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Macroeconomic policy adjustments due to COVID-19: Scenarios to 2025 with a focus on Asia

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ADB Working Paper Series

**MACROECONOMIC POLICY
ADJUSTMENTS DUE TO COVID-19:
SCENARIOS TO 2025 WITH
A FOCUS ON ASIA**

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Warwick J. McKibbin

No. 1219
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Abstract

This paper updates the analysis of the global macroeconomic consequences of the COVID-19 pandemic in earlier papers by the authors with data as of late October 2020. It also extends the focus to Asian economies and explores four alternative policy interventions that are coordinated across all economies. The first three policies relate to fiscal policy: an increase in transfers to households of an additional 2% of the GDP in 2020; an increase in government spending on goods and services in all economies of 2% of their GDP in 2020; and an increase in government infrastructure spending in all economies in 2020. The fourth policy is a public health intervention similar to the approach of Australia that successfully manages the virus (flattens the curve) through testing, contact tracing, and isolating infected people coupled with the rapid deployment of an effective vaccine by mid-2021.

The policy that is most supportive of a global economic recovery is the successfully implemented public health policy. Each of the fiscal policies assists in the economic recovery with public sector infrastructure having the most short-term stimulus and longer-term growth benefits.

Keywords: COVID-19, pandemics, infectious diseases, risk, macroeconomics, DSGE, CGE, G-Cubed

JEL Classification: C54, C68, F41

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1. INTRODUCTION

The novel coronavirus called SARS-CoV-2 emerged in the People's Republic of China (PRC) in late 2019. Amidst increased global interconnectedness, SARS-CoV-2 soon spread worldwide, leading the World Health Organization (WHO) to recognize the epidemic as a public health emergency on 30 January 2020 and, subsequently, as the COVID-19 pandemic on 11 March 2020.

By mid-November 2020, the COVID-19 pandemic had infected over 48 million individuals and claimed 1.22 million lives. The significant social and economic impacts have been widespread. Substantial changes have taken place in the behavior of households and firms in response to the pandemic. Given the highly infectious nature of the virus, countries worldwide have employed various public health responses, including lockdowns, isolation of suspected, exposed, and infected individuals, and contact tracing to track potentially exposed individuals. In addition to the mortality and morbidity arising from infections, the lockdowns and uncertainty coupled with diminished confidence have significantly reduced the economic activity in many economies. The prolonged duration of the pandemic and the scale of policy responses are likely to have caused the worst economic recession since World War II. Governments worldwide have implemented a range of economic policy measures in addition to the health policy responses to curtail the potential economic impacts of COVID-19. Nevertheless, amidst the uncertainties surrounding the further evolution of the virus and the timeline for producing and distributing a vaccine globally, governments have found it challenging to return economic activity to the pre-2020 levels.

McKibbin and Fernando (2020a) circulated a paper on global pandemic scenarios to policy makers in a range of countries in February 2020 before publicly releasing the research in March 2020.¹ They used historical experience from other major global epidemics to explore seven different scenarios for the world economy. They estimated the epidemiological transmission across countries based on various indicators and then used the epidemiological outcomes to design a set of economic shocks. They then applied these shocks to the widely used G-Cubed global economic model.² The analysis gave a range of estimates of the likely macroeconomic consequences of COVID-19 without public health interventions. McKibbin and Fernando (2020c) updated the research in June 2020. The second major paper used actual data for the COVID-19 pandemic and then applied these together with assumptions about different durations of pandemic waves and the health and economic policies that governments had already announced.

Based on the earlier research, the current paper extends the analysis to a new version of the G-Cubed model, focusing on Asian economies within a global framework. It also evaluates plausible policy options to support the economic recovery. We first update our estimates of the global macroeconomic impact of the pandemic given data up to November 2020 before considering how the potential policy options could reduce the adverse macroeconomic consequences of the pandemic. The rest of the paper proceeds as follows. Section 2 summarizes the estimates of macroeconomic effects that our previous studies presented and international financial institutions' forecasts. Section 3 summarizes the global macroeconomic model and the version used for this study, the epidemiological modeling approach, the base case scenario and policy

¹ The CEPR also summarized and quickly published this in McKibbin and Fernando (2020b).

² See McKibbin and Wilcoxon (1999, 2013) and the discussion below.

packages that we simulate, and the formulation of economic shocks. We then discuss the pandemic's macroeconomic consequences and reflect on how the considered policy options could reduce their severity in Section 4 and present the key conclusions from our modeling exercise in Section 5.

2. STUDIES ON THE MACROECONOMICS OF COVID-19

In late 2019, when the PRC started reporting infections from a virus similar to SARS-CoV, the global community expected the outbreaks to confine themselves to the PRC. This assumption was plausible because the PRC was already experienced in managing similar outbreaks of coronaviruses and influenza viruses. However, due to the delay in local officials' reporting and the strong global connectedness, SARS-CoV-2 soon started spreading into other East Asian countries, the United States, South Asia, and Europe. By mid-March 2020, countries all around the world had detected infections.

In early February 2020, the rapid spread of the outbreak caused infectious disease experts to express concerns about its potential to develop into a pandemic. Policy makers around the world were still uncertain about the transmissibility or the contagious nature of the virus and whether its potential health consequences justified restricting international travel and imposing strict lockdowns at a considerable economic cost. Requests from policy makers who were familiar with our earlier work on SARS (Lee and McKibbin 2004a) and Avian influenza (McKibbin and Sidorenko 2006) prompted us to apply and extend the techniques from those studies to explore the macroeconomic consequences of a potential pandemic resulting from COVID-19. McKibbin and Fernando's (2020a, b) research, released in early March 2020, evaluated seven possible scenarios.

The first three scenarios assumed that the outbreak would predominantly affect the PRC, with different attack rates, but would remain in the PRC with some spillover due to global risk assessment changes. The next three scenarios evaluated a pandemic—a virus transmitted to all countries—with varying attack rates. The seventh scenario focused on a mild yet recurring pandemic. Since the epidemiological and virological information about the virus was minimal in February 2020, we utilized the past global experiences of global influenza outbreaks to derive the potential attack rates.

Table 1 summarizes the assumptions underlying the scenarios in McKibbin and Fernando (2020a, b). We introduced shocks to mortality, morbidity, productivity by sector, consumption, government expenditure, and equity risk premia. The last four scenarios used the experience in the PRC as a benchmark for the shocks. We adjusted these with an index of vulnerability that we developed to scale the shocks across the other countries. The simulations provided a range of estimates about the potential economic consequences of pandemics with varying degrees of severity. The results clearly showed the economic and financial costs of not containing the public health emergency.

Table 1: Scenario Assumptions in The Global Macroeconomic Impacts of COVID-19: Seven Scenarios

Scenario	Countries Affected	Severity	Attack Rate in the PRC	Case Fatality Rate in the PRC	Nature of Shocks	Shocks Activated	Shocks Activated
						PRC	Other Countries
1	PRC	Low	1.0%	2.0%	Temporary	All	Risk
2	PRC	Medium	10.0%	2.5%	Temporary	All	Risk
3	PRC	High	30.0%	3.0%	Temporary	All	Risk
4	Global	Low	10.0%	2.0%	Temporary	All	All
5	Global	Medium	20.0%	2.5%	Temporary	All	All
6	Global	High	30.0%	3.0%	Temporary	All	All
7	Global	Low	10.0%	2.0%	Permanent	All	All

Source: McKibbin and Fernando (2020a).

With the gradual evolution of the COVID-19 pandemic, more information has become available, especially regarding the cases, deaths, and government policy responses. The health policy responses mainly focused on raising awareness, encouraging behavioral changes and respiratory hygiene, and elevating health systems' capacity for testing, contact tracing, isolating, quarantining, and treating infected individuals amidst the absence of a vaccine. Many countries imposed movement restrictions and enforced lockdowns until a vaccine would become available. However, as the movement restrictions and lockdowns came at a high economic cost, many countries were reluctant to implement or to sustain these policies for an extended period. In the absence of significant movement restrictions and lockdowns, the infections and deaths surged. While countries experimented with the trade-offs of various strategies in real time, people lost their lives and the economic costs continued to soar. By June 2020, we had enough information to simulate the pandemic's six plausible scenarios to inform policy makers about the macroeconomic consequences of a prolonged pandemic.

By July 2020, in addition to the global economic forecasts that international financial institutions had produced, only a few studies were attempting to model the global macroeconomic consequences of COVID-19. The studies by Maliszewska, Mattoo, and van der Mensbrugghe (2020), the World Bank (2020a), and the World Trade Organization (2020) utilized computable general equilibrium (CGE) models and mainly focused on the impact of mortality, morbidity, and increased production costs on the economies. A study by the IMF (2020a), which utilized a semi-structural dynamic stochastic general equilibrium (DSGE) model, also included disruptions to financial markets.

In June 2020, we had data on the pandemic that could inform our scenarios' design, so we updated our original study (McKibbin and Fernando 2020c). Table 2 summarizes these scenarios. These differed in the intervals of surges and whether economies responded with or without lockdowns. One of the alternative scenarios consisted of 24 simulations in which we assumed that a given country responded well to the pandemic. In contrast, all the other countries were unsuccessful and experienced high economic costs.

