VACCINATING SOUTH ASIA: SAEF SPECIAL CHAPTER

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Carlos Alberto Lara Oliveros, DECHD | Nayantara Sarma, SARCE | Satej Soman, University of Chicago

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THIS PRESENTATION DOES NOT REFLECT FINAL DATA. CHECK THE LATEST REPORT FOR AN UPDATED INFORMATION.
SOUTH ASIA VACCINATES AGAINST COVID-19

The COVID-19 pandemic has been an unprecedented shock to the global economy, has exacerbated inequalities and has been a dramatic setback towards eradicating poverty;

Therefore, vaccination is a key development priority; unlike other policy measures, such as lockdowns, vaccines save lives and livelihoods.

However, vaccinating at the scale and speed required to end the pandemic is a daunting task never attempted before. This presentation highlights:

- Vaccination has a high benefit/cost ratios;
- Having features of a public good, herd immunity by vaccination requires government intervention and its financing, while high, seems ‘feasible’;
- However, financing is one of the challenges; allocation of the vaccine, at least in the short run, presents trade-offs between equity and efficiency;
- And delivering the vaccines – given the current preparedness of the health systems and potential vaccine hesitancy – is an additional key obstacle;
- It is especially important to ensure that vaccines are reaching all those eligible, not just those with the privilege and resources to obtain them.
Introduction: The COVID-19 Pandemic in South Asia

Economics of COVID-19 Vaccine Development and Production

Benefit-Cost Analysis

Preparedness of the Health Systems and Equity Issues

Vaccine Allocation in Theory and in Practice

Health Systems and Vaccine Distribution
01. INTRODUCTION: THE PANDEMIC IN SOUTH ASIA
COVID-19 IN SAR: A REGION HEAVILY AFFECTED

Cases peaked in many countries in Jun-Sep and then fell sharply; some trying to contain widespread outbreaks (Bhutan, Sri Lanka); death rates relatively low, likely due to young population.

...most COVID-19 deaths (>50%) are concentrated in just four countries: USA, Brazil, India, and Mexico.
Most cases among young, most deaths among elderly

Incidence of cases highest among those 20-40 years of age; this is largely driven by population structure.

Case fatality rates vary widely in part due to reporting issues; hard to discern true infection fatality rate.

Incidence of deaths highest among those 60+ years of age, as seen elsewhere in the world.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total cases</th>
<th>Cases per million</th>
<th>Total deaths</th>
<th>Deaths per million</th>
<th>Case fatality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>53,489</td>
<td>1,374</td>
<td>2,277</td>
<td>58</td>
<td>4.3%</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>522,453</td>
<td>3,172</td>
<td>7,781</td>
<td>47</td>
<td>1.5%</td>
</tr>
<tr>
<td>Bhutan</td>
<td>813</td>
<td>1,054</td>
<td>1</td>
<td>1</td>
<td>0.1%</td>
</tr>
<tr>
<td>India</td>
<td>10,466,595</td>
<td>7,584</td>
<td>151,160</td>
<td>110</td>
<td>1.4%</td>
</tr>
<tr>
<td>Maldives</td>
<td>14,109</td>
<td>26,102</td>
<td>49</td>
<td>91</td>
<td>0.3%</td>
</tr>
<tr>
<td>Nepal</td>
<td>264,780</td>
<td>9,087</td>
<td>1,917</td>
<td>66</td>
<td>0.7%</td>
</tr>
<tr>
<td>Pakistan</td>
<td>504,293</td>
<td>2,283</td>
<td>10,676</td>
<td>48</td>
<td>2.1%</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>48,380</td>
<td>9,259</td>
<td>232</td>
<td>11</td>
<td>0.5%</td>
</tr>
<tr>
<td>SAR</td>
<td>11,874,912</td>
<td>6,614</td>
<td>174,093</td>
<td>54</td>
<td>1.5%</td>
</tr>
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</table>
SAR countries are relatively young; Afghanistan has the lowest and Sri Lanka has the highest share of population over age 50.
PREVALENCE OF MOST RISK FACTORS CORRELATED WITH AGE

... meaning that vaccine prioritization by age will also largely mirror prioritization by health risk factors
02. ECONOMICS OF VACCINE DEVELOPMENT AND PRODUCTION
Developing vaccines quickly was an extraordinary achievement.

TYPICAL VACCINE TIMELINE IS 3-4 YEARS

Why so extraordinary? Market failures:
- In the absence of intervention, market failures will delay broad availability of a COVID-19 vaccine.
- Vaccines typically take 5-15 years to develop (Plotkin et al. 2017).
- The timeline to vaccine access is often even longer for developing countries.
- For example, in the case of the Rotavirus vaccine, it took 11 years for vaccination rates in Gavi-eligible countries to catch up to the global average.
Market Failures Cont.

Social value >> private value

• **First**, vaccination has significant health and economic externalities, so market prices and firm profits are unlikely to reflect vaccines’ full social value. For this reason, governments rather than individuals purchase vaccines.

• **Second**, political and/or public pressures may limit vaccine prices, reducing the incentives for firms to make investments in expanding manufacturing capacity.

