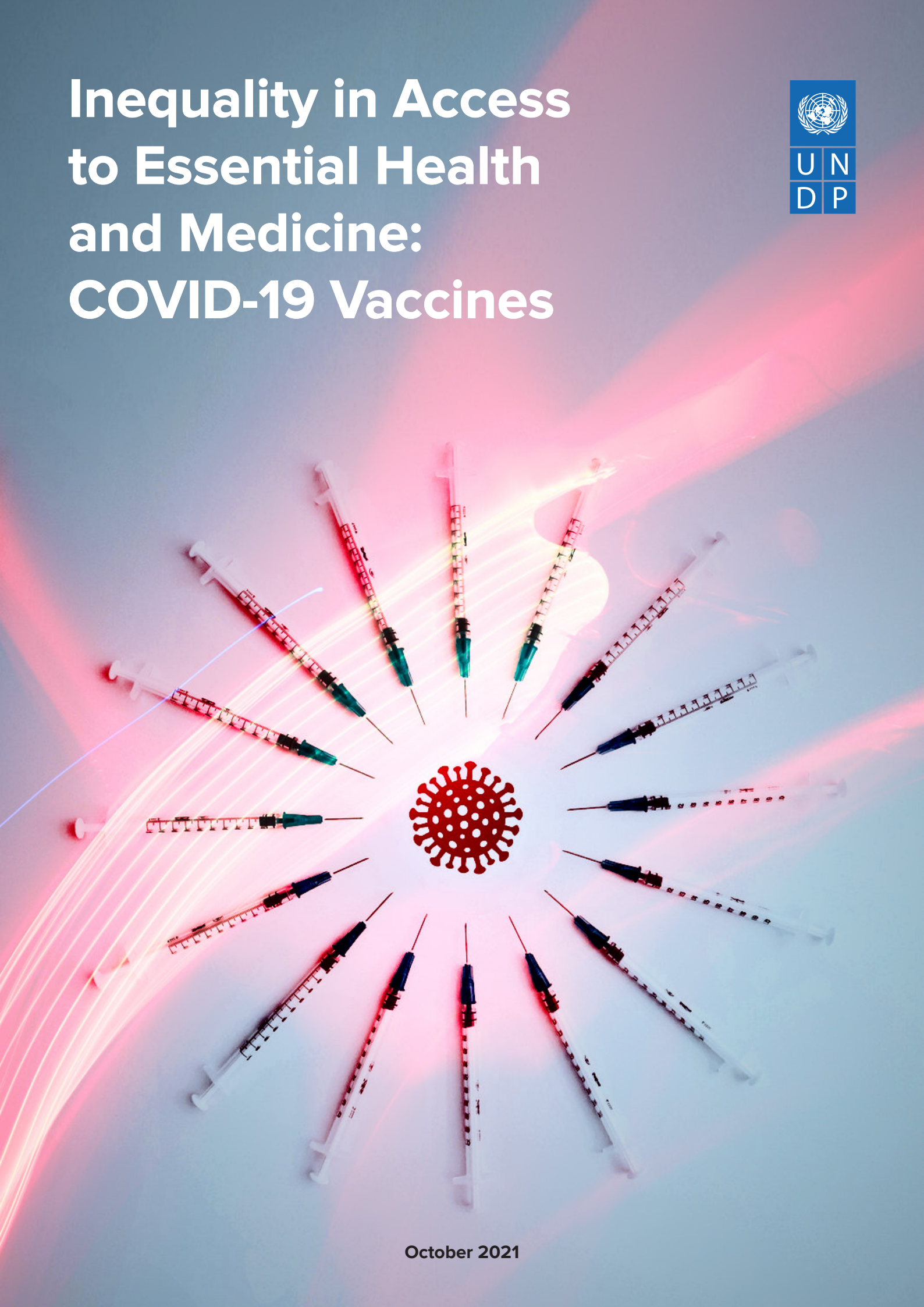
Inequality in Access to Essential Health and Medicine: COVID-19 Vaccines



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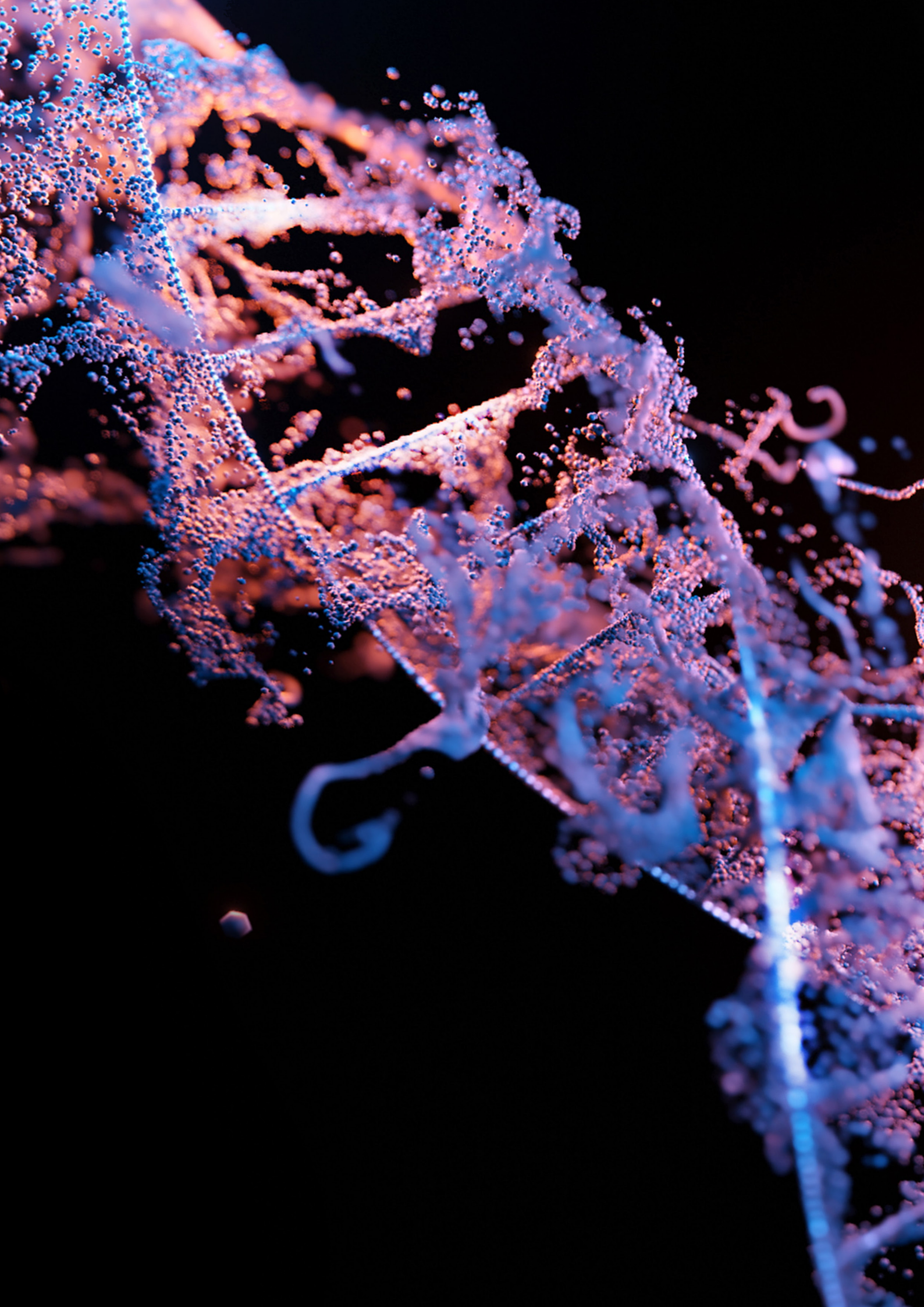

Acknowledgement

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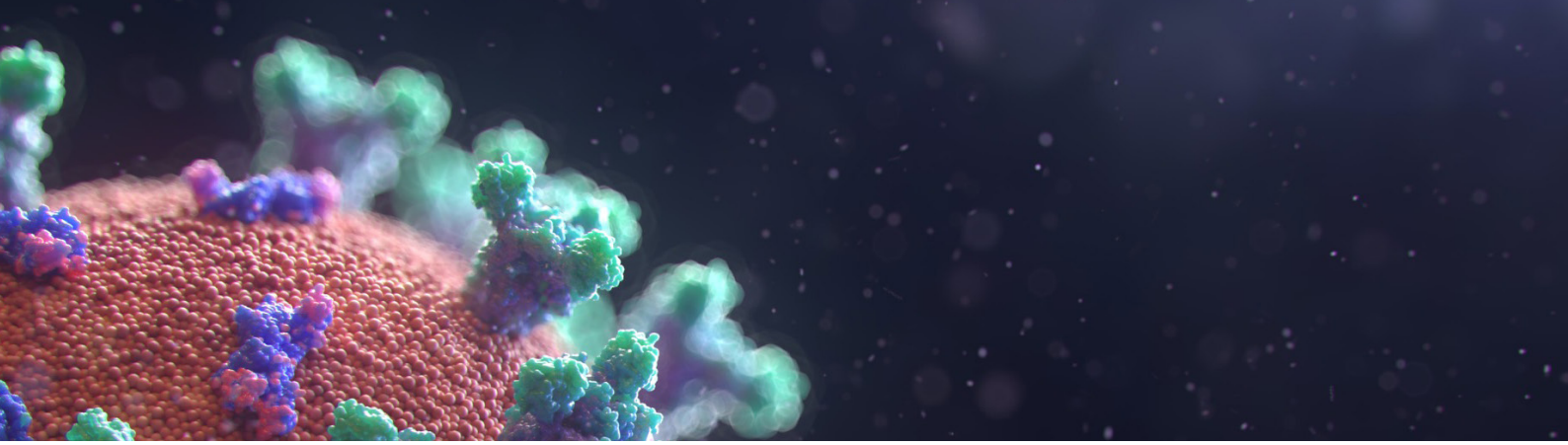


Executive Summary

While most of the countries across the world are recovering from a severe recession resulted from the COVID-19 pandemic by ramping up vaccinations since the first quarter of 2021, a third wave of the virus has already taken a toll on the Asia-Pacific region. Before the pandemic, this region enjoyed the steepest human development growth globally. However, the progress is uneven within the region especially in respect to development in health and the access to essential health and medicine**. The inequality in health is expected to worsen due to the pandemic largely due to the current unequal distribution of COVID-19 vaccines**, between advanced and less-developed countries in Asia-Pacific region. High-income countries have deals securing enough doses to vaccinate their populations twice over, while in many low-income countries fewer than one in 100 people had received a single dose of vaccine.

The COVID-19 pandemic, which many say, could be a "preventable disaster", is now threatening to become even more catastrophic **due to lack of global coordination and dithering in terms of the vaccine distribution**. Significant disparities now surface as countries' responses to the virus differ across the board: i) **direct health impact and response** to COVID-19 (i.e. more than 80 percent of regional cases were found in the lower-middle income countries, and the infection rate per capita in lower-middle income countries is 3.4 times and 3.8 times higher than that in high-income and upper-middle income countries of this region respectively), ii) the **efficiency in controlling the spread of the virus**, iii) the **(in) ability to take advantage of the revival in international goods trade**, and iv) the capacity of **providing fiscal packages and monetary support** to the public and enterprises.

By July 2021, China and Viet Nam seem to be leading the rebound within the Asia-Pacific region with a V-shaped recovery path, while the rest of the region have yet to register genuine and solid recovery outlooks. For a more inclusive and robust recovery within the region, a more synchronized COVID-19 vaccination programme across countries is needed not only to **avoid a further K-shaped recovery** but to prevent a serious **setback to the progress in Sustainable Development Goals** achieved.

To address the problem of vaccine inequality and the potential toll it will take on the lives and livelihoods, COVID-19 Vaccines Global Access (COVAX) Facility, of which most of the Asia Pacific countries are supported; either under Advanced Market Commitment financing or self-financing scheme, is uniquely positioned as an international mechanism in providing low and middle-income countries an access to this global public good. Of question is whether the principle of equitable distribution grounded upon population size irrespective of the severity of the health crisis and economic circumstances satisfies the quest for fairness and efficiency. Drawing upon an optimization model that satisfies individuals' desire for greater health and mobility by taking into account economic and health constraints facing the vaccine allocation decision, it is found that **COVAX's first-stage approach to equitably distribute vaccines across countries based on their population tracks reasonably well the optimal number of vaccines.** The global programme is incentive-compatible relative to first-best decision made by individual countries (as if there is no market failure and risk

heterogeneity) given their current economic capacity, implemented stringency, and the state of the pandemic. And the finding holds true across different prices of vaccine per dose.

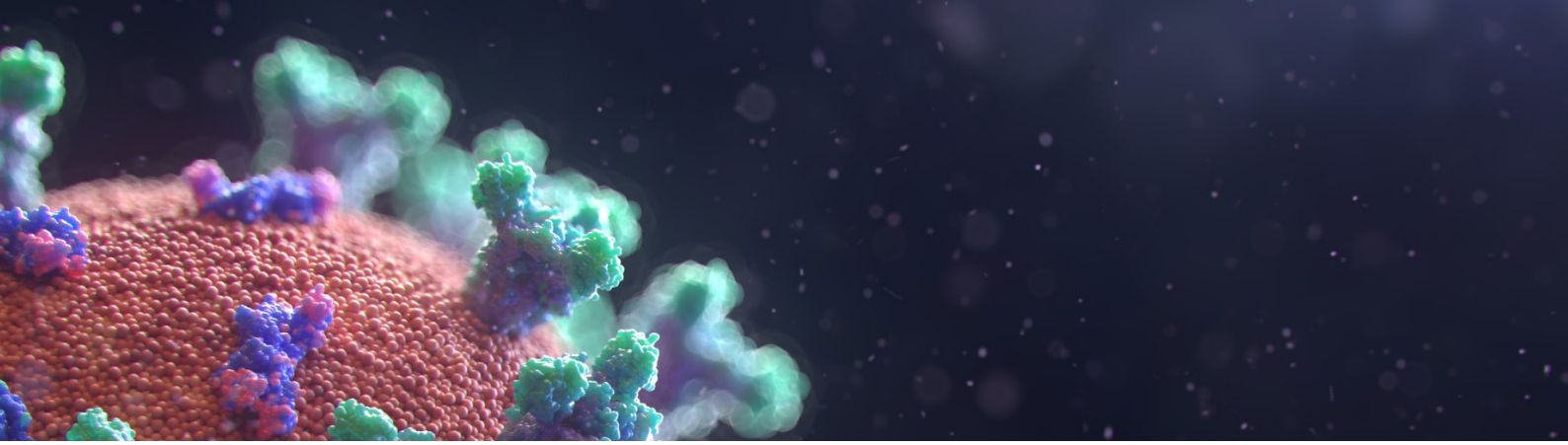
Being dogmatically **equitable, however, does not guarantee fairness in allocation**. Fair allocation is a matter of distributive justice. For utilitarian justice, "a vaccine is a vaccine whoever receives it", but for Rawlsian justice, global social welfare cannot be maximized unless vaccination in the poorest country with more severe health circumstance is accelerated. The worst-off must be prioritized. To reconcile distributive justice across different aisles, a fair allocation shall always be needs-based. **Optimal vaccine allocation that pivots on the societal desire for better health and greater mobility is welfare superior to equitable allocation weighted by population.** This result holds true irrespective of concepts of justice and under different health and economic circumstances. In short, while equitable allocation is efficient, fair yet efficient allocation of vaccines needs not be equal across countries if it is to every country's need.

The perceived most ideal scenario is to have parallel vaccination carried out all over the world, i.e. zero pricing and production barriers. Through a simulation on a two-country epidemiological-macroeconomic model expanded with vaccination and non-pharmaceutical measures, it can be shown that **parallel vaccination flattens the pandemic curve, enabling earlier easing of mitigation measures that affects the economy**. These findings call for a better strategy for a coordinated global vaccine production and distribution for vaccine equality in the future.

But we do not live in the first-best world at this moment. High-income countries that have early access to the limited supply of vaccines unsurprisingly prioritize their citizens over the rest of the world. In such a world with national partiality, low-and-middle-income countries only have access to continuous supply of vaccines six months later than high-income countries, where the latter would have already vaccinated half their population. As a result, virus transmission and death incidents are higher. But **the economic consequence of vaccine inequality is not much worse than that of parallel vaccination**. Partly it can be attributed to the rising tide that lifts the economic boat of developing economies, as the surging aggregate demand in the advanced economies spills over to the rest of the world through global trade in goods. This is conditional of course, upon easing of economic lockdown measures in middle and low-income countries, and existing virus transmission wave dies–even in absence of a vaccination programme roll-out. Circumstances can turn disastrous, however, if middle or low-income countries are hit by the new wave of exogenous virus transmission while waiting for vaccines, subsequently forcing a new round of mobility restriction. The country would have missed a chance to recover economically, and the death toll from the virus and economic hardships would likely continue to rise. There is also **the massive risk of inflationary pressures building up domestically from a protracted disruption of global supply chain.**

Another interesting finding from the simulation exercise is that **slow domestic vaccine rollout due to domestic health inequality and weak state capacity amplifies the loss of human life** in an already unequal **global** vaccine distribution scenario. Without a well-functioning domestic vaccination regime to coordinate vaccination programmes and mobilize mass participation, health benefit of vaccines could just slip right through our fingers. The machinery for domestic vaccine rollout in majority of the countries is predictably weak, reflecting constraints such as inadequate trained staff and lack of storage and logistic infrastructure. **As global supply of vaccines expands over time, it is imperative that domestic vaccination capacity is also massively expanded in the shortest time possible.** In many instances, this would require huge investments and radical new public health approaches, but if done well, would reverse the long run health inequality drivers in the countries.

Pandemics don't happen in isolation, and COVID-19 will not be the last. The next pandemic will occur in an increasingly more polarized and complex world, suffering from further widening health inequality, increasing climate degradation and worsening debt crisis, if we do not take heed of the lessons from this pandemic. Policy thinking must shift in particular regarding the importance of priority-setting for vaccine access, Intellectual Property Rights (IPRs) sharing regime, public health communication strategies, expanding the social protection system to be more agile and comprehensive, making greater investments in pandemic-related infrastructures.



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Chapter 1
Overview

1.1 Human Development in Asia-Pacific: Advanced but Uneven before the COVID-19 Pandemic

The world is emerging from the biggest health, economic and social shock in our living memory. Before the pandemic, as a home to 60 percent of the total population of the world, which also covers the world's most populous countries (i.e. China and India) and some of the smallest populations on the planet (i.e. small island developing states in the Pacific), the Asia-Pacific region achieved the steepest human development growth globally (UNDP, 2019). Yet, this progress is uneven within the region especially in terms of the development in health.

27 out of 36 Asia-Pacific countries and territories with available data spent less than the average global rate of annual health expenditure per capita (US$1,467.19[1]) (**Figure 1.1**). Countries that spend more than the average are those that belong to the high-income category. Among the 27, it is difficult to predict impact of health expenditure on human development. Maldives' health expenditure per capita is $414 (HDI: 0.620) which are more than twice as large as Pakistan's $167 or Myanmar's $109, but their HDI scores are very close to each other, i.e. 0.613 and 0.632 respectively. Similarly, Malaysia's HDI score is 0.783 compared to Thailand 0.782, but records its health expenditure at $1,691 versus Thailand's $516 per capita. In short, wealthier countries tend to have larger per capita health expenditure and better attainment in human development, but within middle- and lower-income countries the relationship is rather ambiguous.

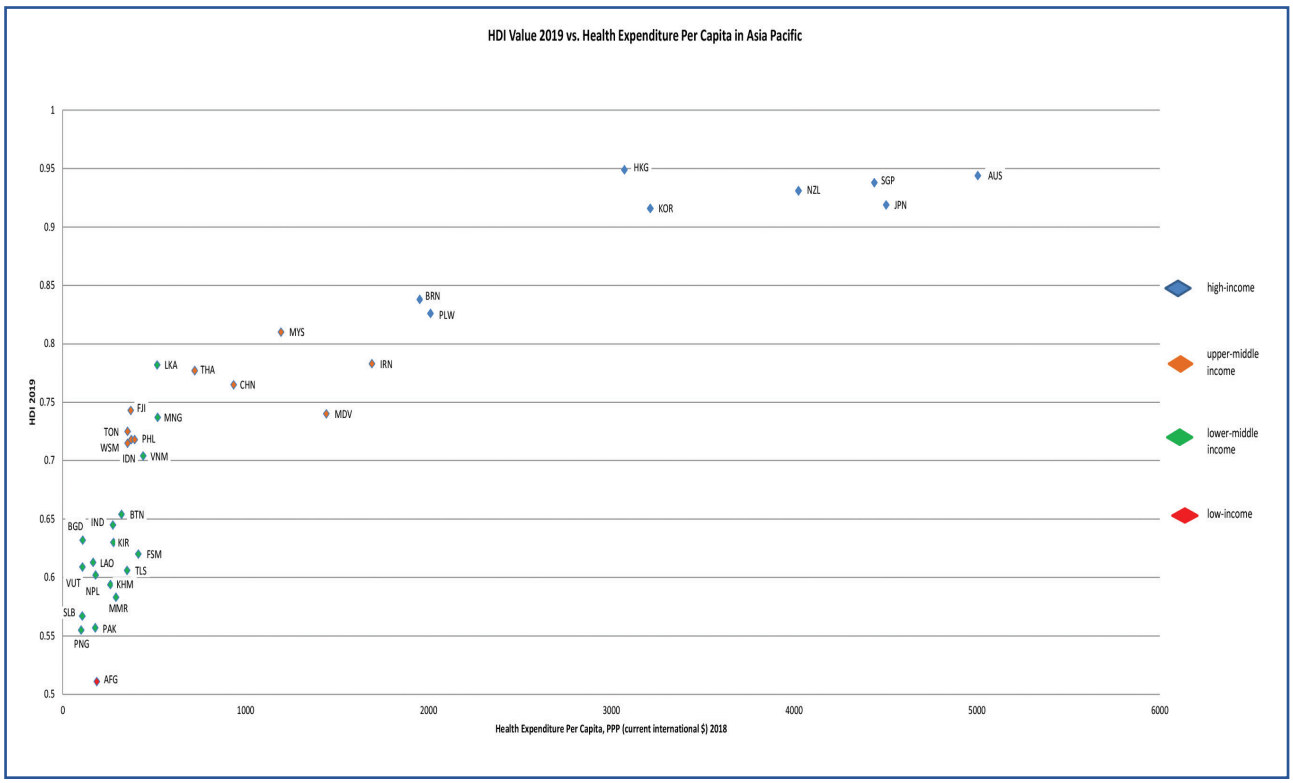


Figure 1.1: Relationship between per capita Health Expenditure and Human Development Index scores

Data Source: 1) Data for HDI Score are retrieved from Human Development Report 2020; 2) Data for Health Expenditure are retrieved from WHO Global Health Expenditure Database.

[1] WHO Global Health Expenditure

One of the key focuses of the health-related Sustainable Development Goal (SDG) is universal health coverage (UHC), including access to safe, effective, quality, and affordable essential medicines and vaccines. Although experts have long argued that vaccination is a highly cost-effective health intervention for children to address health inequalities in adulthood, inequalities in access to childhood immunization still persists in Asia-Pacific region. For example, in terms of MCV2 (Measles Containing Vaccine 2nd Dose), the coverage rate in the wealthier Asia-Pacific countries is much higher than that in poorer ones (**Figure 1.2**).

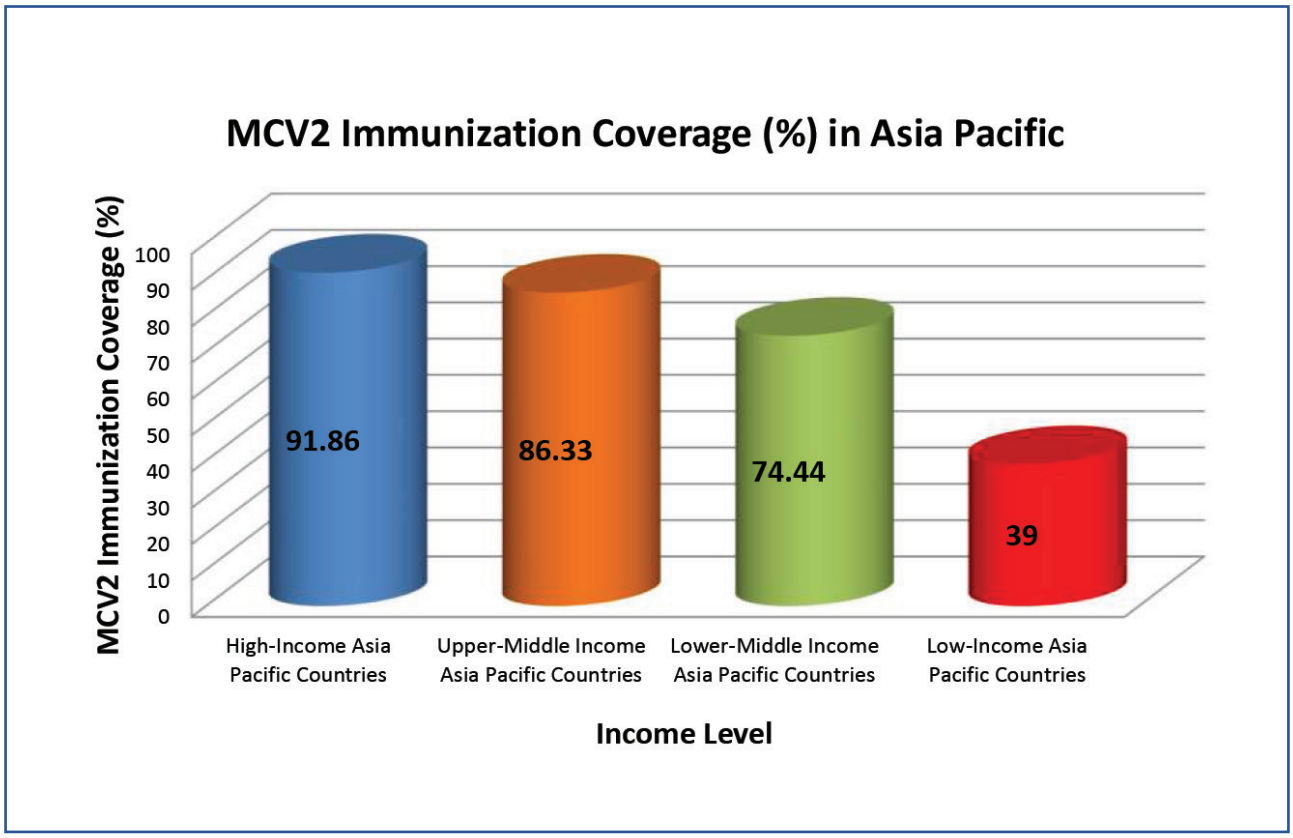


Figure 1.2: MCV2 Coverage Rate in Asia-Pacific Countries Decreases as the Income Level Declines

Source: MIER's own calculation based on data of MCV2 Immunization Coverage Rate from WHO Health Equity Monitor database

Note: 1) Low-Income Asia Pacific Countries (LIC) group only includes Afghanistan; 2) As suggested by WHO, over 95 percent of the target population should be immunized with two doses of MCV (measles-containing vaccine), according to the highly contagious nature of measles (Gay, 2004). Moreover, existing research (Hu et al., 2018) has confirmed that the MCV2 is highly helpful in boosting the antibody titres after the immunity waning and avoiding the primary vaccination failure as well.