We imposed a range of shocks to the labor supply due to changes in mortality and morbidity, shocks to productivity (capturing changes in the cost of doing business, shocks to consumption, shocks to equity risk premia for sectors, which affected investment), and shocks to country risk premia. We also imposed shocks to government expenditure from stimulus packages, distinguishing between government

spending, household transfers, and wage subsidies. We simulated these shocks in the G-Cubed modeling framework (as Section 3.1 describes), which combines the strengths of the CGE and DSGE modeling approaches. The study produced a comprehensive set of results for various macroeconomic variables, including real GDP, private investment, consumption, trade balance, employment, interest rates, inflation, and exchange rates. The results reinforced the argument that the key to alleviating the adverse economic consequences was to restore the confidence among economic agents. As rational households would avoid catching the infection, regardless of lockdowns, controlling the pandemic when there is a surge in cases and the risk of transmission is high is central to maintaining economic activities. The approaches to formulating the shocks and the results of the paper are available from <https://cama.crawford.anu.edu.au/covid-19-macroeconomic-modelling-results-dashboard>.

Table 2: Scenario Assumptions in Global Macroeconomic Scenarios of the COVID-19 Pandemic

Scenario	Number of Waves and Lockdowns in 2020		Number of Waves and Lockdowns in 2021		Recurrence after 2021
	Number of Waves	Existence of Lockdowns	Number of Waves	Existence of Lockdowns	
1	1	Yes	1	Yes	No
2	1	Yes	1	Yes	Yes
3	2	Yes	1	Yes	No
4	2	Yes	2	Yes	No
5	1	Yes	1	No	Yes
6	1	No			
	Country of Interest—1	Yes	Country of Interest—0	-	No
	Rest of the World—2	Yes	Rest of the World—2	Yes	No

Source: McKibbin and Fernando (2020c).

Some of the economic forecasts that the international financial institutions released, contemporary to McKibbin and Fernando (2020c), have recently undergone revision. Table 3 summarizes the economic forecasts relevant to the countries and regions on which the current paper focuses. We obtained the estimates from the *Global Economic Prospects Report* (World Bank Group 2020), *World Economic Outlook* (IMF 2020a), *Asian Development Outlook* (Asian Development Bank [ADB] 2020), and *Global Economic Outlook* (Organisation for Economic Co-operation and Development [OECD] 2020). If forecasts for a particular country were not explicitly available, we used the country's economic forecast for the region to which it belongs.

All of the global studies show that COVID-19 is likely to have created a global recession that could be as severe as the one that occurred after World War II. While a critical determinant of the scale of the global economic consequences of COVID-19 will be the timing and availability of an effective vaccine, a vaccine alone is unlikely to generate a rapid path to recovery. Thus, the economic debates now focus more on policies to support this recovery. Even though a range of policy options is apparent in the literature, studies have not yet evaluated the potential economic trade-offs of various policy options widely at the global level. McKibbin and Vines (2020) assessed the importance of international cooperation in driving the recovery and how it could improve the global economic outcomes. We extend this contribution, in this paper, by

evaluating the potential of a range of fiscal policy options that governments across the world could adopt to support the recovery.

Table 3: Summary of Economic Forecasts by International Financial Institutions

Source	World Bank Group (2020)		IMF (2020a)		ADB (2020)		OECD (2020)	
Description	% Change in Real GDP from the Previous Year		% Change in Real GDP from the Previous Year		GDP Growth Rate (% per annum)		Projected Change in GDP	
Year	2020	2021	2020	2021	2020	2021	2020 (Single Hit)	2020 (Double Hit)
AFR	-2.80	3.10	-3.00	3.10	NA	NA	NA	NA
AUS	-7.00	3.90	-5.80	3.90	NA	NA	-5.00	-6.30
CHN	1.00	6.90	1.90	8.20	1.80	7.70	-2.60	-3.70
EUW	-9.10	4.50	-8.30	5.20	NA	NA	-9.10	-11.50
IND	-3.20	3.10	-10.30	8.80	-9.00	8.00	-3.70	-7.30
INO	0.00	4.80	-3.40	6.20	-1.00	5.30	-2.80	-3.90
JPN	-6.10	2.50	-5.30	2.30	NA	NA	-6.00	-7.30
KOR	-7.00	3.90	-5.80	3.90	-1.00	3.30	-1.20	-2.00
LAM	-7.20	2.80	-8.10	3.60	NA	NA	NA	NA
MEN	-4.20	2.30	-4.10	3.00	NA	NA	NA	NA
MYS	-3.10	6.90	-3.40	6.20	-5.00	6.50	NA	NA
OAS	-2.70	2.80	-1.70	8.00	-6.80	7.10	NA	NA
OEC	-7.00	3.90	-7.10	5.20	NA	NA	-8.45	-9.7
PHL	-1.90	6.20	-3.40	6.20	-7.30	6.50	NA	NA
ROW	-2.40	4.70	-4.10	3.00	-2.10	3.90	NA	NA
THA	-5.00	4.10	-3.40	6.20	-8.00	4.50	NA	NA
US	-6.10	4.00	-4.30	3.10	NA	NA	-7.30	-8.50
VNM	2.80	6.80	-3.40	6.20	1.80	6.30	NA	NA

3. METHODOLOGY

3.1 The G-Cubed Model

This paper applies a global intertemporal general equilibrium model with heterogeneous agents called the G-Cubed multi-country model. This model is a hybrid of the dynamic stochastic general equilibrium (DSGE) models and computable general equilibrium (CGE) models that McKibbin and Sachs (1991) and McKibbin and Wilcoxon (1999, 2013) developed.

The version of the G-Cubed (M) model that we use in this paper is from the study by Liu and McKibbin (2020), who extended the original model that McKibbin and Wilcoxon (1999, 2013) documented. Version 6M of the model consists of six sectors, eleven countries, and seven regions. Table 4 presents all the regions and sectors in the model. Some of the data inputs include the I/O tables from the Global Trade Analysis Project (GTAP) database (Aguiar et al. 2019), enabling us to differentiate sectors by country of production within a DSGE framework. Firms in each sector in each country produce output using the primary factor inputs of capital (K) and labor (L) as well as the

intermediate or production chains of inputs in energy (E) and materials (M). These linkages apply both within a country and across countries.

McKibbin and Wilcoxon (1999, 2013) documented the approach that the G-Cubed model embodies. Several key features of the standard G-Cubed model are worth highlighting here.

First, the model accounts for stocks and flows of physical and financial assets. For example, budget deficits accumulate into government debt, and current account deficits accumulate into foreign debt. The model imposes an intertemporal budget constraint on all households, firms, governments, and countries. Thus, long-run stock equilibrium arises through the adjustment of asset prices, such as the interest rate for government fiscal positions or real exchange rates for the balance of payments. However, the adjustment toward each economy's long-run equilibrium can be slow, occurring over much of a century.

Second, in G-Cubed, firms and households must use money that central banks issue for all transactions. Thus, central banks in the model set short-term nominal interest rates to target macroeconomic outcomes (such as inflation, unemployment, exchange rates, etc.) based on the Henderson–McKibbin–Taylor monetary rules (Henderson and McKibbin 1993; Taylor 1993). These rules aim to approximate the actual monetary regimes in each country or region in the model. They tie down the long-run inflation rates in each country and allow short-term policy adjustments to smooth fluctuations in the real economy.

Table 4: Overview of the G-Cubed (M) Model

Countries (11)	Sectors (6)
Australia (AUS)	Energy
PRC (CHI)	Mining
India (IND)	Agriculture (including fishing and hunting)
Indonesia (INO)	Durable manufacturing
Japan (JPN)	Non-durable manufacturing
Republic of Korea (KOR)	Services
Malaysia (MYS)	
Philippines (PHL)	Economic Agents in each Country (3)
Thailand (THA)	A representative household
United States (US)	A representative firm (in each of the six production sectors)
Viet Nam (VNM)	The government
Regions (7)	
Latin America (LAM)	
Middle East and North Africa (MENA)	
Other Asia (mainly South Asia excluding India) (OAS)	
Rest of the Advanced Economies (Canada and New Zealand) (OEC)	
Rest of the World (mainly Eastern Europe and Central Asia) (ROW)	
Sub-Saharan Africa (AFR)	
Western Europe (EUW)	

Third, nominal wages are sticky and adjust over time based on country-specific labor contracting assumptions. Firms hire labor in each sector up to the point at which the marginal product of labor equals the real wage, which we define in terms of that sector's output price level. Any excess labor enters the unemployed pool of workers. Unemployment or the presence of an excess demand for labor causes the nominal

wage to adjust to clear the labor market in the long run. In the short run, unemployment can arise due to structural supply shocks or aggregate demand changes in the economy.