• **Third**, firms lack incentives to install capacity early enough or at large enough scale—which could result in significant delays in the development, production, and delivery of successful COVID-19 vaccines. Since firms do not recover the full social value of faster or larger capacity installation, it is optimal for governments to make these investments, but as noted, governments may also introduce pressures that constrain prices.

• Installing large capacity may put downward pressure on prices in high-income countries.
Potential market-based policies to address market failures

- **Advance Market Commitments**
  AMCs incentivize development and distribution of vaccines by providing a market-based incentive to produce a vaccine. The agreements promise a relatively high price per dose for a limited number of doses once the vaccine is developed, creating a market return comparable to that of blockbuster drugs for developing a vaccine. AMCs have previously been successfully used in the case of pneumococcal disease to advance development and availability of vaccines.

- **Patent buyouts or patent pools**
  Another option is to purchase patents at their market value from companies once the vaccine is developed. However, some limitations of this include that companies may be reluctant to share intellectual property that cuts across classes of vaccines, and also that there could be limited transferability of technology across firms due to know-how embodied in firms’ production lines that is difficult to transfer.

- **Prizes**
Multilateral efforts to solve market failures

Gavi’s COVAX AMC and facility

- Gavi’s COVAX AMC and facility is intended to ensure faster delivery and equitable access to COVID vaccines.
- All South Asian countries are anticipated to participate in COVAX.
- For so-called AMC 92 countries, vaccines will be subsidized by ODA and free up to the point of delivery at national airports.
- For so-called self-pay countries, prices will be as negotiated by the COVAX facility (anticipated to be less than $10 per dose on average).
- In both cases, distribution costs are to be covered by countries.

World Bank’s Additional Financing for vaccines

- Bangladesh ($500 million), Afghanistan ($110 million) and Nepal ($75 million) IDA heading to Board in March 2021.
CURRENT STATUS OF VACCINE DEVELOPMENT AND APPROVAL

Globally, several vaccines have received at least emergency use authorization for use in various countries (Pfizer, Moderna, AstraZeneca, Bharat Biotech, Sinovac, Sputnik)

• India has approved AstraZeneca/Serum Institute vaccine and Bharat Biotech vaccine, notably without results of phase 3 trials for the latter
• Bangladesh, Pakistan, Sri Lanka have approved AstraZeneca vaccine
• Bhutan, Maldives have received doses of Covishield (AstraZeneca vaccine produced by India’s Serum Institute) – presumably approved for emergency use
• Pakistan reportedly close to approving Sputnik vaccine
Currently two Indian companies with approved vaccine production
  • Serum Institute (Covishield, AstraZeneca vaccine)
  • Bharat Biotech (Covaxin)

Early concerns about nationalization of production, but new commitment to vaccine diplomacy and supply the region/world
  • Serum Institute’s CEO had tweeted that exports would be banned
  • However, India has started exports to Brazil/Morocco as well as sending shipments to regional neighbors such as Bhutan, Maldives, Sri Lanka
03. BENEFIT-COST ANALYSIS
Vaccines are a cost-effective investment for South Asia

• Benefit-cost analysis for if vaccines had been available immediately

• Benefit-cost analysis for current scenario
Table 1: $3 per dose vaccine cost scenario (beyond COVAX initial coverage) – if vaccines had been available at the beginning of the pandemic

