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Special Report: The COVID-19 Epidemic Forecasts

Issue 3

Ping An Group

Ping An Health Technology Research Institute

Ping An Smart City Research Institute

Ping An Macroeconomic Research Institute

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The COVID-19 Epidemic Forecasts Issue 3

Overview

1. **The second wave of global outbreaks: Europe and the U.S. have entered into a moderation period (in line with our forecast on April 8).** We predicted that the second wave would reach the peak of new confirmed cases by April 15, with a total of more than 2 million confirmed cases. The actual number of confirmed cases as of April 15 at 12 p.m. China Standard Time was 2,016,305. The U.S., U.K., Turkey and Canada reached the peak of new confirmed cases on April 9, April 11, April 12 and April 18 respectively. In particular, the peak of the new confirmed cases of the U.S., U.K. and Turkey was in line with the April 8 forecast, while Canada reached its peak later than predicted.

2. **Countries and territories where the epidemic had initially eased in the first outbreak, such as China, still face the risk of a second outbreak.**
   - **Since China implemented a strict entry restriction policy on travelers from overseas, there has been no second outbreak.** China's overseas entry restrictions have been implemented in four stages. 1) In the **low containment measures stage,** centralized quarantine was carried out for people entering China with symptoms; 2) In the **moderate containment measures stage**, all people entering China were quarantined; 3) In the **high containment measures stage**, entry via air and land ports was restricted on the basis of the above stages; 4) In the **complete containment measures stage**, most land ports were closed. As of April 20, there was a total of 1,718 imported and related cases (hereinafter referred to as **cumulative cases**) and no second outbreak.

   - **If China had not implemented overseas entry restriction measures after Feb. 26, it is likely that a second outbreak could have occurred in China.** Assuming domestic control measures are unchanged, we examined four hypothetical situations for China's imported and related cases based on domestic transmission rates and various overseas entry restriction policies: **1) Maintain a high degree of control** (not complete control): the estimated cumulative cases as of April 20 would have been about 5,600 cases; **2)**

Maintain moderate control: the cumulative cases as of April 20 would have been about 14,000 cases; **3) Maintain low control**: the cumulative cases as of April 20 would have been about 25,000 cases; **4) No overseas entry restriction measures**, the estimated cumulative cases as of April 20 would have been about 32,000 cases, 19 times the actual number.

- **If China had relaxed its overseas entry restriction policy on April 20, it could have led to a second outbreak in China by May 31.** Assuming domestic control measures are unchanged, we have predicted the outcomes of overseas imported cases according to five scenarios of various levels of overseas entry restrictions: 1) **Maintain complete control:** no second peak is expected to occur. The cumulative cases on May 31 would be 1,800 to 2,100; 2) **Downgrade to high control:** no second peak is expected to occur, and cumulative cases on May 31 would be more than 4,500 cases; 3) **Downgrade to moderate control:** the peak of the second wave of new confirmed cases would occur between May 6 and May 10, with a total of more than 6,500 cases on May 31. 4) **Downgrade to low control:** the peak of the second wave would occur between May 14 and May 18, with a total of over 14,000 cases by May 31. 5) **Downgrade to no overseas entry restriction control:** the peak of the second wave would be between May 21 and May 25, with a total of over 20,000 cases by May 31.

3. **Countries and territories where the epidemic initially eased in the first outbreak, such as Singapore, face the risk of a second outbreak.**
   - **The number of overseas imported cases and community infection cases surged after March 5 in Singapore, and now it is experiencing a second outbreak.** The development of the epidemic in Singapore can be divided into four stages: **1) First outbreak stage:** primarily overseas imported cases and locally transmitted cases; **2) Low control overseas entry restriction stage:** the number of overseas imported cases surged quickly in Singapore due to the rapid development of the global epidemic after March 5. Singapore conducted testing and quarantine on people coming from key countries and those who displayed COVID-19

symptoms; **3) High control overseas entry restriction stage:** all people entering Singapore were quarantined at home after March 19; **4) Second outbreak stage:** local community infection cases surged after April 3, leading to the second outbreak. The Singapore government began to implement stricter local containment measures. On April 20, there were 1,426 new confirmed cases, with a total of 8,014 cumulative cases.

