

Thursday, April 23, 2020

## WHERE ARE WE IN THE COVID CYCLE?<sup>1</sup>

### I. Introduction

1. **The coronavirus disease, COVID-19, has spread rapidly throughout the world since February 2020 and was declared a pandemic on 11 March, 2020.** The first outbreak was reported in Wuhan, China, in late-December 2019. By end-February 2020, significant increases in cases were recorded in Korea, Iran, and Italy. By mid-March, Europe was considered the epicenter of the pandemic; by end-March, the United States had the largest number of confirmed cases worldwide. According to the World Health Organization (WHO), the pandemic had spread to 213 countries, areas or territories around the globe by April 22 (Figure 1).

2. **In response to the pandemic, many countries have implemented containment strategies to help control or slow the spread of the disease.** Governments have to carefully balance population health concerns and public health resources against the risks of economic and financial collapse. The containment measures have taken many different forms—while some countries or cities have been put under strict lockdown, others have focused on widespread testing, quarantining, contact tracing, social distancing, or a mix of these, and most countries have implemented some form of travel ban.

3. **An important question is how the situation will evolve.** How rapidly is COVID-19 spreading within and across countries, and have the cases in some countries really peaked? How long will it take for the pandemic to subside, and when can containment measures be safely loosened? All of these considerations have important implications for economic activity. While the first wave of infections in China disrupted regional travel and supply chains, pandemic containment measures globally have significantly affected demand and production. Many economies have ground to a virtual standstill, decimating retail sales, investment, trade, tourism, as well as sparking financial market volatility, and pushing unemployment up to historical highs. Governments around the region and globally have had to take unprecedented fiscal and financial measures to support their economies.

4. **To better understand which stage countries are at in the pandemic, we have developed a “Covid Cycle.”** With the situation evolving rapidly and changing daily, the Covid Cycle (hereafter “Cycle”) represents a high-frequency indicator that could help identify the infection and recovery stages of the ASEAN+3 and other economies, and possibly serve as a forward-looking input for analyses and policymaking. The Cycle does not claim any expert medical input but rather, attempts to provide an additional perspective on the pandemic using published data.

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Figure 1. COVID-19: Cumulative Confirmed Cases, as of April 22, 2020



Source: Johns Hopkins Coronavirus Resource Center (<https://coronavirus.jhu.edu/map.html>).

5. **This note lays out our framework and presents findings based on statistical information as of April 22.** Importantly, many parameters with regard to the disease and the pandemic remain guesstimates and, given that the analysis relies on (sometimes volatile) **reported** data, the findings have to be treated with extreme caution. One risk the Cycle cannot capture *ex-ante* is that some countries might be hit by second or third waves of the outbreak as the disease moves across the globe—populations may get infected again because they may not have taken the necessary precautions to ensure that the virus is fully stamped out locally or prevent imported infection.

## II. Data and Methodology

6. **Our analysis relies on published data of confirmed COVID-19 cases, deaths, and recoveries, and should be heavily caveated.** At this point, one of the few things certain about the pandemic is that the number of reported “confirmed” cases is likely to be much lower than the actual number of cases, which remains unknown. Most countries have performed limited testing, with the numbers varying by country (see Section III). What is obvious, though, is the positive correlation between the reported number of confirmed cases and the number of tests. In addition, reported new cases on any particular day may not necessarily reflect actual new cases on that day, given the lead time between testing and obtaining the results; it could also be due to delays or inaccuracies in reporting.

7. **The daily data are sourced from John Hopkins University (via Haver Analytics).** This source is the most widely used in current analyses on the COVID-19 pandemic. The database comprises information synthesized from the WHO, US Centers for Disease Control and Prevention, European Centre for Disease Prevention and Control, China's National Health Commission, and [ncov.dxy.cn](http://ncov.dxy.cn), an independent data source maintained by Chinese physicians. It is updated daily at around 11:59 p.m. Coordinated Universal Time (UTC).

### A. Explaining the Epidemic Curve

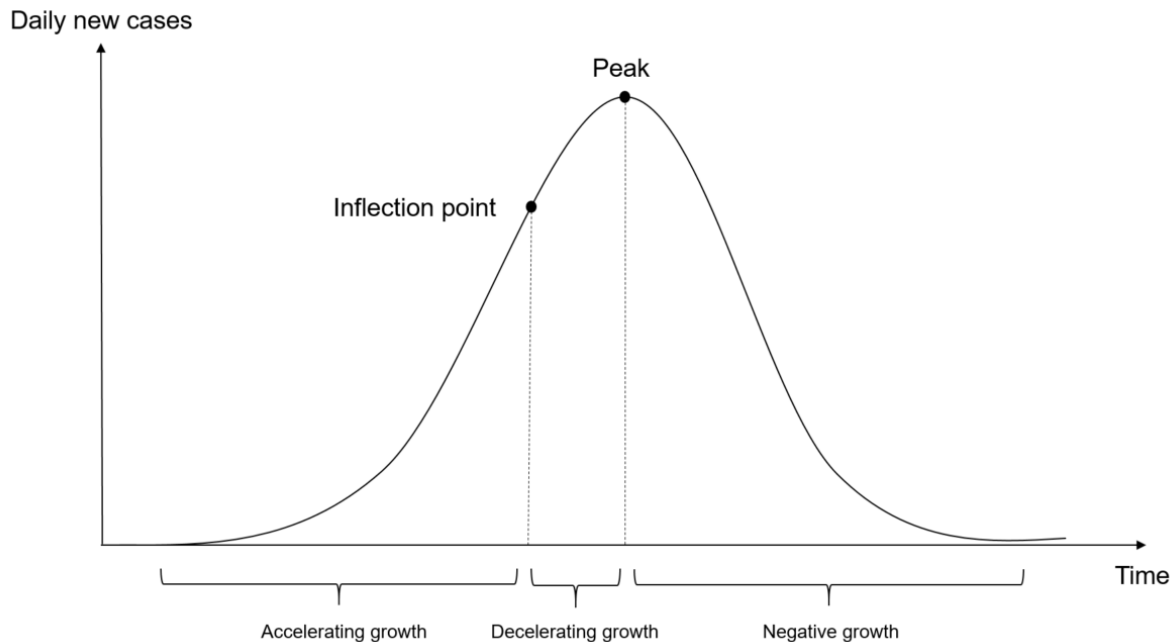
8. **One key metric for assessing a disease outbreak is the epidemic (or “epi”) curve which shows the progression of the outbreak.**<sup>2</sup> The curve helps to assess the magnitude of the outbreak, the distribution of cases over time, and gives an indication of how far along the curve the outbreak is. The epidemic curve depicts the time on the horizontal axis, and new number of cases on the vertical axis (Figure 2). The curve follows a bell shape: after an initiation period, the number of new cases rises rapidly during the acceleration period; growth eventually decelerates before the number of new cases peaks, and then declines. The growth in daily new cases corresponds to the slope of the epidemic curve:

- With high positive growth in daily new cases, a country would be in the accelerating part of the epidemic.
- As the growth rate of daily new cases decelerates and the curve passes the **inflection point**, a country is nearing the **peak**, at which growth is zero.
- From the peak onwards, the growth rate of daily new cases turns negative, and the number of daily new cases becomes fewer and fewer (but are more than zero).

<sup>2</sup> <https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/epi-curves.html>.

- The decline in new cases will be rapid initially, and then tapers off eventually as the outbreak comes to an end with no more new daily cases.

**Figure 2. Schematic: Epidemic Curve**



Source: AMRO staff calculations.

## B. Constructing the “Covid Cycle”

9. **We combine information from the epi curve with that on active cases to derive the Covid Cycle.** The former reveals whether the spread of the pandemic is accelerating or slowing down; the latter—which is calculated as the difference between the number of confirmed cases less the number of recoveries plus deaths—provides a sense of where the country is in terms of the maturation of the pandemic. After all, an economy that is recording zero new cases but still burdened with a large number of active cases is unlikely to be considered free of the virus and will need to remain vigilant about the possibility of reappearances.

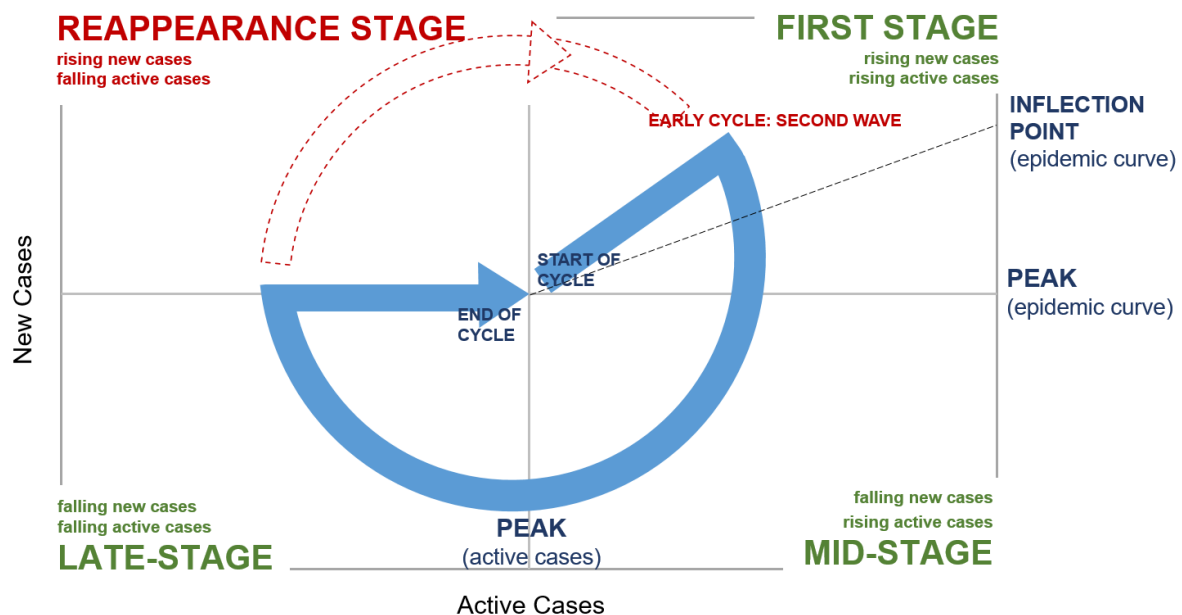
10. **We define the Cycle in four stages** (Figure 3):

- **First stage.** At this stage, changes in both the number of **new cases** and the number of **active cases** are positive and increasing rapidly. The former corresponds to both the accelerating and decelerating parts (that is, the positive slope) of the epi curve (see Figure 2).

**Mid-stage.** At this stage, the number of **new cases**, while positive, is falling from day to day. Hence, the change in the number of new cases becomes negative. This stage corresponds to the earlier part of the negative slope of the epi curve (on the other side of the peak). The **peak of the epi curve** represents the demarcation line between the first and mid-stages. Meanwhile, the change in the number of **active cases** remains positive, lagging the new cases, as the base starts to shrink from recoveries and deaths.

- **Late-stage.** At this stage, the number of **new cases** continues to fall from day to day and the negative change in the number of new cases becomes smaller as they eventually taper off to zero. This stage corresponds to the latter negative growth part of the epi curve. The change in the number of **active cases** also turns negative as the number of recoveries and deaths picks up while the number of active cases falls. The shift from mid- to late-stage traverses the **peak of the active cases**. The Cycle ends when there are no more new cases, and all active cases have been resolved because all patients have either recovered or died from the disease.
- **Reappearance stage.** At this stage, new cases start to appear if infections have not been completely wiped out. If the number of new infections picks up again, then the pandemic would move into the first stage of the next wave.

**Figure 3. Schematic: Stages of the Covid Cycle**  
(Change in number of cases per 1 million population)



Source: AMRO staff.

### III. Analysis

11. **The Covid Cycle provides a more complete picture of a country's path through the pandemic.** The trajectory and speed of a country's progression through the Cycle—and the eventual outcome—will likely be non-linear and significantly influenced by factors such as the extent of testing done on the population, demographic profile, the capacity and quality of the healthcare system (Table 1), as well as data accuracy and policy responses to the outbreak, such as the timing, design and enforcement of mitigation or containment measures. Countries that were first out of the gate in terms of infection may find themselves at risk of reappearance, as the pandemic moves from East to West and possibly back again.

Table 1. ASEAN+3 and Selected Economies: Demographic, Health Resource and COVID-19 Statistics

Economy	Demographics	Healthcare Resources				COVID-19 Disease			
	Population Aged 65 and Older	Hospital Beds	Medical Doctors	Medical and Pathology Lab Scientists	Medical and Pathology Lab Technicians	Tests		Confirmed Cases	Deaths
	Percent of population	Per 10,000 population				Per thousand population		Per million population	
<b>ASEAN+3</b>									
Brunei Darussalam	5.2	27.4	16.1	2.6	0.6	—	—	318.5	2.3
Cambodia	4.7	8.3	1.9	0.3	0.3	—	—	7.4	0.0
China	11.5	42.0	19.8	—	1.6	—	—	57.7	3.1
Hong Kong, China	17.5	—	—	—	—	17.5	<i>tests performed</i>	138.9	0.5
Indonesia	6.1	12.1	4.3	0.01	0.9	—	—	27.4	2.1
Japan	28.0	134.0	24.1	—	—	1.0	<i>people tested</i>	90.7	1.8
Korea	15.1	115.3	23.6	—	6.9	11.2	<i>units unclear</i>	208.8	4.6
Lao PDR	4.2	15.0	3.7	0.9	0.6	—	—	2.7	0.0
Malaysia	6.9	18.6	15.4	1.9	2.0	3.5	<i>units unclear</i>	173.1	2.8
Myanmar	6.0	9.0	6.8	0.5	0.3	—	—	2.3	0.1
Singapore	12.4	24.0	22.9	—	—	10.1	<i>people tested</i>	1,747.1	1.9
Thailand	12.4	21.0	8.1	—	0.4	0.6	<i>people tested</i>	40.6	0.7
Philippines	5.3	5.0	6.0	—	—	0.6	<i>people tested</i>	62.1	3.8
Vietnam	7.6	25.6	8.3	—	—	1.8	<i>units unclear</i>	2.8	0.0
<b>Other economies</b>									
Austria	19.1	76.5	51.7	—	—	23.0	<i>units unclear</i>	1,666.6	51.6
Bahrain	2.5	20.3	9.3	0.01	1.8	57.6	<i>units unclear</i>	1,235.1	4.3
Estonia	20.0	49.6	44.8	—	—	33.6	<i>units unclear</i>	1,176.0	30.3
France	20.4	64.8	32.7	—	—	7.1	<i>units unclear</i>	2,393.1	304.0
Germany	21.6	82.8	42.5	—	—	25.1	<i>tests performed</i>	1,803.8	56.5
Iceland	15.2	31.7	40.8	8.8	—	129.4	<i>units unclear</i>	5,264.9	27.7
India	6.4	6.6	8.6	3.7	—	—	—	15.6	0.4
Ireland	400.0	27.6	33.1	—	—	22.8	<i>units unclear</i>	3,414.4	131.2
Israel	9.3	30.9	46.3	—	—	30.0	<i>tests performed</i>	1,701.8	19.8
Italy	23.0	34.2	39.8	—	—	17.2	<i>people tested</i>	3,093.8	392.3
Luxembourg	14.3	48.2	30.1	—	—	59.8	<i>people tested</i>	5,934.4	121.5
Norway	17.3	38.6	29.2	—	—	—	—	1,364.2	32.1
Spain	19.6	29.7	38.7	—	—	20.0	<i>tests performed</i>	4,458.8	441.5
Switzerland	18.8	46.8	43.0	—	—	26.6	<i>tests performed</i>	3,290.3	163.5
United Kingdom	18.5	27.6	28.1	—	—	6.1	<i>people tested</i>	1,976.8	237.7
United States	16.2	29.0	26.1	16.8	11.6	1.1	<i>tests performed</i>	2,122.5	123.1

Sources: Johns Hopkins Coronavirus Resource Center; Our World in Data; United Nations; WHO; and AMRO staff calculations.