<table>
<thead>
<tr>
<th>Populaton (m)</th>
<th>GDP ($ bn)</th>
<th>2020 % loss</th>
<th>2021 % loss</th>
<th>Total % loss</th>
<th>Total loss ($ bn)</th>
<th>Monthly loss ($ bn)</th>
<th>20% vaccination benefits</th>
<th>20% ($ bn)</th>
<th>B/C Ratio</th>
<th>Cost of vaccinating</th>
<th>Benefit difference</th>
<th>20% -&gt; 50% Vaccination</th>
<th>Cost of vaccinating</th>
<th>B/C Ratio</th>
<th>50% -&gt; 70% Vaccination</th>
<th>Benefit difference</th>
<th>Cost of vaccinating</th>
<th>B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>38.04</td>
<td>19.29</td>
<td>8.50%</td>
<td>1.00%</td>
<td>18.00%</td>
<td>3.4724</td>
<td>0.1447</td>
<td>0.78</td>
<td>0.044</td>
<td>17.75</td>
<td>0.63</td>
<td>0.14</td>
<td>4.49</td>
<td>0.33</td>
<td>0.09</td>
<td>3.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>163.05</td>
<td>302.57</td>
<td>5.20%</td>
<td>5.70%</td>
<td>16.10%</td>
<td>48.7139</td>
<td>2.0297</td>
<td>10.96</td>
<td>0.189</td>
<td>58.09</td>
<td>8.77</td>
<td>0.60</td>
<td>14.68</td>
<td>4.63</td>
<td>0.40</td>
<td>11.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.76</td>
<td>2.53</td>
<td>4.90%</td>
<td>8.30%</td>
<td>18.10%</td>
<td>0.4580</td>
<td>0.0191</td>
<td>0.10</td>
<td>0.001</td>
<td>116.71</td>
<td>0.08</td>
<td>0.00</td>
<td>29.50</td>
<td>0.04</td>
<td>0.00</td>
<td>23.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>1,366.42</td>
<td>2,868.93</td>
<td>15.40%</td>
<td>31.50%</td>
<td>48.90%</td>
<td>903.7130</td>
<td>37.6547</td>
<td>203.34</td>
<td>1.581</td>
<td>128.59</td>
<td>162.67</td>
<td>5.01</td>
<td>32.50</td>
<td>85.85</td>
<td>3.34</td>
<td>25.73</td>
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<td>Maldives</td>
<td>0.53</td>
<td>5.64</td>
<td>27.00%</td>
<td>-3.90%</td>
<td>50.10%</td>
<td>2.8267</td>
<td>0.1178</td>
<td>0.64</td>
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<td>1035.15</td>
<td>0.51</td>
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<td>Nepal</td>
<td>28.61</td>
<td>30.64</td>
<td>6.20%</td>
<td>5.90%</td>
<td>18.30%</td>
<td>5.6074</td>
<td>0.2336</td>
<td>1.26</td>
<td>0.033</td>
<td>38.11</td>
<td>1.01</td>
<td>0.10</td>
<td>9.63</td>
<td>0.53</td>
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<tr>
<td>Pakistan</td>
<td>216.57</td>
<td>278.22</td>
<td>3.90%</td>
<td>2.50%</td>
<td>10.30%</td>
<td>28.6569</td>
<td>1.1940</td>
<td>6.45</td>
<td>0.251</td>
<td>25.73</td>
<td>5.16</td>
<td>0.79</td>
<td>6.50</td>
<td>2.72</td>
<td>0.53</td>
<td>5.15</td>
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<tr>
<td>Sri Lanka</td>
<td>21.80</td>
<td>84.01</td>
<td>10.00%</td>
<td>0.40%</td>
<td>20.40%</td>
<td>17.1378</td>
<td>0.7141</td>
<td>3.86</td>
<td>0.025</td>
<td>152.83</td>
<td>3.08</td>
<td>0.08</td>
<td>38.63</td>
<td>1.63</td>
<td>0.05</td>
<td>30.58</td>
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Table 2: $7 per dose vaccine cost scenario (beyond COVAX initial coverage) – if vaccines had been available at the beginning of the pandemic

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (m)</th>
<th>GDP ($ bn)</th>
<th>2020 % loss</th>
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<td>0.4580</td>
<td>0.0191</td>
<td>0.10</td>
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<td>0.1178</td>
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<td>0.2336</td>
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<td>0.033</td>
<td>38.11</td>
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Covax (up to 20 percent)
<table>
<thead>
<tr>
<th>Country</th>
<th>Population (m)</th>
<th>GDP ($ bn)</th>
<th>2020 % loss</th>
<th>2021 % loss</th>
<th>2022 % loss</th>
<th>Total % loss 2022</th>
<th>Monthly loss ($ bn)</th>
<th>Covax (up to 20 percent)</th>
<th>Benefit difference 20% -&gt; 50%</th>
<th>Cost of vaccinating 20% ($ bn)</th>
<th>B/C Ratio</th>
<th>Benefit difference 50% -&gt; 70%</th>
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<tbody>
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<td>Afghanistan</td>
<td>38.04</td>
<td>19.29</td>
<td>8.50%</td>
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<td>-1.10%</td>
<td>8.40%</td>
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<td>5.70%</td>
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<td>8.90%</td>
<td>26.9288</td>
<td>6.06</td>
<td>6.18</td>
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<td>32.11</td>
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<td>4.90%</td>
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<td>11.60%</td>
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<td>-2.70%</td>
<td>13.40%</td>
<td>384.4366</td>
<td>86.50</td>
<td>69.20</td>
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<td>21.20%</td>
<td>1.1961</td>
<td>0.27</td>
<td>0.22</td>
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<td>109.13</td>
<td>0.11</td>
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<td>86.40</td>
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<td>30.64</td>
<td>6.20%</td>
<td>5.90%</td>
<td>0.20%</td>
<td>12.30%</td>
<td>3.7689</td>
<td>0.85</td>
<td>0.68</td>
<td>0.11</td>
<td>6.38</td>
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<td>0.40%</td>
<td>6.80%</td>
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<td>10.00%</td>
<td>0.40%</td>
<td>1.60%</td>
<td>12.00%</td>
<td>10.0811</td>
<td>2.27</td>
<td>1.81</td>
<td>0.08</td>
<td>22.40</td>
<td>0.96</td>
<td>0.05</td>
<td>17.73</td>
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</table>