- **On April 20, Singapore may have reached the peak level of new confirmed cases of the second outbreak. It is expected that by May 31, 0.3% to 0.5% of Singapore's population will be diagnosed with COVID-19.** Since April 3, Singapore has implemented strict containment measures. It is estimated that on April 20, it reached the peak level of new confirmed cases of the second outbreak. We estimate that the cumulative number of confirmed cases in Singapore on May 31 will reach 17,000 to 28,000, which would be 0.29% to 0.48% of the total population.

4. **Focus on the next stage: the risk of a second outbreak and the third wave of global outbreaks, mainly in developing countries.**
   - **Countries where the epidemic initially eased are recommended to continue to implement overseas entry restrictions and local containment measures until the global epidemic is generally alleviated.** Based on the experiences of China and Singapore mentioned above, countries where the epidemic initially eased should continue to implement overseas entry restriction control – such as restricting the number of people entering the country and centrally isolating people entering, and maintain appropriate local containment measures until the global epidemic situation is generally under control.

   - **Rapid development of the epidemic in Brazil, India, Indonesia and African countries needs further attention.** The cumulative confirmed case totals on April 20 were 38,654 cases in Brazil, 17,615 cases in India, 6,575 cases in Indonesia and 22,992 cases in African countries. Compared to two weeks ago, the cases grew 3.4 times in Brazil, 4.1 times in India, 2.9 times in Indonesia and 2.3 times in African countries. The number of tests per one million

population in these countries (April 20: Brazil 1,373; India 291; Indonesia 154) is also far below the American and European levels (U.S. 11,666; Italy 22,436), and there is still a high risk of a third global outbreak driven by developing countries.

The following report is divided into three chapters. The first chapter is a risk analysis of a second outbreak of China. The second chapter analyzes and predicts the situation of the second outbreak in Singapore. The third chapter analyzes the risk of the third wave of outbreak mainly in developing countries.

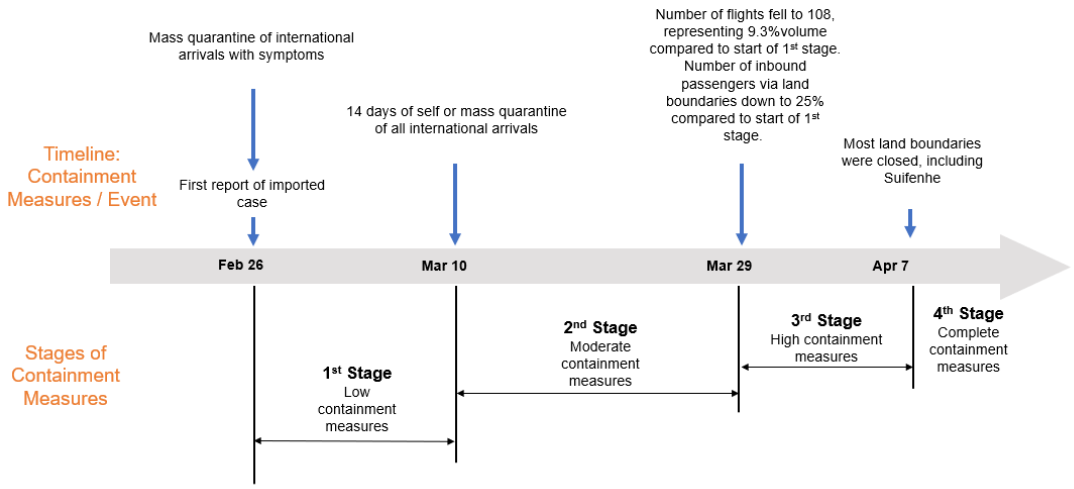
I. The risk analysis of overseas imported cases and the second outbreak in China

China is the first country in the world that had the COVID-19 epidemic outbreak. China had its first overseas imported confirmed case on Feb. 26, but due to implementation of strict overseas entry restriction measures, there has not been a second outbreak. Since Feb. 26, the containment measures of China appear to have been effective: infected individuals can be quarantined immediately and the reproduction number R0 in China – the rate that the virus moves from infected individuals to susceptible individuals in the population – has dropped below 0.8. This chapter will analyze the effect of China's overseas entry control policy, assuming that China's other containment measures remain unchanged, and will also predict the risk of a second outbreak in China.