Quality of and access to healthcare constitutes another key challenge for health systems throughout the Asia-Pacific. As shown in **Figure 1.3**, there is a significant disparity in the access to timely, effective and quality healthcare among Asia-Pacific countries, and the averaged Healthcare Access & Quality (HAQ) Index score of wealthier Asia-Pacific countries is 1.2 times, 1.7 times and 2.4 times better than that of upper-middle income, lower-middle income and low-income ones, respectively.

Recent research shows that COVID-19 will not only reveal the pre-existing inequalities in human development as we presented above but that it also will exacerbate these inequalities for the poor and the marginalized due to the continuing COVID-19 threats in the next few years and a likely uneven vaccine rollout.

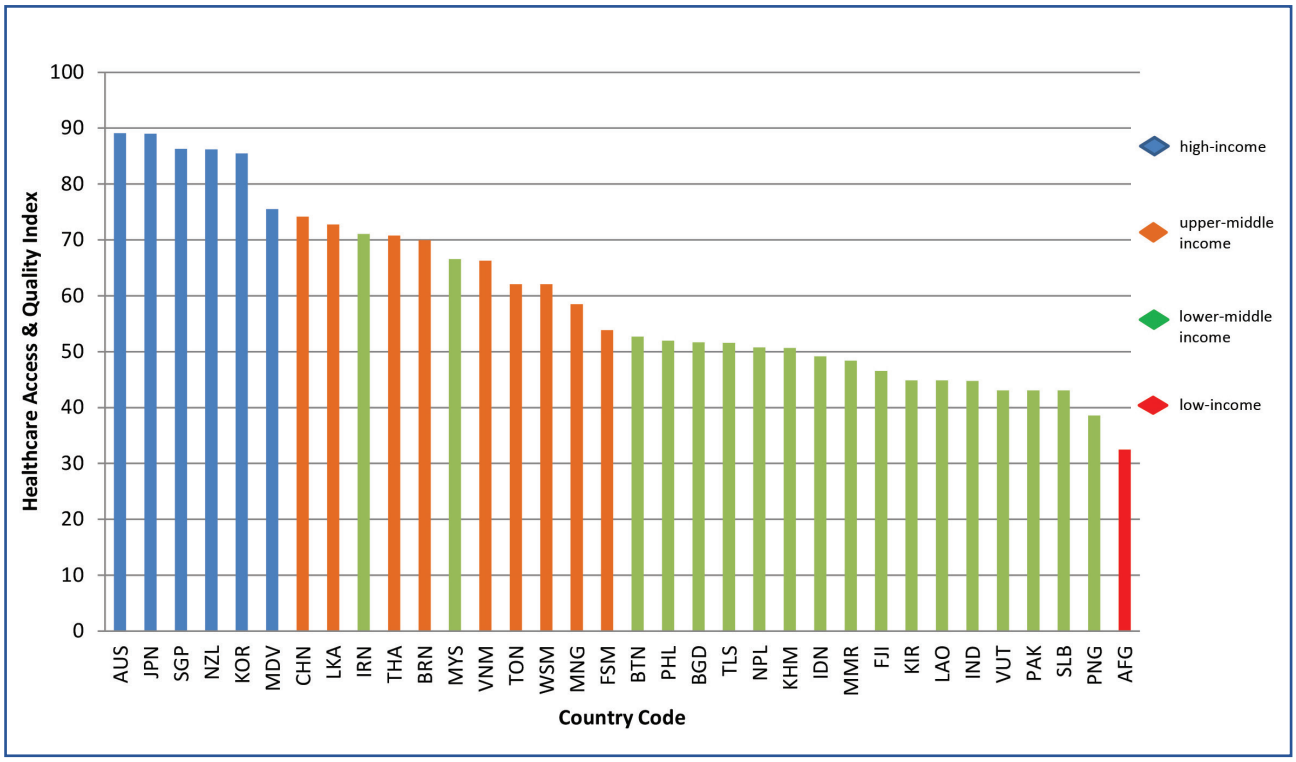


Figure 1.3: Healthcare Access & Quality (HAQ) Index score in Asia-Pacific increases as the income level improves

Data Source: Data for Healthcare Access & Quality (HAQ) Index are retrieved from the database of Institute for Health Metrics and Evaluation (IHME), University of Washington. The HAQ Index is measured on a scale from 0 (worst) to 100 (best) based on death rates from 32 causes of death that could be avoided by timely and effective medical care (also known as "amenable mortality").

1.2 The Unfolding Pandemic in Asia-Pacific: Unprecedented Reversal in Human Development

By mid-July 2021, approximately a quarter of the people who had acquired COVID-19 globally were found in the Asia-Pacific region. Among that, around 80 percent of cases were found in the lower-middle income countries of this region as shown in **Figure 1.4.** The per capita infection rate in lower-middle income countries is 3.4 times and 3.8 times higher than that in high-income and upper-middle income countries respectively in this region. Precisely, among 1,000 people 17 people are infected by the coronavirus in lower-middle income countries, compared to only 5 and 4 in high-income and upper-middle income ones. Hence, there might be a risk that economic recovery in the post-pandemic era will be skewed towards the better off–a 'K-shaped' recovery further marginalizing the relatively disadvantaged and poorer countries in this region. Moreover, this 'K-shaped' recovery is also existent within a country–sectors like tourism and hospitality would recover much later than sectors such as manufacturing subsectors producing COVID-19 vaccines, personal protective equipment or providing health services.

Even in the first half of 2020, a Computable General Equilibrium (CGE) model ran by Asian Development Bank (ADB) (2020) predicted that the total economic loss of the global economy due to COVID-19 would be around $5.8 trillion to $8.8 trillion (6.4-9.7 percent of global GDP), excluding the positive impact from governments' policy interventions. The size of economic impact estimated by ADB at that time was more than double of that from World Bank (Maliszewska et al., 2020a)–a 2-4 percent decline in global GDP, and also higher than that from International Monetary Fund (2020a)–6.3 percent decline in global GDP. In terms of the economic impact in Asia-Pacific region, ADB (2020) forecasted a 6.2 percent decline in regional GDP (equal to a loss at $1.7 trillion) under the three-month containment scenario and a 9.3 percent decline in regional GDP (equal to a loss at $2.5 trillion) under the six-month containment scenario.

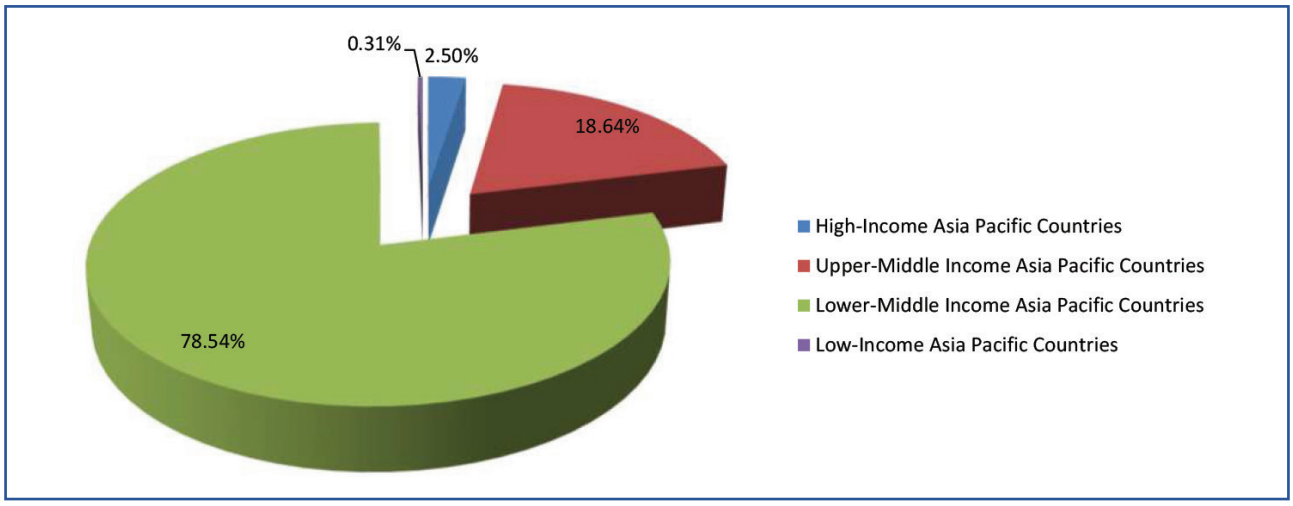


Figure 1.4: Distribution of People Acquired COVID-19 in Asia-Pacific Countries by Income Level

Source: MIER's own calculation based on data from WHO COVID-19 Dashboard per Asia-Pacific countries, updated on 20th July 2021.

Note: Low-Income Asia Pacific Countries (LIC) group only includes Afghanistan.

Along with the GDP disruption, Asia-Pacific's labour markets are affected negatively with increased unemployment rate, plunged labour force participation, and concentrated job losses within low-paid verticals and specific economic activities. Groups which are relatively poorer and vulnerable were affected disproportionately, exposing deep and severe gaps in existing social protection systems as well as exacerbating an already high inequality level within this region (UNDP, 2020). According to ADB's (2020) estimate, the drop in employment in the region would reach 109 million (under short containment scenario) to 167 million jobs (under long containment scenario), which almost took up 70 percent of the forecasted global total employment losses. Moreover, the drop in wage income was estimated between $359 billion and $550 billion–or accounting for 30 percent of the forecasted decline in wage income globally under the two scenarios. This is mainly because the pandemic disproportionately affects lower-paid workers in this region (job losses mainly happened in lower-paid industries), and recent findings have also indicated that in many Asia-Pacific countries the reduction in number of working hours has affected more those in lower-skilled jobs than those in higher-paying managerial and professional occupations (see e.g., ILO, 2020; Jurzyk et al., 2020; IMF, 2021). United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) (2021) claimed that the total working-hour losses in 2020 equalled 140 million full-time jobs in the Asia-Pacific region alone.

Some evidences have been found on the gendered impacts of COVID-19 in the Asia-Pacific (e.g., UN Women, 2020). Women in this region especially those who are working in industries which are relatively more vulnerable to the pandemic such as tourism and hospitality, as well as retail business and services. And this has been furthered with healthcare access challenges, increased domestic violence, childcare responsibility. Seck, Encarnacion, Tinonin and Duerto-Valero (2021) explored whether the pandemic threatens fragile gains on gender equality in paid and unpaid work by using data from Rapid Gender Assessment Surveys in eleven countries in Asia-Pacific. Results indicate that women are disproportionately shouldering the burden of unpaid care and domestic work triggered by the lockdowns, and they are losing their livelihoods at a relatively faster speed than men. Additionally, worsening mental health also emerges as a critical issue disproportionately affecting women.

Disruption to livelihoods and trade creates greater poverty incidences and severity. By using the extreme poverty line ($1.9/day), results from ADB (2020) show an additional 34 million, 78 million, and 185 million extreme poor for the 5 percent, 10 percent, and 20 percent decline in annual per capita consumption expenditure scenarios, respectively. The estimate from UNESCAP (2021a) is within the range of ADB's forecast, where an additional 89 million people in the Asia-Pacific region could have been pushed back into extreme poverty in 2020 based on the $1.9 per day threshold, erasing years of progress in poverty reduction that have been achieved in this region.

1.3 Public and Private Sector Responses

In the face of such unprecedented crisis, governments in the Asia-Pacific region have deployed a series of non-fiscal measures (e.g. lockdown, movement restrictions, social distancing measures, public health measures) to minimize the spread of coronavirus (as shown in **Figure 1.5**), together with a number of fiscal packages

(e.g. macroeconomic stabilization and stimulus policies) for citizens, households and firms to combat with the negative economic effect of COVID-19 in this region as we discussed in the last section.

In total, Asia-Pacific developing countries spent around 7 percent of their GDP as fiscal response to COVID-19 (UNESCAP, 2020), exceeding the region's response to the global financial crisis of 2008. However, the size of fiscal packages as a percentage of the GDP differs greatly between countries. Fiscal response was led by developed countries such as Singapore and Republic of Korea which spent 21 percent and 14 percent of their GDP respectively, against a much smaller size in less developed countries including Cambodia, Lao PDR, Myanmar, Viet Nam, Pakistan and Sri Lanka spent 1.6 percent of GDP on average (Park et al., 2020). UNESCAP's study on fiscal stimulus packages in the region (2020) concludes that income level is one of the most significant factors in determining the size of fiscal response to COVID-19–wealthier Asia-Pacific countries introduced larger size of fiscal packages, while infection rates, the stringency of lockdown or social protection expenditures are not significant determinants.

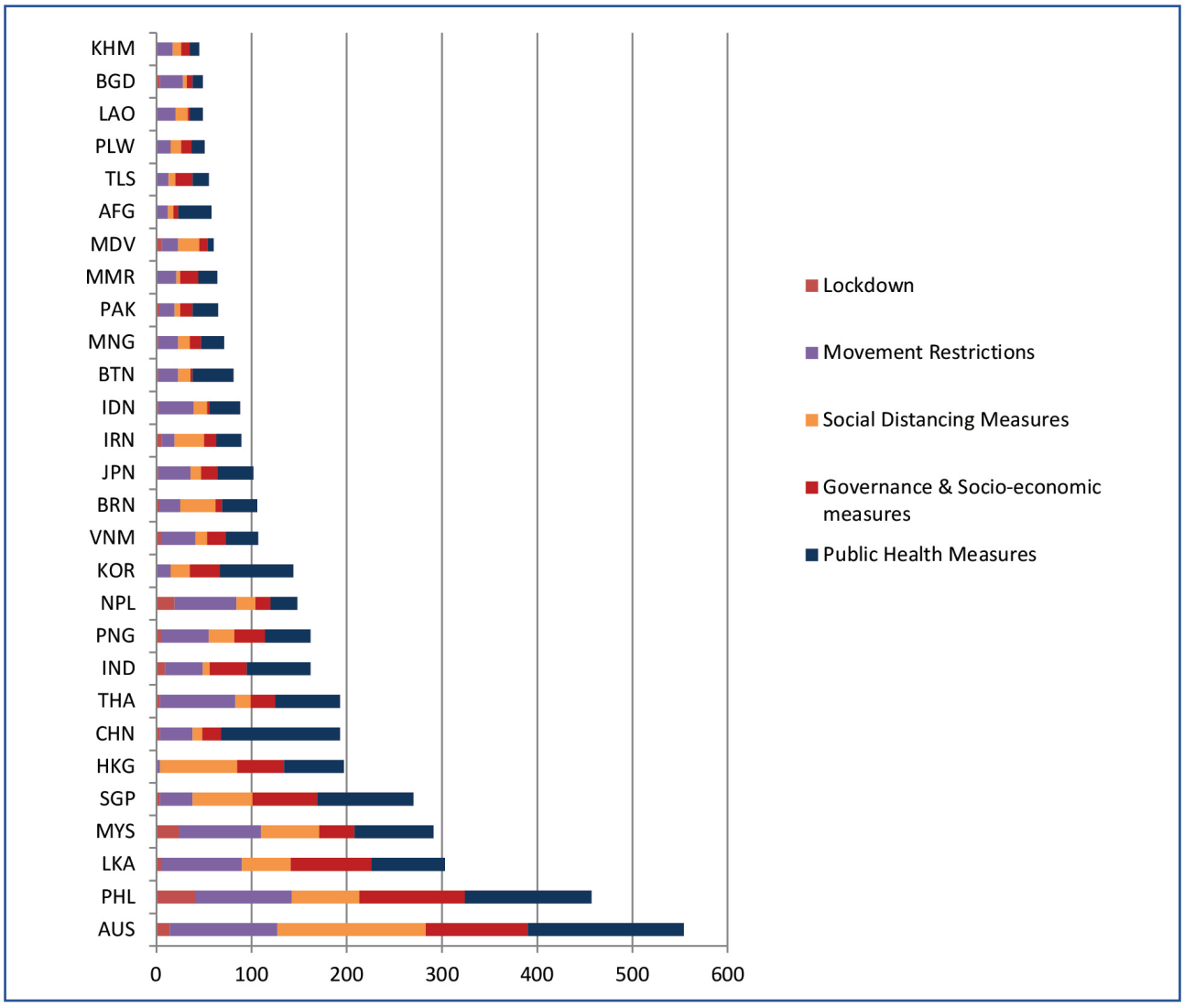


Figure1.5: Number of Non-Fiscal Measures/Interventions Implemented in Asia-Pacific by Five Categories

Source: MIER's own calculation based on data from ACAPS COVID-19 Government Measures Dataset, updated on 20th July 2021.

Despite some positive growth in certain regions and sectors after the third and fourth quarter of 2020, significant disparity in (i) the efficiency with which the virus is contained, (ii) the ability to take advantage of the revival in international goods trade, and (iii) the capacity of governments to provide fiscal and monetary support among Asia-Pacific countries, recovery speed of economies within this region remains uneven (World Bank, 2020b). China and Viet Nam have led the rebound within this region with a V-shaped recovery path, while the rest of the region have not seen a full-fledged recovery yet. (IMF, 2020b).

Current models predict that even until 2023 or 2024, there will not be enough vaccines to cover the demand of the full population globally (McDonnell et al., 2020), manufacturing capacity can be improved with some targeted investment but only to some extent and it will remain a rate limiter. So far, (as shown in **Figure 1.6**), low-income countries are mostly left out of the market while high income countries race to procure the amount

of vaccines to cover their population several times over, leaving very little for low- and middle-income countries and for equity-focused partnerships like COVAX.

The Independent Panel for Pandemic Preparedness and Response (IPPRP), a team of experts convened by the World Health Organization's member states in May 2021 highlighted the fact that while some high-income countries had deals securing enough doses to vaccinate their populations twice over, in many low-income countries fewer than one in 100 people had received a single dose of vaccine. Therefore, the panel called on world leaders to move fast to end the crisis and suggested wealthier countries should donate at least 1 billion vaccine doses to the 92 low- and middle-income countries of the COVAX Gavi Advance Market Commitment, by 1 September, and commit to provide more than 2 billion doses by mid-2022. Although this large-scale 'donation' of surplus vaccine supply from high-income countries did not take off, some countries have started donating progressively. For example, Australia, a country with surplus vaccine supply as shown in the following figure, has taken a move to redirect 1 million AstraZeneca vaccines to Papua New Guinea from the country's secured stockpile, as a positive response to the 'concerning spike' in confirmed COVID-19 cases in that country recently.

According to Airfinitv Ltd's prediction in 2020, the estimated COVID-19 vaccine production capabilities in 2020 and 2021 for US, India, China, UK, Germany and Republic of Korea are 4.69 billion, 3.13 billion, 1.9 billion, 0.95 billion, 0.5 billion and 0.35 billion doses respectively. As one of the biggest vaccine manufacturing countries, China's production capacity has increased from 2 billion doses to 4 billion doses per year, since eighteen vaccine producers have expanded their manufacturing capabilities, which is able to meet 40 percent of the global population's demand, based on calculations of world population and average vaccination rates. However, India, another big vaccine exporter in this region by mid-July 2021, only secured vaccines to cover less than one third of their total population as shown in Figure 1.6, and now seeking imports as COVID-19 cases soar dramatically inside the country.

Besides the disparity in vaccine supplies within the Asia-Pacific region, there is also a disparity in the vaccine distribution between regions. As home to 60 percent of the world population, so far only a quarter of the total number of delivered vaccines in the world has been delivered in the Asia-Pacific.

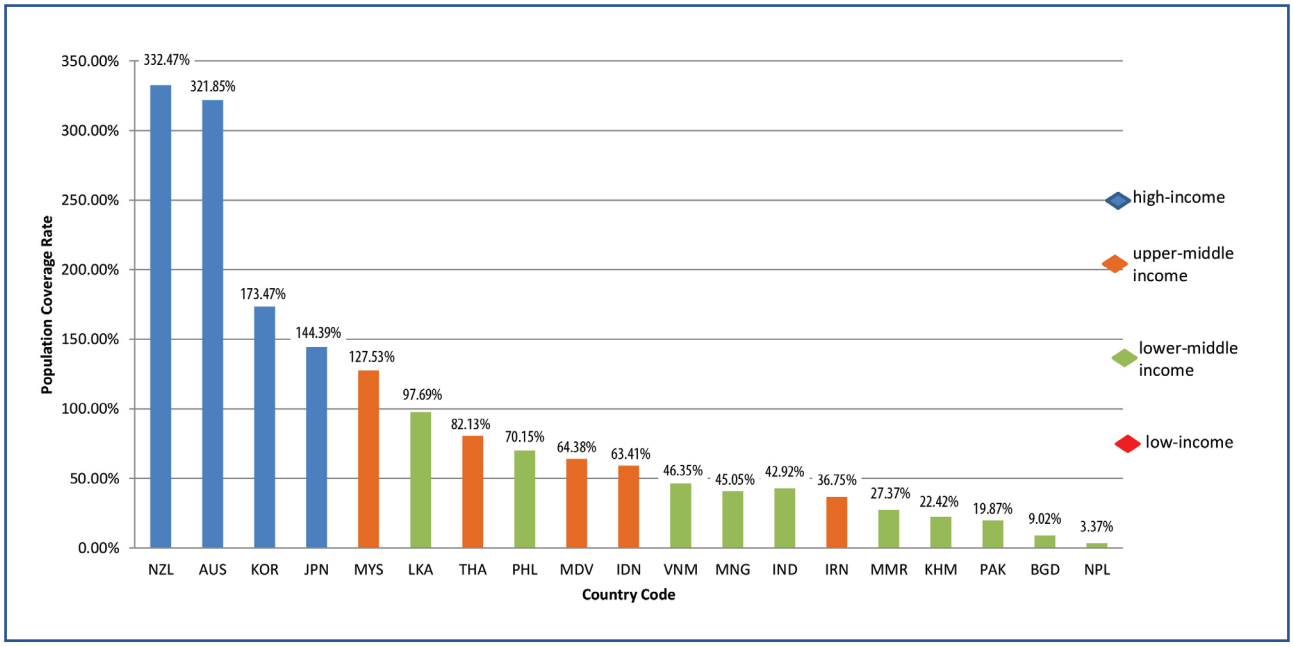


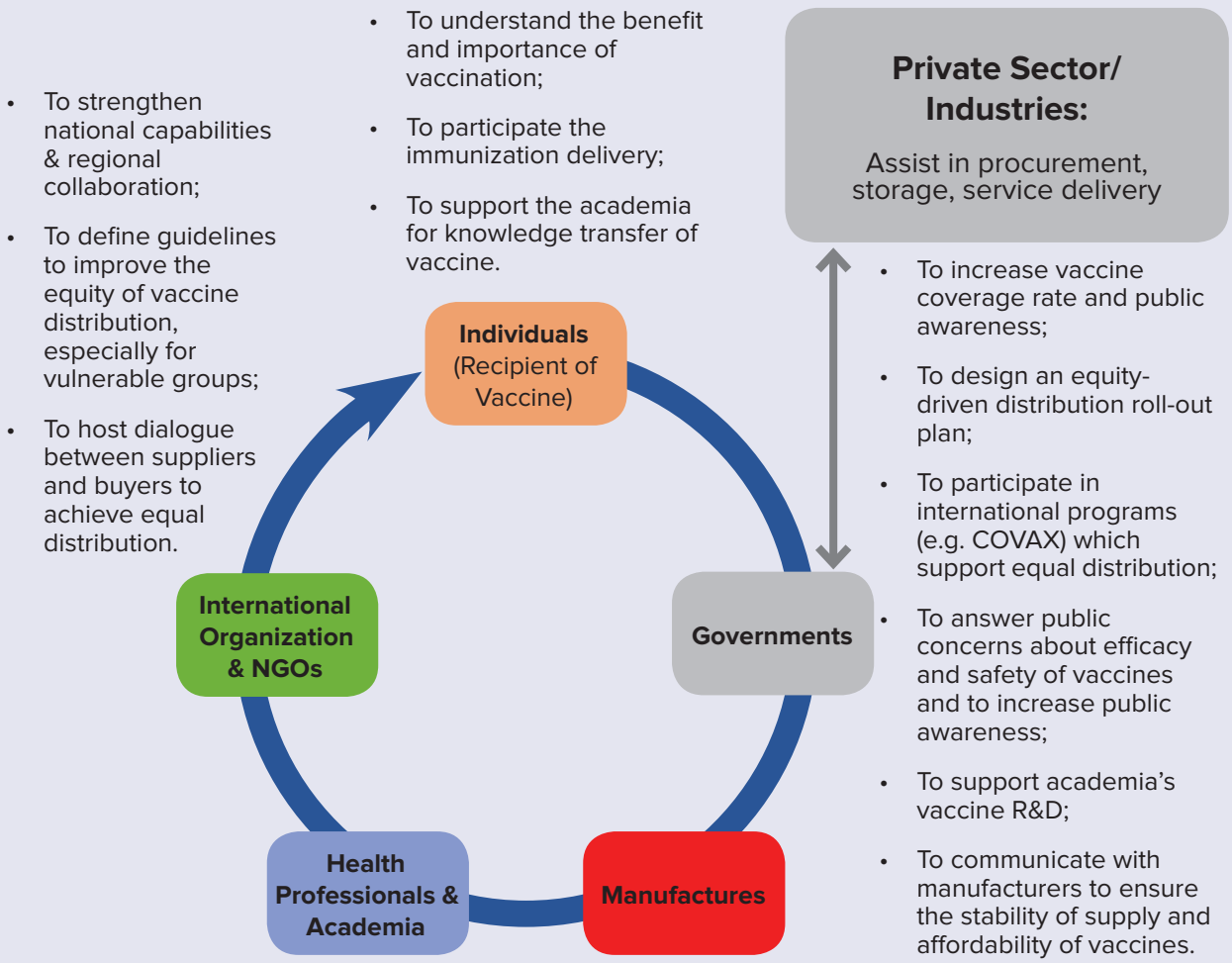
Figure 1.6: Estimated Population Coverage Rate from Bilateral/Multilateral Government Vaccine Purchase Agreements in Asia-Pacific, excluding COVAX

Data Source: UNICEF COVID-19 Vaccine Market Dashboard, updated on 20th July 2021 with available data.

