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Article

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Public health and economic outcomes tradeoffs during the COVID-19 pandemic: political perspectives

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ABSTRACT

This comprehensive study delves into the nuanced relationship between public health initiatives, particularly non-pharmaceutical interventions (NPIs), and their economic repercussions amid the COVID-19 pandemic. Employing a dataset spanning from February 2020 to June 2021, this study conducts a comprehensive analysis of the interplay between democracy, Nonpharmaceutical Interventions (NPIs) and economic outcomes, with a particular focus on unemployment rates. The research findings indicate a nuanced interaction between democracy and the implementation of NPIs, suggesting that democratic contexts do not only enhance the NPI measures' overall efficacy in curbing the pandemic but also preserve economic stability, particularly by mitigating the adverse effects on unemployment rates. Thus, nations with their robust economic reserves and democratic infrastructures, have effectively employed NPIs to protect public health while mitigating economic downturns, aligning with the 'Zero-COVID' strategy. The study also presents a compelling argument that nations under economic strain can still benefit from NPIs, provided they operate within a democratic framework. This assertion is supported by evidence suggesting that democratic governance plays a pivotal role in the effective implementation of NPIs, facilitating both health crisis management and economic stability.

IMPACT STATEMENT

This study explores the complex relationship between nonpharmaceutical interventions (NPIs) and their economic impact during the COVID-19 pandemic, particularly focusing on how democratic governance influences this dynamic. Using data from 50 countries over 17 months, the paper demonstrates that NPIs, such as lockdowns and social distancing, effectively mitigated the spread of COVID-19. Importantly, it reveals that democratic nations, due to their governance structures, were better equipped to balance public health imperatives and economic stability, especially in mitigating unemployment. The research emphasizes the critical role of democracy in ensuring effective implementation of NPIs while reducing the adverse economic consequences. The significance of this work lies in its contribution to understanding how different governance models influenced pandemic management. By offering insights into the interplay between health and economic outcomes, the findings provide valuable lessons for policymakers, especially in the context of managing future public health crises. The study also challenges the perception that public health and economic objectives are mutually exclusive, instead advocating for a more integrated approach that ensures both health preservation and economic resilience.

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1. Introduction

The COVID-19 pandemic has precipitated an unparalleled global upheaval, disrupting the very sinews of health and economic structures. The resultant constrictions in economic activity have led to precipitous declines in GDP and surges in unemployment, revealing the stark vulnerability of global economic

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systems to public health crises (Tandon et al., 2020). Governments stand at a critical juncture, where policy responses must delicately balance the safeguarding of public health with the mitigation of economic fallout.

In this milieu, nonpharmaceutical interventions (NPIs)—such as social distancing, personal protective measures, and travel restrictions—have emerged as pivotal strategies in curbing COVID-19's spread in the absence of robust medical countermeasures (Iezadi et al., 2020). Yet, these interventions have not been without contestation; they have sparked widespread protests and dissent, fueled by fears of unemployment and economic insolvency (Kane, 2020). This pushback has diluted the efficacy of NPIs, complicating efforts to achieve an optimal synergy of health preservation and economic resilience.

The dialectic between health and economic interests is not new; however, the pandemic has intensified its immediacy, challenging conventional wisdom about the inevitability of trade-offs. Emerging scholarship posits that the dividends of public health measures may significantly outweigh their economic costs, even when factoring in recessionary impacts (Oana et al., 2021). Yet, the nature of these trade-offs—whether they are localized or global, transient or enduring—remains to be thoroughly interrogated.

This dynamic is further complicated by the interplay of political determinants. Studies reveal that political allegiance has tangibly shaped public adherence to COVID-19 measures, with partisan governance influencing the degree of social distancing observed across communities (Adolph et al., 2021; Barrios & Hochberg, 2020). Such findings underscore the potency of political ideology in framing the public's risk perception and response to the pandemic.

In light of these considerations, this study seeks to contribute to the nascent body of literature exploring the intersection of health outcomes, economic impacts, and political factors. By elucidating these relationships, we aim to equip policymakers with a more nuanced understanding that could inform more tailored and effective strategies in combating current and future pandemics.

The remainder of this paper is meticulously structured to unravel these complex interdependencies. We commence with a theoretical exploration of the nexus between public health and economic vitality, followed by an exposition of our methodological framework and dataset. Subsequent sections will delineate our empirical findings, culminating in a comprehensive discussion that synthesizes our insights and implications for policy and practice.

2. Literature review

2.1. Theoretical backgrounds

Overall, COVID-19 studies are only at the experimental level of discrete assumptions about its impact on economic and public health. Fortunately, Gans (2020) has formulated theories of economics in the COVID-19 era, including the theory of the trade-off between economic development and public health. He indicates that the COVID-19 pandemic have changed the production possibility frontier (PPF). He builds PPF to demonstrate the tradeoff between health and economics in normal conditions (Figure 1).

Following Gans (2020), the PPF has a curved shape. To elevate our health from a lower level, it often necessitates sacrificing certain economic aspects. Figure 1 illustrates what a pandemic could do to PPF. There are 2 major changes as demonstrated by a new line below the normal PPF line. Firstly, the

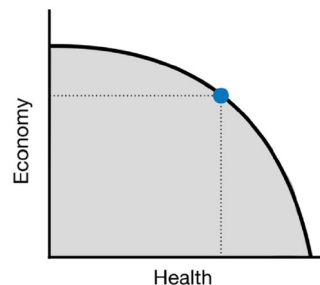


Figure 1. PPF line in the normal situation.

Source: adapted from Gans (2020).

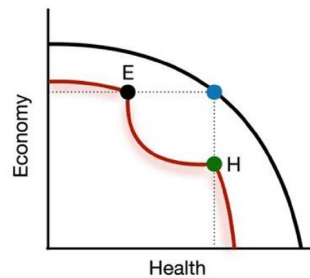


Figure 2. PPF in the pandemic situation.

Source: adapted from Gans (2020).

pandemic PPF line is below the normal PPF line (see Figure 2). This means we cannot remain at the level of health and economy like the normal condition. Secondly, there is an indentation at PPF due to a natural pandemic. For more detail, suppose we are from the initial level of the economy (point E in Figure 2).

Subsequently, if we want to improve the health level during a pandemic, we need to give up a lot of economics. This leads to an argument for social distancing. We need to apply social distance measures to prevent the spread of the pandemic. By contrast, if we just apply a mild social distance measure, we will lose both health and economics. This is similar if we start from our initial health level at point H. In this situation, if we want to release a little health to gain more economics, we can see it is impossible.

In this paper, we propose an empirical model based on the PPF theory of Gans (2020). We investigate the relationship between economic growth and public health to test the theory of pandemic PPF. It is a fact that countries' resources are limited. If they spend more on public health, they must give up something else, like our country's economic outcome. In other words, spending on public health leads to a loss in economic outcomes and vice versa. Therefore, economists often remind us of a tradeoff between economic and health outcomes, especially in the COVID-19 pandemic (Gourinchas, 2020; Porter & Tankersley, 2020). However, the question is, in the age of a pandemic, if a country decides to ignore the public health problem, will it be able to achieve the same level of economic development as before? Gans (2020) stated that if a country lets the pandemic burn through the population, it will cause 'a dark recession'. Gans (2020) explained that, like in a war or natural disaster, when the virus spreads uncontrollably, the country's resources are lost, the ability and health of the workforce are severely reduced, and labor productivity is very low. These result in a severe decline in economic activity which leads to a dark recession. This viewpoint is supported by some evidence in the past pandemic. For example, by analyzing differences in NPIs among different cities of the *United States* during the 1918 influenza pandemic, economists found that those cities that implemented NPIs earlier and stronger ended up bouncing back and having better economic growth thereafter. Conversely, cities that fail to contain the spread of the virus through NPIs could make subsequent economic recovery more complex. This finding suggests that a focus on public health can provide superior economic performance in the long term (Gans, 2020).

2.2. The impact of COVID-19 on economic outcomes

In a mere two-year span, the academic landscape has burgeoned with extensive research probing the multifaceted repercussions of COVID-19 on economic structures, ranging from individual nations to the global stage. The seismic impact of the pandemic on economic constructs is incontrovertible, with a spate of studies delineating its pervasive reach. Nicola et al. (2020) illuminated how containment efforts such as social distancing and travel restrictions have rippled through the world economy, triggering widespread job losses and fluctuating product demand—except in the pharmaceutical sector, which has seen a marked surge.

