Save Lives or Save Livelihoods? A Cross-country Analysis of COVID-19 Pandemic and Economic Growth*

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Abstract

This paper studies whether containing COVID-19 pandemic by stringent strategies deteriorates or saves economic growth. Since there are country-specific factors that could affect both economic growth and deaths due to COVID-19, we first start with a cross-country analysis on identifying risk and protective factors on the COVID-19 deaths using large across-country variation. Using data on 100 countries from 3 January to 27 November 2020 and taking into account the possibility of underreporting, we find that for deaths per million population, GDP per capita, population density, and income inequality are the three most important risk factors; government effectiveness, temperature and hospital beds are the three most important protective factors. Second, inspired by the stochastic frontier literature, we construct a measure of pandemic containment effectiveness (PCE) after controlling for country-specific factors and rank countries by their PCE scores for deaths. Finally, by linking the PCE score with GDP growth data in Quarters 2 and 3 of 2020, we find that pandemic containment effectiveness is positively associated with economic growth in major economies. Countries with average PCE scores, such as Malaysia, would gain more GDP growth by 3.47 percentage points if they could improve their PCE scores for deaths to South Korea's level in Q2 of 2020. Therefore, there is not a trade-off between lives and livelihood facing by governments. Instead, to save economy, it is important to contain the pandemic first. Our conclusion is also mainly valid for infections due to COVID-19.

Keywords: COVID-19; Pandemic Containment Effectiveness (PCE); Economic Growth, Risk and Protective Factors; Underreporting; Ranking
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1 Introduction

On 11 March 2020 WHO Director General characterized COVID-19 as a pandemic. Globally, by the 27 December 2020, there have been more than 80 million confirmed cases of COVID-19, including 1.7 million deaths, reported to WHO. The increasing spread of the coronavirus across countries has prompted many governments to introduce unprecedented public policies and lockdowns to contain the pandemic for saving lives. Such stringent containment policies led to economic disruptions and thus slowed down economic growth. Viscusi (2020) argues that there will be long run economic costs associated with these disruptions. There could be a vicious trade-off facing governments: save lives or save livelihoods. However, Eichenbaum et al. (2020) find that over the long run there exists an optimal containment strategy to reduce economic costs despite a short-term trade-off between economic activity and health outcomes. Hsu et al. (2020) study optimal containment policy for combating a pandemic in an open economy context. Hong et al. (2021) argue that the either/or trade-off misses the benefits of pandemic containment for the economy in the long run. [1]

Different from economists' view, the WHO and IMF think that controlling the pandemic is a prerequisite to saving livelihoods.[2] If the virus is not effectively controlled, people will not be able to consume and hence, the economic recovery will be hindered. From this perspective, pandemic containment could have positive impact on economic growth.[3] Recently, Alvelda et al. (2020) argue that we should save lives first in order to save the economy, by plotting each country's coronavirus deaths against the total economic loss each suffered using data of Quarter 2 (Q2) in 2020.[4] In China's context, Chen et al. (2020) document a strong recovery in April and May 2020 using data of truck flows and online consumption after the 76-day lockdown of Wuhan ended on April 8, 2020.

[1]Cross-country studies that have explored the relationship between the international connectedness and COVID-19 transmission also include Farzanegan et al., (2021a), Hoarau (2021), König and Winkler (2021). In particular, Farzanegan et al. (2021b) find the level of globalization is positively correlated with COVID-19 case fatality rate, after controlling for other country specific factors, while Selvanathan et al. (2021) find positive relationship between international tourism and pandemic outbreak based on infection and death data across 165 countries. Besides, the relationship between pandemic containment and economic recovery have also been extensive discussed by voluminous papers (Magazzino et al., 2021; Wang and Zhang, 2021). In specific, based on the data of six countries during the first wave of pandemic, Coccia (2021) finds that countries with higher spending on healthcare, are able to shorten the duration of lockdown and hence, reduce the subsequent economic costs.

[2]Some say there is a trade-off: save lives or save jobs - this is a false dilemma, April 3, 2020, *The Telegraph.*

[3]"Only Saving Lives Will Save Livelihoods" by Rajeev Cherukupalli and Tome Frieden.

[4]To Save the Economy, Save People First, Nov 18, 2020, Institute of New Economic Thinking.

This paper aims to empirically test whether there is a trade-off between lives and livelihoods using cross-country variation. If we simply link COVID-19 deaths to economic loss using country level data, there is no clear empirical evidence showing deaths per million people are negatively associated with GDP growth, after accounting for country effects. Also, there are many country specific factors, such as GDP per capita, population density, health infrastructure, government effectiveness, etc., that could affect both economic growth and COVID-19 deaths and infections. In the existing literature, several studies have explored the cross-country data to study the economic or governments' responses to the pandemic (Khalid et al., 2021; Milani, 2021; Okafor et al., 2021; Sebuhatu et al., 2020; Shafiullah et al., 2021). However, the definition as well as measure of pandemic containment effectiveness (PCE) have not been extensively discussed. This motivates us to explore the methodology of constructing the PCE index. In other words, this paper contributes to the literature by explicitly quantifying the PCE while controlling for country specific factors. In addition, we test the trade-off between lives and livelihoods by linking our PCE score and GDP growth using cross-country data. Subsequently, a counterfactual analysis shows that a better containment of the pandemic can be translated into GDP gains. This provides policymakers cross-country evidence on designing and implementing optimal pandemic containment strategies when facing significant economic recession due to the pandemic.

In this paper, first, we start with a cross-country analysis on identifying risk and protective factors on the reported deaths due to COVID-19. Second, inspired by the stochastic frontier literature, we construct a measure of pandemic containment effectiveness, after controlling for country-specific factors in the cross-country analysis, and rank countries by their PCE scores for deaths. Third, we estimate the impact of pandemic containment on GDP growth by linking the PCE score with GDP data in Q2 and Q3 of 2020.

In Section 2, we start with how the global pandemic has distributed heterogeneously across countries, by documenting the patterns and statistics for a set of normalized measures by country. This set includes cumulative and daily cases for death per million people, and the case fatality rate (CFR), from 3 January to 27 November 2020. A raw global ranking based on these measures highlights an interesting fact: best and worst countries in the ranking are vastly different in many aspects. "Everyone wants to know how well their country is tackling coronavirus, compared with others", as pointed out in one of the recent BBC reality checks.[5] The United States, for example, has more than 14.4 million of people being infected by COVID-19 on 27 Nov 2020, far more than any other countries. China, on the other hand, only reported 86,601 confirmed cases so far, due to the strict lockdown policies at the beginning of the pandemic. What is underneath the huge variation of the pandemic could be the huge heterogeneity, in some important risk and protective factors of the disease, say, GDP per capita.[6] This motivates our cross-country regression analyses.

Section 3 examines to what extent the substantial variations documented in Section 2 could be explained by a set of predetermined country characteristics. This includes demographic conditions, geographic conditions, economic conditions, global interdependency, healthcare conditions, and public governance. We find there does exist a set of explanatory variables that are robustly significant under different model specifications, across different subsamples, and with reasonable adjustment for the reported death numbers. All else being equal, a country with higher GDP per capita, higher population density, larger income Gini coefficient, fewer hospital beds, lower temperature and lower government effectiveness, tends to have more deaths. For example, all else being equal, a 100% increase in GDP per capita is associated with a 94.4% increase in deaths per million people. Enhancing the government effectiveness from a level of Italy to that of South Korea, would reduce deaths by nearly 96.6%. Given all else being equal, a country with a one standard deviation higher population density than the sample average, expects 65% more reported deaths per million people. A country with 2.60 hospital beds per 1000 people more than the sample average of 3.33, that is, an increase by one standard deviation, would reduce unit deaths by 49.3%, all else being equal. Similarly, a country with 11 degrees Celsius higher from the global average may expect 85.9% lower deaths per million population. More discussions on additional results and robustness checks are delegated to Appendix of Section 7.

Our cross-country regression model provides a useful statistical device. It shows on average how the set of predetermined country characteristics would predict the COVID-19 deaths for each country. As the actual deaths is the outcome of both predetermined country characteristics and the pandemic policies, if we use the global average as a benchmark, the gap between the actual and the predicted numbers is informative about how effectively each

[5] "Coronavirus: Why are international comparisons difficult?" by Chris Morris and Anthony Reuben.

[6] While epidemiologists have been using the SIR models to analyze and forecast the course of the COVID-19 within a country, there are a number of heterogeneities that are important in practice but are not incorporated in the baseline versions of SIR models (Avery, et al, 2020). The importance of heterogeneity calls social scientists to advance the relevant literature using alternative approaches.

country has been dealing with the COVID-19 relative to others.[7] Based on this rationale, and inspired by the stochastic frontier literature, we construct a measure of pandemic containment effectiveness (PCE) and thus provide a global ranking. We find that for some countries, such as China and the US, their rankings do vary a lot over the pandemic course; and for other countries, such as Singapore, their rankings do vary by infections or by deaths. We also find some countries who have been consistently exceptionally better or worse than the global average, after controlling for a large set of predetermined country characteristics.

Based on the cross-country analysis and the PCE scores in Sections 3 and 4, Section 5 empirically examines the relationship between economic growth and pandemic containment performance in major economies using the data in Q2 and Q3 of 2020. We find that the empirical results do not reflect the trade-off between economic activities and the pandemic containment. Instead, there is a significant and positive impact of pandemic containment effectiveness on economic growth. Countries with average PCE scores, such as Malaysia, would gain more GDP growth by 3.47 percentage points if they could improve their PCE scores for infections to South Korea's level in Q2 of 2020.

2 Data and Patterns on Infections and Deaths

Various sources have been tracking the confirmed infections and deaths by country over time. In this paper we use the data from WHO, which are officially reported by the Center for Disease Control and Prevention or Ministry of Health or equivalent of each country. As reported by the WHO, the first mass vaccination started in early December 2020. On 31 December 2020, *Pfizer* vaccine was issued the first emergency use validation from the WHO, indicating the world-wide access to the vaccines. Besides, a new variant of COVID-19 virus, known as *B.1.1.7* (or *Alpha*), was first found in the UK and then began to widely spread in mid-December 2020. Therefore, to avoid confounding factors of vaccination as well as new virus variants in our analysis, we collect number of reported deaths of COVID-19 from 3 January to 27 November 2020 on a daily basis for 100 countries, which have complete information on all the independent variables in our regression analyses.[8] Particularly, it is

[7]The gap may still contain the impact of other variables that are not observed or controlled for. We tried our best to include important variables as many as possible and conducted a series of robustness checks in the appendix. In addition, we also assume that the idiosyncratic pandemic policy responses can be smoothed out along with panel data, so the residual can be informative about the distance to the most containment effective country.

[8]The data are available at the WHO website.

worth taking note that even though there might be potential underreporting issue for both cumulative infections and cumulative deaths which in turn affect our empirical results, the magnitude of such discrepancy is vastly different. As found by Rahmandad et al. (2020), the estimated cumulative infections across 86 countries through July 2020 are 10.5 times higher than the official reports, while the estimated deaths is just 1.47 times above the reported values. In other words, data of reported deaths suffers less from underreporting compared to reported infections. Therefore, in our paper we only report the our main empirical results based on reported deaths due to COVID-19 and provide results based on infections as supplementary in the Appendix.

⟨Figure 1 here⟩

Since its first emergence in late 2019, COVID-19 has rapidly spread to most of the countries in the world. They started increasing rapidly around the declaration of global pandemic by WHO on 11 March. During the last month of our sample period, on average, the coronavirus has infected almost 600,000 people and killed more than 10,000 people worldwide every day, suggesting that the global transmission of the virus has not been under control. The time series plots of global cumulative and daily cases can be found in Figure A1a and A1b in the Appendix. Here we compare the COVID-19 outbreak across countries by plotting daily deaths per million people for four representative countries, Vietnam, China, the US, and Luxembourg, in Figure 1. We find that the scale of the COVID-19 outbreak varies substantially among countries. Vietnam has the lightest outbreak with its highest daily deaths of 0.3 per million people, while that of China is more than 3 times higher. However, the pandemic outbreak is markedly severer in the US and Luxembourg as their maximal daily deaths are around 20 and 17 per million people, respectively. Why are the deaths so different, even after being normalized by population size?

⟨Table 1 here⟩

To better examine the heterogeneity of COVID-19 outbreak across countries, we provide the summary statistics and a raw global ranking for cumulative infections and cumulative deaths per million population, and the CFR in Table 1.[9] Firstly, the substantial difference between minimum and maximum values of pandemic outcomes across countries suggests that

[9]Please take note that the summary statistics are based on reported data without accounting for potential underreporting issue.

most of the worst 10 countries are either developed countries or large emerging economies, while most of the best 10 countries are developing countries. Why the COVID-19 seems severer within countries that are economically more developed? One possible explanation is that economic activities are much higher in developed countries and hence, this causes greater transmission of virus. Alternatively, a lower average income is usually associated with poorer healthcare conditions and public governance, which may lead to more underreporting and hence fewer reported infections and deaths.

Another interesting observation is that the geographical location may also affect infections and deaths as the worst 10 countries are mainly from Europe and the Americas, while most of the best 10 countries are from Africa and South East Asia. Finally, it is also worthwhile to point out that, although there is a large overlap in the list of worst and best countries for infection and death rates, some countries with very bad infection rates may have relatively low death rates. For example, Qatar is one of the worst countries in terms of infections per million people but is among the 10 best countries for CFR.

Overall, all these comparisons and observations suggest that, it is important to control the large heterogeneity in other factors that may affect the death rate in a statistical way, in order to provide a fair global ranking on the pandemic containment effectiveness. This motivates our regression analyses in Section 3.

3 Cross-country Regression

3.1 Empirical Specification

Since different countries were hit by the pandemic on different time points, we put them in same phases of the pandemic by considering the following regression:

$$y_{it} = \beta_0 + \beta_1 X_i + \beta_2 Z_{it} + f(Days_{it}) + \varepsilon_{it}. \qquad (1)$$

Here y_{it} represents the number of cumulative reported deaths per million people, for country i. Different from a usual panel data regression, here t represents days since the first reported death was reported in a country, instead of a calendar date.

X_i denotes a set of predetermined variables that may affect how vulnerable a country is inherently to COVID-19. Z_{it} refers to additional time-varying control variables that may affect the reported deaths besides X_i. As the outbreak of COVID-19 took place in different countries on different dates, a common time trend, $Days_{it}$, days since the first reported death was reported in country i on date t, is included in the regression in a nonlinear form $f(\cdot)$ to control for the impact of different outbreak dates on deaths.[10]

The time-invariant coefficients β_1 and β_2 capture the average effects of X_i and Z_{it} on y_{it} over time. However, depending on the epidemiology of the disease, the same set of variables may have different predicting power to the pandemic over time. In addition, some explanatory variables which are essential determinants in an early stage may become less relevant at a late stage, or the other way round. To allow for time-varying β_1 and β_2, we also run regression of (1) using subsamples made of different weeks over the pandemic course.

Unlike Janiak et al. (2021), who focus on the impacts of pandemic policies such as sanitary protocols on pandemic and economic outcomes, regression (1) does not explicitly include any COVID-19 pandemic policies that countries have been adopting. Although understanding the causal effect of specific policies is crucially important, it is not the goal of this paper. Instead, here we take a reduced-form approach to assess the relative effectiveness of the pandemic policies as a whole for each country. Denote such policies as W_{it}. The deaths in a country y_{it}, should be affected by W_{it}, on top of X_i and Z_{it}, i.e.,

$$y_{it} = \alpha_0 + \alpha_1 X_i + \alpha_2 Z_{it} + \alpha_3 W_{it} + g(Days_{it}) + \eta_{it}. \tag{2}$$

However, such containment policies, by definition, must depend on the situation of the pandemic itself and would be endogenous if they were included in our regressions. Furthermore, as pointed out in Angeli and Montefusco (2020), the containment policies are highly dependent on initial country-specific characteristics. Similarly, Wright et al. (2020) also find that the compliance rate of pandemic containment policies such as shelter-in-place protocols is higher among residents of higher income regions in the US, implying that the effectiveness of such containment policies depends on country-specific factors. That is, W_{it} itself may also depend on X_i and Z_{it}, in addition to y_{it}, which implies that we could write W_{it} as,

$$W_{it} = \pi_0 + \pi_1 X_i + \pi_2 Z_{it} + \pi_3 y_{it} + h(Days_{it}) + \xi_{it}. \tag{3}$$

Plugging W_{it} in equation (2) by (3) and solving for y_{it} leads to equation (1). Therefore, the regression (1) can be regarded as a reduced-form equation for y_{it} from a system of structural

[10] A quadratic form of $f(\cdot)$ is considered in our analysis. In our regression, the logarithm of deaths is used. After taking natural logarithm, deaths per million population no longer exhibits an exponential trend.

equations (2) and (3). As such, coefficients β_1 and β_2 in regression (1) can be interpreted as the overall effects of X_i and Z_{it} on y_{it}.

It is worth noting that to address this research question why the deaths are so different across country, a cross-country regression using a cross-section sample would serve this purpose. However, compared with a cross-section regression, our static regression model (1) using daily observations helps improve the accuracy of estimates.[11] Of course, the regression (1) above with a daily-frequency structure does not account for autocorrelations of both the dependent variable and the time-varying regressors, which could explain a significant part of variation in deaths. However, achieving a better model fit by accounting for the autocorrelation in the data is not the main target of this paper. Our approach is to adopt a static model and leave the dynamics (or autocorrelation) in the errors. The autocorrelation in the errors can be addressed by using clustered standard errors at the country level.[12]

3.2 Data on Independent Variables

Motivated by existing literature on COVID-19 and economic intuitions, we consider six categories of factors in X_i:

i. Demographic conditions (total population, ratio of population 65 years and above, and population density);

ii. Geographic conditions (average temperature and rainfall in March);

iii. Economic conditions (GDP per capita and income Gini coefficient);

iv. Global interdependency (international visitors and international trade);

v. Healthcare conditions (health expenditure as a share of GDP, number of hospital beds per 1,000 people, and SARS outbreak dummy);

vi. Public governance (government expenditure as a share of GDP and government effectiveness index constructed by the World Bank).

⟨Table 2 here⟩

[11] In a special case of no Z_{it} and $f(Days_{it})$, a pooled OLS of regression (1) using a sample of 9 days would have standard errors one third those in a cross-section regression.

[12] As pointed by one referee, a dynamic panel model would be more appropriate when infection and fatality rates are dynamically correlated with their lagged values and government's containment policies. However, to answer the research question why the deaths are so different across country, we mainly rely on cross-section variation to identify among the list of predetermined variables risk and protective factors of the pandemic. And these time-invariant variables X_i cannot be identified in popular dynamic panel data models, e.g., Anderson–Hsiao or the Arellano-Bond approaches. As pointed out in Section 2 of Blundell and Bond (1998), this static model in regression (1) can have a dynamic representation with lagged dependent variable and both contemporaneous and lagged terms of Z_{it} on the right-hand side.

All these variables are fixed and taking values before 2020. In other words, they are exogenous to the outbreak of COVID-19 in our regression analyses. Since there are more than 20 variables for these predetermined factors used in regressions with various specifications, due to limited space, we include the detailed information of these variables in the Appendix, including definitions, years observed and data sources. Table 2 reports their summary statistics.

Besides X_i, we also include two other explanatory variables in Z_{it} as additional controls. The first one is the number of cumulative infections in the rest of the world. This is to control both the potential externality from other countries and the prevailing trend in the course of a global pandemic. The second is the test ratio for COVID-19, defined as the number of people tested for COVID-19 per million people, which is considered as exogenous in our analysis.[13] This is because the testing capability of a country is highly unlikely to change in the short-run. Hence, including the test ratio into the regressions is one way to mitigate the underreporting concerns.

We consider the test ratio as an equilibrium quantity for testing demand and testing supply in a country. The demand for testing depends on both the severity of COVID-19 and the testing criteria in a country. The supply for testing is mainly determined by the capacity and the willingness to test, which largely depends on its predetermined healthcare conditions and public governance. Therefore, conditional on the healthcare conditions and public governance, if two countries have the same severity of COVID-19, the country with a lower test ratio is more likely to have underreported infection cases due to a stricter testing criterion.

3.3 Main Findings

Tables 3 reports the regression results for equation (1) for deaths per million people, respectively. Column (1) is the benchmark results with full sample. Across all these regressions, an R^2 around 0.65 suggests that our explanatory variables explain a big part of variations of the observed deaths across the world.

⟨Table 3 here⟩

[13] It is likely that test ratio could be affected by pandemic policy and thus endogenous. In this case, it should be included in W_{it} and its coefficient should be interpreted as reduced form coefficient. On the other hand, since it could take a few weeks or months to improve the testing capacity, it would be reasonably considered as exogenous for a short period. In a robustness check, we replace test ratio with its lagged value by one month, which is not affeced by the current infections and deaths.

These empirical exercises aim to identify the risk and protective factors for deaths. As potential data underreporting could be a serious concern for interpreting meaningful empirical results, we only report the results for deaths to uncover significant and robust patterns as our main empirical findings. Additional results for infections are discussed in the Appendix.

First, across the large set of our empirical exercises, we find that *GDP per capita*, *population density*, and *Gini coefficient* are the three most important risk factors, and *government effectiveness*, *temperature*, and *hospital beds* are the three most important protective factors for deaths. Figure 2 visualizes our main findings by sorting the risk factors on the right and the protective factors on the left for deaths. The corresponding magnitudes measure the percentage change in deaths per million people due to one standard deviation increase in each of these factors, based on their estimated coefficients in column (1) of Table 3, together with the summary statistics in Table 2.