1.4 Key Stakeholders Involved in the Vaccination Effort

From the vaccine development to vaccine manufacturing, procurement, administration, coordination, distribution, and education, several key stakeholders are involved in the entire chain as shown in **Box 1.1**.

Box 1.1: Stakeholder Ecosystem for Vaccination Progress



- To understand the benefit and importance of vaccination;
- To participate the immunization delivery;
- To support the academia for knowledge transfer of vaccine.

Private Sector/ Industries:

Assist in procurement, storage, service delivery

- To strengthen national capabilities & regional collaboration;
- To define guidelines to improve the equity of vaccine distribution, especially for vulnerable groups;
- To host dialogue between suppliers and buyers to achieve equal distribution.

- To increase vaccine coverage rate and public awareness;
- To design an equity-driven distribution roll-out plan;
- To participate in international programs (e.g. COVAX) which support equal distribution;
- To answer public concerns about efficacy and safety of vaccines and to increase public awareness;
- To support academia's vaccine R&D;
- To communicate with manufacturers to ensure the stability of supply and affordability of vaccines.

- To conduct independent R&D or to collaborate with manufacturers;
- To help to increase public awareness and understanding;
- To conduct national scientific study and test.

- To develop, manufacture & supply high-quality vaccines that meet countries' needs;
- To develop partnership which can expand the capacity of production therefore to improve the supply of vaccine;
- To support possible R&D with academia.

Procurement and distribution decision-making are controlled by the government. The government secures vaccines supplies through bilateral and multilateral agreements, and it is the government that determines vaccination rollout priorities. In the earlier stage of the rollout, vaccination priority is given to healthcare frontliners (i.e. clinically vulnerable groups) and elderly people. Starting from second quarter of 2021, as shown **Table 1.1**, vaccination has been open to non-vulnerable groups as well in some countries at this region.

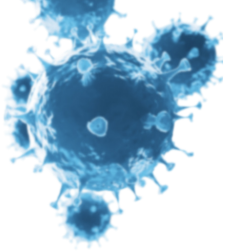
Table 1.1: COVID-19 Vaccination Priority Eligibility Policy in Asia-Pacific Countries

Country/Territory	No. of Priority Eligible Groups	Country/Territory	No. of Priority Eligible Groups
Australia	4	Mongolia	4
New Zealand	2	Philippines	3
Singapore	5	Viet Nam	3
Hong Kong, China	5	Micronesia	No data
Republic of Korea	3	India	4
Japan	4	Bhutan	4
Brunei Darussalam	5	Timor-Leste	4
Palau	No data	Vanuatu	3
Malaysia	4	Kiribati	3
Iran	3	Laos	4
China	4	Bangladesh	2
Fiji	3	Cambodia	4
Thailand	2	Nepal	2
Tonga	4	Pakistan	4
Maldives	No data	Myanmar	2
Samoa	No data	Solomon Islands	1
Indonesia	2	Papua New Guinea	1
Sri Lanka	5	Afghanistan	1

Data Source: Oxford COVID-19 Government Response Tracker, updated on 20th July 2021. 0 – No availability; 1 – Availability for one of following key workers/clinically vulnerable groups/elderly groups; 2 – Availability for two of following key workers/clinically vulnerable groups/elderly groups; 3 – Availability for three of following key workers/clinically vulnerable groups/elderly groups; 4 – Availability for all three plus partial additional availability (selected broad groups/ages); 5 – Universal availability.

Increasingly, there are trends where private sectors acquiring governments' approval for vaccine procurement, to create a private goods market for vaccines. However, this is heavily criticized by vaccine-advocacy groups saying that placing procurement in the hands of the private sector would result in (i) only the well-off is vaccinated, and therefore exacerbate inequality by pricing out the poor, (ii) risks related to transparency, accountability and corruption. UNODC (2020) report argues that these risks include theft of vaccines from the distribution systems, entry of substandard and fake vaccines into the market, leakages in emergency funding designated for the development and distribution of vaccines, nepotism, favouritism and corrupted procurement systems. These potential corruption risks are needed to be addressed and mitigated by governments in order to guarantee people's (especially those vulnerable and marginalized groups) effective and safe access to COVID-19 vaccines. As of July 2021, only the Pakistan and Indonesian governments have officially opened up the private market for COVID-19 vaccines.

However, there are good practices from the African region on how local communities could benefit from private sector's assistance to procure vaccine supplies, develop storage facilities and ensure efficient service delivery processes. The common and key ingredient underpinning the success of these public-private-partnership initiatives is good governance (Clarke et al., 2021). Asia-Pacific countries' governments may consider mobilizing health sectors' advantages and resources in the healthcare system in order to achieve the life-saving target during COVID-19 pandemic. Additionally, the pandemic presents an opportunity for the private sector to scale up greening the health system including building cold chains that are powered by solar or wind energy and vaccines delivered through measures involving lower carbon footprints.



Chapter 2
Vaccine Inequality: Health, Economic, Political and Social Perspectives

2.1 Economic Growth, Income Inequality and Health

Significant improvement in life expectancy and child mortality rates throughout the developing world have been widely considered as primary determinants of historical and contemporary mortality decline since the second half of the twentieth century (Gwatkin, 1980; Deaton, 2013; McKeown, 1976). The earliest study on the relationship between economic growth and health is likely the one from Preston (1975) on Preston Curve, which showed the connection between life expectancy and income per capita across countries. Increase in average income is found to be significantly related to the increase in life expectancy among the poorest countries. However, this relationship flattens out as income per capita rises, and it is much weaker or even absent among the richest countries. In this way, if such a nonlinear relationship holds within countries, population in countries with a more equal income distribution should demonstrate a longer life expectancy. It also follows that if an income transfer from the rich to the poor is brought about, this can improve the average health conditions in a country, since the health of the poor is significantly affected by their income they receive.

Although gains in income were significant for improving health condition, there are countries that were able to improve health conditions even without economic growth (Reinhart, 1999). Instead of economic development, the national health condition is primarily determined by the healthcare technology and knowledge transfer. The current mortality rate due to pandemics is viewed as evidence of the failure of globalization in transferring effective drug-based treatments or technology from advanced countries to the less developed ones (Shastry and Weil, 2003). This view can fit in with economic growth theories in the 80's which treated technology as endogenous, and human capital demonstrates increasing rates of return (Romer, 1986; Lucas, 1988).

Therefore, in summary, there are until today two views regarding the relationship between economic growth and health. One, the 'health view' which assumes that underdevelopment and income inequality are due to inequality in health environments. The cause-and-effect work through four channels of transmission, better health brings about (i) enhanced labour productivity, (ii) greater labour supply, (iii) skills through education and training, and (iv) higher savings leading to higher investment on physical and intellectual capital; all of which contributes to higher economic growth (Bloom et al., 2004, 2010; Weil, 2007).

Alternatively, the 'income view' argues that health inequality is fundamentally caused by unequal distribution of income across the population. Technology or physical capital accumulation drives inequality, which in turn drives health inequality via two major channels–infant mortality and life expectancy. A high level of income inequality also impairs the economy's human capital insofar as low-income earners do not have sufficient access to capital formation, education and health care.

OECD (OECD and WHO, 2018) reported that while healthcare access has improved among Asia-Pacific countries in the last several decades but marginalized groups, such as women from poor households, still face difficulties in accessing quality healthcare because of their limited income. For instance, the gap in access to antenatal care between females from poorer and wealthier families is still quite large in Bangladesh, Laos and Pakistan. Additionally, disparities in other health indicators (including but not limited to the life expectancy at birth, survival to age 65, under age 5 mortality rate, and health expenditure) between low-middle income & low-income countries and upper-middle income & high-income countries in Asia-Pacific are highly significant as well (OECD and WHO, 2020). For example, in terms of spending on healthcare, high-income countries in this region on average spent $4,018.8 per person per year, while low-middle income and upper-middle income countries in the same region only able to spent $238.2 and $670.9 respectively. Rising inequality is a serious concern mainly because of its long-term intergenerational effect; countries with higher level of income inequality tend to have lower levels of social mobility between generations, with parent's earnings being a more important determinant of children's earnings (Corak, 2013).

2.2 Other Drivers of Health Inequality

Two main clusters of determinants of health inequality can be identified. The first cluster is related to structural inequities in the population, including intrapersonal, interpersonal, institutional, and systemic mechanisms which affects resource distribution along lines of race, class, sexual orientation, gender identity and expression (NASEM, 2017; McCartney et al., 2021). Structural inequities also encompass policy, law and governance that directly or indirectly discriminates against individuals or groups when accessing healthcare and medicine. The second cluster – social determinants of health, includes unequal allocation of goods, services, and societal attention–which manifest in unequal social, economic, and environmental conditions (WHO, 2008; Ward, Mamerow and Meyer, 2013).

Policies which foster the inequities at community, state and country levels are critical drivers of structural inequities, while social, environmental, economic, and cultural determinants of health are the terrain on which structural inequities produce health inequalities (NASEM, 2017). A right-based approach to health requires public frameworks or policies on health to prioritize the needs of those vulnerable groups, a principle that has been highlighted in the 2030 Agenda for Sustainable Development and Universal Health Coverage. However, even with an ostensible public health objective, laws still can institutionalize inequality, discriminate against those already vulnerable, and remove opportunities for stigmatized groups to access qualified healthcare and treatment (Gostin et al., 2019). The right to health must be guaranteed and enjoyed without any discrimination that is related to people's race, age, ethnicity or any other status. Non-discrimination and equality require public sector to address laws, practices or policies that carry or allows discriminatory elements.

2.3 COVID-19 Vaccine Distribution and Inequality Outcomes

Previous pandemic histories taught us that income inequality in affected countries will increase and its effect sustained over a long period of time, beyond the duration of the pandemic itself, for a long-term period. Furceri et al. (2020) examined the impact of five previous pandemics, namely SARS (2003), H1N1 (2009), MERS (2012), Ebola (2014) and Zika (2016) on inequality and found that the negative effect of pandemics on inequality, proxied by the Gini coefficient, is consistent. Over the five years following each pandemic, the Gini coefficient increased by 1.25 percent comparing to its pre-shock level. Not only that, changes in the relative shares of income across different quantiles was also observed. Within the 64 sampled countries, on average, the share of income going to the Top20 is 46 percent, while that goes to the Bottom20 is only 6 percent–a gap of 40 percent points.

Short-term projections done by international and regional organizations suggest that income inequality and extreme poverty for emerging and low-income countries are both likely to become worse after the pandemic. Studies also found that impact of pandemic on the labour market is uneven, differing by job characteristics, occupations and type of enterprise (Avdiu and Nair, 2020). First of all, workers with low-paid jobs have relatively lower ability to work from home than those with high-paid occupations; Secondly, workers with higher education are less likely to lose their jobs or stop working during pandemic than those with lower levels of education. Similarly, women are less likely to lose their job or stop working during pandemic than men; Thirdly, smaller sized firms have a higher risk in falling into arrears. Thus, the temporary revenue loss may turn into a long-term erosion of jobs and entrepreneurial capital for the lower income group, which therefore will further disproportionately affect workers who are relatively younger, with less skills and ability to access capital.

In addition, the economic and educational shutdowns during the pandemic are likely to have a dramatic impact on productivity and the formation of human capital, therefore leading to a further exacerbation of the level of poverty and inequality, since those from poorer families are more vulnerable to effects or losses from schooling disruptions. Recent evidence from developing countries (Wieser et al., 2020) shows that the Bottom20 families are less likely to provide children with alternative learning choices after school closures compared to the Top20 households. Disruptions to schooling have long-term and intergenerational effects since existing literature shows that significant learning losses during pandemic can increase educational inequality. This goes without saying that schools are yet to reopen in many places due to lack of vaccination of school staff and unavailability of vaccines for children. Virtual teaching and learning are not helpful, as the access to online schooling is also inequitable.

What is even worse, the negative impact of the pandemic on inequality tends to be long-term. Evidence from previous pandemics suggests that not only can welfare impact on the less wealthy families be larger, recovery after the hit can also be relatively slower.

Lower lifetime earnings due to lost working hours, experiences, skills depreciation (i.e. low skilled workers' productivity depends a lot on their dexterity, hence loss of time spent not working will erode their productivity) and scarring effects, are bound to hit workers from poorer families or workers lower skills more severely than the higher skilled group.

Vaccination Campaign start in Iran, using Russia's Sputnik V vaccine.

Coping strategies adopted by disadvantaged groups during the pandemic–such as reducing food consumption will lead to lower, both human capital's formation and physical capital's accumulation. In this way, the nutritional deprivation for children and mothers resulted from food related coping strategies will bring about long-term or even intergenerational negative consequences.

Unequal distribution of COVID-19 vaccines between and within developed and developing countries will delay an even recovery of the global economy, labour market and cross-country trading, and worsen the existing health inequalities between wealthy and poor. Wealthier countries (with only 19 percent of the world's adult population globally), have collectively secured 54 percent of global purchased vaccine doses. Of the remaining vaccines, only 33 percent have been procured by low- or middle-income countries (LMICs) which are homes to 81 percent of the world's adult population; and remaining 13 percent goes to COVAX. By July 2021, high-income countries secured more than enough doses to vaccinate their populations twice over while LMICs can only cover one third of their population. Çakmaklı et al. (2021) examined the potential loss of the global economy due to an unequal vaccine distribution scheme and found that under the scenario where rich economies are vaccinated within four months in 2021 while only 50 percent of the population from emerging markets and developing economies are vaccinated until early of 2022, the global economic costs can reach as high as $3.8 trillion. Almost half of these costs will be borne by high-income countries.

Recently, amid ramped up vaccinations globally, the third wave of this virus has already taken a toll on the world especially on the Asia-Pacific region. Countries especially India, Pakistan, Bangladesh, Indonesia, Malaysia and Philippines are grappling with the fresh wave of COVID-19 from second quarter of 2021 after a significant drop in confirmed cases and death rate also during the first quarter. Among them, the situation in India–the world's second most populous country after China is the most serious–reported more than 31 million confirmed cases since early of July. The Institute for Health Metrics and Evaluation even estimated that India will see a staggering 1 million deaths from COVID-19 by 1 August, 2021 (Lancet, 2021). And this third wave of pandemic in India could easily affect the world economy in several ways: First of all, India itself is the world's fifth largest economy, contributing to global economic growth significantly. The impact of further GDP reduction in India on the world growth is expected to be considerable; its scale has the potential to prolong the slump in global supply chains. The pharmaceutical industry in India is the third largest in the world in terms of volume and 11th largest in terms of value. India produces around 70 percent of the world's vaccines. Therefore, the crisis in India has already meant that the exports of the vaccine will be postponed or even cancelled, leaving many countries vulnerable to fresh waves of the virus and probably delaying their efforts to return to business as usual. India also provides back-office support or data hub for many industries such as healthcare, financial and IT for Western European and American companies. Again, in this way, the crisis in India could drag the recovery speed of global economy further.

Asia Pacific Vaccine Access Facility (APVAX) Philippines. Distribution, preparation, and COVID-19 vaccination in Caloocan City, Philippines.

Given all these issues and evidence, advanced economies and less-developed countries are bounded closely along the post-pandemic recovery period; and no economy can fully recover until every economy recovers from this unfolding humanitarian crisis through an inequitable vaccine distribution scheme across the world.

2.4 Political Economy Considerations of Access to Vaccines

The ability of countries to withstand the COVID-19 pandemic and take appropriate action to quell the scourge varies with the level of income of the respective countries as well as their available fiscal space. During the pandemic, government expenditure was directed towards retraining, wage support or subsidies, cash transfers, social insurance, and expanding healthcare and COVID-19 response measures. Expenditure on infrastructure and construction were increased because of their high backward and forward linkage effects, to boost aggregate demand and employment in the economy. Countries dealt with the impact of the pandemic with varying fiscal stances, depending upon their level of development. The middle-income and low-income developing countries faced increasing deficits alongside declines in revenues due to muted economic activity. High income economies rolled out large fiscal stimulus package, some as high as 54 percent of the GDP, in the case of Japan, compared to Pakistan, at less than 3 percent. Similarly, advanced economies have extended equity, loans and guarantees, on average, by more than 10 percent of GDP in 2020, the figure being less than 3 percent for emerging economies. Low-income developing countries have had less capacity to do so as part of their fiscal response.

Fiscal measures are important during the pandemic and in the recovery phase and these two phases should be seen as being distinct. The more fiscal margin a country has, the more it can do in terms of extending access to health care and vaccines. As far as health care is concerned, there are two aspects to it. First, with sufficient government spending it will be possible to expand the facilities of public hospitals and clinics; and they can also offer adequate testing facilities that cover an extensive proportion of the population. This will be particularly useful for countries that does not yet offer universal health care or have a strong and comprehensive public health care system. The second aspect is more immediate in that it relates to access to vaccines. Countries with little fiscal reserves faces constraints in the purchase and distribution of vaccines. India's health expenditure as a percentage of GDP is about 3.5 percent, as compared to 9.3 percent for Australia and 11 percent for Japan, though it is much higher for the US (16.9 percent). Indonesia's comparable expenditure is 2.8 percent and

Pakistan's 3.2 percent. As for the number of doctors per 1,000, India's figure is 0.9, with Pakistan recording a somewhat similar figure at 1.0. Developed countries do much better with the US and Japan having better ratios at 2.6 and 2.4, respectively.

Tax and re-distributional policies had to be recalibrated during times of pandemic in order to address the shortfall in government revenue, and increase in demand for public health expenditure and social protection. Most pressing, is the issue of tax progressivity. Many believe that progressive tax policies hold the key for governments to increase tax revenue in times of need, and to transfer resources from the rich to the under-privileged. If the poorer sections of society are able to access cash transfers that can help tide them over the worst period during the pandemic, they would be able to maintain healthy nutrition levels and also afford face masks, sanitizers and undertake self-quarantining, thus helping to reduce the spread of the pandemic in the population.

Increased tax rates at the upper end of the income spectrum allows the government to collect more taxes at a time when consumption-based taxes (VAT or GST) and corporate taxes are compromised due to economic slowdown related to the pandemic. Alternatively, the introduction of windfall taxes on those companies making more than normal profits due to the pandemic, or inheritance taxes and property taxes can be considered. By raising tax revenue, the government will be able to afford better health care and more vaccine protection for the people.

A comprehensive fiscal policy should be flexible enough to suit different stages and needs due to the pandemic. In the initial stages of a pandemic where tight lockdowns are imposed, it will be necessary to increase public health facilities for testing and treatment and provide immediate cash support for displaced workers, casual workers and owners of micro-enterprises. This support will be in the form of cash transfers, wage subsidies and even food packages. As the threat of the virus recedes the modus operandi will shift towards expanding existing hospital facilities and build new hospitals or temporary hospitals, usually requiring anther considerable government budgetary allocation. Then come the phase where the government purchase vaccines and roll out mass vaccination programmes with the overall objective of achieving herd immunity in the population. Access to vaccines is not sufficient on its own; it is also necessary that testing be carried out as widely as possible, a clear picture of the extent of the pandemic should also be obtained and appropriate responses and measures to curb the spread of the pandemic taken.

OECD recommends that a centre of government (CoG) should be instituted in order that the multi-disciplinary activities and multi-organizational activities are coordinated. The CoG can be defined as a "body or group of

Inequality in vaccine distribution has led to a shortage of COVID-19 vaccines in vaccination centres, such as at the Dahisar area of Mumbai, India.

bodies that provide direct support and advice to Heads of Government and the Council of Ministers or Cabinet" (OECD and WHO, 2018). The CoG's role is expected to be seen in three areas: use of evidence to inform decision-making, coordination and strategic planning and communicating decisions to the public.

The CoG should be constituted to encompass various existing national advisory bodies so that they are able to act and communicate effectively and reflect a clear single line of command. Specific national advisory bodies may include the following:

1. Epidemiological modelling and scenario analysis
2. Scientific and technical studies, including the assessment of vaccines and their suitability
3. Economic modelling based on scientific studies and the evaluation of economic policies based on scientific findings. This will include an assessment of the extent of the pandemic, the population segments that will be affected and the geographical reach.
4. Fiscal policies and support measures. The framing of policies by the respective ministries of finance should not be seen as an isolated activity. Fiscal policies should be designed in line with the findings that arise out of epidemiological models and economic models and forecasts.
5. Monitoring and tracking outcomes and implementation. Data is essential for good policy. Data is collected at the level of the infection and through testing, but also through numbers hospitalized, having severe respiratory problems and the numbers in intensive care units, indicating the different levels of complication that the infected population goes through. Aside from that it is important to have data on economic variables, such as casual and migrant labour without jobs and single mothers who have descended into poverty.

With the experiences gained from many countries in designing and coordinating CoG arrangements, it will now be possible to create arrangements that are well-coordinated and where feedback loops are recognized and incorporated within the national system.

Distribution of hygiene and health supplies by community workers in Bangladesh. The emergency support originated out of the collaboration of UNDP with the DFID and the Bangladesh government.

2.5 Market Failure and Institutional Arrangements

The global spread of COVID-19 raises the issue of market externalities–what happens within a country and the actions it took more often than not will affect its neighbours, trading partners and the rest of the world. In an inter-connected world, the extent of infection in one country affects the risk of infection in other countries. Worsening conditions in a country not only increase the risk of infection but also increase the likelihood of new variants emerging and spreading to other countries. The lack of adequate healthcare and availability of vaccines in one country can impose negative externalities on other countries. Hence, the problem of externalities makes multilateral cooperation an imperative to be pursued.

COVAX Advance Market Commitment (COVAX), led by institutions such as the GAVI, the Vaccine Alliance (GAVI), WHO and the Coalition for Epidemic Preparedness Innovations (CEPI), was set up to ensure an equitable allocation of COVID-19 vaccines. It holds the key to solving the externality issue via donor-funded vehicles that will make vaccines available for people in poor countries, although the countries will have to share some of the costs of the vaccines.

Aside from vaccine procurement, another fundamental challenge that governments in low-income countries have to deal with is the acquisition of health supplies, technologies (such as virus-tracing software) and health equipment to deliver the vaccines efficiently to the people. The private sector in many of these countries will not be able to rise to the challenge, leaving the respective governments inadequately prepared to handle high rates of hospitalization, a shortage of staff, and over-stressed facilities. It is for these reasons that regional and international arrangements are necessary to alleviate the pressures of the pandemic. COVID-19 is a global problem and no country is safe unless all countries have had a full vaccination programme. Vaccination is a less costly alternative to the economic loss facing a country from disruption of travel and logistics, affecting trade, travel, education and productivity.

Regional policy cooperation will help support the production and distribution of diagnostic test kits, vaccines and medicines for the treatment of COVID-19. To some extent funds dedicated to WHO's COVID-19 Tools (ACT) Accelerator will help to achieve this. The COVID-19 ASEAN Response Fund is another initiative with the same purpose.

Other activities that can be carried out under the flagship of regional cooperation include the creation of regional financial safety net. This is essential to provide financial stability and fiscal policy space to handle public health issues and engage with the economic dimensions of the crisis, especially in less developed countries (LDCs). This will require expanding currency swap arrangements and the issuance of special drawing rights. All barriers to trade in medical products and services should be removed or waived. This includes tariff and non-tariff barriers for medicines and equipment. Trade should be allowed to resume, albeit with necessary safety measures throughout the supply chain, to mitigate the effects of the pandemic on health, lives and livelihoods.

