Effects of COVID-19 risk controls on the Global Supply Chain

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Abstract: Countries have imposed rigorous restrictions on travel and in-person commerce to halt the coronavirus illness of 2019 (COVID-19) from spreading. Using the most recent paradigm for modelling global commerce, we examine the consequences of a variety of imaginary lockdown scenarios on the supply chain in this article. We discover that the number of nations applying limitations has a significant impact on supply-chain losses associated with the first COVID-19 lockdowns and that losses are more sensitive to the length of a shutdown than its strictness. Longer confinement that can completely wipe out the illness, however, comes with a lesser loss than a shorter one. Lockdowns that are tougher, shorter, and more frequently reduce total losses. If it prevents the need for additional lockdowns, a "go-slow" strategy for releasing limitations may decrease total damages. Whatever the plan, the intricate nature of global supply networks will amplify losses beyond COVID-19's immediate consequences. Therefore, preventing pandemics is a public benefit that needs cooperation from all countries and assistance from those with weaker capacities.

Keywords: covid 19, supply chain, lockdown, global, modelling

Introduction

The World Health Organization (WHO) classified COVID-19, which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), to be a pandemic on March 11, 2020. COVID-19 first appeared in late December 2019, but swiftly expanded to other nations1 in Asia, Europe, and North America [1]. Nearly every nation in the world now has confirmed cases of COVID-19 and the WHO has urged affected nations to slow the spread of the virus by enacting containment and suppression measures. These measures range from stringent restrictions on travel, social gatherings, and commercial activities aimed at "flattening the curve" to less stringent ones created to protect immunological systems [2].

Different evaluations of the public health danger presented by COVID-19 as well as the social and economic effects of the various measures can be seen in the differences in the strictness of such laws and the speed with which jurisdictions have implemented and eased them [3]. To inform ongoing efforts to contain COVID-19 and to reveal more generally how pandemic-related economic losses will be distributed along global supply chains, we quantitatively assess the short-run supply-chain effects of different containment strategies across countries and industries sectors using a recently developed economic disaster model [4].

Analytical Strategy

Our analytical strategy is described in more detail in the Methods. In conclusion, we modelled industry-specific transportation and labour supply restrictions as the short-term economic shocks of various COVID-19 response scenarios. The model uses weekly time steps, the most recent input-output data available from around the world, and accounts for interactions throughout intricate global supply networks as well as the settings of shortage and imbalance that are prevalent in most markets. Our improved adaptive regional input-output (ARIO) model takes into account input substitutability and dynamic selections of supply-chain links, which helps to reflect bottlenecks along global supply chains more accurately. We can evaluate the possible effects of various policies on the supply chains by using our model to simulate control strategies during a pandemic.

We created four different sets of pandemic scenarios, three of which (a total of 36 scenarios) depict various COVID-19 pandemic spread and containment responses, and the fourth set of scenarios (a total of 3 scenarios) evaluates the costs associated with maintaining some restrictions for a longer period as well as the losses if lockdowns are implemented once more next fall or winter. The pandemic's spatial distribution is measured by the number of nations that are impacted globally. The length of time a lockdown is in effect is measured in months. The proportion by which labour availability and transportation capacity is reduced in comparison to pre-pandemic levels is used to gauge the degree of strictness. Given the effects of lockdown measures on the availability of labour the degree and closeness of in-person encounters, the availability of vital or life-sustaining resources (such power), and the possibility of working from home. Therefore, the degree of lockdown restrictions represented in the scenario (for example, 80% strictness will result in an 80% reduction in overall transportation capacity) and the sector-specific multipliers determine the constraints on labour availability for each industry (for example, 0.5 for wheat production as the level of exposure is low and 0.1 for electricity and gas supply as essential activities). The results are reported in terms of economic supply-chain consequences, quantified in absolute terms of, and dependent on, the spatial distribution, duration, and strictness used in each of the 39 scenarios.