The impact of COVID-19 on economic outcomes has been significant and far-reaching. The pandemic has caused widespread disruptions to economies around the world, leading to negative consequences in various sectors and regions (Grömling, 2021; Morgan et al., 2021). Numerous studies have documented the immediate economic consequences of the pandemic, including widespread job losses,

business closures, and declines in economic output. For example, a study by Adams-Prassl et al. (2020) found a substantial increase in unemployment rates across multiple countries shortly after the onset of the pandemic. Similarly, research by McKibbin and Fernando (2020) estimated significant declines in global GDP growth due to COVID-19-related disruptions. The effects of COVID-19 on economic output, sustainability, and growth potential have been extensively studied.

The global pandemic has resulted in a decline in economic activities, including primary, secondary, and tertiary sectors (Kaur & Saini, 2022). The consequences of the pandemic on the economy have been compared to those of natural disasters and wars (Sethi et al., 2021; Shah et al., 2021). The economic impacts of COVID-19 have been observed at both national and industrial levels (Duan et al., 2021). The pandemic has also affected the three dimensions of sustainability, namely economic, social, and environmental aspects (Zhang et al., 2020).

The COVID-19 outbreak has had a significant impact on China's economy, with implications for various sectors and industries (Duan et al., 2021; Zhang et al., 2020). The pandemic has disrupted supply chains, leading to ripple effects on other economies (Jagrič et al., 2022). The economic consequences of COVID-19 have been analyzed in different regions, including the Baltic Sea Region Bilczak (2022) and the Mazovia region (Mackiewicz et al., 2022). The pandemic has also affected specific industries, such as the construction industry in Oman Amri (2021) and the tourism industry (Fernández et al., 2022).

The economic recovery from the pandemic requires rethinking the type of economy needed in the future, with a focus on green and sustainable approaches (Barbier, 2020). The role of corporate social responsibility and micro waqf banks in economic resilience during the pandemic has also been explored (Harto et al., 2022).

Moreover, Johnson et al. (2020) employed scenario analysis to forecast the potential ramifications of the pandemic on the social and economic fabric of the European Union, offering strategic inferences for safeguarding societal health and economic stability. Complementarily, McKibbin and Fernando (2020) utilized economic modeling to navigate seven distinct scenarios, estimating the pandemic's impact on macroeconomic indicators and global financial markets. This investigation revealed a disproportionate short-term economic burden on less developed countries, as opposed to their developed counterparts, primarily attributed to disparities in healthcare infrastructure and population density.

Shadmi et al. (2020), through a comparative study encompassing 13 countries, delved into the pandemic's inequitable effects on impoverished groups, minorities, and other vulnerable demographics, attributing these disparities to varied coronavirus spread rates and differential capacities to leverage public health resources.

At the national level, research like that of Das and Patnaik (2020) has dissected the extensive economic disruptions inflicted by COVID-19 in India across diverse sectors. Complementary analyses by Sahoo (2020) have scrutinized the pandemic's impacts on growth, manufacturing, trade, and the SME sector within India. In a similar vein, Anthony (2020) has scrutinized the pandemic's economic toll on Africa, with a focused case study on Nigeria. These scholarly contributions underscore the global imperative for nuanced, context-sensitive economic interventions tailored to the heterogeneity of impacts across different societal strata and geopolitical boundaries.

2.3. COVID-19 government policies on the pandemic development and economic activities

Since its emergence in December 2019, the COVID-19 pandemic has relentlessly traversed the globe, transcending borders via land, air, and sea routes, and facilitating its human-to-human transmission. The rapid spread of the virus has led to a public health emergency with a fatality rate and symptom severity that have surpassed those of many previous infectious outbreaks, including Ebola, influenza, and the common cold. To combat the spread, an array of nonpharmaceutical interventions (NPIs) have been enacted worldwide at various governmental levels, from countries to cities.

Reflecting on the historical precedent of the 1918–1920 influenza pandemic, NPIs such as social distancing and lockdowns have been shown to play a crucial role in reducing both local peak and cumulative mortality rates. However, the effectiveness and impact of these interventions on contemporary economies and public health systems have been topics of considerable debate. Correia et al. (2020) found that timely and coordinated implementation of NPIs was associated with better health outcomes

and less severe economic disruptions when evaluated the impact of non-pharmaceutical interventions (NPIs) such as stay-at-home orders and business closures on pandemic outcomes and economic activity. However, studies such as Lin and Meissner (2020) have scrutinized data from U.S. states and counties, concluding that NPIs have had only a marginal impact on economic and health outcomes during the COVID-19 pandemic. Their findings suggest that the implementation of stay-at-home orders did not significantly alter the trajectory of confirmed cases, nor did it substantially affect economic indicators such as job loss rates or general economic activity. This could be partially explained by behavioral changes in the population that preempt or respond to policy enactments in various states.

Building on this inquiry, Newbold et al. (2020) developed an epidemiological-economic model to ascertain the optimal duration and intensity of physical distancing measures. Their model weighs the potential lives saved against the economic costs of maintaining such interventions, a complex calculus given the pandemic's dynamic nature.

The question of a public health-economy trade-off is particularly vexing in the context of COVID-19. Theoretically, stay-at-home mandates and travel restrictions are likely to inhibit economic growth and contribute to rising unemployment. Nonetheless, during critical periods of the pandemic, public engagement with news and events tends to rise, potentially leading to spillover effects that could alter the anticipated outcomes of such policies (Baldwin, 2020; Eichenbaum et al., 2020; Krueger et al., 2020). Moreover, identifying the nuances of this trade-off is challenging due to the rarity of global pandemics, the lack of historical precedents to draw from, and the inconclusive nature of economic theories when applied to such unprecedented scenarios (Barro et al., 2020; Jordà et al., 2020).

While there have been studies investigating the health-economy nexus within one or two countries, these often involve limited samples and may not capture the full scope of the pandemic's impact. For example, Eichenbaum et al. (2020) focused on Korea and the UK, observing that lockdown measures reduced both GDP and infection rates. In the short term, an early lifting of lockdowns could boost GDP, but at the cost of a potential surge in COVID-19 cases, thereby increasing the strain on healthcare systems and public apprehension regarding infection risks. Conversely, a prolonged lockdown might minimize economic losses while flattening the infection curve, suggesting that the perceived trade-off between economic output and public health may not be as pronounced as initially thought.

Similarly, Gori Maia et al. (2021) found no evidence that strict social distancing in Brazilian cities hindered economic efficiency. Their findings proposed that the efficacy of social distancing might vary based on a city's level of development and could be undermined if disease spread is not concurrently controlled in neighboring regions. In Africa, Alhassan et al. (2021) identified no clear link between public health expenditure and economic growth in Nigeria, indicating that the relationship between health measures and economic performance may be more complex than simple causality suggests.

Further research by Ozili and Arun (2020) examined the influence of social distancing policies on economic activity and stock market indices, identifying impacts from the duration of lockdowns, monetary policy decisions, and international travel restrictions on economic indicators and major stock markets. Similarly, Hale et al. (2020) analyzed government responses to the pandemic and found that early and stringent containment measures, such as lockdowns and travel restrictions, were associated with lower transmission rates and mortality. Moreover, a cross-European study by Oana et al. (2021) illuminated that EU citizens generally favored stringent public health measures, even at the expense of economic performance, demonstrating a collective preference for health over economic concerns.

Despite the growing body of research, the results remain inconclusive, and the debate continues. This study aims to address these ambiguities by employing a rich dataset from 37 OECD countries to analyze the interplay between economic and health outcomes. Additionally, it seeks to elucidate the effects of various government policies on the progression of the COVID-19 pandemic and economic activities within a broader sample of 50 countries worldwide. By doing so, it contributes to the critical discourse on managing public health crises without sacrificing economic stability.

2.4. Democracy and public policy adherence in the covid-19 pandemic

The nexus between politics and public compliance in the face of the COVID-19 pandemic has proven to be fertile ground for academic inquiry, with research revealing a nuanced interplay between governance

styles and crisis management. Cronert (2022) sweeping analysis of 167 countries unearthed a striking pattern: democracies tended to shutter schools more promptly than their authoritarian counterparts, a phenomenon that aligns with the theory of political survival logic posited by de Mesquita et al. (2003). In democratic nations, where leaders' tenures are at the mercy of the electorate, the pressure to act swiftly in crisis is magnified, driven by the twin forces of electoral accountability and the watchful eye of a free press. The relationship between democracy and public policy adherence in the COVID-19 pandemic has been examined across different countries and regions such as Hale et al. (2021) compared government responses and public adherence to COVID-19 measures across countries, highlighting the importance of democratic governance in shaping responses to the COVID-19 pandemic, with variations in government policies and public adherence reflecting differences in democratic norms and institutions across countries.

