and second quarter of 2020

Michael König and Adalbert Winkler examine whether differences in GDP development across countries during the first and second quarters of 2020 were primarily driven by the intensity of government-imposed restrictions. As mentioned above some countries, such as the United Kingdom and the United States, were hesitant to enforce rigorous lockdowns, whilst others, such as Italy and Spain, acted fast in response to high fatality rates. The rationale for these policy decisions included worries about the social and economic costs of lockdowns versus the potential health hazards of not implementing strict safeguards.According to the data, lockdowns have a two-fold economic impact: they directly reduce economic activity and they mitigate health hazards, indirectly supporting economic activity.

Correlation study shows that the stringency index and mortality rate are positively connected in the first quarter but not in the second. The intensity of government-imposed measures has a high negative link with GDP growth in the second quarter of 2020, but not the first quarter. Meanwhile, mortality rates have a negative link with GDP growth in both quarters, though with a little lower significance than the correlation between stringency and growth in the second quarter.

It has also been found that travel prohibitions enforced by foreign governments and voluntary trip cancellations by non-residents have had a huge impact on the local tourist industry. To assess countries' vulnerability to social distancing measures implemented overseas, we have to look at factors such as the proportion of tourism receipts in total exports and trade openness. Research reveals that these factors have a significant combined effect, with estimates showing that they could account for up to 70% of the entire reduction in economic activity caused by COVID-19 in countries such as Switzerland. Findings show that the stringency index and fatality rate have independent influences on cross-country GDP growth in both quarters, with tighter government actions and higher fatality rates linked with lower economic activity.

However, when all variables and all controls are considered together, the mortality rate loses significance in the first quarter, although the stringency index remains significant in both. Furthermore, tourism exposure and trade openness explain for large disparities in second-quarter GDP growth, showing the influence of international social distancing policies.

In conclusion, increases in required government-imposed distancing measures, rather than voluntary social distancing due to health hazards, propelled GDP growth in the first half of 2020. However, high death rates lead to voluntary social separation, showing a twofold economic consequence.

The factors that influenced the stringency index

In 2022 , Hatice Gökçen Öcal Özkay conducted the stringency index analysis. The analysis covers data from March 11, 2020, to June 29, 2021. Consistently with previous research, it highlights characteristics such as daily death rates, population density, the proportion of persons aged 65 and up, and GDP per capita as major influences on countries' policy responses.The findings show that greater daily death rates correspond to higher stringency index scores at all quantile levels during the pandemic, albeit to varied degrees. Similarly, population density influences the stringency index, with denser populations having a greater impact in countries with less regulations. Higher GDP per capita is connected with lesser stringency measures. In contrast, as the proportion of people aged 65 and older rises, so do stringency measures, particularly in countries with moderate to severe limitations.

THE INTRODUCTION OF VACCINES

In July 2021, the mass vaccination campaign started showing its effects. This, marked the turning point in the COVID-19 pandemic as it was the first step toward settling the issue. As a result of the uneven distribution of vaccines and varying government actions, the relationships between our variables of interest became less definite.In general, the introduction of vaccines shows a consistent decrease in deaths across countries. Most countries experienced a marked reduction in deaths compared to the onset of the pandemic in early 2020. Summer months displayed a similar trend in deaths over the two years, indicating a seasonal influence on the virus. Although the lower death toll in the first quarter of 2021 might partially be due to fewer susceptible individuals, the impact of vaccines became evident after the summer, leading to a significant reduction in fatalities across all countries.

3.4 VACCINES POLICY AND GDP

In 2022 Antonini et al conducted a study on the economic effects of vaccinations considering five countries: Italy, Spain, Israel and France. Amongst their findings we note that France and Italy implemented stricter measures to encourage vaccination amid rising infections, contrasting with Israel's initial rapid rollout followed by renewed restrictions due to a surge in cases. Spain's lower stringency reflects higher vaccination acceptance. Economic impacts varied, with Spain experiencing the largest GDP drop, while Israel faced minimal losses depicts unemployment rates, showing Israel maintaining pre-pandemic levels, whereas Spain experienced a significant increase, albeit returning to baseline after vaccine introduction.

France and Italy showed stability, with Italy's unemployment rate initially decreasing due to labor force reduction during the pandemic's onset. Exploring vaccination willingness in relation to COVID-19 impact, reveals differing trends among countries, this is also the cause for differing results. While France shows a negative relationship between fatalities and vaccination rates, suggesting lower vaccination in more affected regions, Israel, Italy, and Spain display positive correlations. However, statistical significance varies.

From this we can conclude that while, a higher level of vaccinations is associated with a lower level of stringency index, the results on the actual decrease in deaths are not always immediate, but vaccination success would become clear in the long-run.

From the begining of 2022 the success of mass vaccinations started to take form. Campaigns for vaccinations were essential in helping economies recover after the pandemic's devastating effects. Governments progressively loosened regulations on companies and public events as immunization rates rose, which stimulated the economy. GDP growth rates have gradually recovered in advanced economies with strong healthcare systems and availability to vaccines. Businesses and consumers gained faith in the possibility of obtaining herd immunity through vaccination, which resulted in more spending and investment.

As vaccination campaigns advanced, so did the stringency index, governments, started to modify their strategy as vaccination coverage increased, progressively loosening restrictions mostly in line with vaccination rates. This shift demonstrated a strategic harmony between public health issues and goals for economic recovery.

The number of excess deaths decreased as vaccination coverage rose, especially among vulnerable populations, demonstrating the efficacy of vaccinations in reducing COVID-19-related fatalities. This reduction eased the burden on healthcare systems and made a positive impact on public health in general.

3.5 DATA COMPARISON

In this section we will take a closer look at the relationship we are examining with some practical examples, having a visual representation of the GDP per capita, excess deaths and stringency index taken from the archive of 'Our World in Data' and of the ECB along with the archive of national banks . The stringency index takes values between 0 and 100, the color red is associated with restrictions applied to non-vaccinated individuals, green to vaccinated individuals and finally blue is the median of the two indexes. Excess deaths are measured as the percentage change in deaths with respect to the same period of the previous year. Finally quarterly GDP is measured in local currency.