⟨Figure 2 here⟩

We start our discussion with the effect of GDP per capita on deaths. The coefficient 0.944 interpreted as the elasticity of infections with respect to GDP per capita, implies that a country with a 100% higher GDP per capita may expect 94.4% more reported cumulative deaths per million people, all else being equal. A unit elasticity of GDP per capita on death rate is very close to similar studies using cross-country data, such as Goldberg and Reed (2020). The importance of average income may explain a striking fact that most of the top 10 countries with the highest deaths per million people listed in Table 1, have relatively higher GDP per capita compared to the top 10 countries with least deaths. This somewhat unpleasant finding is consistent with Adda's (2016) findings on incidence of several viral diseases in France over a quarter of a century. As higher GDP per capita implies more market production, consumption, as well as social activities and interaction among people, leading to more deaths. Thus, this finding may indicate that economic activity is a fundamental mechanism for the spread of the epidemic.

Population density is the second most important contributing factor of deaths, suggesting that a country with a dense population is more vulnerable to the spread of COVID-19. The elasticity of 0.184 implies that all else being equal, a country with a one standard deviation higher population density than the sample average, expects 65% more reported deaths per million people. Combining the big impacts of both GDP per capita and population density on reported deaths, it is logical to expect large infection numbers in many megacities in developed economies, such as New York City, London, and Milan.

Income inequality measured by *Gini coefficient* is the third most important factor that induces more reported deaths. The coefficient 0.042 suggests that on average, a country with a higher Gini coefficient than the cross-country average by one standard deviation could witness 34.2% more cumulative deaths per million people. While identifying the exact mechanisms on why inequality could spread COVID-19 is beyond the scope of this paper, our cross-country findings echo the statement of Ahmed et al. (2020) that pandemics rarely affect all people in a uniform way.[14]

Among the three most important protective factors, *government effectiveness* and *hospital beds* are of our key interest, as they have directly applicable policy implications. The government effectiveness index used here is provided by the Worldwide Governance Indicators, and reflects the performance of government in the quality of public services and policy implementation, and the credibility of the government's commitment.[15] By the definition of this index, the government effectiveness is expected to be closely related to the quality and implementation of pandemic containment policies in one country, e.g., mandates of wearing masks, social distancing, and lockdowns. However, its protective effect is surprisingly remarkable. In Table 3, we observe that the coefficient -1.098 suggests that an increase in government effectiveness index by one standard deviation from the sample average, a value close to Italy's, to the value of South Korea, would reduce unit deaths by 96.6%, holding other explanatory variables constant. This finding is in line with Liang et al. (2020), who find COVID-19 mortality has negative relationships with test number and government effectiveness.

Another important protective factor comes from the number of hospital beds, a key measure of medical infrastructure. Its coefficient -0.631 suggests that a country with 2.60

[14]This could become worse when the economy was hit heavily by the pandemic which leads to higher unemployment rate, especially among those lower income people. Such findings are also supported by Dingel and Neiman (2020). They find that jobs that can be done remotely usually pay more than those that cannot be done at home. In other words, people with lower income are more exposed to the COVID-19 compared to people with higher income. Again, this suggests that people are not uniformly affected by the pandemic. Specifically, greater income inequality is associated with higher infection or death rates.

[15]By the definition in the Worldwide Governance Indicators, the government effectiveness index reflects the performance of government in the following fields: (1) the quality of public services; (2) the quality of civil services and the degree of its independence from political pressures; (3) the quality of policy formulation and implementation; (4) the credibility of the government's commitment to such policies. The data of government effectiveness index collected here is in 2018.

hospital beds per 1000 people more than the sample average of 3.33, that is, an increase by one standard deviation, would reduce unit deaths by 49.3%, all else being equal. Our finding illustrates that adequate medical infrastructure can effectively reduce the death of infectious diseases. This is consistent with the findings by Okoi and Bwana (2020) on the importance of access to health services in addressing the COVID-19 outbreak in Sub-Saharan Africa.

As the third robust protective factor, *temperature* also has a big negative impact on the COVID-19 deaths, indicating that a higher temperature is not conducive to the survival and spread of the viruses that cause deaths. The coefficient of -0.078 infers that countries with 11.01 degrees Celsius higher from the sample average (14.78 degrees Celsius) expect 85.9% lower unit deaths. This evidence may suggest why countries from Africa and South East Asia, are on average hit relatively less severely by the pandemic during the sample period. The blessing effect of high temperature is consistent with many epidemic-related researches, such as Bannister-Tyrrell et al. (2020).

In addition, we address the underreporting issue and conduct robustness checks in Table 3.[16] In particular, we first adjust our dependent variable with the universal health coverage (UHC) and the voice and accountability (VA) as both indices are expected to have inverse relationship with the tendency of underreporting. Secondly, we also add results of random effects (RE), correlated effects models (CRE), and fixed effect filtered (FEF) estimates in Table 3. The results are all consistent with our benchmark results in column (1) of Table 3. Besides that, we also add a series of robustness checks in Tables A2-A5 in the Appendix. Overall, the results are robust to different subsamples, different measure of dependent variable and additional explanatory variables.

4 Pandemic Containment Effectiveness: A Global Ranking

In Section 3, risk factors and protective factors have been identified to explain the huge cross-country variations observed in cumulative deaths, after being normalized by population size. In this section, we aim to rank countries by their pandemic containment effectiveness performance in terms of deaths, after controlling for the predetermined and time-varying observable factors. The rankings and constructed effectiveness scores can be regarded as an indirect and holistic inference on how effective the pandemic public policies have been on

[16] Please refer to the Appendix for more details.

reducing deaths relative to other countries.

Recently, Viscusi (2020) applies the value of a statistical life (VSL) to monetize COVID-19 deaths, and estimates that the costs of the US and global mortality over 100 countries are \$1.4 trillion and \$3.5 trillion, respectively, in the first half of 2020. Inspired by Greene (2004) on the cross-country health care comparison, we treat regression equation (1) as a production process, with deaths as outputs. In light of the fact that COVID-19 deaths are associated with huge medical costs and GDP loss due to economic activity disruptions, regression equation (1) can be interpreted as a process similar to a cost function.

Inspired by the stochastic cost frontier literature, we decompose the error term in equation (1) into two parts: a one-sided inefficiency term $u_{it} \geq 0$ and a two-sided idiosyncratic error v_{it}: (Greene, 2007, pp.117, 137),

$$\varepsilon_{it} = u_{it} + v_{it}. \tag{4}$$

The inefficiency term $u_{it} \geq 0$ measures the deviation from the cost frontier. A larger value of u_{it} implies higher costs associated with deaths and the corresponding country i is less cost effective. The idiosyncratic error v_{it} is considered as a measurement error.

Kumbhakar et al. (2015) summarize several approaches to estimate cost efficiency in stochastic frontier models with cross-sectional data and panel data, including maximum likelihood estimation, corrected ordinary least squares (COLS) and panel data methods. To be in line with coefficient estimation results in Section 3, COLS is adopted in our context. Denote e_{it} the pooled OLS residual obtained from equation (1): $e_{it} = y_{it} - \hat{y}_{it}$. As in equation (4.29) of Kumbhakar et al. (2015, p.109), an efficiency measure

$$\exp(min_j e_{jt} - e_{it}) \tag{5}$$

can be used for cost effectiveness for country i on day t when ranking countries.

However, as pointed out in the literature, this approach could be vulnerable to extreme values in the data. In specific, its accuracy could be contaminated by the presence of the zero-mean random shock v_{it} in the error term ε_{it}. To make good use of panel data in our sample and smooth out v_{it}, we can split the sample into K periods, i.e.,$T_1, \ldots, T_K$, and use a time-average of e_{it} over a time period from $T_{k-1}+1$ to T_k, say a two-week period, i.e., $\bar{e}_i(T_k) = \frac{1}{T/K} \sum_{t=T_{k-1}+1}^{T_k} e_{it}$.

Similar to the cross-sectional data counterpart of (5), $\bar{e}_i(T_k)$ can be considered as a measure of deviation from the cost frontier. A country with a smaller value of $\bar{e}_i(T_k)$ is more cost effective or efficient. Intuitively, its actual deaths are smaller relative to its model predictions. In specific, for a time period over which we assume that u_{it} is relatively stable, i.e.,

$$u_{it} = u_i(T_k) \text{ and } \varepsilon_{it} = u_i(T_k) + v_{it},\ t = T_{k-1}+1, \ldots, T_k. \tag{6}$$

Given that the COLS residual e_{it} is a consistent estimator of ε_{it}, v_{it} can be smoothed out in the time-average $\bar{e}_i(T_k)$ for the period T_k. In this case, $\bar{e}_i(T_k)$ can be regarded as a good estimator of the inefficiency term $u_i(T_k)$, the distance to the cost frontier for the period T_k.

Recall that ε_{it} is the error in the reduced form equation (1). One concern is that governments' pandemic containment policies W_{it} are not included in equation (1) and thus ε_{it} is a mix of the residual impacts of the pandemic and residual policy responses to the pandemic. In specific, $\varepsilon_{it} = (\eta_{it} + \alpha_3\xi_{it})/(1-\alpha_3\pi_3)$, where η_{it} is the residual impacts of the pandemic in the structural equation (2) and ξ_{it} is the residual pandemic policy responses in equation (3). To separate the impact of residual pandemic policy responses, ideally, η_{it}, instead of ε_{it}, should be used to construct a measure of deviation from the cost frontier. However, without sufficient information on W_{it} in (2) and dealing with endogeneity in (3), η_{it} cannot be identified. Under the assumption that ξ_{it} is an idiosyncratic shock with $E\xi_{it} = 0$, $\frac{1}{T/K}\sum_{t=T_{k-1}+1}^{T_k} \xi_{it}$ is close to zero, implying that residual pandemic policy responses can be smoothed out in the time-average $\bar{e}_i(T_k)$. Thus, η_{it} can be identified by ε_{it} up to a scale $(1/(1-\alpha_3\pi_3))$ in this panel data model (6), and $\bar{e}_i(T_k)$ can be considered as a good estimate of the time-invariant part of η_{it}.[17]

We rank all 100 countries in our sample based on $-\bar{e}_i(T_k)$ by using their corresponding 14-day averaged residuals obtained from regression (1) in respective pandemic weeks. A country with a larger value of $-\bar{e}_i(T_k)$ has a higher ranking. Like the efficiency measure in (5) which lies in (0,1), a normalized *pandemic containment effectiveness* (PCE) score for country i the period T_k is defined as:

$$PCE_i(T_k) = \frac{max_j\bar{e}_j(T_k) - \bar{e}_i(T_k)}{max_j\bar{e}_j(T_k) - min_j\bar{e}_j(T_k)},\ k = 1, \ldots, K. \tag{7}$$

A PCE score hence is constructed by taking all the predetermined country specific factors such as government effectiveness, geographical location, demographic condition into account.

[17] W_{it} can be considered as monetary value of inputs of panedemic policy responses, i.e., additional manpower, facilities, increasing with infections and deaths in equation (3), implying that $\pi_3 > 0$. Pandemic policy responses are used to repress the spread of virus, thus $\alpha_3 < 0$ in equation (2). Ranking based on $\bar{e}_i(T_k)$ and the PCE score defined in equation (7) are free from the scale parameter $1/(1-\alpha_3\pi_3) > 0$.

Using PCE_i, the country which is the most pandemic containment effective or cost efficient in the sample achieves a score of 1 and the least effective one scores 0. Countries with a smaller number of ranking are more effective in constraining the pandemic in terms of deaths.[18]

Since equation (7) is a monotonically increasing function of $-\bar{e}_i(T_k)$, the ranking based on $PCE_i(T_k)$ is same as that based on $-\bar{e}_i(T_k)$. In the same spirit as the two-sided technical efficiency measure proposed by Feng and Horrace (2012), $PCE_i(T_k)$ has the advantage of having a same scale across the sample, so that PCE score differences among different countries are comparable. In this sense, PCE scores are cardinal. A cardinal measure of PCE scores makes it possible to use its difference to explain cross-country GDP growth variation in the next section.

Figure 3 presents PCE rankings of 10 selected countries in terms of deaths. Except China, Iran and Philippines, the rest of countries in the sample with death cases either have their first death case in March and April or at least three weeks after their first confirmed infection case. Thus, we use the $\bar{e}_i$ from column (1) of Table 3, that is since first confirmed death as a common starting point for our PCE ranking exercises. In this way, we are comparing China on 11 January with Italy on 23 February, the US on 3 March and the UK on 7 March, and onwards. As we observe from Figure 3, during the first 2 weeks after first reported death, the US performed the best among the 100 countries. In comparison, China's PCE ranking is at the very bottom among the 10 selected countries because the spread of virus in China was drastically fast during its initial stage. Thanks to the prompt responses, massive resource mobilization and strict containment policies, its PCE ranking improves steadily over time. By late June, China achieved the 21^{st} spot out of 97 countries, indicating that the COVID-19 has been effectively contained. In contrast, the PCE ranking for the US has been declining quickly since week 5 to 6, consistent with the massive outbreak in the US starting at the end of March. Nevertheless, at the end of our sample period, despite the US has the world's highest number of deaths, its PCE ranking is 45^{th} out of 97. This suggests the importance of controlling for the risk factors and protective factors for a fair global ranking. Overall, Japan has a steady and high PCE ranking since its first two weeks. Brazil, Spain, and the UK have been performing persistently poorly, while New Zealand, South Korea and Japan,

[18] It is worth noting that the PCE is not equivalent to *pandemic policy effectiveness*, which is related to the effects of pandemic policies on infections or deaths, measured by α_3 in equation (2). Our PCE score is based on the distance to the cost frontier, relative to the most effective country in the sample. In addition, it is also different from the variable of government effectiveness, which is a measure of public governance.

are among the most efficient group.

⟨Figure 3 here⟩

Interestingly, Singapore's PCE ranking in terms of deaths is constantly high, which is vastly different from its PCE ranking in terms of infections in Figure A5 in the Appendix.[19] In other words, despite its high cumulative infections due to the massive dormitory transmission among migrant foreign workers, the number of its cumulative deaths is one of the lowest in the world. This is consistent with its advanced health infrastructure and well-known government effectiveness, two most important protective factors for death highlighted by our empirical exercises.

5 Pandemic Containment and Economic Growth

In this section, we examine whether pandemic containment effectiveness is associated with economic growth. In specific, GDP growth is regressed on the pandemic containment effectiveness measured by PCE scores obtained in section 4. Thus, the hypothesis on the trade-off between the lives and livelihoods can be tested by looking at the effect of PCE. Due to data availability, we collect data of GDP growth in the first three quarters of 2020 for 73 and 70 major economies, respectively. The quarterly GDP growth rates are on a year-over-year (YoY) basis with seasonal adjustment. The regression model considered here is:

$$\text{Growth}_i = \gamma_0 + \gamma_1 PCE_i(T_k) + \text{controls}_i + \epsilon_i. \tag{8}$$

As in the ranking analysis of Section 4, we use PCE instead of a raw measure of deaths here, thus, effects of country-specific factors on deaths can be controlled. Control variables in regression (8) here include cumulative announced economic stimulus spending (in USD) and economic support index as fiscal measures collected from the Oxford Coronavirus Government Response Tracker (OxCGRT) database. For a better interpretation of the parameter of interest γ_1, a PCE score multiplied by 100 is included in regression equation (8).

[19]We construct the two-week average of existing indices such as the Oxford Stringency Index and compare it with our proposed PCE score. The correlation between the two scores are negative throughout our sample period. This implies that the more stringent containment policies do not necessarily lead to better performance in containing COVID-19 as there may exists reverse causality. Therefore, our PCE score provides additional information about the pandemic containment across countries compared to existing indices.

As reported by the WHO, most countries in our sample reached their first death around March 2020. Therefore, for GDP growth in Q1 of 2020 we consider the PCE scores measured at weeks 3-4 after the first death in these countries, implying that most countries in the sample are at the end of March 2020. Similarly, for GDP growth in Q2 and Q3 of 2020, respective PCE scores measured in weeks 15-16 and weeks 27-28, corresponding to late June and late September 2020, are used in the regression (8).

Table 4 presents the estimated impacts of PCE for deaths on GDP growth. Column (1) reports the cross-section regression for GDP growth in Q2 of 2020 with control variables. Similarly,the regression for GDP growth in Q3 of 2020 is included in column (2) of Table 4. The positive and significant PCE score coefficients in these regressions suggest that those countries that control the pandemic more effectively achieve higher economic growth rates. The magnitude of 0.105 in column (1) and 0.074 in column (2) shows that on average 1.05 and 0.74 percentage points of GDP would be added if a country could increase its PCE score (multiplied by 100) for deaths by 10 points in Q2 and Q3 of 2020, respectively.

⟨Table 4 here⟩

Equivalently, this implies that countries with average PCE scores (0.54), such as Denmark, Malaysia, and Switzerland in Q2 of 2020, would gain 3.47 more percentage points in their GDP growth if they could improve their PCE scores for deaths to South Korea's level (0.87) in Q2 of 2020, respectively. The lost GDP growth rate of 3.47 can be translated into 11.68 Billion USD in Malaysia in Q2 of 2020. This also echoes the findings in Dai et al. (2021) that firms' resilience to the pandemic shock is largely determined by their business performance.

To address the potential concern of endogeneity due to the reverse causality between deaths and economic stimulus (and fiscal situation), and unobserved country-specific factors, a first-difference (FD) estimate using both Q2 and Q3 of 2020 data is reported in column (3) of Table 4. Since the data collected by OxCGRT on economic stimulus and fiscal situation is time-invariant during the sample period, these controls are omitted in column (3). FD estimation here also controls other country-specific factors that could potentially affect GDP growth. The result shows that the FD coefficient of PCE is still significantly positive at 10% nominal level, which is consistent with our findings in the previous two columns.

For robustness checks, first, we run the regression (8) using data of Q1 of 2020 in column (4). As expected, the coefficient of PCE is -0.003 and insignificant, suggesting that pandemic containment effectiveness has no significant impact on economic growth in Q1 of 2020. Second, in columns (5)-(7), we examine the lag effect of PCE scores on GDP growth by altering the subsamples of Q2 of 2020 from weeks 15-16 to weeks 13-14, Q3 of 2020 from weeks 27-28 to weeks 23-24, respectively. In this case, the PCE scores are measured by different pandemic weeks within same quarters. Similarly, the coefficients of PCE scores are still significantly positive throughout these columns and the FD coefficient is even more significant at 1% nominal level, implying that the positive relationship between pandemic containment effectiveness and economic growth is stable within a short period. Third, in columns (8)-(11) we report results by excluding countries with smaller size in Asia, South America and Africa.[20] We observe similar patterns throughout these columns.

Additionally, one may argue that the economic growth of a country is also be affected by country-specific factors. To address this concern, we control for GDP per capita, Gini coefficient, total population, population 65+, international trade, and government expenditure, which are included in the regression (1), in addition to economic stimulus spending and economic support index in equation (8). The results are reported in columns (1)-(3) in Table 5.

⟨Table 5 here⟩

By construction, the PCE score, a linear function of the averaged residuals of regression (1), is uncorrelated with these additional contry-specific variables included in regression (1). Thus, it is not surprising to see that the coefficients of PCE in columns (1)-(3) of Table 5 are similar to those in columns (1), (2), and (4) of Table 4. We still observe significantly positive coefficients associated with PCE score, suggesting its conducive impact on GDP growth, after accounting for country-specific factors. The coefficient in Q1 is insignificant which is also consistent with our previous findings in Table 4.

Besides, we also include more countries in columns (4)-(6) in Table 5 by collecting yearly GDP growth from the International Monetary Fund (IMF) database. In particular, we regress the annual GDP growth on the quarterly PCE scores in equation (8). Similar to the

[20]We include 38 OECD and G20 countries and Singapore. The 48 countries include Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russian Federation, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, the UK, Turkey, and the US.

results in columns (1), (2) and (4) of Table 4, we still observe that PCE scores are positively related to economic growth, indicating a country with higher effectiveness in terms of deaths will achieve higher GDP growth subsequently.

6 Conclusion

Does battling COVID-19 pandemic bust or save economic growth? To answer this question, we first find out that the substantial variation in the cross-country deaths is indeed associated with many contributing factors. Our empirical exercises suggest that countries with a higher population density, lower temperatures, a higher average income, and more income inequality, are predicted to be more vulnerable to the global pandemic. Although most of these factors are either impossible or undesirable to change, there are certainly other factors that countries could improve, for example, the healthcare infrastructure, and in particular, the effectiveness of a government.

Next, the cross-country regression analyses allow us to identify groups of countries that are exceptionally better or worse than predicted in a systematic way. As our ranking exercises can be regarded an indirect and holistic inference on the pandemic policy efficiency, it could help policymakers to think why one country might be doing better than another, and what they can learn from that. For example, Edwards (2020) claims that the relative success of New Zealand in managing the virus could provide an opportunity for countries in the Pacific region to explore the pathway of recovery from COVID-19. We also find the importance of some risk and protective factors does change over time. This could be useful to policy makers in those countries hit by the pandemic later than other countries to make good use of the protective factors and to best prevent or respond to risk factors. In addition, some protective factors such as hospital beds are not possible to expand especially for some developing countries with financial constraints. Alternatively, our findings suggest that those developing countries could switch to improve their income inequality via wealth transfer or improve their government effectiveness instead. For developed countries, on the other hand, they have the capability to improve all the protective factors as they have less constraints. In this case, all of the countries could be well prepared not only for COVID-19 but for any such crisis in the future.

Most importantly, our cross-country empirical results show a significant positive relationship between the pandemic containment effectiveness and economic growth. In particular, countries with higher PCE score are able to achieve higher GDP growth. The key policy implication of our findings is that battling COVID-19 better helps to boost the economic growth.

In addition, a counterfactual analysis also suggests that countries with average PCE scores, such as Malaysia, would gain more GDP growth by 3.47 percentage points if they could improve their PCE scores for deaths to South Korea's level in Q2 of 2020. This provides constructive insights for policymakers when implementing the optimal containment policy. In particular, policymakers could quantify such a trade-off in terms of monetary values, which has not been extensively discussed in the existing literature.