Note: COVID-19 test data are as of April 19–22, 2020, except for Hong Kong; Singapore; Spain, and the United States (which refer to earlier data between April 13–18, 2020); a total of 81 countries report test data. COVID-19 cases data are as of April 22, 2020.



12. **The experiences of two diverse countries, Brunei Darussalam and Germany, show the different paths taken to the late-stage of the Cycle.** Germany, which reported its first COVID-19 case in January 2020 and imposed a lockdown on March 22 (when it was in the first stage), moved to late-stage about two-and-a-half weeks after (Figure 4). Germany is also one of the countries that have run the highest number of tests relative to the size of its population. Separately, Brunei, which imposed a “no outside travel” policy as soon as 5 days following its first reported infection case, followed up by banning incoming travel 9 days after. It moved into late-stage after 7 days and is currently deep into late-stage.

13. **The world, as a whole, is between the first and mid-stages of the pandemic.** In aggregate, there were several sharp “surges” during the first stage before moving towards and around the “global” epi curve peak (Figures 5 and 6, left panel). However, it is not necessarily reflective of individual country situations where their Cycles have started at different times. A similar caveat applies to many large countries, such as China, India, Indonesia, and the United States. Outbreaks might be concentrated in certain states or provinces and may move from one to another over time, so that the aggregate nationwide data are not necessarily representative of individual states or provinces.

14. **Importantly, this example underscores the data caveats highlighted above.** When measured according to its own scale, it is clear that the “world” appears to have progressed through the Covid Cycle to the epi curve peak. However, the global aggregate appears very small after scaling for population (Figure 6, right panel), when mapped against the axes scales used for advanced economies, such as Italy and Switzerland (Figures 7 and 8), which were heavily infected and have reportedly run high numbers of tests (see Table 1). The danger is that the apparent small scale at the global level could be a harbinger of forthcoming surges in many developing countries and hence a cause for grave concern.

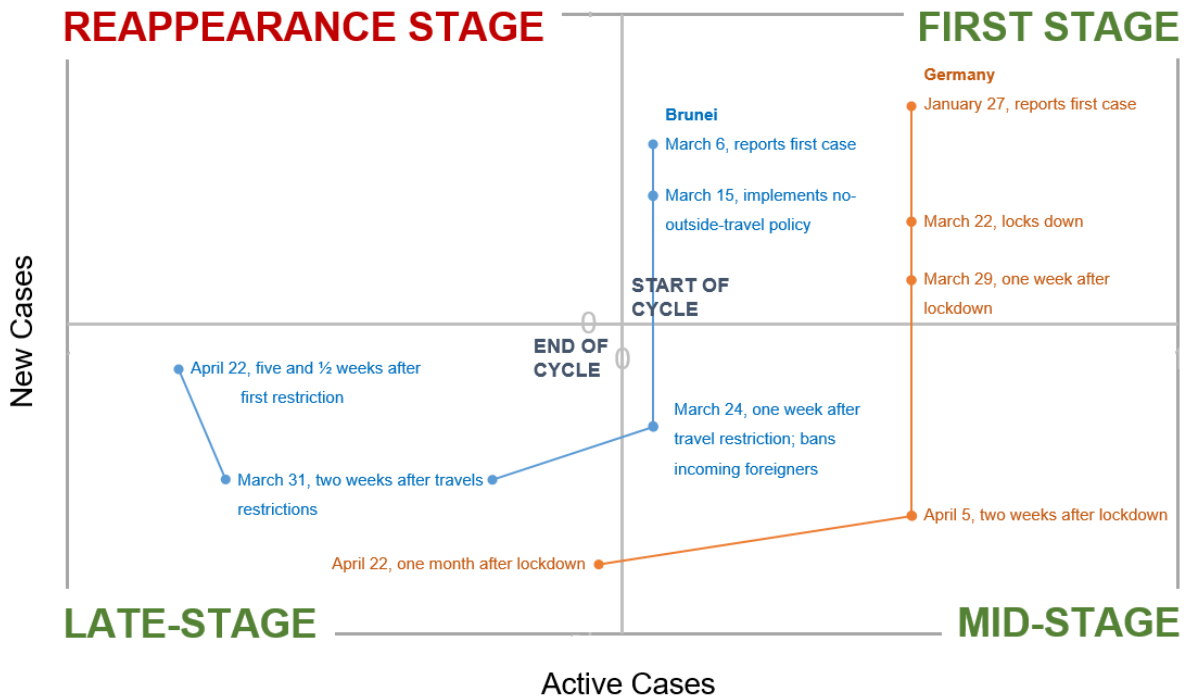
15. **ASEAN+3 economies are at varying stages of the Covid Cycle.** Nine of the 14 members are in late-stage (Figure 9). However, with the exception of Brunei, Cambodia, China, and Korea, the majority have only just entered this phase within the past two weeks. Some of the other economies, such as Indonesia, Japan, Myanmar and the Philippines are at or around the epi curve peak, straddling the border of first and mid-stage, with Singapore remaining in the first stage of the Cycle.<sup>3</sup>

16. **The “positions” of many countries are arguably not yet stable.** Any sudden increase in new cases—either from a surge in discovered cases, or new infections as a result of a premature lifting of containment measures—could see these countries slipping back. For example, the Philippines reached mid-stage in the week of April 10, but found itself back in the first stage the following week, driven by a resurgence in active cases, before reaching its current position. Singapore, currently in the first stage, had progressed quickly to the late-stage as early as February 21, but then regressed after March 6 following the discovery of new “clusters.” Even China moved between the first and mid-stages several times before finally settling in the late-stage and moving towards the end of the Cycle.

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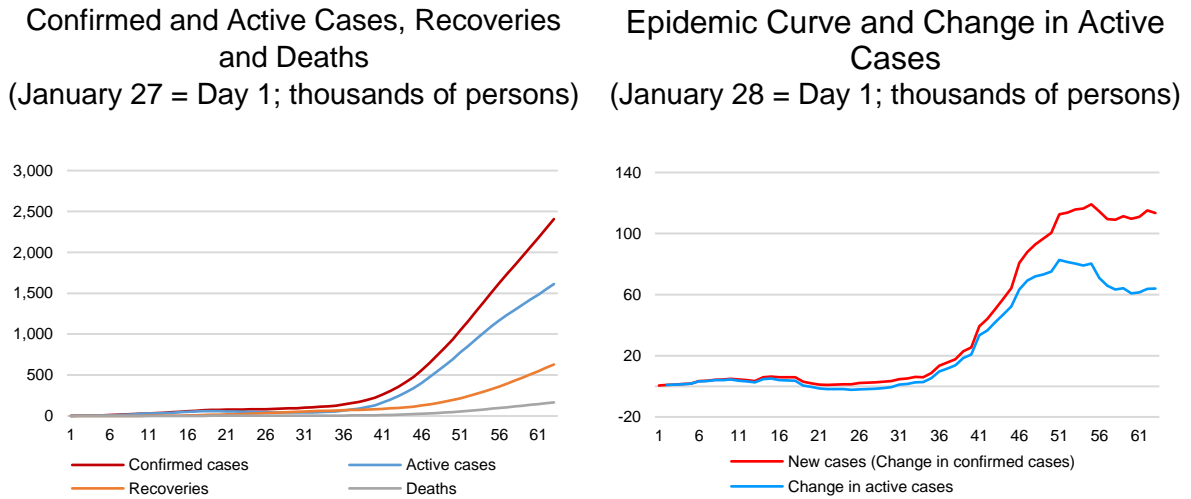
<sup>3</sup> Appendix I presents the individual epidemic curves and Covid Cycles for the ASEAN+3 and selected countries. As much as possible, chart axes are scaled by groups of like countries to magnify the images and enable comparison, but they also highlight the issues relating to the large differences in the spread of the disease and/or the quality of the reported data.

**Figure 4. Brunei Darussalam and Germany: Progress through the Covid Cycle, as of April 22, 2020**  
(Change in number of cases per 1 million population)



Sources: Various media; and AMRO staff estimates.

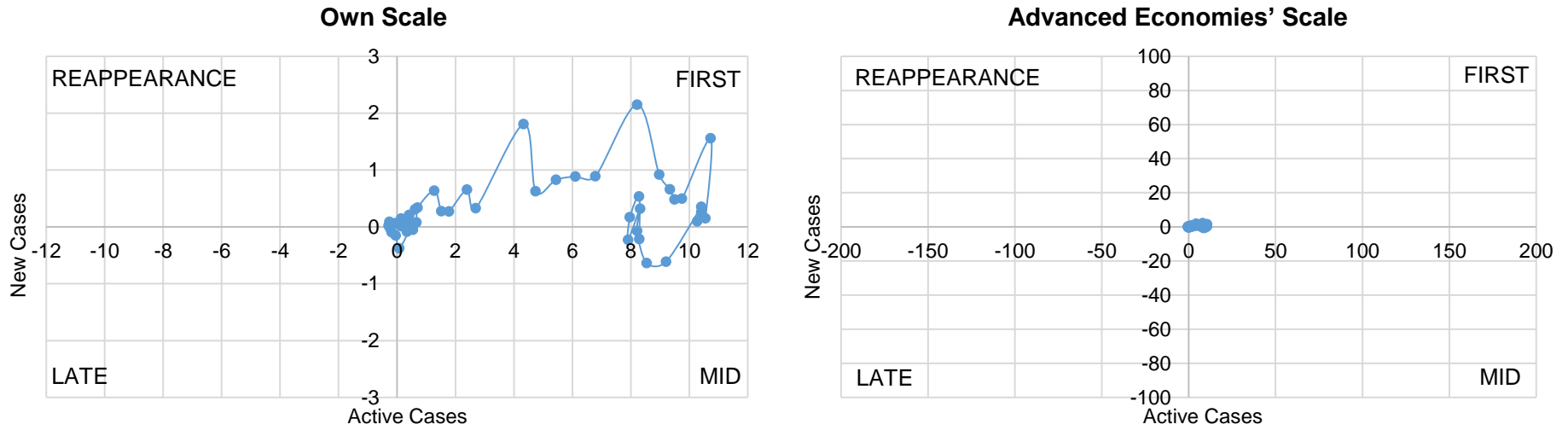
**Figure 5. World: COVID-19 Developments**



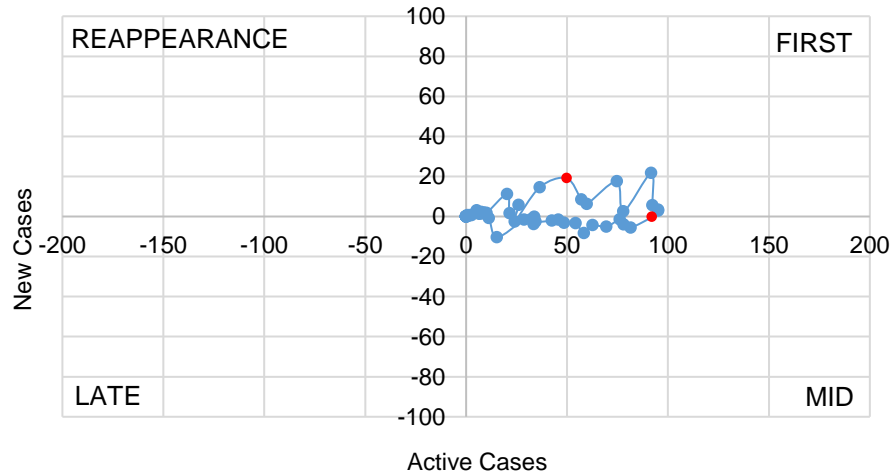
Sources: Johns Hopkins Coronavirus Resource Center; and AMRO staff calculations.  
Note: Numbers are calculated as rolling 7-day averages to smooth daily volatilities.