2.6 Economic Impact on World Trade

Until every country is safe from the effects of COVID-19 the world will not be safe. The high numbers of cases (regardless of location) can be a threat simply because as the cases increase, the risk of mutations also increases. A mutation in one geographical location is a threat to the entire world. Trade and investment will continue to be clouded by uncertainty as long as the pandemic is around, even if it be found to be prevalent in some of the poorer countries in the world. The world's leading growth countries such as the US, China, the EU and Japan have the financial and technical resources to be able to provide the vaccines to their population, but that is not a complete solution because if the poorer countries do not have access to the vaccine global trade, everyone will still be affected.

Covid has affected global foreign direct investment (FDI). FDI declined significantly in 2020. It fell an estimated 42 percent from $1.5 trillion in 2019 to about $859 billion in 2020. The decline in FDI was felt more significantly in developed countries, with FDI flows falling by 69 percent as compared to a more moderate decrease in developing countries (-12 percent). The fall in FDI flows across developing regions has been uneven. Latin America and the Caribbean have been worst affected with a 37 percent contraction, followed by Africa which experienced -18 percent. FDI inflows were moderate for developing Asia (-4 percent). East Asia was the largest host region, accounting for one-third of global FDI in 2020.

The impact of the pandemic on merchandise trade volumes varied with region in 2020, with most regions recording large declines in both exports and imports (**Table 2.1**). Export volumes for Asia were up 0.3 percent and import volumes down by 1.3 percent in 2020, and this was against the trend in other regions such as Africa (-8.8 percent), South America (-9.3 percent) and the Middle East (-11.3 percent). Trade volumes are expected to pick up in 2021 on the back of poor performance in 2019 and 2020. Asia, once again, is projected to see high imports and exports in 2021, driven due to high demand from North America.

There are two factors that will hinder global trade if the less developed and under-developed countries are not able to arrest the pandemic. First, the aggregate demand coming from these countries will continue to be low. Second, the investments that are located in the low-income countries will face disruptions if there is a continuing pandemic. This in turn will affect the multinational corporations that have investments in the lower-income countries. But more than that the production disruptions in low-income countries will decrease output, consumption and therefore global demand, too.

Table 2.1: Merchandise Trade Volume (annual % change)

	2019	2020	2021P
Volume of world merchandise trade	0.2	-5.3	8.0
Exports			
North America	0.3	-8.5	7.7
South America	-2.2	-4.5	3.2
Europe	0.6	-8.0	8.3
Commonwealth of Independent States	-0.3	-3.9	4.4
Africa	-0.5	-8.1	8.1
Middle East	-2.5	-8.2	12.4
Asia	0.8	0.3	8.4
Imports			
North America	-0.6	-6.1	11.4
South America	-2.6	-9.3	8.1
Europe	0.3	-7.6	8.4
Commonwealth of Independent States	8.5	-4.7	5.7
Africa	2.6	-8.8	5.5
Middle East	0.8	-11.3	7.2
Asia	-0.5	-1.3	5.7

Source: WTO, Retrieved from: https://www.wto.org/english/news_e/pres21_e/pr876_e.htm

Unless, the incidence of COVID-19 is resolved in developing countries, global value chains will remain severely disrupted. This will have impact on developing countries which are active participants of production supply chains, resulting in reduced demand for domestic companies and a consequent increase in unemployment.

Pressures in the global container shipping industry continues to be an important determinant of economic health, in particular, inflation. While global trade carrying capacity is improving relatively, there is still a long way to go for trade to recover to a healthy level if not normalized completely. Even regions that are not deeply integrated into the global trading market such as Latin America, South Asia and sub-Saharan Africa have the potential to hold back global trade recovery and can reignite the threat of another wave of the pandemic due to their internal challenges with vaccine access and domestic inequality.

Access to vaccines, equipment and technologies for containing the spread of the virus will allow supply chains to readjust to changing production shifts faster, as well as reduce policy and business uncertainties. The economic efficiencies firms expect from diversifying their production activities and leveraging of GVCs may outweigh the costs firms expect from typical trade and market uncertainties. However, prolonged periods of low demand pressures due to the effect of COVID-19 and underutilized capacity will result in changes in investment plans and diversion of investment from the low-income countries that continue to be affected by the pandemic. The consequences will be debilitating under these circumstances and will be felt more severely by low-income countries that most in need of trade and investment.

Chapter 3
Brief Critical Review of COVID-19 Vaccine Distribution Frameworks

3.1 COVAX Allocation Scheme

Research and development (R&D) in vaccines incurs high sunk cost with highly uncertain outcome. If successful, however, the payoff to the society is substantial. Like any other public goods where private returns are typically lower than social returns, the situation normally results in sub-optimal incentive for private R&D and production of vaccines.

COVID-19 vaccine is a perfect example of a global public good. Just like the transmission of the coronavirus recognizes no sovereign borders, so does the efficacy of vaccines: a dose is as effective in Malaysia as it is in the United States, in Tajikistan as it is in New Zealand. Marginal benefit of getting a jab is going to outweigh marginal cost of securing an additional dose across countries, laying out the "Samuelson condition" for the supply of vaccines as global public goods (Samuelson, 1954).

Heterogeneity in the risk of contracting a disease also restrains the manufacturer's ability to extract surplus with products. Think about the varying probability of catching COVID-19 across different countries. In April 7, 2021, for every 10,000 people in Armenia, 638 are likely to get infected, 106 in Malaysia, 25 in Uzbekistan, 4 in Thailand, and not even 1 in Viet Nam. A non-uniform distribution of disease risk implies an erratic willingness to pay for vaccines across countries (Kremer and Snyder, 2015). By not knowing the producer surplus to be extracted at the time of manufacturing, private incentives for vaccine R&D will be extremely distorted and this will consequently result in production levels lower than needed by the society.

In the context of providing *global public good* and eliminating *ex ante heterogeneity in risk*, the world would do well with a global cooperation framework. COVAX being a global collaboration that signs advance purchase agreements and negotiates prices with pharmaceutical companies as a monopsony, is able to help eliminate the ex-ante heterogeneity in disease risk, thereafter incentivising acceleration in vaccine R&D activities (**Figure 3.1**). Its early at-risk investments in vaccine manufacturing capacity over a portfolio of vaccines, which include AstraZeneca/Oxford, Johnson & Johnson, Novavax, and Sanofi/GSK candidates, prior to regulatory approval have had huge net benefits for countries for all levels of income (Ahuja et al., 2021).

As long as the overall benefits to the participating countries from the global provision of vaccines are at least as great as the cost of vaccine procurement for COVAX, which seems to be high given the escalating risks of new variants emerging, the COVAX Facility is able to protect global social welfare.

Palette of COVAX vaccine arrived at Henderson Airport, Honiara, Solomon Islands.

COVAX as supranational institution that secures the availability of vaccines as global public good for world distributions

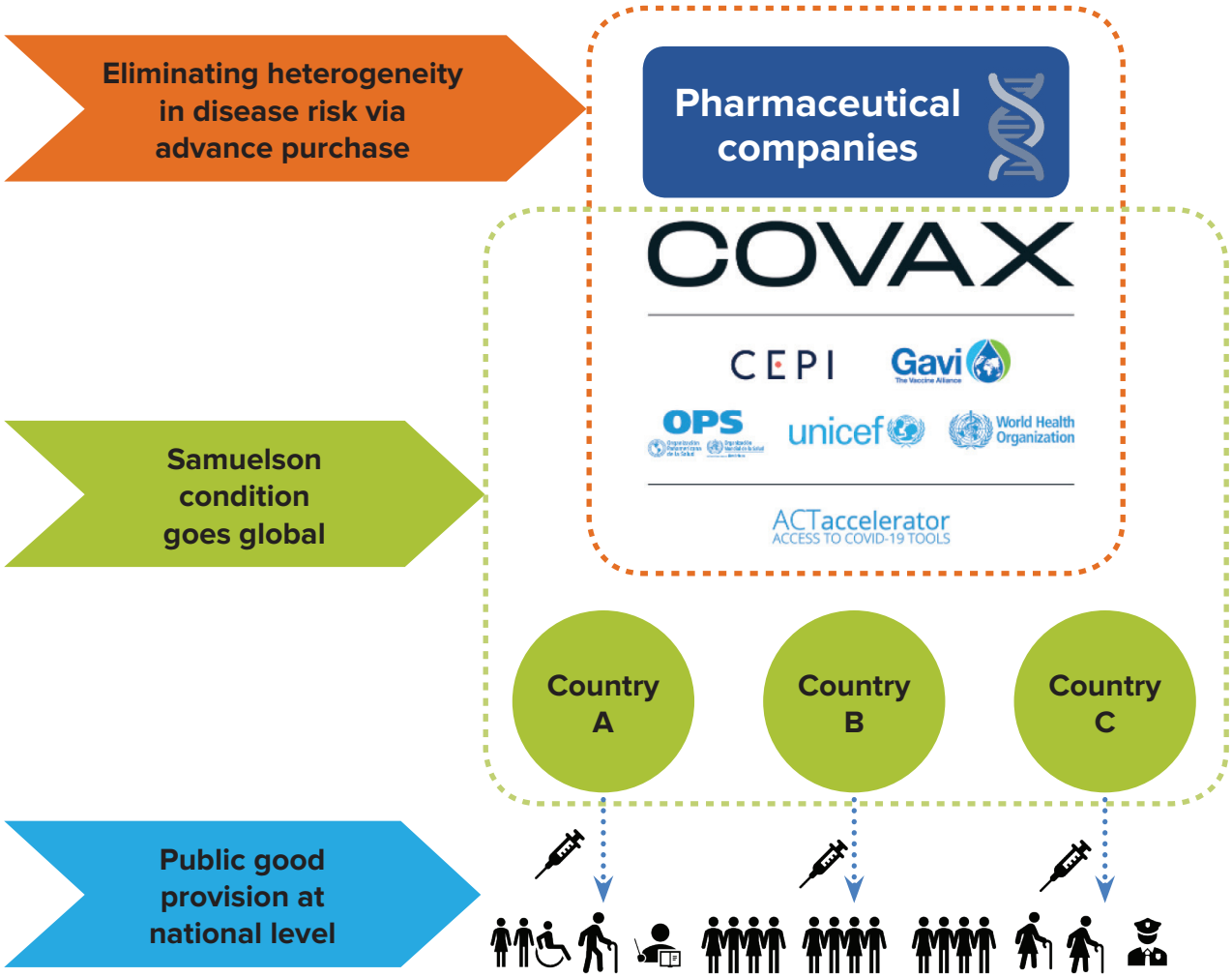


Figure 3.1: A Framework for Global Procurement and Distribution of Vaccines

Note: Samuelson condition is satisfied at global level when total additional benefits of getting vaccines for participating countries equal marginal cost of procuring vaccines, ∑ MB=MC. At national level, by making vaccination freely available for all citizens, provision of vaccines is always and everywhere welfare improving ∑ MB>0.

Equitable COVAX Allocation is Efficient

As of July 2021, COVAX represents the strongest hope for a total of 92 low- and middle-income countries to get access to COVID-19 vaccines in the short and medium term. The COVAX Facility is funded by COVAX Vaccines Advance Market Commitment (AMC) financing instrument. As shown in **Table 3.1**, majority of the Asia Pacific countries are supported by the COVAX AMC more than the number of self-financing participating countries (SFP).

Table 3.1: Expected Numbers of Doses per Million People Delivered by COVAX Facility at the End of 2021

Majority of the Asia Pacific countries are supported by the COVAX Advance Market Commitment

	Participation scheme	Expected number of doses (in thousand) by COVAX Facility at the end of 2021
Afghanistan	AMC	6,140
Armenia	SFP	600
Azerbaijan	SFP	2,005
Bangladesh	AMC	33,300
Bhutan	AMC	148
Brunei Darussalam	SFP	92
Cambodia	AMC	3,192
Fiji	AMC	178
Georgia	SFP	744
India	AMC	268,517
Indonesia	AMC	53,620
Korea, Republic of	SFP	10,342
Kyrgyzstan	AMC	1,278
Lao PDR	AMC	1,375
Malaysia	SFP	6,516
Maldives	AMC	107
Marshall Islands	AMC	11
Micronesia, Federated States of	AMC	21
Mongolia	AMC	660
Myanmar	AMC	10,868
Nepal	AMC	5,941
New Zealand	SFP	983
Pakistan	AMC	42,234
Papua New Guinea	AMC	1,860
Philippines	AMC	21,460
Samoa	AMC	40
Singapore	SFP	1,141
Sri Lanka	AMC	4,361
Tajikistan	AMC	1,842
Timor Leste	AMC	259
Uzbekistan	AMC	6,716
Vanuatu	AMC	58
Viet Nam	AMC	19,297

Source: Calculated based on COVAX's goal to have 2 billion doses distributed proportional to the population of the participating countries to vaccinate 20 percent of the populations

Grounded upon the principles of 'Human Well Being', 'Equal Respect', and 'Global Equity', the first phase of COVAX's vaccine allocation mechanism aims to have 2 billion doses distributed to participating countries proportional to their population, with the first doses going to frontline workers in health care and social care. Additional vaccines would be delivered to help countries vaccinate up to 20 percent of their populations by the end of 2021.

While the principle of equitable distribution of vaccines across countries satisfy the non-excludable and non-rivalrous criterion for a global public good–as no countries irrespective of the level of income shall be left behind–it is unclear if equity is fair and efficient. For example, the perceived value of vaccines for Maldives with 446 in every 10,000 people on average contracting the coronavirus and has experienced sharp economic contraction (-18.6 percent in 2020) must be markedly different from an economically growing Viet Nam with only 27 infected in every million people on average.

We consider henceforth, a model in which individuals treasure mobility and health. Greater mobility and more vaccines that provide the herd immunity cover for the society from the coronavirus make the society happy. Vaccinations are complementary to mobility as the former enables the latter. In this respect, government must optimally decide on the degree of vaccination and non-pharmaceutical interventions, i.e. restricted mobility, that maximizes the utility of their citizens–this is by no means easy as they have to walk a tightrope between not vaccinating enough and risk of pre-mature easing current mobility restrictions.

It resembles a trade-off between vaccinations and easing non-pharmaceutical interventions

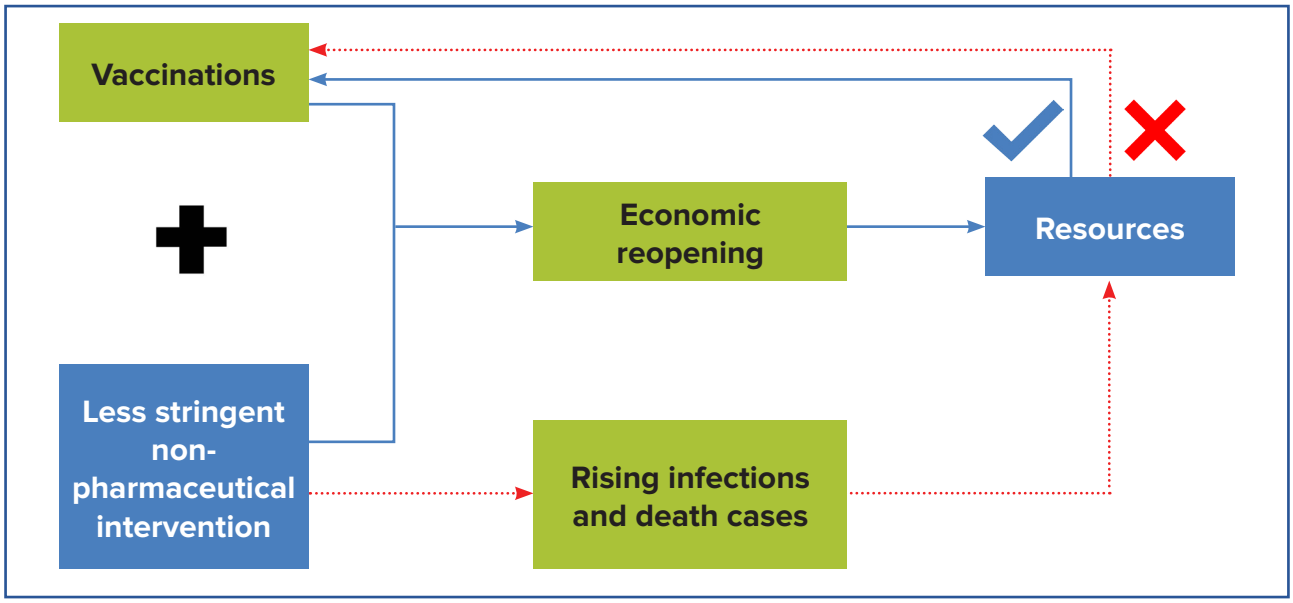


Figure 3.2: An Economic Model of Optimal Vaccine Allocation

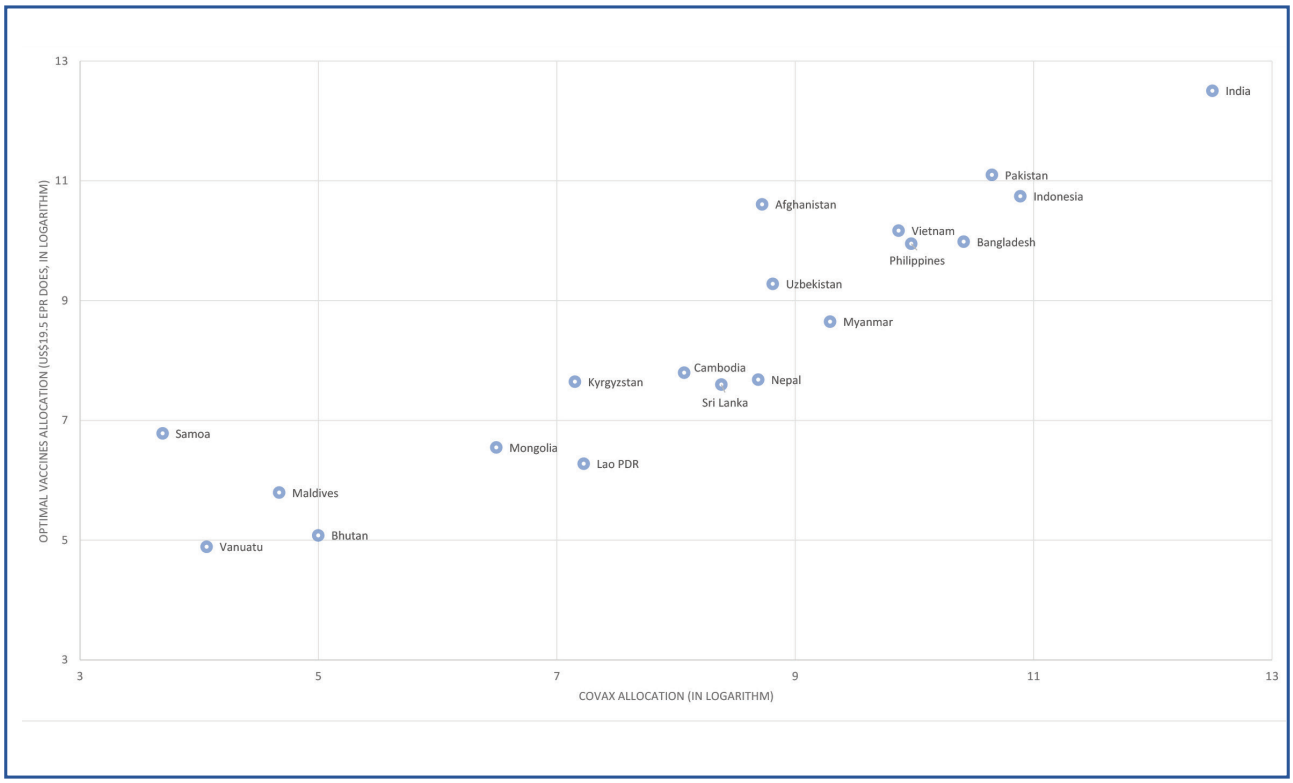
Note: See Box 3.1 for a formal description of the conceptual framework for optimal complementarity between vaccinations and relaxation of non-pharmaceutical interventions

As illustrated in **Figure 3.2**, greater vaccination rates allow mobility restrictions to be lifted earlier, accelerating economic reopening and recovery. Economic expansion then contributes to tax revenue, which in turn can be used to further boost self-financing vaccinations. But reinstating mobility too soon could risk a resurgence of infections and fatality rates, all of which will divert resources away economic recovery back to increased public health expenditure. An efficient allocation of vaccines, therefore, is one that satisfies individuals' desire for greater health and mobility by taking into account economic and health constraints of the resource allocation decision. **Box 3.1** presents a formal description of the model.

As shown in **Figure 3.3**, COVAX's first-stage approach to equitably distribute vaccines across countries based on their population numbers tracks reasonably well the optimal quantities of vaccines. Countries with larger population that draw more heavily on COVAX facility are typically those who are relatively more in need of vaccines given their public health and economic vulnerabilities. In view of this, the COVAX programme is incentive-compatible relative to first-best decision made by individual countries (as if there is no market failure and risk heterogeneity). This outcome is given their current economic resilience level, ability to implement public health restrictions, and the state of the pandemic. The finding appears to hold true across prices of vaccine per dose and echoes Hogan et al.'s (2020) assertion that a strategy in which doses are allocated to countries in proportion to their population size is close to optimal in averting deaths.

COVAX allocation policy replicates reasonably well the optimal vaccine allocation

1. Price per dose of vaccine = US$3



2. Price per dose of vaccine = US$19.50

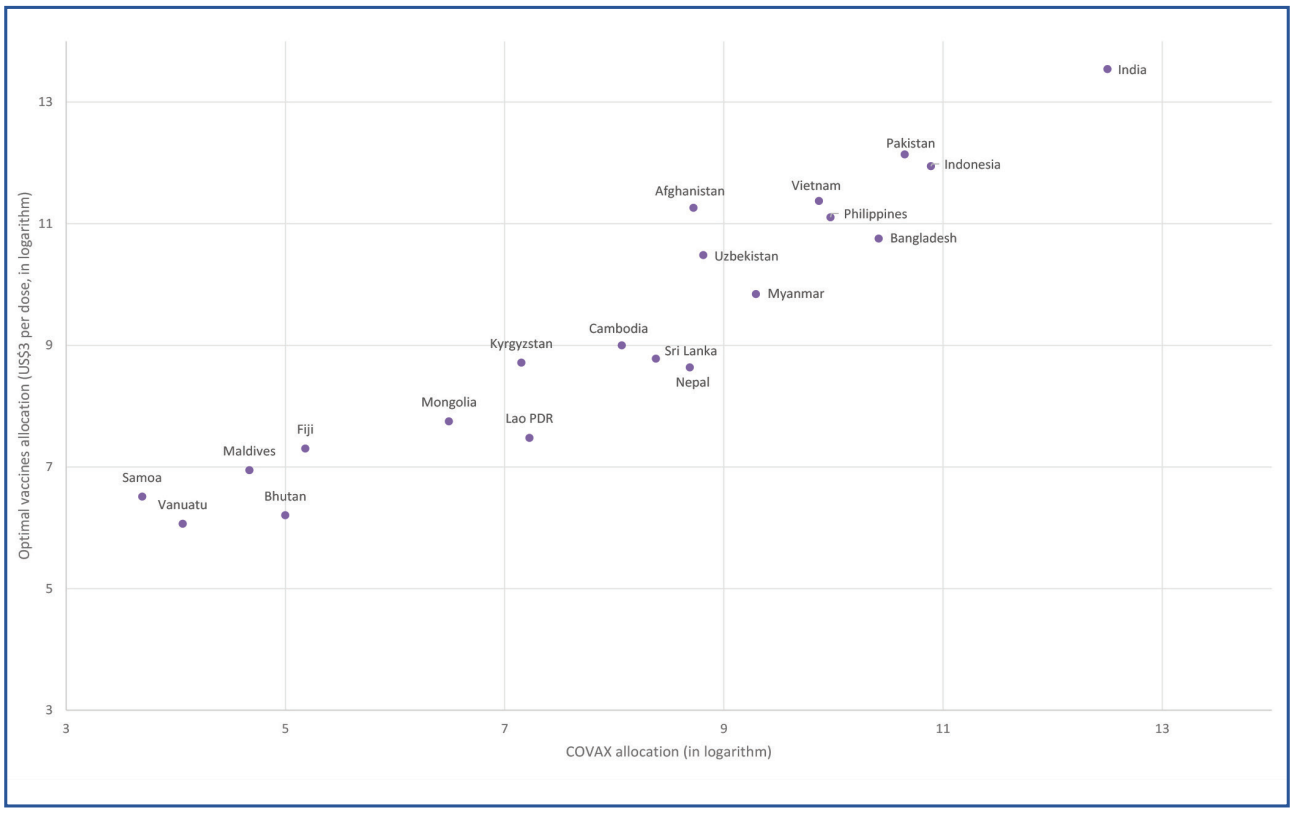


Figure 3.3: COVAX Allocation Policy versus Optimal Vaccine Allocation

Source: Author's calculation.

Note: US$3 is the price per dose paid by the COVAX Facility, whereas US$19.50 is the price per dose of Pfizer/BioNTech vaccines in the U.S. It is assumed that 1 percent of tax revenue collected is spent on the purchase of vaccines and the efficacy of the vaccines is 90 percent. Average tax rate is computed by taking a ratio between tax revenue and nominal gross domestic product in 2019 based on the data extracted from ADB Key Indicators.