Fourth, rigidities prevent the economy from moving quickly from one equilibrium to another. These rigidities include the nominal stickiness that wage rigidities cause and firms' costs of adjustment in investment, with physical capital being sector specific in the short run. A lack of complete foresight in the formation of expectations and among monetary and fiscal authorities following particular monetary and fiscal rules also affects the adjustment path. Short-term adjustments to economic shocks can be very different from long-run equilibrium outcomes. A focus on short-run rigidities is essential for assessing the impact over the first decades of a major shock.

Fifth, we incorporate heterogeneous households and firms. We model firms separately within each sector. We assume two types of consumers in each economy and two types of firms within each sector within each country. One group of consumers and firms bases its decisions on forward-looking expectations. The other group follows simple rules of thumb that are optimal in the long run.

3.2 Epidemiological Modeling

Although the virus outbreak started in late 2019 in the PRC, it reached other parts of the world at different times. Some countries experienced the pandemic early and appeared to have controlled the first waves. Some other countries have also experienced second waves. Overall, the pandemic is continuing in a majority of countries. For each country, we model the likely number of infections and deaths due to COVID-19 for 2020 by using actual data up to late October 2020 and then project the remainder of 2020 and subsequent years.

To determine whether the first wave is continuing or has ended for a particular country or region, we analyze the daily cases via Our World in Data (2020) from late 2019 to 20 October 2020. We aggregate the infection numbers by the countries and regions in the model and visually approximate whether the first wave is continuing or has ended. If there is more than one significantly observable wave, which is clearly distinguishable from surges or spikes, we estimate the likely day on which the first wave could have ended. Here, we check for a considerable interval between the waves with zero or very few new cases for countries. For regions, we check for the global minimum among the inflection points. Appendix 1 presents the infections in each model region up to 20 October 2020. Table 5 summarizes the index date for the model regions, the status of the first wave as of 20 October 2020, and the duration of the first and second waves (in the case that a second wave has emerged).

Based on the pandemic status, whether the first or the second wave is continuing, we estimate the cumulative curve for cases using a non-linear logistic approximation from 20 October 2020 to 31 December 2020. The logistic approximation assumes that the momentum that the pandemic demonstrated up to 20 October 2020 would continue. Due to this assumption, the total number of cases does not reflect the later emergence of new clusters of cases. Table 6 summarizes the infections during the first and second (if applicable) waves for the model regions until 31 December 2020. Appendix 2 presents the cumulative curves for cases for the current wave for the model regions.

Table 5: Status of the Pandemic Waves in the Model Regions

Model Region	Index Date for the First Wave	Status of the First Wave as of 20 October 2020	Duration of the First Wave (if the First Wave has Ended or as of 31 December 2020) (Days)	Duration of the Second Wave as of 31 December 2020
AFR	28 February 2020	Continuing	307	
AUS	25 January 2020	Ended	119	222
CHN	31 December 2019	Continuing	366	
EUW	25 January 2020	Ended	163	178
IND	30 January 2020	Continuing	336	
INO	2 March 2020	Continuing	304	
JPN	15 January 2020	Ended	135	216
KOR	20 January 2020	Ended	108	238
LAM	14 January 2020	Continuing	352	
MEN	27 January 2020	Continuing	339	
MYS	25 January 2020	Ended	160	181
OAS	21 January 2020	Continuing	345	
OEK	26 January 2020	Ended	159	181
PHL	30 January 2020	Continuing	336	
ROW	1 February 2020	Continuing	334	
THA	13 January 2020	Continuing	353	
US	21 January 2020	Continuing	345	
VNM	24 January 2020	Ended	101	241

Table 6: Total Infections in the Model Regions

Model Region	Infections during the First Wave	Infections during the Second Wave	Total Infections
AFR	1,241,929	-	1,241,929
AUS	7,081	20,328	27,409
CHN	91,006	-	91,006
EUW	1,490,568	9,420,611	10,911,179
IND	9,335,908	-	9,335,908
INO	603,454	-	603,454
JPN	16,651	78,015	94,666
KOR	10,806	16,436	27,242
LAM	11,558,520	-	11,558,520
MEN	3,702,391	-	3,702,391
MYS	8,640	194,491	203,131
OAS	1,024,012	-	1,024,012
OEK	105,373	374,124	479,497
PHL	401,533	-	401,533
ROW	3,559,084	-	3,559,084
THA	3,700	-	3,700
US	9,332,319	-	9,332,319
VNM	270	870	1,140

3.3 Base Case Scenario and Shocks

We first solve the model without a pandemic occurring in 2020. We then create a base case scenario that is our best guess about the pandemic's current state. In the base case scenario, we introduce the pandemic shocks to estimate the macroeconomic consequences in 2020 due to disruptions to economic activities emanating from COVID-19-related health effects, behavioral changes of households and firms, and government policy responses. In this base case, we assume that there is no available vaccine yet and that complete elimination of SARS-nCoV-2 might be ambitious (Heywood and Macintyre 2020). We assume that the pandemic will then recur at a declining rate over future years, causing all the shocks to decline at the same rate. Below, we discuss the shocks that we developed in the base case scenario. Appendix 3 contains flowcharts that present a schematic view of the construction of the shocks. Further details are also available on the results dashboard accessible via: <https://cama.crawford.anu.edu.au/cama-publications/asian-development-bank-institute-modelling-results-dashboard>.

3.3.1 Shock to the Labor Supply

The shock to the labor supply originates from the mortality and morbidity related to the infection. When formulating the mortality shock, we first obtain the COVID-19 case fatality rates for the model regions as of 20 October 2020 and apply those rates to the total infections that we find from the epidemiological modeling, as Section 3.2 explains. We then compute the deaths as a percentage of the total population to estimate the epidemiological shock's magnitude. As deaths would mean a loss of the existing and potential labor force for an economy, the shock applies permanently in the simulations. Table 7 presents the case fatality rates, the estimated number of deaths in 2020, and the magnitude of the mortality shock in 2020.

The morbidity shock has two elements. Firstly, members of the labor force cannot work if they catch or are exposed to the infection. Therefore, we assume that a proportion of the labor force would not work for the standard isolation or quarantine period, following the recommendation of the WHO, of 14 days. To estimate the proportion of the labor force, within the age group of 20–59 years, infected or exposed to the infection, we use the reports from the medical authorities of the countries (see Australian Government Department of Health 2020; California Department of Public Health 2020; Cam 2020) and the age breakdown of infections from Statista (2020a–j). For the model regions for which this information is not available, we approximate it using a country or region that closely reflects its epidemiological characteristics. Using the proportion of the labor force affected and the World Bank (2020b) data on the labor force participation in the model regions, we calculate the number of productive days lost and obtain the proportion of days lost in a 251-day working year.

Secondly, we assume that a proportion of the labor force, equal to 70% of its female labor force participation, would lose productive time due to caregiving for dependent children in the 0–19 years age group who catch the infection. Assuming the same isolation or quarantine period of 14 days and using the World Bank (2020c) data on female labor force participation rates, we estimate the proportion of days lost due to caregiving in a 251-day working year. As children have been less vulnerable to the infection, the second component of the morbidity shock is smaller than the first. Table 8 presents the magnitudes of the morbidity shocks.

Table 7: Case Fatality Rates, Deaths in 2020, and Mortality Shock in 2020

Model Region	Case Fatality Rate	Deaths in 2020	Mortality Shock in 2020
AFR	2.13%	26,444	0.0023%
AUS	3.30%	905	0.0036%
CHN	5.21%	4,739	0.0003%
EUW	2.57%	280,301	0.0645%
IND	1.52%	141,564	0.0103%
INO	3.45%	20,846	0.0076%
JPN	1.79%	1,697	0.0013%
KOR	1.76%	481	0.0009%
LAM	2.31%	266,843	0.0408%
MEN	3.16%	117,009	0.0214%
MYS	0.89%	1,807	0.0056%
OAS	0.95%	9,687	0.0016%
OECD	3.24%	15,553	0.0365%
PHL	1.86%	7,462	0.0068%
ROW	2.08%	73,889	0.0177%
THA	1.59%	59	0.0001%
US	2.68%	250,081	0.0756%
VNM	3.07%	35	0.0000%

**Table 8: Components of the Morbidity Shock in 2020
(Lost Days as a Proportion of Total Working Days)**

Model Region	Absenteeism due to Infection	Absenteeism due to Caregiving
AFR	0.0070%	0.0003%
AUS	0.0073%	0.0073%
CHN	0.0004%	0.0001%
EUW	0.1540%	0.0816%
IND	0.0339%	0.0050%
INO	0.0109%	0.0006%
JPN	0.0061%	0.0035%
KOR	0.0034%	0.0019%
LAM	0.0880%	0.0048%
MEN	0.0342%	0.0042%
MYS	0.0428%	0.0222%
OAS	0.0129%	0.0062%
OECD	0.0754%	0.0713%
PHL	0.0234%	0.0023%
ROW	0.0430%	0.0025%
THA	0.0004%	0.0001%
US	0.2213%	0.1617%
VNM	0.0001%	0.0000%

3.3.2 Shock to Total Factor Productivity

The productivity shock results from the lockdowns that governments have imposed to reduce the transmission of the virus. We estimate the shock to productivity for each sector in each country using the durations of the lockdowns and the proportion of broad production sectors that the lockdowns disrupted.