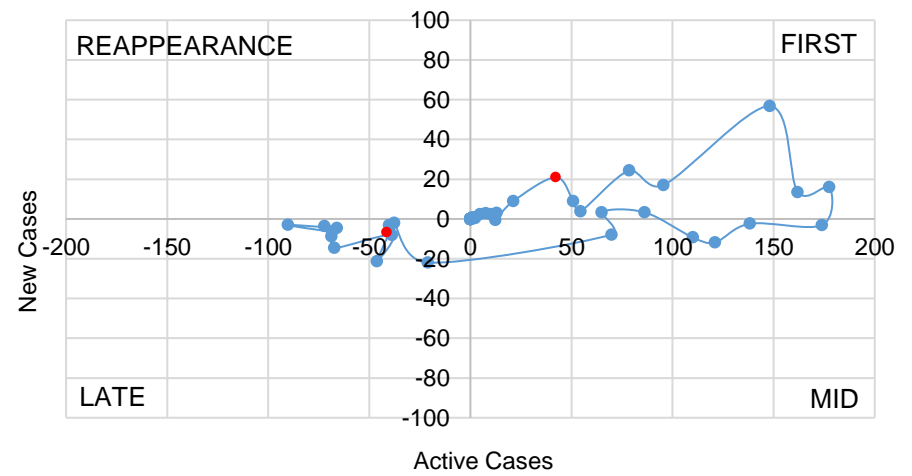
**Figure 6. Covid Cycle: World**  
(Change in number of persons per 1 million population)



**Figure 7. Covid Cycle: Italy**  
(Change in number of persons per 1 million population)

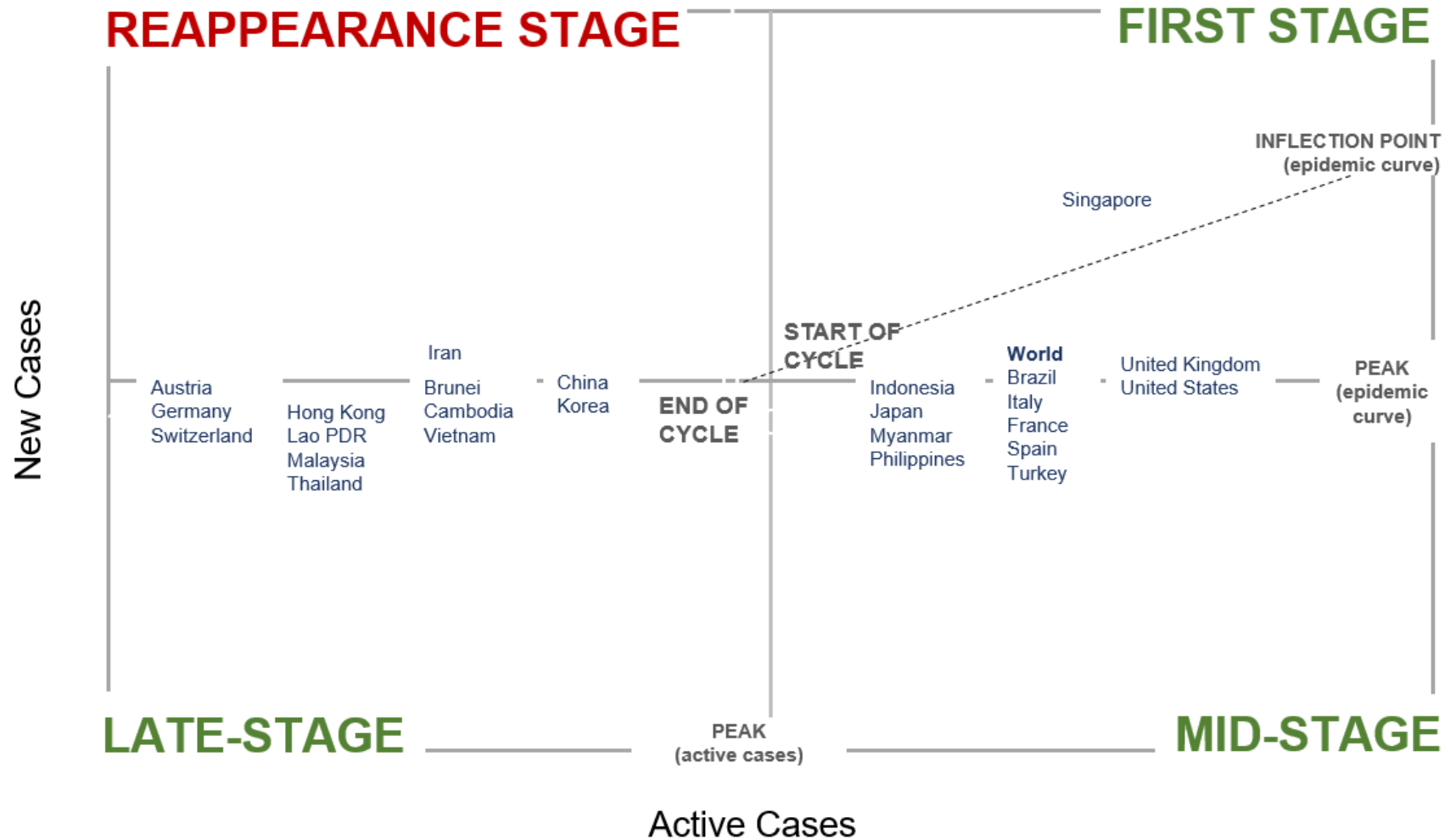


**Figure 8. Covid Cycle: Switzerland**  
(Change in number of persons per 1 million population)



Sources: Johns Hopkins Coronavirus Resource Center; and AMRO staff estimates.  
Note: Numbers are calculated as rolling 7-day averages to smooth daily volatilities. Red dot represents day when lockdown was implemented or extended.

**Figure 9. ASEAN+3 and Selected Economies: Stage of the Covid Cycle as of April 22, 2020**  
 (Change in number of persons per 1 million population)



Source: AMRO staff estimates.

Note: The recovery statistics for the United Kingdom has not been reported since April 13, 2020.

17. **The Covid Cycle provides a tool for policymakers to plan their containment responses.** Those in the first stage may need to be stricter in their policy measures in order to “flatten the curve.” For example, the Cycle suggests that the current Manila lockdown—put in place since March 16 and extended on April 7—may yet see another extension (Table 2). Japan, on the other hand, had been hovering around the first stage, and the declaration of a state of emergency on April 8, followed by a nationwide state of emergency on April 16, may have moved the country to the peak of the epi curve. On the other hand, countries that are comfortably in the late-stage of the Cycle may consider starting to cautiously ease some of their restrictions on movement and internal travel bans, in order to restart economic activity. For example, China’s lifting of its Wuhan lockdown was consistent with it being at almost the end-point of the Cycle.

18. **The Covid Cycle also allows policymakers to monitor developments in other countries and to learn from actions taken elsewhere.** For instance, the easing of restrictions in other parts of the world could provide insights into when and how to safely reopen an economy. Austria, which is well into the late stage, reopened non-essential businesses from April 14; the Swiss, also deep into late-stage, will start easing restrictions from 27 April. This tool could also provide information on which countries to be wary of when lifting international travel bans. For example, Spain has partially restarted economic activity, even though it is still in between the first to mid-stages of the Cycle, and some US states are planning to reopen businesses, although the country as a whole is also in between the first and mid-stages of the Cycle (with the possibility of inter-state travel and cross-infections).

**Table 2. ASEAN+3: Implementation of Containment Measures**

Timeline of Implementation	Economy	Type of Measure	Stage of Cycle	
			As of Implementation Date	As of April 22, 2020
23 Jan 2020	China <sup>e</sup>	Lockdown of cities in Hubei; outdoor restrictions and closed management on community basis elsewhere	First	Late
25 Jan 2020	Hong Kong	Limited closures	First	Late
15 Mar 2020	Brunei	Overseas travel ban	First	Late
16 Mar 2020	Philippines	Community quarantine	First	First - Mid
18 Mar 2020	Malaysia	Movement control order	First	Late
24 Mar 2020	Myanmar	Community (village) lockdown	—	First - Mid
26 Mar 2020	Thailand	Partial lockdown	First	Late
30 Mar 2020	Lao PDR	Lockdown	First	Late
1 Apr 2020	Vietnam	Lockdown	Mid	Late
7 Apr 2020	Indonesia	Partial lockdown around Jakarta	First	First - Mid
	Singapore	Lockdown	First	First
8 Apr 2020	Japan	Request-based distancing	First	First - Mid
10 Apr 2020	Cambodia	Lockdown	Late	Late

Sources: Various media articles; and AMRO staff.

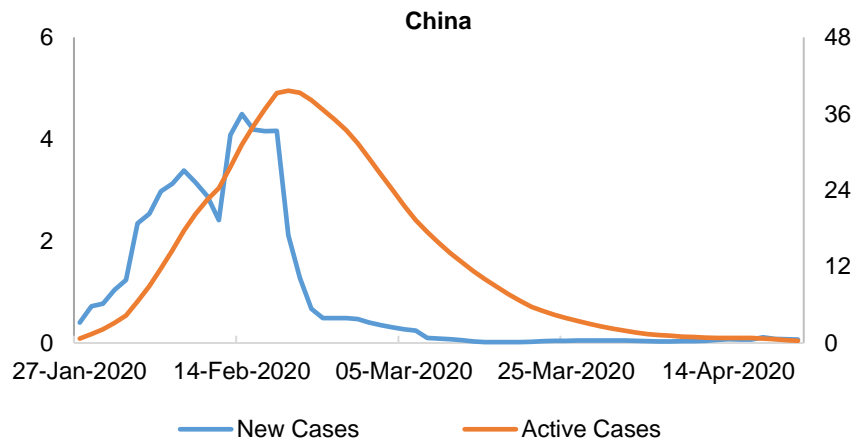
Note: The measures refer to the initial implementation of lockdowns (full or partial); city, provincial, and/or community quarantines; similar movement control orders; large-scale social distancing and isolation measures; and restricted outward border movements. Policies may or may not be accompanied by announcements of state of emergency. Bans against foreigners’ inward travel, if implemented prior to aforementioned date, and subsequent extensions of the measures above, are not covered. Those marked as “lockdowns” may still have exempted portions of the country.

<sup>e</sup> Measure has expired/ been lifted.

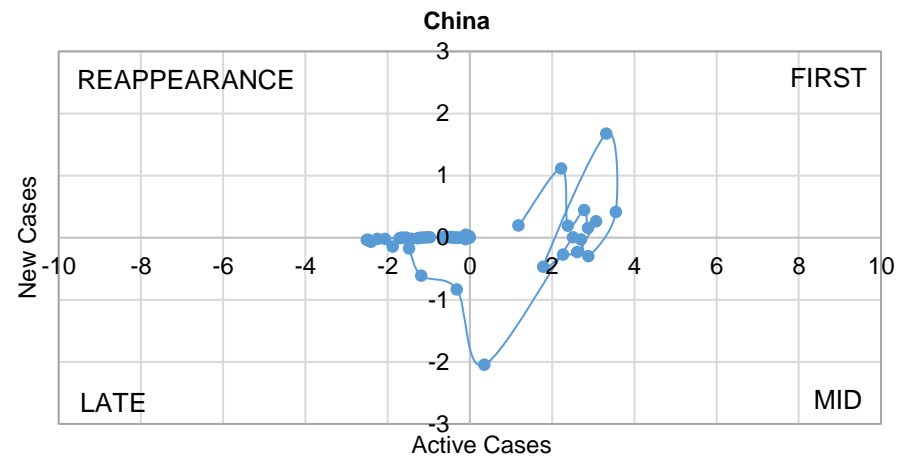
**Appendix I. The Epidemic Curves and Covid Cycles of ASEAN+3 and Other Economies**

**Appendix Figure 1. ASEAN+3 and Selected Countries: Epidemic Curve and Covid Cycle, as of April 22, 2020**  
 (Level per 1 million population; change in number of persons per 1 million population)

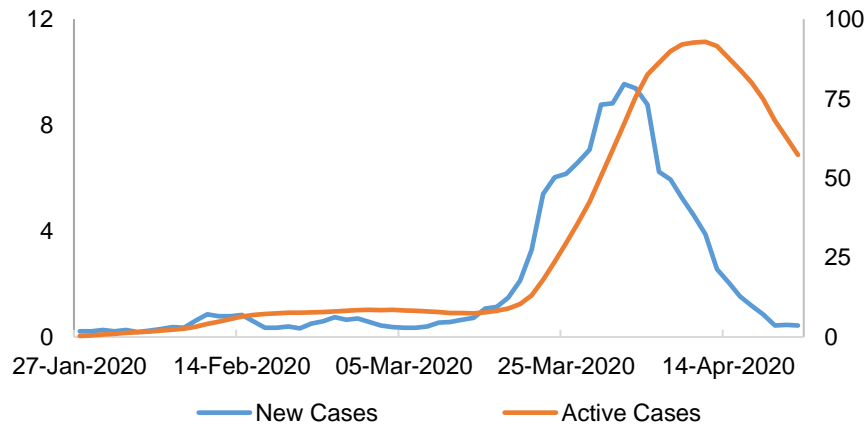
**Epidemic Curve and Active Cases**



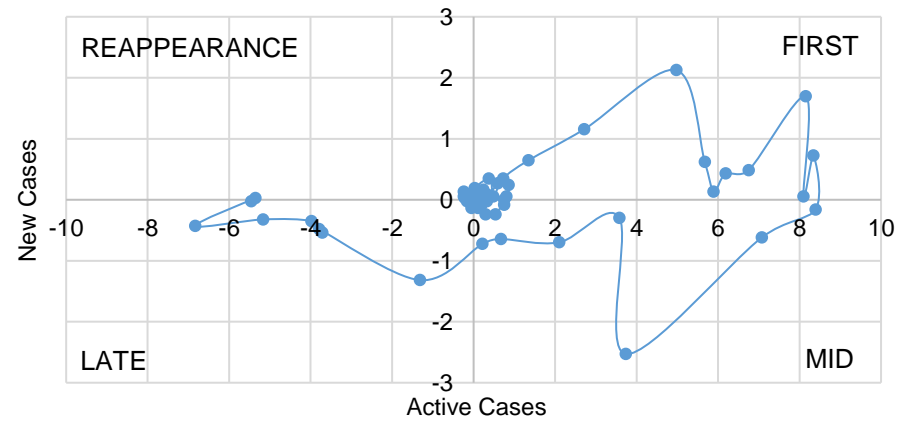
**Covid Cycle**



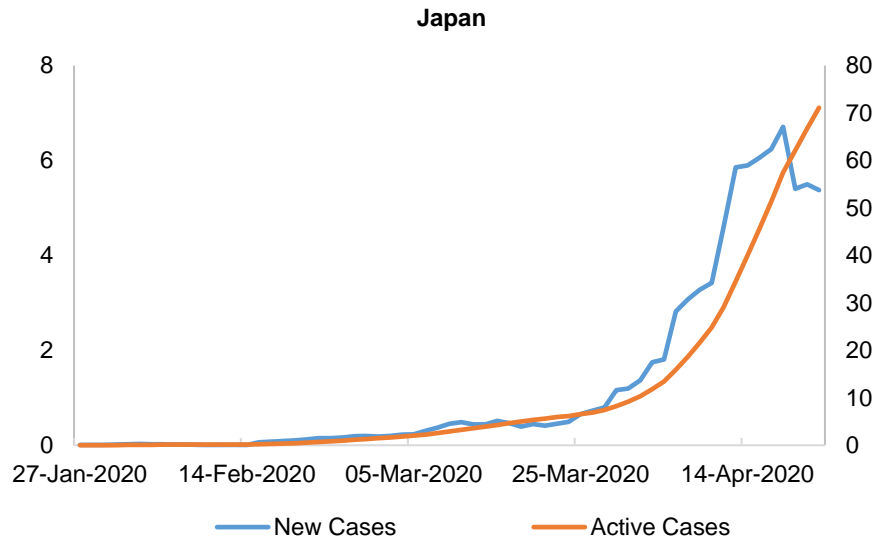
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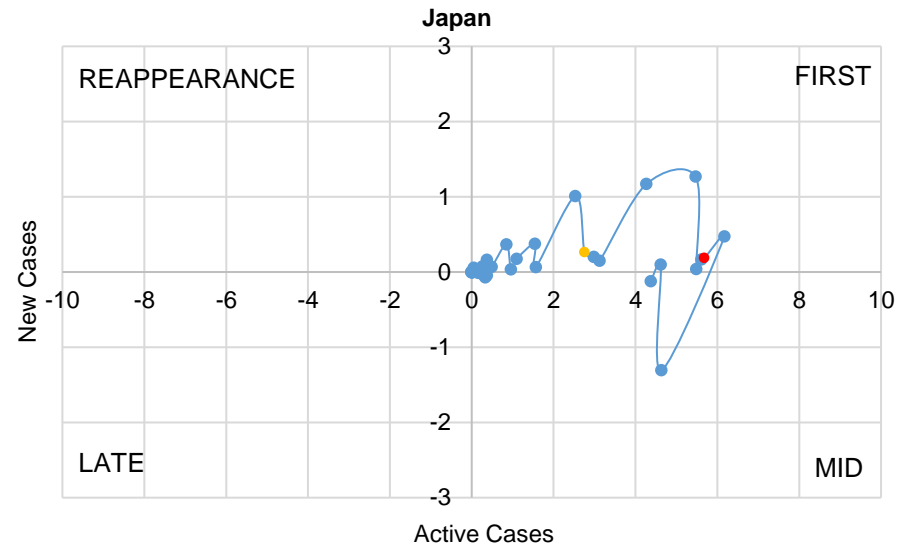
**Hong Kong, China**