Box 3.1: An Analytical Framework for Optimal Vaccine Allocation

Say the authority of country i chooses optimally the amount of vaccines V_i and the extent of non-pharmaceutical interventions, e.g. mobility restrictions; $0<h_i<1$; that can maximize an individual's utility function. The utility function is expressed as

$$\max_{V,h} u_i = \frac{1}{1-\sigma}(V_i(1-h_i)^{\omega})^{1-\sigma}$$

The parameter ω measures the complementarity between vaccinations and mobility, while σ is risk aversion parameter. Vaccine rollout is subject to the country's budget constrained by the amount of vaccines provided by the COVAX Facility b_i and self-financing capability that depends on the level of the economy Y_i and tax revenue collected $\tau_i Y_i$. Let's assume that the government spends 1 percent of the tax revenue collected $\varphi_i=0.01$ on vaccine rollout priced at P per dose. At the same time, the budget available will fall if resources need to be diverted towards dealing with rising infectious and lethal transmission if mobility restrictions are eased.

Overall budget constraint takes the form

$$V_i \leq b_i + \frac{\varphi_i \tau_i Y_i}{P} - r_i d_i (1-h_i) N_i$$

where r_i denotes probability of infection, and d_i the probability of death. N_i refers to the population of country i. The national production has a function that can be expressed as

$$Y_i = \exp\left(\frac{V_i}{N_i} - h_i - 1\right) K_i^{\alpha} L_i^{1-\alpha}$$

When the population is fully vaccinated $V_i/N_i = 1$, and the non-pharmaceutical measures are completely abolished $h_i= 0$, the production function boils down to the conventional Cobb-Douglass function $Y_i=K_i^{\alpha} L_i^{1-\alpha}$, implying a fully reopened economy. By equating the marginal rate of substitution between vaccines and mobility with the cost ratio at efficiency frontier, we can obtain an optimal vaccine allocation with Pareto efficiency:

$$V_i^* = \frac{(1-h_i)N_i\left(\frac{\varphi_i \tau_i Y_i}{P} - r_i d_i N_i\right)}{\omega\left(\frac{\eta \varphi_i \tau_i Y_i}{P} - N_i\right)}$$

Moving away from the principle of allocation into the distribution of vaccines, **Figure 3.4** illustrates how vaccine distribution forecasted in February 2021, as released by the COVAX Facility, has actually tracked the numbers of confirmed cases relatively well *ex post* as of July. Countries with the largest number of people contracting the coronavirus are also the one receiving the most doses.

Countries with more acute situation received more doses

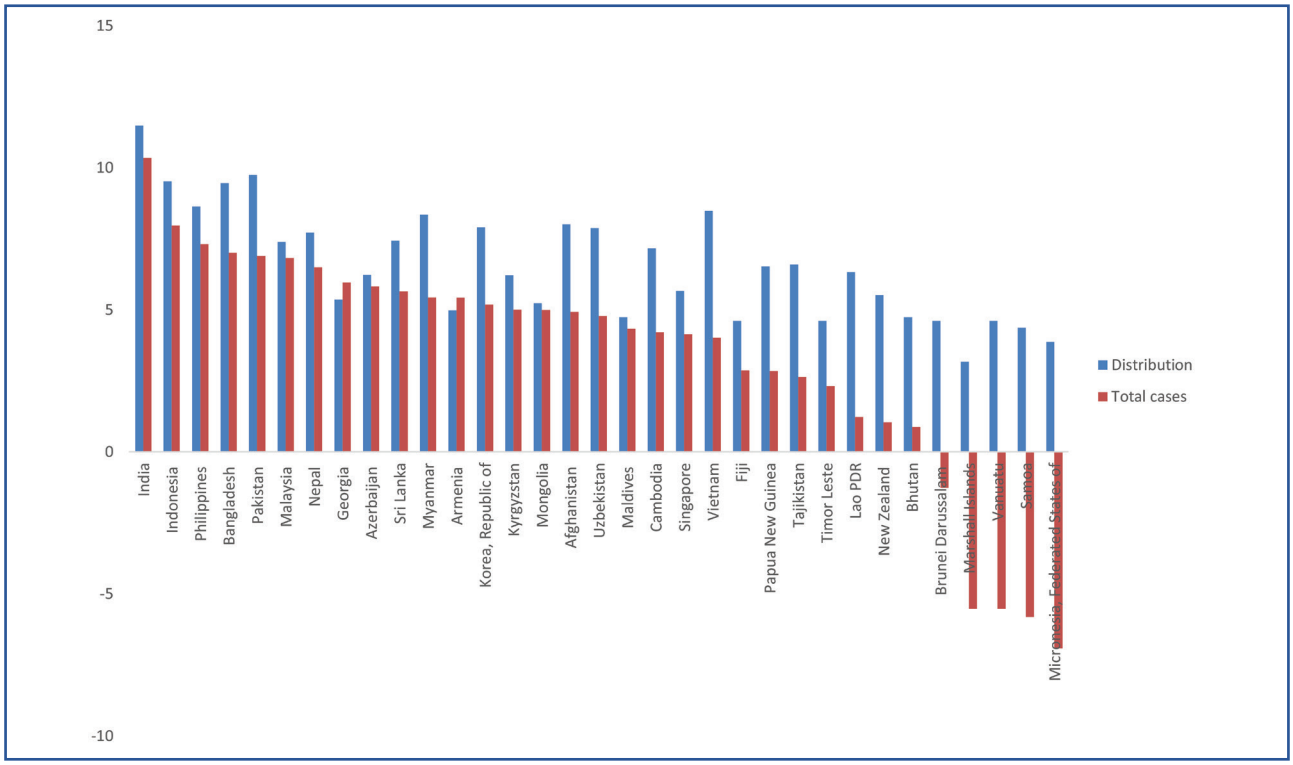


Figure 3.4: COVAX Vaccine Distribution Follows where the Virus Goes

Source: The COVAX Facility: Interim Distribution Forecast as of 3 February 2021, total confirmed cases as of 18 July 2021 from Our World in Data (Mathieu et al., 2021)), and author's calculation. Numbers (in thousand) are in logarithm.

One could certainly still wonder about the intuition underlying the distribution. For example, Samoa, which has only 3 confirmed cases (up to 18 July 2021) and suffered 5 percent economic contraction in 2020, is expected to receive 79,200 doses that approximately account for 40 percent of the population, whereas Philippines with more severe economic contraction (-8.3 percent) and acute pandemic (1.1 million confirmed cases) receive doses that account for only 5.2 percent of the population. Identical circumstances happen in other countries like Laos, Brunei, Fiji and so on.

But How Far can COVAX Global Vaccine Distribution Go?

When comparing the distribution forecast and administered dosage with the COVAX Phase 1 target itself, (**Figure 3.5**) one can see that some of the Asia Pacific countries will receive doses of vaccines more than twice of the 20 percent target, while some fewer than one third of the target. There is neither health nor economic intuition to be observed in the relationship.

What is more revealing is the uneven vaccine rollout between countries. Even more than six months after putting the vaccines on the market, there are countries that either have not reached the 20 percent vaccination rate for their population, or total vaccines administered are less than the COVAX distribution recommendation. Both may indicate domestic vaccine rollout constraints or the inability to purchase enough vaccines in the first place (if not included in the AMC scheme).

Overall domestic vaccination rollouts are highly uneven

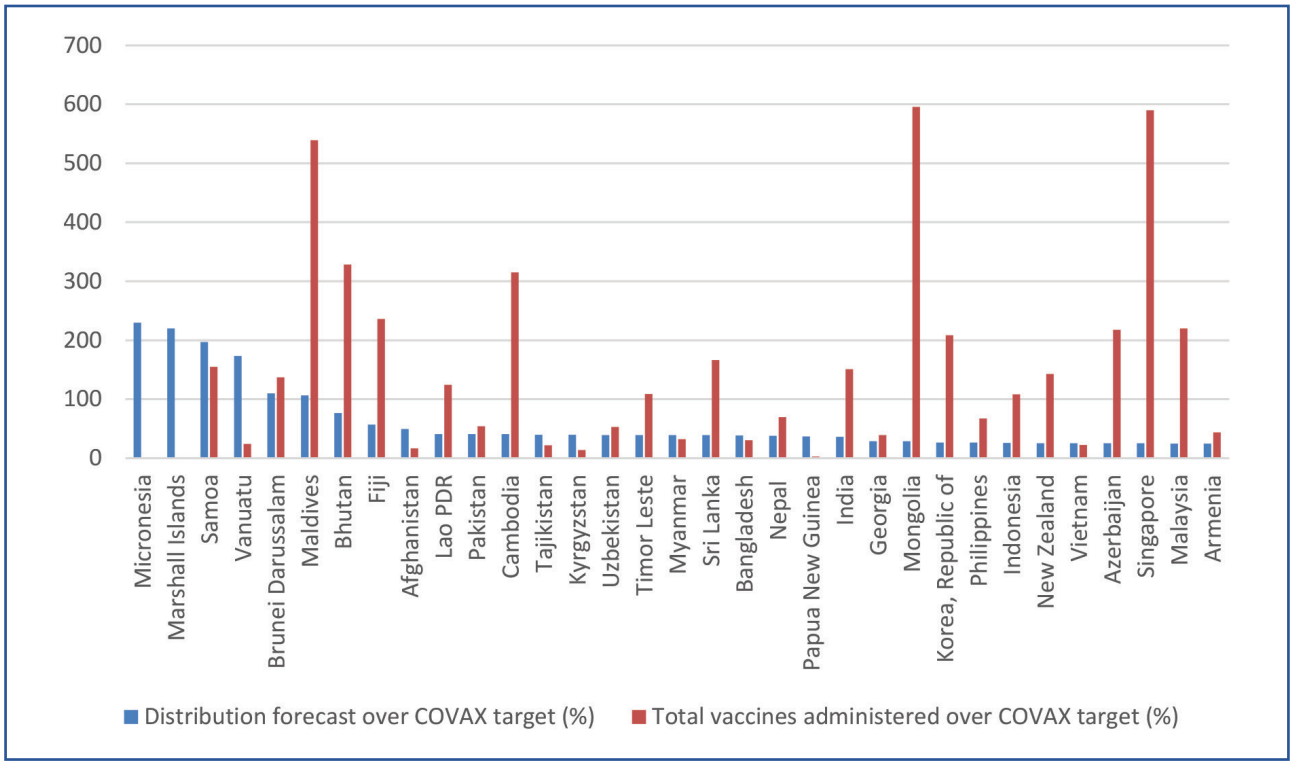


Figure 3.5: Uneven Progress of Vaccinations

Source: The COVAX Facility: Interim Distribution Forecast as of 3 February 2021, total vaccines administered as of 18 July 2021 from Our World in Data (Mathieu et al., 2021), and author's calculation

National Vaccine Distribution Considerations

For a national COVID-19 immunization strategy to be effective, the government still needs to consider the principles prescribed as the "COVAX Rule" (**Figure 3.6**).

Compatibility: Through regular public communications, messaging and education, vaccination programme must communicate with the citizens accurately with information they can trust so that individual's incentive for vaccine shot is aligned with national immunization strategy.

Omnichannel: Channels for vaccination shall be diversified so that individuals can receive vaccination at convenient locations and time. In addition to passive strategy waiting for scheduled individuals to turn up, vaccination programme can also be active by following the crowds: it goes wherever there is huge and synchronous demand for vaccinations, especially workplaces and factories.

Visibility: Like justice, vaccination must not only be done, it must also be seen to be done so that the process can be regarded as simple, secured, and efficient to build social consensus important for national immunization.

Accountability: The vaccinated citizens receive full course of treatment and followed-up monitoring to build social confidence for the citizens to come over for taking a jab.

Xenodochy: Those who have doubts on the effectiveness and side-effects of vaccines (The Xeno), either for legitimate or illegitimate reasons, shall neither be harassed nor discriminated. Instead, they shall be persuaded and induced to voluntarily participate in the programme via strategies implemented for compatibility, omnichannel, visibility and accountability (showing dochy).

An effective national vaccination strategy must address the "COVAX" aspects

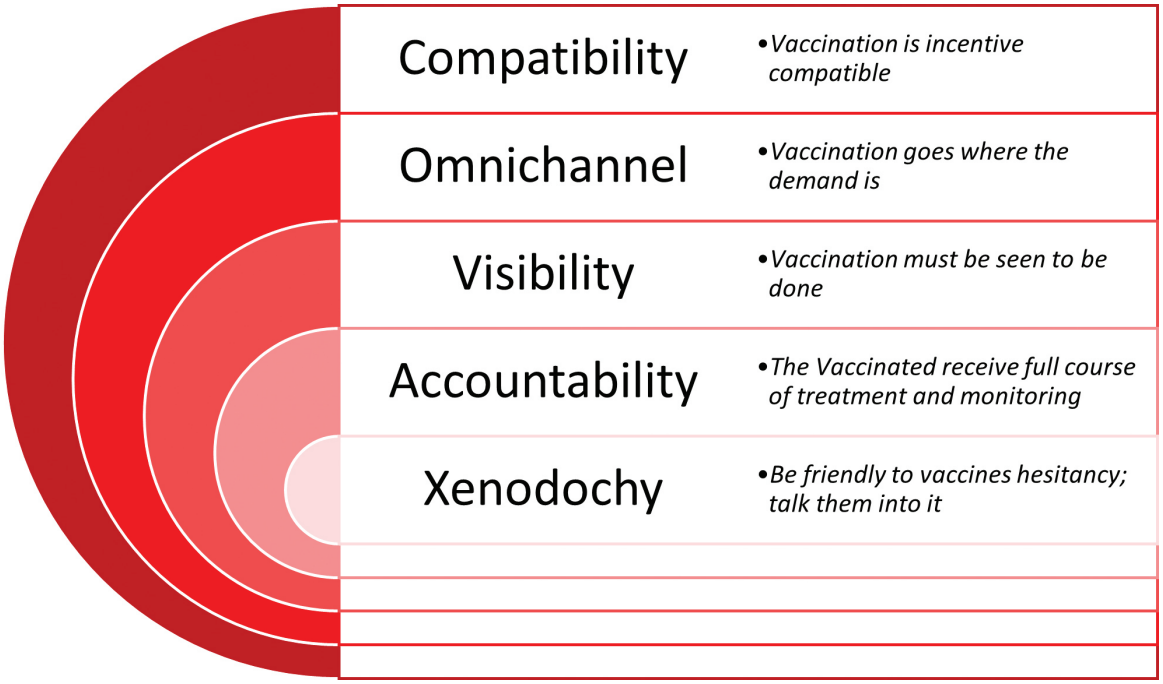


Figure 3.6: "COVAX Rule" for Administrating Vaccines

3.2 Universal Vaccination Initiative

Much has been said about "vaccinationalism" which is referring to bilateral deals between countries and manufacturers outside of COVAX arrangements; hence, defeating the purpose of setting up COVAX to ensure equitable vaccine distribution for all countries (UN News, January 18, 2021; UN, September 22, 2020). The high-income countries with more ability to pay have directly dealt with the manufacturers to secure more vaccines for their population, leaving little for low- and middle-income countries. Pharmaceutical companies which benefitted from government investments or grants such as AstraZeneca and Johnson & Johnson, have pledged to keep vaccine prices low, but other companies can sell their vaccines at a premium in the private market if they wish so (Wouters et al., 2021).

It was reported that by January 2021, over 39 million doses had been administrated in high-income countries, compared to only 25 doses given in one lowest-income country (UN News, January 18, 2021). The majority of the lower- and lower-middle-income countries are yet to vaccinate anyone, whereas the high-income countries have, on average, vaccinated their citizens at a rate of one dose per second starting from 2021 (UNAIDS, March 10, 2021). The disparities between them are too apparent and unacceptable. For us to be safe, everyone needs to be safe.

Furthermore, due to pre-existing structural inequalities and discrimination, vulnerable groups were often left behind in the vaccination programs (UN OHCHR, 2020). The vulnerable groups include people living in poverty, women, indigenous peoples, persons with disabilities (PWD), elderly, minority communities, internally displaced people, persons in overcrowded settings and residential institutions, people in detention, homeless persons, refugees, migrants and undocumented, and others experiencing marginalization. A study highlighted the unequal distribution of three critical resources in securing vaccination appointment: time, technology, and trust (Jean-Jacques and Bauchner, 2021).

Vaccines must become a public good globally. The call for global solidarity is never stronger than it is now, vaccines must be made available for everyone, everywhere as a basic human right. Without a concerted global commitment to guarantee universal access to vaccines, vaccines will go to those who can pay rather than those who need it most.

3.3 Towards a Fair Allocation Framework

The first phase of the global allocation prioritizes the high-risk and vulnerable groups–target to immunize 3 percent of a country's population. This is typically more than enough to protect medically-vulnerable individuals in majority of the Asia Pacific countries. Georgia, Armenia, Maldives and to some extent Azerbaijan perhaps are the exceptions with higher proportion of high-risk group that approximates 7.6 percent, 6.4 percent, 4.5 percent, and 2.6 percent, respectively. Phase I is completed once 20 percent of the population is covered.

This brings us to the ensuing second phase of the allocation: what underpins a fair allocation mechanism? Should it be one that is based on levels of public health risks and vulnerability as outlined in WHO (2020), which by then would be likely to overlook the second half of the overarching goals in WHO's framework for allocation of COVID-19 pandemic health products, namely "minimizing impact on societies and economies"?

Should the supply of vaccines remain limited and requires rationing, all the arguments boil down to "who shall get it first?". If what matters is to vaccinate as many people as possible globally in the sense of utilitarianism, 'global' social welfare would still increase irrespective of whether the recipient country is poor or rich, facing severe or mild death rates. "A vaccine is a vaccine whoever receives it." This is equivalent to zero aversion to vaccine inequality.

Going from one extreme to the other is the Rawlsian perspective that views justice as fairness, in which global social welfare cannot get better unless vaccination in the poorest country with more severe health circumstance is accelerated. The worst-off is prioritized. This is equivalent to a large if not infinite aversion to vaccine inequality.

Hence, fairly allocating COVID-19 vaccines among countries, in Emanuel et al.'s (2020) words, is a problem of distributive justice. What's interesting is that the optimal vaccine allocation developed in Section 3.2, in which individuals' welfare in each country is the pivot of moral concern, brings about higher global social welfare than equitable allocation weighted by population across different concepts of justice under different scenarios.

As shown in **Table 3.2**, whether the world remains troubled by the pandemic that requires mobility restriction; individuals in the recipient countries are neutral or adverse to risk; mobility restriction easing is preferred to vaccines as situation is getting better or the vice versa when the pandemic is getting worse, optimal vaccine allocation is simply welfare superior regardless of how distributive justice is judged.

While equitable allocation is efficient, efficient allocation of vaccines needs not be equal across countries if it is to every country's advantage. **Figure 3.7** illustrates a fair allocation framework built on individual's welfare that takes into account complementarities between health and wealth with some key metrics to be observed and assessed.

Table 3.2: Comparing Global Social Welfare Implication between COVAX Phase I Allocation and Optimal Vaccine Allocation across Varying Fairness Perceptions

Optimal vaccine allocation is welfare-superior even when Rawlsian justice is emphasized

Scenario	Utilitarianism	Rawlsian
i. Individuals are risk neutral with the ongoing pandemic and restricted mobility	(496.6>**392.8**)	(-0.00<**4274.4**)
ii. Individuals are risk-averse with the ongoing pandemic and restricted mobility	(-0.14<**0.06**)	($2.4X10^{70}$>**$4.7X10^{61}$**)
iii. Pandemic is getting over; easing of mobility restriction is preferred over vaccines by risk-averse individuals	(-0.07<**0.01**)	($9.6X10^{81}$<**$1.5X10^{82}$**)
iv. Pandemic is getting worse; vaccines are preferred over mobility by risk-averse individuals	(-2.66<**-0.27**)	($1.7X10^{53}$<**$3.7X10^{61}$**)

Note: Numbers in the bracket are "global" social welfare that sums up all individual's utility of the AMC-funded Asia Pacific countries, $W = (1/T) \sum(u_i^{1-\gamma}) (1-\gamma)^{-1}$. The metrics of individual's utility is calculated using *Our World in Data*'s stringency index and doses of vaccines, in which COVID-19 Phase 1 target produces global social welfare value on the left of the bracket, while optimal doses of vaccines for values (in thick red) on the right of the bracket. γ=0 is set for utilitarianism justice, whereas $\gamma = 50$ for Rawlsian justice. These results should be read cautiously upon the uncertainty in parameters (e.g. infection level) and measurement error (e.g. stringency index).

People-centric and health-wealth balanced

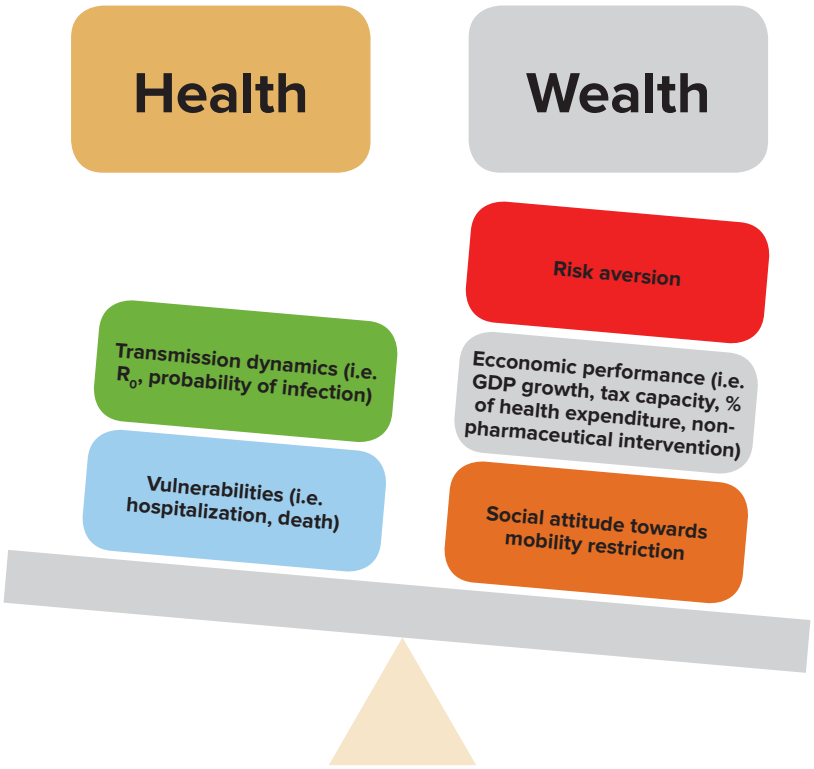


Figure 3.7: Towards a Fair Allocation Framework

3.4 National & Sub-National Distribution Framework

The pandemic and the uncertainty of the situation throw policymakers around the world in a difficult position in balancing the response across the health, economic and social issues it poses. Vaccines give hope to end the pandemic to control the spread of COVID-19, potentially through herd immunity. However, with a limited vaccine supply, policymakers have to strategize and prioritize vaccine distribution. Vaccine rollouts do not just end with the number of doses available for the countries; it also caters flow of the process from the procurement of vaccines until the delivery of the vaccines to the targeted populations.

3.4.1 COVID-19 Vaccinations in Japan

In Japan, vaccines will be free for all residents, including the foreign resident registered under the municipality. The first vaccine rollouts for Japan started on February 17, 2021, with the priority group of medical workers and an approximate total of 3.7 million personnel. This is followed by 36 million senior citizens over 65 and people with underlying conditions, such as respiratory issues and heart disease, in April. Meanwhile, the vaccination for the general public began in July.

To ensure smoothness of the vaccination registration process and clear communication, the vaccination form and information have been translated into 17 languages by the Ministry of Health (Steen, March 29, 2021). The translated documents act as a reference for the foreign residents when they fill-up the form in the Japanese language for the usage of healthcare personnel. As of May 2021, only 1 percent of the Japanese population has been vaccinated, which is lower than other countries such as India and China (Normile, May 13, 2021). The delay in the Japan vaccination programme happened primarily due to the requirements of bridging studies on drugs or vaccines that have been approved elsewhere to confirm their safety for its population. This step is taken to tackle scepticism among the Japanese people that could lead to a lower rate of vaccine acceptance despite the faster availability of vaccines.

The Japanese government established a large-scale vaccination centre in Tokyo and Osaka to administer over 10,000 vaccines a day (Steen, April 28, 2021). The medically certified Self-Defense Forces personnel have been responsible to administer the vaccines in both of the centres.

3.4.2 COVID-19 Vaccinations in Malaysia

As of the time of writing in July 2021, Malaysia has over 391,924 accumulative cases with 1,436 deaths. The first case of COVID-19 was discovered in December 2020. Following that, the Special Committee for Ensuring Access to COVID-19 Vaccine Supply (JKJAV) was established on 14 October 2020 to plan, implement, and monitor the COVID-19 Immunization Programme. In November 2020, the country signed the COVAX Facility to ensure vaccine supply for 10 percent of Malaysia's population. Malaysia also made an advance purchase from five vaccine manufacturers, of which the vaccine will be released subject to the National Pharmaceutical Regulatory Agency (NPRA) approval. As a result, Malaysia hopes to achieve herd immunity by the end of 2021 by immunizing 80 percent of its population.

To ensure the smooth rollout of its vaccination programme, Malaysia, through the Ministry of Health (MOH), sets up over 605 Vaccine Administration Centres (VACs) and 54 Vaccine Storage Centres (VSCs) (JKJAV, 2021). Meanwhile, registration for the vaccine can be made through MySejahtera, a government website, hotline, public and private health facilities, and outreach programmes. MySejahtera is a Malaysian government-developed application that allows users to assess their COVID-19 risk and help track the outbreak. In addition, the application is used to track movement and provide an assessment of the locations. The COVID-19 vaccination is voluntary and free of charge to all those living in Malaysia, citizens and non-citizens. The vaccines are to be distributed in three phases according to the target groups (see **Fig. 3.8**).