1) China's overseas entry restriction measures implementation stages

The implementation of the containment measures for China's entry policy is divided into four stages: the low containment measures stage, the moderate containment measures stage, the high containment measures stage and the complete containment measures stage (Figure 1). The stages are divided according to the aviation control policy of the Civil Aviation Administration, the entry control policies for land ports issued by the National Immigration Administration and control policies issued across the country for persons entering China.

Fig. 1 Stages of overseas entry containment in China



- **First stage – low containment measures** (Feb. 26 to March 9): China announced its first overseas imported case on Feb. 26, and with the epidemic outbreaks in Korea, Italy and Iran, China started to require all persons entering China who showed symptoms to undergo centralized quarantine to reduce the local epidemic transmission due to overseas imported cases.

- **Second stage – moderate containment measures** (March 10 to March 28): during this period, due to a massive epidemic outbreak in many countries and the surge in overseas imported cases, many cities and regions in China started to improve their quarantine measures, requiring all persons entering China to undergo centralized quarantine.

- **The third stage – high containment measures** (March 29 to April 6): the Civil Aviation Administration launched its aviation control policy. The planned number of flights per week was only 108 from March 29, equivalent to 9.3% of the total international passenger flight volume in China in the early days of the outbreak. At the same time, some land ports issued an entry restriction policy, which lowered the number of persons entering China through land ports to about 25% of the volume at the beginning of the epidemic outbreak.

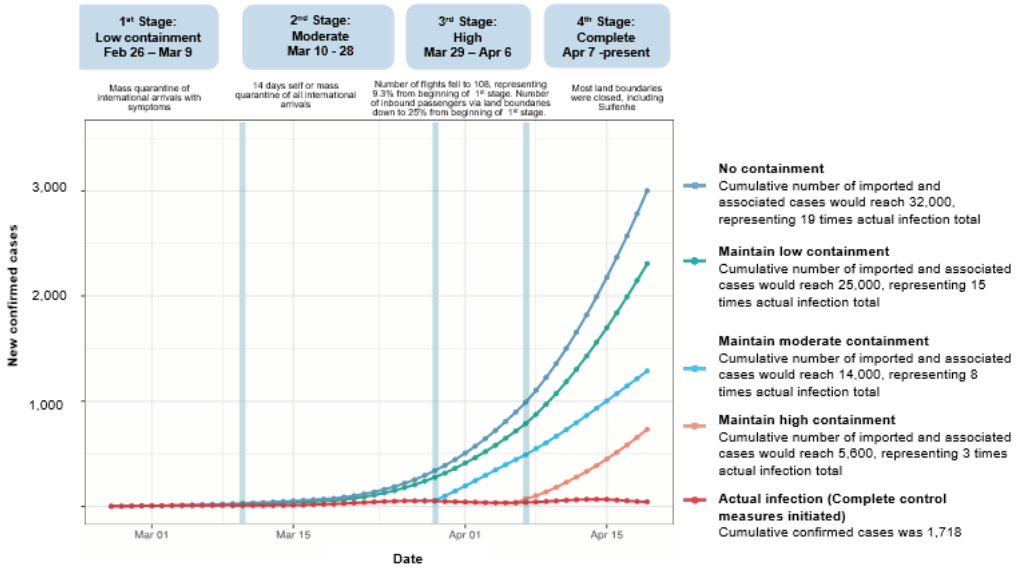
- **The fourth stage – complete containment measures** (April 7 to present): with the increasingly severe epidemic situation in Suifenhe

in Heilongjiang Province, most of the land border crossings, including the China-Russia land border crossings have been temporarily closed. From April 7, the airport and land ports have taken the most stringent control measures. As of April 20, China had a total of 1,718 imported and related cases (hereinafter referred to as **cumulative cases**).

2) Retrospective deduction of imported cases and related cases in China

If China did not implement the entry restriction policies after Feb. 26, the number of cumulative imported cases and related cases as of April 20 could have been 19 times more than the current figure, and China would have a second outbreak. Assuming that China's domestic containment measures are unchanged, and given the basic reproduction number (R0 = 0.80) in China – the rate that the virus moves from infected individuals to susceptible individuals in the population, we used the modified Susceptible-Exposed-Infectious-Recovered (SEIR) compartmental model to examine four hypothetical situations for China's imported cases and related cases (Figure 2).