Finally, there is still room for improvement in our paper. First, our proposed PCE score provides a measure to rank countries on their pandemic performance. Future research may improve our findings by using state or city level data instead of country level, to allow for more variations. Next, in the main analysis, we measure international interdependency by number of international tourists and international trade shares. Moreover, we incorporate a SAR model to quantify the spatial spillovers in the robustness checks. Future research could explore models such as gravity model as a good alternative to examine the connectedness between economic activities or human mobility and respective pandemic outcomes. Moreover, it would also be interesting to investigate the relationship between pandemic containment and economic growth by accounting for the impact of vaccination. Lastly, this paper uses data up to November 2020, in order to avoid any confounding factors of COVID-19 new variants and vaccination. Future research may extend the sample period to account for new variants such as Delta and Omicron.

7 Appendix I: Additional Results on Risk and Protective Factors

To provide an overview of the global situation, we display the time series plots of global cumulative and daily cases in Figure A1a and A1b, respectively. An exponential form of global cumulative infections and deaths is revealed in Figure 1a. Specifically, the curves were relatively flat in January and February 2020. The fact that early to middle March is the global outbreak point is also revealed in Figure 1b by the sharp increase of daily cases. After April, daily infections continue growing, while daily deaths show a flattening trend. Starting from June, the number of daily infections rises quickly again although daily death cases stay relatively stable. Subsequently, we observe a second wave of pandemic outbreak as daily confirmed cases increased rapidly again at the beginning of October 2020. Table A1 reports summary statistics of additional variables used in regressions.

⟨Figure A1a and A1b here⟩

7.1 Addressing Underreporting

There have been many media reports, based on anecdotes and some anatomies, on how individual countries may have omitted or concealed infection and death cases. The academia has tried to infer the magnitude of underreporting under various assumptions and with the auxiliary of some additional information, such as Bommer and Vollmer (2020), Hortaçsu et al. (2021), Li et al. (2020), and Stock et al. (2020). However, most of these researches focus on individual countries. The estimated magnitude also varies vastly across different researches. To address the underreporting issue in a cross-country setup, we first show evidences from our empirical analyses that are consistent with the presence of underreporting. This motivates us to adjust our dependent variables in a systematic way to address underreporting. We then examine whether our main findings are robust to such adjustment.

In column (1) of Table 3, we have reported the full sample for death regression. Interestingly, health expenditure is significantly positive for both infections and deaths, which seems to be counterintuitive. However, if we focus on the subsample of countries with top 25% COVID-19 virus test ratios reported in column (2) of Table 3, the coefficient of health expenditure changes from positive to negative. This is no longer counterintuitive. This pattern seems consistent with our conjecture that death data is subject to underreporting.[21]

Motivated by this empirical finding, we adjust the deaths data by the country-specific universal health coverage (UHC) index and the voice and accountability (VA) index. The UHC index, provided by the World Bank, measures coverage index for essential health services that people have access to without financial hardship, including services of reproductive, maternal, newborn and child health, infectious diseases, and non-communicable diseases. UHC

[21] Countries with higher health expenditures or government expenditure, on the one hand, may have a better medical system or public sector, which will contribute to reducing the infection and death rates. On the other hand, these countries could be more confident to roll back COVID-19, resulting in less underreporting and more confirmed cases. Thus, the regression coefficients are the joint outcome of these two opposing forces. All else being equal, countries with a higher test ratio on average are less likely to underreport and are more likely to deliver reliable results. This explains why healthcare expenditure and government expenditure have different or opposite effects in the full sample and in the sub-sample.

is presented on a scale of 0 to 100, and a higher index suggests stronger medical capability and easier access to health services. The VA index is provided by the Worldwide Governance Indicators. It reflects the degree of freedom of people in a country, including participation in selecting their government, freedom of expression, freedom of association, and free media. We normalize the VA index from the original -2.5 to 2.5 into a scale of 0 to 100, too, where a higher index implies a louder voice of people and more transparent information.

Presumably, the magnitude of underreporting in a country is largely determined by its testing regimes and reporting guidelines, which should be inversely related to UHC and VA.[22] Thus, we modify our dependent variables by multiplying the number of infection or death with the square root of (100-UHC) or (100-VA) in two separate robustness checks, reported in columns (3) and (4) of Table 3.[23] Under this adjustment, for a country with the lowest UHC or VA, we assume its actual deaths are nine times larger than the reported numbers. For the rest countries, the magnitude of underreporting decreases with UHC and VA in a declining fashion. Thus, we assume that unless a country has the full score in UHC and VA, there is always some underreporting. As we obtain in Table 3, no matter whether the adjustment index is UHC or VA, the results in columns (3) and (4) are very similar to those in column (1) of Table 3. This implies that our main findings are robust to underreporting, at least to the type of adjustment we have applied.

7.2 Robustness Checks

To control for the country effects, we add results of random effects (RE) and correlated random effects models (CRE) in columns of (5) and (6) in Table 3 as robustness checks. In addition, fixed effect filtered (FEF) estimates proposed by Pesaran and Zhou (2017) are also reported in column (7) of Table 3. Though the coefficients of RE, CRE, and FEF are slightly different from the baseline results in column (1), the main findings are unchanged.

[22]By analyzing all available data on international COVID-19 cases from 20 January until 18 February 2020, Lau et al. (2020) find those countries with lower Healthcare Access and Quality (HAQ)-index either may underreport COVID-19 cases or are unable to detect them adequately. The HAQ and UHC index are highly correlated with a coefficient of 0.860. We obtain very similar results for column (3) of Table 3, if we adjust the deaths data with HAQ.

[23]Multiplied by the square root of (100-UHC) or (100-VA), the adjusted infections or deaths can be from 200% to 1000% those reported numbers in the paper. This range is in line with the findings in literature. Stock, et al. (2020) estimate the percentage of undetected infections ranged from 88.7% to 93.6% in the US in March 2020. Li, et al. (2020) report that 86% of cases were undocumented before travel restriction in China. Albani (2021) find that infections can be 32–632% larger between March to July and 10-238% larger between July to December 2020.

A series of additional robustness checks are presented in Tables A2-A5 discussed in the Appendix. Particularly, in Table A2, we include month dummies in column (1). It turns out that the results are consistent with the benchmark findings in Tables 3. Moreover, the coefficients of the dummies generally increase over time, which motivates our second robustness check. In columns (2) and (3), we divide the full sample into two subsamples, January to April and May to November. As shown, most of the risk factors in column (3) have significantly larger coefficients than those of column (2), again suggesting the massive transmission of virus at a later stage. More interestingly, the coefficient of international trade in columns (2) and (3) of Table A2 turns from positive to negative, after changing the sample period from Jan-April to May-Nov. This is partly due to the stringent pandemic containment and border control policies imposed by many countries at later phase of COVID-19.

To address potential concern on autocorrelation in the data, in column (4) of Table A2, cross-country regression results using one observation for each country (105^{th} day since the first death case) are reported. Though adjusted R^2 slightly decreases to 0.503 in Table A2 from 0.647 in column (1) of Table 3, the important risk and protective factors remain valid with similar coefficients. This comparison indicates that our findings mainly come from cross-country variation, instead of time series variation, and thus autocorrelation is less of a concern. Besides, as the mechanism of death rate could be different in the epicenter and in the rest of the world, it is important to know whether our findings are robust by excluding China from the sample. Also, it is possible that the relationship between death per million people and population density is mainly driven by the size of countries. In this case, we exclude small countries with population density above 1,000 people per square kilometer in column (5) of the table. It turns out that the conclusion for all the protective and risk factors remains and the impact of population density on death rate become even more pronounced. Column (6) of Table A2 shows that excluding the initial epicenter from our sample has little impact on our main findings.

Lastly, test ratio could be endogenous since it could be considered as one containment measure and depend on infections and deaths. To address this concern, we reexamine the regression (1) by replacing the current value of daily test ratio with its 30-day lag in column (7) of Table A2, as its lagged value is less likely to be affected by the current value of deaths or infections. Overall, column (7) of Table A2 presents similar results to those in column (1) of Table 3.

⟨Table A2 here⟩

7.3 Results Using Weekly Subsamples

To allow for time-varying β_1 and β_2, we also run regression (1) using weekly subsamples and plot the estimates together with their 95% confidence intervals by week in Figure A2 for deaths. As there could be many random factors in the first week of a pandemic and there are too few observations in the later weeks, only results from week 2 to week 30 are presented.

⟨Figure A2 here⟩

Consistent with Table 3, same set of risk and protective factors are also identified in Figure A2, using weekly subsamples. More interestingly, a salient pattern is that the magnitude of some risk factors and protective factors do change over time, suggesting the importance of different factors along the course of the pandemic.

Overall, we can observe that the importance of most of the protective and risk factors increases over time. In particular, GDP per capita becomes the most prominent risk factor by the end of the sample period, while that of population density remains relatively flat. From the perspective of protective factors, government effectiveness and temperature both have consistent protective power against the pandemic over time, while that of hospital beds remains constant after five pandemic weeks. This is in line with our common sense as the government plays a critical role in containing the pandemic and the number of hospital beds within a country is very unlikely to expand in the short run.

7.4 Additional Robustness Checks

Additional robustness checks are presented in Tables A3-A5. In Table A3, we first control for spillover effects from neighboring countries. In particular, we include continent dummies in column (1), while in column (2), we account for spillovers of the pandemic from neighboring countries of the same continent. The results are consistent with the findings in Table 3. Next, we exclude African countries as those countries may be outliers due to much higher average temperature and potential underreporting issues. The results in column (3) of Table A3 indicate that there is little impact on our main findings by excluding African countries. Moreover, since the global outbreak started around March, the climate in the northern is completely different from those of southern hemispheres. Therefore, we exclude the countries in the southern hemisphere and report the results in column (4) of Table A3. We observe that the main risk and protective factors remain unchanged.

⟨Table A3 here⟩

Additionally, we also examine the robustness by dividing countries into two subgroups. Specifically, we use samples of OECD and European countries in columns (5) and (6), respectively. Since countries belong to the same economic zone usually share similar government regimes, therefore, it accounts for all country-specific characteristics. Compared with the results shown in column (1) of Table 3, most of the factors have become less significant in the two columns. One possible explanation is that the variations of GDP per capita, Gini coefficient, and number of hospital beds are small for countries in Europe.[24]

The next set of robustness checks investigate whether our results are sensitive to the sample of countries included. In column (7) of Table A3, we exclude countries with population sizes less than two million. This is similar as excluding countries with population density above 1,000 people per square kilometer in column (5) of Table A2. The results are generally similar compared to the baseline results in column (1) of Table 3. This suggests that our findings are not driven by including either too small countries or too crowded countries.

Furthermore, we also experiment with an alternative measure for the death rate. In our main results, the death rate is defined as the number of deaths per million people. An alternative definition is the CFR, which represents the proportion of deaths among all the infected individuals. Presumably, the data on CFR is more likely subject to measurement error problem, as it depends on two variables: the denominator - infections and the numerator -deaths. Besides, the reporting guidelines for infections, and for deaths, could vary substantially across countries or even over time within a country. Thus, we only restrict our analyses to those countries with the highest 25% test ratios. The results in column (8) of Table A3 are consistent with our baseline findings. Similar to column (1) of Table 3, GDP per capita is the most important risk factor, while hospital beds and government effectiveness remain to be the most important protective factors. What is more interesting is that the magnitudes of all these factors are even larger for CFR than for the number of deaths per million people. Particularly, the coefficient of population 65+ has changed from -0.006 in the benchmark to 0.470. This result is more intuitive as age is the most prominent risk

[24]This is also the case for subsample results using countries in European Union. Given a small number of countries, little variation of variables leads to unreliable results.

factor for death (see Karlsson et al., 2014). Also, the magnitude of government effectiveness has increased by more than three times from -1.098 to -3.348.

Next, we include alternative controls to further examine the determinants of deaths in Table A4. More specifically, we include percent of people living in urban areas to control for demographic factors in column (1), and the share of employment in agriculture to account for economic conditions in column (2), respectively. As shown, the coefficient of urban population ratio is positive but insignificant in column (1) of Table A4. On the other hand, countries with higher shares of employment in the agriculture sector may expect fewer reported cumulative deaths. Overall, the results are consistent with our main findings. It also provides a reason of why developed countries have been hit harder by the pandemic.

⟨Table A4 here⟩

Also, we include other measures of government effectiveness in World Governance Indictors in order to examine the impacts of lockdown or cross-border measures on the pandemic outcomes. Columns (3), (4), and (5) of Table A4 show the results accounting for control of corruption, political stability, and rule of law, respectively. As expected, we observe significantly negative coefficients of political stability and rule of law, indicating important protective factors. The results emphasize the importance of government regulation and enforcement. Additionally, the importance of government effectiveness declines, compared to our main findings in Table 3. One potential reason is that the impact of government effectiveness is partly explained by these additional three measures.

In addition, we also address spatial spillovers from neighboring countries by a Spatial AutoRegressive (SAR) model (Lee, 2002). In particular, we replace the infection rate from rest of the world (ROW) with a spatial lag term in column (6) of Table A4. The spatial lag term is defined as the sum of death rates in the rest of the countries, weighted by a weighting matrix which contains information of economic distance. The economic distance in the weighting matrix is computed by the international trade shares among the 100 countries. As shown in the table, the coefficients of spatial lag term are significantly positive, indicating that higher death rates in neighboring countries, weighted by the economic distance, lead to a higher pandemic outbreak in country i. Also, the results of both risk and protective factors still remain, which implies that our empirical results are robust to different measures of pandemic spillovers from the rest of the world.

We also examine the robustness by including variables of government debt, industrial production output and population mobility in the regression (1) separately and all together. The results are reported in Tables A5. Particularly, we collect the information of government debt ratio from CEIC, industrial production ratio from the world bank, and the Google mobility index from the community mobility report. The results show that our main findings are almost unchanged.

⟨Table A5 here⟩

Finally, one may argue that the positive relationship between PCE score and economic growth found in our empirical results is simply because those countries were hit less by the pandemic and hence, incurred less economic loss. Consequently, we conduct another robustness check by replacing the PCE score with raw death measures as our explanatory variable. Table A6 lists the regression results of economic growth over deaths.

⟨Table A6 here⟩

In columns (1) and (2), we observe significantly negative coefficients of death rate in Q2 and Q3, which suggests that countries with higher death rate, achieve lower economic growth in the subsequent quarter of 2020. This is consistent with our main empirical findings. After accounting for country specific fixed effects, however, we find significantly positive coefficient of death rate in column (3), which is counterintuitive. On the other hand, the results of Q1 in column (4) is still insignificant indicating the fact that the GDP growth in Q1 is not heavily affected by the pandemic. Also, we still find similar results after controlling for other country-specific factors included in regression (1) in columns (5), and (6). In addition, similar results are obtained even though the coefficients become less significant if we exclude countries with small size in Asia, South America, and Africa in columns (7)-(10).

8 Additional Results for Infections

We now supplement our results by switching to the regression (1) with infection rate as the dependent variable. Firstly, in column (1) of Table A7, a coefficient of 1.207 for GDP per capita interpreted as the elasticity of infections with respect to GDP per capita, implies that a country with a 100% higher GDP per capita may expect 120.7% more reported cumulative infections per million people, all else being equal.

⟨Table A7 here⟩

Population density is the second most important contributing factor of infections, suggesting that a country with a dense population is more vulnerable to the spread of COVID-19. The elasticity of 0.319 implies that all else being equal, a country with a one standard deviation higher population density than the sample average, expects 112.7% more reported infections per million people.

Income inequality measured by *Gini coefficient* is the third most important factor that induces more reported infections. The coefficient 0.039 suggests that on average, a country with a higher Gini coefficient than the cross-country average by one standard deviation could witness 31.8% more cumulative infections per million people.

Among the two most important protective factors, *government effectiveness* is of our key interest, as it is directly applicable policy implications. Its protective effect is surprisingly remarkable. The coefficient -0.870 suggests that an increase in government effectiveness index by one standard deviation from the sample average, a value close to Italy's, to the value of South Korea, would reduce unit infections by 76.6%, holding other explanatory variables constant.

As the second robust protective factor, *temperature* also has a big negative impact on the COVID-19 infections, indicating that a higher temperature is not conducive to the survival and spread of the viruses. The coefficient of -0.068 infers that countries with 11.01 degrees Celsius higher from the sample average (14.78 degrees Celsius) expect 74.9% lower unit infections. The impacts of risk and protective factors on infections are visualized in Figure A3 below.

⟨Figure A3 here⟩

Comparison between Figures 2 and A3 also reveals a few interesting findings. First, *GDP per capita*, *population density*, and *Gini coefficient* are also the three most important risk factors for infections with relatively larger magnitude. Second, some predetermined factors are less pronounced on infections than on deaths. In particular, the coefficients of *hospital beds* becomes insignificant when using infection rate as the dependent variable, suggesting that it is no longer a protective factor for infections. The coefficient of *temperature* in column (1) of Table 3 is -0.078, that is 1.15 times compared to their corresponding coefficients for infections reported in column (1) of Table A7.

Next, we also allow for time-varying coefficients by using weekly subsamples for our baseline regression. Overall, these changes are consistent with our expectation and echo the time-varying patterns of parameters highlighted in Figure A2. The only exception is that *hospital beds* is no longer a protective factor for infection rate and hence, it is not reported in Figure A4.

⟨Figure A4 here⟩

In addition, we also conduct the same sets of robustness checks for infection rate and present the results in Tables A8-A11. The only difference is that we use the CFR as the dependent variable in Table A3, while we use observations since the first 50 infection cases instead of the first case in column (8) of Table A9. This is to address the concern that some countries, such as the US, there has been a long-time gap between the first imported case and the subsequent large-scale outbreak. We report the results in column (8) of Table A9. The effects of government effectiveness are even more pronounced. Overall, we still obtain similar results compared to the baseline model in column (1) of Table A7.

⟨Tables A8, A9, A10, and A11 here⟩

8.1 Global Ranking for Infections

For infections, to rule out the big randomness in early days of infections, we use the $\bar{e}_i$ from column (8) of Table A9, after the first 50 confirmed infection cases for our PCE ranking exercises. In this way, we are comparing China on 3 January with Italy on 23 February, the US on 24 February and the UK on 3 March, and onwards. As we observe from Figure A5, during the first 2 weeks after the first 50 confirmed infections, the US performed the best in terms of infection among the 99 countries. Again, China's performance in terms of infection was at the bottom (95^{th}) among affected countries and then, its ranking improved after the implementation of strict containment policies. By late June, China achieved the 6^{th} spot out of 98 countries, indicating that the COVID-19 has been effectively contained. In contrast, the PCE ranking for the US has been declining quickly since week 5 to 6, consistent with the massive outbreak in the US starting at the end of March. Similarly, at the end of our sample period, the PCE ranking of the US is 73^{rd} out of 98 even though it has the highest number of infections in the world, again suggesting the importance of controlling for the risk factors and protective factors for a fair global ranking. Overall, Japan still has a steady and high PCE ranking in terms of infection over the whole sample period. South Korea, New Zealand, and Italy improve their rankings over time, while countries such as Brazil and Spain perform persistently below the average.

⟨Figure A5 here⟩

8.2 Growth Regression for Infections

The regression results using PCE for infections are presented in Table A12. Column (1) reports the cross-section regression for GDP growth in Q2 of 2020 with control variables. Similarly, regressions for GDP growth in Q3 of 2020 are included in column (2). The positive and significant PCE score coefficients in these regressions suggest that those countries that control the pandemic more effectively achieve higher economic growth rates. The magnitude of 0.158 in column (1) and 0.115 in column (2) show that on average 1.58 and 1.15 percentage points of GDP would be added if a country could increase its PCE score (multiplied by 100) for infections by 10 points in Q2 and Q3 of 2020, respectively.

⟨Table A12 here⟩

In other words, countries with average PCE scores (0.47), such as Australia, Finland, and Mexico in Q2 of 2020, would gain 4.58 more percentage points in their GDP growth if they could improve their PCE scores for infections to South Korea's level (0.76) in Q2 of 2020, respectively. The lost GDP growth rate of 4.58 can be translated into 123.66 Billion USD in Mexico in Q2 of 2020.

Similarly, to address the potential concern of endogeneity due to the reverse causality between infections and economic stimulus (and fiscal situation), and unobserved country-specific factors, a first-difference (FD) estimate using both Q2 and Q3 of 2020 data is reported in column (3) of Table A12. The result shows that the FD coefficient of PCE is significantly negative, while that of Table 4 is significantly positive. For other robustness checks, we replicate Table 4 by using PCE score for infections instead of deaths throughout columns (4)-(11). Similarly, the coefficients of PCE scores are still significantly positive throughout these columns, implying that the positive relationship between pandemic containment effectiveness and economic growth is stable within a short period. Some counterintuitive results in columns (4) and (10) are mainly due to the underreporting in infections. In general, the robust findings in these two tables suggest that there is no a clear trade-off between lives and livelihood facing by governments and international agencies. Instead, to save economy, it is important to contain the pandemic first.

Next, we also examine the robustness by accounting for more country-specific factors in equation (8) for infection rate in Table A13. As we observe from the table, we consistently obtain significantly positive impact of PCE scores in terms of infection rate against both annual and quarterly GDP growth rate. This also supports our findings in Table 5 using PCE scores for death rate.

⟨Table A13 here⟩

Finally, we replicate the robustness checks in Table A6 by replacing the PCE scores with raw infections per million people in Table A14. Overall, the results based on infection rate are mostly consistent with our main findings based on death rate, even though there are still some discrepancies due to severe underreporting of infection number.

⟨Table A14 here⟩

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10 Appendix II: Additional Information on Data

The data used in this study are all collected from official sources that are publicly available. Our explanatory variables include six categories: demographic conditions, geographic conditions, economic conditions, global interdependency, healthcare conditions and public governance. This data appendix provides a detailed definition and data source of these variables.