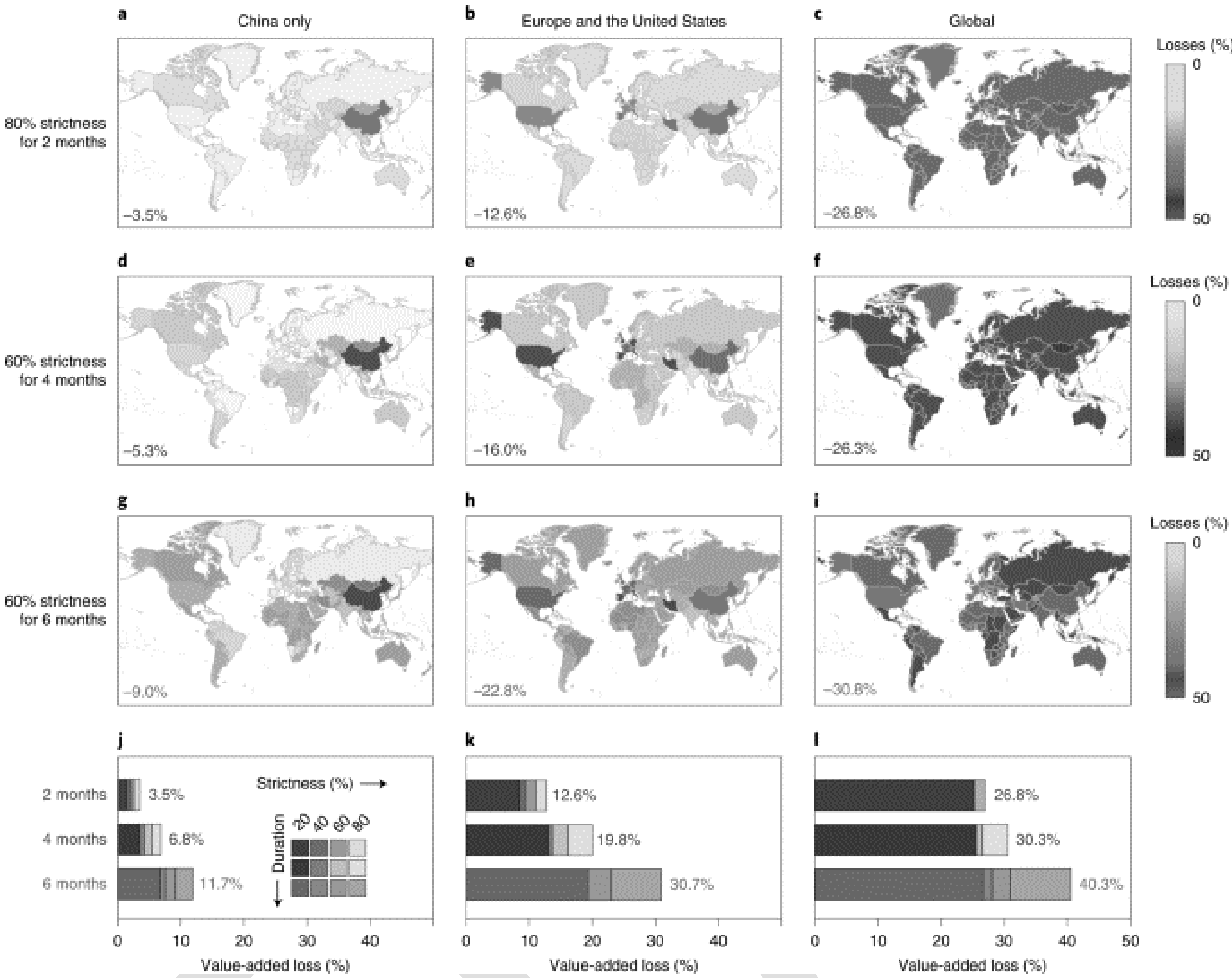

Figure 1 variation of value-added loss of China, Europe and Global

The model's first key finding is that the number of afflicted nations, followed by the length of time that lockdown measures must be in place, determines the pandemic's overall cost; the strictness of these measures, however, is comparably less crucial. The primary factor influencing the worldwide cost is the pandemic's geographic scope. Our findings indicate that the worldwide supply-chain effects would have been 3.5% of the global GDP if only China had been impacted. We discovered that the worldwide supply-chain effects increased nearly fourfold to 12.6% with the expansion to highly industrialized western nations and containment efforts implemented in Europe and the United States.