Yet, this is only part of the story. Cronert (2022) also highlights the intricate role of state capacity, finding that robust administrative systems may either hasten or delay policy implementation like school closures, depending on the breadth of resources and strategies at their disposal. Singapore stands as a testament to this, having kept schools open longer despite the global trend of closures, a decision underscored by its formidable state apparatus.

Divergent findings emerge as we delve deeper into the literature. Frey et al. (2020) leveraged the Oxford COVID-19 Government Response Tracker (OxCGRT) against mobility data across 111 countries, discovering a somewhat paradoxical trend: autocracies were prompter and more stringent in imposing lockdowns, yet this did not translate to a significant reduction in mobility. In democracies, public adherence to COVID-19 measures was notably higher by 20%, suggesting a complex relationship between policy stringency and community compliance.

On the flip side, Cepaluni et al. (2020) presented a counterintuitive finding that democracies experienced higher per capita death rates in the initial phase of the pandemic, sparking a debate about the efficacy and responsiveness of policy measures across different political regimes.

These disparate strands of research underscore the need for a deeper exploration into how political structures influence policy effectiveness in times of global crises. As we grapple with these mixed results, one thing becomes clear: the unique characteristics of nations play a critical role in shaping the success of public health policies. A nuanced understanding of the political determinants of individual compliance is not just academic; it is crucial for policymakers worldwide to tailor strategies that resonate with their citizenry, thereby enhancing the collective fight against not only the current pandemic but also future national crises. Given the existing gap in scholarly research, this study tries to explore the complex relationship between public health measures, specifically Nonpharmaceutical Interventions (NPIs), and their economic effects amid the COVID-19 crisis. In addition, an extensive examination of the interaction between democracy, NPIs, and economic outcomes, with a specific emphasis on changes in unemployment rates will be examined.

3. Methodology

3.1. Data

The data of this study is collected from different databases. Data on the COVID-19 cases were collected from the Coronavirus Pandemic (COVID-19) dataset of Our World in Data database. Macroeconomic variables were gathered from the International Money Funds and Worldbank databases. Monthly unemployment rates are used in this paper as a proxy for the overall economy collected from the OECD countries dataset. Democracy index scores are collected from The Economist Intelligence Unit report in 2020. Finally, the data on the government's NPIs' response indexes including the Containment and Health, Government Response, and Stringency indices were collected from The Oxford COVID-19 Government Response Tracker project, University of Oxford. The study's sample is of 50 countries (see Appendix A4) that have the data available for a duration of 17 months (February 2020–June 2021). Table 1 shows the descriptive statistics of variables used in this paper. Table 2 presents the descriptions and how the key variables are constructed.

Table 1. Descriptive statistics.

Variable	Obs	Mean	Std. dev	Min	Max
Unemployment rate (%)	467	6.751637	3.347853	2	17.6
ContainmentAndHealth	490	0.6356171	1.438006	−0.0105106	9.458544
Stringency	485	0.0821194	0.3360407	−0.3664579	3.208683
GovernmentResponse	487	0.0792918	0.4300307	−0.6530985	3.984371
EconomicSupport index	454	0.057879	0.296444	−0.76214	2.262804
Democracy	522	8.165383	0.852589	6.07	9.81
CasesGrowth	850	0.635617	1.438006	−0.01051	9.458544
PopulationDensity	850	136.6856	135.4159	3.202	527.967
GDP per capita (thousand \$)	850	32.345	17.569	6.427	94.278
CPI (%)	491	0.0026986	5.11856	−15.06129	28.5
Interest rate (%)	514	1.074497	1.517552	−5.684917	6.084819
BCI	505	0.6529357	1.232988	−0.832	7.37
CCI	509	98.9612	2.484476	90.16856	106.3312

Note. Unemployment rate: monthly unemployment rate in percentage in OECD countries; Containment and health/Stringency/Government Response/Economic support index: relative monthly changes in Containment and Health index/Stringency index/Government response/Economic support index; Democracy: democracy index score from the Economist Intelligence Unit report in 2020; Population density: Cases Growth: relative month changes in COVID-19 confirmed cases per million; CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long-term average = 100); CCI: monthly consumer confidence index (long term average = 100). Vaccinations per hundred: monthly relative changes in the total number of people who received the COVID-19 vaccination. Cases per million: monthly relative changes in total confirmed COVID-19.

3.2. Methodology

To address the research question, the two-step dynamic system GMM framework is used in this study. Originally proposed by Arellano and Bond (1991), standard GMM, which is also known as the Difference GMM, treats essential modeling problems namely endogeneity of regressors and simultaneity bias when applying the OLS approach. However, the usage of first difference lags for instrumental variables in the standard GMM to avoid dynamic panel bias is both an advantage and disadvantage where the estimator can eliminate the potential omitted variables bias only. As the nature of the panel data and the consideration of interactive variables, this study considered the role of dynamics in model designation and estimation to address the impact of COVID-19 government nonpharmaceutical intervention policies on the COVID-19 pandemic development and economic activities over time.

Based on the general model presented above, the specific model of this paper is expressed as follows:

$$Y_{it} = \alpha + \beta Y_{it-1} + NPI_{it} + CV_{it} + \mu_{it} + v_{it} + y_t$$

where Y_{it} stands for COVID-19 case growth as COVID-19 pandemic development dependent variable and Unemployment rate as the main economic activities dependent variable; Y_{it-1} is the lagged dependent variable; NPI_{it} represents the main independent variable, which stands for the nonpharmaceutical interventions policies include: stringency index (Stringency), Government response index (Government response), and Containment and health index (Containment and health); CV_{it} is a set of control variables: Population Density; GDPG and CPI; μ_{it} is the country- specific effect; y_t is the time dummy to assess the time- specific effect; and v_{it} represents the error term. Moreover, i indicates the country ($i = 1, \dots, N$), t indexes for the time period ($t = 1, \dots, T$), and j stands for the control variables ($j = 1, \dots, K$) included in the specific model.

To robust the finding, we use quantile regression for panel data with Markov chain Monte Carlo (MCMC) optimizations for testing the robustness of the previous results with a different method. Introduced by Koenker and Bassett (1978b), quantile regression is known for its ability to provide complete conditional distribution details. Due to the inherent robustness of quantiles, in quantile regression outliers and extreme data are usually less influential (Waldmann et al., 2013). The use of Bayesian additive models such as MCMC supply the entire posterior distribution of the parameter, whereas allow taking into account parameter uncertainty when making predictions (Yu & Moyeed, 2001). In addition, unlike conventional regression models that typically predict the mean of the dependent variable, quantile regression allows for the examination of the entire conditional distribution. This means it can provide insights into how independent variables affect the distribution of the dependent variable at different points (quantiles), offering a fuller picture of the relationship between variables. Quantile regression is also inherently more robust to outliers and extreme values in the data set which is quite popular in cross-countries datasets. By analyzing

Table 2. Description of key variables.