10.1 Demographic Conditions

10.1.1 Total Population

The World Bank provides us the midyear estimate of the total population in 2018, which are combined from the United Nations Population Division and Census reports of different national statistical offices. All residents, regardless of legal status or citizenship, belong to the total population of each country. We fill in any missing value of the total population in 2018 with the latest value we can obtain from the same source in an early year. The same procedure is applied to all the other explanatory variables if missing values arise to ensure the data integrity.

10.1.2 Population 65+

Population65+ is calculated by taking the ratio of the population age 65 and above to the total population. The definition of the total population is discussed above, while the population age 65 and above is offered by the World Bank. The World Bank staff estimates the total population age 65 and above by using the source of age/sex distributions of the United Nations Population Division's World Population Prospects: 2019 Revision. The latest data is for 2018, and we fill in the missing value with the latest value we can obtain.

10.1.3 Population Density

To reduce measurement error, we use land area instead of the territorial area to calculate population density. The World Bank provides land area (sq.km) in 2018, which excludes area under inland water bodies, national claims to continental shelf, and exclusive economic zones, collected by the Food and Agriculture Organization (FAO) of the United Nations through annual questionnaires. Population density is the total population divided by land area in square kilometers.

10.1.4 Urban Population Ratio

The World Bank provides us with the urban population ratio updated to 2018, which is the proportion of the population living in the urban areas as defined by the National Bureau of Statistics to the total population. The data is calculated by using population estimates and urban ratios from the United Nations World Urbanization Prospects.

10.2 Geographic Conditions

10.2.1 Temperature, Rainfall

Temperature and rainfall are provided by the Climate Change Knowledge Portal, a portal under the World Bank to comprehensive country data related to climate change. We use the average temperature ($^\circ$) and average rainfall (mm) across countries in March 2016 as proxies of temperature and rainfall during the pandemic of COVID-19. The data for 2016 is the latest data available on the website, and climate change is not significant in just a few years. Besides, the COVID-19 is characterized as a pandemic by WHO in March. Thus, we believe the data of March 2016 are reasonable proxies.

10.3 Economic Conditions

10.3.1 GDP per capita

The World Bank provides GDP across countries in 2018, which is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Data are in current U.S. dollars. GDP per capita is GDP divided by the total population we defined above.

10.3.2 Debt ratio

The CEIC data provides us with the quarterly data of debt ratio, which is the proportion of the national government debts to nominal GDP. The debt ratio is calculated by monthly government debt and rolling sum of quarterly nominal GDP. We use the average debt ratio of 2019 as proxies of government debt position and fill in the missing value with the latest value we have.

10.3.3 Gini Coefficient

Based on primary household survey data of the most recent year, the World Bank constructs the Gini coefficient, measuring the degree of inequality in a distribution. The Gini coefficient is the ratio of the area between the Lorenz curve and a hypothetical line of absolute equality over the total area under the hypothetical line of absolute equality. Thus, a Gini coefficient of 0 implies perfect equality, while a coefficient of 100 implies perfect inequality.

10.3.4 Employment in Agriculture

The World Bank provides us with an estimate of the ratio of employment in the agriculture sector to total employment. Employment refers to persons of working age who are engaged in activities to produce goods or provide services for pay or profit. Any activity in agriculture, hunting, forestry, and fishing belongs to the agriculture sector. We collected data for 2018 and fill in the missing value with the latest value we can obtain.

10.3.5 Industrial ratio

The industrial ratio is the percentage of industry value added to GDP, provided by the World Bank. Industry includes mining, manufacturing, construction, and electricity, water and gas, corresponding to ISIC divisions 05-43 and ISIC divisions 10-33. Value-added refers to net output after adding up all outputs and subtracting intermediate inputs. We collected data for 2019 from the World Bank.

10.4 Global Interdependency

10.4.1 International Visitor

Collected data from the World Tourism Organization, the World Bank provides us with the number of international inbound tourists in 2018. International inbound tourists refer to people who travel to a country other than their usual residence and usual environment for a period not exceeding 12 months. Also, the primary purpose of this travel is other than an activity remunerated from within the country visited. The international visitor variable in our study is normalized by taking the natural logarithm of international visitors per million people.

10.4.2 International Trade

Using the import and export of goods of each country in 2018 provided by United Nations Comtrade, we construct a measure of global interconnectedness. We start with a matrix where the first row is filled country 1's import from and export of goods to country 2, 3, 4, and so on, respectively. The rest rows have a similar definition. The diagonal of the matrix, which is the country's import and export of goods to itself, is 0. Then we normalize this matrix from absolute values into shares of import and export of each country, using its total import and export to the rest of the world. For data in row i and column j, it measures the effect on the country i from each country j. International trade is calculated by summing up all the shares in one column, let's say column j. It measures the weighted interconnectedness of country j with respect to the rest of the world. Ideally, this measure should be based on by-country international passengers from a country and into a country. However, such information is not publicly available. Thus, we use the by-country import and export of goods as an alternative.

10.5 Healthcare Conditions

10.5.1 Health Expenditure

The World Bank provides us with current health expenditure expressed as a percentage of GDP in 2017, which stems from the WHO Global Health Expenditure Database. Estimates of this variable include the consumption of healthcare goods and services during each year but exclude capital health expenditures such as buildings, machinery, IT, and stocks of vaccines for emergencies or outbreaks.

10.5.2 GHS

We collected the Global Health Security (GHS) index from the official website of GHS index. The GHS index is developed by considering the following six categories: (1) disease prevention; (2) detection and reporting for epidemics; (3) rapid response to pandemic; (4) strong health systems; (5) compliance with international norms; (6) overall risk environment. The overall score of health security is from 0 (weak) to 100 (strong).

10.5.3 Hospital Beds

The information of hospital beds per 1,000 people is offered by World Bank who supplement WHO's original data by country data. The latest data available is for 2015, with massive missing values. Thus, a large amount of data is supplemented by data in the previous years, such as 2013 or 2014. Hospital beds include inpatient beds that can be used in public, private, general, and specialized hospitals and rehabilitation centers. In most cases, this also includes emergency and chronic beds.

10.5.4 SARS Outbreak

SARS outbreak is a dummy variable, which equals one if the country reported probable cases of SARS in 2003. The source is collected from Cumulative Number of Reported Probable Cases of Severe Acute Respiratory Syndrome (SARS), reported by WHO.

10.6 Public Governance

10.6.1 Government Expenditure

Government expenditure refers to the ratio of general government final consumption expenditure to GDP. It includes most government and security expenditures such as the purchases of goods and services, compensation of employees, and expense of national defense and security. However, it excludes government military expenditures that are part of government capital formation. We collect the source in 2018 from the World Bank database.

10.6.2 Political regimes

The Our World in Data combines the Wimmer and Min (2006) and Center for Systemic Peace to provide the political regime worldwide. The range of this variable is from -10 (autocracy) to 10 (full democracy). We collected the data for 2015 as proxies of political regimes during the pandemic of COVID-19.

10.6.3 Government Effectiveness

We collected the data of government effectiveness in 2018, provided by the Worldwide Governance Indicators. Estimates of government effectiveness reflect the performance of government in the following field: (1) the quality of public services; (2) the quality of civil services and the degree of its independence from political pressures; (3) the quality of policy formulation and implementation; (4) the credibility of the government's commitment to such policies. The range of this variable is from approximately -2.5 (weak) to 2.5 (strong).

10.6.4 Control of Corruption

We collected the data of control of corruption in 2018, provided by the Worldwide Governance Indicators. Estimates of control of corruption capture the extent to which public power is exercised for private gain. This behavior mainly includes two aspects: (1) petty and grand forms of corruption; (2) capture of the state by elites and private interests. The range of this variable is from approximately -2.5 (weak) to 2.5 (strong).

10.6.5 Political Stability

We collected the data of political stability in 2018, provided by the Worldwide Governance Indicators. Its full name is Political Stability and Absence of Violence/Terrorism, which measures the probability of political instability and politically motivated violence, including terrorism. The range of this variable is from approximately -2.5 (weak) to 2.5 (strong).

10.6.6 Rule of Law

We collected the data of rule of law in 2018, provided by the Worldwide Governance Indicators. It mainly captures the people's trust and compliance with social rules in the following field: (1) contract enforcement; (2) property rights; (3) the quality of police and courts; (4) the possibility of crime and violence. The range of this variable is from approximately -2.5 (weak) to 2.5 (strong).

10.7 Additional Controls

10.7.1 Rest of World Infections

Based on the daily number of infections of COVID-19 for each country from WHO, we construct the rest of world infection relative to a country by calculating cumulative infection cases of COVID-19 excluding the country itself.

10.7.2 Rest of Region Infections

We construct the rest of region infection relative to a country by calculating the cumulative infection cases of COVID-19 in the same region excluding the country itself. Being in the same region is defined as being on the same continent. Based on the classification of WHO, we divided the world into 6 continents, including Africa, Americas, Eastern Mediterranean, Europe, South-East Asia and Western Pacific.

10.7.3 Daily Test Ratio

We download the total COVID-19 tests performed by country from the Our World in Data, that compiles sources from different government databases and only updates from time to time. At the moment of our current empirical exercises, which is 18 December, the most recent complete data for our country list is up to 15 December. We use this latest test data of each country to construct the time-variant daily test ratio. The number of daily test is filled with value of zero before the first test performed in the country, in order to construct a balanced panel dataset. The daily test ratio in our paper is normalized by taking the natural logarithm of total test per million people.

10.7.4 Google mobility indices

The COVID-19 Community Mobility Reports reported by Google provide the movement trends over time across different places including retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential. We collect these six mobility indices from 15 Feb 2020 to 27 Nov 2020, which show the percentage change of the movement over time in these different places. The baseline day is the median value from the 5-week period from 3 Jan 2020 to 6 Feb 2020. For any day from Monday to Sunday, there is a baseline day. That is, the baseline is not a single value.

10.8 Additional Variables

10.8.1 Quarterly Economic Growth Rate

The economic growth rate is defined as the GDP growth rate compared to the same quarter in the previous year with seasonal adjustment. The sample period is from 2020Q2 to 2020Q3, for all the OECD countries and Singapore. The data source is OECD.Stat database and Singapore Department of Statistics. We also include more countries in our regression model (8) by switching to the CEIC database.

10.8.2 Annual Economic Growth Rate

The annual economic growth rate is defined as the annual GDP growth rate in year 2020, on a year-on-year basis. More countries are included compared to our quarterly data. The data is collected from the World Economic Outlook database.

10.8.3 Economic Stimulus Spending

The variable records cumulative monetary value in USD of fiscal stimuli since 1 January 2020, includes any spending or tax cuts since the outbreak of COVID-19, excluding international support, emergency investment in healthcare, and investment in vaccines. We take the natural logarithm of it in our regression models (1) and (8). The data source is Oxford COVID-19 Government Response Tracker database.

10.8.4 International Support

The variable records cumulative monetary value in USD of international announced offers of COVID-19 related aid spending to other countries since 1 January 2020. We take the natural logarithm of it in our regression model (1). The data source is Oxford COVID-19 Government Response Tracker database.

10.8.5 Economic Support Index

The index measures how much economic support has been made available (such as income support and debt relief since the outbreak of COVID-19. The value of the index is between 0-100. The data source is Oxford COVID-19 Government Response Tracker database.

10.8.6 Containment and Closure Policies

The set of variables record containment and closure policies stringency since 1 January 2020. It includes: (1) school closing; (2) workplace closing; (3) cancel public events; (4) restrictions on gatherings; (5) close public transport; (6) stay at home requirements; (7) restrictions on internal movement, repectively. A value of zero suggests no measures for each containment and closure policy, while larger value implies more stringent policy. The data source is Oxford COVID-19 Government Response Tracker database.

10.8.7 COVID-19 Economic Stimulus Index

The set of data constructed by Elgin et al. (2020), covers 166 countries and records their corresponding: (1) fiscal policy stimulus; (2) interest rate cut; (3) macro-financial package; (4)other monetary measures; (5) balance of payment (BoP) measures; (6) other BoP measures. While other monetary measures and other BoP measures are binary dummy variables, the rest of the variables are all in percentage form.

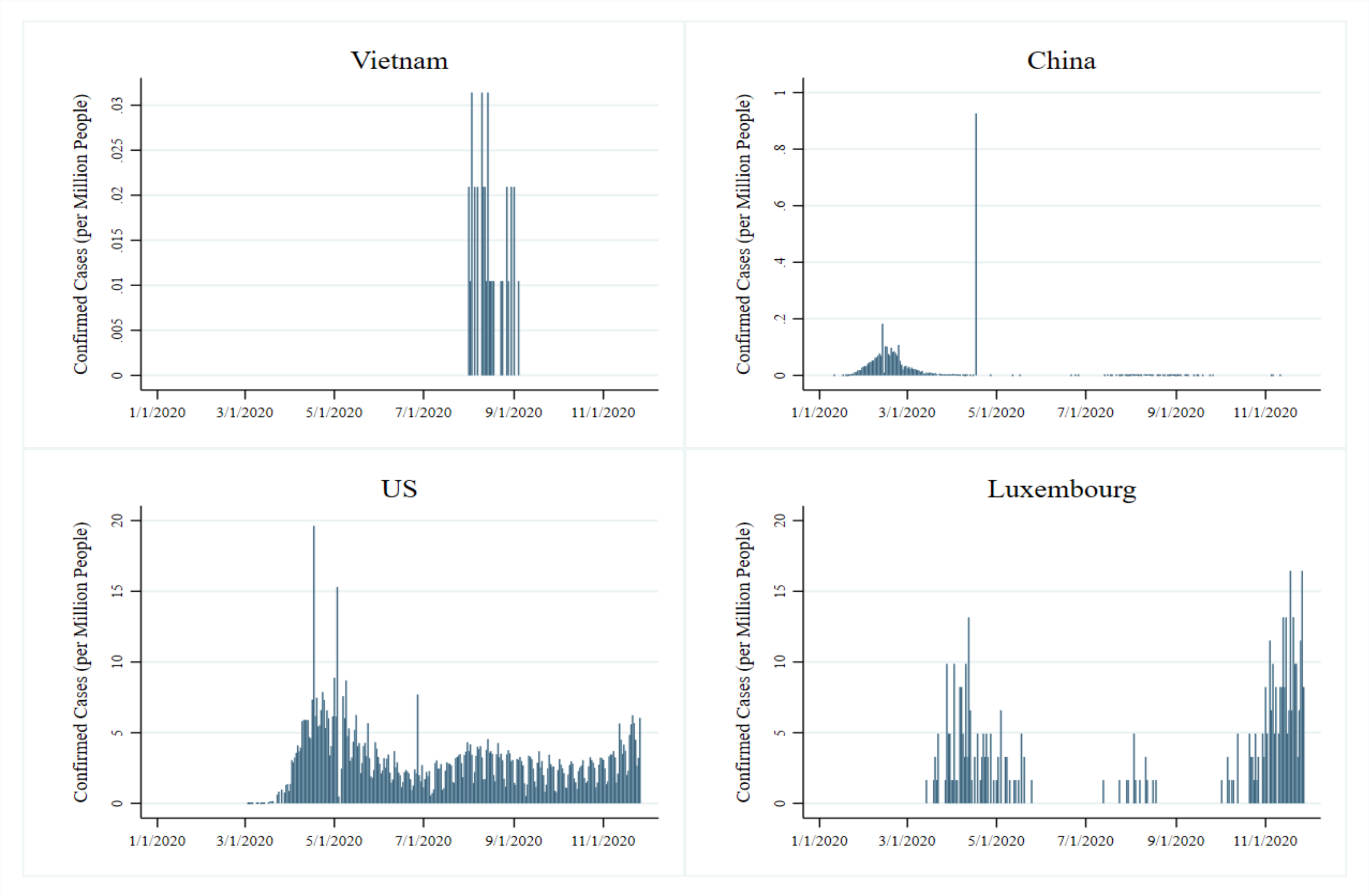

Figure 1: Daily Deaths of Four Representative Countries

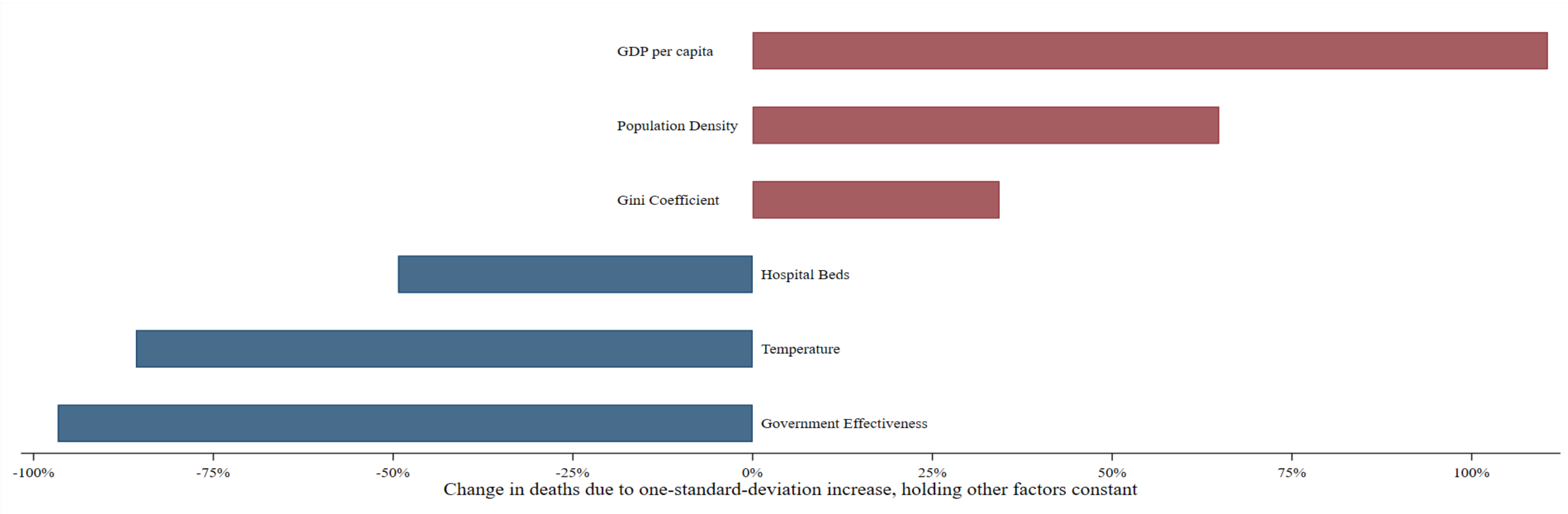

Figure 2: Impacts of Risk and Protective Factors on Deaths

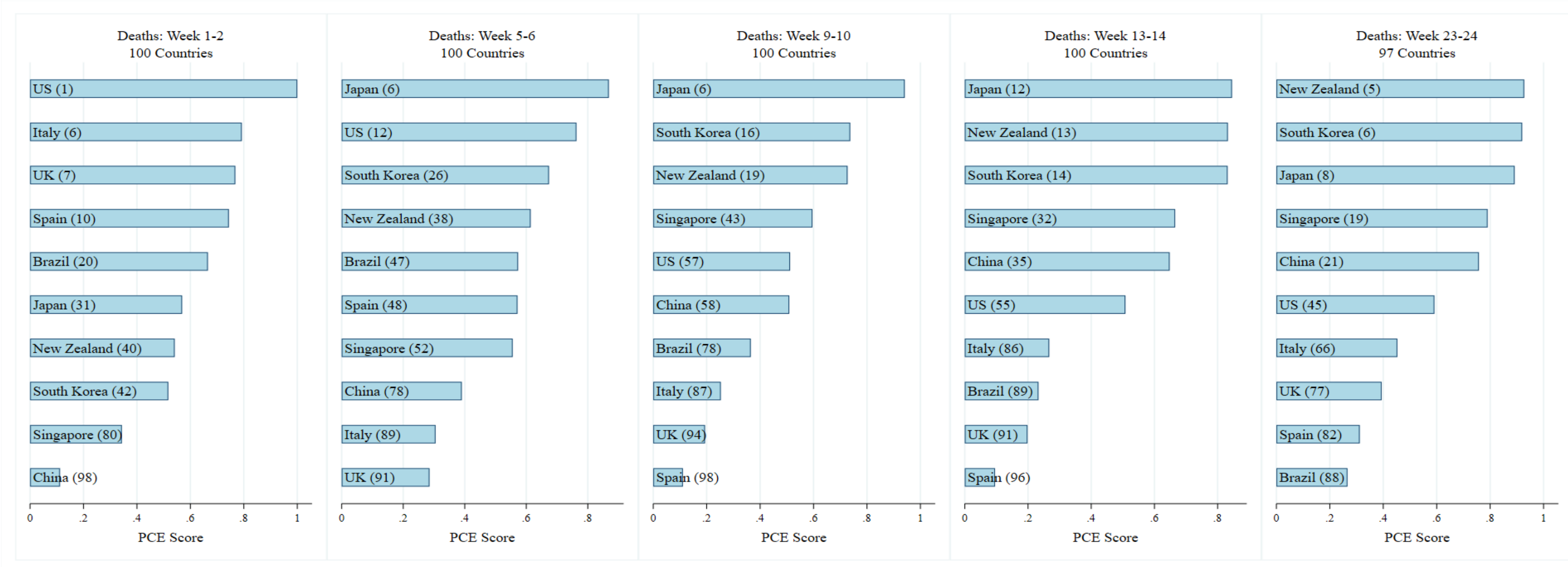

Figure 3: Ranking of Pandemic Containment Effectiveness (PCE) for Deaths in 10 Representative Countries

Table 1 Cumulative Infections and Deaths: Summary Statistics, Worst and Best 10 Countries

Variables	(1) Unit	(2) Mean	(3) Median	(4) Std. D	(5) Min	(6) Max	(7) Worst 10	(8) Value	(9) Best 10	(10) Value	(11) Form in regression
Cumulative infections	per million people	14,043	9,416	13,881	6	52,800	Luxembourg	52,800	Laos	6	log
							Qatar	49,634	Vietnam	14	
							Belgium	49,630	Cambodia	19	
							Czechia	48,121	Thailand	57	
							Armenia	44,836	China	67	
							US	38,085	Burkina Faso	141	
							Panama	37,955	Nigeria	342	
							Israel	37,397	New Zealand	349	
							Switzerland	36,734	Uganda	447	
							Spain	34,561	Rwanda	476	
Cumulative deaths	per million people	283	139	320	0	1,419	Belgium	1,419	Cambodia	0	log
							Peru	1,117	Laos	0	
							Spain	948	Bhutan	0	
							Italy	875	Vietnam	0	
							UK	858	Thailand	1	
							Argentina	848	China	3	
							Mexico	821	Burkina Faso	3	
							Brazil	815	Rwanda	4	
							Chile	813	Mozambique	4	
							US	789	Uganda	4	
Case fatality rate (CFR)	ratio	2.0%	1.7%	1.5%	0.0%	9.7%	Mexico	9.7%	Laos	0.0%	ratio
							Ecuador	7.1%	Cambodia	0.0%	
							Bolivia	6.2%	Bhutan	0.0%	
							Egypt	5.8%	Singapore	0.0%	
							Iran	5.1%	Qatar	0.2%	
							China	5.1%	Botswana	0.3%	
							Peru	3.7%	UAE	0.3%	
							UK	3.6%	Sri Lanka	0.4%	
							Italy	3.5%	Iceland	0.5%	
							Guatemala	3.4%	Malaysia	0.6%	

Data source: World Health Organization (as of 27 November 2020)
Statistics are computed from 100 countries.