Table 3: $3 per dose vaccine cost scenario (beyond COVAX initial coverage) – current scenario
<table>
<thead>
<tr>
<th>Country</th>
<th>Population (m)</th>
<th>GDP ($ bn)</th>
<th>2020 % loss</th>
<th>2021 % loss</th>
<th>2022 % loss</th>
<th>Total % loss 2022</th>
<th>Total loss ($ bn)</th>
<th>Monthly loss ($ bn)</th>
<th>20% vaccination benefits</th>
<th>Cost of vaccinating 20% ($ bn)</th>
<th>B/C Ratio</th>
<th>20% -&gt; 50% Vaccination</th>
<th>Benefit difference</th>
<th>Cost of vaccinating 50% ($ bn)</th>
<th>B/C Ratio</th>
<th>50% -&gt; 70% Vaccination</th>
<th>Benefit difference</th>
<th>Cost of vaccinating 70% ($ bn)</th>
<th>B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>38.04</td>
<td>19.29</td>
<td>8.50%</td>
<td>1.00%</td>
<td>-1.10%</td>
<td>8.40%</td>
<td>1.6205</td>
<td>0.06752</td>
<td>0.36</td>
<td>0.044</td>
<td>8.28</td>
<td>0.29</td>
<td>0.24</td>
<td>1.22</td>
<td></td>
<td>0.15</td>
<td>0.16</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>163.05</td>
<td>302.57</td>
<td>5.20%</td>
<td>5.70%</td>
<td>-2.00%</td>
<td>8.90%</td>
<td>26.9288</td>
<td>1.12203</td>
<td>6.06</td>
<td>0.189</td>
<td>32.11</td>
<td>4.85</td>
<td>1.03</td>
<td>4.72</td>
<td>2.56</td>
<td>0.69</td>
<td>3.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.76</td>
<td>2.53</td>
<td>4.90%</td>
<td>8.30%</td>
<td>-1.60%</td>
<td>11.60%</td>
<td>0.2935</td>
<td>0.01223</td>
<td>0.07</td>
<td>0.001</td>
<td>74.79</td>
<td>0.05</td>
<td>0.00</td>
<td>10.99</td>
<td>0.03</td>
<td>0.00</td>
<td>8.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>1,366.42</td>
<td>2,868.93</td>
<td>15.40%</td>
<td>0.70%</td>
<td>-2.70%</td>
<td>13.40%</td>
<td>384.4366</td>
<td>16.0182</td>
<td>86.50</td>
<td>1.581</td>
<td>54.70</td>
<td>69.20</td>
<td>8.61</td>
<td>8.03</td>
<td>36.52</td>
<td>5.74</td>
<td>6.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maldives</td>
<td>0.53</td>
<td>5.64</td>
<td>27.00%</td>
<td>-3.90%</td>
<td>-1.90%</td>
<td>21.20%</td>
<td>1.1961</td>
<td>0.04984</td>
<td>0.27</td>
<td>0.001</td>
<td>438.03</td>
<td>0.22</td>
<td>0.00</td>
<td>64.34</td>
<td>0.11</td>
<td>0.00</td>
<td>50.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nepal</td>
<td>28.61</td>
<td>30.64</td>
<td>6.20%</td>
<td>5.90%</td>
<td>0.20%</td>
<td>12.30%</td>
<td>3.7689</td>
<td>0.15704</td>
<td>0.85</td>
<td>0.033</td>
<td>25.61</td>
<td>0.68</td>
<td>0.18</td>
<td>3.76</td>
<td>0.36</td>
<td>0.12</td>
<td>2.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pakistan</td>
<td>216.57</td>
<td>278.22</td>
<td>3.90%</td>
<td>2.50%</td>
<td>0.40%</td>
<td>6.80%</td>
<td>18.9191</td>
<td>0.7883</td>
<td>4.26</td>
<td>0.251</td>
<td>16.99</td>
<td>3.41</td>
<td>1.37</td>
<td>2.49</td>
<td>1.80</td>
<td>0.91</td>
<td>1.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>21.80</td>
<td>84.01</td>
<td>10.00%</td>
<td>0.40%</td>
<td>1.60%</td>
<td>12.00%</td>
<td>10.0811</td>
<td>0.42004</td>
<td>2.27</td>
<td>0.025</td>
<td>89.90</td>
<td>1.81</td>
<td>0.14</td>
<td>13.20</td>
<td>0.96</td>
<td>0.09</td>
<td>10.45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
04. HEALTH FINANCING & HEALTH SYSTEMS CONSIDERATIONS
Assumes cost of vaccine per person is US$19.27 across all countries:

- $1.66 per dose (Domestic distribution cost, UNICEF working group)
- $0.89 per dose (International transport)
- $7 per dose (GAVI estimate)

A constant 10% wastage rate is also assumed.

Assumes 20% coverage from COVAX in 2021 and 50% self-financed by countries (10% in 2021 and 40% in 2022) to reach the target 70% herd immunity.
Scenario 1:
Percent of government spending on vaccines in contrast to other sectors, associated with 20% coverage from COVAX and 50% self-financing by countries (10% in 2021, 40% in 2022), assuming $19.27 per vaccinated person for all countries in SAR
### Scenario 1: Country-Specific

Coverage, costs, budget share, and GDP share associated with 20% coverage from COVAX and 50% self-financing by countries (10% in 2021, 40% in 2022), assuming $19.27 per vaccinated person, by SAR country.