Phase 1 : February - April 2021 (500,000 people)

- **Priority Group 1**
  Frontliners comprising of public and private healthcare personnel
- **Priority Group 2**
  Frontliners consisting of essential servies, defence and security personnel

Phase 2 : April - August 2021 (9.4 million people)

- **Priority Group 1**
  Remainder of healthcare workers as well as those in essential services and defence and security personnel
- **Priority Group 2**
  Senior citizens (those aged 60 and over), high-risk group with chronic diseases such as heart disease, obesity, diabetes and high blood pressure and people with disabilities (OKU)

Phase 3 : May 2021 - February 2022 (13.7 million people or more)

- **Priority Group 1**
  Adult population aged 18 years and above (citizens and non-citizens)
- **Priority Group 2**
  Priority was given to those in the red zones; followed by those in the yellow zones and finally those in the green zones

Figure 3.8: Vaccine Target Groups for Malaysia

Source: JKJAV (2021).

The first phase aims to ensure that the health sector can operate at an optimum level, followed by lowering the burden of public healthcare facilities by protecting the high-risk groups and eventually controlling the spread of the diseases. Integrated platforms are used for real-time monitoring and to ensure the efficiency and accuracy of the Immunization Programme. The side effects and adverse effects following immunization (AEFI) are also monitored through a scheduled notification through the MySejahtera application to report their experience.

3.4.3 COVID-19 Vaccinations in India

India aims to vaccinate 300 million most vulnerable people by August 2021, a goal that will be difficult to achieve given the country's existing cold storage infrastructure (Shahidi and Rampal, December 7, 2020). India's vaccine logistics network currently includes 27,000 cold chain locations, 76,000 cold chain vehicles, 700 reefer trucks, 55,000 cold chain handlers, and 2.5 million health staff, but the country's cold chain infrastructure is biased towards the wealthy (Shahidi and Rampal, December 7, 2020).

India faced unprecedented challenges during this pandemic despite being one of the leading manufacturers of COVID-19 vaccines. As of 10 May, 2021, total cases in India have reached 22.7 million with over 246,000 death tolls. The second wave of the pandemic rolls over as the Indian government gave the impression that the country had control over the spread of the virus, thus allowing the mass gathering for a religious festival, leading to the second wave of COVID-19.

At first, starting from mid-January, India's vaccine distribution plan works in such a way that the prices of the vaccines were negotiated between the federal government and the manufacturers. The vaccines were restricted to priority groups (i.e. the elderly and healthcare workers) in which the states managed the distribution. However, upon vaccination of less than 2 percent of its population three months afterwards, there is a shortage of vaccination doses due to the unavailability of raw materials. Despite the shortage in vaccine supplies, the government then shift the strategy allowing everyone over 18 to get the vaccination and granting permission to state governments and private hospitals to make a direct purchase from manufacturers (Pradan et al., April 29, 2021). It worsened the situation and crumbled the overall vaccination drive of India.

Discussion

None of the countries discussed above introduced mandatory vaccination for any targeted population or the general population. Lack of trust in the government and vaccination process could reduce the ability of countries to reach herd immunity. Fake information on the vaccine and the side effects also hold up people from registering for the vaccination. However, mandatory vaccination, even for COVID-19, can be ethically acceptable if there is a serious danger to public health, there is a strong level of trust in the vaccine's protection and efficacy, the perceived utility of mandatory vaccination is greater than the alternatives, and the punishments or costs for noncompliance are proportionate (Savulescu, 2021).

COVID-19 Vaccine is given out at the All India Institute of Medical Sciences, India.

Box 3.2: Should the Vaccines be Made Mandatory?

Since first detected back in December 2019, there has been a total of 188 million COVID-19 cases with over 4.06 million deaths worldwide as of 15 July, 2021. In fighting the virus, the rollout of the first vaccine started in December 2020, and at the time of writing, 25.8 percent of the world population has received at least one dose of a COVID-19 vaccine (Ritchie et al., 2020). It seems that we still have a long way to go. Achieving herd immunity for the world's population is crucial to combat the COVID-19 virus. How to get that? By ensuring that at least 60-70 percent of the population of the countries get vaccinated. To date, it has been up to individual citizens to decide whether or not to get vaccinated. However, fake news, misinformation, lack of trust in vaccine development and institutions are among the reasons that contributed to the low uptake of vaccines among the people. Therefore, knowing that vaccines can prevent the suffering and deaths associated with the infectious disease led to the question, should the vaccines be made mandatory?

WHO (2021) suggested that before contemplating the decisions of mandatory vaccination, efforts should be undertaken by the government or policymakers to highlight the benefits and safety of vaccines to achieve the highest possible vaccine acceptance rate. It must be necessary for and proportionate to the achievement of the intended public-health goals. Apart from that, the WHO also outlines other ethical considerations and caveats that should be evaluated explicitly in reference to COVID-19 mandatory vaccination:

- Sufficient evidence of vaccine safety for the populations for whom the vaccine is to be made mandatory
- Sufficient evidence of vaccine efficacy for whom the vaccine must be made mandatory and effective in achieving an important public health goal
- Sufficient, reliable and free access of vaccine supply for whom the vaccine is to be made mandatory
- Policymakers have to carefully evaluate the impact that mandating vaccination might have on public confidence and trust
- The ethical examination and decision-making about mandatory vaccination should include transparency and step-by-step decision-making by the legitimate public health authority

However, it was suggested that mandatory vaccinations should be imposed, for instance, in the case of low vaccine uptakes, the uncontrollable spread of the virus, and hospitals' capacity and public health system. In the case of COVID-19, the emergence of the new variant, which is highly contagious in the midst of battling the virus, may also become the push factor for mandatory vaccinations. The coercive policies are often viewed as the last resort needed to fight the crisis at hand. Among countries that imposed mandatory COVID-19 vaccination are Indonesia, the aged-care and quarantine workers must be vaccinated in Australia, and Pakistan imposed mandatory vaccination for all public and private employees.

Another challenge highlighted was the cold chain management and reaching out to everyone to the last mile. Cold chain management is crucial in vaccine acquisition. The overall process starts from manufacturing vaccines, delivering to the countries, storage, and administering vaccines to the recipient. Proper handling procedure and storage facilities must be in place to avoid mishandling or errors during the transportation of the vaccines. Any mishandling, for instance, mistakes in shipping temperature, could result in significant losses. So as any spillage or wastages. Alongside that, a key person should be assigned at each vaccination facility to oversee the flow from vaccine acquisition until the administration process to citizens. Thus, the government has to bear the costs by acquiring the proper machines and equipment for the cold chain supply and training for the key person for handling the vaccines.

Furthermore, due to vaccine sensitivity towards temperature and time, countries must be prepared for storage and logistic process to the designated vaccination centres. This is challenging as it involved large scale vaccine delivery and time-critical where it needs to be distributed across and within countries promptly. For this reason, the Malaysian government has approved RM16.6 million for the cold chain, and ultra-cold chain as the Pfizer-BioNTech vaccine requires ultra-cold storage at -70°C (Jun, Jan 5, 2021). On the other hand, India has to ramp up their existing cold chain capacity to disburse the COVID-19 vaccines. Countries need to evaluate their current cold chain network if there's any and potentially improve from there. The goal is to reach out to everyone and not leave anyone behind; thus, the issue of biased cold-chain infrastructure toward the urban and wealthy should not be happening.

Vaccines are for everyone, and everyone must have access to it–including the vulnerable groups. However, the lack of a database could jeopardize the whole process of achieving herd immunity. The vulnerable groups are often left behind even when they were more likely to be hit the hardest during the pandemic. Therefore, the database on the eligible vaccine candidates has to be solid; any undercounting or under-reporting dampens the efforts made by the government on vaccine distributions. Furthermore, the correct assessment of epidemic risk is critical to preventing, controlling, and even eradicating COVID-19. For example, cities and urban settlements have higher risks of spreading the virus due to high population densities. In some cases, their living conditions are in such situations that social distancing is not possible, such as migrants, refugees, and illegal settlements.

To ensure widespread vaccination acceptance, developing an effective engagement approach for healthcare professionals and the target population is critical. Communication is the key to build trust in this whole process. First, the government must share the known facts and available information with the public regarding vaccines. Then, the information must reach everyone to dispel misinformation, to clear sentiment which could worsen the stigmatization towards the specific group and consequently, build trust and increase the uptake of the vaccines. Regarding the vaccine prioritization groups, clear information should be shared not just on 'who' get the vaccines first (i.e. the priority groups) and on the 'why' these groups are chosen to be on the priority list.

WHO SAGE roadmap outlines the prioritizing uses of COVID-19 vaccines in the context of limited supply. However, as the socio-economic impact deepens alongside the protracted and uncertain evolution of the pandemic, the prioritization becomes a more complex exercise and certainly pressuring governments to consider beyond the frontline health workers, elderly and people with underlying health conditions. Japan, for instance, took another step by including people with mental disabilities in its priority list (Japan COVID-19 Vaccine, 2021). Additionally, as mentioned earlier, the vaccination rollout in India is under the state government. Kerala has included 32 categories in the priority group by considering them as frontline workers such as bank employees, Air India field officers, and police trainee (Thiruvananthapuram, June 3, 2021). This shows that, throughout the time, the governments may need to consider the various opportunity costs as it may be difficult to prescribe general scenario or policy recommendations given the limited vaccine supplies and the variations in the national recovery plans.

The communication strategy and planning must be implemented to identify how the information will be delivered to different population groups, such as the non-tech savvy and minorities that might be difficult to reach through online platforms. Malaysia, for instance, has low vaccination registration among the elderly, who are the priority group in phase 2 of the Immunization Programme (Anand, March 26 2021). This might be happening due to no internet knowledge or unfamiliarity with the MySejahtera online application among the elderly. Fear could also be a factor when there is no access to information on vaccine's safety. Similarly, India's poor and rural citizens also faced difficulties due to an over-reliance on app-based technology (Pradan et al., April 29, 2021). This is where civil society, local authority, and community leaders could play a role as the representative for those excluded from the vaccination efforts either due to digital divide, discrimination, or hard to reach location. In the past, India successfully runs a polio vaccination drive by utilising the Accredited Social Health Activists to reach those in rural vicinity (Pradan et al., April 29, 2021).

Most importantly, there is no room for corruption and political or personal interest in the access given for vaccination. No one with the power or money should be able to bypass the decision made on the priority list and received the vaccination for themselves. WHO SAGE roadmap for prioritizing uses of COVID-19 vaccines in the context of limited supply outlined few strategies to improve the public's perception of the development and prioritization process of vaccination (WHO, 2021):

1. Culturally and linguistically accessible communications made freely available regarding COVID-19 vaccination
2. Recruitment of community opinion leaders to improve awareness and understanding of such communications
3. Inclusion of diverse and affected stakeholder opinions in decision-making

Chapter 4
Modelling Distribution Scenarios

While coronavirus recognizes no sovereignty borders, it is widely acknowledged that the pandemic has hit the lives and livelihoods of low-income countries particularly harder. Recall **Figure 1.4**: more than 80 percent of the infected individuals in this region reside in low- and middle-income countries. The rationale is rather straightforward: in low-income countries, health systems are less prepared to deal with the pandemic, governments have limited financial capacity to mitigate the pandemic's adverse health and economic impact, and informality-centric labour market structure becomes impediment to the effectiveness of government's economic rescue plans.

The progress of vaccination thus far only intensifies the scar of inequality left by the pandemic. **Figure 4.1**, so does **Figure 1.6** that depicts the uneven coverage of vaccines secured, vividly illustrates the fact that rich countries are far ahead in the horse race of vaccination. When the vaccines were just put on the market, nearly 99 percent of vaccines administered in the world (as of 18 January 2021) took place in high and upper-middle income countries. Six months later, high and upper-middle income countries still account for a whopping 83 percent of total vaccines administered in the world. Only 0.27 percent was administered in low-income countries.

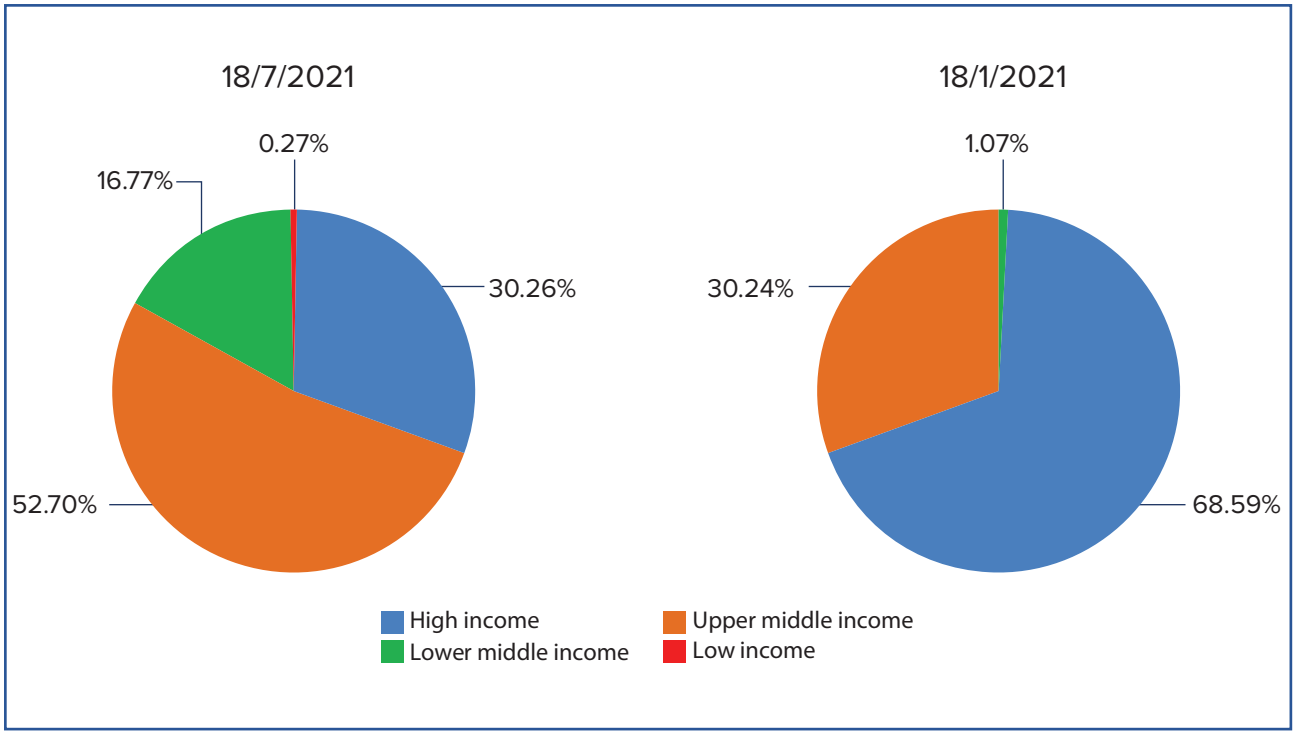


Figure 4.1: Share of Total Vaccines Administered in the World, as of 18 July 2021, by Income Level

Source: Mathieu et al. (2021)

In a world connected with trade and production, part of the economic cost of globally unequal distribution of vaccines is ironically going to be borne by the advanced economies (Çakmaklı et al., 2021; Hafner et al., 2020). Vaccine inequality is not without cost.

4.1 Conceptual Framework

To describe potential economic impact of heterogenous vaccine distribution globally, a two-country model representing low- and middle-income and high-income economies is set up. It is an integration of dynamic general equilibrium macroeconomic model and epidemiological model. There are several important bells and whistles in the model that reflect the pandemic and economic reality:

i. Countries are connected via cross-border trade in intermediate and final goods

ii. The pandemic is both supply and demand shocks to the economy

iii. Coronavirus transmission is more than just a random event, it is also the outcome of physical contact via workplace and shopping

iv. There is a non-pharmaceutical mitigation strategy that curbs the transmission of the virus but hurts the production

v. Vaccines play the role of curbing transmission and minimizing the fatality of the virus

The essence of the model is depicted in **Figure 4.2**, of which the technical description can be found in **Box 4.1**. The key message of **Figure 4.2** is that the labour and goods markets cannot return to normalcy if the virus's transmission prevails via physical contact between susceptible and infected individuals. Non-pharmaceutical measures, while mitigating the spread of the virus, fragment and paralyse the market that further slows down the return to normalcy. All these adverse effects will be spilled over to the rest of the world via trade in intermediate and final goods. Vaccinating the population becomes the only viable solution to solving the health and economic crisis.

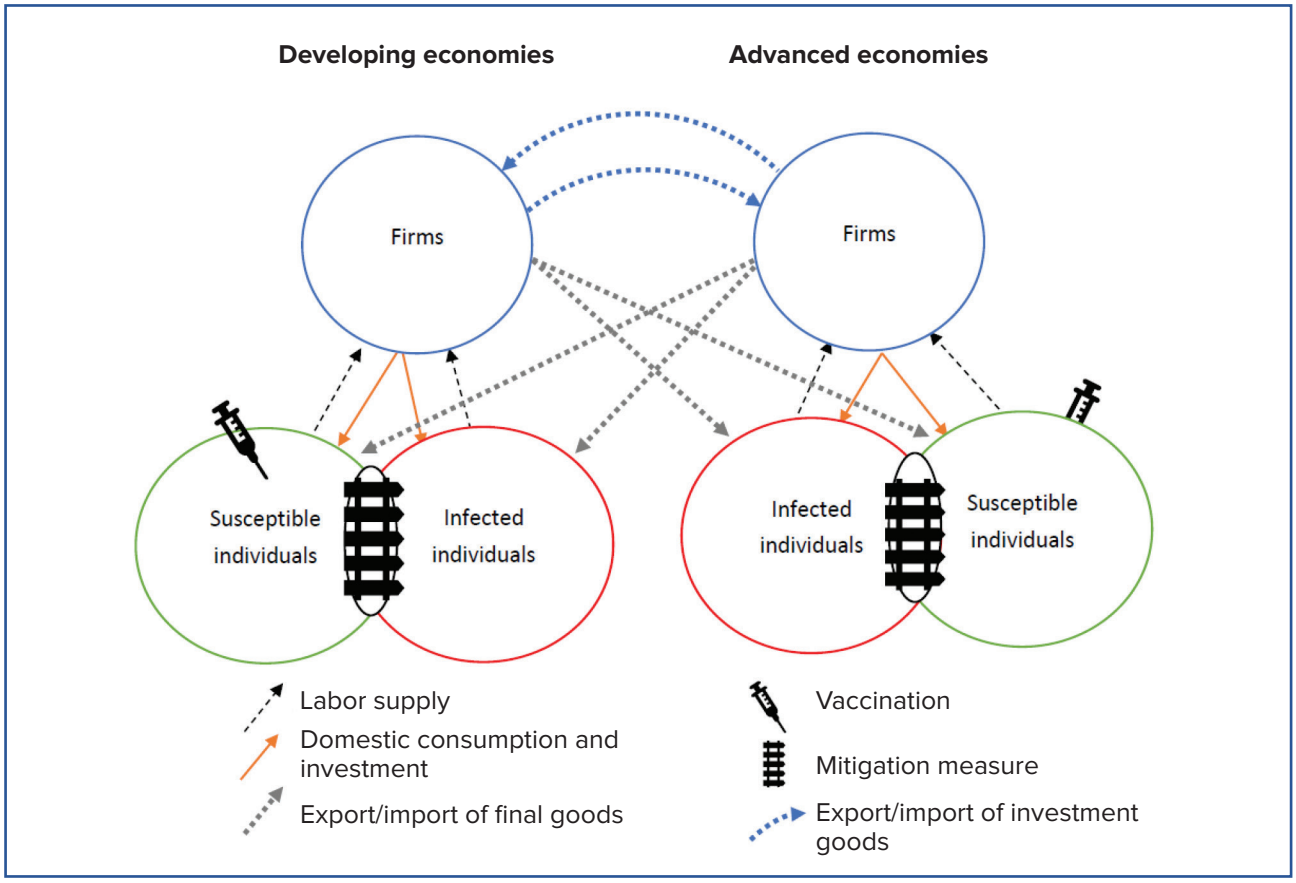


Figure 4.2 An Endogenous SIR-Macro Model with Vaccination and Mitigation

By grouping all the upper- and lower-middle income Asia-Pacific countries on top of low-income countries as 'Low-and-middle-income countries', LIC in short, while the remaining as 'High-income countries' HIC, the model is taken to data to calibrate the parameter values and steady states of the model.

Box 4.1 A Two-Country Dynamic General Equilibrium SIR-Macro Model

Endogenous SIR Model with Vaccination

The most widely used epidemic model is the susceptible-infected-recovered (SIR) model laid out in Kermack and McKendrick's (1927). It captures the dynamics of an infectious disease in a population from being susceptible, infected, and then recovered or death. By denoting S_t as the size of the population susceptible in time t, its evolution can be written as

$$S_t = S_{t-1} - \beta T_{t-1} \tag{4.1}$$

where T_t indicates total number of newly infected people. The parameter β represents the rate at which the disease is transmitted from infected population I_t to susceptible individuals.

In the classic SIR model, T_t is the outcome of random meeting between susceptible and infected people, $T_t = S_t I_t$, which does not depend on economic activities. But the disease becomes more contagious when people bump into each other more frequently via work and shopping. Following Eichenbaum et al. (2020), we expand T_t to incorporate spread of the disease from infected to susceptible group $S_t I_t$ enabled by the interactions through shopping $C_t^I C_t^S$ and work $L_t^I L_t^S$ with a probability of ρ_c, on top of the random transmission with a probability of ρ_r.

$$T_t = \left((\rho_c \{ C_t^I C_t^S + L_t^I L_t^S \} + \rho_r) S_t I_t e^{-h_t} + \varepsilon_{T,t} \right) (1 - \lambda V_t) \tag{4.2}$$

where $\varepsilon_{T,t}$ refers to exogenous shock hitting the coronavirus transmission. The spread can be curbed by either imposing nationwide mitigation strategy h_t, which includes mandatory order from the government (i.e. movement control, lockdown), and individuals' mitigation effort (i.e. social distancing, washing hands, wearing mask, work from home), that reduces physical interaction $S_t I_t$ or vaccination V_t. The parameter λ measures vaccine efficacy. Higher vaccination with greater efficacy reduces transmission.

The size of infectious population at time is increasing along with the number of active cases, that is the difference between newly infected and recovered γI_{t-1} and deceased people θI_{t-1}

$$I_t = I_{t-1} + \beta T_{t-1} - (\gamma + \theta e^{-V_t}) I_{t-1} \tag{4.3}$$

where γ represents recovery rate, and θ the fatality rate. Note that vaccination reduces fatality rate by θe^{-Vt}. Finally, the evolution of recovered and deceased population can be written as

$$R_t = R_{t-1} + \gamma I_{t-1} \tag{4.4}$$

$$D_t = D_{t-1} + \theta e^{-V_t} I_{t-1} \tag{4.5}$$

The entire population is normalized to one so that the variable indicates the fraction of population.

Vaccination

The share of vaccinated population grows according to the following simple law of motion

$$V_t = \chi V_{t-1} + (1 - \chi) \tilde{V} \tag{4.6}$$

where $\tilde{V}$ refers to targeted share of vaccinated population, and the parameter χ measures the efficiency of domestic rollout. Higher χ indicates slower progress toward the goal.

Production

Turning to the economic side, firm's production takes the Cobb-Douglas function in such a way that

$$Y_t = (1 - h_t)Z(K_{t-1})^{\alpha}(AL_t^e)^{1-\alpha} \tag{4.7}$$

where K_{t-1} refers to pre-installed capital stock, A as labour-augmenting technology parameter while Z is total factor productivity shifter, and L_t^e is the effective labour demand pooled from healthy susceptible and recovered labor supply together with a fraction of working hours from infected workers

$$L_t^e = (1 - I_t - D_t)L_t^S + I_t L_t^I \tag{4.8}$$

Capital stock comprises both domestic $K_{h,t}$ and imported investment goods $K_{fh,t}$

$$K_t = \left((1-\phi)^{1/\kappa}\left(K_{h,t}\right)^{1-1/\kappa} + \phi^{1/\kappa}\left(K_{fh,t}\right)^{1-1/\kappa}\right)^{\frac{\kappa}{\kappa-1}} \tag{4.9}$$

where ϕ is the share of imported capital goods, and $\kappa > 0$ refers to the elasticity of substitution between domestic and imported capital goods. The law of motion for capital stock accumulation is given by

$$K_{h,t} = (1-\delta)K_{h,t-1} + \mathcal{I}_{h,t}e^{-h_t - \varepsilon_{T,t}} \tag{4.10}$$

$$K_{fh,t} = (1-\delta)K_{fh,t-1} + \mathcal{I}_{fh,t}e^{-h_t - \varepsilon_{T,t}} \tag{4.11}$$

where $I_{h,t}$ and $I_{fh,t}$, respectively, refer to demand for domestic and imported investment goods. δ is the rate of depreciation. Two points stand out: first, coronavirus transmission has both supply and demand shock effects, as it reduces labor supply and demand for investment goods. So does the mitigation measures. Second, countries are linked via trade in investment goods, allowing the adverse economic impact of the pandemic and mitigation measure to spill over borders.