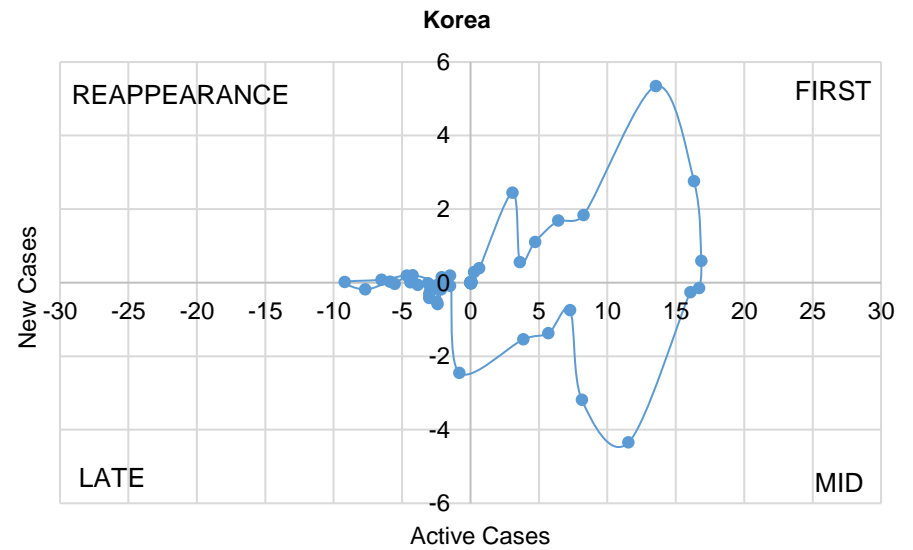
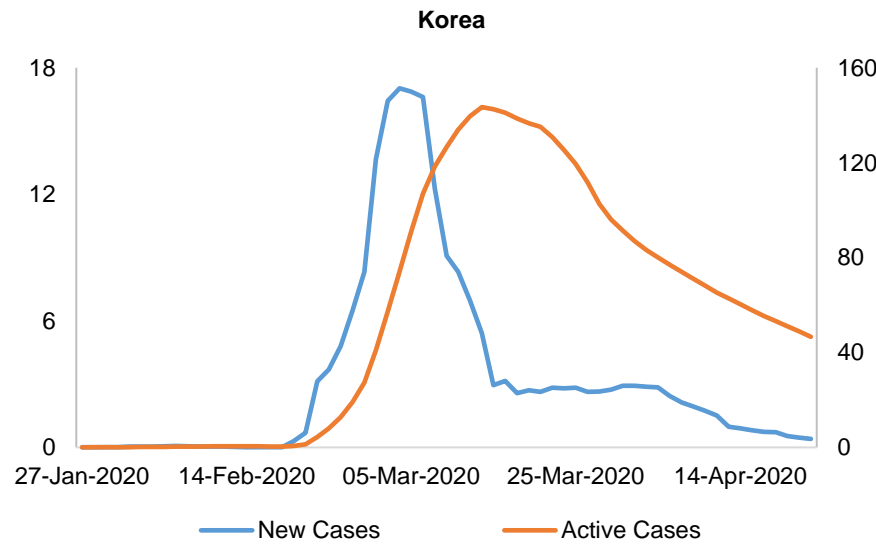
### Epidemic Curve and Active Cases



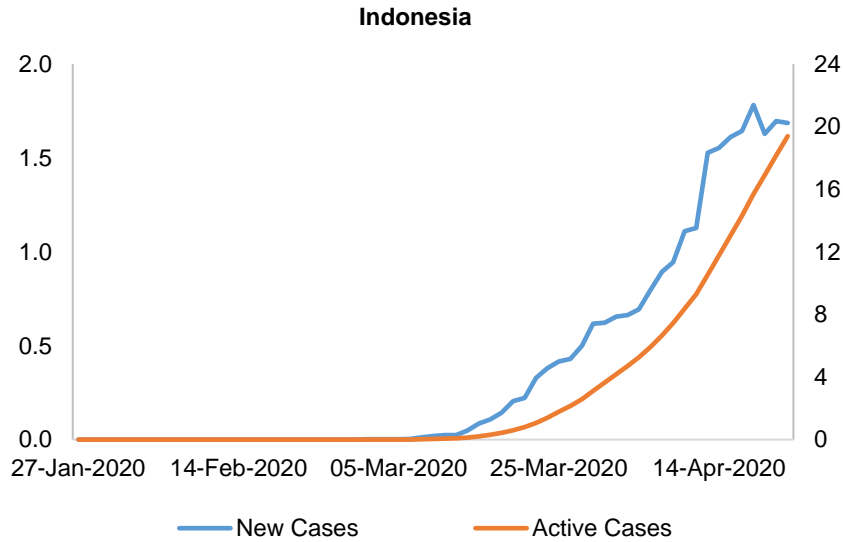
### Covid Cycle



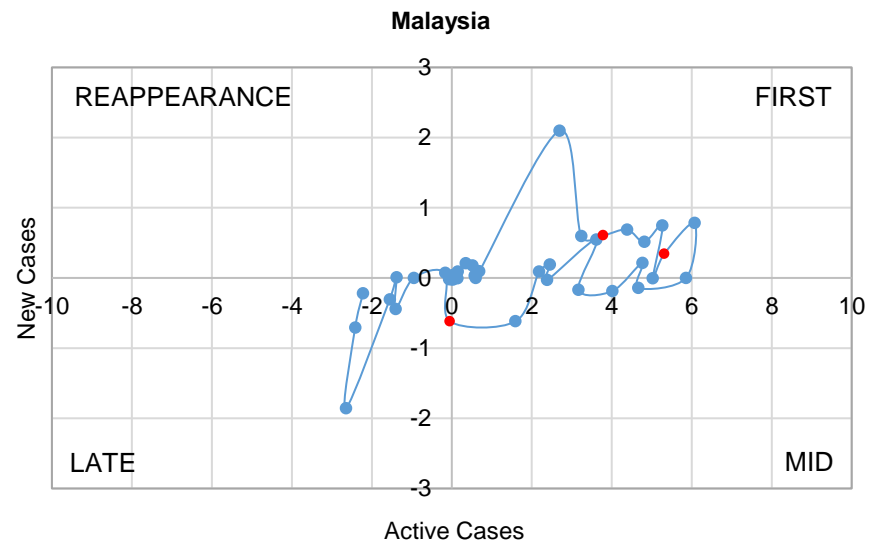
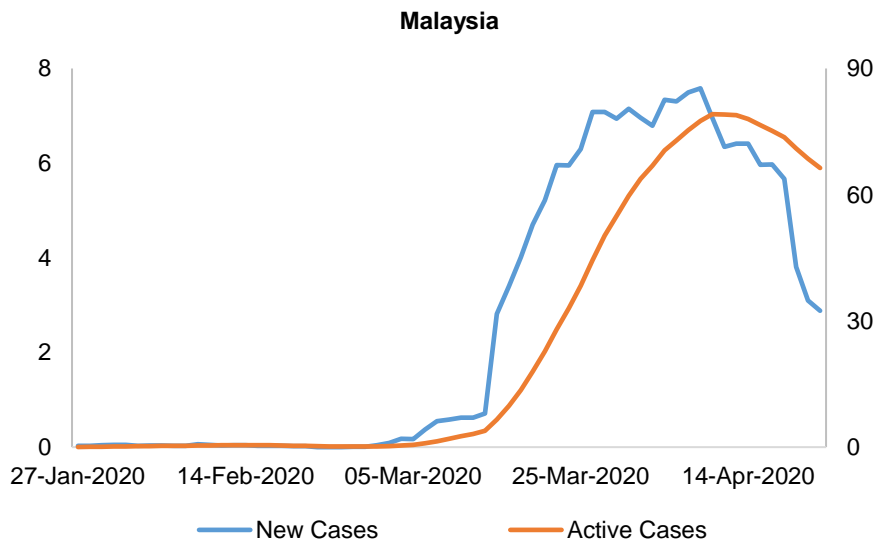
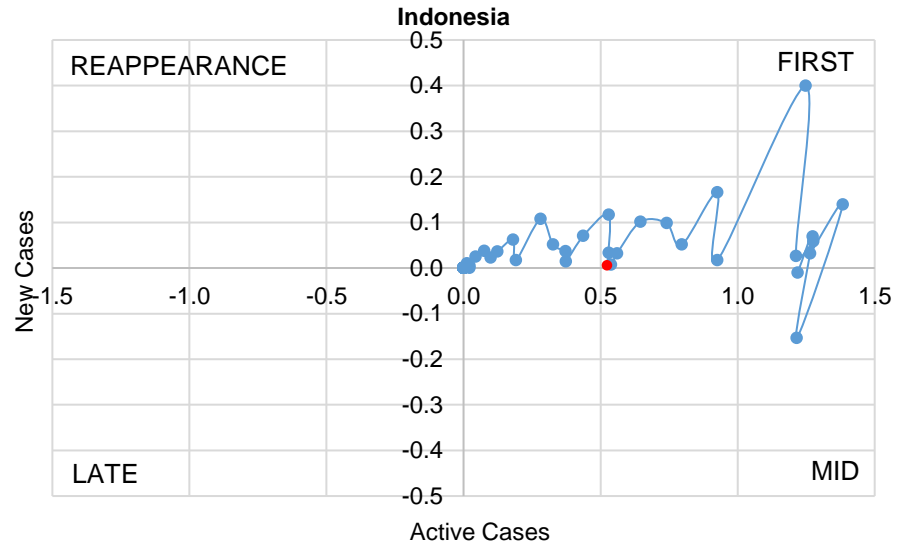
Note: Yellow dot represents declaration of emergency in selected prefectures; red dot for nationwide.



### Epidemic Curve and Active Cases

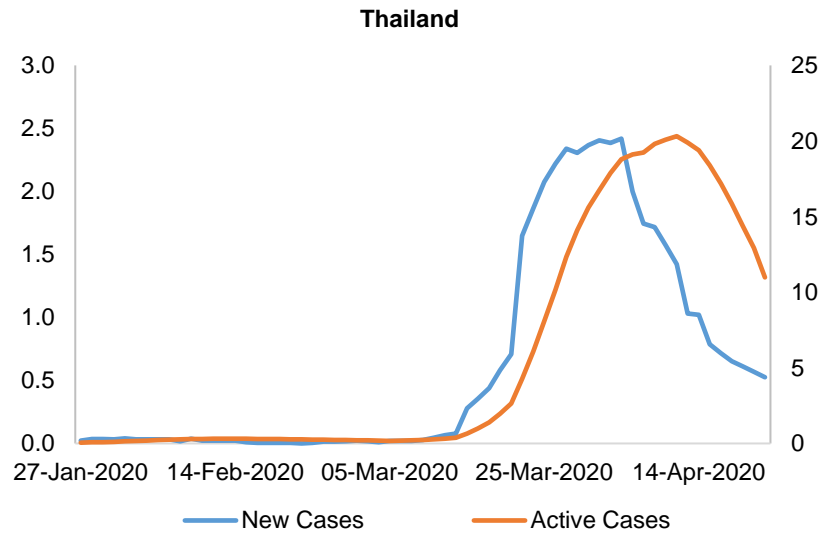
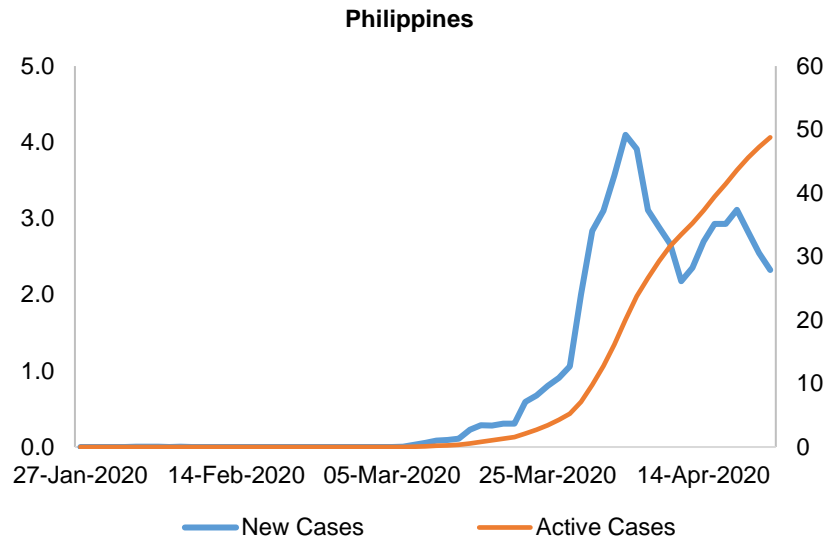