The data refers to Italy and the UK in the period from March 2020 to December 2022
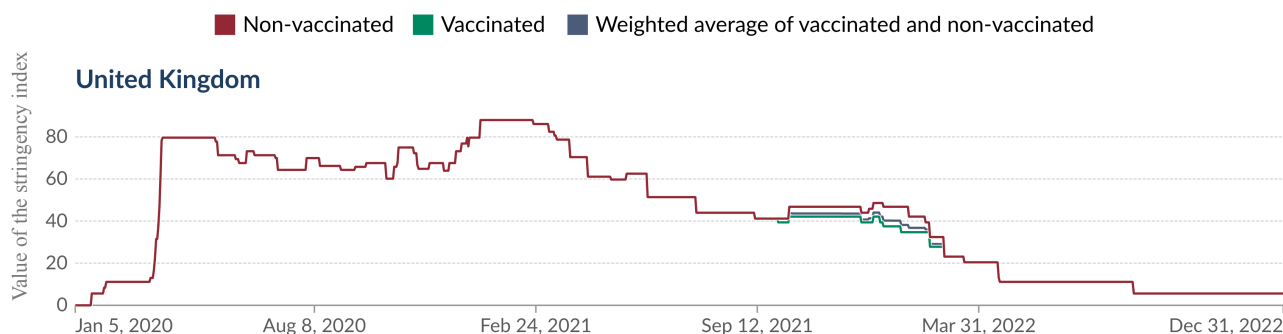
THE CASE OF ITALY
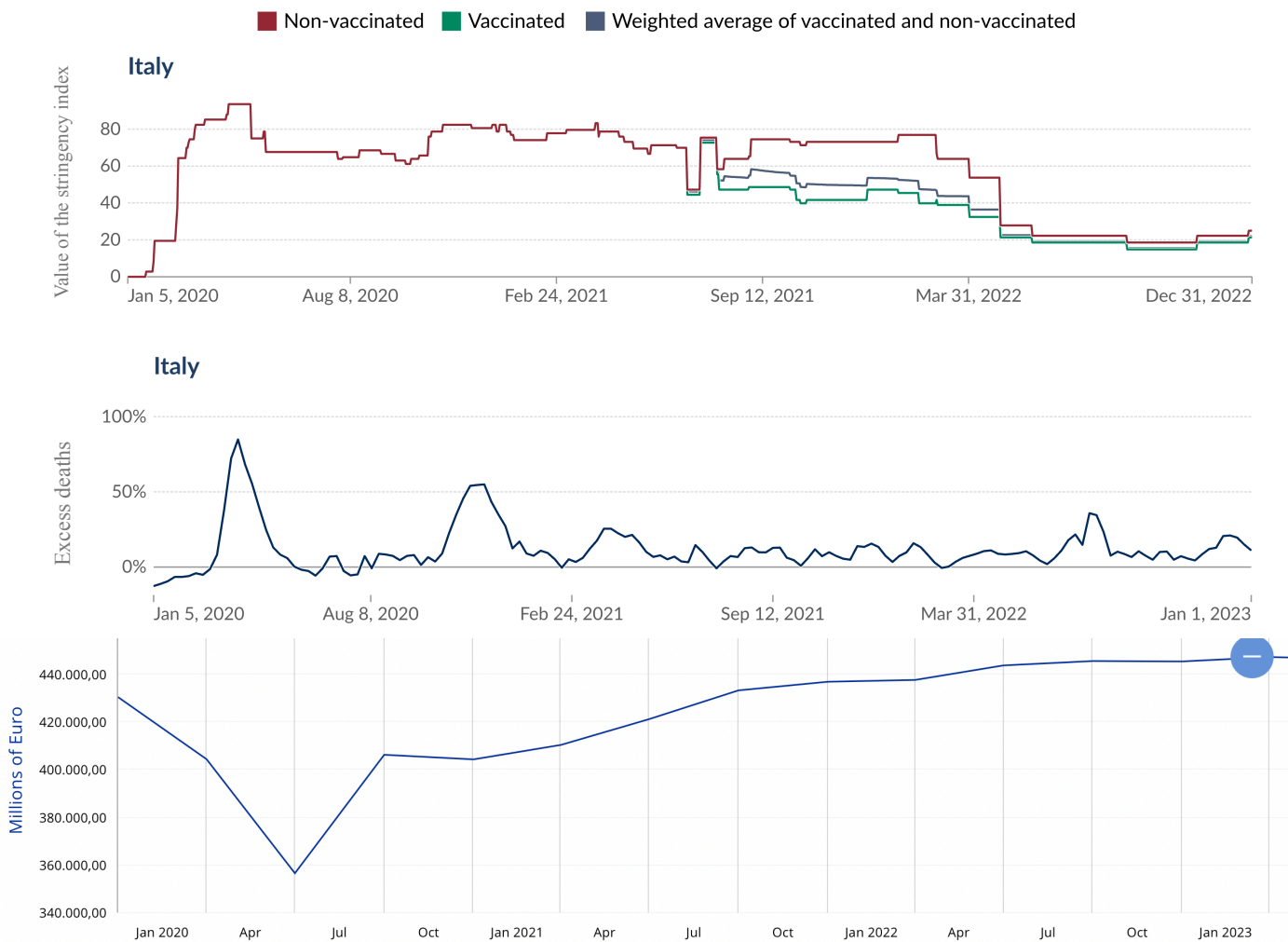
The three graphs above illustrate the Stringency Index, excess fatalities, and GDP in Italy over the study period.
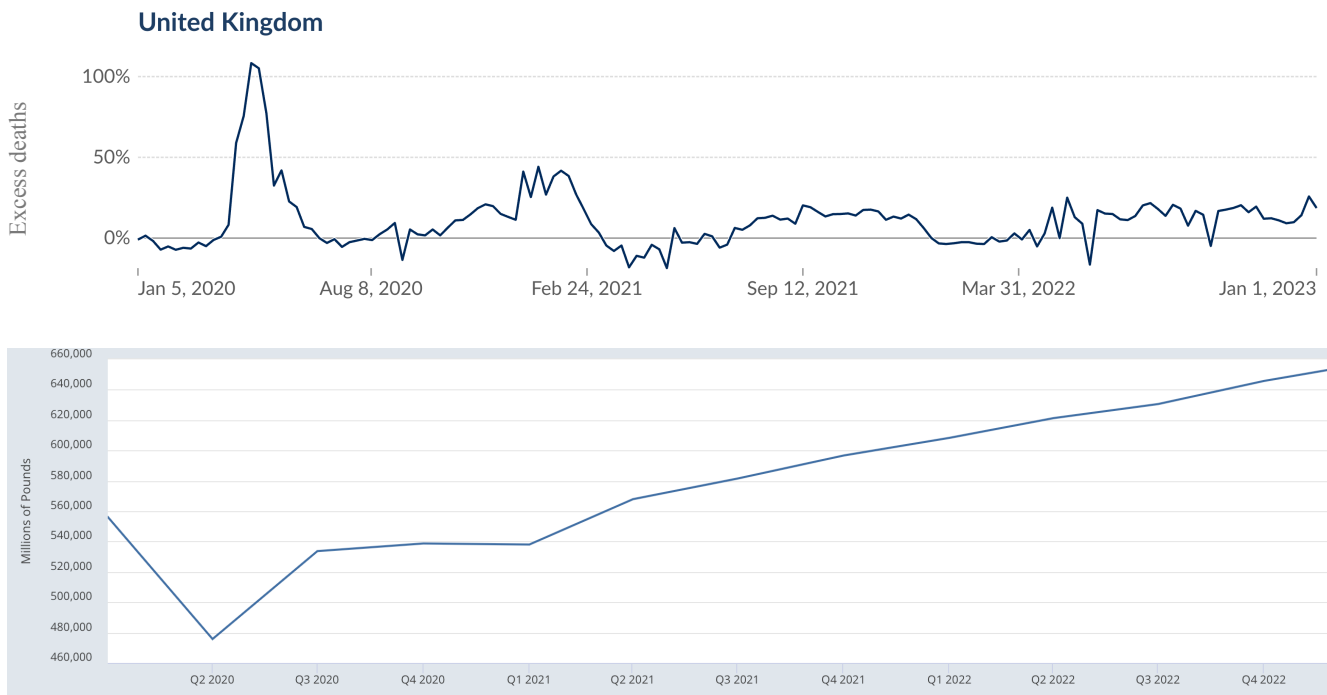
Italy implemented strict restrictions during the start of the pandemic, with the stringency index reaching its peak in April. It is close to 100, indicating the most severe level of lockdown. After a relaxation of stringency policies in the summer of 2020, the government was forced to re-strengthen policies to a level of 80, which will be reduced again with the implementation of mass vaccinations. Immediately following the introduction of mass vaccination, an imprudent reduction in stringency forced the government to raise it again, but from September on, stringency steadily began to diminish for individuals who had been vaccinated. Unvaccinated individuals must wait until February 2022 to be subject to more flexible restrictions.