<table>
<thead>
<tr>
<th>Country</th>
<th>Coverage (millions)</th>
<th>Vaccine cost ($millions)</th>
<th>Share health (%)</th>
<th>Share budget (%)</th>
<th>Share GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>11.7</td>
<td>15.9</td>
<td>110.2</td>
<td>334.7</td>
<td>43.8</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>51.0</td>
<td>68.7</td>
<td>481.5</td>
<td>1,444.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.2</td>
<td>0.3</td>
<td>2.2</td>
<td>6.5</td>
<td>3.0</td>
</tr>
<tr>
<td>India</td>
<td>418.7</td>
<td>563.8</td>
<td>3,951.4</td>
<td>11,845.9</td>
<td>13.6</td>
</tr>
<tr>
<td>Maldives</td>
<td>0.1</td>
<td>0.2</td>
<td>1.1</td>
<td>3.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Nepal</td>
<td>8.8</td>
<td>11.8</td>
<td>82.7</td>
<td>248.6</td>
<td>15.1</td>
</tr>
<tr>
<td>Pakistan</td>
<td>63.7</td>
<td>86.6</td>
<td>601.6</td>
<td>1,819.2</td>
<td>18.0</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>6.6</td>
<td>8.9</td>
<td>62.5</td>
<td>186.6</td>
<td>4.4</td>
</tr>
<tr>
<td>SAR ave.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.8</td>
</tr>
</tbody>
</table>

- Vaccine-related costs relatively low in 2021, averaging only 0.7% of government budgets across the region (0.18% of GDP), since only delivery-related costs would need to be financed for two-thirds of the total coverage in 2021.

- Estimated costs in 2022 exceed 2% of government budget in Afghanistan (5.7%), Pakistan (2.7%), Bangladesh (2.5%), and Nepal (2.2%), which is likely to be difficult for governments to cover.
A constant 10% wastage rate is again assumed.

Assumes 20% coverage from COVAX in 2021, 50% self-financed by countries (10% in 2021 and 40% in 2022) to reach the target 70% for herd immunity.
Scenario 2:
Percent of government spending on vaccines in contrast to other sectors, associated with 20% coverage from COVAX and 50% self-financing (10% in 2021, 40% in 2022), assuming country-specific costs for all countries in SAR.
SCENARIO 2: COUNTRY-SPECIFIC

20% coverage from COVAX and 10% self-financed in 2021, 40% self-financed by countries in 2022, assuming country-specific costs, by country in SAR

<table>
<thead>
<tr>
<th>Country</th>
<th>Coverage (millions)</th>
<th>Vaccine cost ($millions)</th>
<th>Share health (%)</th>
<th>Share budget (%)</th>
<th>Share GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>11.7</td>
<td>15.9</td>
<td>84.5</td>
<td>229.6</td>
<td>33.6</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>51.0</td>
<td>68.7</td>
<td>369.3</td>
<td>990.4</td>
<td>21.7</td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.2</td>
<td>0.3</td>
<td>0.8</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>India</td>
<td>418.7</td>
<td>563.8</td>
<td>2,450.1</td>
<td>5,780.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Maldives</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>2.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Nepal</td>
<td>8.8</td>
<td>11.8</td>
<td>63.4</td>
<td>170.5</td>
<td>11.6</td>
</tr>
<tr>
<td>Pakistan</td>
<td>63.7</td>
<td>86.6</td>
<td>601.6</td>
<td>1,819.2</td>
<td>18.0</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>6.6</td>
<td>8.9</td>
<td>47.9</td>
<td>128.0</td>
<td>3.4</td>
</tr>
<tr>
<td>SAR ave.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.2</td>
</tr>
</tbody>
</table>

- Estimated costs in 2022 exceed 3% of government budget in Afghanistan (3.9%), which is likely to be difficult for the government to cover.
- For all countries, cost is less than the total health budget in both 2021 and 2022.
- Notably lower than Scenario I (pessimistic), but costs remain high for some countries - likely to still need to mobilize additional financing.
Assumes 20% coverage from COVAX in 2021, 50% self-financed by countries (10% in 2021 and 40% in 2022) to reach the target 70% for herd immunity.

Assumes vaccine costs can be negotiated down to a maximum of $3 per dose (plus international and domestic transport costs = total $11.10 per vaccinated person), mirroring the vaccine costs in India:

**Scenario 1**
- Afghanistan: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Bangladesh: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Bhutan: Domestic distribution costs only (100% coverage from Indian government gift)
- Maldives: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Nepal: $3 per dose + domestic distribution costs only (after 20% COVAX coverage)
- India: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Sri Lanka: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Pakistan: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)

**Scenario 2**
- Afghanistan: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Bangladesh: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Bhutan: Domestic distribution costs only (100% coverage from Indian government gift)
- Maldives: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Nepal: $3 per dose + domestic distribution costs only (after 20% COVAX coverage)
- India: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Sri Lanka: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Pakistan: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)