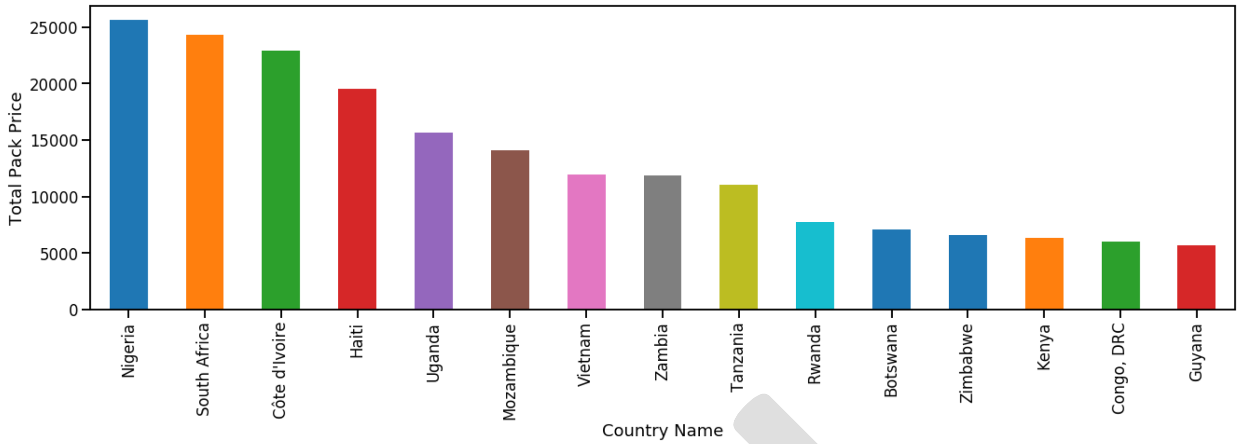

Figure 2Bar graph representation of pack price vs country

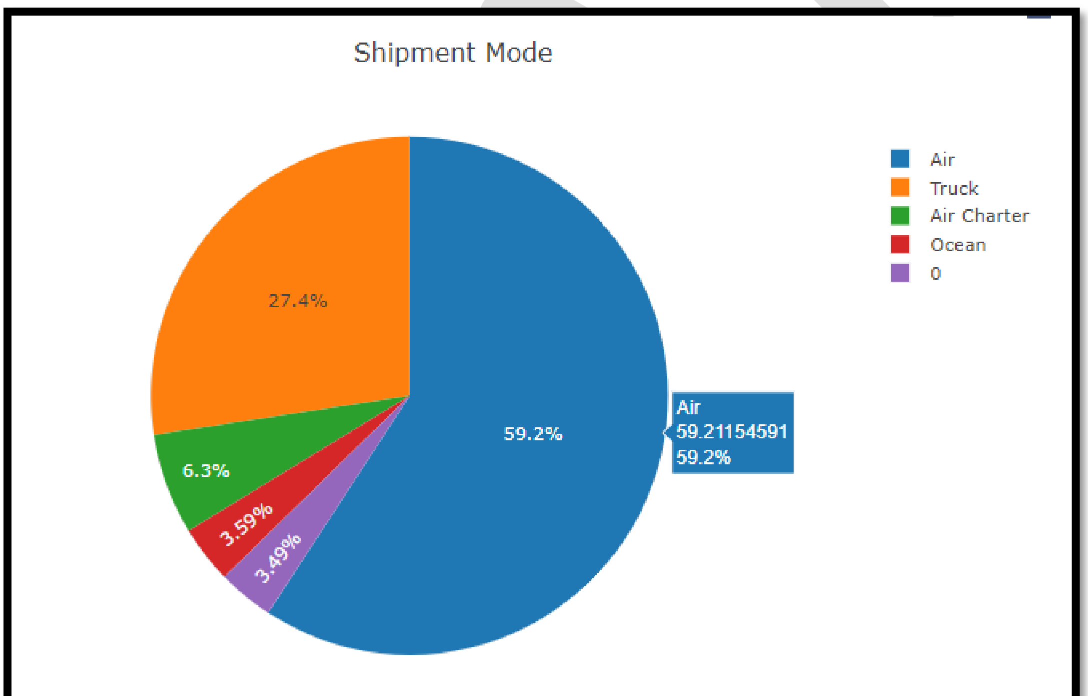

Figure 3 Pi chart to represent different shipment modes

Finally, 26.8% of global GDP is the estimated impact of worldwide lockdowns in reaction to COVID-19. 1f, I, which depicts the consequences of worldwide dissemination and moderately stringent (60%) lockdowns for 4 and 6 months, illustrates the length of the lockout. Global value-added losses in this scenario rise by a little over 4%. illustrates once more the sharp rise in global losses with lockdown length. For instance, the global supply-chain effects in the strictest lockdown scenarios (i.e., 80%) with global spread increase from US$20.0 trillion under a 2-month duration to US$22.7 trillion under a 4-month duration to US$30.1 trillion (equivalent to 40.3% of global value added) under a 6-month duration. The same bar charts, however, demonstrate that worldwide losses are considerably less sensitive to the severity of lockdown measures than they are to the pandemic's scope or the lockdown's duration. If just China had been impacted, for instance, increasing the strictness by twofold would have an approximately linear effect over two months. The economic loss is less susceptible to variations in strictness as the period lengthens. In the global scenario, the effects of a two-month lockdown are only 7.2% worse at 80% strictness than under 20% strictness. Although the domestic output and transportation capacity—which connects upstream suppliers to downstream consumers—are determined by both length and strictness, the economic harm caused by supply-chain connections is far more sensitive to the duration of the restrictions.