When it comes to excess deaths, we can see how peak values are followed by peak stringency (the peak in deaths in March causes the peak in stringency in April), implying that, while stringency and excess deaths do have a positive correlation, it is the number of excess deaths that initially defines the stringency of government actions. The drop in excess fatalities towards summer of 2020 relaxes the stringency index, and their new growth is related to the previously described increase in stringency. Once vaccines were provided, mortality appeared to have been kept under control, with little variability and a detachment from stringency beginning in April 2022.

Finally, GDP appears to have a negative correlation with both stringency and deaths, which is consistent with our previous research. The value declined significantly during the first months of the pandemic, reaching its lowest point in June 2020, owing to the accumulation of the effects of the other two variables during the preceding months. GDP went on to recover quickly after that, thanks to the reduction in stringency in summer 2020, returning to its pre-pandemic level. After a brief dip due to post-summer restrictions, it decouples from other variables, rises again thanks to the role of vaccines, and gradually settles its value.

THE CASE OF THE UK

United Kingdom

Excess deaths

100%	
50%	
0%	

Jan 5, 2020   Aug 8, 2020   Feb 24, 2021   Sep 12, 2021   Mar 31, 2022   Jan 1, 2023

Millions of Pounds

660,000
640,000
620,000
600,000
580,000
560,000
540,000
520,000
500,000
480,000
460,000

Q2 2020   Q3 2020   Q4 2020   Q1 2021   Q2 2021   Q3 2021   Q4 2021   Q1 2022   Q2 2022   Q3 2022   Q4 2022

In the United Kingdom, we see a low stringency index at first, followed by a large surge at the end of March, which settles the value on 80 for the next months. Beginning in early summer 2020, the stringency index oscillates between 60 and 80 before gradually increasing to a number close to 100 until March of the following year. From March 2021, the stringency index begins a slow fall with few swings. Data on vaccines begins in August 2021, although policies surrounding vaccinated and unvaccinated people are very similar. By the end of March 2022, the index will be close to zero.

Excess fatalities rise between March and April, which explains why the stringency index spikes as a result around the same time. They have dramatically decreased since August 2020 thanks to stringent measures whose effect will remain until December 2020. The second peak, which is smaller than the first, occurs between December 2020 and February 2021; in this scenario, the stringency level achieves its highest level in the history of the UK pandemic, this is to avoid further large oscillation of stringency in the future, the country was looking for a once and for all resolution. From March to July, the measures keep deaths low, causing the stringency index to progressively fall. At this point, the index oscillates between low values until December 2021; however, due to the spread of vaccinations, this little increase has minimal effect on the stringency index; in reality, the stringency index of vaccinated people has changed little throughout this time and has differed only minimally from the one of non-vaccinated people. In 2022, deaths remain close to zero, with a minor increase beginning in March, but at this stage in the pandemic, the stringency index continues to drop.

Finally, GDP has declined from the beginning of January, hitting its lowest point at the end of June. This is due to the effects of the economy's closure in previous months. Following that, it rapidly expands again due to the reduction in stringency measures, reaching pre-pandemic levels where it settles more or less until the end of March 2021. This stagnation is attributed to increased stringency. From this point forward, GDP growth accelerates and continues until the end of 2022.

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ITALY VS. UK

Comparing the results of the economies under consideration allows us to have a better understanding of the factors that influence their performance. Italy had a considerably more cautious approach at the start of the pandemic, as evidenced by the high level of stringency index applied soon after the beginning of the pandemic, whereas the United Kingdom, which initially aimed for herd immunity, maintained low levels of stringency. As a result, both countries' initial high death rates triggered two distinct responses. In Italy, mortality increased until April before declining, whereas in the United Kingdom, the peak of deaths occurs approximately a month or two later and with higher magnitude. When the UK abandoned its objective for herd immunity, the degree of stringency measures remained below that of Italy, resulting in a larger peak in mortality. In the summer of 2020, the two countries faced a similar scenario, but in autumn, although Italy reapplied stringency measures immediately, the UK waited a few months, forcing the government to achieve levels of stringency that were higher than the first phase (100). The third distinction between the two countries is that in Italy, policies for vaccinated and unvaccinated people were very diverse, but in the UK, they were not. However, thanks to their successful monitoring approach, the UK was able to keep deaths under control, though with less success than Italy. The GDPs of the two countries likewise behave similarly. They both decline in the first semester of 2020, though the decline in Italy accelerates beginning in March. Summer was favorable to both economies as tourism and business activities resumed, bolstering the economy. While Italy experienced a slight decline from October to December, the UK saw the beginning of an increase in the GDP curve. This was due to the countries' varying levels of stringency applied during this period, as well as the countries' diverse participation in vaccine production, which was a key player in raising GDP for the UK. From the first semester of 2021 onwards, both economies' GDP increased above pre-pandemic levels, with the UK reaching greater levels.