### Covid Cycle

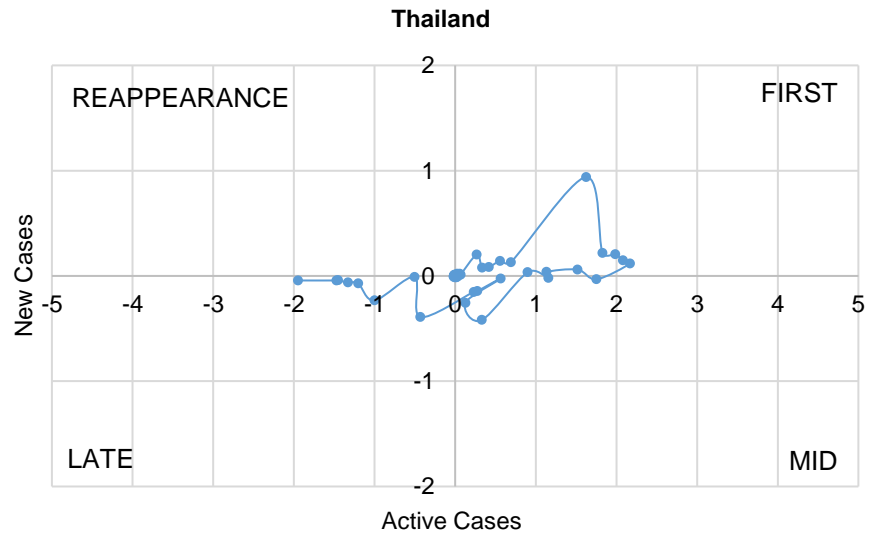
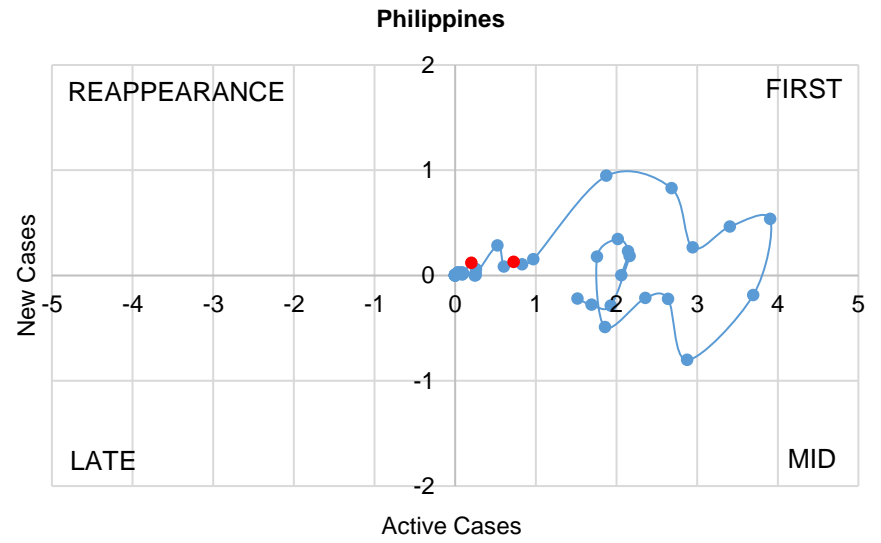


Note: Red dot represents day when lockdown was implemented or extended.

### Epidemic Curve and Active Cases



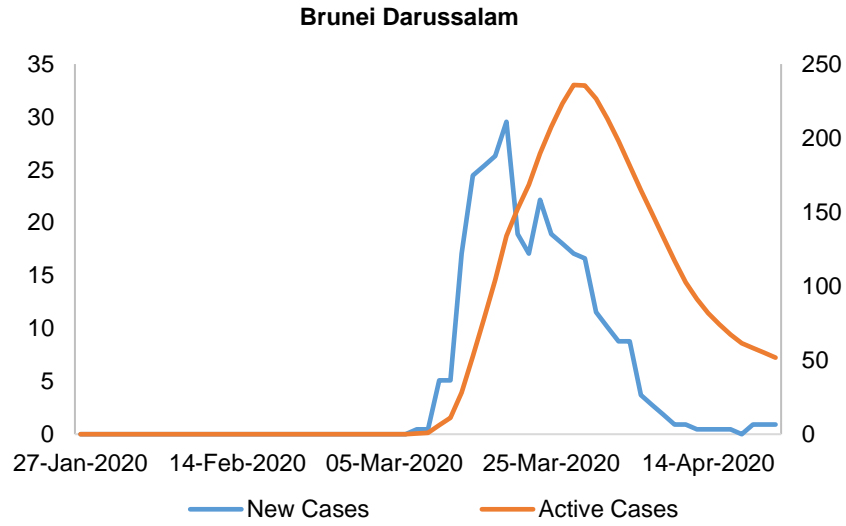
### Covid Cycle



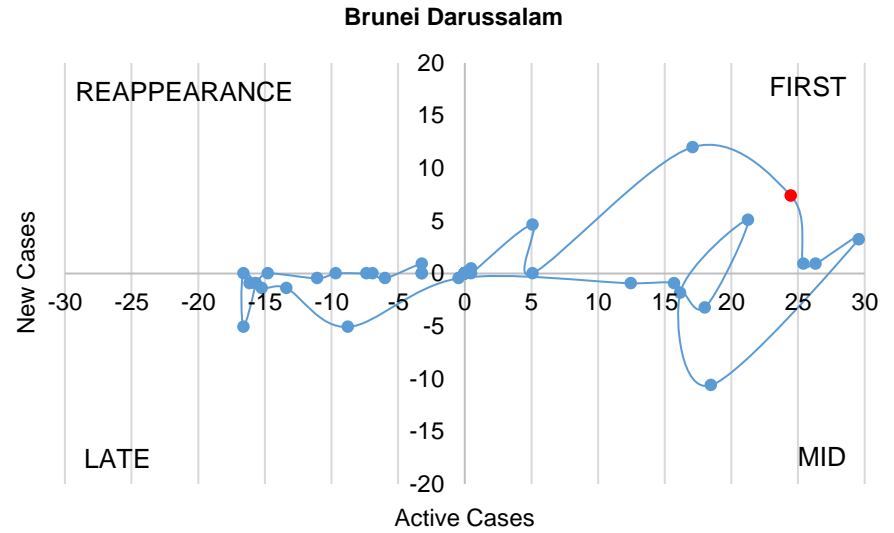
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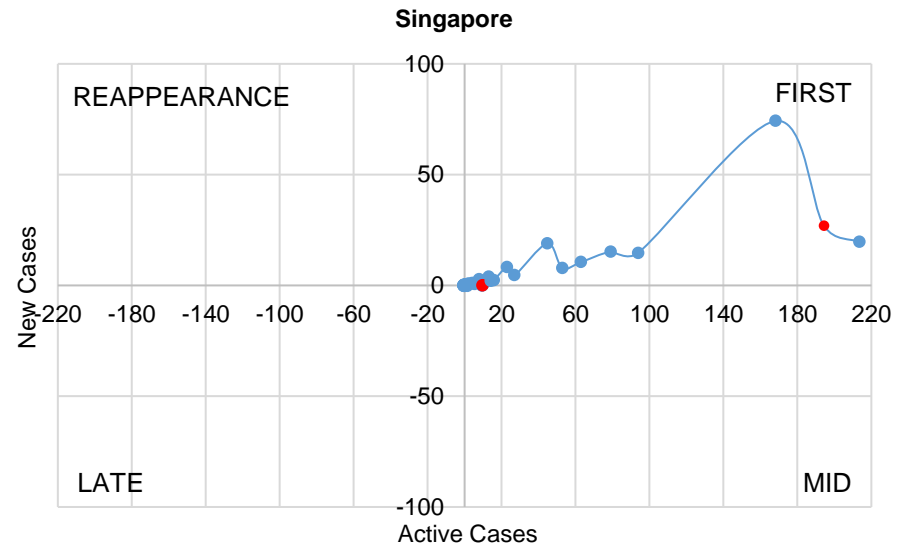
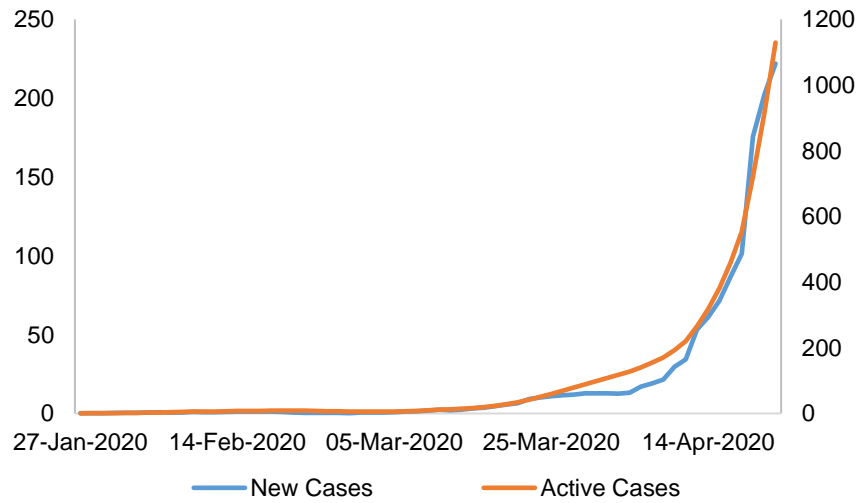
**Epidemic Curve and Active Cases**



**Covid Cycle**

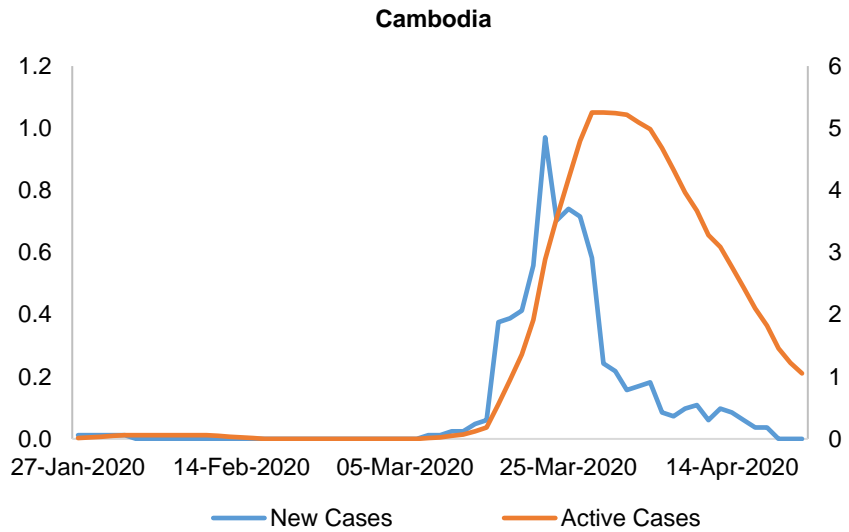


**Singapore**

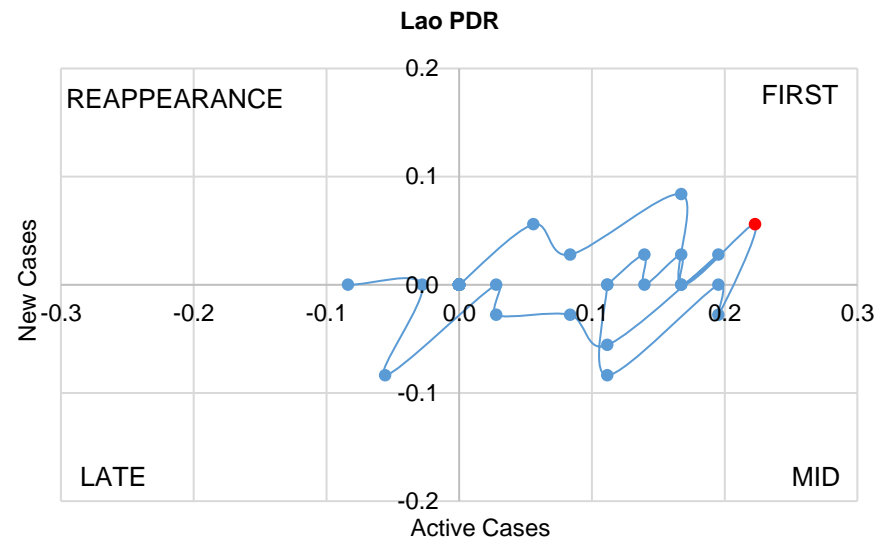
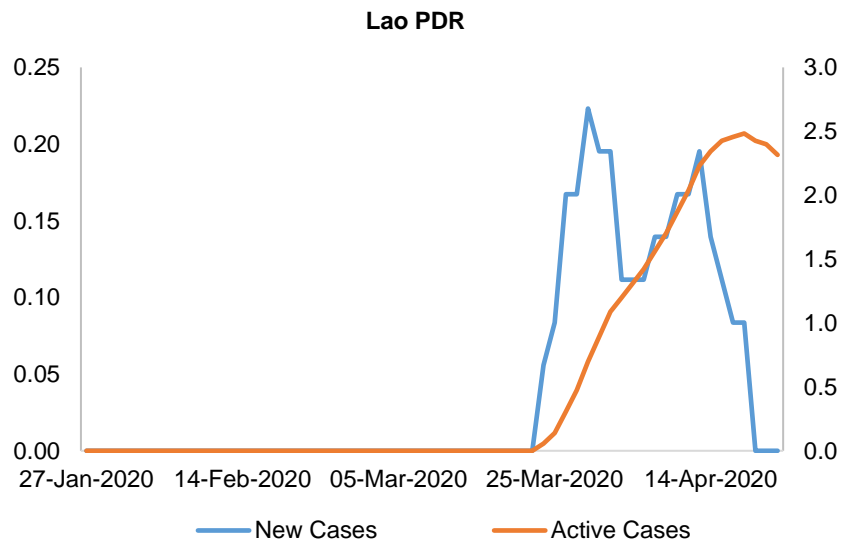
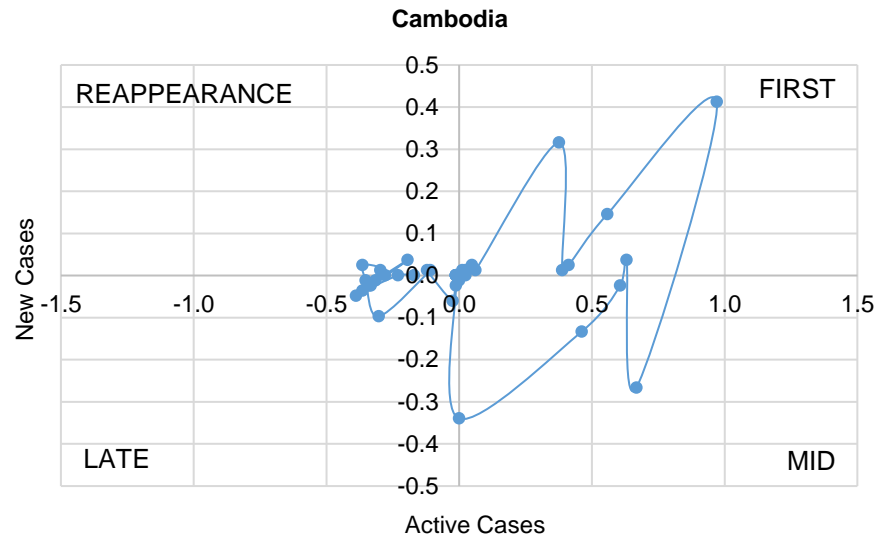


Note: Red dot represents day when lockdown was implemented or extended.