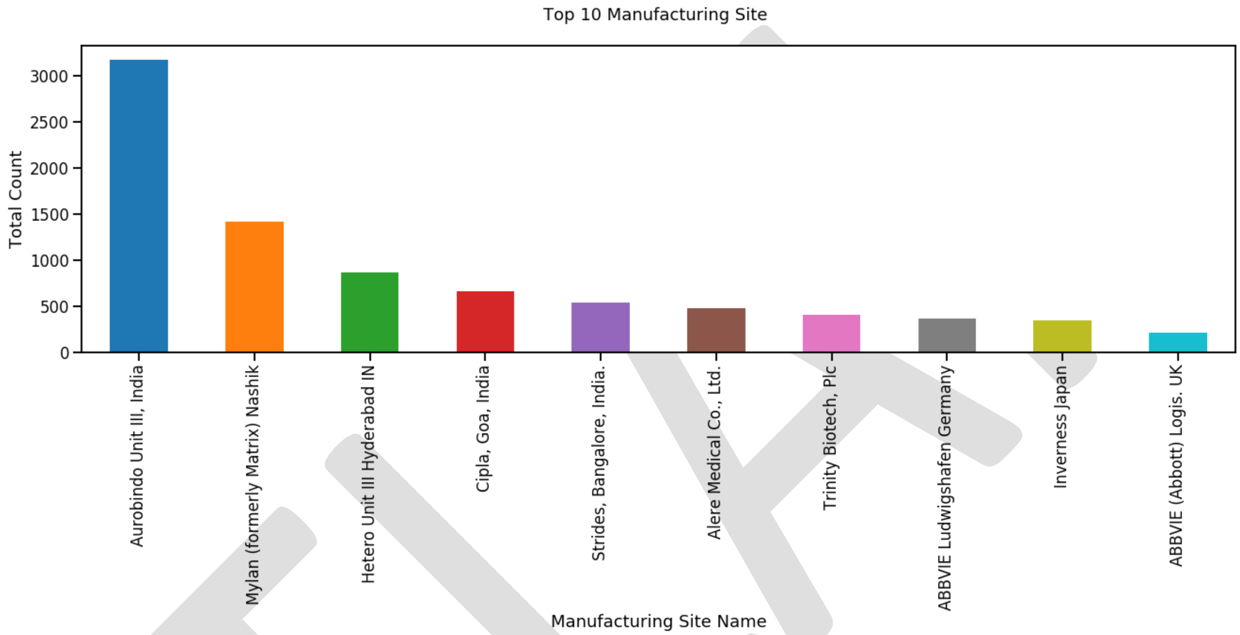

Figure 4 top ten manufacturing site data

The second lesson learned from the model is the significance of spreading across international supply chains; even those nations not directly impacted by the virus still suffer significant losses, and low- and middle-income nations are especially susceptible to indirect consequences. Figure 5 displays the propagation impacts via global supply chains for each of the three scenario sets as well as the direct consequences caused by domestic containment measures, such as lockdown or suppression. In the situations where an epidemic is limited in China, direct losses are significant but by definition only occur in China, accounting for 16.7% of China's yearly GDP.

However, the virus's economic impact would not have been limited to China even if it had. Further losses of 4.8% are caused through forward and backward propagations along supply chains inside China and with other nations, for a total impact on China's yearly value added of 21.5%. For instance, despite not being directly impacted by COVID-19 in this scenario, the United States and New Zealand would still experience value-added losses of 0.6% and 2.2%, respectively, during a lockdown with 80% strictness for 2 months in China as a result of the decline in China's output as well as a decrease in China's final demand for their products.