Table 2 Summary Statistics of Independent Variables

	Variables	Unit	Mean	Std. D	Min	Max	Form in regression	Source
1	total population	million	66.90	196.56	0.35	1392.73	log	World bank
2	population 65+	%	11.2	6.7	1.1	27.6	%	World bank
3	population density	per square kilometer	229	809	3	7,953	log	World bank
4	urban population ratio	%	64.72	21.36	17.21	100.00	%	World bank
5	temperature	℃	14.78	11.01	-15.17	31.91		Climate Change Knowledge Portal
6	rainfall	millimeter	63.65	56.66	0.00	356.37	log	Climate Change Knowledge Portal
7	GDP per capita	dollars	20,436	23,929	499	116,597	log	World bank
8	debt ratio	%	52	36	6	198	%	CEIC
9	employment in agriculture	%	18.77	18.71	0.06	72.45	%	World bank
10	Industrial ratio	%	26.90	8.30	11.32	56.89	%	World bank
11	Gini coefficient		37.44	8.15	24.20	63.00		World bank
12	international visitors	per million people	780,549	1,089,944	4,552	6,644,912	log	World bank
13	international trade		0.88	1.63	0.00	10.85		United Nations Comtrade
14	health expenditure	%	6.91	2.65	2.27	17.06	%	World bank
15	GHS		49.03	13.36	25.20	83.50		https://www.ghsindex.org/
16	hospital beds	per thousand people	3.33	2.60	0.30	13.40	log	World bank
17	SARS outbreak		0.26	0.44	0	1	0 or 1	World Health Organizatio
18	government expenditure	%	16.36	4.98	4.93	30.05	%	World bank
19	political regime		1.90	1.00	0.00	3.00		Our World in Data
20	government effectiveness		0.38	0.88	-1.07	2.23		Worldwide Governance Indicators, World Bank
21	rest of world infections		1.81×10^{7}	1.7×10^{7}	0	6.05×10^{7}	log	World Health Organizatio
22	rest of region infection		2.8×10^{6}	4.6×10^{6}	0	2.51×10^{7}	log	World Health Organizatio
23	daily test ratio	per million people	13,082	45,347	0.644	450,019	log	Humanitarian Data Exchange
24	Economic stimulus spending	dollars	1.21×10^{11}	4.24×10^{11}	9×10^{6}	2.86×10^{12}	log	Oxford COVID-19 Government Response Tracker database
25	Economic support index		62	23	12.5	100		Oxford COVID-19 Government Response Tracker database

For definitions and sources, see data appendix.

Table 3 Risk and Protective Factors for Deaths

Dependent variable	log of deaths per million population						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sample	Full	TOP25	UHC adjusted	VA adjusted	RE	CRE	FEF
Days	0.028***	-0.001	0.034***	0.035***	0.024***	0.013***	0.029***
	(6.466)	(-0.155)	(7.115)	(7.238)	(62.532)	(28.934)	(5.368)
$Days^2$	-0.000***	-0.000	-0.000***	-0.000***	-0.000***	-0.000***	0.000***
	(-5.802)	(-1.336)	(-7.199)	(-7.338)	(-51.169)	(-23.180)	(-4.856)
total population	0.146	0.485***	0.126	0.171	0.141	0.191	0.186
	(1.249)	(2.921)	(0.999)	(1.368)	(1.162)	(1.592)	(1.602)
population 65+	-0.006	0.151***	-0.002	-0.028	-0.013	0.005	-0.005
	(-0.170)	(2.993)	(-0.062)	(-0.779)	(-0.377)	(0.152)	(-0.159)
population density	0.184*	0.177*	0.200**	0.218**	0.187*	0.182*	0.224***
	(1.956)	(1.833)	(1.988)	(2.221)	(1.952)	(1.913)	(2.600)
temperature	-0.078***	-0.058***	-0.087***	-0.086***	-0.074***	-0.074***	-0.065***
	(-4.933)	(-4.927)	(-4.758)	(-5.014)	(-4.266)	(-4.336)	(-3.603)
rainfall	-0.027	0.365	-0.049	-0.044	-0.056	-0.065	-0.055
	(-0.219)	(1.295)	(-0.359)	(-0.331)	(-0.444)	(-0.517)	(-0.348)
GDP per capita	0.944***	1.658***	0.976***	1.060***	0.927***	1.078***	1.005***
	(5.634)	(3.201)	(5.248)	(5.700)	(4.843)	(5.678)	(6.019)
Gini coefficient	0.042**	-0.045	0.049**	0.043**	0.037*	0.044**	0.038**
	(2.350)	(-0.829)	(2.361)	(2.107)	(1.805)	(2.163)	(2.214)
international visitors	0.172	-0.163	0.167	0.223	0.133	0.144	0.065
	(1.330)	(-0.417)	(1.143)	(1.530)	(0.954)	(1.038)	(0.579)
international trade	-0.172*	-0.035	-0.173*	-0.163*	-0.158	-0.198**	-0.218***
	(-1.799)	(-0.487)	(-1.669)	(-1.750)	(-1.574)	(-1.981)	(-2.979)
health expenditure	0.216***	-0.018	0.212***	0.217***	0.223***	0.204***	0.216***
	(4.344)	(-0.229)	(3.822)	(4.092)	(3.717)	(3.434)	(4.367)
hospital beds	-0.631***	-1.162***	-0.702***	-0.576**	-0.535**	-0.583***	-0.414*
	(-2.763)	(-3.439)	(-2.819)	(-2.331)	(-2.508)	(-2.760)	(-1.688)
SARS outbreak	0.103	-0.887	0.030	0.076	0.142	0.045	-0.018
	(0.283)	(-1.581)	(0.077)	(0.201)	(0.429)	(0.138)	(-0.046)
government expenditure	-0.009	-0.064	-0.012	-0.007	-0.000	-0.006	0.003
	(-0.352)	(-1.011)	(-0.448)	(-0.271)	(-0.001)	(-0.224)	(0.113)
government effectiveness	-1.098***	-1.621***	-1.187***	-1.360***	-1.131***	-1.138***	-1.190***
	(-4.027)	(-3.821)	(-3.934)	(-4.713)	(-3.891)	(-3.949)	(-4.484)
rest of world (ROW) infections	0.118	1.017***	0.187	0.194	0.130***	-1.015***	
	(0.973)	(4.948)	(1.346)	(1.416)	(13.192)	(-32.843)	
ROW infections time average						1.090***	-0.009
						(21.598)	(-0.078)
daily test ratio	0.007		0.004	0.011	0.067***		
	(0.265)		(0.120)	(0.367)	(22.009)		
daily test ratio time average						0.327***	0.085**
						(17.337)	(2.378)
Number of observations	24,241	6,442	24,241	24,241	24,241	24,241	27,724
Adjusted R^2	0.647	0.745	0.643	0.651	N.A.	N.A.	N.A.

Notes:

1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first death case.
3. Column (2) reports results of a subsample of 25 countries with the hightest test ratio.
4. Columns (3) and (4) report results of using deaths adjusted by UHC and VA to ad concern. UHC and VA refer to the universal healthcare and voice and accountablity indices, respectively, constructed by the World Bank.
5. Column (5) reports results of the random effect model based on the specification in column (1).
6. Column (6) reports results of the correlated random effect model by including the time average of the time-variant variables, based on the specification in column (1).
7. Column (7) appies the fixed-effect filtered estimates proposed by Pesaran and Zhou (2018).

Table 4 Economic Growth and Pandemic Containment Effectiveness (PCE) for Deaths

Dependent Variable	Quarterly GDP growth rate										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Sample period	Q2	Q3	Q2-Q3	Q1	Q2'	Q3'	Q2'-Q3'	Q2	Q3	Q2-Q3	Q1
PCE Score (X 100)	0.105***	0.074***	0.169*	-0.003	0.105***	0.070***	0.270***	0.100***	0.053**	0.236**	-0.009
	(2.820)	(3.190)	(1.963)	(-0.177)	(2.879)	(2.838)	(3.643)	(2.955)	(2.092)	(2.562)	(-0.604)
economic stimulus spending	0.522	0.310			0.532	0.339*		0.017	0.247		
	(1.364)	(1.593)			(1.395)	(1.683)		(0.042)	(1.172)		
economic support index	-0.030	-0.019			-0.026	-0.017		-0.034	0.004		
	(-0.927)	(-1.033)			(-0.833)	(-0.900)		(-0.848)	(0.124)		
Specification	OLS	OLS	FD	OLS	OLS	OLS	FD	OLS	OLS	FD	OLS
Sample countries	CEIC							OECD+G20+Singapore			
Number of observations	73	70	70	70	73	70	70	48	48	48	48
R^2	0.149	0.157	0.073	0.000	0.146	0.135	0.184	0.159	0.101	0.203	0.005

Notes:

1. *t*-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. PCE scores of Quarters 2 and 3 of 20202 in columns (1)-(3) and (8)-(10) are determined by Weeks 15-16 and Weeks 27-28 after first confirmed death, respectively.
3. PCE scores of Quarter 1 of 2020 in columns (4) and (11) are measured by Weeks 3-4 after first confirmed death.
4. PCE scores of Quarters 2 and 3 of 2020 in columns (5)-(7) are determined by Weeks 13-14 and Weeks 23-24 after first confirmed death, respectively.
5. Data used in columns (8)-(11) exclude more countries with smaller size in Asia, South America, and Africa.
6. For a full list of countries used in the regressions in columns (8)-(11), see footnote 22 of the text.

Table 5 Economic Growth and Pandemic Containment Effectiveness (PCE) for Deaths: Robustness Checks

Dependent variable	Quarterly GDP growth rate			Annual GDP growth rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Sample period	Q2	Q3	Q1	Q2	Q3	Q1
PCE Score (X 100)	0.101***	0.064**	0.006	0.054***	0.047***	-0.013
	(2.747)	(2.437)	(0.328)	(3.189)	(2.863)	(-0.656)
economic stimulus spending	0.160	0.161		0.001	-0.062	
	(0.358)	(0.724)		(0.005)	(-0.380)	
economic support index	-0.005	-0.004		-0.025*	-0.033**	
	(-0.154)	(-0.203)		(-1.854)	(-2.281)	
GDP per capita	0.924	0.272	-0.251			
	(0.831)	(0.350)	(-0.594)			
Gini coefficient	-0.456***	-0.174*	-0.023			
	(-2.884)	(-1.936)	(-0.541)			
total population	0.275	0.095	-0.186			
	(0.305)	(0.146)	(-0.606)			
population 65+	-0.390**	-0.178	-0.071			
	(-2.499)	(-1.477)	(-1.277)			
international trade	0.558	0.353	-0.268			
	(1.006)	(1.007)	(-0.869)			
government expenditure	-0.031	-0.007	-0.112			
	(-0.130)	(-0.040)	(-1.418)			
Specification	OLS	OLS	OLS	OLS	OLS	OLS
Sample countries	CEIC			IMF		
Number of observations	73	70	70	89	85	89
R^2	0.316	0.215	0.199	0.150	0.117	0.004

Notes:

1. *t*-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. PCE scores of Quarters 2 and 3 of 2020 in columns (1)-(2) and (4)-(5) are determined by Weeks 15-16 and Weeks 27-28 after first confirmed death, respectively.
3. PCE scores of Quarter 1 of 2020 in columns (3) and (6) are measured by Weeks 3-4 after first confirmed death.
4. Annual GDP growth data retrieved from the IMF database including more countries is used in columns (4)-(6).
5. The PCE scores in columns (4)-(6) are still on a quarterly basis.