**Scenario 3: "Optimist" costs and "realistic" coverage in 2021**
- Afghanistan: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Bangladesh: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Bhutan: Domestic distribution costs only (100% coverage from Indian government gift)
- Maldives: $3 per dose + international and domestic distribution costs (after 20% COVAX + 10% Indian government gift coverage)
- Nepal: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- India: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Sri Lanka: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)
- Pakistan: $3 per dose + international and domestic distribution costs (after 20% COVAX coverage)

A constant 10% wastage rate is likewise assumed.
Scenario 3:
Percent of government spending on vaccines in contrast to other sectors, associated with 10% self-financing in 2021 and 40% self-financing in 2022, assuming vaccine costs are negotiated down to no more than $11.10 per vaccinated person, for all countries in SAR.
SCENARIO 3: COUNTRY-SPECIFIC

20% coverage from COVAX and 10% self-financed in 2021, 40% self-financed by countries in 2022, assuming vaccine costs are negotiated down to no more than $11.10 per vaccinated person, by country in SAR.

- Reasonably affordable (~0.5% of budget in 2021, ~1.1% in 2022)
- Demonstrates impact of negotiating price down to Serum level
- However, still potentially unaffordable for Afghanistan (3.3%) in 2022 – only country with cost exceeding 3% of budget

<table>
<thead>
<tr>
<th>Country</th>
<th>Coverage (millions)</th>
<th>Vaccine cost ($millions)</th>
<th>Share health (%)</th>
<th>Share budget (%)</th>
<th>Share GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>11.7</td>
<td>15.9</td>
<td>76.0</td>
<td>194.5</td>
<td>30.2</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>51.0</td>
<td>68.7</td>
<td>331.8</td>
<td>839.2</td>
<td>19.5</td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.2</td>
<td>0.3</td>
<td>0.8</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>India</td>
<td>418.7</td>
<td>563.8</td>
<td>2,450.1</td>
<td>5,780.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Maldives</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>1.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Nepal</td>
<td>8.8</td>
<td>11.8</td>
<td>57.0</td>
<td>144.5</td>
<td>10.4</td>
</tr>
<tr>
<td>Pakistan</td>
<td>63.7</td>
<td>86.6</td>
<td>414.6</td>
<td>1,057.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>6.6</td>
<td>8.9</td>
<td>43.1</td>
<td>108.5</td>
<td>3.0</td>
</tr>
<tr>
<td>SAR ave.</td>
<td>10.6</td>
<td>24.9</td>
<td>10.6</td>
<td>24.9</td>
<td>5.1</td>
</tr>
</tbody>
</table>
05. VACCINE ALLOCATION IN SOUTH ASIA
New SARS-CoV-2 vaccines developed in record time

In order for vaccination scheme to be effective, a significant percentage of the population needs to be vaccinated

Large-scale vaccination hampered by constraints:
- Limited number of doses
- Limited distribution capacity

Prioritization + distribution plans required to make the most effective use of vaccine stock
DISCUSSION OF VACCINE POLICY OBJECTIVES

• Vaccines save lives and livelihoods → two types of benefit: health and economic
  Natural immunity of recovered patients means their health value of vaccination is lower, but they experience economic benefits from a vaccination program.

• Maximizing these health and economic benefits in aggregate may not be the only objective;
  - Vaccination plans must be cognizant of ethical, political, and social concerns when making equity and efficiency trade-off decisions.
  - Here we describe a positive analysis, not policy recommendations (normative analyses).

• Determining effect of vaccination requires defining an alternative public health policy whose effects are compared to that of vaccination (counterfactual choice; some restrictions, voluntary or mandated, of the transmission of the virus).
DEVELOPING A VACCINATION ALLOCATION STRATEGY

1. Define subpopulations by variables allowing prioritization at scale (e.g. breakdowns by age, sex, employment category, location, etc.)

2. Calculate the value of vaccinating a given person in each subpopulation

3. Aggregate these values to guide purchase/subsidy schedule to target highest-value subpopulations

Key here is calculation of the **VALUE of vaccinating**
HOW TO MEASURE THE VALUE OF VACCINATION
(1/2)

1. **Survival benefits**
   - Quantify the number of years of life lost (YLL) due to vaccination
   - Disease risk data is spotty, especially in developing-world context
   - Need to make a choice on modeling hazards (e.g. epidemiological models, curve fitting, constant hazards)

2. **Income benefits**
   - Quantify additional income gained due to survival from vaccination
   - Poor real-time economic quality data in general, we use CMIE data (monthly panel dataset for India)
   - Other countries lack this data, leading to lower-precision estimates
3. Disease externalities

- Model reduction in the reproductive rate, $R_t$: the average number of secondary infections caused by each current infection
- Requires assumptions on reproductive rate estimation techniques, and subpopulations mixing structure

4. Economic externalities

- Measure non-health benefits to general population as socioeconomic activity resumes (incomes rise as societies re-open)
- Difficult to disentangle
Unfortunately, equity and efficiency are sometimes at odds:

- **Region:** Spreading limited vaccines out over multiple regions may not enable release from suppression (lockdown) in any one area. This means equity sacrifices income.