Utility

The utility function for susceptible individuals takes the typical form as follows

$$u^S = e^{-h_t - \varepsilon_{T,t}}\Xi^{S,t}\left(\frac{1}{1-\sigma^S}(C_t^S - bC_{t-1}^S)^{1-\sigma^S} - \ln(L_t^S)\right) \tag{4.12}$$

where b refers to the degree of habit persistence. There are three aspects that differentiate susceptible from contracted and recovered individuals: firstly, susceptible individuals are more risk-averse than those contracted and recovered $\sigma^S > \sigma^I$. Secondly, virus transmission shock is inconsequential for recovered

individuals, and lastly, susceptible individuals are more impatient and thus have lower subjective time preference $\Xi^{S,t} < \Xi^{I,t}$. Note also that both pandemic and mitigation measures resemble adverse preference shock. As an individual's consumption bundle consists of domestic $C_{h,t}$ and imported consumption goods $C_{fh,t}$ as below,

$$C^i = \left((1-\varphi)^{1/\varepsilon}\left(C_{h,t}\right)^{1-1/\varepsilon} + \varphi^{1/\varepsilon}\left(C_{fh,t}\right)^{1-1/\varepsilon}\right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (4.13)$$

countries are linked via trade in final goods as well. φ measures the share of imported consumption goods, and ε captures the elasticity of substitution between domestic and imported goods. The setting is equally applied to "Low-and-middle-income countries" and "High-income countries" in a two-country model.

4.2 Alternative Virus Transmission and Vaccination Scenarios

Scenario Setting

Four different scenarios solved and simulated over a period of 24 months pertaining to cross-country heterogeneity in vaccine access. In the first scenario, dubbed as "*Baseline*" as illustrated in **Figure 4.3**, no vaccine is available for both LICs and HICs within 24 months following the beginning of pandemic outbreak. This serves as a benchmark for the worst scenario. In the second scenario called "*Parallel vaccination*", vaccines are available after 12 months of the pandemic. Both HICs and LICs have equal access to vaccines, and therefore are able to roll out vaccination in parallel. Assuming a milestone of vaccinating half of the population within six months, by the end of the period, approximately 71 percent of the population are vaccinated in both economies. The scenario serves as a reflection of what the world with equal distribution can achieve in fighting the virus. And throughout the timeline, externally imposed movement restrictions are relaxed considerably.

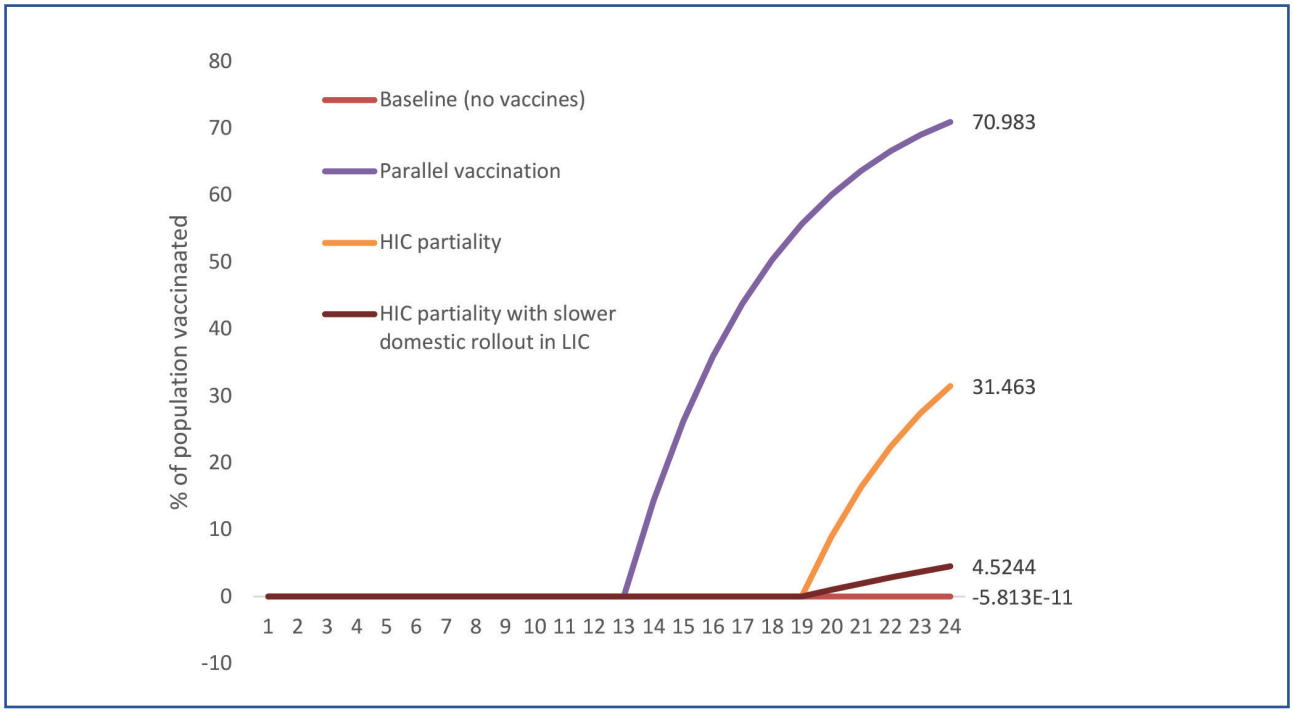


Figure 4.3: Three Global Vaccine Distribution Scenarios and Two Domestic Vaccine Rollout Scenarios for LICs

Note: Path of vaccination is simulated for 24 months. For "*Baseline*" scenario, no vaccines are available throughout the 24 months. For "*Parallel vaccination*" scenario, vaccines are available from 13th month onwards for low-and-middle-income countries (LICs) and high-income countries (HICs) in parallel. Vaccination target is 80 percent and domestic rollout efficiency is χ=0.82, which gives a speed wherein half of the population is vaccinated after six months, for both LICs and HICs. For "*HIC partiality*", LICs have access to vaccines only six months after HICs start vaccination. Vaccination target for LICs is lowered to 50 percent by the end of 24th month. For "*HIC partiality with slower domestic rollout in LIC*", all assumptions are as of "*HIC partiality*" except for a slower progress of domestic rollout toward the target in LICs at higher autocorrelation coefficient χ=0.95.

In the third scenario, HICs are assumed to be six months ahead of LICs in the access to vaccines by prioritizing its own citizens. This scenario is called "*HIC partiality*". By the end of the period, 71 percent of the population in HICs are vaccinated while only 31.5 percent of LICs' population received their jabs. This scenario is closer to the actual vaccination paths in the real world circa Quarter 3 of 2021. Whenever vaccination progresses slower, mitigation measures in LICs are eased slower too than HICs.

In all the global vaccine distribution scenarios, LICs are assumed to have domestic rollout capabilities in par with the HICs. However, years of inequality in health access and medical preparedness as discussed earlier (refer to **Figure 3.5**) cast doubt on this assumption. To address the critical importance of domestic rollout capability alongside global vaccine inequality, a weaker rollout progress is assumed in the scenario of "*HIC partiality with slower domestic rollout in LIC*" (the fourth scenario).

Results

In a nutshell, the model results (**Figure 4.4**) show that the ability to roll out a "parallel vaccination" strategy, i.e. Scenario 1, makes the best sense in curbing global spread of the virus. This is a strong argument to be made on the importance of vaccine equality among nations. On the other hand, if vaccine access is unequal in favour of HICs, i.e. Scenario 2, this will lead to the virus spreading faster in LICs. A more severe situation is expected if the LICs suffer from poor public health system's readiness to roll out the vaccines, i.e. Scenario 3. In particular, given the identical external environment and exogenous transmission shock, share of the population contracting the virus can be more than quadrupled when domestic rollout is progressing slowly (as in Scenario 4's description earlier). In other words, poor health and medical preparedness domestically simply magnifies the effect of global vaccine inequality in term of vaccine distribution effectiveness.

The model is extended further to consider two additional scenarios. One is where the vaccines administered in LICs are of lower efficacy, say 60 percent compared to 90 percent as assumed in the earlier set of four scenarios. This is not an unreasonable assumption, given that LICs' vaccine pool may come from those with lower efficacy values or are not capable to fight emergent virus variants, or the country's system are prone to vaccine distribution failures (logistical constraints and mishandling). The other additional scenario reflects a worst-case scenario, i.e. where the world is experiencing a more transmissive second wave sweeping the LICs, which are most likely have not received the necessary supply of vaccines; and if they do, the vaccines are of lower efficacy type and the countries themselves have poor domestic rollout capabilities. In this dire scenario, the rate of population infected by the virus will be almost 7 times higher than the best-case scenario of parallel vaccination in both HIC and LIC countries.

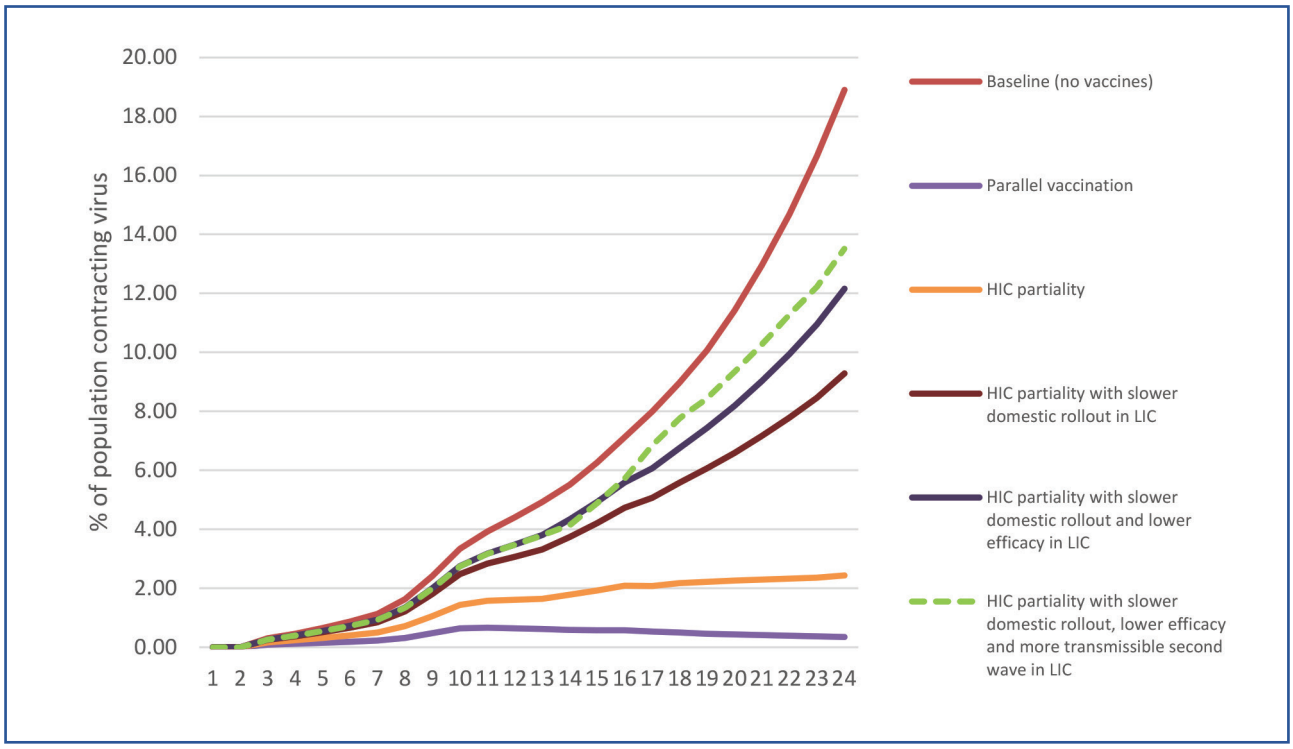


Figure 4.4: Virus Transmission in LICs under Alternative Paths for Vaccination

Note: Transmission path is simulated according to Eq. (4.2) in a two-country macro-SIR model setting as in Box 4.1. For the scenario of "*HIC partiality with slower domestic rollout and lower efficacy in LIC*", vaccine efficacy, which presumes 90 percent efficacy in all the scenarios, is lowered to 60 percent. For "*HIC partiality with slower domestic rollout, lower efficacy and more transmissible second wave in LIC*", it is further assumed that LICs face second wave of exogenous shock that is more transmissive in month 14th while waiting for the vaccines. See Note in Figure 4.3 for the explanation of the remaining scenarios.

4.3 Health and Economic Outcomes under Alternative Scenarios

The COVID-19 crisis is like no other. It caught the world in 2020 by surprise, sending both advanced and developing economies into health and economic crises. The most tragic outcome is the unnecessary and premature death. To what extent does an early availability of vaccine, however unequal, could have minimized the death incident of the pandemic?

Figure 4.5 shows the time path of the death as a percentage of population under different scenarios outlined above. Without vaccines within the first two years, total death can amount to 1 percent of the total population in LICs. By having an early and parallel access to vaccines ("*Parallel Vaccination*" scenario), however, death incident can be substantially reduced to 0.02 percent. However, the scenario that is closest to reality, the "HIC *Partiality*" scenario can be shown to result in relatively higher death (0.11 percent) all over the world. That said, LICs facing unequal vaccine availability would still be far better off than without vaccines at all (1.056 percent). In short, while vaccine equality as the hypothetical first-best world is certainly a goal worth pursuing, national partiality, however imperfect, as the second-best world is still much more favourable than the worst scenario.

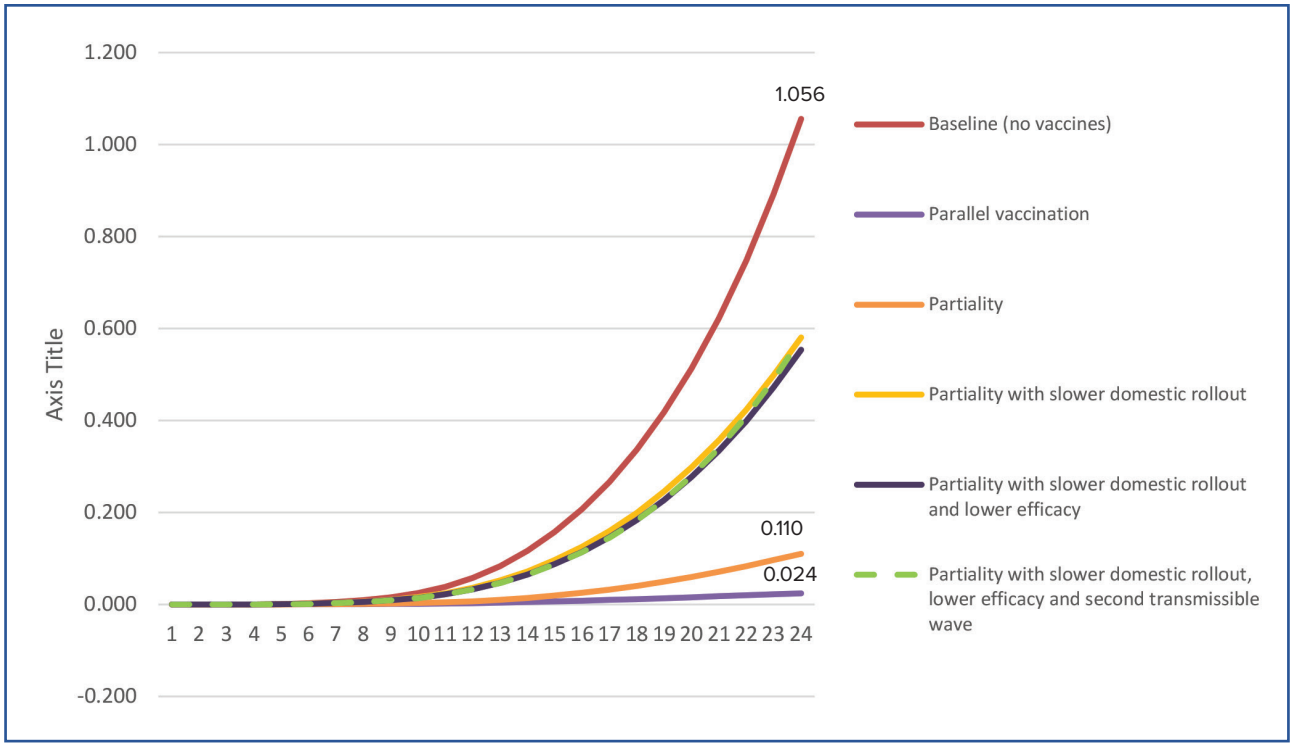


Figure 4.5: Path of Monthly Deaths under Alternative Scenarios in LICs

The findings above hold true even when the health outcome is judged by fatality rate, as depicted in **Figure 4.6**. More alarming but less discussed is the weak state capacity in LICs to coordinate vaccination programme and mobilize mass participation (Scenarios 4 through to 6). Countries rarely succeed in promoting development in the absence of well-functioning public institution (Rodrik, 2000; Besley and Persson, 2011; Acemoglu and Robinson, 2012). Likewise, without a coordinated functioning of domestic vaccination regime, health benefit of vaccines could easily slip through our fingers even when vaccine supply is no longer a constraint. As vividly shown in **Figures 4.5** and **4.6**, the second-best world of "*Partiality*" can quickly become the second worst in terms of the loss of human life when domestic rollout is slow.

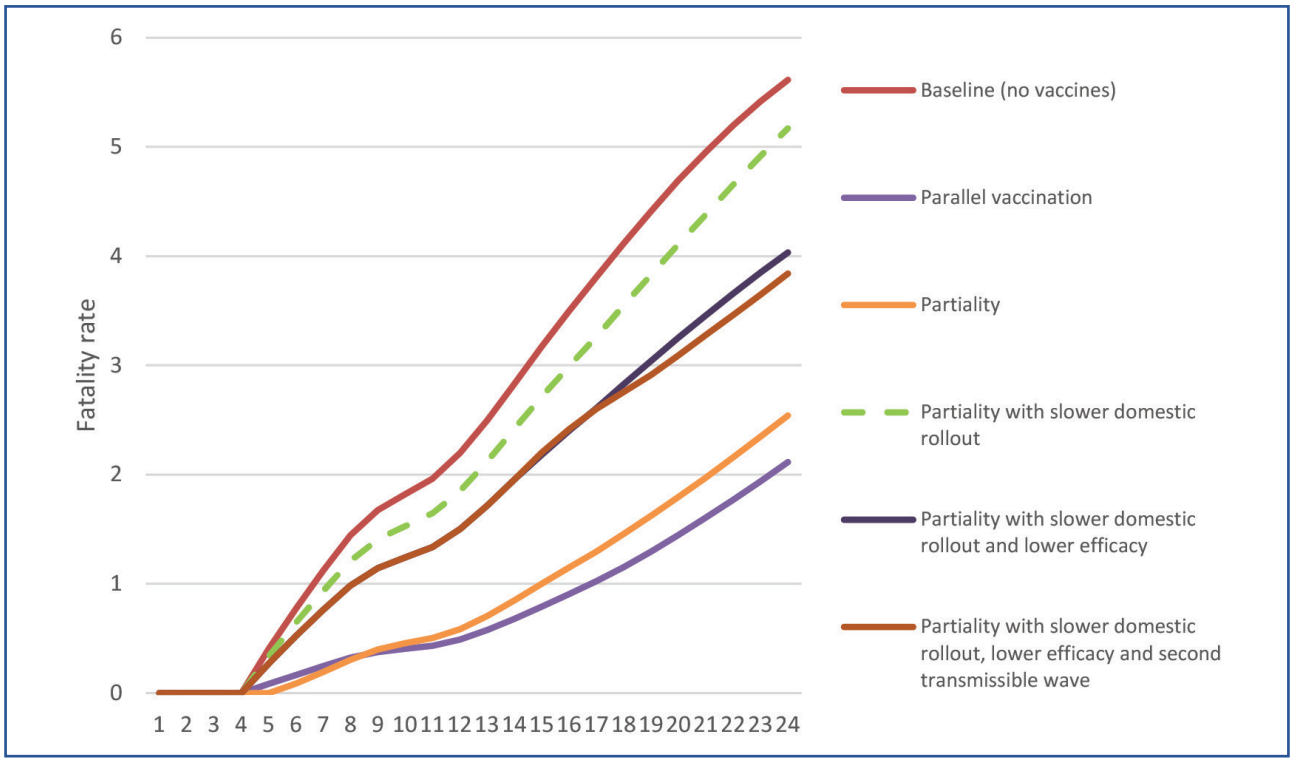


Figure 4.6: Path of Fatality Rate under Alternative Scenarios in LICs

Note: Fatality rate is the ratio between total death and total infected cases

Turning to the economic outcome of vaccination, **Figures 4.7** and **4.8** illustrate percentage of deviation from long-run equilibrium for employment measured in total hours worked and consumption, respectively. A comparison between "*Baseline*" and "*Parallel vaccination*" scenarios for both employment and consumption crystallize the strategic importance of vaccines in macroeconomic stabilization. Vaccine supports economic recovery through its ability to curb virus transmission via physical interaction, and therefore allowing removal of most if not all mobility restrictions and in the near term, allowing economic reopening and normalization at the earliest. Theoretically, recession curve will be flattened, and cyclical effects on the economy can be moderated.

What's perplexing at first sight is the relatively mild contraction in total hours worked as well as consumption for "*Partiality*" and "*Partiality with slow domestic rollout*" scenarios as if vaccine inequality is inconsequential to economic stabilization during the pandemic. Probing deeper into the underlying mechanism, one finds the economic consequence of mitigation measures. While LICs are still waiting for the supply of vaccines, exogenous virus transmission shock by model setting has started receding. As depicted in **Figure 4.4**, virus transmission in "*Partiality*" scenario is relatively low and flattened towards the end of period. This allows mitigation easing and economic reopening even before vaccination begins. On top of this, an earlier economic reopening in HICs also benefits LICs via trade linkage in investment and final goods.

Note also that when second wave of virus transmission hits LICs, as in the "*Partiality with slower domestic rollout, lower efficacy and second transmissible wave*" scenario, the authorities have to retighten the lockdown measures, pushing the economy towards the brink of economic hardship closer to that under the worst "*Baseline*" scenario, despite the fact that the path of vaccination under this scenario is identical to that under "*Partiality*", which shows a relatively mild contraction in employment and consumption.

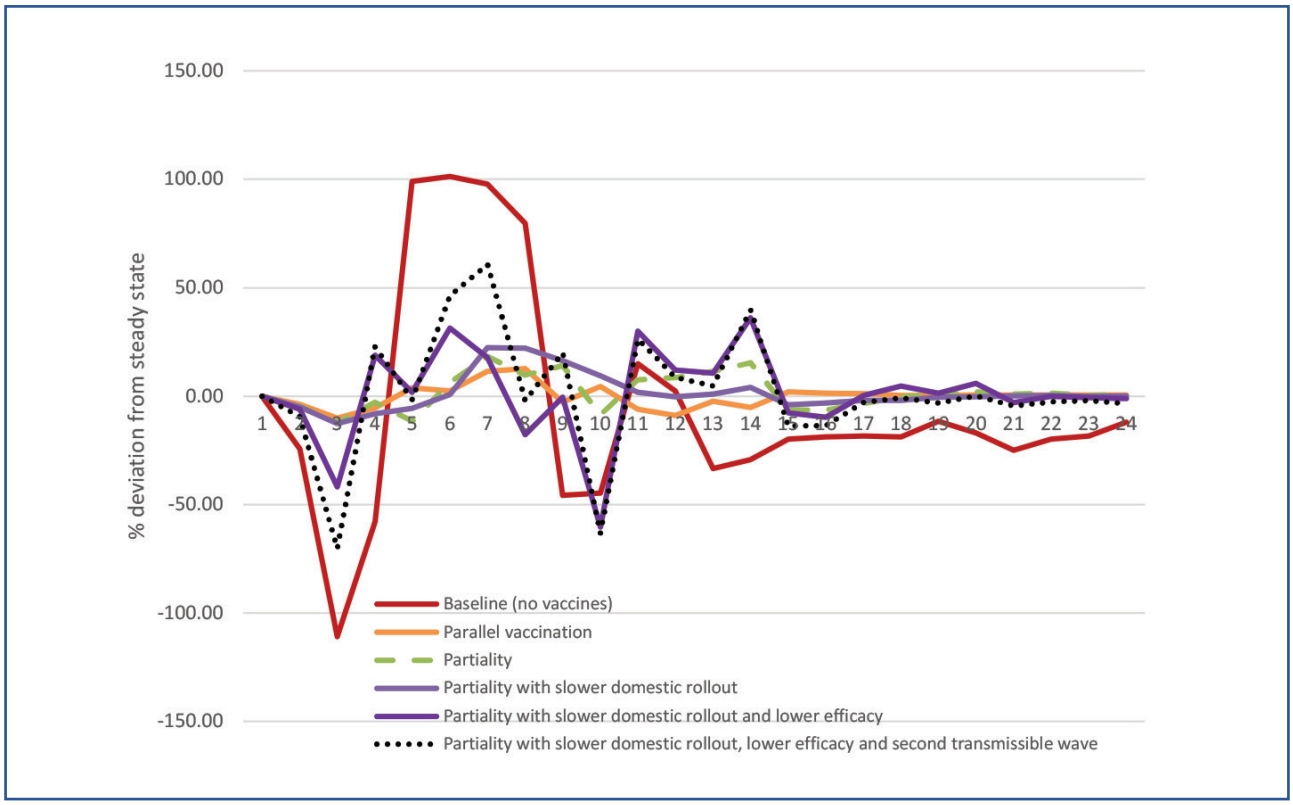


Figure 4.7: Dynamic Responses of Employment under Alternative Scenarios in LICs

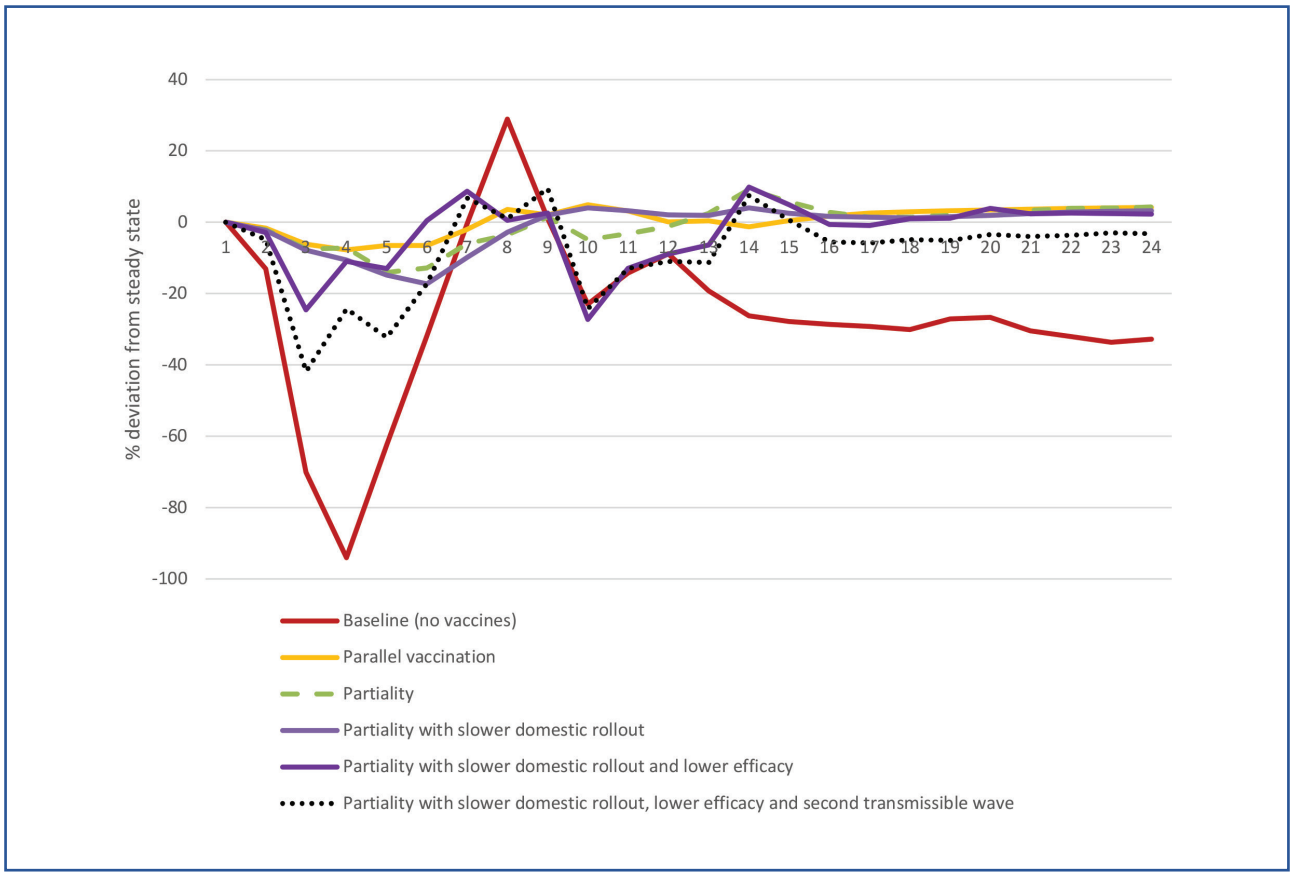


Figure 4.8: Dynamic Responses of Consumption under Alternative Scenarios in LICs

Key takeaways

1. Vaccine is the ultimate solution to effectively curb virus transmission and minimize ultimate health and economic damage from the pandemic.
2. Parallel vaccination offers the best health and economic outcomes, rates of infection, fatality, employment and consumption. Ensuring an earlier and parallel access for both HICs and LICs to vaccines in preparing for future pandemic should become a common policy goal.
3. Together, unequal access to health facilities, poor medical readiness, and weak state capacity in coordinating vaccination programme and mobilizing mass participation severely undermine global vaccination achievements. Effects from presence of both global vaccine inequality and domestic health inequality on a country are disastrous.
4. Nationwide mitigation strategy shapes the economic consequence of the pandemic and vaccination.