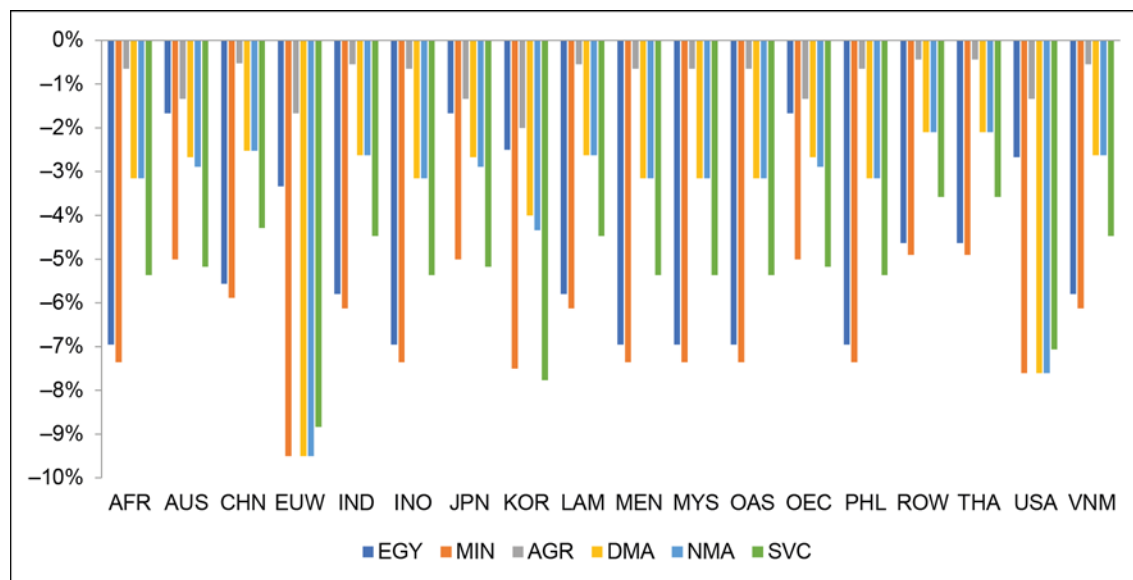
When calculating the duration of the lockdowns, we use the data on workplace closure across the world from the Coronavirus Government Response Tracker (Blavatnik School of Government 2020). The database reports the workplace closures at three levels of stringency; at the third level, only essential workplaces, such as grocery stores and pharmacies, operate. Thus, different days have different stringency levels. To calculate the overall stringency level, we allocate a weight of 33.33% to days with stringency of level 1, 66.66% to days with stringency of level 2; and 100% to days with stringency of level 3. Weighting different stringency levels enables us to calculate an effective number of days when stringency of level 3 would have prevailed. We further split the number of days of workplace closures into two waves for 187 countries and calculate the number of days with effective workplace closures as a proportion of the total duration of the pandemic. By using the pandemic's duration, which we derive from the epidemiological modeling, we calculate the effective number of months with workplace closures except for essential production sectors.

When determining the proportions of sectors that do not operate during lockdowns, we utilize the estimates from the Australian Bureau of Statistics (Australian Broadcasting Cooperation [ABC] 2020) and AUSGRID for Australia and from Statista (2020k–m) for Australia, the UK, and India. We then multiply the sub-sectors' output shares in the broad sectors by the proportions of sectors not operating to obtain the ratios of broad sectors not operating. This calculation allows us to differentiate the proportions of broad sectors not operating across the model regions even though we assume similar behavior in sub-sectors across the world in this regard. Finally, we scale the proportions depending on the lockdown duration (as a proportion of a year) to obtain the productivity shocks for broad sectors.

Table 9 summarizes the effective durations of lockdowns in months in 2020 for the model regions. Figure 1 presents the proportions of broad sectors not operating in the model regions.

Table 9: Effective Lockdown Duration
(Months)

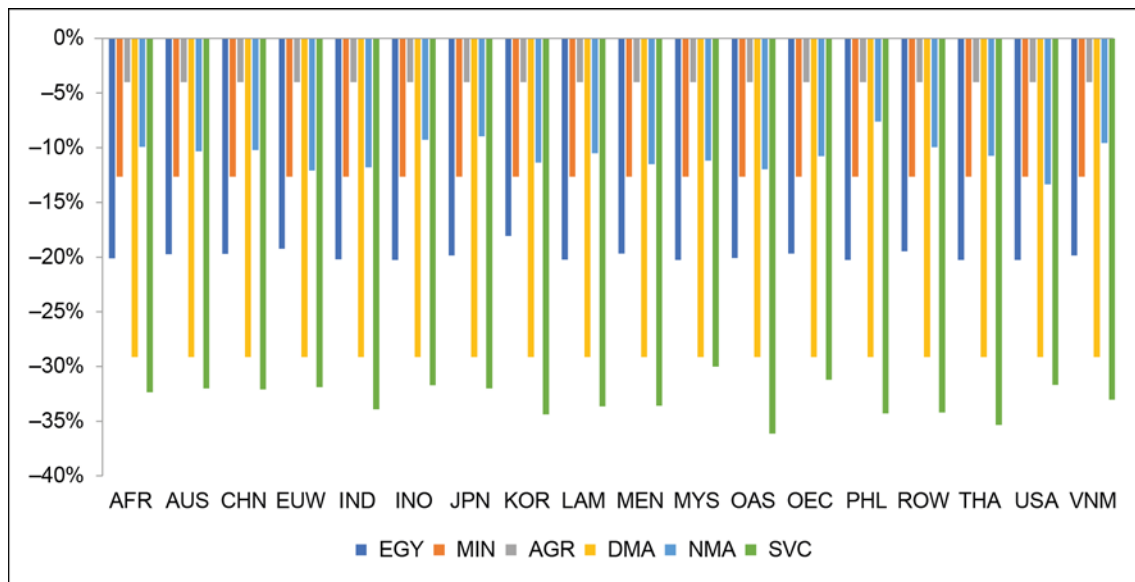
Model Region	Lockdown Duration (Months)
AFR	6
AUS	4
CHN	5
EUW	5
IND	5
INO	6
JPN	4
KOR	6
LAM	5
MEN	6
MYS	6
OAS	6
OEC	4
PHL	6
ROW	4
THA	4
US	4
VNM	5

Figure 1: Proportions of Sectors Not Operating during the Pandemic in 2020

3.3.3 Shock to Consumption

As Section 3.1 describes, households maximize their lifelong utility from consumption. In achieving this objective, changes in household consumption during the pandemic would arise due to a variety of factors, including changes in income from employment, changes in the value of future wealth due to the long-term implications of the current impacts from the pandemic, changes in the relative prices in different sectors, changes in interest rates, changes in the ability to consume certain goods and services, as well as changes in consumer preferences. While some of these effects are endogenous to the model, the consumer preferences in each broad sector and the risk premium on the discount rate that households use to discount their future income to calculate human wealth are exogenous to the model.

Using the data from consumer surveys that Statista (2020n) conducted in Australia, we map the changes in consumer preferences in various activities onto production sub-sectors. We then aggregate the changes in consumer preferences to the broad sectors across the model regions using the consumption shares that sub-sectors claim within aggregated sectors. Similar to the productivity shock that Section 3.3.2 discussed, the aggregation of consumer preference changes in the sub-sectors to the broad sectors allows us to vary the overall consumption in the aggregate sectors despite assuming similar consumption changes for sub-sectors. Then, we adjust the changes in consumer preferences in broad sectors by the duration of the pandemic. We estimate the exogenous shock to the aggregate consumption in the model regions by aggregating the sector consumption changes using the overall sector consumption shares in the overall consumption. Figure 2 presents the changes in consumer preferences in the model regions by broad sectors. Table 10 shows the changes in overall consumption in the model regions that we aggregate from the sectoral preference shifts.

Figure 2: Changes in Consumption Preferences during the Pandemic**Table 10: Exogenous Shocks to Aggregate Consumption from Preference Shifts in 2020**

Model Region	Changes in Overall Consumption	Changes in Overall Consumption as a Proportion of the GDP
AFR	-8.33%	-2.04%
AUS	-11.90%	-2.19%
CHN	-15.18%	-1.50%
EUW	-11.39%	-2.18%
IND	-9.29%	-1.79%
INO	-11.30%	-2.17%
JPN	-4.67%	-0.90%
KOR	-14.53%	-2.10%
LAM	-11.00%	-2.52%
MEN	-12.38%	-2.39%
MYS	-12.19%	-1.61%
OAS	-13.22%	-2.26%
OEC	-9.12%	-1.82%
PHL	-11.74%	-3.12%
ROW	-8.17%	-1.53%
THA	-8.53%	-1.31%
US	-12.03%	-2.94%
VNM	-7.67%	-1.70%

We model the second impact on consumption as a change in the risk premia that households use to discount their future labor income to calculate their human wealth. We approximate the changes in risk premia by using the movement of the US VIX (volatility) Index (Wall Street Journal (WSJ) 2020a), which gives a measure of the change in market sentiment. We approximate the volatility in the US VIX from March to October 2020 and take its deviation from the volatility during the same period in 2019. We then approximate the changes in risk premia in other model regions using the Risk Aversion Index that Gandelman and Hernández-Murillo (2014) developed. For model

regions for which the index is not available, we approximate it using their closest peers in respect of their economic characteristics. We then obtain the shock to risk premia by scaling the changes in risk premia by the effective durations of lockdowns. Figure 3 presents the values of the Index of Risk Aversion for the model regions in comparison with the US. Figure 4 shows the magnitude of the shock to risk premia in the model regions in 2020.