### Epidemic Curve and Active Cases

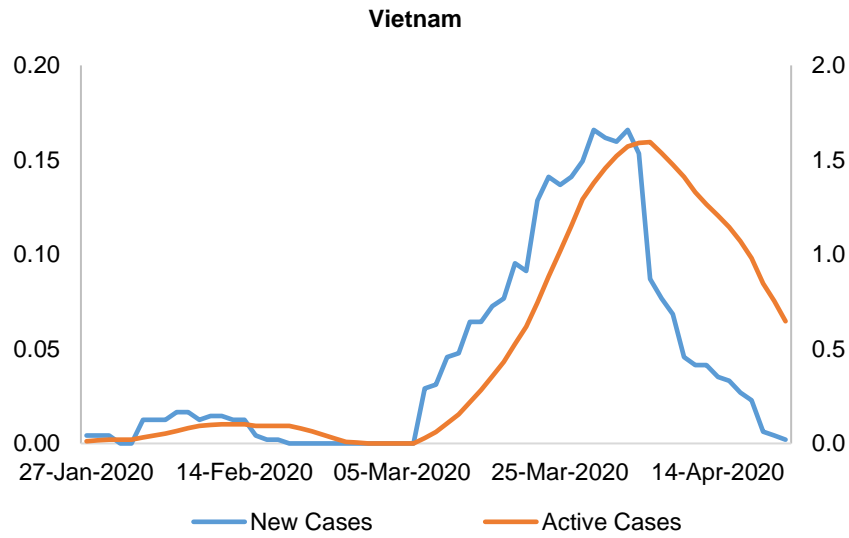
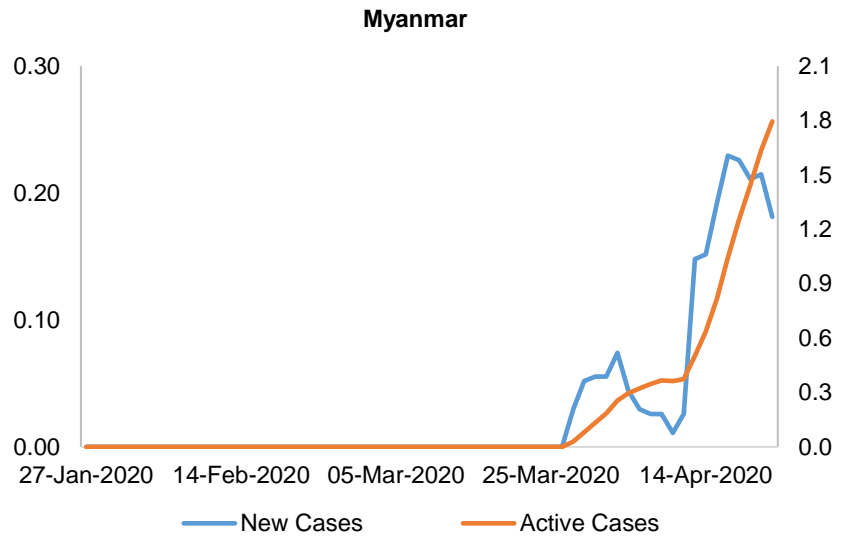


### Covid Cycle

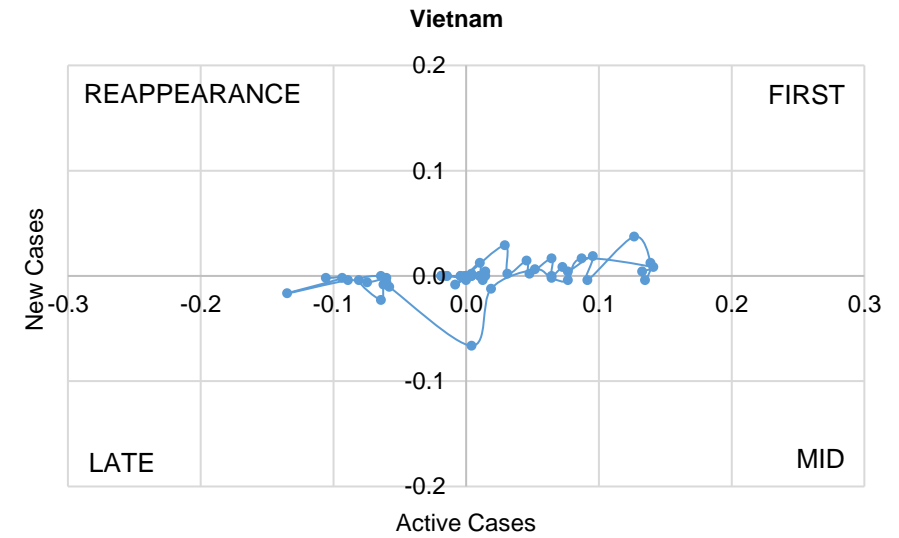
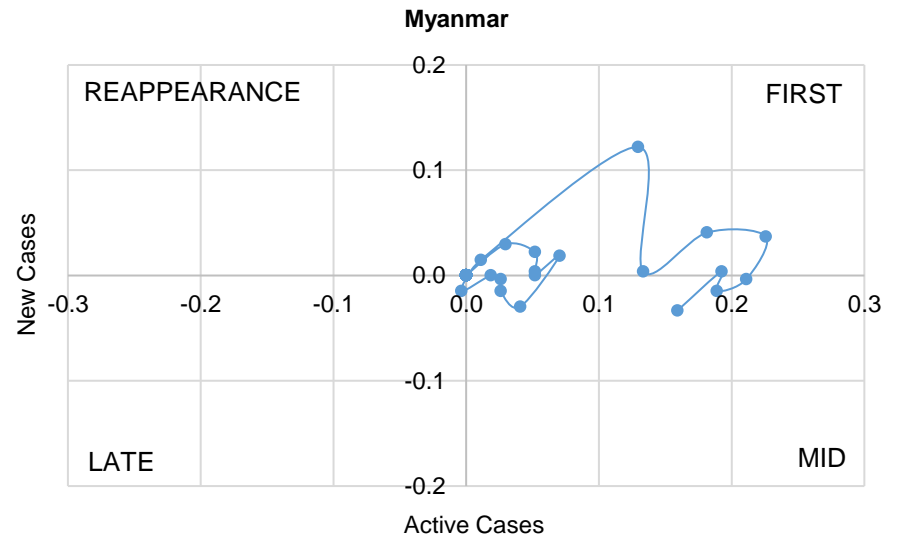


Note: Red dot represents day when lockdown was implemented or extended.

**Epidemic Curve and Active Cases**

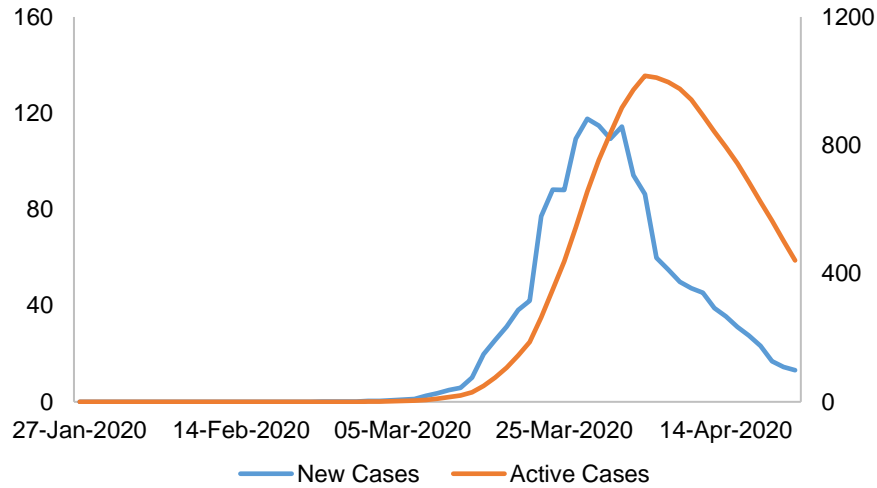


**Covid Cycle**



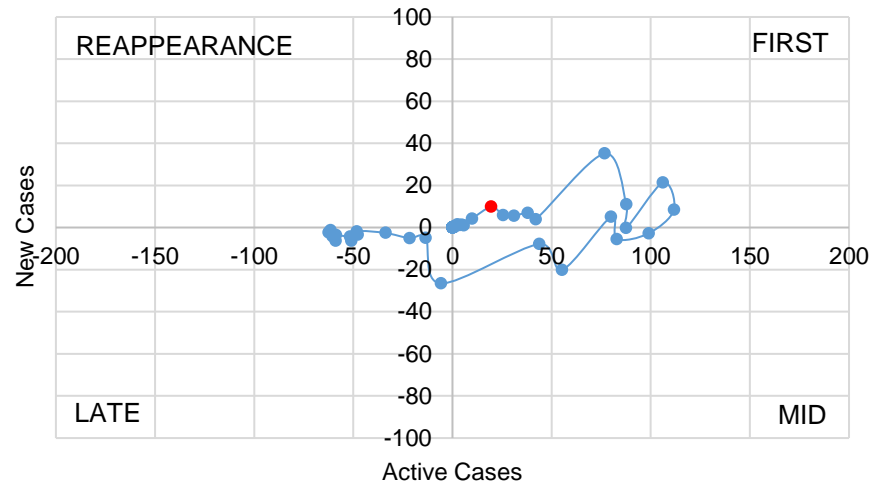
**Epidemic Curve and Active Cases**

**Austria**

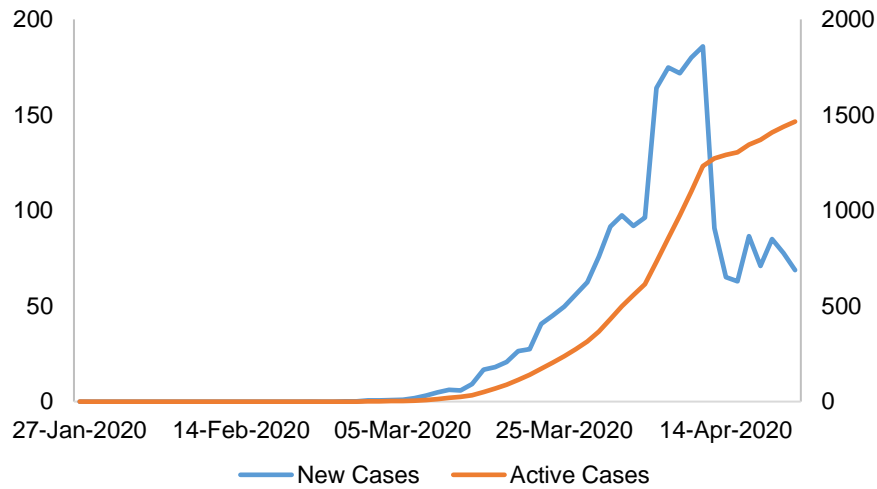


**Covid Cycle**

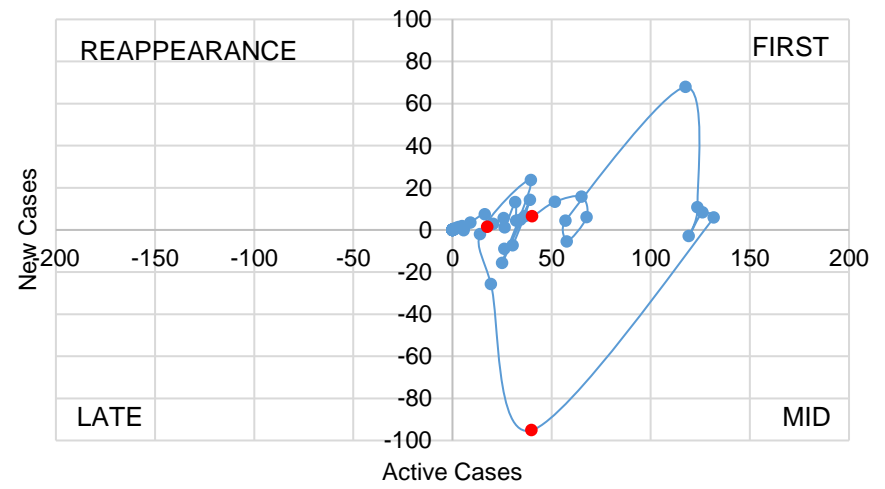
**Austria**



**France**



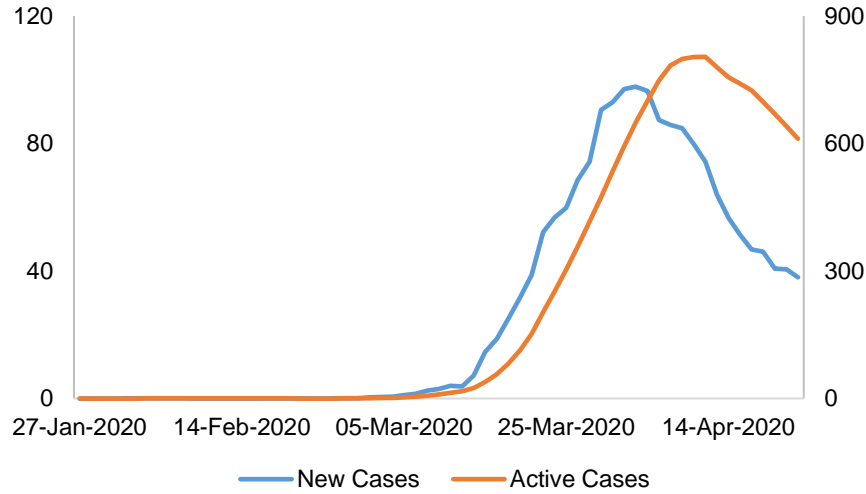
**France**



Note: Red dot represents day when lockdown was implemented or extended.