Chapter 5
Lessons for the Future

5.1 Methods or Algorithm of Prioritizing Access at International and National Levels

Priority setting is a necessary yet daunting task at international and national levels. It is challenging because it is a political decision in responses to population ethical judgement and practical need, which therefore is inevitably controversial. And yet it is necessary due to the limited financial and medical resources.

Prioritizing-access-to-vaccine exercises must be able to address the following aspects:

- Direct, which include death and permanent organ damage linked to the COVID-19, and indirect, which involves the loss of life of the uninfected due to the strain on the health care system, damage to health
- Devastated economy with escalating unemployment and rising poverty incidence

Each aspect apparently has different priority setting, and the trade-off is fundamentally in line with the people-centric fair allocation framework that strikes a balance between health and wealth as outlined in Section 3.3.

To minimize the loss of life directly and indirectly linked to the coronavirus, high-risk and vulnerable groups comprising essential workers and those with pre-existing medical conditions and aged 60 and above shall be prioritized. However, to minimize the spread of virus and stringency of non-pharmaceutical measures, vaccinating the community, workplace, and malls prone to contact-driven transmissions shall be prioritized, irrespective of age, pre-existing medical conditions, and profession.

In this respect, vaccine priority setting depends on the fatality and transmissivity of the coronavirus. The more transmissive a virus is, the greater will be the marginal benefit of mass vaccination regardless of medical and age factors. Likewise, the marginal benefit of prioritizing high-risk and vulnerable groups grows exponentially with increasing fatality. **Figure 5.1** depicts the principles of setting vaccine prioritization.

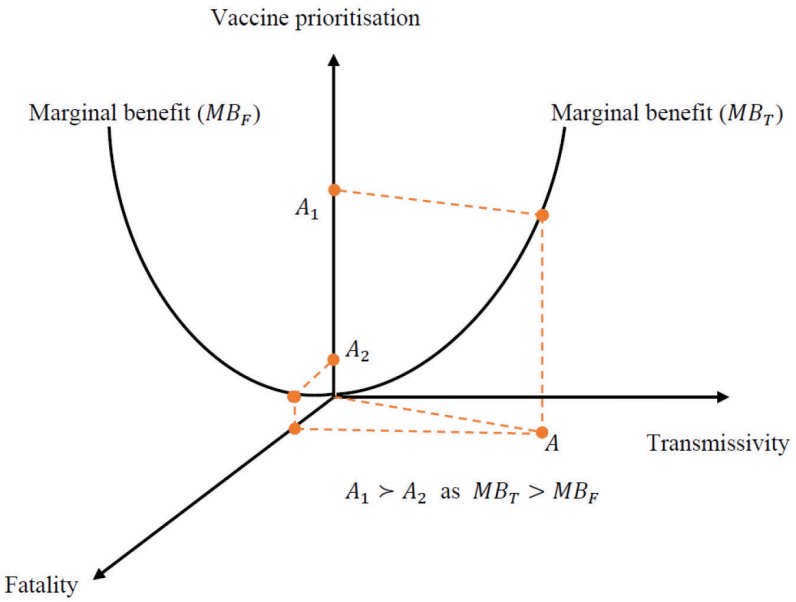


Figure 5.1: Principle of Vaccine Prioritization

For hypothetical circumstance with low fatality but high transmissivity, for instance, location-based vaccination programme that can cover the population as wide as possible is preferred to age-based programme. By the same token, it can be easily conjectured that to mitigate the harms incurred by a more lethal but less transmissive

virus, marginal benefit of risk-based, age-based vaccination strategy outweighs the location-based strategy. A lethal and highly transmissive virus requires a combination of both risk-based and location-based prioritization. **Figure 5.2** picturizes the implementational aspect of risk-based, location-based, and the hybrid vaccination prioritization.

Vaccine prioritization shall be agile and adaptable to the changing context in terms of the nature of the virus, economic performance, and social attitude towards mobility restriction and other mitigation effort like face-masking and social distancing outlined in **Figure 3.7**. However, this is not easy to do except at the margins–the administrative costs and the communication costs to the population could be high. Shifting from risk-based to location-based prioritization, for instance, may require sustained mitigation to advert substantial death (Agarwal et al., 2021).

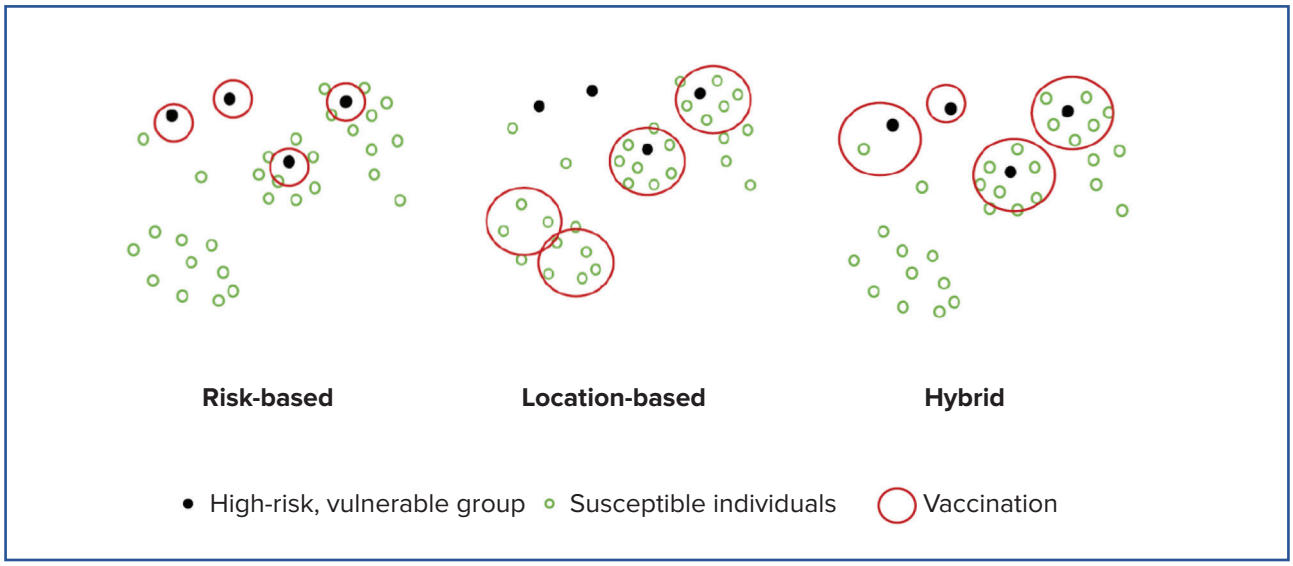


Figure 5.2: Risk-Based, Location-Based and the Hybrid Prioritizing Access

5.2 Intellectual Property Rights and Trade Agreements

The current shortage of vaccines that the less developed countries face can be overcome if some issues in IPR regime are revisited. Compulsory licensing and parallel imports have been longstanding issues in trade agreements and developing countries have made valiant attempts to relax these constraints. These provisions should be re-examined and the necessary amendments made (Bozorgmehr et al., 2021).

The 1994 WTO Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) has strengthened the laws regarding IPR the world over. By virtue of its reach, IPRs have been effectively upheld in countries throughout the world. The stranglehold of IPRs has long been debated and attempts have been made to relax its constraining effect over developing countries, particularly the lower-income countries. The low-income developing countries do not have the capacity to create vaccines and other pharmaceutical products to combat COVID-19 and its complications; neither can they afford the cost of these medicines and vaccines. This has placed the health of those in the low-income developing countries in a precarious position. There is an urgent necessity to revisit how the international community will re-look the position of IPRs.

Since developing countries have limited vaccine manufacturing capacities and are not able to produce sufficient amounts of vaccine to combat the vaccine, it has been proposed that there be a TRIPS Agreement waiver. This proposal has the support of the WHO and the United Nations General Assembly. Some WTO members oppose the TRIPS Agreement waiver, arguing that there are sufficient flexibilities to address emergencies such as the Covid pandemic. Article 31 (bis) of the TRIPS Agreement allows compulsory licenses for the export of pharmaceutical products in the event of unavailability in a country or if there is insufficient manufacturing capacity. This argument is opposed on the grounds that these flexibilities do not serve much purpose in the case of the Covid pandemic because the negotiations surrounding compulsory licensing are complex, time consuming, and costly.

The discussion on the waiver of the TRIPS agreement is delicate because to waive IPRs would disincentivize pharmaceutical companies from expanding on research (a necessary cost for product development and commercialization). Yet, not to relax IPRs would result in an increase in the pandemic claiming its toll in developing countries, increasing the risk of infection in other countries. A proposed alternative has been to encourage technology transfer to developing countries and to extend licensing of manufacturing-to-manufacturing companies in these countries. A noteworthy example of the latter is the licensing of AstraZeneca to the Serum Institute of India.

India and South Africa have urged that COVID vaccine patents be suspended, however the European Union has rejected the proposal stating that there is no evidence that IPRs hamper access to COVID-19-related medicines and technologies. The UK, too, has rejected the proposal citing the lack of justification that IPRs have acted as a barrier to accessing vaccines, treatments or technologies in containing and treating COVID-19. This places the poor in developing countries at a severe disadvantage and will see the loss of life among them. It is in recognition of the extraordinary circumstances of the pandemic that the US is supporting the patent waiver, in the interests of ending the pandemic, although the US doubtlessly believes in IPRs.

Wealthy countries have blocked access of medication to poor countries when HIV and AIDS was at its height. The same was the case in advertise2004 when the avian influenza H5N1 re-emerged. Considering the widespread impact of the pandemic, and taking into account that the poor in low-income countries are worst hit, a more humane policy is required if we are to be successful in closing the gap of access to vaccines and other medicines necessary for the treatment of COVID-19.

Access of vaccines, medicines, and technologies in dealing with COVID-19 are currently very limited for low-income countries–typically with large populations most vulnerable to the disease. Whereas high-income countries have access to vaccine doses far in excess of their populations as compared to that of low-income countries. High-income countries have also pre-booked a disproportionately high share of the global supply capacity of future vaccines, leaving the developing and least developed countries with a limited share.

Parallel imports involve the import and resales of patented products in a country without the consent of the patent holder. Parallel importation of a patented pharmaceutical product can be made from a country where it is sold at a lower price and brought into importing country, thereby allowing patients in the importing country to gain access to the product. Although the TRIPS Agreement does not prohibit parallel imports, developed countries are mostly not in favour of the arrangement. Compulsory licensing allows a government the right to issue a license to a private company or government agency without the patent holder's consent, although the latter will be compensated accordingly. However, developed countries have strongly pushed back on compulsory licenses.

In order to overcome the lack of access to drugs, equipment and technologies necessary to fight COVID-19, some of the clauses to the TRIPS Agreement should be reviewed. Article 31 makes it difficult to procure pharmaceutical products from a supplier because the bureaucratic process makes it time consuming and expensive for developing countries to import drugs. Greater flexibility in the regulations may help the poorer countries develop drugs and vaccines on their own, if that is at all possible for them.

5.3 Effective Communication Plan

Side effects are possible after receiving the COVID-19 vaccine, as they are with any drugs. However, these adverse effects are only temporary (24-48 hours), and severe side effects (such as allergic responses or blood clotting) are extremely uncommon. The truth is that the disease's risk much outweighs the COVID-19 vaccine's risk. According to recent research, the majority of people in Asia-Pacific countries understand the relevance of the COVID-19 vaccines and are willing to get vaccinated, as presented in **Table 5.1**.

Table 5.1: Potential Acceptance Rate of COVID-19 Vaccine in Asia-Pacific

	Wouters et al. (2021) Published in Lancet	Lazarus et al. (2021) Published in Nature
Country	**Potential Acceptance Rate**	**Potential Acceptance Rate**
Viet Nam	98%	-
India	91%	74.53%
China	91%	88.62%
Republic of Korea	87%	79.79%
Malaysia	86%	-
Indonesia	83%	-
Hong Kong SAR, China	74%	-
Japan	67%	-
Pakistan	56%	-
Singapore	-	67.94%

Source: 1) Wouters, O.J., Shadlen, K.C., Salcher-Konrad, M., Pollard, A.J., Larson, H.J., Teerawattananon, Y., and Jit, M. (2021). Challenges in ensuring global access to COVID-19 vaccines: production, affordability, allocation, and deployment. *The Lancet*. 2) Lazarus, J.V., Ratzan, S.C., Palayew, A., Gostin, L.O., Larson, H.J., Rabin, K., ... and El-Mohandes, A. (2020). A global survey of potential acceptance of a COVID-19 vaccine. *Nature Medicine*, 1-4.

Possible factors promoting acceptance towards the COVID-19 vaccine:

- It is convenient, free and easy
- They have confidence in the safety of the vaccine and trust in the system that delivers it
- Their healthcare professionals recommend it
- Role models, friends and family or others “like them” have been vaccinated
- People are reminded that their actions can foster community immunity and help others
- People recognize the risk from the disease and understand vaccination is an effective solution to that risk

Possible factors creating hesitancy towards the COVID-19 vaccine:

- Ideological reasons
- Safety concerns
- Misinformation
- Mistrust in the process of vaccine development
- Language barriers
- Many marginalized communities traditionally face obstacles and inequalities in healthcare; therefore, they may have collective negative past experiences with medical practice that affect current trust
- Some people wish to become free-riders, letting others have the vaccine while they receive the benefits of herd immunity
- Some young and healthy people believe they are not at risk from COVID-19

One of the points worth noting is the mistrust in COVID-19 vaccine due to the amount of time taken to develop it compared to previous vaccines. Public distrust of the research and science behind it–“if it is too fast, then it can’t be safe”–to some extent caused vaccine hesitancy. Aside from the vaccine-based issues, the interplay of local and national politics impacted the success of immunization programs; especially where trust in governments and the public health system are particularly already low.

Communication is one of the crucial elements to ensure success in the containment of the pandemic. Therefore, strategic planning must be in place to ensure the flow of information to the people and patients. Content, accuracy, comprehensive signs, symbols, language, culture, and semiotic rules were important in effective communication (Reddy and Gupta, 2020). Effective and consistent communication scheme in a broad sense, including advocacy, social and community mobilization, and information, education, and communication (IEC) can be viewed and implemented in phases as below:

1) **Before**: Target the prioritized groups and key influencers
    - Identify and respond to specific vaccine requirements of health care professionals, and provide clear pathways for timely and effective information transmission to support their vaccine confidence. They can then be the primary channels to reach the general public. Additionally, consider the messaging, materials, and training requirements for healthcare personnel to effectively tailor push and pull vaccination distribution techniques to target communities with access barriers and vaccine-hesitant populations.
    - Enrol the help of community and religious leaders, high-profile health experts, educators, social media influencers and celebrities with large following.
    - Establish partnerships with Civil Society Organizations (CSOs) serving marginalized and vulnerable groups that COVID-19 disproportionately impacts, such as migrants, refugees, and displaced persons, people in prisons and closed settings and people who use drugs. CSOs can also assist in reaching out to those that might be excluded due to the digital divide.
2) **During**: Identify the most effective and equitable communication channels
    - Optimize media channels to reach out to the general public.
    - To increase confidence, communicate openly with marginalized communities by presenting stories of people from those categories who were effectively vaccinated earlier.
    - Consider distributing targeted pamphlets and posters in public places where a target group frequently visits.
3) **After**: Monitor and evaluate communication
    - Use various methods such as knowledge, attitudes, and practices surveys, social media listening, media monitoring, and establishing a toll-free vaccine Q&A hotline to assess COVID-19 vaccine confidence in different population groups on a regular basis.
    - Identify skill and resource shortfalls and improve the ongoing communication plan, get feedback from key influencers, community and religious leaders, and civil society organizations.
    - Examine the disaggregated vaccination coverage data to discover and map communities with lower immunization rates.

5.4 Country Preparation Measures

Tracking the Virus and the Vaccine

The impact of the COVID-19 pandemic is wide-reaching and devastating; thus, countries need to have an adequate infrastructure to curb the pandemic and be better prepared in the future. The government will have to invest more, especially in public health facilities, transport and logistic. While the current cold chain is financed and operated by the government, expanding capacity to meet the needs of a vaccine program that would cover the entire population will necessitate the involvement of private players. The public-private partnership in terms of the logistic and transportation of vaccines could enhance the capacity and efficiency of vaccine distributions. As highlighted earlier, the available COVID-19 vaccines especially the mRNA are temperature- and time-sensitive. It must be kept at an ultra-cold temperature and must be given in timely manners. Planning and solution must be put in place for the vaccine to reach the poorer countries, hard-to-reach locations, or locations where the average daytime temperature is high, electricity unavailability, difficulty in transportation access, also countries or areas that is affected due to political and civil unrest (Ford and Schweik, January 5, 2021).

In addition to that, investment in digital infrastructure is also crucial to curb pandemics. Some countries have invested in contact-tracing technologies to enable people to have real-time data and accurate information with regards to the virus. Tracking applications provide information on the cases at the nearby radius quickly, detect potential spreader or high-risk locations, trace back the close contact and history of places that the patients have visited.

Tracking of inventory, delivery and administration of vaccines also require a sound database structure and capabilities. Identification of gaps between areas or exclusion of certain groups of the population could easily be traced, and necessary action can be put in place by the authority. A tracker for side effects and adverse events of vaccination should also be integrated with the system. Overall, digital infrastructure needs to be developed, strengthened, and upgraded to deal with the impacts of COVID-19. It is also for better preparedness for future crises.

Reducing Overlaps and Confusion

There must be a clear distinction between the national and local governments' functions and other arms in the local government and maintain cross-coordination and communication to ensure the resources go to where it needed the most (Rajadhyaksha, April 2021). District offices or local governments can work together with parliamentarians, youth, women or religious leaders to spread awareness of COVID-19 and the vaccination programme to the people, particularly those in remote areas or vulnerable groups.

5.5 Infrastructure to Support the Update of COVID-19 Vaccination Process

Domestic vaccine supply chain in many developing countries must be strengthened to efficiently procure, store and distribute the COVID-19 vaccines. The standard operating procedure must be in place, particularly with regards to the supply chain and cold chain management of the vaccines. This is to ensure that the logistic requirement is being met and enhance the capability to distribute the vaccine even to the most remote communities. The distribution mapping is vital in tracking the progress of the immunization programme.

Alongside the logistics facilities, countries should also have adequate human resources capacity in handling the supply chain throughout the process, and a medical waste management system appropriate to cope with increased demand for its services. Vaccine development and production are only the first steps towards achieving herd immunity; the challenges lie in vaccine distributions, especially on the last mile of delivery, especially for developing countries (Vesper, November 18, 2020) and tracking all of the processes throughout the supply chain.

5.6 Innovators, Manufacturers, and Other Key Stakeholders Should Take a Long-Term View of Investments

Uncertainty and informational asymmetries characterize the COVID-19 vaccine production chain. With heterogeneous probability of contracting the disease, and hence varying consumers' willingness to pay, vaccines as preventive measure is less profitable, leading to underinvestment in vaccine R&D (Kremer and Snyder, 2003; 2015).

The issue of underinvestment is further complicated by the fact that value chains of vaccine manufacturing is highly disintegrated. Pfizer production requires 280 inputs sourced from 86 suppliers over 19 countries, all to be put through a multistage production process, all of which requires extensive collaboration. The possibility that a nation would impose export ban on vaccine output during the emergency leads to too little subsidization of vaccine inputs (Brown and Bollyky, 2021).

There are several important approaches all the key stakeholders should take to prepare the world for next pandemic:

- Advanced Market Commitments (AMCs) that commit to a subsidy policy over a pool of potential vaccine developments help address the hold-up and underinvestment problem, besides insure against the R&D risk. It worked for pneumococcus conjugate vaccine, and it is working for SARS-CoV-2 vaccine. Without AMCs, the pharma companies may not serve low-income countries at all. Solidifying the financing mechanism of AMCs, which includes the creation of vaccine bonds, is critical for a more equitable global distribution of vaccines in the future.
- Preparing the country for the next pandemic is a mission in which policymakers must participate. Positive externalities of vaccines are simply too large to be left to private companies that will inevitably end with underinvestment in vaccines. It needs massive amount of government subsidy (Goodkin-Gold et al., 2020). And the subsidy can be utilized to encourage "pre-emptive collaboration", in Monrad et al.'s (2021) term, between different companies to pool expertise for future breakthroughs and knowledge spill-overs, to expand vaccine R&D capacity among public agencies and universities, and to directly fund manufacturing capacity (Ahuja et al., 2021).

- Creating a multilateral cooperation platform along the supply chains of vaccines to coordinate global production and distribution of vaccines among the participating countries to minimize the hold-up problem at global level due to export restriction of vaccine input and output. Together with COVAX, it shall be an important step moving towards achieving a global consensus on an equitable global distribution of vaccines before the next pandemic strike.

5.7 Vaccines for All – Leave No One Behind

The positive impact of vaccination programmes is not limited to reducing morbidity and mortality per se but also positively contributed to the economic and social effects (Rodrigues and Plotkin, 2020). One of the crucial strategic objectives of the vaccination programme is fair allocation for all countries. Whereas countries' national vaccination strategy should prioritize inclusivity, which is translated into the plan of actions in distributing and allocating vaccines to all, including the vulnerable population. It is crucial to ensure that no one is left behind. The exclusion of certain groups of people from the vaccination plan would undermine the public interest and public health goal of ending the pandemic.

It is crucial to remove the barriers of vaccine production and accelerate the distribution, especially with the emergence of the new strains of COVID-19. The COVID-19 pandemic is still raging, and the discovery of new mutant strains raises huge concern worldwide. This is because the new strains are associated with a higher transmissibility rate, severe infections, and a higher risk of death. For instance, South Africa B.1.351 and UK B.1.1.7 are associated with a greater transmission rate (Darby, and Hiscox, 2021). Thus, vaccine uptake and herd immunity are important in controlling the spread of the virus by maintaining a low number of cases and preventing the spread of new strains that are more transmissible and resulting in severe infections.

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