Figure 3: Index of Risk Aversion (US = 100)

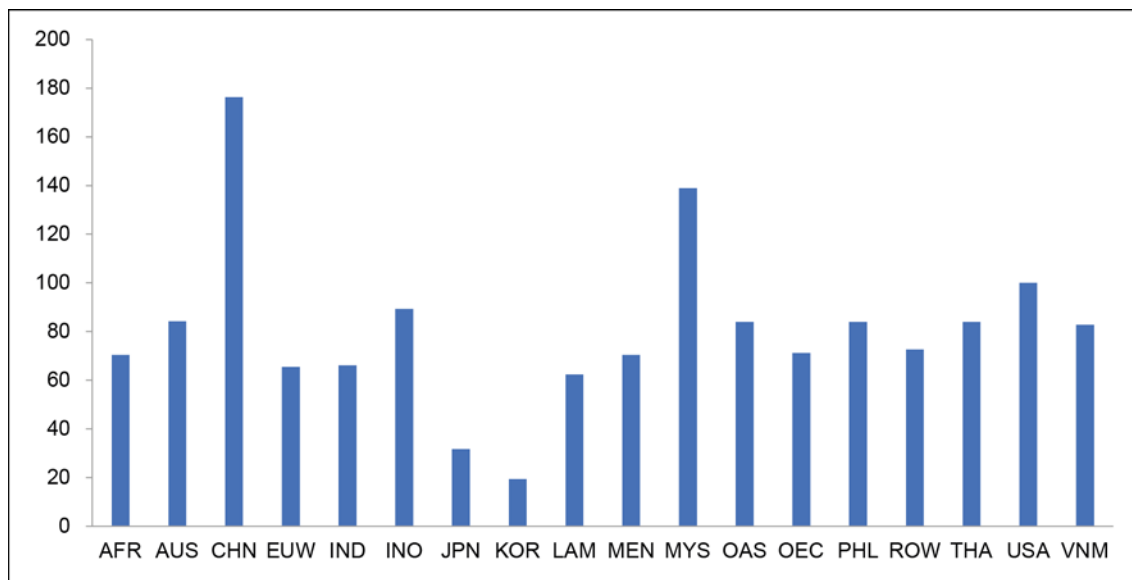
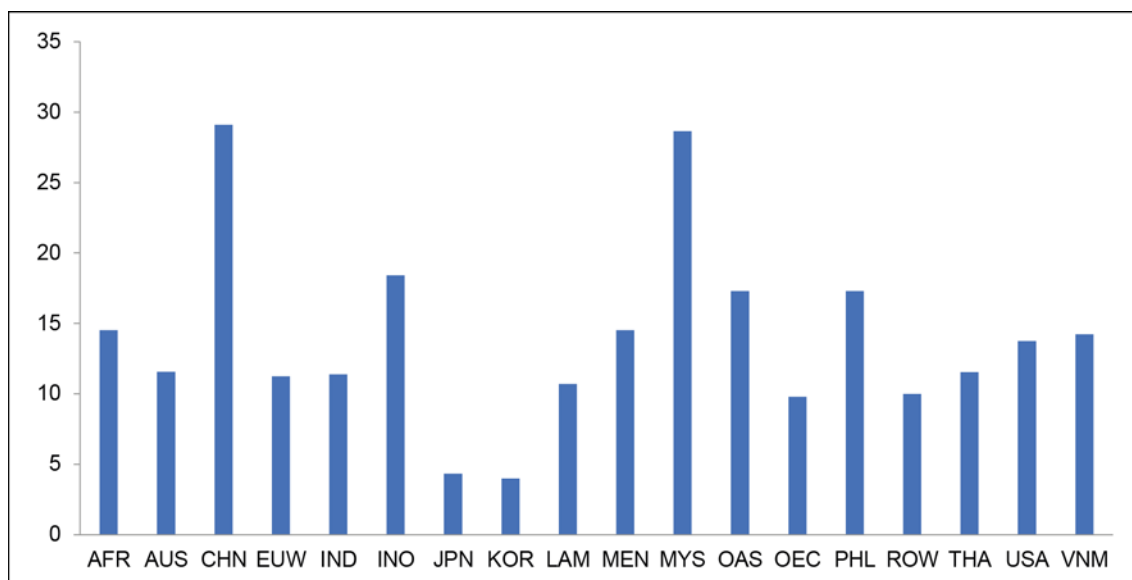


Figure 4: Shock to Risk Premia in the Discount Rate for Human Wealth in 2020



3.3.4 Shocks to Country and Sector Risk Premia

While all countries have responded to the pandemic, the actual policy responses have differed across countries. Financial markets have reflected these differences when investors have rebalanced their portfolios to diversify the risks. We map these changes

in relative risks in different countries and sectors to shocks for the model using country and sector risk premium shocks.

When constructing the shock to country risk premia, we follow the approach that Lee and McKibbin (2004a, b) and McKibbin and Sidorenko (2006, 2009) introduced and McKibbin and Fernando (2020a, b, c) improved. The approach involves constructing three indices for health, governance, and financial risks.

The Index of Health Risk is the average of the Index of Health Expenditure per capita, which we construct using the health expenditure per capita data from the World Health Organization (WHO) (2019). We create the Index of Health Security using the Global Health Security Index of the Nuclear Threat Initiative, Johns Hopkins University, and the Economist Intelligence Unit (2020). The Global Health Security Index covers six categories, which include the ability to prevent, detect, and respond to outbreaks and diseases. It also assesses the health and political systems in a given country and evaluates its compliance with international health standards. Figure 5 presents the Index of Health Risk for the regions in the model. A higher value indicates a higher health risk.

We calculate the Index of Governance Risk using the International Country Risk Guide (ICRG) (PRS Group 2012). The ICRG Index scores countries based on their performance in 22 variables, which it categorizes into political, economic, and financial dimensions. The political dimension accounts for government stability, the rule of law, and the prevalence of conflicts. The economic aspect consists of the GDP per capita, real GDP growth, and inflation, among others. Exchange rate stability and international liquidity are the two main variables constituting the financial dimension. Figure 6 presents the Index of Governance relative to the US. A higher value indicates higher governance risk.

The Index of Financial Risk utilizes the IMF (2019) data on countries' current account balance as a proportion of their GDP to calculate their financial risk. Figure 7 presents the value of the index relative to the US.