- **Income:** Poor areas have been hit harder (incidence of infection). But higher levels of natural immunity imply lower returns to vaccination.

- **Demographics:** Males may be more at risk of dying.

Equity is an issue along multiple dimensions:

- Region
- Income
- Other (gender, age)

Sometimes equity is hard to define. E.g., should we weight lives equally or life years?

Both efficiency (maximizing the number of lives saved or income gains) and equity (equal opportunities or doses) are important.
Application: India (Tamil Nadu)
HEALTH AND ECONOMIC DATA FOR TAMIL NADU

• **Epidemiological data:**
  - Daily case and death data, by age and district (from TN state government)
  - New, district population representative sero-prevalence survey in TN with N = 26,140 from October-November 2020 [Malani et al., 2021]
  - Contact rates from AP & TN [Laxminarayan et al., 2020]

• **Economic data:**
  - CMIE Consumer Pyramids Household Survey (panel of 174,000 households across India, 11,148 in TN, surveyed every 4 months)
HEALTH IMPACT OF VACCINATION IN TAMIL NADU (BY AGE GROUPS)
TOTAL (HEALTH + ECONOMIC) IMPACT OF VACCINATION IN TAMIL NADU (BY AGE GROUPS)
IMPACT OF VACCINATION IN TAMIL NADU (BY AGE GROUPS AND DISTRICTS)
06. PREPAREDNESS OF THE HEALTH SYSTEMS AND EQUITY ISSUES
PREPAREDNESS OF THE HEALTH SYSTEM AND INEQUALITY DIMENSIONS

Backward-looking assessment: what have been the main challenges and bottlenecks of the health systems in SAR in the recent past (as these may be affecting COVID-19 vaccine campaign).

1. The capacity and performance of the health systems:
   a. Health expenditure and immunization per capita in SAR countries
   b. Supply side health services issues including immunization
   c. Demand side health services issues including immunization

2. The inequality dimension of health outcomes in the SAR countries
   a. Economic and disease burden according to socioeconomic characteristics
   b. Socio-economic indicators impacting selected health outcomes including immunization
SAR Health Systems: overall size and performance, comparisons with respect to other countries regions
Public spending on health per capita, US$, 2017

Source: World Development Indicators.
Note: Both X- and Y-axes expressed in logarithmic scale (left graph)
Both overall and public financing for health are relatively low in SAR and private OOP financing dominates: the region has the lowest average per capita total spending on health as well as the lowest total health spending share of GDP; this low prioritization of health in government financing suggests that additional resources may be required to ensure smooth vaccine delivery.
Immunization coverage (%) including Bacillus Calmette-Guérin (BCG) and Diphtheria, Tetanus Pertussis third dose (DTP3), Measles and Polio for Children between 12 and 23 months of age in SAR countries

Source: World Development Indicators.
Note: Both X- and Y-axes expressed in logarithmic scale.
Supply side issues
SUPPLY SIDE BARRIERS: NUMBER OF DOCTORS, NURSES AND MIDWIVES IN SAR COUNTRIES EXCLUDING MALDIVES

Total physicians, nurses and midwives (per 1000)

- Maldives: 10.22
- Nepal: 3.76
- Sri Lanka: 2.92
- India: 2.89
- Bhutan: 2.04
- Pakistan: 1.60
- Bangladesh: 0.86
- Afghanistan: 0.43

WHO recommended minimum: 4.45

Source: World Bank Group
* Latest data available, 2017 and 2018
About 50% of the population has access to primary care services within 5km (Basic Health Unit, BHU)
- access to Rural Health Center is even less at 23%
- access to hospitals is 28%

Source: author’s production using DHS 2017-18 data.
Out of 56 electrical Cold chain equipments, 9% were nonfunctional, 48% were noncompliant with WHO standards, 5% were not chlorofluorocarbon free.

These problems on the cold chain equipments could be an important supply limitation in the introduction of the COVID-19 vaccine.
Demand side issues

With a 90% effective vaccine, need 77.7% acceptance rate to get to 70% (herd immunity);
With a 70% effective vaccine, need 100% acceptance rate!
COVID-19 BELIEFS, BEHAVIORS & NORMS SURVEY
JOINT STUDY BY WHO, JOHNS HOPKINS, FB, GOARN AND MIT

• Sample survey of more than 1.2 million Facebook users in 67 countries.
• Incorporated weights to reduce bias due to nonresponse and to target each country's adult or Internet-using population.
• Survey contains both snapshots and waves for different countries. However, current results use only aggregated country-level data.
• Micro-data includes more information on preventive norms, access and trust regarding COVID-19 information. (pending request approval)
Vaccine acceptance is high in South Asia with a regional average of 74% of the population relative to other regions (North America average is 52%).