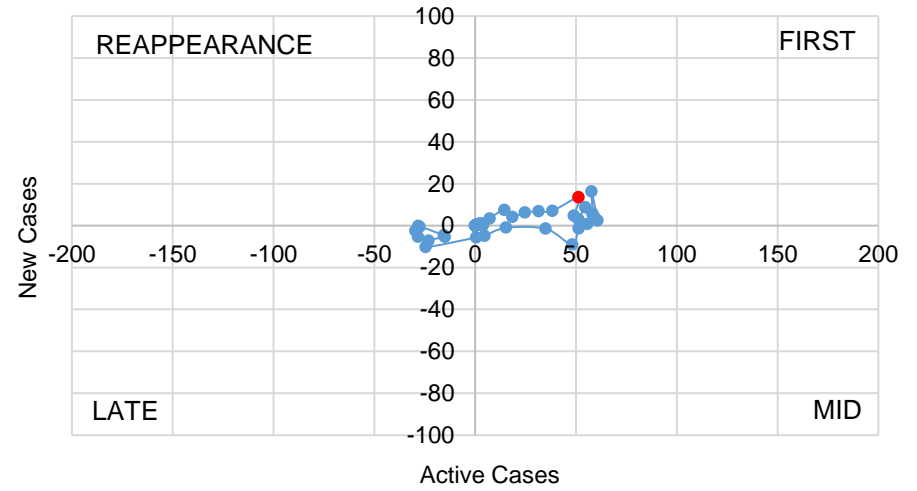
### Epidemic Curve and Active Cases

#### Germany

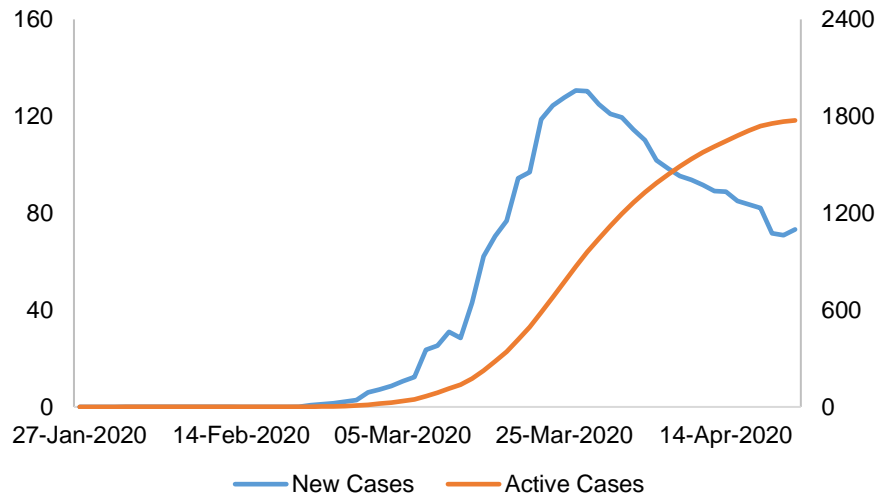


### Covid Cycle

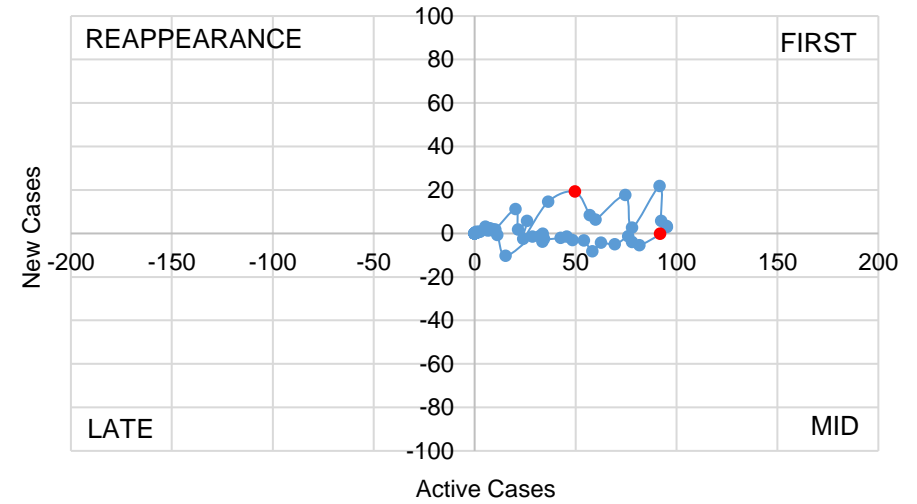
#### Germany



#### Italy

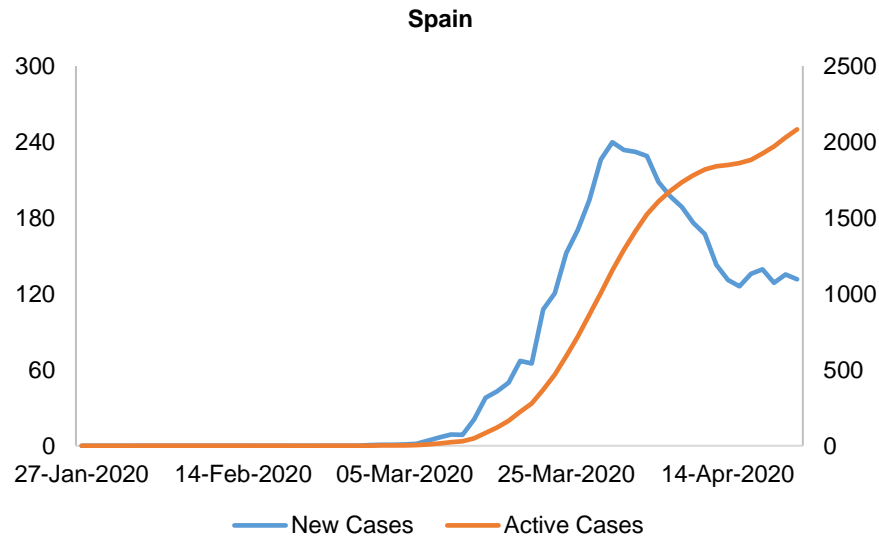


#### Italy

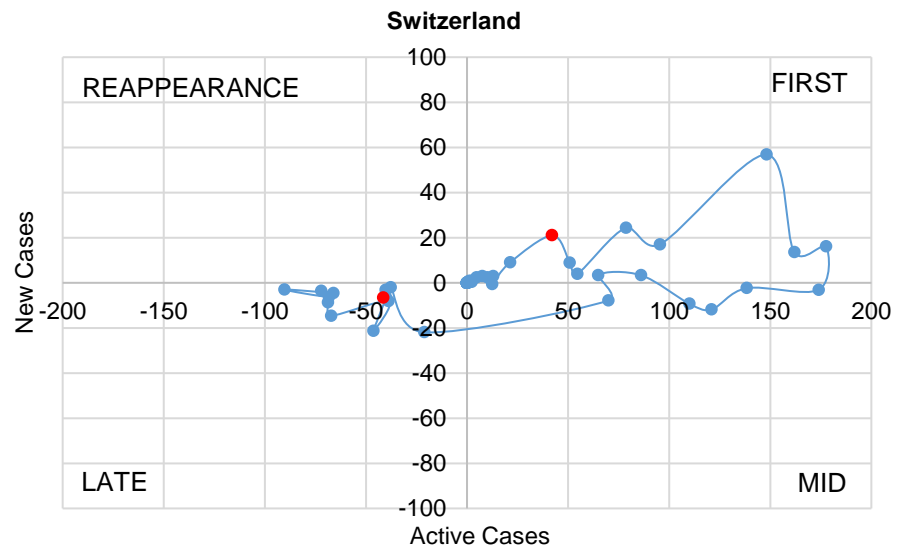
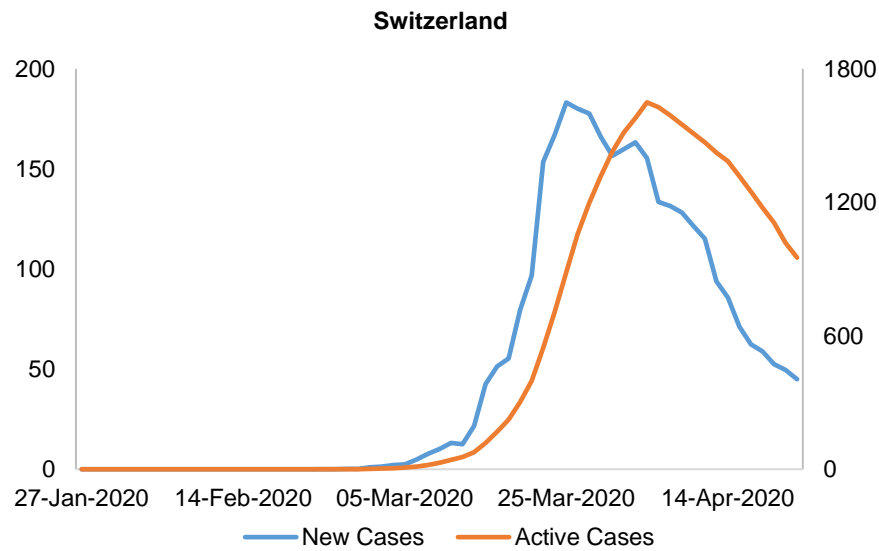
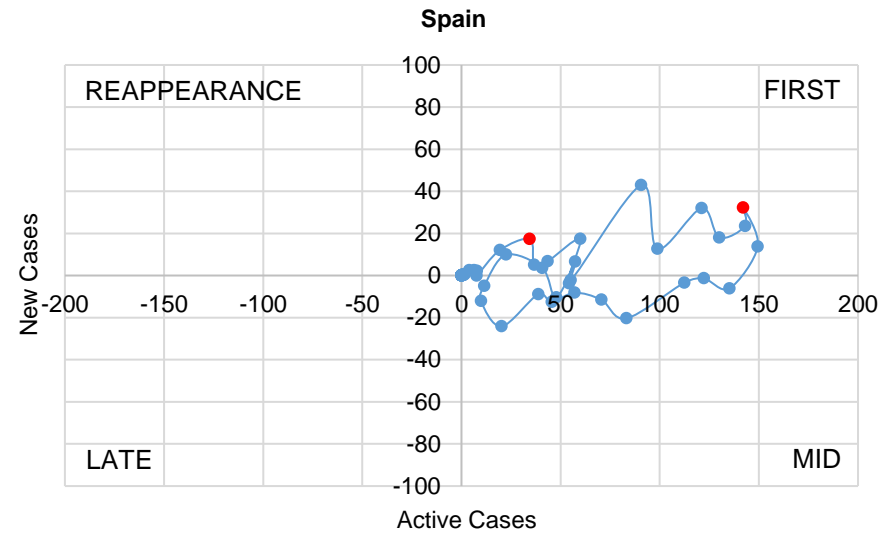


Note: Red dot represents day when lockdown was implemented or extended.

### Epidemic Curve and Active Cases



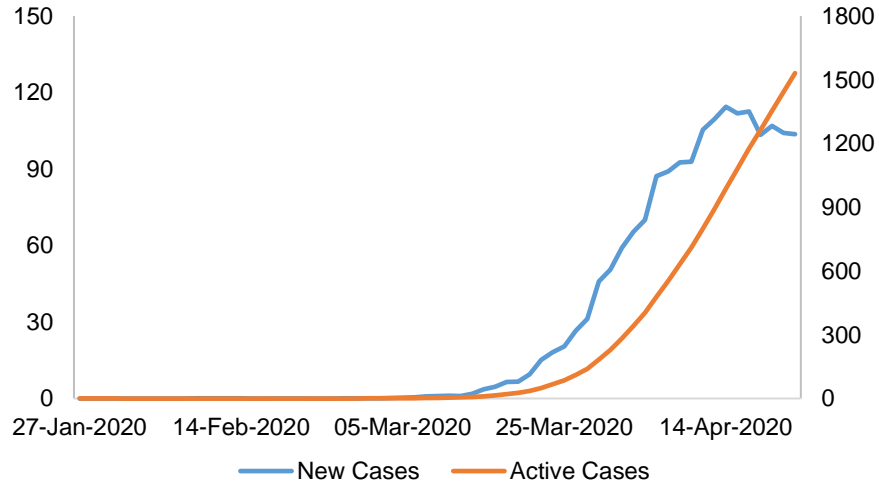
### Covid Cycle



Note: Red dot represents day when lockdown was implemented or extended.