EMERGING ECONOMIES

This chapter looks at how COVID-19 government policies, as measured by the Oxford Stringency Index, affect excess mortality and national GDP in emerging nations. As previously stated, international spillovers are significant in evaluating these interactions. Reverse casualty effects were easily isolated in modern economies due to similar initial conditions. However, emerging economies possess certain traits that make analysis difficult. As a result, making broad conclusions for this category will be more difficult, so we will examine each example separately. To minimize bias, we only include countries with long-term market access, middle-income development, and expanding global economic prominence.

FIRST PHASE OF THE PANDEMIC

During the first phase of the pandemic (January 2020-June 2021), emerging economies showed a significant link between stringency index and GDP decline, which was exacerbated by their economic structure. The link between excess fatalities and stringency, on the other hand, is negative but less than the first, meaning that, while governments implemented generally highly severe measures, they maintained them almost regardless of excess deaths. This is owing to demographic trends and resource availability, which have made dynamic policies difficult to execute without significant risks.

4.1 DID EMERGING ECONOMIES HAVE A HARDER TIME THAN OTHER COUNTRIES?

Emerging markets suffered disproportionately quantitatively as a result of their high concentration of employment in socially engaged occupations and limited public assistance programs. This condition forced economically disadvantaged households to continue working rather than remaining at home.

According to a Titan Alon research published in 2022, emerging markets suffered disproportionately from poor public health and economic outcomes. Between 2019 and 2020, GDP per capita in these markets decreased by an average of 6.7%, compared to 2.4% in advanced economies and 3.6% in low-income countries. Excess mortality had a similar pattern. The Economist projected that developing countries had a 75% greater excess mortality rate than developed economies.

Although many countries enacted similar "lockdown-style" measures and expanded social insurance programs, the scope of these projects differed greatly. According to the Oxford Coronavirus Government Response Tracker, lockdown measures targeting particular activities (such as school and workplace closures) were generally tougher in emerging nations. Wealthier countries, on the other hand, typically provided more substantial social insurance plans. Recognizing these policy changes is vital since they can directly effect both mortality rates and economic growth during the pandemic.
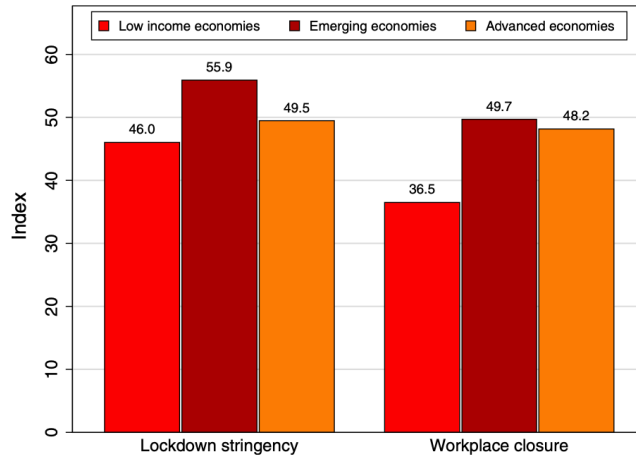
FIGURE 1: comparison between stringency and workplace closure
on average in different countries categories

4.2 GDP AND EXCESS DEATHS: DILEMMA IN EMERGING MARKETS

Policymakers in emerging economies struggled to strike a balance between economic progress and COVID-19-related mortality. Economists have developed frameworks for assessing trade-offs, revealing that both uncontrolled breakouts and long-term lockdowns have significant costs. Targeted social distancing strategies, such as isolating infected persons or concentrating on at-risk groups, could help contain the pandemic while lowering economic costs. Adopting such solutions proved difficult, particularly in situations with limited resources or multigenerational cohabitation. According to a 2020 study by Constantino Hevia and Andy Neumeyer, whereas developed economies can use redistributive policies to alleviate the effects, emerging economies have less options, resulting in a worse health-economic trade-off. To limit damage, emerging economies required focused health and economic policy solutions that addressed their specific challenges. We can thus add new elements to our previously described dilemma: government resource availability, multi-ethnic and multigenerational cohabitation, and the need for job relationships. Overall, the trade-off between GDP and excess fatalities is significantly greater than in the previous scenario.

Economic decline in the second quarter of 2020 vs. total confirmed COVID-19 deaths (as of August 2020)

The vertical axis shows the number of COVID-19 deaths per million, as of August 30, 2020. The horizontal axis shows the percentage decline of GDP relative to the same quarter in 2019. It is adjusted for inflation.
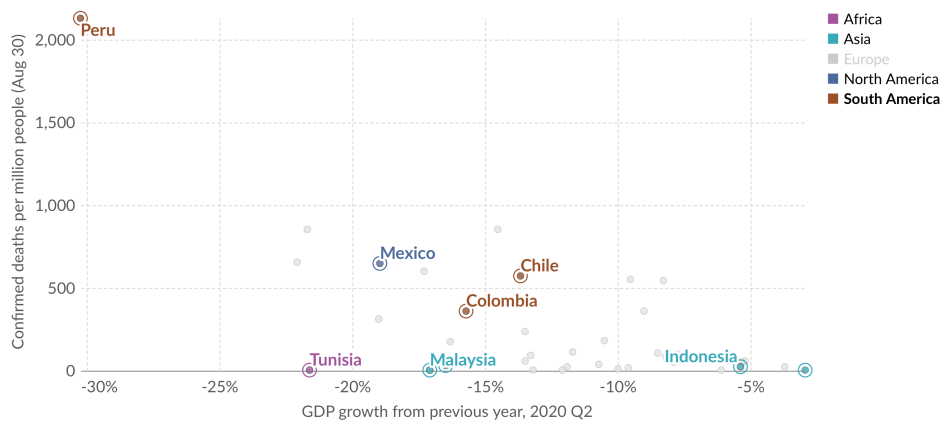
Data source: WHO COVID-19 Dashboard; Eurostat, OECD and individual national statistics agencies
Note: Due to varying protocols and challenges in the attribution of the cause of death, the number of confirmed deaths may not accurately represent the true number of deaths caused by COVID-19. Data for China is not shown given the earlier timing of its economic downturn. The country saw positive growth of 3.2% in Q2 preceded by a fall of 6.8% in Q1.
OurWorldInData.org/coronavirus | CC BY

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Looking at the data available after the first semester of the pandemic, we can see that, as expected, COVID-related mortality was lower in total than in advanced economies, but GDP loss was much higher in all nations.

The graph above represents two extreme cases: Peru, which has very high mortality and significant GDP losses, and Indonesia, which has low deaths and moderate GDP losses.