Variable	Description	Source	Construction/Measurement
COVID-19 Cases	The total number of confirmed COVID-19 cases.	Coronavirus Pandemic (COVID-19) dataset, Our World in Data	Collected daily, the data represent the cumulative number of confirmed cases, adjusted for reporting differences and testing rates across countries.
Macroeconomic Variables	Key economic indicators, including GDP growth rate, inflation rate, BCI, CCI and others, to assess the economic condition of a country.	International Monetary Fund (IMF) and World Bank databases	Compiled from official national and international sources, these variables are used to analyze economic trends and impacts.
Monthly Unemployment Rate	The percentage of the labor force that is jobless and seeking employment, is used as an indicator of economic health.	OECD countries dataset	Monthly data collected from national statistical offices, reflecting the current state of the labor market and serving as a proxy for overall economic performance.
Democracy Index Scores	A measure reflecting the state of democracy in 167 countries, categorized into four regimes: full democracies, flawed democracies, hybrid regimes, and authoritarian regimes.	The Economist Intelligence Unit's Democracy Index 2020	Scores are based on 60 indicators across five categories: electoral process and pluralism, civil liberties, the functioning of government, political participation, and culture.
Government Response Indexes	Indicators tracking government actions in response to COVID-19, including containment and health measures, economic support policies, and vaccination rates.	The Oxford COVID-19 Government Response Tracker project, University of Oxford	Indices are calculated based on the presence and extent of government actions in various categories, quantifying the rigor and comprehensiveness of response efforts.
Containment and Health Index	An aggregate measure combining various indicators related to containment policies (such as lockdowns and travel restrictions), public health practices (including testing and contact tracing), and health system readiness (such as healthcare capacity).	The Oxford COVID-19 Government Response Tracker project, University of Oxford	The index is calculated by averaging the scores of nine indicators, each normalized to a value between 0 and 100, where higher scores indicate stricter containment and more robust health measures. These indicators include school closures, workplace closures, public event cancellations, restrictions on gatherings, public transport closures, stay-at-home requirements, public information campaigns, testing policies, and contact tracing efforts.
Stringency Index	A composite measure designed to reflect the strictness of government policies intended to reduce person-to-person contact, which can help limit the spread of COVID-19.	The Oxford COVID-19 Government Response Tracker project, University of Oxford	The Stringency Index is derived from nine indicators, including school and workplace closures, cancellation of public events, restrictions on gatherings, public transport closures, stay-at-home orders, public information campaigns, and restrictions on internal and international movement. Each indicator is assigned a value from 0 to 100, and the index is the average of these values, providing a snapshot of the overall policy strictness at any given time.

different quantiles of the dependent variable, quantile regression can uncover varying effects of the independent variables across the distribution. This is especially useful in this study because it could help to identify how the NPIs policies might have differential impacts on different segments of countries which have distinct macro and social economics' characteristics.

4. Results and discussions

4.1. Nonpharmaceutical interventions policies and covid-19 pandemic development

In Table 3, results show that nonpharmaceutical interventions policies (NPIs) variables have negative and significant influences on the COVID-19 cases growth, affirming NPIs are effective in containing the spread of the COVID-19 pandemic. These results suggest that the tighter countries implement travel

Table 3. The effects of nonpharmaceutical intervention policies (NPIs) on COVID-19 pandemic development.

	(1) Case growth	(2) Case growth	(3) Case growth
<i>I.Case growth</i>	−0.0151 (−0.24)	−0.0381 (−0.70)	−0.0350 (−0.63)
<i>Stringency</i>	−0.353** (−2.83)		
<i>Government response</i>		−0.381** (−2.93)	
<i>Containment and health</i>			−0.378** (−2.80)
<i>Time</i>	−0.00420* (−2.24)	−0.00392* (−2.50)	−0.00465** (−3.11)
<i>Time²</i>	0.00001 (1.84)	0.00001* (2.40)	0.00001** (2.76)
<i>Population density</i>	0.0290 (1.23)	0.221 (1.38)	0.237 (1.51)
<i>GDPG</i>	−0.295 (−1.13)	0.0387 (0.16)	0.0394 (0.16)
<i>CPI</i>	0.855 (1.13)	0.0673 (0.34)	0.0514 (0.21)
<i>Constant</i>	−2.412 (−0.71)	0.509 (0.55)	0.546 (0.50)

Note. Case growth: relative changes in monthly case growth; Containment and health: relative changes in monthly Containment and Health index of COVID-19 NPIs; Government response: relative changes in monthly Government response index of COVID-19 NPIs; Stringency index: relative changes in monthly stringency index of COVID-19 NPIs; Vaccinations per hundred, Cases growth: relative month changes in COVID-19 confirmed cases per million; Time: variable to control the month time effects; CPI: monthly consumer price index changes from the previous year (2015 = 100); Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

restrictions and strong disease control policies, the lower the number of infections in the community, thereby helping to control the spread better. Consequently, on the one hand, the number of infections in countries that implement strict policies to control the disease will be lower than in the rest. On the other hand, the tightening of epidemic prevention measures helps reduce the number of infections compared to before implementation.

4.2. Nonpharmaceutical policies, democracy, and unemployment rates

The interplay between government policies, democratic governance, and the efficacy of nonpharmaceutical interventions (NPIs) is a dance of delicate balance and nuanced interactions. As evidenced in our findings, encapsulated in Table 4, there is a tangible synergy between NPIs and democratic indices that seems to have a palliative effect on unemployment rates amidst the OECD countries. This implies a somewhat intriguing phenomenon: with equal levels of NPI enforcement, nations scoring higher on the democracy index appear to better weather the economic storms wrought by the COVID-19 pandemic compared to their less democratic counterparts. More specifically, Table 4 presents that the interaction term between Democracy and Containment and Health index ($\beta_{\text{Democracy} * \text{ContainmentAndHealth}} = -0.342$ with a significance level of * $p < 0.10$), indicating a statistically significant negative effect on the unemployment rate when containment and health measures are implemented in countries with higher levels of democracy. This suggests that in more democratic countries, stricter health and containment measures may be more effectively translated into lower unemployment rates, possibly due to better compliance, more effective implementation, or stronger institutional trust.

The interactions of Democracy and Government response index ($\beta_{\text{Democracy} * \text{GovernmentResponse}} = -0.355$ with a * $p < 0.10$) indicates a similar trend, where the effectiveness of the government's overall response to COVID-19 (including economic measures) in reducing unemployment is enhanced in countries with higher democracy scores. This could reflect more comprehensive and responsive policy measures in democratic settings that are better able to mitigate the economic impacts of the pandemic.

However, the interaction of Democracy and Stringency presents a non-significant coefficient of -0.195 , suggesting that the direct relationship between strictness of lockdown measures and unemployment is not significantly influenced by the level of democracy, at least not to a statistically significant degree within the observed data. This may indicate that the effect of strictness of measures on

Table 4. The interactive effects of nonpharmaceutical policies and democracy on economic activities in OECD countries.

	(1) Unemployment rate	(2) Unemployment rate	(3) Unemployment rate
<i>ContainmentAndHealth</i>	−0.437** (0.152)		
<i>L1. Containment and health</i>	0.144 (0.076)		
<i>Democracy* containment and health</i>	−0.342* (0.154)		
<i>L1. Democracy* containment and health</i>	0.070 (0.058)		
<i>Government response</i>		−0.439* (0.183)	
<i>L1. Government response</i>		0.135 (0.075)	
<i>Democracy* Government response</i>		−0.355* (0.169)	
<i>L1. Democracy* Government response</i>		0.064 (0.061)	
<i>Stringency</i>			−0.352* (0.139)
<i>L1. Stringency</i>			0.092 (0.060)
<i>Democracy* stringency</i>			−0.195 (0.301)
<i>L1. Democracy* stringency</i>			0.054 (0.053)
<i>Democracy</i>	0.575** (0.205)	0.562** (0.201)	0.460 (0.282)
<i>Case growth</i>	−0.011 (0.020)	−0.017 (0.022)	−0.008 (0.015)
<i>GDP per capital</i>	−0.521 (0.461)	−0.383 (0.421)	−0.570 (0.562)
<i>CPI</i>	−0.046 (0.041)	−0.050 (0.043)	−0.032 (0.036)
<i>BCI</i>	2.321 (1.450)	2.135 (1.921)	1.278 (1.622)
<i>CCI</i>	−3.286 (3.109)	−3.561 (3.303)	−2.227 (2.839)
<i>Interest rate</i>	0.109 (0.118)	0.123 (0.120)	0.075 (0.128)
<i>Constant</i>	11.812 (10.347)	12.482 (10.335)	12.230 (7.298)
<i>AR(2) Prob > Z =</i>	0.433	0.314	0.219
<i>Hansen test prob > Chi2 =</i>	0.188	0.425	0.621
<i>Number of countries</i>	28	28	28
<i>Number of observations</i>	399	399	399

Note. L1.[variables]: the 1-month lag value of the [variables]; L2.[variables]: the 2-month lag value of the [variables]; Containment and health: relative changes in monthly average Containment and Health index; Government response: relative changes in monthly average Government response index; Stringency index: relative changes in monthly average Stringency index; Case growth: monthly relative changes in total confirmed COVID-19; Democracy: democracy index score from the Economist Intelligence Unit report in 2020; CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long term average = 100); CCI: monthly consumer confidence index (long term average = 100). L1.(variable): the one-period lagged variables of the index; GDP per capita: country's GDP divided by its total population; Population density: measurement of population per unit land area. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

employment does not vary as much by democracy level or that the data does not provide enough evidence of such an interaction effect.