Figure 5: Index of Health Risk

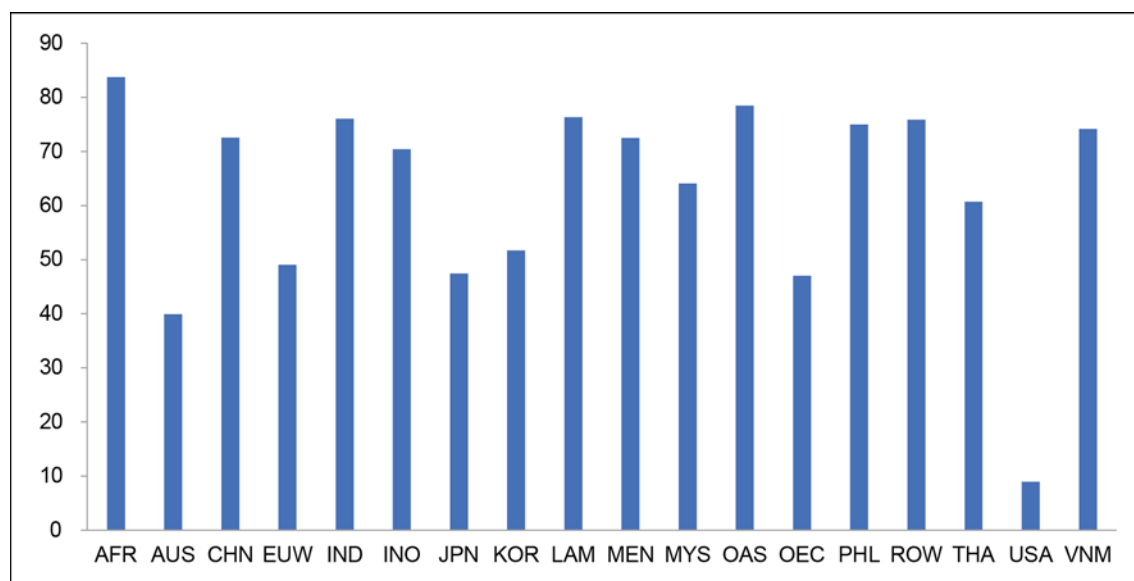
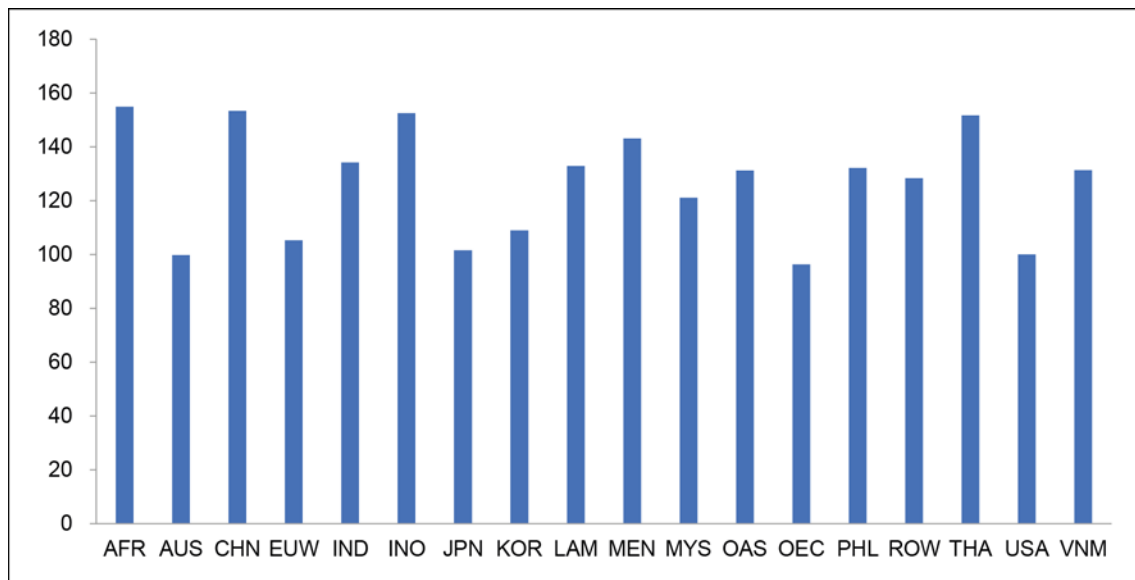
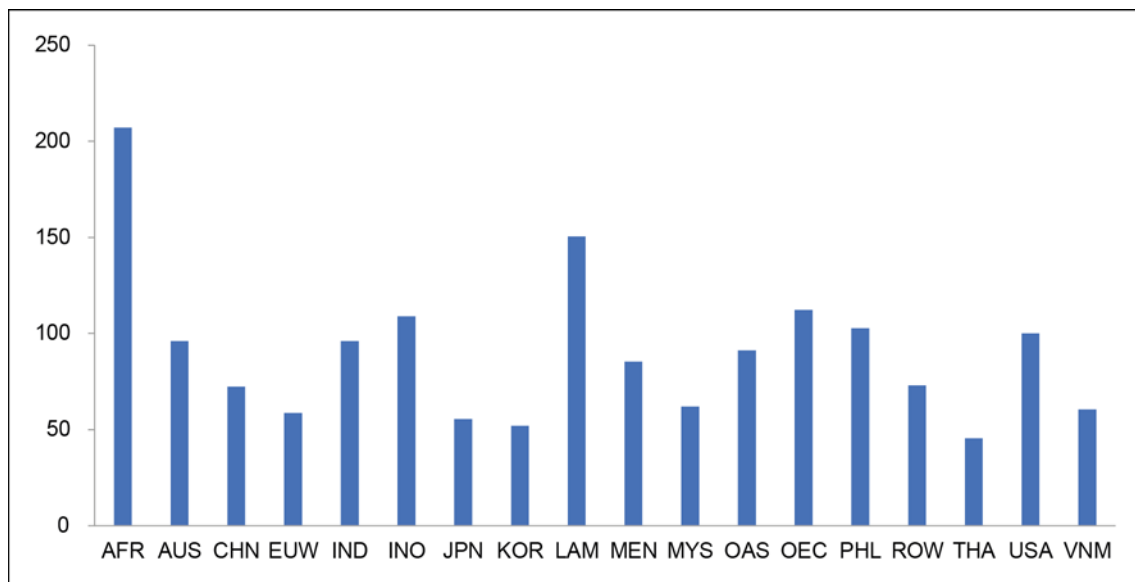
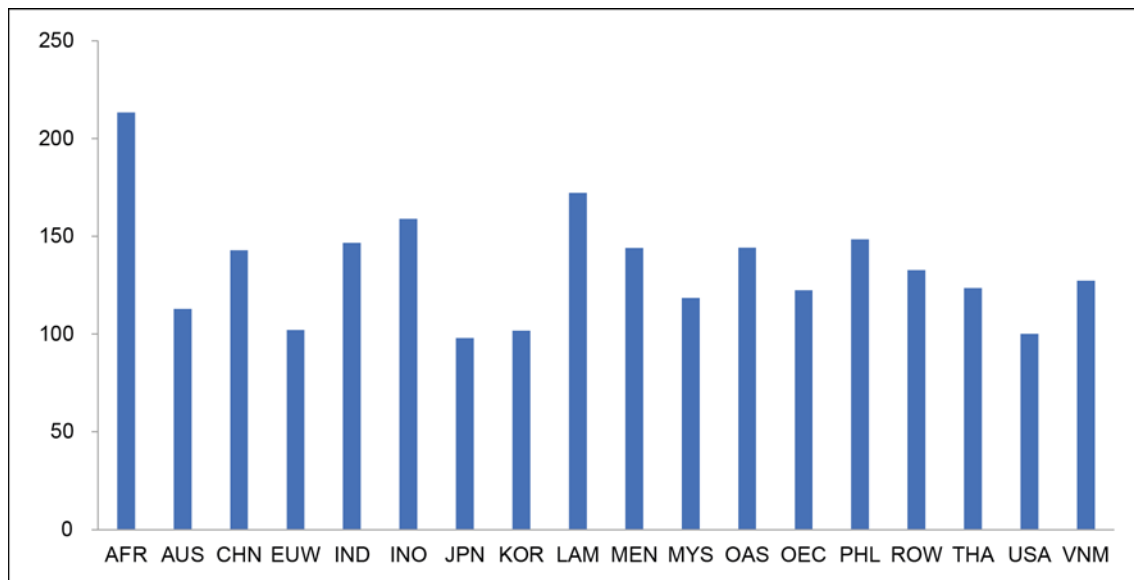
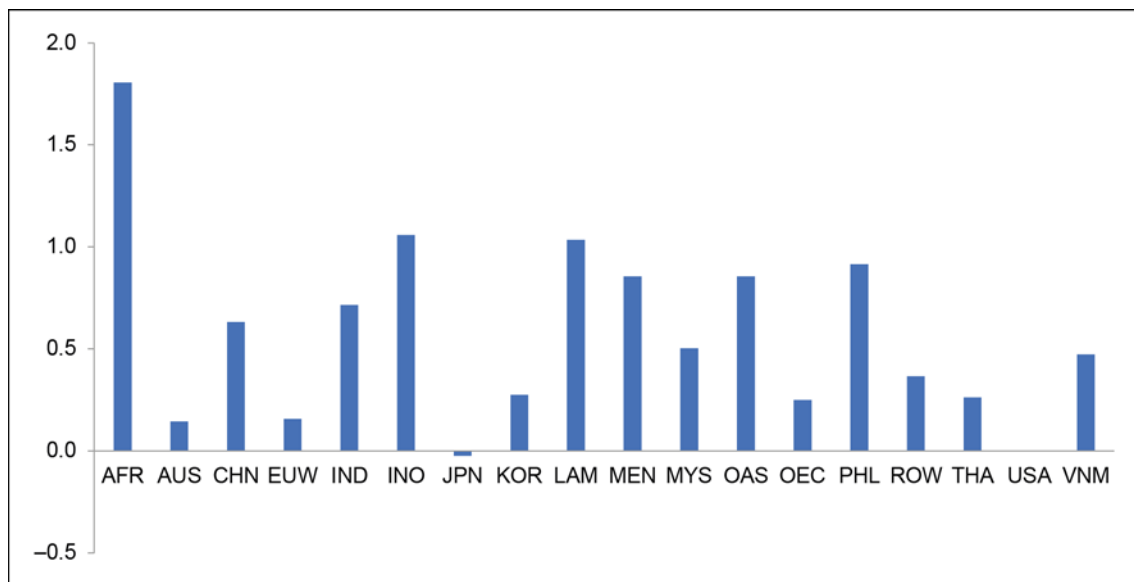


Figure 6: Index of Governance Risk**Figure 7: Index of Financial Risk**

Although somewhat arbitrary, we calculate the Index of Country Risk as the arithmetic average of the three indices. Figure 8 shows the index's value relative to the US (= 100) due to the prevalence of well-developed financial markets there (Fisman and Love 2004).

We then estimate the average volatility of the Nasdaq's daily returns and the Dow Jones and S&P 500 stock market indices in the US financial markets (WSJ 2020b) during the eight months from March to October 2020. Using the US financial markets' volatility as a benchmark, we then obtain estimates for other countries by scaling for the lengths of lockdowns and the Index of Country Risk. Figure 9 shows the magnitude of the country risk premium shock in the base case scenario in 2020 for the model regions.