Fig. 2 Hypothetical impacts of overseas entry containment measures on China's outcome by April 20



- **The first scenario – only maintain high containment measures** (not complete control): in this scenario, Suifenhe and other land ports are not closed on April 7, and the risk of imported cases through land ports from high-risk surrounding countries cannot be controlled. It is estimated that the cumulative overseas imported and related cases (hereinafter referred to as **cumulative cases**) as of April 20 would have been about 5,600, which is three times the actual figure.

- **The second scenario – only maintain moderate containment measures:** in this scenario, there are no restrictions on planned flight volume and land port entry after March 29, and the risk of cases imported through flights and land ports from countries at high risk for global outbreaks cannot be controlled. The number of cumulative cases as of April 20 would have been about 14,000, which is eight times the actual figure.

- **The third scenario – only maintain low containment measures:** in this scenario, persons entering China with no symptoms are not required to be quarantined for 14 days from March 10. Asymptomatic persons (including patients in the incubation period) may cause the local spread of the epidemic. It is estimated that the number of cumulative cases as of April 20 would have been about 25,000, which is 15 times the actual figure.

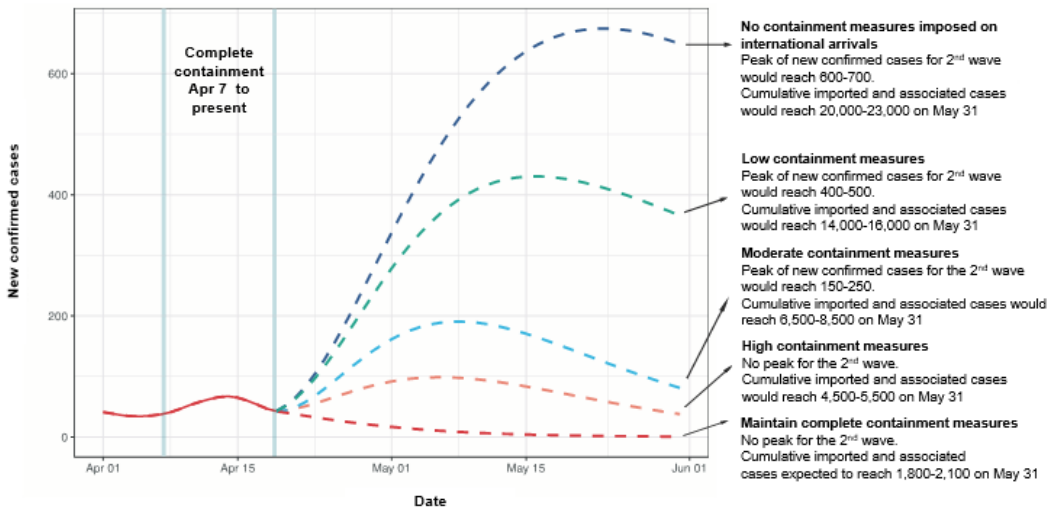
- **The fourth scenario – no entry restriction measures:** in this scenario, all persons entering into China are not required to be quarantined, and the risk of importing cases through flights and land ports from countries at high risk for the global epidemic cannot be controlled, leading to the local spread of the epidemic. The cumulative number of cases on April 20 would have been around 32,000, which is 19 times the actual figure.

3) Prediction of the trend of overseas imported cases and related cases

If China immediately relaxes its overseas entry restriction measures, there could still be a second outbreak of the epidemic, and it is

possible that an additional 20,000 overseas imported and related cases would be added before May 31. China implemented complete containment measures after April 7: all persons entering China have to undergo mandatory quarantine for 14 days. High-intensity port control measures were also implemented. Using April 20 as a starting point and assuming existing domestic control measures are unchanged, we have predicted the number of imported cases from overseas and related cases based on the rates of new confirmed cases in the countries that exported the greatest number of cases into China. We used the modified SEIR predictive model, combined with inputs corresponding to various levels of overseas entry control policies, to predict five different possible outcomes (Figure 3).

Fig. 3 Impact of hypothetical changes to containment measures in China, April 20 to May 31



- **The first scenario – maintain complete containment measures:** in this scenario, the imported cases would continue to decline, and there would not be a second peak of new confirmed cases. It is predicted that the number of cumulative cases would be around 1,800 to 2,100 on May 31.

- **The second scenario – downgrade to high containment measures:** there would be no second peak of new confirmed cases. The cumulative cases would be 4,500 to 5,500 on May 31.