One could posit that this resilience is rooted in the fertile soil of trust and societal infrastructure. In democratic states, where education, healthcare, and living standards often rank higher, citizens not only have greater trust in their governments but also engage more willingly with public health directives, from social distancing to vaccination drives. Indeed, extant literature suggests that in democratic countries, transparent governance mechanisms and accountability measures play a crucial role in building trust between citizens and their governments (Helliwell & Huang, 2014). When governments are perceived as trustworthy and competent, individuals are more inclined to seek guidance from them during health crises. Moreover, trust in government institutions has been shown to promote the adoption of policies aimed at protecting public health (Gilson, 2003; Khemani et al., 2020). Besides that, empirical evidence was found that countries with more democratic governance structures tended to have higher

levels of public compliance with government instructions (Hale et al., 2021). The importance of trust in public health compliance is further emphasized by the finding that trust in public health institutions, rather than political leaders, is a consistent predictor of compliance (Badman et al., 2022). Therefore, even with a consistent NPIs score, the actual impact on halting COVID-19's advance is markedly more substantial in these higher-scoring democracies.

Furthermore, the economic muscle of democratic nations cannot be overlooked. Typically aligned with developed economies, these countries boast a more robust toolkit of monetary and fiscal remedies to counter the pandemic's adverse effects, as delineated in [Appendix A2](#). This financial flexibility enables them to mitigate the dire consequences that NPIs might otherwise have on employment, a stark contrast to the implications drawn from [Appendix A1](#), where stringent NPIs, in isolation, appear to exacerbate joblessness.

Peering through the prism of vaccine accessibility reveals yet another layer of disparity. [Appendix A3](#) lays bare the stark contrast in vaccine campaign onset between democracies and authoritarian regimes, with the former rolling out immunization efforts an average of 110 days (about 3 and a half months) earlier post-2000 confirmed cases per million, highlighting the advantages of swift and decisive action.

Countries like Germany, Australia, and New Zealand have exemplified the 'Zero-COVID' strategy from the pandemic's onset, a testament to the proactive stance that wealthier nations can afford. Yet, this is not a one-size-fits-all solution. Low-income countries stand at a crossroads, grappling with the harrowing choice between safeguarding their populations and preserving their economic vitality. The path forward for these nations is fraught with challenges, as they navigate the twin crises of health and economy, endeavoring to strike a balance that will allow them to emerge from the pandemic without lasting scars.

4.3. Robustness test

4.3.1. Robustness test of the impacts of NPIs to economic activity

Diving deeper into the complex fabric of public health policy and economic vitality, we've pushed the envelope with advanced statistical techniques to reaffirm our discoveries. Employing quantile regression, paired with the finesse of MCMC (Markov Chain Monte Carlo) optimizations for panel data, we've dissected the robustness of our initial findings through a fresh analytical lens ([Table 5](#) and [Figure 3](#)).

Results presented in [Table 5](#) and [Figure 3](#) have unmasked a dynamic relationship between NPIs and unemployment rates within OECD countries, revealing a multi-faceted narrative. In the lower echelons of the unemployment spectrum (those beneath the 75th percentile), a tighter embrace of NPIs seems to weave a protective shield against future joblessness. Yet, as we ascend to the upper quantiles (above the 75th percentile), this relationship undergoes a metamorphosis, and the delicate balance between public health and economic prosperity becomes palpable.

The tapestry of our results lays bare a truth often veiled in complexity: the interplay between health measures and economic performance is not uniform but is deeply influenced by the underlying macroeconomic conditions and support policies of each nation. In realms where the macroeconomic climate is robust, stringent NPIs may be the wind beneath the wings of economic activity. However, in territories marred by economic strife, the tightening grip of disease control measures can exacerbate the wounds of the economy, inflating unemployment rates and stoking the flames of financial distress.

This nuanced understanding fortifies the argument that the recipe for marrying public health imperatives with economic welfare is not a universal doctrine but a tailored strategy, sensitive to the economic heartbeat of each nation. Our study, thus, offers a compass for policymakers navigating the stormy seas of pandemic management, providing insights that resonate with the unique economic rhythms of their lands.

4.3.2. Robustness test of the relationships between nonpharmaceutical policies, democracy, and unemployment rates

Employing a fixed effects model to account for the distinct attributes of different countries, this study examines the interaction between democracy and Non-Pharmaceutical Interventions (NPIs), and their combined effect on the unemployment rate. The findings presented in [Table 6](#) corroborate the

Table 5. Panel quantile regression for the impacts of NPIs on the unemployment rate.

	(1) Unemployment rate 25th quantile	(2) Unemployment rate 50th quantile	(3) Unemployment rate 75th quantile
<i>Containment and health</i>	−0.684** (0.205)	−0.567** (0.077)	2.397** (0.030)
<i>L1.Containment and health</i>	−0.983** (0.150)	−2.186** (0.154)	−3.352** (0.072)
<i>L2.Containment and health</i>	0.199 (0.131)	0.709** (0.091)	0.999** (0.064)
<i>Government response</i>	0.241* (0.110)	−0.428** (0.104)	6.582** (0.329)
<i>L1.Government response</i>	−1.309** (0.149)	−0.345** (0.113)	−2.225** (0.158)
<i>L2.Government response</i>	0.379** (0.063)	−0.377** (0.072)	0.311* (0.148)
<i>Stringency</i>	−0.427* (0.171)	−0.754** (0.018)	−0.245 (0.205)
<i>L1.Stringency</i>	−0.909** (0.058)	−0.396** (0.042)	4.382** (0.240)
<i>L2.Stringency</i>	0.203** (0.058)	0.256** (0.018)	1.370** (0.079)
N	372	372	372
MCMC mean acceptance rate			
<i>Containment and health</i>	0.373	0.578	0.359
<i>Government response</i>	0.564	0.620	0.536
<i>Stringency</i>	0.674	0.406	0.343

Exogenous explanatory variables include: Cases per million, Vaccinations per hundred, GDP per capital, CPI, Interest rate, BCI, CCI.

Note. L1.[variables]: the 1-month lag value of the [variables]; L2.[variables]: the 2-month lag value of the [variables]; Containment and health: relative changes in monthly Containment and Health index of COVID-19 NPIs; Government response: relative changes in monthly Government response index of COVID-19 NPIs; Stringency index: relative changes in monthly stringency index of COVID-19 NPIs; Cases per million: monthly relative changes in total confirmed COVID-19. CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long-term average = 100); CCI: monthly consumer confidence index (long term average = 100). L1.index: the one-period lagged variables of the index; L2.index: the two-period lagged variables of the index; GDP per capita: country's GDP divided by its total population; Population density: measurement of population per unit land area. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

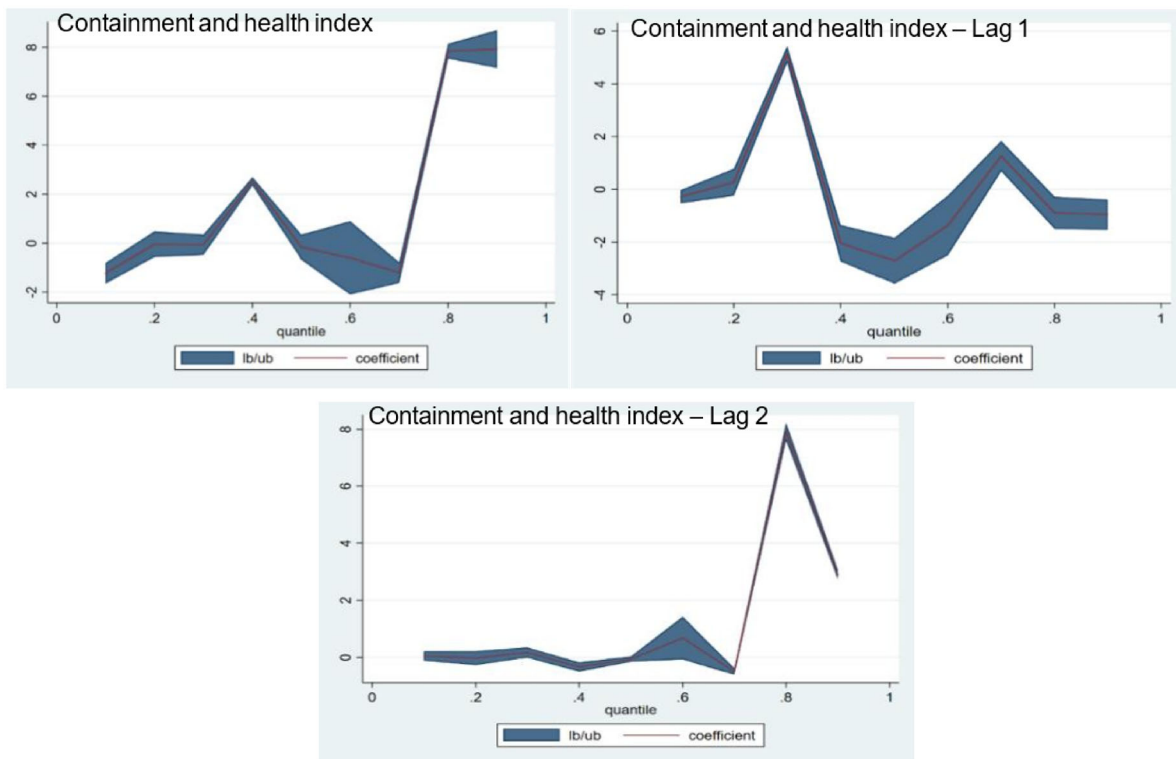
**Figure 3.** Coefficient and confidence interval of Containment and health index across quantile of unemployment rate.