Peru moved quickly in response to the imminent COVID-19 threat. To limit the spread of the virus and avoid overcrowded healthcare systems, the country promptly imposed severe restrictions such as border closures, curfews, and lockdowns. Despite the rapid response, Peru's healthcare system was severely tested. Hospitals, particularly in urban areas such as Lima, struggled to keep up with the COVID-19 outbreak.The lockdown measures had a significant economic impact, notably on Peru's substantial informal sector. Travel restrictions and business closures caused many informal laborers to lose their jobs. In parallel, there were several instances of people violating tight policies in order to keep their positions or due to disinformation. The economy's closure resulted in lower GDP, yet strict restrictions did not minimize excess mortality.

The remaining limit scenario for Indonesia can be justified as follows. Indonesia was chastised for its first response to the pandemic, which was regarded to be inadequate and ambiguous. The administration underestimated the virus's fatality rate and initially opposed stringent lockdowns, citing concerns about the economic impact. Despite early hesitation to adopt drastic measures, Indonesia eventually implemented social distance rules, mask regulations, and restrictions on big gatherings to help control the virus's spread. However, enforcement differed by region, and compliance was occasionally problematic. The outbreak had a significant impact on Indonesia's economy, namely in tourism, hospitality, and retail. Lockdowns and mobility restrictions caused company disruptions and job losses.However, the government implemented economic stimulus packages to stimulate enterprises and provide financial help to affected individuals and families. Indonesia gradually adjusted its response to changing conditions. For these reasons, GDP did not suffer the general decline that other countries have seen as a result of less stringent and more flexible stringency regulations, and excess deaths were kept under control thanks to separate policies and demographic considerations such as life expectancy. COVID-19 Mortality rates rise with age, making countries with longer life expectancies more susceptible to the pandemic. Countries with lower life expectancy typically have lower death rates and fewer stringent government controls.

4.3 STRINGENCY AND GDP IN ASIA AND LATIN AMERICA

As previously noted, establishing broad generalizations about rising economies is more difficult than in the previous case. As a result, we conduct a case-by-case analysis to investigate the impact of stringency laws, starting with emerging economies in Asia and moving to Latin America. The link between stringency and GDP is negative in both cases but for different reasons.

Weakened factors of GDP in Asia.
During the first semester of the 2020s, the response to the pandemic varied widely across Asia's subregions. South Asia, with an average stringency of 88, saw relatively harsh containment

measures and severe mobility restrictions, primarily due to India's strict lockdown measures. East Asia, on the other hand, had fewer stringency measures (57 on average) and a slight mobility loss of -8%. Rather than imposing strict lockdowns, economies in this subregion relied on intensive testing and contact tracking. However, there were considerable variances within each subregion.
Data indicate a significant correlation between the harshness of containment measures, mobility limits, and decreased GDP growth in emerging economies. Significant relationships between stringency, mobility, and economic indicators have been established. A 10-percentage-point rise in stringency resulted in incremental negative adjustments of around 0.6-0.7 percentage points in consumption growth and 1.2-1.3 percent in investment growth. Similarly, a 10-point decline in mobility was related to further downward adjustments of around 0.5 percentage points in consumption growth and 1.1 percentage points in investment growth. Furthermore, the pandemic's impact extended beyond domestic demand disruptions, particularly in tourist-dependent countries. The fall in global travel resulted in significant decreases in tourist arrivals, with some countries experiencing up to a 100% loss.

The consequences of a precarious labor market in Latin America
Globally, labor markets have become a source of concern for policymakers, with Latin America being especially vulnerable for two reasons. The labor market in the region is insecure, as it is in many rising countries worldwide. Approximately 60% of the labor force is classified as insecure, which includes independent workers without security and benefits, informal laborers, and persons who hold both statuses concurrently. This contrasts starkly with non-Latin American OECD economies, where just roughly 15% of the labor force faces similar precarious situations.Second, labor markets in Latin America have experienced substantially more severe lockouts than the global norm. These restrictions have been especially harsh in areas where employment is already uncertain. Lockdown measures, both legally and practically, have a favorable correlation with unstable labor arrangements. This association emphasizes the catastrophic ramifications of tight lockdowns that interact with vulnerable labor markets, exacerbating the negative effects on employment.The combination of weak job markets and strict lockdowns hinders legislative solutions. A significant portion of the region's economic stimulus packages frequently include job subsidies and other forms of employment-related aid for formally employed individuals. However, because these assistance programs were confined to registered employment, a considerable segment of the workforce was left unprotected, relying solely on welfare payments (if any aid was provided at all). This gap compounded the problems encountered by precarious workers and highlighted the inadequacy of existing social safety nets in reaching them. Governments often lacked the necessary tools to preserve unstable labor links and stabilize income for these individuals. As a result, labor policies are unable to adequately address these challenges, resulting in a reliance on basic income programs that risk diminishing human capital and increasing inequality.These challenges are worsened by rising poverty rates, with preliminary CEPAL estimates indicating a nearly 3% increase across the region. Certain countries, such as Argentina, Brazil, Ecuador, and Nicaragua, have seen even greater increases in poverty rates, exacerbating the region's socioeconomic challenges.

In general, informal employment shares are substantially connected with changes in GDP during the pandemic, but lockdown stringency has a strong negative correlation. The median age and indexes of government economic support indicate smaller but significant connections. Negative outcomes in emerging markets were primarily caused by pre-existing economic and demographic factors, rather than specific policy decisions. This is especially important when considering the global economic losses caused by the pandemic. Fixed characteristics, such as age distribution and employment

sector composition, can significantly impact output declines in emerging markets. Following rich economies' lockout and transfer policies would result in 1.4 times greater GDP decreases in emerging markets, making this the only viable approach.

4.4 STRINGENCY AND EXCESS DEATHS

We know that emerging economies have significantly higher death rates because they lack the favorable demographics of low-income nations and have a high share of social sector occupations, making sickness control difficult while working. Differences in lockdown intensity have a minor impact on excess mortality, indicating that the most important cross-country policy difference during the pandemic was the size of public insurance systems and other demographic factors. Based on our findings, there is no substantial association between stringency and excess mortality in emerging countries. The causal relationship is maintained, but the impacts are far less significant than in advanced economies. This is because, on the one hand, multiple violations of rigorous limitations undermined their effectiveness in averting unnecessary fatalities. Governments in these economies prioritized high stringency levels over fluctuating with excess death trends to avoid early closure.