- **The third scenario – downgrade to moderate containment measures:** the epidemic would reach its second peak between May 6 and May 10, with new confirmed cases reaching its peak at about 150 to 250 people, and the cumulative cases would be 6,500 to 8,500 on May 31.

- **The fourth scenario – downgrade to low containment measures:** it is estimated that the second peak of the new confirmed cases would be May 14 to May 18, with new confirmed cases reaching its peak at about 400 to 500 people, and the cumulative cases would be about 14,000 to 16,000 on May 31.

- **The fifth scenario – downgrade to no containment measures for overseas entry into China:** the second peak of the new confirmed cases would be May 21 to May 25, with new confirmed cases reaching its peak of 600 to 700 people, and cumulative cases would be about 20,000 to 23,000 on May 31.

II. The analysis of the second outbreak in Singapore

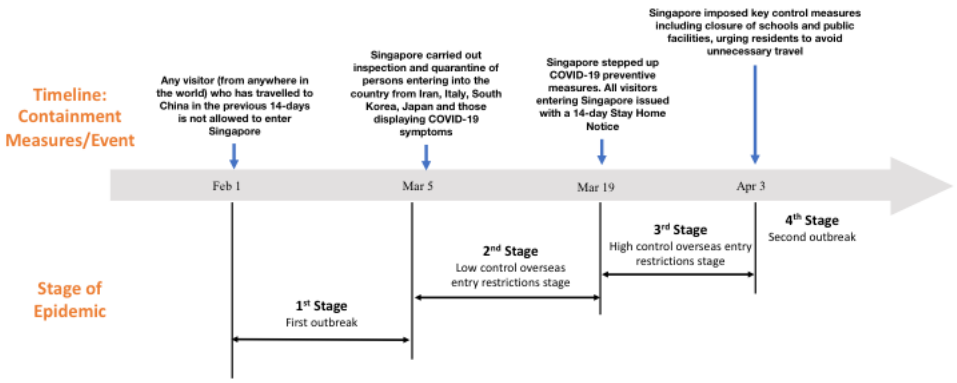
A number of overseas imported cases and community infection cases have surged since March 5 in Singapore, and it is now experiencing a second outbreak. This chapter will analyze the stages of development of the epidemic in Singapore and predict the development trend of Singapore's second outbreak.

1) Development of Singapore's epidemic and containment policies

The development of the epidemic and its containment policies in Singapore can be divided into four stages: **1) First outbreak stage:** initially overseas imported cases and locally transmitted cases; **2) Low control overseas entry restriction stage:** The number of overseas imported cases surged quickly in Singapore due to the rapid development of the global epidemic after March 5. Singapore conducted testing and quarantine on people coming from key countries and those with COVID-19 symptoms; **3) High control overseas entry restriction stage:** After March 19, all persons entering Singapore were required to quarantine at home; **4) Second outbreak stage:** as local community

infection cases surged after April 3 and the epidemic developed into the second outbreak phase, the Singapore government began to implement stricter local containment measures (Figure 4).

Fig. 4 Development of the epidemic and containment policies in Singapore



- **The first outbreak stage** (Feb. 1 to March 4): since Feb. 1, Singapore has banned the entry of tourists from China, but multiple infectious communities gradually emerged in Singapore, and the number of locally confirmed cases began to increase. The Singapore government quickly adopted quarantine measures of suspected cases and imposed entry restrictions on Chinese tourists, effectively controlling the spread of the epidemic, and was recognized internationally as a "model for epidemic prevention."

- **Low control overseas entry restriction stage** (March 5 to March 18): due to the rapid development of the global epidemic after March 5, the overseas imported cases surged. Singapore carried out testing and quarantine of persons entering the country from Iran, Italy, South Korea, Japan and those displaying COVID-19 symptoms.