Table 6. The relationship between Nonpharmaceutical policies, democracy, and unemployment rates using fixed effects model.

	(1) Unemployment rate	(2) Unemployment rate	(3) Unemployment rate
<i>Containment and health</i>	−0.750** (0.345)		
<i>L1.Containment and health</i>	0.047 (0.146)		
<i>Democracy* Containment and health</i>	−0.188 (2.754)		
<i>L1.Democracy* Containment and health</i>	−2.141* (1.117)		
<i>Government response</i>		−0.690* (0.369)	
<i>L1.Government response</i>		0.061 (0.147)	
<i>Democracy* Government response</i>		−0.729 (2.861)	
<i>L1.Democracy* Government response</i>		−1.936* (1.145)	
<i>Stringency</i>			−0.598** (0.255)
<i>L1.Stringency</i>			0.023 (0.113)
<i>Democracy* Stringency</i>			0.206 (2.228)
<i>L1.Democracy* Stringency</i>			−1.929** (0.869)
<i>Case growth</i>	0.120 (0.145)	0.098 (0.145)	0.132 (0.144)
<i>CPI</i>	−0.213*** (0.062)	−0.208*** (0.062)	−0.217*** (0.063)
<i>BCI</i>	−0.017 (0.026)	−0.020 (0.026)	−0.016 (0.026)
<i>CCI</i>	0.178*** (0.044)	0.177*** (0.044)	0.180*** (0.044)
<i>Interest Rate</i>	−0.832*** (0.184)	−0.826*** (0.185)	−0.867*** (0.180)
<i>Constant</i>	−8.366** (3.878)	−8.009** (3.891)	−8.710** (3.867)
<i>N</i>	370	370	371

Note. L1.[variables]: the 1-month lag value of the [variables]. Containment and health: relative changes in monthly average Containment and Health index; Government response: relative changes in monthly average Government response index; Stringency index: relative changes in monthly average Stringency index; Case growth: monthly relative changes in total confirmed COVID-19; Democracy: democracy index score from the Economist Intelligence Unit report in 2020; CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long term average = 100); CCI: monthly consumer confidence index (long term average = 100). L1.(variable): the one-period lagged variables of the index; GDP per capita: country's GDP divided by its total population; Population density: measurement of population per unit land area. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

robustness of the earlier results shown in Table 4, indicating that a country's level of democracy moderates the impact of NPIs on its unemployment rate. More precisely, in nations with a higher degree of democracy, the implementation of NPIs can lead to a significant reduction in the unemployment rate in subsequent periods. For example, the coefficient $\beta_{L1.Democracy*ContainmentAndHealth} = -2.141$ is significant at the 10% level. These results imply that in democratic countries, NPIs aimed at controlling the COVID-19 pandemic can be more effective, as these countries are better positioned to navigate the trade-offs between public health and economic outcomes.

To elucidate the moderating influence of democracy on the nexus between Non-Pharmaceutical Interventions (NPIs) and unemployment rates across diverse groups of countries, which are categorized based on their varying levels of unemployment, a quantile panel regression methodology is utilized. The findings delineated in Table 7 affirm the consistent moderating role of a country's democratic level on the dynamics between NPIs and unemployment rates across different unemployment quantiles. Notably, the interaction effects between democracy and NPIs are more pronounced in nations experiencing higher unemployment rates (as evidenced in the 50th and 75th percentiles of unemployment rates presented in Table 7). This observation suggests that, even in the face of economic challenges (manifested through higher unemployment rates), the presence of robust democratic institutions can amplify the effectiveness of NPIs in combating the COVID-19 pandemic, without necessitating compromises on

Table 7. The relationship between nonpharmaceutical policies, democracy, and unemployment rates using quantile panel regression.

	(1) Unemployment rate 25th quantile	(2) Unemployment rate 50th quantile	(3) Unemployment rate 75th quantile
<i>L1.Democracy* Containment and health</i>	−0.627*** (0.711)	−3.709*** (7.409)	−5.089*** (7.879)
<i>Containment and health</i>	0.063*** (0.102)	0.0604 (0.637)	−1.269*** (2.322)
<i>L1.Containment and health</i>	−0.117*** (0.160)	0.0645 (0.542)	0.574*** (1.662)
<i>L1.Democracy* Government response</i>	0.267 (4.022)	−3.832*** (7.971)	−5.892*** (5.237)
<i>Government response</i>	0.059** (0.259)	0.031 (0.625)	0.051 (1.149)
<i>L1.Government response</i>	−0.181*** (0.393)	0.0791 (0.504)	−0.093** (0.365)
<i>L1.Democracy* Stringency</i>	0.778 (6.142)	−2.648*** (3.734)	−2.198*** (1.437)
<i>Stringency</i>	0.107 (0.996)	0.062** (0.313)	0.160*** (0.263)
<i>L1.Stringency</i>	0.283*** (0.991)	0.056* (0.319)	−0.028 (0.382)
N	372	372	372
MCMC mean acceptance rate			
<i>Containment and health</i>	0.479	0.452	0.187
<i>Government response</i>	0.550	0.307	0.333
<i>Stringency</i>	0.191	0.389	0.458

Exogenous explanatory variables include Cases per million, Vaccinations per hundred, GDP per capital, CPI, Interest rate, BCI, CCI.

Note. L1.[variables]: the 1-month lag value of the [variables]. Containment and health: relative changes in monthly Containment and Health index of COVID-19 NPIs; Government response: relative changes in monthly Government response index of COVID-19 NPIs; Stringency index: relative changes in monthly stringency index of COVID-19 NPIs; Cases per million: monthly relative changes in total confirmed COVID-19. CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long-term average = 100); CCI: monthly consumer confidence index (long-term average = 100). L1.index: the one-period lagged variables of the index; L2.index: the two-period lagged variables of the index; GDP per capita: country's GDP divided by its total population; Population density: measurement of population per unit land area. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

economic performance. Although a similar reinforcing effect of democracy on the efficacy of NPIs is observed in countries with lower unemployment rates, the extent of this effect is comparatively lesser.

5. Implication and conclusion

The intricate dance between public health initiatives and economic outcomes, as our study reveals, does not follow a uniform beat across the global stage. Instead, it manifests distinctly in local settings, particularly within developed economies. These nations, buoyed by ample economic reserves and robust democratic frameworks, find that their proactive Nonpharmaceutical Interventions (NPIs) resonate positively, safeguarding public health while simultaneously cushioning economic trajectories.