The GDP of nations with strong ties to China's supply networks, such as Vietnam, Malaysia, and Nigeria, would decline by 5.2%, 3.6%, and 3.1%, respectively, under the same scenario. Interestingly, countries with niche industries, such as Kazakhstan (energy), Mongolia (livestock), and Jamaica (tourist), suffer even greater losses, with annual GDP declines of 6.1%, 4.2%, and 11.4%, respectively. Likewise, losses from imports might continue to damage nations where the virus has been contained. Even if the virus is contained in China for two months but spreads elsewhere, China would continue to experience economic disruption as a result of the spread ($5.77 trillion in the global scenario with 40% tight lockdowns for six months).

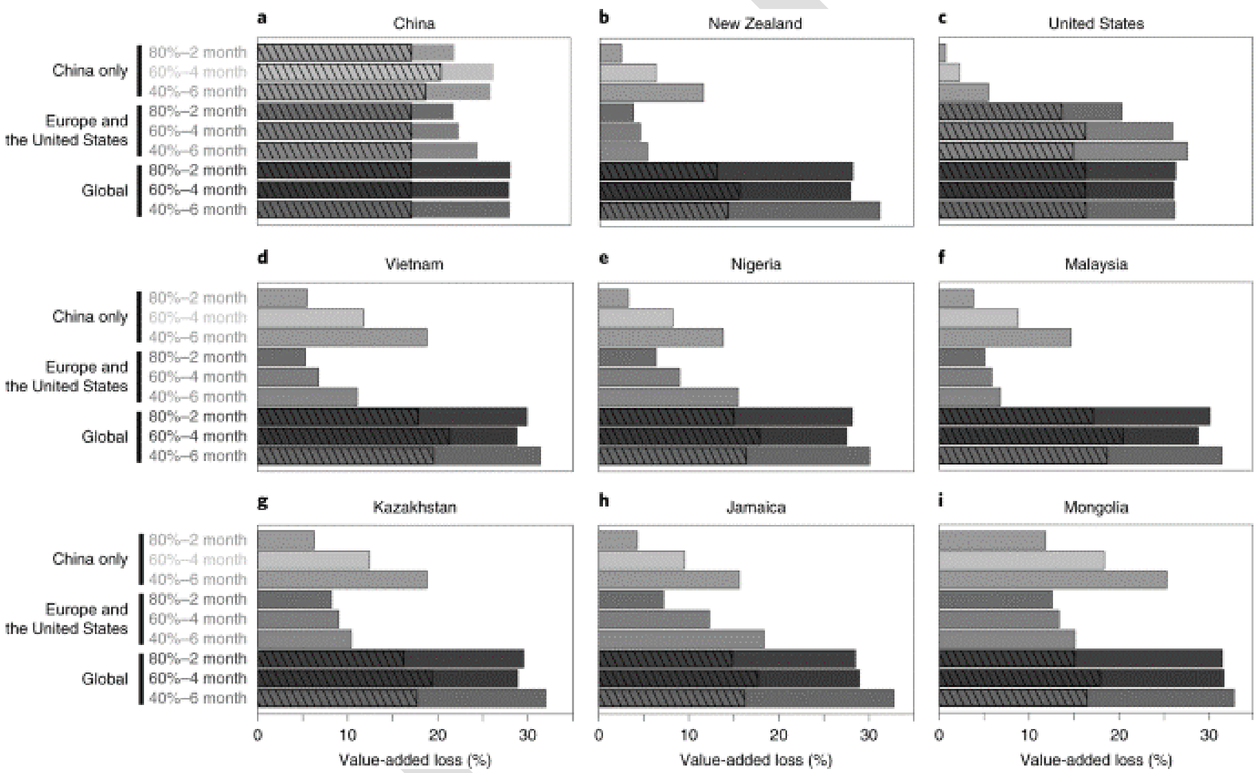

Figure 5 Variation of value added loss w.r.t different Countries

Scenarios of spread and containment

The three key criteria that determine the loss brought on by the pandemic are the number of afflicted nations, the length of confinement, and the strictness of containment. We created three sets of scenarios, namely China alone, Europe and the United States, and worldwide, using these three indicators as dimensions and then consulting the current pandemic condition. While scenarios within the same scenario set make varying assumptions about the length and rigour of the confinement, distinct sets of scenarios indicate different COVID-19 effect zones.