- **High control overseas entry restriction stage** (March 19 to April 2): on March 19, the Singapore government increased its overseas entry and prevention measures, requiring all overseas arrivals to undergo a 14-day home quarantine. On March 23, the number of new confirmed cases of overseas imports reached its peak and dropped. However, the

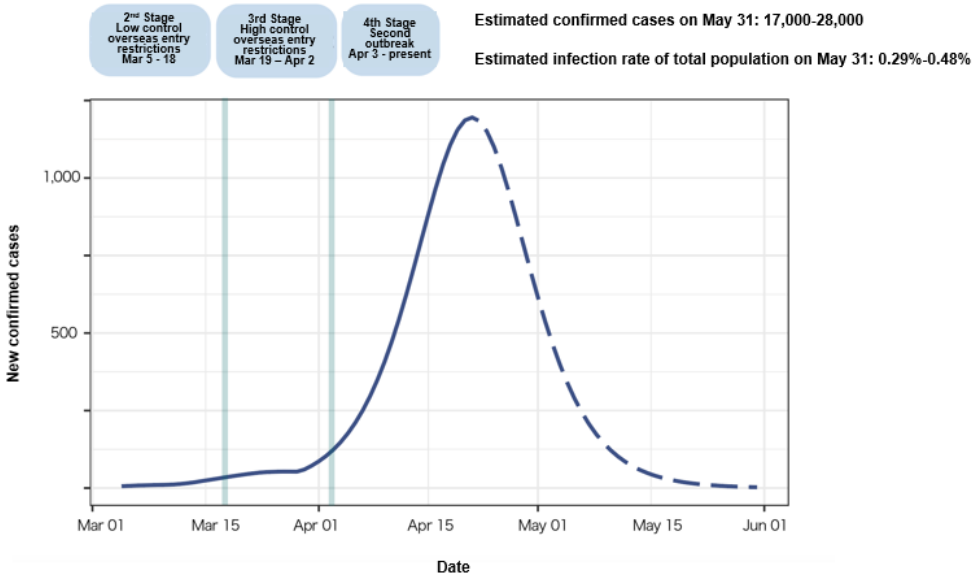
government did not implement strict local containment measures, and there was a surge in transmissions in local communities.

- **The second outbreak stage** (April 3 to present): the local community infection cases surged in Singapore, and the development of its epidemic entered the fourth stage, becoming the first country with a second outbreak. The Singapore government began to implement stricter local containment measures and school suspensions and closed most public places. Residents were recommended to avoid unnecessary travel, but there was a delay before the policy took effect. On April 20, there were 1,426 new confirmed cases, setting a new record for a single-day increase, with a cumulative total of 8,014 confirmed cases.

2) The prediction of the trend of the number of confirmed cases of the second outbreak in Singapore

Singapore implemented its major containment measures for the second outbreak on April 3. When these measures were launched, the cumulative confirmed cases were 190 per one million population, which categorizes it as a higher infection rate scenario as described in our April 8 report. **As of April 20, Singapore may have reached the peak level of new confirmed cases of the second outbreak.** Using the situation of the confirmed cases on April 20 as a starting point, we applied the modified (SEIR) compartmental model to predict the trend of the second outbreak in Singapore. **It is estimated that the cumulative number of confirmed cases in Singapore on May 31 will reach 17,000 to 28,000, which is 0.29% to 0.48% of the total population** (Figure 5).

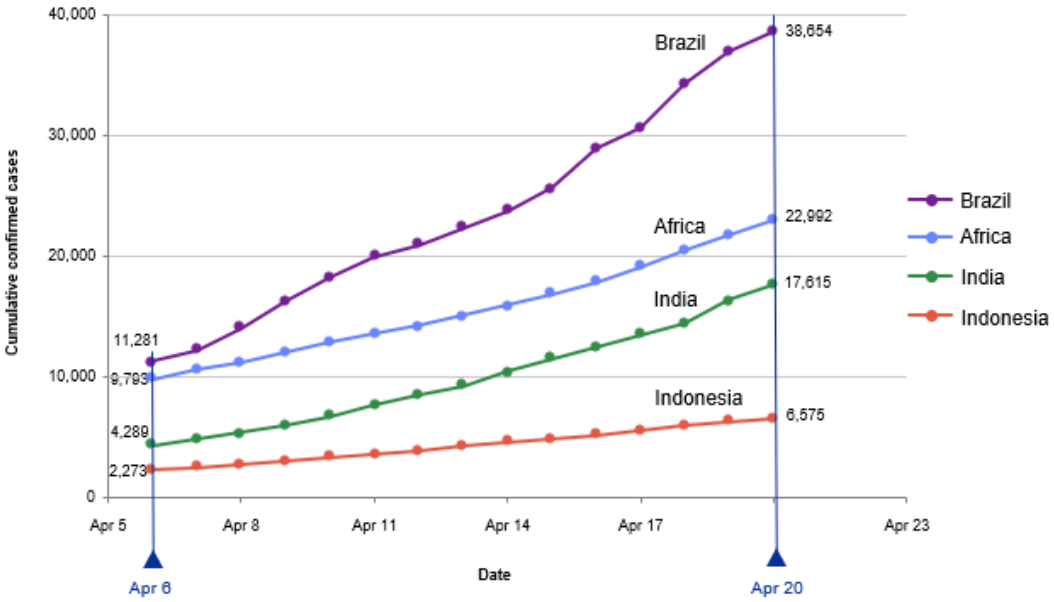
Fig. 5 Prediction of trend of second outbreak in Singapore