Figure 8: Net Country Risk Index (US = 100)**Figure 9: Country Risk Premium Shock in 2020 Relative to the US**

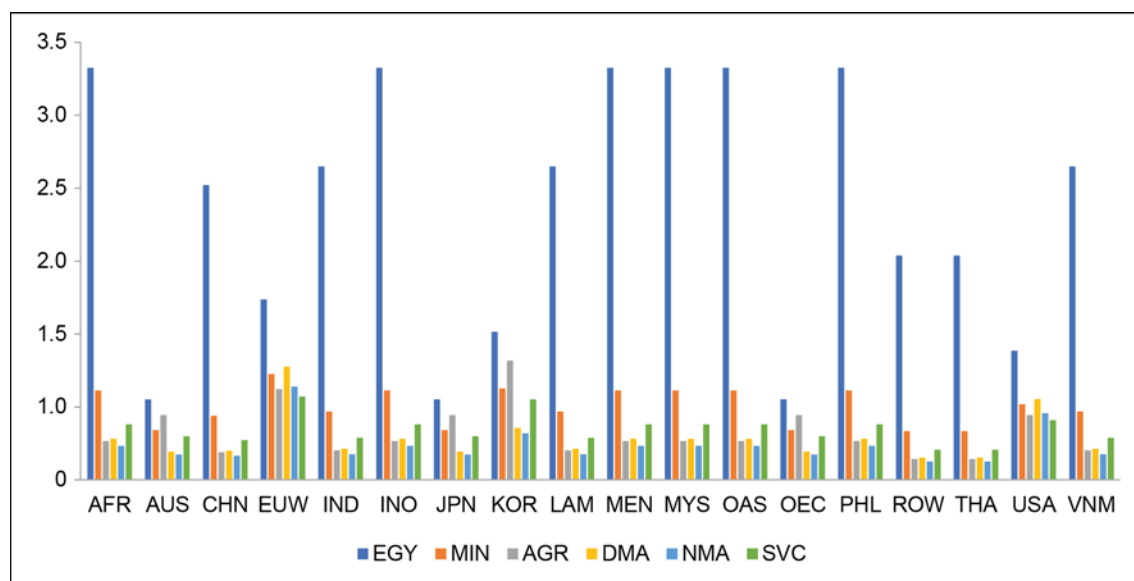
When calculating the equity risk changes in different sectors, we use the daily returns for the S&P 500 sector indices for the US (WSJ 2020c–m). We calculate the average volatility of the sector indices' daily returns during the eight months from March to October 2020. We map the changes in the sector equity beta to the sub-sectors and then, using the sub-sector shares in the broad sectors, to the broad sectors. We then scale the equity risk premium changes in the US sectors by the effective length of lockdowns and the sector productivity changes relative to the US. Figure 10 presents the magnitude of the sector equity risk premia in the base case scenario in 2020 for the model regions.

3.3.5 Shocks to Government Expenditure, Transfers, Wage Subsidies, and Tax Concessions

In the model, there are endogenous changes in fiscal variables and exogenous changes that we impose in the form of shocks. Each country follows the same overall fiscal rule to ensure debt sustainability. The budget deficit is endogenous. The fiscal rule is that the government levies a lump sum tax on all households to cover the additional interest servicing costs of changes in the net government debt resulting from a change in the fiscal deficit in response to the shocks that we impose on the model. Government debt can permanently change after a shock, but debt levels eventually stabilize. National government expenditure is exogenous, while transfers respond to changes in economic activity, like tax revenues. There are taxes on household income, corporate income, and imports. These fiscal variables all respond when shocks occur in the model. The budget deficit's ultimate change is a combination of exogenous changes in government spending, transfers, and wage subsidies, where they occur, and endogenous fiscal stabilizers operating via the fiscal rule.

While imposing the lockdown measures, many governments have implemented a range of fiscal measures to cushion the impact on the economy emanating from the virus, the change in household and firm behavior, and the economic shutdowns. The IMF's (2020b) compilation of different countries' policy responses to COVID-19 revealed that the fiscal measures that they have adopted to support firms include deferring or relieving firms from paying tax and social contributions, targeted subsidies for hard-hit sectors, exemptions from paying utility bills, providing liquidity via subsidized loans, and credit guarantees. The fiscal measures to support households include deferral of or relief from tax payments, exemptions for settling utility bills, and direct transfers. Wage subsidies have also been an essential component of the assortment of fiscal measures worldwide. As well as supporting targeted firms and households, governments have reallocated their current budgets to accommodate priority sectors and increased the spending on the healthcare sector. Some governments have also increased the expenditure on infrastructure projects.

Figure 10: Shock to Sector Equity Risk Premia in 2020



The IMF's (2020c) Fiscal Monitor Database, which it updated in October 2020, summarizes the range of fiscal measures into three main categories. These are "above the line measures," "below the line measures," and "contingent liabilities." "Above the line measures" include three sub-categories, namely additional spending and forgone revenue in the health sector, additional expenditure and forgone revenue in non-health sectors, and accelerated spending and deferred revenue in non-health sectors. "Below the line measures" include equity injections, asset purchases, loans, and debt assumptions, including extra-budgetary funds. "Contingent liabilities" include guarantees on loans and deposits and quasi-fiscal operations, referring to public corporations' non-commercial activities on behalf of governments.

As the last two categories and their sub-categories are not yet fully accessible, and there is no certainty about the proportions of those categories, we focus only on the "above the line" measures. We also exclude accelerated spending and deferred revenue in areas other than health.

We then reclassify all of the actions that the IMF (2020c) listed for the 66 countries in the first two sub-categories of the above the line measures into four groups: transfers to households, wage subsidies, government spending on goods and services, and reduced revenue from firms. In this exercise, for some countries, precise amounts (in local currency or as %GDP) are available for various fiscal measures, while, for other countries, only the aggregate payments are available. Where the exact amounts are lacking, we distribute the aggregate amount across the groups, attributing reasonable weights depending on the total number of measures and resembling those of countries' closest peers. Table 11 presents the total increase in government expenditure as a proportion of the GDP, aggregated for the model regions, and its reclassification into the four groups.

**Table 11: Increase in Government Expenditure in 2020
due to Fiscal Stimulus Measures**

Model Region	Additional Government Spending and Forgone Revenue	Transfers	Wage Subsidies	Fiscal Expenditure on Sectors	Forgone Revenue
AFR	2.24%	0.90%	0.25%	0.52%	0.56%
AUS	11.73%	1.48%	5.33%	4.92%	0.00%
CHN	4.64%	2.52%	0.50%	0.15%	1.46%
EUW	5.30%	1.01%	1.56%	2.18%	0.55%
IND	1.79%	1.39%	0.18%	0.22%	0.00%
INO	2.67%	1.12%	0.00%	0.94%	0.61%
JPN	11.30%	2.48%	0.42%	3.47%	4.93%
KOR	3.50%	1.26%	0.08%	2.03%	0.13%
LAM	4.68%	1.44%	0.88%	1.49%	0.87%
MEN	1.70%	0.61%	0.27%	0.63%	0.18%
MYS	2.59%	1.05%	1.00%	0.11%	0.43%
OAS	4.34%	1.05%	1.00%	1.36%	0.93%
OEC	15.96%	0.85%	7.29%	7.83%	0.00%
PHL	2.31%	0.56%	0.56%	0.97%	0.22%
ROW	3.27%	0.78%	0.77%	1.01%	0.71%
THA	8.19%	1.54%	1.54%	3.58%	1.54%
US	11.77%	1.21%	3.04%	5.44%	2.08%
VNM	1.24%	0.35%	0.00%	0.32%	0.56%

The transfers to households feed into the model as a separate shock. We distribute the government spending on firms and reduced revenue due to tax concessions across the sectors based on each sector's overall GDP share. Figure 11 presents the output shares of the broad sectors. Figures 12 and 13 show the increase in government expenditure and tax concessions for each sector in the base case scenario in 2020.