Numerous nations have demonstrated exemplary management of the COVID-19 pandemic, excelling in areas such as containment and health measures, the stringency of interventions, comprehensive government responses, and substantial economic support initiatives. This analysis identifies countries like New Zealand, South Korea, Taiwan, Germany, and Australia as leading examples, each offering instructive lessons for global pandemic preparedness and response. New Zealand distinguished itself through rigorous border controls, early initiation of lockdown protocols, and an extensive testing and contact tracing regime. The success of New Zealand's strategy was underpinned by effective communication from the government, a forward-looking stance on pandemic management, and high levels of community engagement. South Korea's response was characterized by its aggressive testing and contact tracing framework, complemented by innovative use of technology to swiftly identify and isolate COVID-19 cases. The government's commitment to transparency, coupled with concerted public health initiatives and specific interventions, played a crucial role in curtailing the virus's spread. Taiwan's preemptive actions, such as implementing early border restrictions, conducting widespread testing, and enforcing rigorous quarantine measures, were pivotal in halting the virus's transmission. The efficacy of Taiwan's approach was bolstered by rapid governmental actions, a data-centric strategy, and strong public adherence to health guidelines. Germany's response benefited from its robust healthcare

infrastructure, a decentralized approach to pandemic management, and effective coordination across different levels of government. Emphasizing widespread testing, healthcare system preparedness, and socio-economic support mechanisms, Germany managed to mitigate the broader impacts of the pandemic. Australia achieved success through stringent border measures, targeted lockdowns, and an expansive testing and tracing strategy. The adaptability of Australia's policy measures, effective public health communication, and comprehensive economic support packages were crucial elements of its pandemic response strategy.

The experiences of these countries underscore the significance of swift and decisive measures, advanced testing and contact tracing capabilities, clear and consistent communication, intergovernmental collaboration, flexible policy frameworks, and focused economic relief efforts. By analyzing the strategies employed by these nations, other governments can derive valuable insights and best practices for enhancing their readiness and improving outcomes in facing public health emergencies.

Conversely, the challenges encountered by less developed countries are significantly more acute, as they contend with a dual crisis of protecting public health while averting economic disaster. These nations, constrained by scarce resources, face formidable obstacles in enacting stringent Non-Pharmaceutical Interventions (NPIs). The implementation of rigorous NPIs, while essential for controlling the outbreak, poses a substantial burden on countries already struggling with limited capacity to manage a prolonged crisis. Moreover, the prospect of economic recovery becomes increasingly remote without effective outbreak management.

This study presents evidence indicating that countries experiencing economic difficulties, as evidenced by higher initial unemployment rates, can still derive benefits from the application of NPIs, provided that the institutional framework of the country exhibits a high level of democracy. The findings suggest that democratic institutions may play a critical role in mediating the effectiveness of NPIs, thereby facilitating not only the management of the health crisis but also mitigating the economic repercussions associated with the pandemic. This underscores the importance of robust democratic governance structures in enhancing the capacity of nations to navigate the complex interplay between public health imperatives and economic sustainability in the face of COVID-19.

Moreover, in lieu of the 'Zero-COVID' approach, countries' strategic pivot hinges on accelerating vaccination drives, aiming for swift community immunity to facilitate a phased economic reawakening. The velocity at which vaccination campaigns can be scaled up becomes the linchpin of this strategy. However, this already Herculean task is further complicated by the specter of 'vaccine nationalism,' where vaccine acquisition becomes a zero-sum game disproportionately favoring wealthy nations. This not only stymies the immunization efforts of developing economies but also jeopardizes global economic resurgence. Addressing this imbalance calls for an urgent and cooperative international response, transcending nationalistic impulses to ensure equitable vaccine distribution—a step that is not only an ethical imperative but also a pragmatic necessity for a harmonized global recovery.

Our policy recommendations thus crystallize into a multi-faceted approach: developed countries should continue to harness their resources to maintain and enhance NPIs, ensuring public health and economic recovery move in tandem. For less developed nations with more uncertainty in their macroeconomics, firstly, the significance of transparent governance emerges as a cornerstone for fostering public trust and compliance with NPIs. Democracies, through their commitment to the free flow of information, ensure that citizens are well-informed about the pandemic's dynamics and the logic underpinning various interventions. This transparency is instrumental in securing public adherence to health guidelines, a factor crucial for the timely containment of the virus and the minimization of economic disruptions. Furthermore, the inherent trust in public institutions characteristic of democratic societies amplifies the efficacy of public health measures. When the populace has confidence in their government's response, voluntary compliance with NPIs is heightened, reducing the need for stringent enforcement that could potentially stifle economic activity. In addition, Adaptive policy responses, enabled by the flexibility and inclusivity of democratic governance, allow for the refinement of NPIs based on evolving evidence and public input. Such adaptability ensures that measures remain both effective against the pandemic and minimally invasive to economic life. In conclusion, democracies, by leveraging these strengths, can implement NPIs that not only curb the spread of the virus but also safeguard economic well-being, offering valuable lessons for global public health governance.

Limitations and future research direction

Our study, while extensive, is not without its limitations, which in turn pave the way for future research opportunities. One limitation is the reliance on available data, which may not capture the full spectrum of NPIs' effectiveness across different cultures and political systems. Moreover, the rapidly evolving nature of the COVID-19 pandemic means that data and outcomes are continually changing. This underscores the need for ongoing research to update and verify our findings against new data.

Another limitation is the scope of our economic analysis, primarily focused on employment rates. Future studies could expand this to include a broader range of economic indicators such as GDP growth, inflation rates, and sector-specific impacts to provide a more comprehensive economic analysis. Furthermore, the study's focus on 50 countries means that the findings may not be generalizable to all countries with differing economic, political, and healthcare infrastructures. Future research could address these gaps by including a more diverse range of countries and by examining the interplay of additional factors such as healthcare capacity, cultural norms, and social behaviors.

The complex interplay between political structures and public adherence to NPIs also warrants deeper investigation. Future studies could explore the role of trust in government and public institutions, and how this influences compliance with and the effectiveness of public health policies. Additionally, the impact of 'vaccine nationalism' and unequal vaccine distribution on global recovery is a pressing concern that merits further exploration. Research could investigate strategies for improving international cooperation and equitable vaccine distribution, along with the economic impacts of such strategies.

The study only encompassed data from the early phases of the pandemic, spanning 18 months from February 2020 to June 2021. Excluding data from the later stages of the pandemic (Q3 of 2021 onwards) may limit the ability to capture the evolving impact of COVID-19 on public health and economic outcomes. The exclusion of data from later stages suggests that trends or magnitudes of outcomes could have changed as the pandemic situation evolved in each country. Future research should consider including a longer time duration to examine how these outcomes evolved during different waves of the pandemic and to understand the effectiveness of various strategies and interventions over time. This would provide a more comprehensive understanding of the long-term effects of COVID-19 on public health and economic indicators. Lastly, our study could serve as a springboard for longitudinal research to assess the long-term effects of NPIs on public health and economic outcomes. Such research could provide valuable insights into the enduring impacts of the pandemic and the effectiveness of different strategies over time.

Author's contribution

Huan Huu Nguyen: Conceptualization, Methodology, Software, Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing, Formal analysis. Vu Minh Ngo: Methodology, Investigation, Writing- Original draft preparation, Writing- Reviewing and Editing. Uyen Hoang Dinh Nguyen: Formal analysis, Supervision, Writing- Reviewing and Editing.

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Data availability statement

Data available on request from the authors

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Appendices

Appendix A1: Effects of nonpharmaceutical interventions policies (NPIs) on economic activities without other interventions.

	(3) Unemployment rate	(2) Unemployment rate	(1) Unemployment rate
<i>Case growth</i>	0.591 (0.42)	-0.0488 (-0.58)	-0.327 (-0.70)
<i>Stringency</i>	5.119* (2.42)		
<i>L.Stringency</i>	-3.250		
<i>L2.Stringency</i>	(-1.75) 1.236* (2.71)		
<i>Government response</i>		-0.0555 (-0.29)	
<i>L.Government response</i>		0.439* (2.17)	
<i>L2.Government response</i>		-0.129 (-1.34)	
<i>Containment and health</i>			-0.132 (-1.18)
<i>L.Containment and health</i>			0.596* (2.34)
<i>L2.Containment and health</i>			-0.235 (-0.80)
<i>GDP per capital</i>	0.425 (0.74)	-1.520 (-1.00)	-0.988 (-1.09)
<i>CPI</i>	-0.150 (-1.04)	-0.233* (-2.10)	-0.359** (-3.43)
<i>BCI</i>	6.734 (0.93)	5.102 (1.07)	10.38 (1.41)
<i>CCI</i>	-21.08 (-0.95)	4.522 (0.44)	-4.567 (-0.33)
<i>Interest Rate</i>	0.0660 (0.36)	-0.0618 (-0.33)	-0.0481 (-0.16)
<i>_cons</i>	50.45 (0.57)	-27.14 (-1.08)	-14.84 (-0.48)
<i>AR(2) Prob > Z =</i>	0.219	0.314	0.433
<i>Hansen test prob > Chi2 =</i>	0.621	0.425	0.188
<i>Number of countries</i>	28	28	28
<i>Number of observations</i>	342	374	374

Containment and health: relative changes in monthly Containment and Health index of COVID-19 NPIs; Government response: relative changes in monthly Government response index of COVID-19 NPIs; Stringency index: relative changes in monthly stringency index of COVID-19 NPIs; Case growth: monthly relative changes in total confirmed COVID-19. CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long term average = 100); CCI: monthly consumer confidence index (long term average = 100). L1.index: the one-period lagged variables of the index; L2.index: the two-period lagged variables of the index; Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix A2: The effects of nonpharmaceutical intervention policies (NPIs) on unemployment rate in OECD countries with economic support policies.