4.5 THE SITUATION OF LOW-INCOME COUNTRIES

COVID-19's economic risk is distinct from its health risk, and in some cases, the two may be orthogonal. Despite low case counts and fatalities, the pandemic had a huge economic impact. Despite reporting less than 20 cases and no deaths, Seychelles and Fiji were largely reliant on tourism and had limited fiscal means to confront the consequent slump. Other countries with manageable caseloads faced comparable challenges in assisting faltering enterprises, expanding safety nets for disadvantaged populations, and preventing prolonged recessions. In a 2020 study, Nguyen Doan et al. used a disaster risk modeling framework developed by the United Nations Disaster Risk Reduction Office. Economic risk is measured using this paradigm's hazard, exposure, vulnerability, and resilience metrics. In underdeveloped nations where the pandemic has not spread as quickly as in wealthier, temperate regions, the economic risk appears to be independent of the infection risk (COVID-19). Exposure, vulnerability, and resilience have a greater impact on economic risk in these nations than the virus. Exposure refers to the pathogen's impact on populations and economic activities, as well as any behavioral changes that may ensue. Vulnerability describes how the virus affects the economy, with greater vulnerability yielding more negative outcomes. Resilience measures an economy's ability to recover from shocks, with more resilient economies seeing lower post-shock income losses. The virus spreads slower in poorer countries due to reduced life expectancy and population density.The poorest places, such as Sub-Saharan Africa and parts of South and Southwest Asia, where the disease is only moderately prevalent, are thought to pose the greatest economic risk. An epidemic's economic impact includes both direct losses (loss of income and output, increased healthcare costs) and indirect losses, which are likely to be more considerable, especially in countries not directly affected by the virus but affected by the global economic shock.

Improvements in public health systems during the last century may have reduced the epidemic's health effects, but the economic consequences remain immense. Globalization, increased tourism and labor flows, and social media have heightened behavioral responses and vulnerabilities,

exacerbating economic losses. Economic informality and social capital in underdeveloped countries both contribute to the epidemic. Informality impedes government initiatives (Bosio and Djankov 2020), whereas social capital can reduce health and economic costs through mutual assistance (Aldrich 2012).

COVID-19 poses the greatest economic risk not in China, where the virus originated, but in the US and Western Europe, where the majority of cases have been found. Instead, they are in locations with little worldwide attention, notably in developing countries, where the economic implications have generally gone unnoticed.

A closer look to sub-Saharan Africa

Calvin Z. Djiofack's analysis from the end of 2020 can help us understand the impact of COVID on the poorest regions. Despite its late debut, COVID-19 has rapidly spread over Sub-Saharan Africa. As of May 20, 2020, there were 191,000 confirmed cases and 2,834 deaths. Because of the restricted testing capability, the actual number of illnesses is likely to be much higher. South Africa saw the region's largest outbreak, with 17,200 confirmed cases. In response, the country declared a national emergency and implemented a number of measures to limit the virus's spread, such as a travel ban for foreign citizens from high-risk countries, a prohibition on public gatherings of more than 100 people, and school closures. West Africa (Burkina Faso, Côte d'Ivoire, Senegal, Ghana, and Nigeria), Central Africa (Cameroon, Gabon, Congo, DRC, and Chad), and East Africa (Tanzania, Uganda, Rwanda, and Kenya) have all experienced significant epidemics. These governments have also imposed a number of strict measures, such as travel bans, restrictions on public gatherings, and school closures. The economic impact of COVID-19 in Africa was expected to be severe. The drop in worldwide demand, along with the necessary domestic steps to handle the virus, had a severe economic impact. Failure to rapidly contain the virus will exacerbate the economic repercussions of these restrictions. Income reductions disproportionately impacted the poor and vulnerable, who would also suffer from reduced agricultural output, resulting in lower rural incomes and consumption.The findings emphasized the need of policy in limiting the pandemic, mitigating short-term economic consequences, and supporting recovery. The scenarios also show how a lack of international cooperation could magnify the negative outcomes.

THE INTRODUCTION OF VACCINES

COVID-19 vaccines offer optimism for emerging economies, reducing the pandemic's impact on both public health and the economy. Vaccines have significantly and diversely impacted emerging economies since their widespread availability. The commencement of the immunization campaign varied by country, but it generally began a few months after vaccinations were distributed in industrialized economies in Autumn 2021.

4.6 THE ROLE OF VACCINES

Primarily, the availability of vaccines gave essential support to emerging economies' beleaguered public health systems, which have been hammered the hardest by the virus's ongoing attack. Vaccination campaigns were essential measures for limiting COVID-19 transmission, resulting in lower infection rates, hospital admissions, and, eventually, deaths. Emerging nations were able to gain some control over the epidemic by immunizing their citizens, reducing demand on healthcare facilities and diverting resources to other essential health concerns. Furthermore, successful vaccination implementation holds the promise of economic revival for emerging economies grappling with the pandemic's terrible financial implications. Lockdowns and travel bans have had a tremendous impact on businesses, employment, and livelihoods in specific regions. However, widespread vaccination created the stage for a gradual reopening of economies, allowing firms to resume operations, individuals to return to work safely, and supply chains to restore traction. This resurgence in consumer and investor confidence has the ability to stimulate economic activity, encourage development, and resuscitate struggling industries. The global distribution of vaccines enabled emerging economies to foster international collaboration and solidarity. Access to vaccines remains uneven, with wealthy countries receiving the majority of doses, leaving underdeveloped countries with low supplies. To reduce disparities in vaccination distribution, affluent countries collaborated to share doses, technology, and experience with less privileged peers. COVAX demonstrates how teamwork may ensure equitable and timely vaccine distribution, leveling the global playing field in the fight against COVID-19. Nonetheless, significant hurdles arose in realizing the full potential of COVID-19 vaccines in emerging countries. Vaccine hesitancy, logistical hurdles, and inadequate healthcare infrastructure were major impediments to achieving universal immunization coverage. Overcoming these challenges required targeted public health campaigns to boost vaccination acceptability, investments in cold chain facilities to enable vaccine distribution, and healthcare system enhancements to ensure effective dose delivery and administration.

Impact of vaccination on our variables of interest

Vaccines have greatly reduced excess mortality in emerging nations by reducing viral spread and preventing severe cases that require hospitalization. As vaccination rates increased, especially among disadvantaged communities and frontline workers, the number of COVID-19-related deaths fell. Reducing excess mortality greatly benefited emerging economies' healthcare systems, freeing up resources for other essential needs and improving public health outcomes.

Vaccine availability enhanced GDP growth in emerging economies by allowing for market reopening and economic activity to resume. The epidemic's rigorous containment efforts negatively

impacted businesses, jobs, and consumer confidence, resulting in economic downturns in several emerging markets. Universal immunization improved consumer and investor confidence, resulting in increased spending, investment, and productivity. As restrictions are lifted and economic activity resumes, GDP growth is likely to go up, helping recovery efforts and fostering long-term economic development.

immunization use can impact stringency index readings in emerging economies, as governments adapt public health policies to reflect shifting epidemiological trends after immunization. As vaccination efforts progressed and the COVID-19 threat decreased, stringency index scores shifted. As vaccination coverage improved, governments increasingly removed restrictions on travel, gatherings, and corporate operations, leading to lower stringency index scores over time.