Source: COVID-19 Beliefs, Behaviors & Norms Survey of more than 1.2 million Facebook users in 67 countries. Data are weighted to reflect adult population/population using the internet.
DHS Data (eligible women): Wealth is a significant predictor of tetanus toxoid vaccination only in Nepal and Pakistan, but not so in other countries.
SAR Health and inequality
Prevalence of ARI among children under 5

Communicable Disease Burden i.e ARI (children under age 5) by wealth categories
Prevalence of stunting among children under age 5

Prevalence of under 5 mortality
ACUTE RESPIRATORY INFECTION : TRENDS

Prevalence of ARI among children under 5

Difference in pp (Poorest - Richest):
2007 → 3.9 pp
2017 → 2.6 pp

Diff in diff (how much the gap has closed or not):
1.3 = 3.9 – 2.6

ARI

PAKISTAN (2006-2017)
NEPAL (2006-2016)

Difference in pp (Poorest - Richest):

Child immunization coverage
BCG VACCINATION: TRENDS -- AN EXAMPLE FOR PAKISTAN

Difference in pp (Richest - Poorest):
2017 → 35.6 pp
2006 → 32.6 pp

Diff in diff (how much the gap has closed or not):
3 = 35.6 - 32.6
## Vaccination: Trends in the Gaps Between Poorest and Richest Groups

The chart below shows the differences in vaccination coverage between the richest and poorest groups in Bangladesh, Nepal, and Pakistan from 2006-2017 for BCG, DPT-3, and Polio-3.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Country</th>
<th>Period</th>
<th>Diff in pp (Richest - Poorest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>Pakistan</td>
<td>2006-2017</td>
<td>35.6</td>
</tr>
<tr>
<td></td>
<td>Nepal</td>
<td>2006-2016</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bangladesh</td>
<td>2007-2017</td>
<td></td>
</tr>
<tr>
<td>DPT-3</td>
<td>Pakistan</td>
<td>2006-2017</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nepal</td>
<td>2006-2016</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bangladesh</td>
<td>2007-2017</td>
<td></td>
</tr>
<tr>
<td>Polio-3</td>
<td>Pakistan</td>
<td>2006-2017</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nepal</td>
<td>2006-2016</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bangladesh</td>
<td>2007-2017</td>
<td></td>
</tr>
</tbody>
</table>

The differences in vaccination coverage are marked by the color of the bars, with red indicating a higher vaccination rate in the richest group and blue indicating a higher rate in the poorest group.
VACCINATION: TRENDS IN THE GAPS BETWEEN POOREST AND RICHEST GROUPS

- **Pakistan (2006-2017)**
- **Nepal (2006-2016)**
- **Bangladesh (2007-2017)**

- **Measles**
- **Poli-3**
- **DPT-3**
- **BCG**

**Diff. in pp (Richest - Poorest)**
VACCINATION: TRENDS IN THE GAPS BETWEEN POOREST AND RICHEST GROUPS

- **Pakistan (2006-2017)**
  - Measles
  - Polio-3
  - DPT-3
  - BCG

- **Nepal (2006-2016)**
  - Measles
  - Polio-3
  - DPT-3
  - BCG

- **Bangladesh (2007-2017)**
  - Measles
  - Polio-3
  - DPT-3
  - BCG

**Diff. in pp (Richest - Poorest)**

-5 0 5 10 15 20 25 30 35 40
Adult immunization coverage
ADULT VACCINATION COVERAGE
WOMEN AGE 15-49 WHOSE LAST LIVE BIRTH IN THE PAST 5 YEARS WAS PROTECTED AGAINST NEONATAL TETANUS THROUGH TETANUS TOXOID VACCINATION

Vaccination by country and wealth quintile

<table>
<thead>
<tr>
<th>Country</th>
<th>Wealth Quintile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan (2015-16)</td>
<td></td>
</tr>
<tr>
<td>Bangladesh (2011)</td>
<td></td>
</tr>
<tr>
<td>India (2015-16)</td>
<td></td>
</tr>
<tr>
<td>Maldives (2016-17)</td>
<td></td>
</tr>
<tr>
<td>Nepal (2016-17)</td>
<td></td>
</tr>
<tr>
<td>Pakistan (2017-18)</td>
<td></td>
</tr>
</tbody>
</table>

- poorest
- poorer
- middle
- richer
- richest
SOUTH ASIA VACCINATES AGAINST COVID-19

The COVID-19 pandemic has been an unprecedented shock to the global economy, has exacerbated inequalities and has been a dramatic setback towards eradicating poverty;

Therefore, vaccination is a key development priority; unlike other policy measures, such as lockdowns, vaccines save lives and livelihoods.

However, vaccinating at the scale and speed required to end the pandemic is a daunting task never attempted before. This presentation highlights:

• Vaccination has a high benefit/cost ratios;
• Having features of a public good, herd immunity by vaccination requires government intervention and its financing, while high, seems ‘feasible’;
• However, financing is one of the challenges; allocation of the vaccine, at least in the short run, presents trade-offs between equity and efficiency;
• And delivering the vaccines – given the current preparedness of the health systems and potential vaccine hesitancy – is an additional key obstacle;
• It is especially important to ensure that vaccines are reaching all those eligible, not just those with the privilege and resources to obtain them.
THANKS!

Do you have any questions?