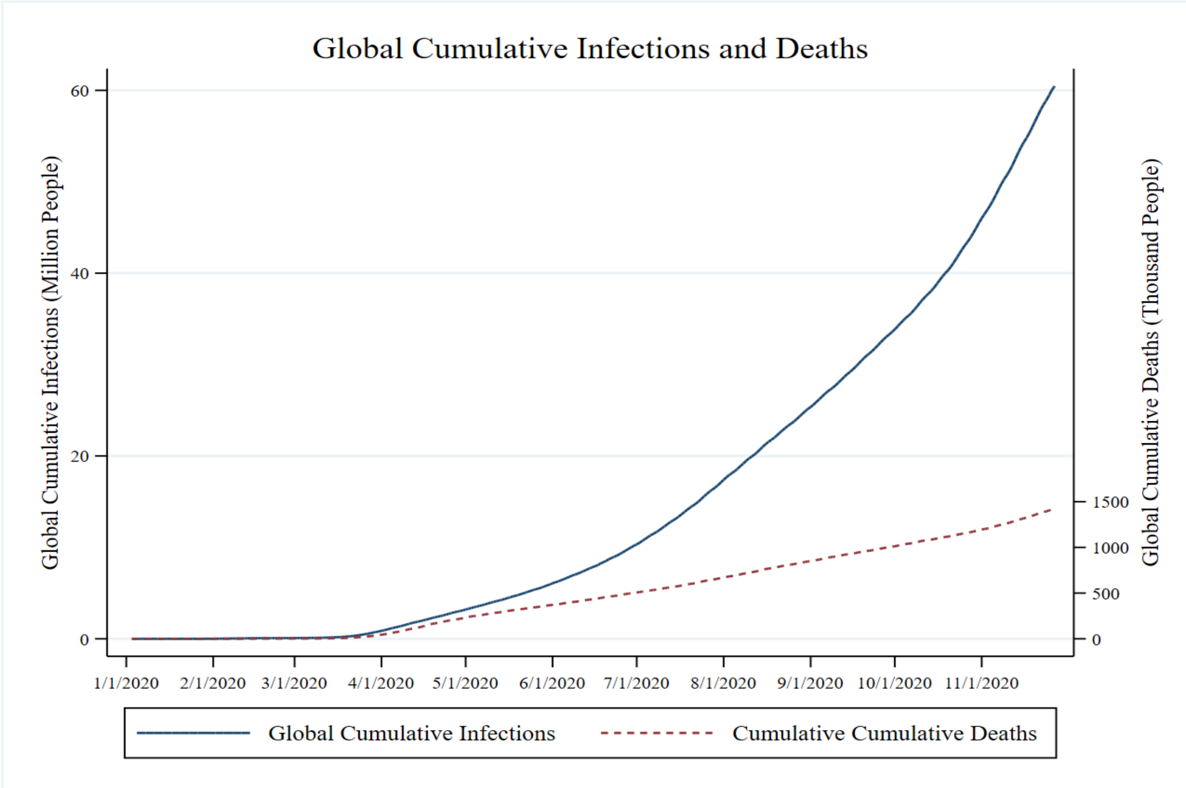

Figure A1a: Global Cumulative Infections and Deaths in 2020

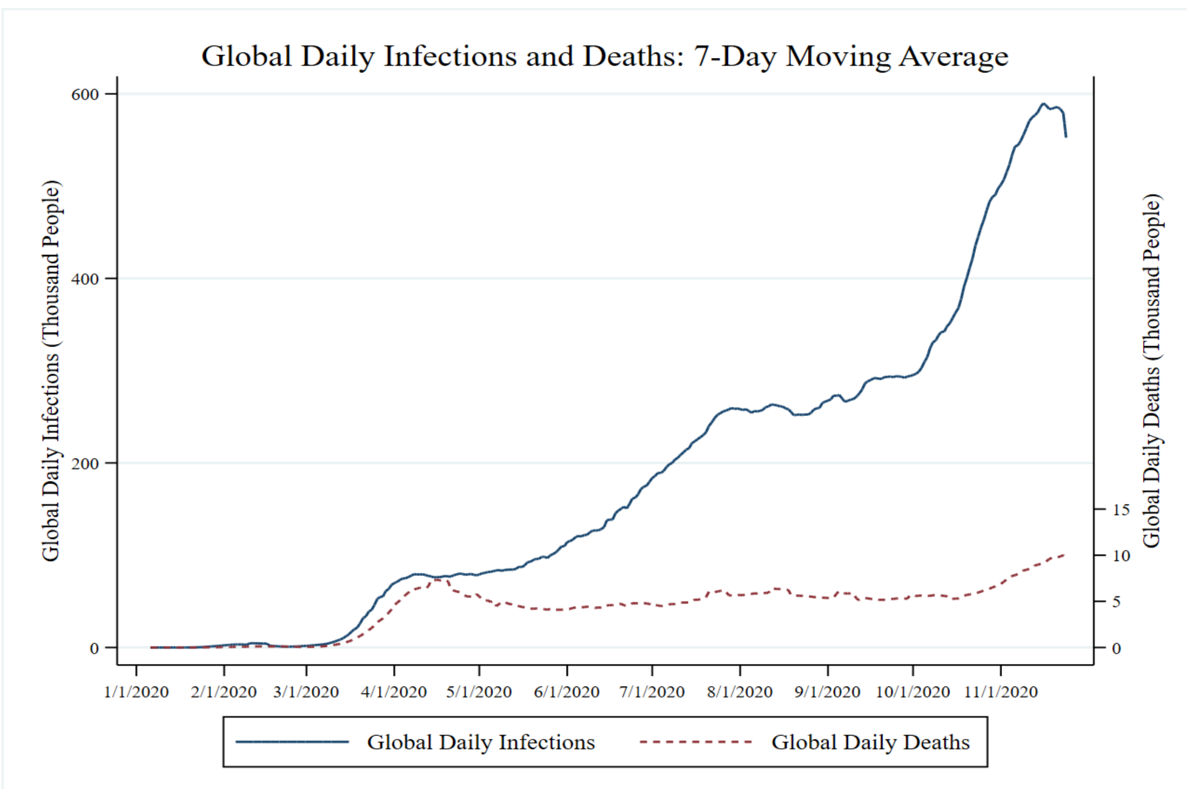

Figure A1b: Global Daily Infections and Deaths in 2020

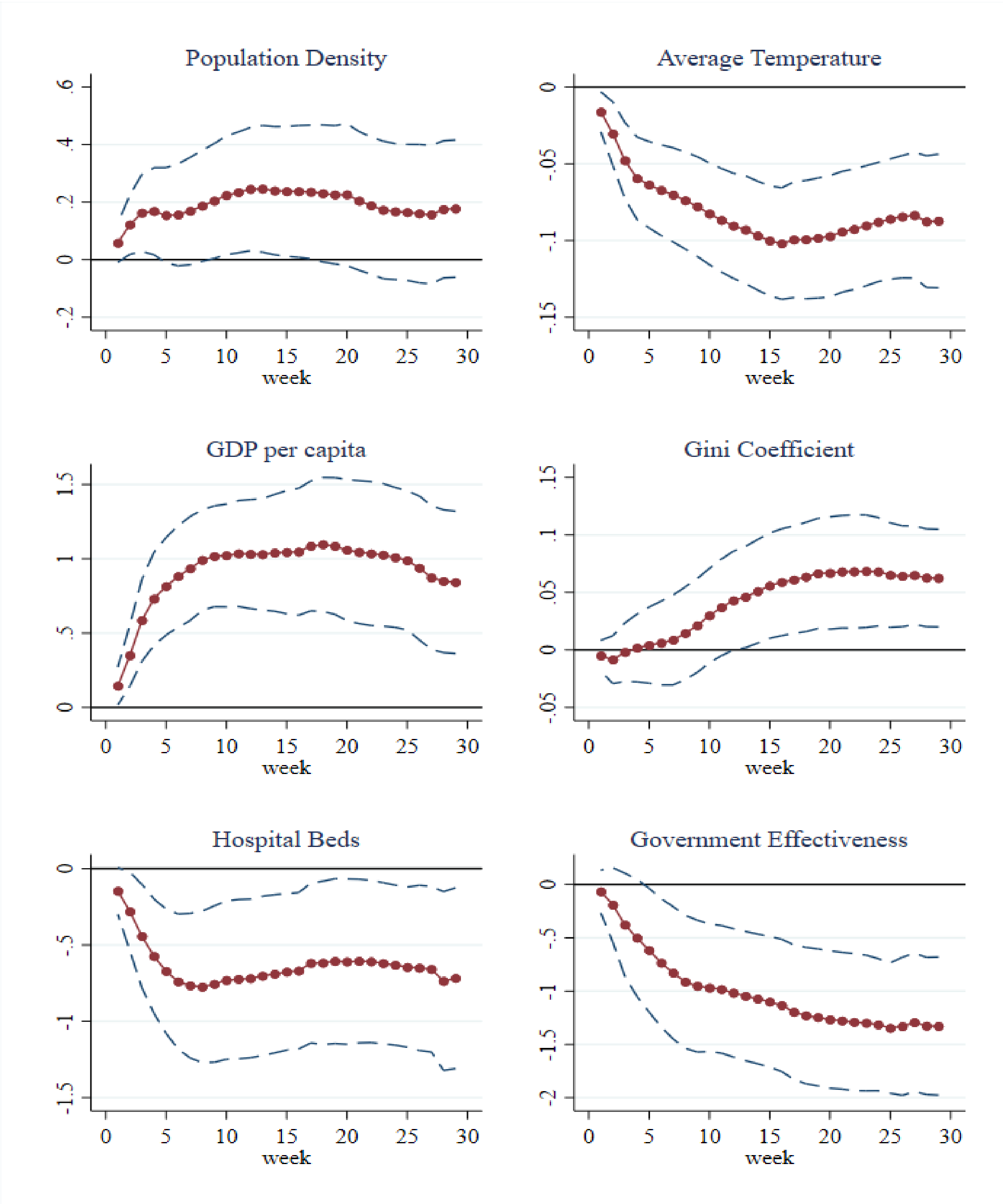

Figure A2: Impacts of Risk and Protective Factors on Deaths over Time

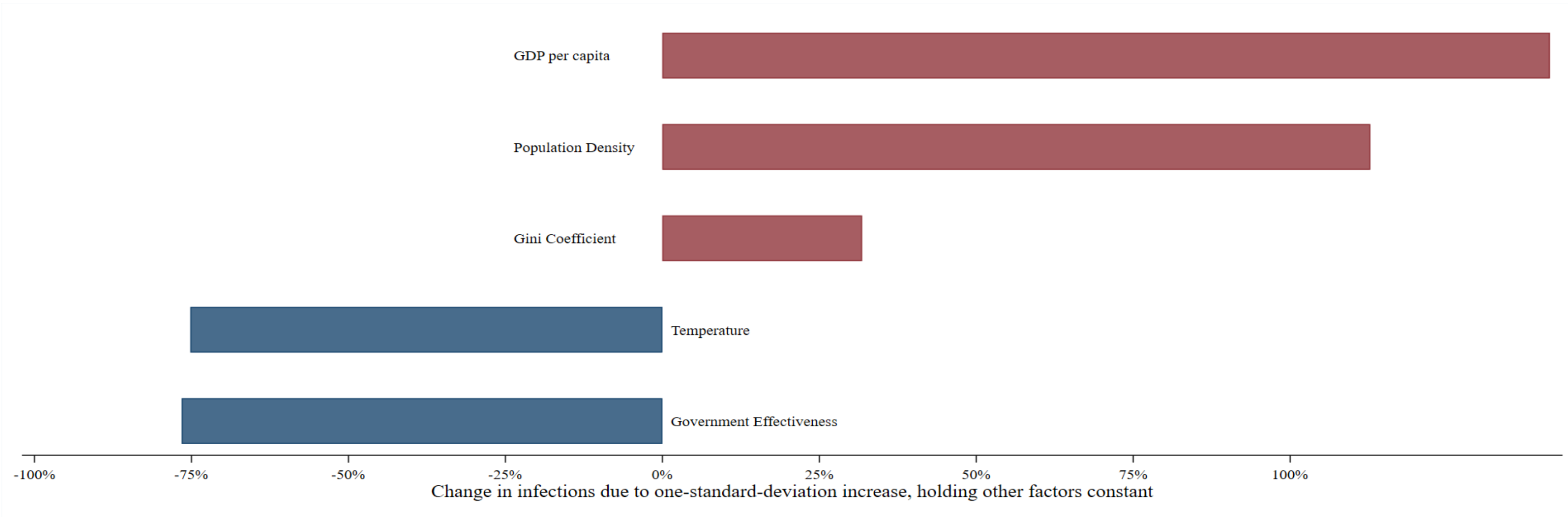

Figure A3: Impacts of Risk and Protective Factors on Infections

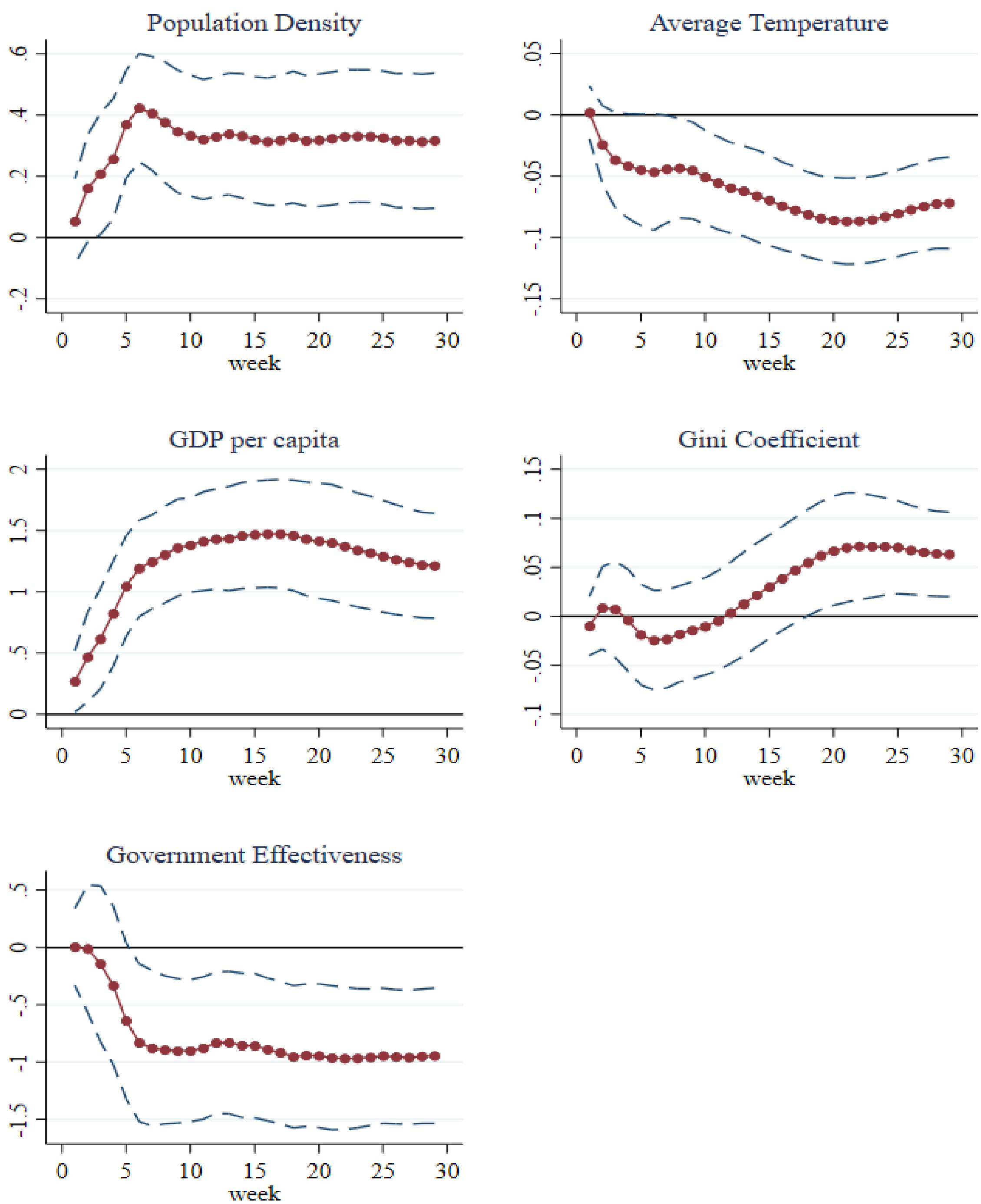

Figure A4: Impacts of Risk and Protective Factors on Infections over Time

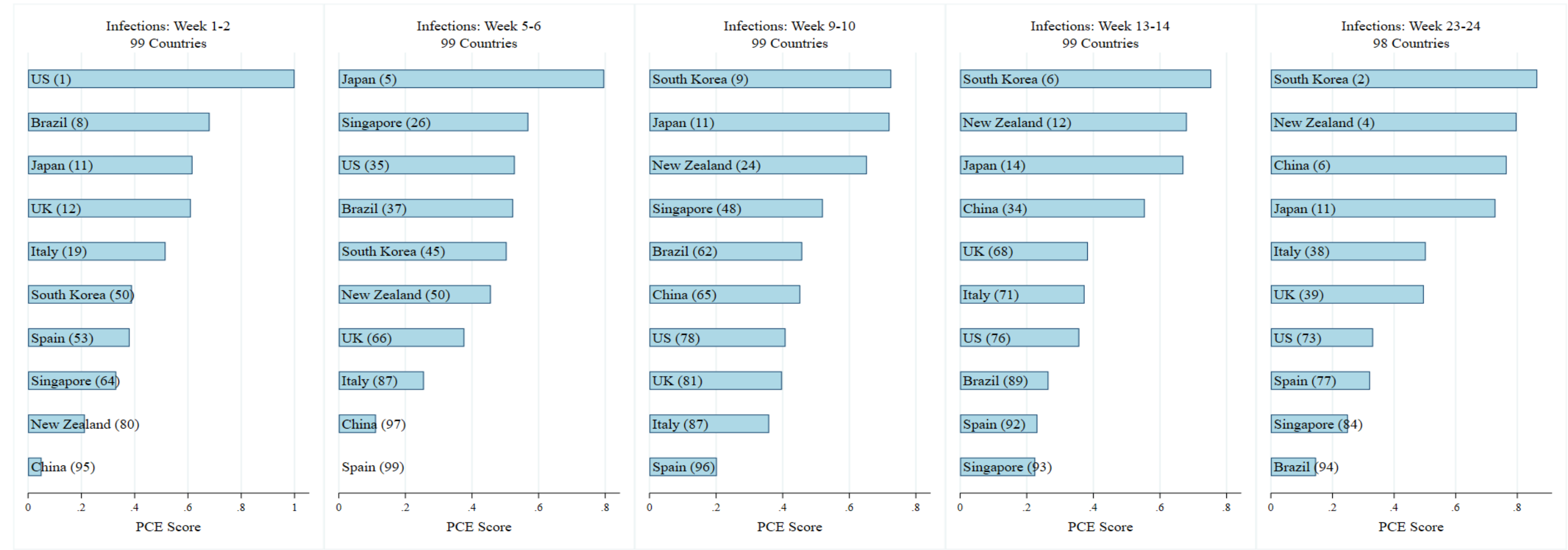

Figure A5: Ranking of Pandemic Containment Effectiveness (PCE) for Infections in 10 Representative Countries

Table A1 Summary Statistics of Additional Variables

	Variables	Unit	Mean	Std. D	Min	Max	Form in regression	Source
1	School closing		1.81	1.22	0	3		Oxford COVID-19 Government Response Tracker database
2	Workplace closing		1.41	1.05	0	3		Oxford COVID-19 Government Response Tracker database
3	Cancel public events		1.35	0.85	0	2		Oxford COVID-19 Government Response Tracker database
4	Restrictions on gatherings		2.39	1.61	0	4		Oxford COVID-19 Government Response Tracker database
5	Close public transport		0.58	0.73	0	2		Oxford COVID-19 Government Response Tracker database
6	Stay at home requirements		0.99	0.95	0	3		Oxford COVID-19 Government Response Tracker database
7	Restrictions on internal movement		0.95	0.92	0	2		Oxford COVID-19 Government Response Tracker database
8	Fiscal policy stimulus	%	10.08	8.83	-1.19	54.90	%	Elgin et al., 2020
9	Interest rate cut	%	28.29	33.33	-76.74	100.00	%	Elgin et al., 2020
10	Macro-financial package	%	10.61	11.54	0	64.64	%	Elgin et al., 2020
11	Other monetary measures		0.35	0.48	0	1.00	0 or 1	Elgin et al., 2020
12	BoP measures	%	1.49	3.52	0	16.30	%	Elgin et al., 2020
13	Other BoP measure		0.35	0.48	0	1.00	0 or 1	Elgin et al., 2020
14	Control of corruption		0.26	1.01	-1.33	2.21		Worldwide Governance Indicators, World Bank
15	Political stability		0.07	0.84	-2.26	1.50		Worldwide Governance Indicators, World Bank
16	Rule of law		0.28	0.94	-1.15	2.05		Worldwide Governance Indicators, World Bank
17	Retail and recreation		-18.55	18.03	-65.46	30.00		Community Mobility Reports
18	Grocery and pharmacy		2.88	15.11	-26.60	76.00		Community Mobility Reports
19	Transit stations		-14.44	18.11	-61.90	49.00		Community Mobility Reports
20	Workplaces		-24.76	16.27	-56.50	31.00		Community Mobility Reports
21	Parks		-16.31	12.34	-56.09	11.00		Community Mobility Reports
22	Residential		8.58	6.12	-12.31	27.00		Community Mobility Reports
23	Quarterly economic growth rate	%	-5.39	6.95	-38	8.15	%	CEIC Database
24	Annual economic growth rate	%	-5.31	3.59	-13.94	3.80	%	World Economic Outlook database
25	International support	dollars	1.03×10^{10}	8.94×10^{10}	0	8.40×10^{11}	log	Oxford COVID-19 Government Response Tracker database

For definitions and sources, see data appendix.

Table A2 Risk and Protective Factors for Deaths: Robustness Checks 1

Dependent variable	log of deaths per million population						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sample	Monthly	Jan-April	May-Nov	105^{th} day	Density 1K-	no China	lag test ratio
Days	0.038***	0.080***	0.032***		0.028***	0.025***	0.027***
	(7.497)	(7.704)	(5.671)		(6.229)	(6.020)	(6.483)
$Days^2$	-0.000***	-0.001***	-0.000***		-0.000***	-0.000***	-0.000***
	(-5.096)	(-3.956)	(-5.073)		(-5.696)	(-5.782)	(-5.713)
total population	0.136	-0.183**	0.174	0.188	0.120	0.105	0.147
	(1.149)	(-2.433)	(1.304)	(1.223)	(1.028)	(0.848)	(1.254)
population 65+	-0.011	0.008	-0.016	-0.025	-0.008	-0.002	-0.005
	(-0.325)	(0.289)	(-0.439)	(-0.600)	(-0.239)	(-0.067)	(-0.163)
population density	0.189**	0.184***	0.186*	0.237*	0.228**	0.165*	0.184*
	(1.987)	(3.142)	(1.770)	(1.940)	(2.165)	(1.767)	(1.958)
temperature	-0.080***	-0.051***	-0.087***	-0.099***	-0.075***	-0.078***	-0.078***
	(-5.067)	(-4.792)	(-4.996)	(-5.089)	(-4.842)	(-5.045)	(-4.927)
rainfall	-0.012	0.169**	-0.045	-0.026	-0.023	-0.020	-0.027
	(-0.095)	(2.393)	(-0.337)	(-0.172)	(-0.182)	(-0.162)	(-0.220)
GDP per capita	0.870***	0.536***	0.904***	1.039***	0.933***	0.947***	0.947***
	(5.079)	(3.841)	(4.727)	(4.687)	(5.465)	(5.262)	(5.717)
Gini coefficient	0.044**	-0.013	0.055***	0.054**	0.043**	0.041**	0.042**
	(2.440)	(-1.028)	(2.796)	(2.183)	(2.451)	(2.274)	(2.389)
international visitors	0.186	0.121	0.195	0.149	0.199	0.151	0.171
	(1.451)	(1.531)	(1.357)	(0.862)	(1.506)	(1.133)	(1.325)
international trade	-0.189*	0.051	-0.244**	-0.201	-0.166*	-0.027	-0.172*
	(-1.857)	(0.838)	(-2.001)	(-1.577)	(-1.791)	(-0.227)	(-1.797)
health expenditure	0.224***	0.080**	0.253***	0.234***	0.215***	0.181***	0.216***
	(4.583)	(2.327)	(4.572)	(3.812)	(4.304)	(3.136)	(4.342)
hospital beds	-0.632***	-0.724***	-0.621**	-0.678**	-0.622***	-0.640***	-0.632***
	(-2.801)	(-4.391)	(-2.508)	(-2.419)	(-2.674)	(-2.825)	(-2.769)
SARS outbreak	0.111	0.188	0.068	0.126	0.180	0.051	0.102
	(0.307)	(0.734)	(0.169)	(0.293)	(0.486)	(0.139)	(0.283)
government expenditure	-0.008	0.027*	-0.017	0.006	-0.010	-0.007	-0.009
	(-0.315)	(1.682)	(-0.624)	(0.198)	(-0.425)	(-0.301)	(-0.361)
government effectiveness	-1.040***	-0.659***	-1.095***	-1.078***	-1.065***	-1.120***	-1.100***
	(-3.821)	(-2.702)	(-3.783)	(-3.244)	(-3.900)	(-4.115)	(-4.019)
rest of world infection	-0.040	0.141	-0.472*	-0.377	0.124	0.204	0.120
	(-0.250)	(1.544)	(-1.797)	(-0.970)	(0.979)	(1.596)	(1.031)
daily test ratio	0.010	0.007	0.008	0.024	0.008	0.002	
	(0.353)	(0.326)	(0.267)	(0.587)	(0.288)	(0.082)	
30 day lag daily test ratio							0.008
							(0.294)
Number of observations	24,241	4,091	20,150	97	23,502	23,919	24,241
Adjusted R^2	0.662	0.694	0.600	0.503	0.649	0.653	0.647

Notes:
1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first death case.
3. Column (1) reports results adding monthly dummies.
4. Columns (2) and (3) report results for subsamples during Jan-April and May-Nov 2020, respectively.
5. Column (4) reports results for subsamples of day 105 since first death case.
6. Column (5) reports results excluding countris with population density larger than 1,000 people per square kilometer.
7. Column (6) reports results excluding China in the sample.
8. Column (7) resports results using the 30-day lag of daily test ratio.

Table A3 Risk and Protective Factors for Deaths: Robustness Checks 2

Dependent variable	log of deaths per million population							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
sample	Region	Neighborhood	no Africa	Northern	OECD	Europe	Pop. 2M+	CFR
Days	0.028***	0.020***	0.027***	0.028***	-0.006	0.002	0.029***	0.039**
	(6.144)	(6.682)	(4.896)	(6.129)	(-0.780)	(0.239)	(6.608)	(2.731)
Days^2	-0.000***	-0.000***	-0.000***	-0.000***	-0.000	-0.000	-0.000***	-0.000***
	(-5.513)	(-5.065)	(-4.842)	(-5.853)	(-0.597)	(-1.284)	(-5.886)	(-4.560)
total population	0.140	0.160	0.205	0.060	0.292	0.128	0.132	1.110***
	(1.407)	(1.519)	(1.536)	(0.515)	(1.354)	(1.023)	(0.974)	(3.039)
population 65+	-0.020	-0.019	0.001	0.004	0.026	-0.002	-0.007	0.470***
	(-0.671)	(-0.634)	(0.020)	(0.101)	(0.608)	(-0.050)	(-0.209)	(2.955)
population density	0.126*	0.185**	0.157	0.177	0.456***	0.445**	0.163	0.538*
	(1.729)	(2.222)	(1.590)	(1.488)	(3.290)	(2.371)	(1.575)	(1.826)
temperature	-0.025**	-0.068***	-0.084***	-0.071***	-0.035*	-0.064	-0.076***	-0.073**
	(-2.276)	(-3.998)	(-5.311)	(-3.500)	(-2.007)	(-1.609)	(-4.624)	(-2.592)
rainfall	-0.049	-0.084	0.218	0.005	-0.692*	0.770**	-0.012	1.711**
	(-0.449)	(-0.722)	(1.546)	(0.036)	(-1.889)	(2.276)	(-0.093)	(2.304)
GDP per capita	0.527***	0.813***	1.137***	1.066***	1.125**	0.362	0.927***	2.779***
	(2.806)	(5.268)	(5.359)	(5.573)	(2.118)	(0.824)	(5.376)	(3.245)
Gini coefficient	0.043**	0.046***	0.048**	0.028	0.034	0.003	0.037*	-0.233
	(2.480)	(2.698)	(2.323)	(1.356)	(0.746)	(0.120)	(1.880)	(-1.475)
international visitors	-0.020	0.118	0.119	0.094	0.753**	0.019	0.207	-0.892
	(-0.194)	(1.072)	(0.880)	(0.744)	(2.466)	(0.082)	(1.539)	(-1.134)
international trade	-0.100*	-0.126	-0.169	-0.155	0.096	-0.099	-0.155	-0.194
	(-1.808)	(-1.482)	(-1.577)	(-1.652)	(0.843)	(-0.755)	(-1.549)	(-1.013)
health expenditure	0.147***	0.173***	0.173***	0.206***	0.069	0.042	0.226***	-0.284
	(2.847)	(3.395)	(3.597)	(4.328)	(0.450)	(0.438)	(4.113)	(-1.486)
hospital beds	-0.401**	-0.555**	-0.734***	-0.639**	-1.442***	-0.423	-0.667***	-3.818***
	(-2.608)	(-2.584)	(-2.708)	(-2.466)	(-3.684)	(-1.304)	(-2.880)	(-3.685)
SARS outbreak	0.471*	0.213	-0.159	0.313	0.178	1.098**	0.130	-0.071
	(1.943)	(0.695)	(-0.415)	(0.840)	(0.508)	(2.339)	(0.361)	(-0.044)
government expenditure	-0.007	0.004	-0.009	-0.014	-0.003	0.045	-0.007	0.019
	(-0.315)	(0.172)	(-0.326)	(-0.523)	(-0.067)	(0.938)	(-0.281)	(0.139)
government effectiveness	-0.324	-0.800***	-1.200***	-1.237***	-0.716	-0.308	-1.141***	-3.348***
	(-1.266)	(-3.238)	(-3.757)	(-4.142)	(-0.904)	(-0.689)	(-3.938)	(-3.681)
rest of world infections	0.084		0.190	0.137	1.155***	0.853***	0.112	0.407
	(0.662)		(1.221)	(1.070)	(5.516)	(4.178)	(0.905)	(0.829)
daily test ratio	0.016	-0.004	-0.007	-0.008	-0.055	0.030	0.006	
	(0.685)	(-0.171)	(-0.258)	(-0.304)	(-1.608)	(1.156)	(0.192)	
rest of region infections		0.322***						
		(4.383)						
Number of observations	24,241	24,241	20,947	20,986	9,135	10,242	22,787	6,442
Adjusted R^2	0.729	0.681	0.635	0.669	0.720	0.706	0.653	0.642

Notes:

1. t-values are reported in parentheses. *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first death.
3. Column (1) reports results adding continent dummies.
4. Column (2) reports results using rest of region infections to control for spillover effect.
5. Column (3) reports results excluding countris in Africa.
6. Column (4) reports results excluding countries in the Southern Hemisphere.
7. Column (5) reports results using subsample of OECD countries.
8. Column (6) reports results using subsample of European countries.
9. Column (7) reports results excluding countris with population less than 2 million.
10. Column (8) resports results using CFR as dependent variable and a subsample of 25 countries with the hightest test ratios.