III. The analysis of the third outbreak

The cumulative number of confirmed cases in Brazil, India, Indonesia and African countries has increased by two to four times in the past two weeks, and there may be a third wave of global outbreak driven by developing countries. From April 6 to April 20, the cumulative confirmed cases in Brazil increased from 11,281 to 38,654, in India from 4,289 to 17,615, in Indonesia from 2,273 to 6,575 and in African countries from 9,793 to 22,992. These were respectively increases of 3.6 times, 4.1 times, 2.9 times and 2.3 times compared to two weeks ago. Among them, new confirmed cases in Brazil, India, and Africa each exceeded 1,000 in a single day recently, and the epidemic has developed rapidly (Figure 6).

Fig. 6 Development of the epidemic in Brazil, India, Indonesia and Africa to April 20



The volumes of testing in Brazil, India, Indonesia and African countries are far lower than that in Europe and the U.S., and the number of infected persons may be seriously underestimated. At the same time, these countries have a shortage of medical resources compared to Europe and the U.S., and their medical systems may face great pressure. As of April 20, the cumulative tests per one million population were 1,373 in Brazil, 291 in India, 154 in Indonesia, 1,934 in South Africa and 537 in Egypt, far below European and American levels (U.S. 11,666 per one million population, Italy 22,436; and Spain 19,896). The actual number of infections may be seriously underestimated. In addition, the number of intensive care unit (ICU) beds per one million population is 52 in India, 27 in Indonesia and 5 in Africa, significantly lower than the level of European and American countries (U.S. 347 per million; Italy 125; and Spain 97). As the epidemic develops further, the medical systems in these countries may face enormous pressure.

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Ping An Insurance (Group) Company of China, Ltd. ("Ping An") is a world-leading technology-powered retail financial services group. With over 200 million retail customers and 516 million Internet users, Ping An is one of the largest financial services companies in the world.

In 2019, Ping An ranked 7th in the Forbes Global 2000 list and 29th on the Fortune Global 500 list. Ping An also ranked 40th in the 2019 WPP Millward Brown BrandZ™ Top 100 Most Valuable Global Brands list. For more information, please visit www.pingan.cn.

Ping An Health Technology Research Institute is a world-leading healthtech research institute, being top-ranked in nine global competitions in the field of healthtech. It has more than 1,000 top scientists and nearly 10,000 developers in China, Boston and San Francisco. **Ping An Macroeconomic Research Institute** utilizes more than 50 high frequency data points, more than 30 years of historical data and more than 1.5 billion data points, to drive research on "AI + Macro Forecast", to provide insights and methods towards precise macroeconomic trends. Driven by the leading healthtech, **Ping An Smart City Research Institute** has developed solutions including artificial intelligence (AI)-based disease prediction, medical image recognition, smart medical decision support and treatment and smart chronic disease management, with operations in more than 150 cities in China and Southeast Asia. Its solutions have been adopted by over 10,000 medical institutions.

Over the past two months, Ping An Health Technology Research Institute, Ping An Macroeconomic Research Institute and Ping An Smart City Research Institute have closely followed the developments of the COVID-19 pandemic, and have conducted corresponding analyses and forecasts. The first issue of the overseas epidemic analysis report was published on 21 March 2020 and the second on 7 April 2020. For further information, please contact Dr. Li Xiang through lixiang453@pingan.com.cn.

Disclaimer

This research report is based on current public information that we consider reliable, but we do not represent it is accurate or complete, and it should not be relied on as such. The information, opinions, estimates and forecasts contained herein are as of the date hereof and are subject to change without prior notification. We seek to update our research as appropriate, but various regulations may prevent us from doing so. Other than certain reports published on a periodic basis, the large majority of reports are published at irregular intervals as appropriate in the analyst's judgment.