To summarize, vaccines have a considerable and complicated effect on excess mortality, GDP growth, and stringency index indicators in emerging economies. Vaccines have an important role in determining the pandemic's trajectory and strengthening emerging nations' resilience to future health crises by lowering virus transmission, facilitating economic recovery, and influencing public health policy. Effective collaboration between governments, healthcare systems, and international partners is necessary to promote equitable vaccine access and optimize benefits for the most vulnerable populations.

4.7 DATA COMPARISON

In this section we will take a closer look at the relationship we are examining with some practical examples, having a visual representation of the GDP per capita, excess deaths and stringency index taken from the archive of 'Our World in Data' and of Chile's and the Philippines national banks. The data refers to Chile and the Philippines in the period from March 2020 to December 2022. The three graphs above respectively provide data regarding the stringency index excess deaths and GDP for both economies. The stringency index takes values between 0 and 100, the color red is associated with restrictions applied to non-vaccinated individuals, green to vaccinated individuals and finally blue is the median of the two indexes. Excess deaths are measured as the percentage change in deaths with respect to the same period of the previous year. Finally quarterly GDP is measured in local currency.

THE CASE OF CHILE
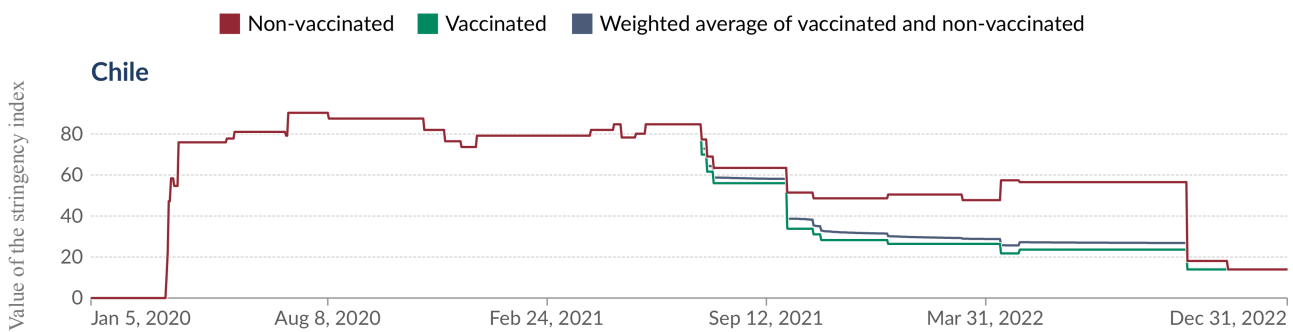
The three graphs above show data on the stringency index, excess fatalities, and GDP in Chile. The stringency index ranges from 0 to 100; the color red represents restrictions imposed on non-vaccinated individuals, green on vaccinated individuals, and blue represents the median of the two indices. Excess fatalities are calculated as the percentage change in deaths compared to the same time the previous year. Finally, quarterly GDP is measured in local currency.

According to our prior research, Chile implemented strict measures from the onset of the epidemic, maintaining a stringency score of roughly 80 from March to June 2020. Contrary to what happened in advanced countries, the summer of 2020 did not result in a relaxation of the index; rather, the index rose to 100 from June to October 2020, then declined to 80 until the summer of 2021. When the effects of immunization became apparent, the stringency index was gradually reduced to 60 until November 2021. Diversification is currently being practiced for both vaccinated and unvaccinated people. Non-vaccinated individuals were subjected to a stringency index ranging from 50 to 60 until the autumn of 2022 when they reached levels of 15. Vaccinated people, on the other hand, were granted more freedom over the same period, with a limit of 20-30 before reaching 15 in Autumn 2022.

We see that the first spike in the stringency index does not appear to coincide with any excess death peak over the same time period; in fact, the first excess death peak occurred in summer 2020. While this raised the stringency index from 80 to 100, future excess death oscillations did not appear to have a meaningful relationship with the stringency index during the period when vaccinations were unavailable. The link between stringency and excess deaths has become uncertain after the advent of vaccines. For example, the January 2022 surge in excess deaths resulted in just a 10-point increase in the stringency index for non-vaccinated individuals.

Finally, the GDP has performed as projected. Following a rapid decrease, it reached a low in June 2020 before gradually recovering. While GDP fluctuates little, we can observe that its gradual effects can be attributed to strict economic policies that prevent a large expansion at any moment.