Table A4 Risk and Protective Factors for Deaths: Robustness Checks 3

Dependent variable	log of deaths per million population					
	(1)	(2)	(3)	(4)	(5)	(6)
sample	Urban	Agriculture	Corruption	Stability	Law	Spatial
Days	0.027***	0.025***	0.027***	0.026***	0.026***	0.021***
	(6.149)	(5.169)	(5.925)	(5.611)	(5.490)	(78.034)
$Days^2$	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(-5.554)	(-4.829)	(-5.460)	(-5.229)	(-5.135)	(-43.886)
total population	0.119	0.135	0.113	0.017	0.100	0.109
	(0.992)	(1.224)	(0.939)	(0.135)	(0.852)	(1.309)
population 65+	-0.002	-0.010	-0.007	0.011	0.006	-0.010
	(-0.061)	(-0.322)	(-0.227)	(0.338)	(0.174)	(-0.389)
population density	0.188*	0.175*	0.174*	0.132	0.187**	0.158**
	(1.980)	(1.904)	(1.844)	(1.396)	(2.134)	(2.376)
temperature	-0.080***	-0.083***	-0.075***	-0.069***	-0.076***	-0.044***
	(-5.211)	(-5.611)	(-4.808)	(-4.590)	(-4.818)	(-3.553)
rainfall	-0.005	0.122	-0.024	-0.013	-0.055	0.018
	(-0.043)	(0.945)	(-0.186)	(-0.101)	(-0.446)	(0.205)
GDP per capita	0.768***	0.538**	0.975***	0.955***	1.007***	0.551***
	(3.830)	(2.579)	(5.784)	(5.964)	(5.907)	(3.940)
Gini coefficient	0.038**	0.034**	0.037**	0.045**	0.040**	0.034**
	(2.115)	(2.050)	(2.013)	(2.608)	(2.251)	(2.345)
international visitors	0.156	0.115	0.142	0.172	0.108	0.038
	(1.161)	(1.016)	(1.094)	(1.402)	(0.817)	(0.401)
international trade	-0.152	-0.124	-0.166	-0.124	-0.182*	-0.123*
	(-1.536)	(-1.335)	(-1.649)	(-1.319)	(-1.838)	(-1.762)
health expenditure	0.207***	0.196***	0.231***	0.217***	0.237***	0.167***
	(4.137)	(4.263)	(4.563)	(4.572)	(4.573)	(4.066)
hospital beds	-0.666***	-0.831***	-0.706***	-0.587***	-0.722***	-0.468***
	(-2.959)	(-3.726)	(-2.968)	(-2.891)	(-3.293)	(-3.147)
SARS outbreak	0.138	-0.001	0.102	0.083	0.091	0.043
	(0.382)	(-0.004)	(0.282)	(0.237)	(0.250)	(0.182)
government expenditure	-0.012	-0.014	0.003	-0.020	-0.004	-0.004
	(-0.505)	(-0.591)	(0.108)	(-0.827)	(-0.174)	(-0.190)
government effectiveness	-1.060***	-0.934***	-0.677	-0.799***	-0.301	-0.804***
	(-3.781)	(-3.522)	(-1.570)	(-2.886)	(-0.602)	(-3.954)
rest of world infection	0.136	0.173	0.142	0.164	0.176	
	(1.074)	(1.258)	(1.102)	(1.217)	(1.287)	
daily test ratio	0.008	0.014	0.007	0.004	0.001	0.124**
	(0.299)	(0.534)	(0.261)	(0.145)	(0.025)	(2.130)
urban population ratio	0.012					
	(1.604)					
employment in agriculture		-0.038***				
		(-3.534)				
control of corruption			-0.419			
			(-1.201)			
political stability				-0.546**		
				(-2.303)		
rule of law					-0.829*	
					(-1.929)	
spatial lag						0.445***
						(90.063)
Number of observations	24,241	24,241	24,241	24,241	24,241	33,000
Adjusted R^2	0.652	0.665	0.650	0.658	0.656	N.A.

Notes:
1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first death.
3. Column (1) reports results including urban population ratio as an additional explanatory variable.
4. Column (2) resports results including employment share in agriculture as an additional explanatory variable.
5. Column (3) resports results including control of corruption as an additional explanatory variable.
6. Column (4) resports results incluing political stability as an additional explanatory variable .
7. Column (5) resports results including rule of law as an additional explanatory variable.
8. Column (6) reports results replacing *rest of world infections* with a *spatial lag*

Table A5 Risk and Protective Factors for Deaths: Robustness Checks 4

Dependent variable	log of deaths per million population					
	(1)	(2)	(3)	(4)	(5)	(6)
sample	Mobility	Debt	Industrial	Mob+Ind+Deb	Regime	GHS
Days	0.037***	0.028***	0.028***	0.040***	0.028***	0.028***
	(7.388)	(5.235)	(6.254)	(6.424)	(6.403)	(6.600)
$Days^2$	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(-6.490)	(-5.202)	(-5.634)	(-6.357)	(-5.766)	(-5.958)
total population	0.114	0.232*	0.169	0.182	0.153	0.010
	(0.930)	(1.716)	(1.563)	(1.278)	(1.334)	(0.077)
population 65+	-0.027	0.017	-0.039	-0.006	-0.042	-0.021
	(-0.693)	(0.471)	(-1.039)	(-0.146)	(-0.868)	(-0.586)
population density	0.118	0.257***	0.144	0.110	0.216**	0.213**
	(1.341)	(2.641)	(1.459)	(1.171)	(2.137)	(2.242)
temperature	-0.070***	-0.075***	-0.074***	-0.077***	-0.078***	-0.080***
	(-4.677)	(-4.771)	(-4.575)	(-4.320)	(-5.330)	(-5.136)
rainfall	0.127	0.204	-0.040	0.256**	-0.037	-0.010
	(1.076)	(1.373)	(-0.320)	(2.045)	(-0.315)	(-0.090)
GDP per capita	0.816***	1.126***	1.064***	0.984***	0.927***	0.902***
	(5.058)	(5.400)	(6.811)	(4.841)	(5.879)	(5.519)
Gini coefficient	0.019	0.047**	0.031*	0.021	0.035*	0.045***
	(0.966)	(2.412)	(1.706)	(1.169)	(1.859)	(2.638)
international visitors	0.164	0.111	0.142	0.127	0.216	0.116
	(1.282)	(0.813)	(1.205)	(1.051)	(1.633)	(0.888)
international trade	-0.007	-0.212**	-0.218***	-0.046	-0.143	-0.140
	(-0.073)	(-2.224)	(-2.658)	(-0.446)	(-1.607)	(-1.553)
health expenditure	0.188***	0.231***	0.224***	0.166***	0.197***	0.188***
	(3.384)	(4.837)	(4.700)	(2.941)	(4.270)	(3.590)
hospital beds	-0.514**	-0.678**	-0.493**	-0.572**	-0.520**	-0.562**
	(-2.206)	(-2.306)	(-2.156)	(-2.040)	(-1.994)	(-2.326)
SARS outbreak	-0.060	-0.014	0.306	-0.011	0.164	-0.052
	(-0.185)	(-0.041)	(0.905)	(-0.038)	(0.452)	(-0.157)
government expenditure	0.030	0.030	0.005	0.045*	0.005	-0.006
	(1.331)	(1.049)	(0.219)	(1.849)	(0.205)	(-0.289)
government effectiveness	-1.047***	-1.419***	-1.191***	-1.250***	-1.248***	-1.343***
	(-4.098)	(-4.676)	(-4.657)	(-4.695)	(-4.462)	(-4.411)
rest of world infections	0.150	0.154	0.100	0.206	0.107	0.109
	(1.275)	(1.053)	(0.796)	(1.524)	(0.873)	(0.896)
daily test ratio	-0.001	0.005	0.011	-0.022	0.012	0.002
	(-0.033)	(0.195)	(0.435)	(-1.017)	(0.449)	(0.069)
retail and recreation	-0.023***			-0.020***		
	(-4.085)			(-4.363)		
grocery and pharmacy	0.011***			0.012***		
	(2.721)			(3.286)		
transit stations	0.004**			0.003*		
	(2.199)			(1.827)		
workplaces	-0.007			-0.008		
	(-0.969)			(-1.058)		
parks	-0.004			-0.001		
	(-0.784)			(-0.163)		
residential	0.005			0.021		
	(0.233)			(1.137)		
debt ratio		-0.005		-0.006		
		(-1.253)		(-1.650)		
industrial			-0.025*	-0.015		
			(-1.686)	(-1.107)		
political regimes					0.279	
					(1.412)	
GHS						0.034**
						(1.995)
Number of observations	21,051	20,409	23,480	17,889	24,241	24,241
Adjusted R^2	0.703	0.654	0.671	0.722	0.653	0.659

Notes:
1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Column (1) reports results including six google mobility indices as additional explanatory variables.
3. Column (2) reports results including debt ratio as an additional explanatory variable.
4. Column (3) reports results including industrial ratio as an additional explanatory variable.
5. Column (4) reports results for subsamples including political regime as an additional explanatory variable.
6. Column (5) reports results including Global Health Security as an additional explanatory variable.
7. Column (6) reports results including six google mobility indices, debt ratio, and industrial ratio as additional explanatory vari
8. Column (7) reports results including economic stimulus spending and international support as additional explanatory variable
9. Column (8) reports results including seven containment policy indices as additional explanatory variables.

Table A6 Economic Growth and Deaths

Dependent Variable	Quarterly GDP growth rate									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample period	Q2	Q3	Q2-Q3	Q1	Q2	Q3	Q2	Q3	Q2-Q3	Q1
Deaths per million population	-1.073**	-0.831**	4.946***	-0.347	-1.160*	-0.790**	-1.065*	-0.511	4.205***	0.082
	(-2.077)	(-2.389)	(5.631)	(-1.148)	(-1.897)	(-2.020)	(-1.768)	(-1.080)	(3.028)	(0.246)
economic stimulus spending	0.517	0.352*			0.146	0.114	-0.026	0.255		
	(1.299)	(1.777)			(0.287)	(0.477)	(-0.058)	(1.206)		
economic support index	-0.021	-0.011			-0.008	-0.007	-0.026	0.010		
	(-0.688)	(-0.600)			(-0.252)	(-0.317)	(-0.643)	(0.318)		
GDP per capita					1.291	0.751				
					(1.018)	(0.989)				
Gini coefficient					-0.428***	-0.162*				
					(-2.717)	(-1.767)				
total population					0.082	0.059				
					(0.086)	(0.089)				
population 65+					-0.334**	-0.146				
					(-2.251)	(-1.236)				
international trade					0.590	0.388				
					(1.050)	(1.115)				
government expenditure					-0.042	-0.006				
					(-0.175)	(-0.035)				
Specification	OLS	OLS	FD	OLS	OLS	OLS	OLS	OLS	FD	OLS
Sample countries	CEIC						OECD+G20+Singapore			
Number of observations	73	70	70	70	73	70	48	48	48	48
R^2	0.093	0.115	0.312	0.020	0.269	0.196	0.092	0.053	0.227	0.001

Notes:

1. *t*-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Deaths of Quarters 2 and 3 of 2020 in columns (1)-(3) and (5)-(9) are determined by averaged deaths of Calendar Weeks 15-16 and Weeks 27-28, respectively.
3. Deaths of Quarter 1 of 2020 in columns (4) and (10) are measured by the averaged death rate of Calendar Weeks 3-4.
4. Data used in columns (7)-(10) exclude more countries with smaller size in Asia, South America, and Africa.

Table A7 Risk and Protective Factors for Infections

Dependent variable	log of infections per million population						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sample	Full	TOP25	UHC adjusted	VA adjusted	RE	CRE	FEF
Days	0.029***	-0.025***	0.029***	0.029***	0.034***	0.019***	0.034***
	(3.155)	(-3.054)	(2.738)	(2.823)	(68.373)	(36.515)	(3.671)
$Days^2$	-0.000***	0.000	-0.000***	-0.000***	-0.000***	-0.000***	0.000***
	(-3.371)	(1.631)	(-3.196)	(-3.271)	(-59.190)	(-29.572)	(-3.687)
total population	0.012	-0.082	-0.015	0.028	-0.000	0.060	0.000
	(0.118)	(-0.812)	(-0.147)	(0.276)	(-0.002)	(0.568)	(-0.003)
population 65+	-0.080**	-0.093**	-0.077**	-0.104***	-0.090***	-0.065**	-0.091***
	(-2.448)	(-2.572)	(-2.345)	(-3.166)	(-2.891)	(-2.041)	(-2.817)
population density	0.319***	0.215***	0.323***	0.341***	0.329***	0.327***	0.329***
	(3.860)	(3.763)	(3.850)	(3.908)	(3.982)	(3.878)	(4.020)
temperature	-0.068***	-0.027***	-0.069***	-0.067***	-0.066***	-0.073***	-0.066***
	(-4.605)	(-3.364)	(-4.399)	(-4.586)	(-4.411)	(-4.792)	(-4.092)
rainfall	-0.042	0.392*	-0.055	-0.047	-0.056	-0.068	-0.056
	(-0.334)	(1.935)	(-0.422)	(-0.377)	(-0.504)	(-0.598)	(-0.410)
GDP per capita	1.207***	0.260	1.138***	1.206***	1.132***	1.297***	1.131***
	(6.654)	(1.177)	(6.105)	(6.497)	(6.832)	(7.660)	(6.691)
Gini coefficient	0.039**	0.026	0.043**	0.035*	0.033*	0.052***	0.033*
	(2.072)	(0.912)	(2.175)	(1.828)	(1.888)	(2.875)	(1.699)
international visitors	0.017	0.123	0.002	0.066	0.010	0.021	0.010
	(0.119)	(0.632)	(0.013)	(0.438)	(0.085)	(0.172)	(0.074)
international trade	-0.171**	0.140***	-0.146*	-0.136*	-0.199**	-0.289***	-0.199***
	(-2.206)	(3.460)	(-1.814)	(-1.875)	(-2.301)	(-3.263)	(-2.617)
health expenditure	0.150***	0.048	0.132**	0.136**	0.174***	0.142***	0.174***
	(2.649)	(0.866)	(2.235)	(2.380)	(3.406)	(2.715)	(3.281)
hospital beds	-0.128	-0.453*	-0.146	-0.012	-0.063	-0.122	-0.062
	(-0.511)	(-1.853)	(-0.569)	(-0.047)	(-0.341)	(-0.643)	(-0.247)
SARS outbreak	-0.191	0.389	-0.253	-0.192	-0.151	-0.240	-0.150
	(-0.490)	(1.054)	(-0.632)	(-0.495)	(-0.518)	(-0.804)	(-0.380)
government expenditure	0.008	0.060	0.005	0.010	0.009	-0.005	0.009
	(0.297)	(1.589)	(0.196)	(0.370)	(0.392)	(-0.200)	(0.333)
government effectiveness	-0.870***	-0.608***	-0.847***	-1.008***	-0.908***	-0.750***	-0.909***
	(-3.298)	(-3.652)	(-3.135)	(-3.892)	(-3.585)	(-2.897)	(-3.434)
rest of world infections	0.485**	1.745***	0.641***	0.631***	0.276***	-1.507***	
	(2.404)	(12.346)	(2.791)	(2.821)	(28.941)	(-40.559)	
ROW infections time average						1.501***	0.274
						(34.408)	(1.415)
daily test ratio	0.087**		0.086**	0.094**	0.144***		
	(2.262)		(2.155)	(2.391)	(42.814)		
daily test ratio time average						0.555***	0.145***
						(43.206)	(3.298)
Number of observations	27,724	7,213	27,724	27,724	27,724	27,724	27,724
Adjusted R^2	0.766	0.880	0.762	0.765	N.A.	N.A.	N.A.

Notes:

1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first infection case.
3. Column (2) reports results of a subsample of 25 countries with the hightest test ratio.
4. Columns (3) and (4) report results of using infections adjusted by UHC and VA to address underreporting concern. UHC and VA refer to the universal healthcare and voice and accountablity indices, respectively, constructed by the World Bank.
5. Column (5) reports results of the random effect model based on the specification in column (1).
6. Column (6) reports results of the correlated random effect model by including the time average of the time-variant variables, based on the specification in column (1).
7. Column (7) appies the fixed-effect filter proposed by Pesaran and Zhou (2018).

Table A8 Risk and Protective Factors for Infections: Robustness Checks 1

Dependent variable	log of infections per million population						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
sample	Monthly	Jan-April	May-Nov	day 105	Density 1K-	no China	lag test ratio
Days	0.039***	0.074***	0.021		0.029***	0.018***	0.025**
	(3.822)	(4.288)	(1.533)		(3.109)	(3.718)	(2.571)
$Days^2$	-0.000***	-0.000***	-0.000***		-0.000***	-0.000***	-0.000***
	(-5.317)	(-3.374)	(-2.630)		(-3.291)	(-3.916)	(-2.877)
total population	0.040	-0.253**	0.097	0.120	0.030	0.021	0.018
	(0.416)	(-2.107)	(0.837)	(0.970)	(0.289)	(0.208)	(0.175)
population 65+	-0.077**	-0.030	-0.094**	-0.095**	-0.080**	-0.077**	-0.076**
	(-2.460)	(-0.935)	(-2.434)	(-2.414)	(-2.482)	(-2.439)	(-2.360)
population density	0.327***	0.196***	0.360***	0.326***	0.275***	0.319***	0.319***
	(4.007)	(3.501)	(3.606)	(2.947)	(3.014)	(3.824)	(3.833)
temperature	-0.068***	-0.028*	-0.085***	-0.068***	-0.070***	-0.068***	-0.070***
	(-4.762)	(-1.798)	(-4.866)	(-3.373)	(-4.490)	(-4.755)	(-4.807)
rainfall	-0.065	0.165*	-0.112	-0.118	-0.056	-0.057	-0.044
	(-0.550)	(1.675)	(-0.787)	(-0.738)	(-0.430)	(-0.462)	(-0.359)
GDP per capita	1.220***	0.786***	1.341***	1.468***	1.185***	1.210***	1.233***
	(6.733)	(5.629)	(6.101)	(6.227)	(6.495)	(6.714)	(6.829)
Gini coefficient	0.037*	-0.010	0.058**	0.026	0.039**	0.037**	0.042**
	(1.909)	(-0.607)	(2.501)	(0.888)	(2.078)	(1.989)	(2.217)
international visitors	0.028	0.102	-0.009	0.010	0.035	0.018	0.017
	(0.192)	(0.928)	(-0.052)	(0.052)	(0.231)	(0.123)	(0.109)
international trade	-0.175**	0.161	-0.304**	-0.099	-0.170**	-0.129	-0.166**
	(-2.053)	(1.313)	(-2.428)	(-1.032)	(-2.146)	(-1.242)	(-2.160)
health expenditure	0.150***	0.043	0.188***	0.152**	0.160***	0.143**	0.143**
	(2.647)	(0.676)	(2.694)	(2.149)	(2.778)	(2.189)	(2.576)
hospital beds	-0.136	-0.149	-0.142	-0.036	-0.129	-0.128	-0.141
	(-0.563)	(-0.763)	(-0.477)	(-0.107)	(-0.527)	(-0.528)	(-0.573)
SARS outbreak	-0.057	-0.289	-0.173	0.246	-0.226	-0.119	-0.198
	(-0.148)	(-0.786)	(-0.364)	(0.536)	(-0.574)	(-0.314)	(-0.513)
government expenditure	0.004	0.023	0.002	-0.009	0.011	0.005	0.005
	(0.159)	(0.904)	(0.081)	(-0.286)	(0.415)	(0.189)	(0.202)
government effectiveness	-0.836***	-0.494*	-0.987***	-0.861**	-0.896***	-0.848***	-0.851***
	(-3.317)	(-1.947)	(-3.361)	(-2.528)	(-3.302)	(-3.279)	(-3.184)
rest of world infection	0.264	0.454***	0.548	1.250*	0.476**	0.727***	0.577***
	(0.882)	(2.952)	(0.856)	(1.851)	(2.309)	(6.487)	(2.928)
daily test ratio	0.083**	0.096***	0.078*	0.103**	0.090**	0.086**	
	(2.143)	(3.499)	(1.746)	(2.101)	(2.256)	(2.176)	
30 day lag daily test ratio							0.075**
							(2.187)
Number of observations	27,724	6,624	21,100	100	26,883	27,395	27,724
Adjusted R^2	0.784	0.741	0.618	0.570	0.764	0.778	0.763

Notes:

1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first infection case except for column (8).
3. Column (1) reports results adding monthly dummies.
4. Columns (2) and (3) report results for subsamples during Jan-April and May-Nov 2020, respectively.
5. Column (4) reports results for subsamples of day 105 since first infection case.
6 Column (5) reports results excluding countris with population density larger than 1,000 people per square kilometer.
7. Column (6) reports results excluding China in the sample.
8. Column (7) resports results using the 30-day lag of daily test ratio.