The COVID-2019 epidemic is presumed to be limited to mainland of China in our initial scenario set, China alone. Due to the requirement for epidemic control, mainland China's labour supply and transportation were constrained starting in the fourth week of 2020. (that is, 22 January 2020). We established four degrees of strictness (i.e., 20%, 40%, 60% and 80%) and three durations (i.e., 2, 4 and 6 months) to study the effects of policy strictness and duration of the epidemic on the global economic system. For instance, the scenario "China just 20%-2 months" describes a two-month pandemic with 20% labour supply and transportation constraints.

Different industries' labour markets are affected by isolation measures differently. We determined a particular multiplier for each sector based on three criteria: the degree of exposure required for the sector's job, if it is a lifeline, and whether working from home is an option. The sector multiplier will be low if a sector has limited work exposure, is a lifeline sector, or makes it simple to work from home. The opposite is also true.

The benchmark constraint in the scenario and sector-specific multipliers are then used to establish the limits on the availability of labour in each sector. Because of the low degree of exposure to its production operations, we, for instance, assume that the multiplier for the wheat production sector is 0.5. The labour supply in the wheat production sector will therefore decrease by 10%, or 20% multiplied by 0.5, under China’s only 20%-2-month scenario. Transport between mainland China and other areas will also decrease by 50% during the outbreak, according to the scenario established.

The pandemic has an influence on the world economy's supply side as well as its demand side, which affects economic production. The COVID-2019 epidemic zone will see a significant decline in tourism demand. Due to a lack of data, we assumed that during the outbreak, demand in the two sectors of accommodations, food, and service activities, as well as entertainment and other services, decreased by 99% in the outbreaking region.

Result and Discussion

Using imagined scenarios in which the number of countries, the duration and strictness of lockdowns, as well as how limitations are loosened as the pandemic abates, were changed, our modelling of COVID-19 lockdowns illustrates the potential for substantial economic losses in afflicted nations. We selected variables in each scenario that are affected by or determined by public health policy decisions made throughout the world. Our methodology was created to pinpoint the most crucial containment elements and gauge the severity of propagation impacts across international supply chains. When compared to prior macroeconomic analyses that seek to quantify the costs of COVID-19, the analytical framework settings are radically different. Our model is constrained by ignoring technology advancements and presuming that output and consumption patterns would remain unchanged from before the crisis. Since our model concentrates on short-term scenarios and circumstances following a shock, those modifications are improbable.

Our model is further limited by the sectoral trade relationships between nations, and because it is unable to account for the intricacy of supply-chain networks at the company level, it may overestimate the overall impact. Finally, modelling the dynamic general equilibrium consequences or health-related implications, such as mortality, quality-adjusted life year, and disability-adjusted life year is neither our goal nor our method. As a result, this essay is unable to analyse the costs and advantages of different approaches.

Based on our findings, we have identified several insights that together imply that stronger initial lockdowns will minimise economic losses, given that such strictness shortens the length of the measures. New data from similar studies appear to confirm this relationship. Our analysis of various recovery scenarios, however, indicates that a prolonged period of some restrictions—for instance, 20% reductions in labour and transportation capacity in our new normal scenario—is still economically preferable to a quicker return to pre-pandemic activity followed by another round of global lockdowns. This is an important conclusion for policymakers who want to remove limitations and promote economic recovery, even though it may be uncomfortable.

Our findings also highlight the significant and diverse effects spread by international supply networks, which have a surprising impact on the degree of economic loss to a nation or industry. Furthermore, just as people who stay at home safeguard both themselves and others, so do nations that enforce rigorous lockdowns for the sake of other nations. For instance, according to our estimates, a rigorous lockdown that prevented the COVID-19 epidemic from spreading to China would have cost China 21% of its GDP while reducing the world GDP by 3.5%. Theoretically, illness prevention efforts should be stepped up to the point when marginal societal costs of prevention barely outweigh marginal social gains. From the standpoint of global optimization, the positive externalities of public health initiatives to avert a pandemic may result in market failures, underinvestment, and delayed action. A worldwide cost-sharing tool might guarantee that the costs of monitoring, controlling, and suppressing the next emerging illness are equitably allocated, reducing some of the barriers to early action and bringing long-term benefits to the economy and global health.

Future Scope

This research study is very helpful for researchers working in the same field.

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