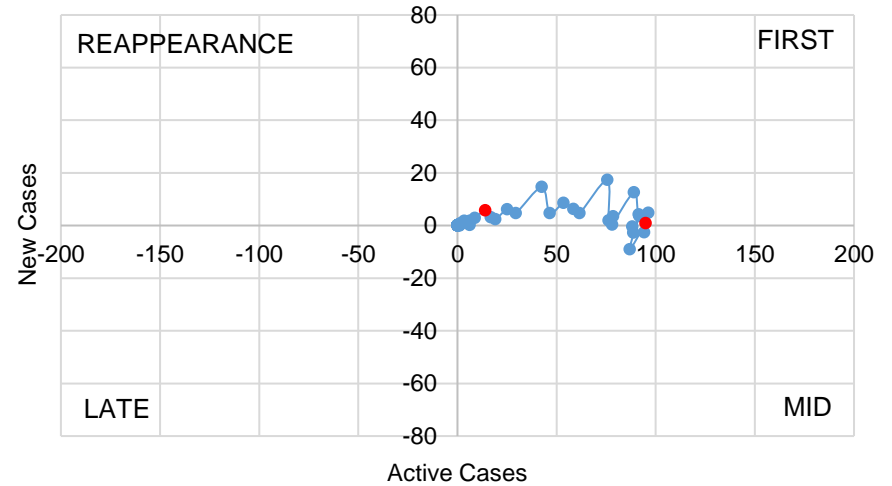
### Epidemic Curve and Active Cases

United Kingdom



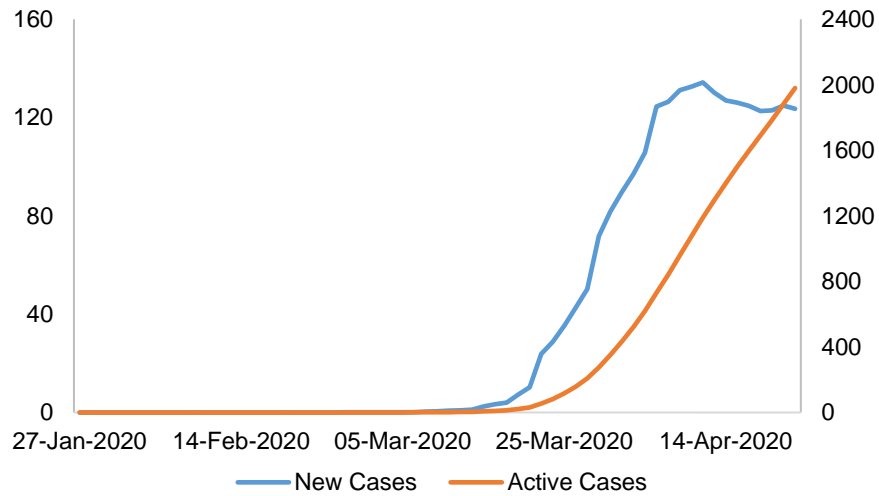
### Covid Cycle

United Kingdom

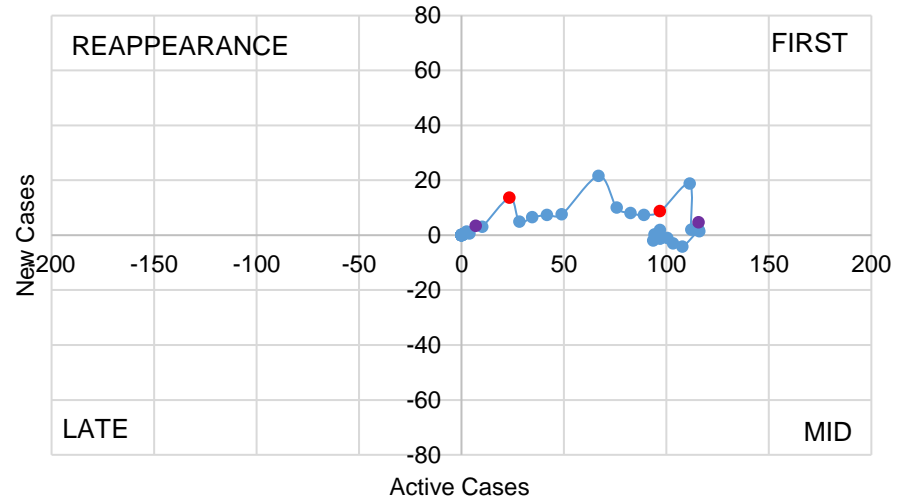


Note: The recovery statistics for the United Kingdom has not been reported since April 13, 2020.

United States



United States

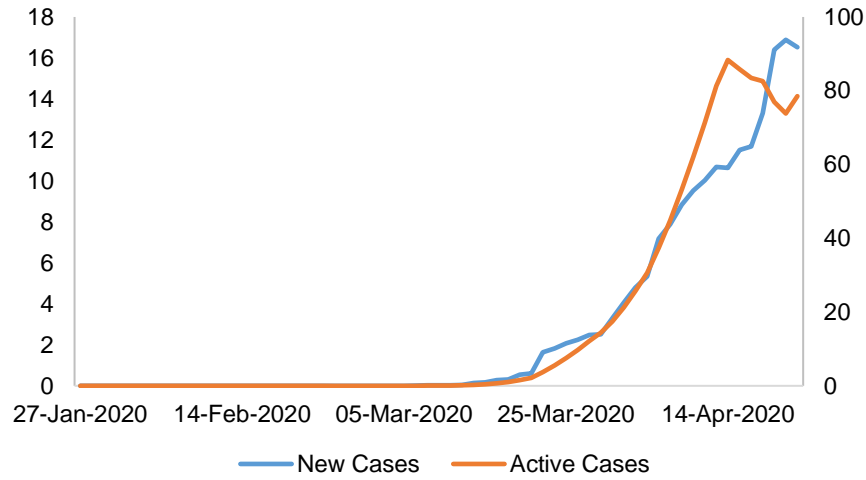


Note: Chart only shows lockdown days for California (purple) and New York (red).



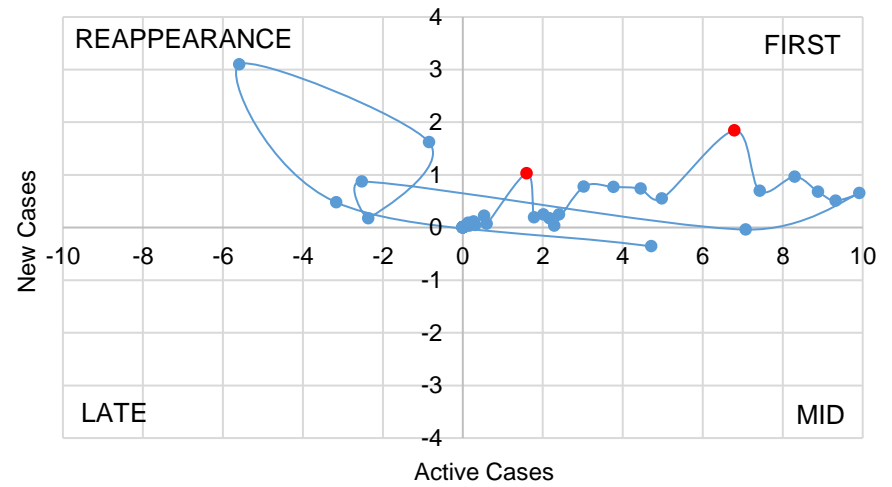
### Epidemic Curve and Active Cases

#### Brazil

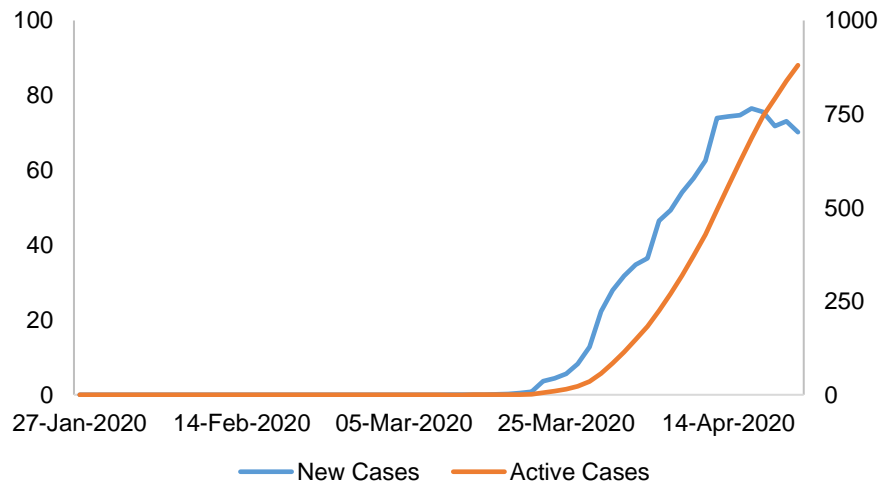


### Covid Cycle

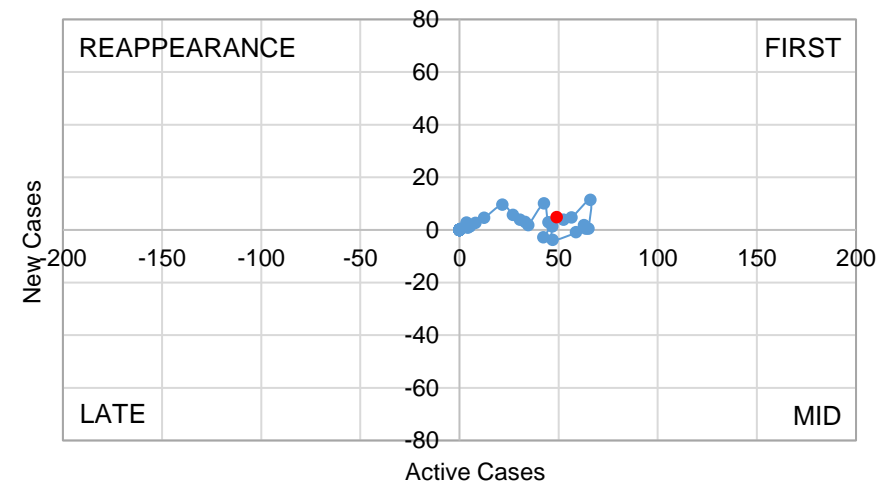
#### Brazil



#### Turkey



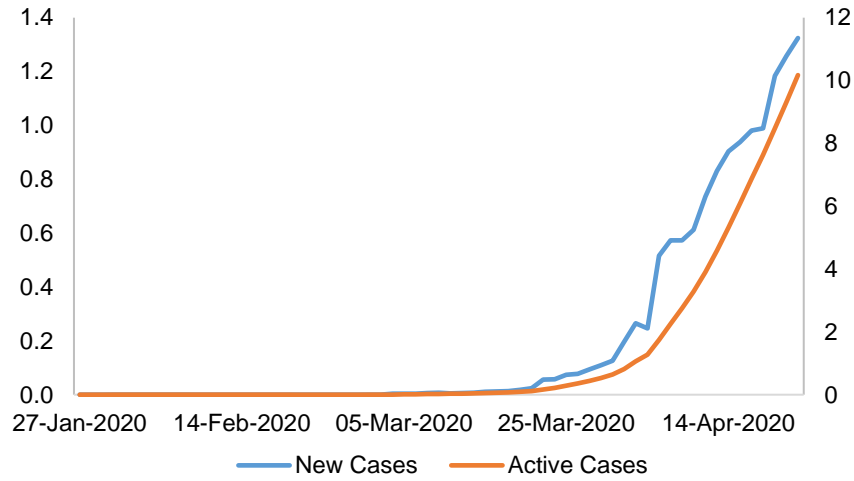
#### Turkey



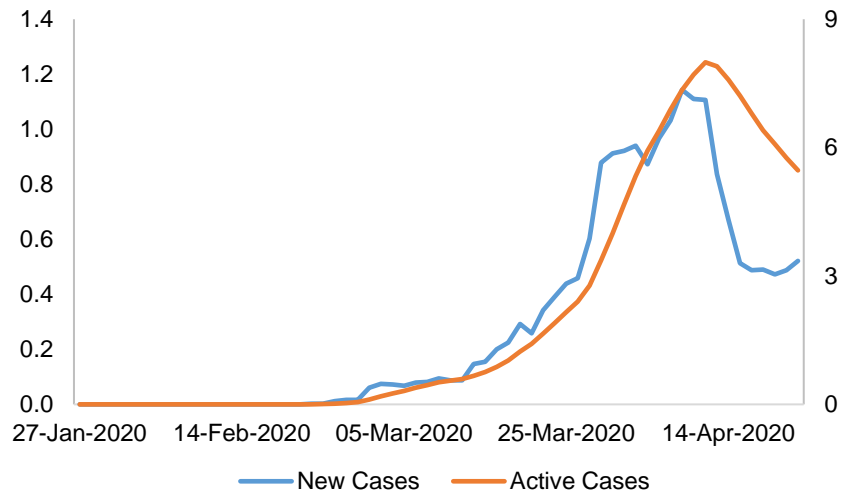
Note: Red dot represents day when lockdown was implemented or extended.

### Epidemic Curve and Active Cases

India

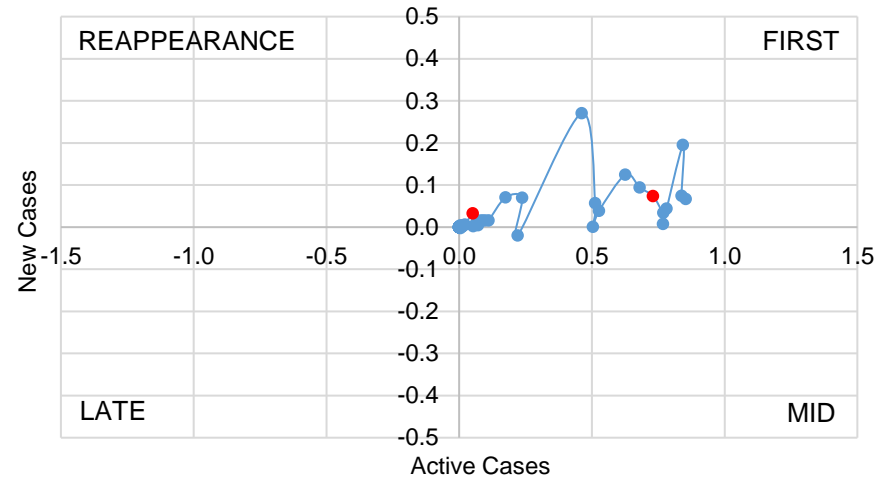


Iran

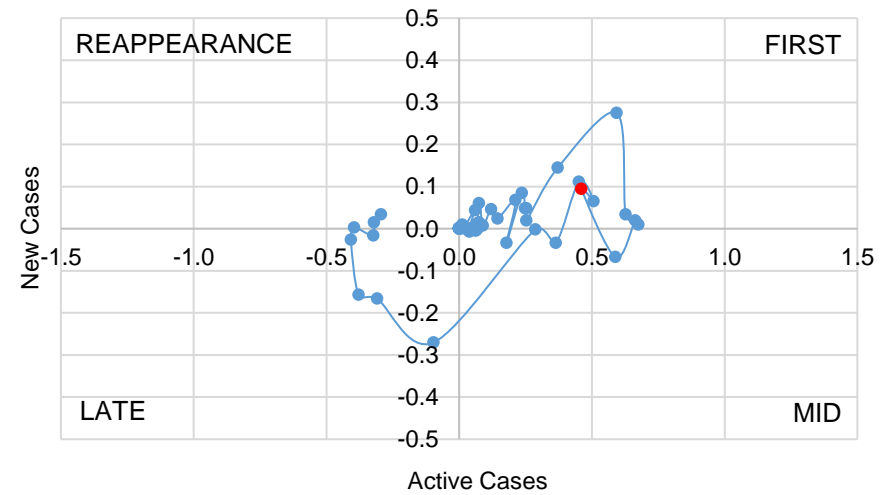


### Covid Cycle

India



Iran



Note: Red dot represents day when lockdown was implemented or extended.