THE CASE OF PHILIPPINES
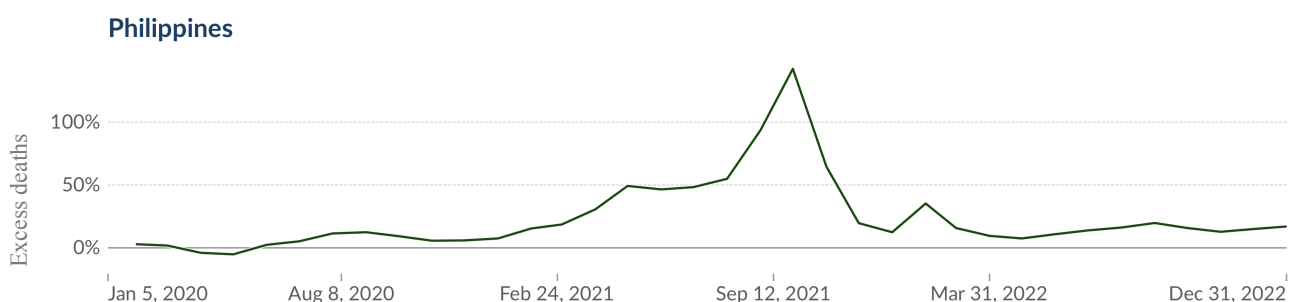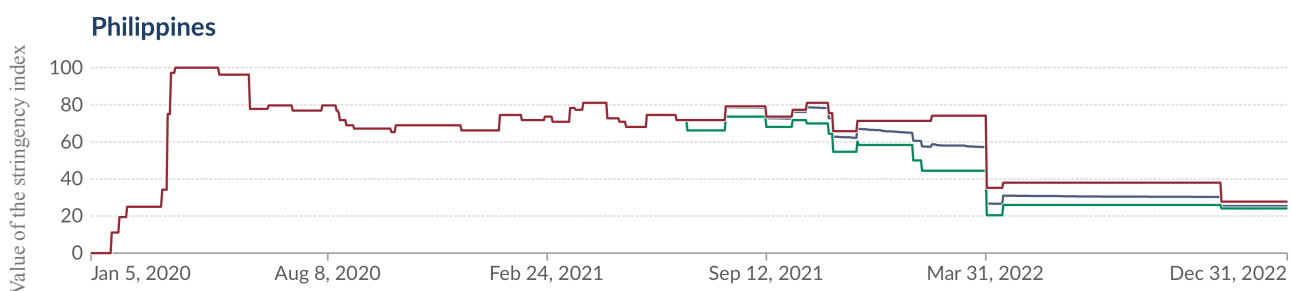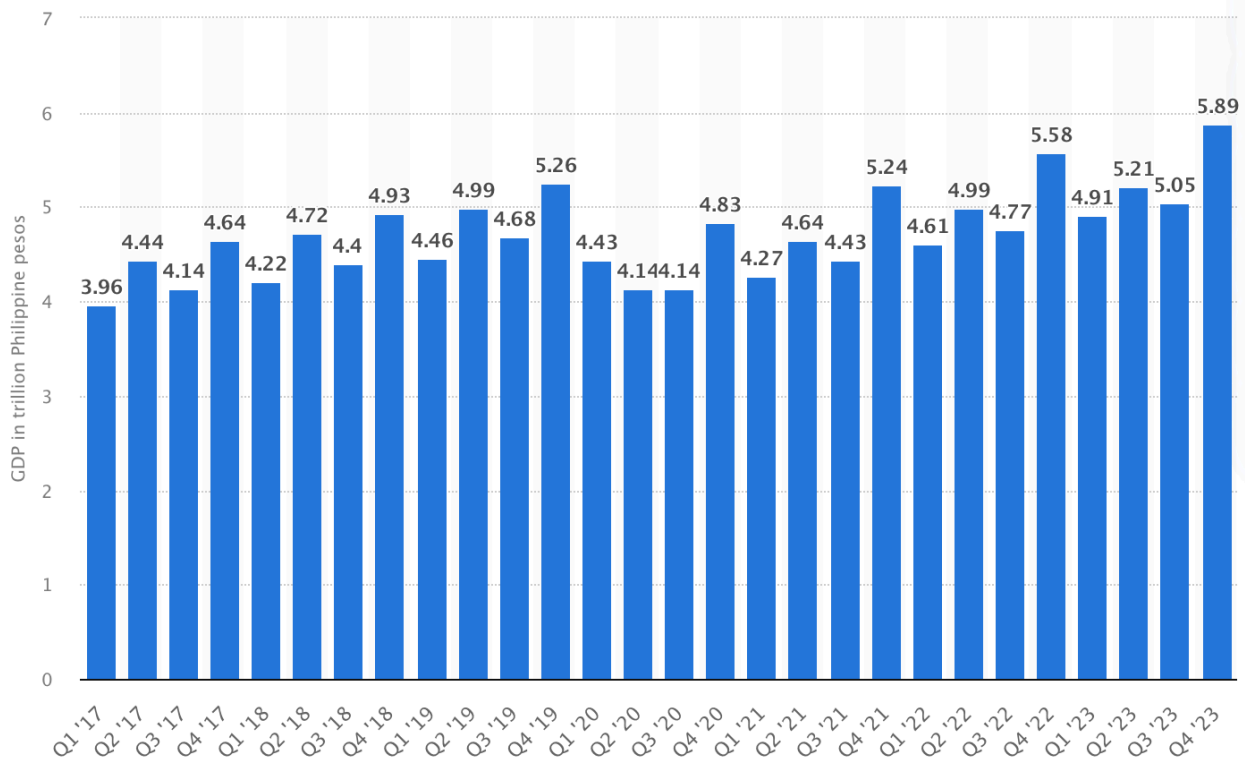
In March 2020, the Philippines began implementing stringent stringency measures, quickly obtaining a stringency index of 100. The approach was maintained until the summer of 2020, when the stringency was reduced to 80 until the fall. Winter 2020 has a stringency level of 65, but beginning February 2021, the index varies between 60 and 80, imposing medium-high stringency constraints. Vaccination effects begin in July 20201. The limitations are initially set at 80 for all groups, but beginning in January 2022, the index stabilizes around 70 for non-vaccinated people and 40-60 for vaccinated people until April 2022, when values between 20 and 30 are applied to all categories and maintained until the end of the year.

Excess fatalities have a slight association with the stringency index, as illustrated in the graph. The first phase of the pandemic was characterized by low excess fatalities and a high stringency index. The peak in excess deaths in September 2021 was not related with large changes in the stringency index, supporting our findings about emerging markets.

National GDP, as expected, fell significantly during the two semesters of the pandemic, but it remained low until December 2020, signaling difficulties in recovering from the crisis. From there, it gradually begins to rise again, with multiple oscillations, reaching a stable level only by the beginning of 2023. In this situation, neither the stringency measures nor the GDP show considerable variation.

CHILE VS PHILIPPINES

These two examples show the diverse approaches and impacts of stringent measures, as well as their impact on excess mortality and GDP during the COVID-19 epidemic.

In Chile, strict safeguards were rapidly implemented, and the stringency index remained high throughout the pandemic's early stages. Even throughout the summer months of 2020, which are typically associated with relaxation in other countries, Chile maintained strict controls, resulting in an increase in the stringency index. However, the link between stringency and excess fatalities is less clear because the first increase in the stringency index did not coincide with a high in excess deaths. With the introduction of vaccines, the stringency index gradually decreased, particularly among vaccinated persons, indicating a shift toward differentiated policy. Despite changes, Chile's GDP has shown a slight recovery trend, albeit with limited expansion due to the country's sustained restrictive measures.

On the other hand, the Philippines swiftly implemented severe protections, obtaining a maximum stringency index early in the pandemic. Unlike Chile, stringency levels fluctuated during the initial pandemic phase, with varying amounts of restrictions imposed. Chile, on the other hand, has a wider range of vaccination and non-vaccination policies. Despite a small link between stringency and more deaths, adjustments in stringency levels did not always result in additional fatalities. The Philippines experienced difficulty in GDP recovery, with significant losses extending until late 2020 and a gradual rebound afterward, indicating persistent economic hardships despite many stringent measures.

In conclusion, while both countries implemented strict measures early in the pandemic, Chile maintained a higher level of stringency for a longer length of time, whereas the Philippines experienced swings in stringency. The association between stringency measures and excess deaths was less evident in both cases, underscoring the intricacy of the factors that influence mortality rates in developing countries. Furthermore, both countries had economic recovery challenges, with Chile making modest progress due to severe measures and the Philippines struggling with long-term economic woes.

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