Table A9 Risk and Protective Factors for Infections: Robustness Checks 2

Dependent variable	log of infections per million population							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
sample	Region	Neighborhood	no Africa	Northern	OECD	Europe	Pop. 2M+	50 Cases
Days	0.036***	0.025***	0.027**	0.027**	-0.007	-0.022***	0.031***	-0.028***
	(4.349)	(5.855)	(2.430)	(2.580)	(-0.731)	(-2.950)	(3.369)	(-3.508)
$Days^2$	-0.000***	-0.000***	-0.000***	-0.000***	0.000	0.000**	-0.000***	0.000**
	(-4.365)	(-4.593)	(-2.675)	(-2.813)	(0.197)	(2.143)	(-3.566)	(2.531)
total population	-0.069	0.017	0.052	-0.081	-0.027	-0.107	-0.007	-0.097
	(-0.890)	(0.175)	(0.475)	(-0.887)	(-0.168)	(-1.103)	(-0.052)	(-0.897)
population 65+	-0.086***	-0.102***	-0.093**	-0.082**	-0.040	-0.090**	-0.079**	-0.089**
	(-3.621)	(-3.639)	(-2.481)	(-2.256)	(-1.350)	(-2.031)	(-2.224)	(-2.206)
population density	0.217***	0.315***	0.290***	0.345***	0.259***	0.219*	0.323***	0.280***
	(2.739)	(4.092)	(3.221)	(3.272)	(3.574)	(1.718)	(3.420)	(5.044)
temperature	-0.013	-0.061***	-0.078***	-0.071***	-0.022*	-0.035	-0.070***	-0.034***
	(-0.975)	(-4.060)	(-5.231)	(-3.922)	(-1.767)	(-1.241)	(-4.446)	(-4.342)
rainfall	-0.022	-0.114	0.270*	-0.000	-0.539*	0.154	-0.045	0.411**
	(-0.188)	(-0.972)	(1.944)	(-0.001)	(-1.699)	(0.711)	(-0.340)	(2.260)
GDP per capita	0.649***	0.952***	1.287***	1.275***	0.860*	0.521*	1.182***	0.382*
	(3.465)	(5.665)	(5.910)	(6.091)	(1.897)	(1.696)	(6.050)	(1.869)
Gini coefficient	0.039**	0.049**	0.055***	0.041**	0.040	0.005	0.041**	0.032
	(2.156)	(2.626)	(2.782)	(2.033)	(1.292)	(0.276)	(2.017)	(1.193)
international visitors	-0.133	-0.027	-0.036	-0.071	0.507**	0.170	-0.007	0.192
	(-1.185)	(-0.217)	(-0.287)	(-0.582)	(2.364)	(0.984)	(-0.042)	(0.991)
international trade	-0.067	-0.130*	-0.171*	-0.151*	0.139*	0.056	-0.171*	0.093**
	(-1.240)	(-1.707)	(-1.944)	(-1.783)	(1.931)	(0.658)	(-1.973)	(2.773)
health expenditure	0.074	0.110**	0.116**	0.128**	0.086	0.103	0.142**	0.080
	(1.441)	(2.040)	(2.122)	(2.209)	(0.998)	(1.580)	(2.247)	(1.419)
hospital beds	0.046	-0.136	-0.089	-0.081	-0.613*	-0.102	-0.111	-0.452*
	(0.280)	(-0.586)	(-0.325)	(-0.288)	(-1.918)	(-0.358)	(-0.423)	(-1.797)
SARS outbreak	0.194	-0.086	-0.439	-0.025	-0.064	0.829*	-0.195	0.262
	(0.708)	(-0.257)	(-1.091)	(-0.063)	(-0.217)	(1.916)	(-0.485)	(0.699)
government expenditure	0.001	0.028	0.008	0.014	0.011	0.044	0.007	0.057
	(0.038)	(1.071)	(0.272)	(0.508)	(0.341)	(1.132)	(0.248)	(1.531)
government effectiveness	-0.040	-0.449*	-0.840***	-0.939***	-0.367	-0.517	-0.827***	-0.884***
	(-0.157)	(-1.817)	(-2.657)	(-3.187)	(-0.713)	(-1.593)	(-2.893)	(-4.603)
rest of world infection	0.327*		0.539**	0.543**	1.245***	1.573***	0.458**	1.473***
	(1.843)		(2.363)	(2.452)	(5.255)	(11.884)	(2.279)	(8.851)
daily test ratio	0.081***	0.070**	0.073*	0.067*	0.005	0.043	0.091**	0.088**
	(2.801)	(2.147)	(1.705)	(1.731)	(0.151)	(1.682)	(2.168)	(2.567)
rest of region infections		0.449***						
		(9.115)						
Number of observations	27,724	27,724	23,850	24,009	9,976	11,129	25,841	6,625
Adjusted R^2	0.814	0.811	0.766	0.775	0.816	0.841	0.764	0.822

Notes:

1. t-values are reported in parentheses. *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first infection.
3. Column (1) reports results adding continent dummies.
4. Column (2) reports results using rest of region infections to control for spillover effect.
5. Column (3) reports results excluding countris in Africa.
6. Column (4) reports results excluding countries in the Southern Hemisphere.
7. Column (5) reports results using subsample of OECD countries.
8. Column (6) reports results using subsample of European countries.
9. Column (7) reports results excluding countris with population less than 2 million.
10. Column (8) resports results using observations since first 50 infection cases, instead of the first case.

Table A10 Risk and Protective Factors for Infections: Robustness Checks 3

Dependent variable	log of infections per million population					
	(1)	(2)	(3)	(4)	(5)	(6)
sample	Urban	Agriculture	Corruption	Stability	Law	Spatial
Days	0.030***	0.030***	0.029***	0.029***	0.030***	0.044***
	(3.296)	(3.221)	(3.073)	(3.141)	(3.203)	(137.702)
$Days^2$	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(-3.484)	(-3.409)	(-3.296)	(-3.364)	(-3.418)	(-98.891)
total population	-0.050	-0.052	-0.039	-0.180	-0.061	-0.023
	(-0.481)	(-0.614)	(-0.373)	(-1.627)	(-0.602)	(-0.209)
population 65+	-0.074**	-0.088***	-0.083**	-0.059*	-0.068**	-0.055*
	(-2.209)	(-2.989)	(-2.561)	(-1.800)	(-2.123)	(-1.672)
population density	0.317***	0.283***	0.311***	0.238***	0.331***	0.304***
	(4.002)	(3.729)	(3.695)	(2.909)	(4.311)	(3.516)
temperature	-0.071***	-0.078***	-0.067***	-0.057***	-0.068***	-0.042***
	(-5.056)	(-5.453)	(-4.622)	(-4.301)	(-4.556)	(-2.623)
rainfall	0.006	0.227*	-0.035	-0.014	-0.070	0.031
	(0.057)	(1.894)	(-0.270)	(-0.105)	(-0.558)	(0.263)
GDP per capita	0.813***	0.452**	1.218***	1.175***	1.252***	0.756***
	(4.222)	(2.111)	(6.771)	(6.805)	(6.906)	(4.166)
Gini coefficient	0.030*	0.024	0.034*	0.040**	0.038**	0.057***
	(1.687)	(1.444)	(1.801)	(2.343)	(1.998)	(3.020)
international visitors	0.003	-0.041	-0.024	0.042	-0.073	-0.160
	(0.019)	(-0.368)	(-0.166)	(0.321)	(-0.490)	(-1.288)
international trade	-0.129*	-0.075	-0.162*	-0.102	-0.192**	-0.150*
	(-1.678)	(-1.034)	(-1.961)	(-1.399)	(-2.390)	(-1.662)
health expenditure	0.136**	0.102**	0.161***	0.151***	0.176***	0.125**
	(2.516)	(2.259)	(2.860)	(2.998)	(3.075)	(2.329)
hospital beds	-0.204	-0.522**	-0.195	-0.093	-0.230	-0.280
	(-0.877)	(-2.216)	(-0.743)	(-0.433)	(-0.952)	(-1.448)
SARS outbreak	-0.131	-0.324	-0.174	-0.195	-0.186	-0.531*
	(-0.347)	(-0.980)	(-0.453)	(-0.548)	(-0.492)	(-1.746)
government expenditure	-0.003	0.001	0.021	-0.012	0.015	0.017
	(-0.112)	(0.057)	(0.769)	(-0.490)	(0.558)	(0.685)
government effectiveness	-0.785***	-0.560**	-0.420	-0.440	0.143	-0.754***
	(-2.930)	(-2.377)	(-1.058)	(-1.503)	(0.312)	(-2.854)
rest of world infection	0.465**	0.465**	0.494**	0.496**	0.487**	
	(2.359)	(2.366)	(2.428)	(2.462)	(2.438)	
test ratio	0.087**	0.095***	0.090**	0.081**	0.084**	0.304***
	(2.260)	(2.956)	(2.338)	(2.309)	(2.133)	(4.038)
urban population ratio	0.025***					
	(3.547)					
employment in agriculture		-0.062***				
		(-5.368)				
control of corruption			-0.422			
			(-1.529)			
political stability				-0.752***		
				(-2.771)		
rule of law					-1.025***	
					(-2.687)	
spatial lag						0.413***
						(99.061)
Number of observations	27,724	27,724	27,724	27,724	27,724	33,000
Adjusted R^2	0.777	0.794	0.768	0.777	0.773	N.A.

Notes:
1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Days stands for the number of days since first infection.
3. Column (1) reports results including urban population ratio as an additional explanatory variable.
4. Column (2) resports results including employment share in agriculture as an additional explanatory variable.
5. Column (3) resports results including control of corruption as an additional explanatory variable.
6. Column (4) resports results incluing political stability as an additional explanatory variable .
7. Column (5) resports results including rule of law as an additional explanatory variable.
8. Column (6) reports results replacing *rest of world infections* with a *spatial lag* and using the robustness standard errors.

Table A11 Risk and Protective Factors for Infections: Robustness Checks 4

Dependent variable	log of infections per million population					
	(1)	(2)	(3)	(4)	(5)	(6)
sample	Mobility	Debt	Industrial	Mob+Ind+Debt	Regime	GHS
Days	0.031***	0.028**	0.031***	0.030***	0.030***	0.029***
	(4.147)	(2.478)	(3.256)	(3.678)	(3.192)	(3.147)
$Days^2$	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(-4.642)	(-2.819)	(-3.431)	(-4.329)	(-3.403)	(-3.361)
total population	-0.015	0.003	0.042	-0.002	0.017	0.026
	(-0.130)	(0.029)	(0.461)	(-0.015)	(0.171)	(0.210)
population 65+	-0.053	-0.077**	-0.117***	-0.034	-0.098**	-0.078**
	(-1.312)	(-2.332)	(-3.159)	(-0.798)	(-2.019)	(-2.247)
population density	0.213**	0.314***	0.271***	0.176*	0.334***	0.315***
	(2.445)	(3.614)	(3.185)	(1.992)	(3.594)	(3.698)
temperature	-0.056***	-0.066***	-0.067***	-0.066***	-0.068***	-0.068***
	(-4.034)	(-4.736)	(-4.940)	(-4.247)	(-4.718)	(-4.495)
rainfall	0.075	0.221	-0.056	0.273**	-0.046	-0.043
	(0.520)	(1.507)	(-0.451)	(2.159)	(-0.375)	(-0.340)
GDP per capita	1.085***	1.291***	1.331***	1.238***	1.201***	1.211***
	(6.581)	(5.929)	(7.289)	(6.080)	(6.623)	(6.735)
Gini coefficient	0.031	0.037*	0.029	0.021	0.035*	0.039**
	(1.463)	(1.926)	(1.595)	(1.083)	(1.787)	(2.050)
international visitors	-0.030	0.011	0.001	-0.013	0.044	0.024
	(-0.207)	(0.101)	(0.009)	(-0.122)	(0.303)	(0.168)
international trade	-0.045	-0.127	-0.218***	0.026	-0.158**	-0.174**
	(-0.412)	(-1.412)	(-3.149)	(0.260)	(-2.150)	(-2.169)
health expenditure	0.099	0.122**	0.152**	0.036	0.140**	0.153**
	(1.390)	(2.497)	(2.603)	(0.564)	(2.517)	(2.555)
hospital beds	-0.195	-0.222	0.002	-0.352	-0.079	-0.137
	(-0.766)	(-0.842)	(0.008)	(-1.391)	(-0.283)	(-0.554)
SARS outbreak	-0.359	-0.259	-0.017	-0.278	-0.165	-0.173
	(-0.960)	(-0.720)	(-0.045)	(-0.920)	(-0.417)	(-0.447)
government expenditure	0.052**	0.047*	0.018	0.071***	0.014	0.008
	(2.118)	(1.730)	(0.768)	(3.035)	(0.511)	(0.287)
government effectiveness	-0.655**	-1.125***	-0.955***	-0.953***	-0.947***	-0.842***
	(-2.494)	(-3.731)	(-3.820)	(-3.614)	(-3.429)	(-2.686)
rest of world infections	0.573***	0.554**	0.454**	0.751***	0.475**	0.485**
	(3.365)	(2.316)	(2.235)	(4.849)	(2.340)	(2.405)
daily test ratio	0.088*	0.060*	0.086**	0.033	0.089**	0.088**
	(1.953)	(1.813)	(2.343)	(1.215)	(2.323)	(2.248)
retail and recreation	-0.034***			-0.030***		
	(-5.534)			(-5.817)		
grocery and pharmacy	0.021***			0.021***		
	(4.471)			(4.809)		
transit stations	-0.001			-0.002		
	(-0.398)			(-0.875)		
workplaces	0.008			0.006		
	(1.100)			(1.033)		
parks	-0.010*			-0.000		
	(-1.778)			(-0.081)		
residential	0.009			0.037*		
	(0.462)			(1.878)		
debt ratio		-0.003		-0.006		
		(-0.923)		(-1.652)		
industrial			-0.028*	-0.005		
			(-1.737)	(-0.388)		
political regimes					0.135	
					(0.703)	
GHS						-0.004
						(-0.242)
Number of observations	23,513	22,778	26,883	19,657	27,724	27,724
Adjusted R^2	0.815	0.779	0.778	0.843	0.766	0.766

Notes:

1. t-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Column (1) reports results including six google mobility indices as additional explanatory variables.
3. Column (2) reports results including debt ratio as an additional explanatory variable.
4. Column (3) reports results including industrial ratio as an additional explanatory variable.
5. Column (4) reports results for subsamples including political regime as an additional explanatory variable.
6. Column (5) reports results including Global Health Security as an additional explanatory variable.
7. Column (6) reports results including six google mobility indices, debt ratio, and industrial ratio as additional explanatory variables.
8. Column (7) reports results including economic stimulus spending and international support as additional explanatory variables.
9. Column (8) reports results including seven containment policy indices as additional explanatory variables.

Table A12 Economic Growth and Pandemic Containment Effectiveness (PCE) for Infections

Dependent Variable	Quarterly GDP growth rate in 2020										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Sample period	Q2	Q3	Q2-Q3	Q1	Q2'	Q3'	Q2'-Q3'	Q2	Q3	Q2-Q3	Q1
PCE Score (X 100)	0.158***	0.115***	-0.156**	0.043***	0.166***	0.103***	-0.139**	0.167***	0.105***	-0.083	0.023
	(3.205)	(5.258)	(-2.099)	(2.956)	(3.337)	(4.450)	(-2.071)	(3.332)	(4.659)	(-0.861)	(1.469)
economic stimulus spending	0.411	0.204			0.450	0.250		0.008	0.211		
	(1.066)	(1.090)			(1.168)	(1.343)		(0.018)	(1.144)		
economic support index	-0.049	-0.039**			-0.044	-0.033*		-0.046	-0.010		
	(-1.499)	(-2.100)			(-1.384)	(-1.792)		(-1.206)	(-0.369)		
Specification	OLS	OLS	FD	OLS	OLS	OLS	FD	OLS	OLS	FD	OLS
Sample countries	CEIC							OECD+G20+Singapore			
Number of observations	73	70	70	70	73	71	71	48	48	48	48
R^2	0.163	0.270	0.047	0.108	0.161	0.234	0.041	0.197	0.267	0.015	0.039

Notes:

1. *t*-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. PCE scores of Quarters 2 and 3 of 2020 in columns (1)-(3) and (8)-(10) are determined by Weeks 15-16 and Weeks 27-28 after 50 confirmed infection cases, respectively.
3. PCE scores of Quarter 1 of 2020 in columns (4) and (11) are measured by Weeks 3-4 after 50 confirmed infection cases.
4. PCE scores of Quarters 2 and 3 of 2020 in columns (5)-(7) are determined by Weeks 13-14 and Weeks 23-24 after 50 confirmed infection cases, respectively.
5. Data used in columns (8)-(11) exclude more countries with smaller size in Asia, South America, and Africa.
6. For a full list of countries used in the regressions in columns (8)-(11), see footnote 22 of the text.

Table A13 Economic Growth and Pandemic Containment Effectiveness (PCE) for Infections

Dependent Variable	Quarterly GDP growth rate			Annual GDP growth rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Sample period	Q2	Q3	Q1	Q2	Q3	Q1
PCE Score (X 100)	0.149***	0.107***	0.041**	0.052**	0.056***	0.030
	(3.150)	(4.933)	(2.221)	(2.218)	(2.911)	(1.595)
economic stimulus spending	0.116	0.153		-0.106	-0.173	
	(0.247)	(0.690)		(-0.629)	(-1.004)	
economic support index	-0.019	-0.018		-0.031**	-0.041***	
	(-0.603)	(-0.850)		(-2.124)	(-2.851)	
GDP per capita	0.837	0.015	-0.416			
	(0.728)	(0.019)	(-0.922)			
Gini coefficient	-0.425***	-0.146	-0.044			
	(-2.749)	(-1.426)	(-1.067)			
total population	-0.097	-0.005	-0.434			
	(-0.111)	(-0.008)	(-1.266)			
population 65+	-0.462***	-0.185*	-0.041			
	(-2.832)	(-1.710)	(-0.692)			
international trade	0.805	0.358	-0.109			
	(1.558)	(1.250)	(-0.427)			
government expenditure	-0.075	-0.019	-0.092			
	(-0.337)	(-0.127)	(-1.169)			
Specification	OLS	OLS	OLS			
Sample countries	CEIC			IMF		
Number of observations	73	70	70	91	87	91
R^2	0.327	0.316	0.260	0.105	0.137	0.030

Notes:

1. *t*-values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.

2. PCE scores of Quarters 2 and 3 of 2020 in columns (1)-(2) and (4)-(5) are determined by Weeks 15-16 and Weeks 27-28 after 50 confirmed infection cases, respectively.

3. PCE scores of Quarter 1 of 2020 in columns (3) and (6) are measured by Weeks 3-4 after 50 confirmed infection cases.

4. Annual GDP growth data retrieved from the IMF database including more countries is used in columns (4)-(6).

5. The PCE scores in columns (4)-(6) are still on a quarterly basis.

Table A14 Economic Growth and Infections

Dependent Variable	Quarterly GDP growth rate									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample period	Q2	Q3	Q2-Q3	Q1	Q2	Q3	Q2	Q3	Q2-Q3	Q1
Infections per million population	-1.105*	-1.198***	5.063***	-0.365*	-1.576**	-1.400***	-1.171	-1.155***	5.096***	-0.020
	(-1.914)	(-3.439)	(9.683)	(-1.792)	(-2.309)	(-3.937)	(-1.568)	(-2.889)	(5.978)	(-0.079)
economic stimulus spending	0.411	0.244			0.108	0.083	-0.118	0.159		
	(1.036)	(1.323)			(0.210)	(0.362)	(-0.252)	(0.794)		
economic support index	-0.025	-0.015			-0.017	-0.020	-0.020	0.016		
	(-0.792)	(-0.814)			(-0.519)	(-0.854)	(-0.494)	(0.520)		
GDP per capita					1.926	1.230				
					(1.411)	(1.589)				
Gini coefficient					-0.397**	-0.115				
					(-2.581)	(-1.116)				
total population					-0.288	-0.163				
					(-0.315)	(-0.267)				
population 65+					-0.483***	-0.231**				
					(-2.768)	(-2.110)				
international trade					0.619	0.312				
					(1.188)	(1.028)				
government expenditure					-0.026	0.024				
					(-0.111)	(0.150)				
Specification	OLS	OLS	FD	OLS	OLS	OLS	OLS	OLS	FD	OLS
Sample countries	CEIC						OECD+G20+Singapore			
Number of observations	73	70	70	70	73	70	48	48	48	48
R^2	0.084	0.187	0.480	0.047	0.283	0.279	0.071	0.134	0.485	0.000

Notes:

1. *t* -values are reported in parentheses. The stars *, ** and *** indicate the significance at 10%, 5% and 1%.
2. Infection rate of Quarters 2 and 3 of 2020 in columns (1)-(3) and (5)-(9) are determined by the averaged infection rate of Calendar Weeks 15-16 and Weeks 27-28, respectively.
3. Infection rate of Quarter 1 of 2020 in columns (4) and (10) are measured by the averaged infection rate of Calendar Weeks 3-4.
4. Data used in columns (7)-(10) exclude more countries with smaller size in Asia, South America, and Africa.
5. For a full list of countries used in the regressions in columns (7)-(10), see footnote 22 of the text.