	(1) Unemployment rate	(2) Unemployment rate	(3) Unemployment rate
<i>Containment and health</i>	−9.152*		
	(−2.33)		
<i>L.Containment and health</i>	0.482		
	(1.15)		
<i>L2.Containment and health</i>	−0.0332		
	(−0.27)		
<i>Containment and health* EconomicSupport</i>	2.000*		
	(2.34)		
<i>Government response</i>		−10.80*	
		(−2.19)	
<i>L.Government response</i>		0.599	
		(1.02)	
<i>L2.Government response</i>		−0.0925	
		(−0.89)	
<i>Government response* Economic support</i>		2.350*	
		(2.23)	
<i>Stringency</i>			0.924
			(0.46)
<i>L. Stringency</i>			0.221
			(1.83)
<i>L2. Stringency</i>			−0.0228
			(−0.66)
<i>Stringency* economic support</i>			−0.306
			(−0.68)
<i>Economic support</i>	−8.138*	−9.416*	1.323
	(−2.31)	(−2.25)	(0.73)
<i>L.Economic support</i>	−0.193	−0.0661	−0.0352
	(−0.93)	(−0.53)	(−0.52)
<i>CaseGrowth</i>	−0.126	−0.0487	−0.0531
	(−1.12)	(−0.50)	(−1.24)
<i>GDPPerCapital</i>	−0.183	0.0310	0.270
	(−0.42)	(0.07)	(0.88)
<i>CPI</i>	0.0164	−0.0638	−0.204*
	(0.39)	(−0.48)	(−2.77)
<i>BCI</i>	3.720	2.114	6.855*
	(1.05)	(0.67)	(2.67)
<i>CCI</i>	−7.660	0.0972	−3.261
	(−0.98)	(0.03)	(−1.00)
<i>Interest Rate</i>	−0.0945	−0.0256	0.240
	(−0.66)	(−0.12)	(1.52)
<i>_cons</i>	58.12*	32.89	−22.20
	(2.58)	(1.32)	(−1.19)
<i>AR(1) Prob > Z =</i>	0.449	0.396	0.168
<i>AR(2) Prob > Z =</i>	0.491	0.333	0.147
<i>Hansen Test Prob > Chi2 =</i>	0.383	0.331	0.652
<i>Number of countries</i>	28	28	28
<i>Number of observations</i>	374	373	374

Containment and health: relative changes in monthly Containment and Health index; Government response: relative changes in monthly Government response index; Stringency index: relative changes in monthly stringency index; Economic support: relative changes in monthly Government response index; Case growth: monthly relative changes in total confirmed COVID-19. CPI: monthly consumer price index changes from the previous year (2015 = 100); BCI: monthly business confidence index (long term average = 100); CCI: monthly consumer confidence index (long term average = 100). L1.index: the one-period lagged variables of the index; L2.index: the two-period lagged variables of the index; Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix A3: Days to COVID-19 vaccine access according to countries' political regimes.

	(1) Daysfrom500cases	(2) Daysfrom1000cases	(3) Daysfrom2000cases
Full democracy	-84.130*** (28.076)	-56.194 (39.642)	-129.767*** (41.808)
Flawed democracy	-68.388*** (25.248)	-56.552* (33.830)	-107.426*** (34.813)
Hybrid regime	-25.234 (27.649)	-42.728 (38.672)	-3.757 (35.106)
Asia	-90.419*** (33.089)	-101.788*** (37.750)	-85.968** (39.297)
Africa	17.638 (45.596)	-19.552 (51.523)	-26.060 (60.793)
Europe	0.545 (39.840)	16.561 (43.118)	97.984** (49.075)
Oceania	-122.288 (83.658)	-60.471 (51.152)	-331.783*** (65.285)
South America	10.374 (20.536)	1.183 (24.427)	4.239 (25.039)
Population_density	0.003 (0.005)	0.003 (0.008)	0.016*** (0.005)
Aged_65_older	-1.967 (2.212)	-6.395** (2.710)	-3.393 (2.504)
GDP per capita	0.001* (0.000)	0.001 (0.000)	0.001 (0.000)
Life_expectancy	3.487 (3.106)	4.279 (4.216)	1.327 (4.510)
Vaccine_purchased	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
WorldBank_Support	0.158* (0.085)	0.106 (0.104)	-0.033 (0.124)
Vaccine_donation_received	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
tradingwChina	-0.476 (0.406)	-0.452 (0.452)	0.266 (0.513)
tradingwUSA	0.585 (0.452)	0.598 (0.551)	1.300** (0.526)
tradingwUK	-0.385 (0.335)	-0.296 (0.493)	-0.487 (0.491)
tradingwGermany	0.314 (0.619)	0.250 (0.690)	-0.282 (0.725)
tradingwRussia	0.453 (0.348)	0.525 (0.436)	-0.459 (0.502)
constant	-12.647	-72.969	136.172
Number of countries	114	110	103
adj. R2	0.292	0.244	0.391

Note. Daysfrom500/1000/2000cases: number of days taken to get the 1st vaccinated case from the date of 500/1000/2000 cases per million confirmed; tradingwChina/Germany/Russia/UK/USA: the countries' ranking according to their trading value with China/Germany/Russia/UK/USA (import value (\$)); Population_density: population density index; Aged_65_older: share of populations with age 65 and over; Life_expectancy: average life expectancy in years; Vaccinepurchased: number of vaccines doses which countries have contracted to purchase from COVID-19 vaccine manufacturers; Vaccineproduced: dummy binary variables indicating home countries of COVID-19 vaccines manufacturers; WorldBank_Support: money supported by Worldbank to countries for vaccine purchasing purpose; Vaccine_donation_received: number of COVID-19 vaccine doses received from donations. Asia/ Africa/ Europe/ Oceania: dummy continent control. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix A4: Countries in the analysis.

No	ISO Code	Country name	Continent
1	ALB	Albania	Europe
2	ARG	Argentina	South America
3	AUS	Australia	Oceania
4	AUT	Austria	Europe
5	BEL	Belgium	Europe
6	BIH	Bosnia and Herzegovina	Europe
7	CAN	Canada	North America
8	CHL	Chile	South America
9	CHN	China	Asia
10	COL	Colombia	South America
11	CRI	Costa Rica	North America
12	CYP	Cyprus	Europe
13	CZE	Czechia	Europe
14	DNK	Denmark	Europe
15	ECU	Ecuador	South America
16	EST	Estonia	Europe
17	FIN	Finland	Europe
18	FRA	France	Europe
19	GEO	Georgia	Asia
20	DEU	Germany	Europe
21	GRC	Greece	Europe
22	HUN	Hungary	Europe
23	ISL	Iceland	Europe
24	IND	India	Asia
25	IDN	Indonesia	Asia
26	IRL	Ireland	Europe
27	ISR	Israel	Asia
28	ITA	Italy	Europe
29	JPN	Japan	Asia
30	LVA	Latvia	Europe
31	LUX	Luxembourg	Europe
32	MEX	Mexico	North America
33	NLD	Netherlands	Europe
34	NZL	New Zealand	Oceania
35	NOR	Norway	Europe
36	PHL	Philippines	Asia
37	POL	Poland	Europe
38	PRT	Portugal	Europe
39	RUS	Russia	Europe
40	SRB	Serbia	Europe
41	SVK	Slovakia	Europe
42	SVN	Slovenia	Europe
43	ZAF	South Africa	Africa
44	KOR	South Korea	Asia
45	ESP	Spain	Europe
46	SWE	Sweden	Europe
47	CHE	Switzerland	Europe
48	TUR	Turkey	Asia
49	GBR	United Kingdom	Europe
50	USA	United States	North America