Figure 11: Output Shares of the Broad Sectors

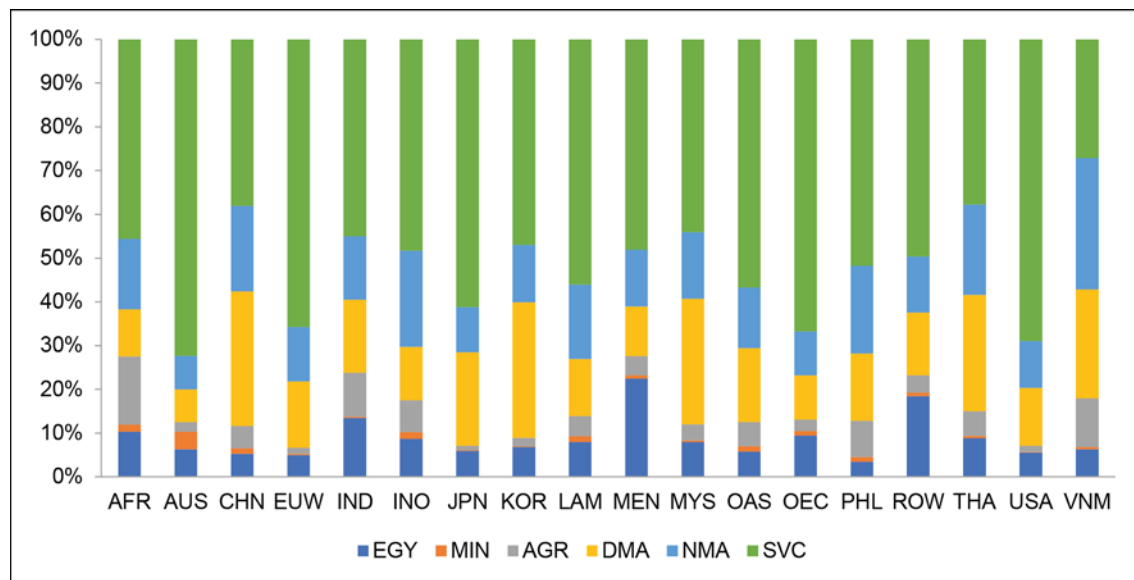
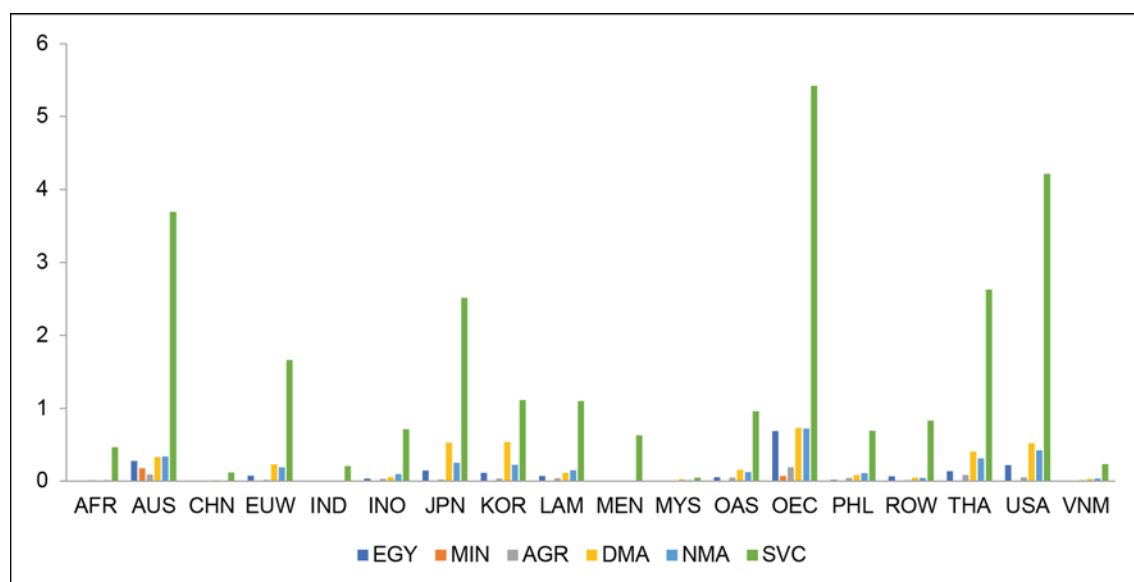


Figure 12: Increase in Government Expenditure by Sector in 2020 (%GDP)



As no information is available about the impact of wage subsidies on employment for most countries, we calibrate the wage subsidy shock for the model regions using Australia's data. Following McKibbin and Fernando (2020c), we assume that the overall reduction in unemployment due to the wage subsidies would be 5%. We then scale the shock across the model regions according to the size of the wage subsidy compared

with Australia, the output shares of the broad sectors relative to Australia, and the model regions' effective pandemic duration. Figure 14 presents the wage subsidy shock size for each sector in the model regions in 2020.

Figure 13: Tax Concessions for Each Sector in 2020
(%GDP)

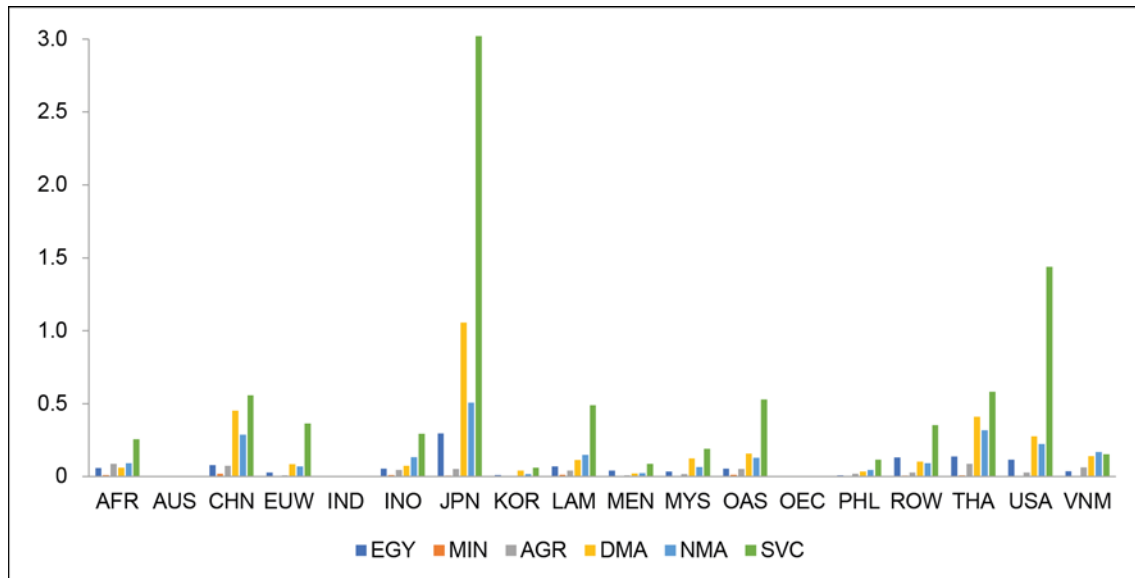
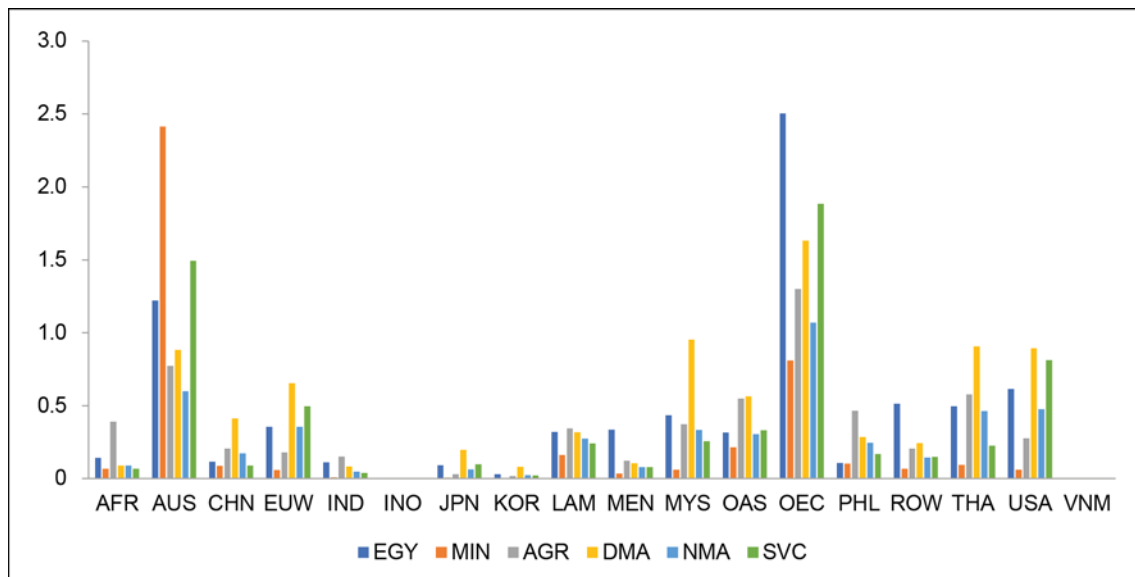


Figure 14: Wage Subsidy Shock to Each Sector in 2020
(% Increase)



3.4 Policy Packages and Additional Shocks

The COVID-19 pandemic and policy response have triggered an economic downturn. There is a continuing debate about the most appropriate measures to manage the pandemic in the future and to cushion the impacts of the recession.

To contribute to the above debate about policy responses, we evaluate four policy packages' impacts in this paper. The policy packages are an additional increase in the fiscal transfers to households, further extension of the existing stimulus packages, additional investments in public infrastructure, and substantial improvements in the health policy response, including the rapid distribution of a vaccine.

3.4.1 Policy Package 1: Increase in Fiscal Transfers

Fiscal transfers to households would increase households' disposable income and enable them to utilize the transfers in a manner that maximizes their utility. These would thus be a timely intervention to boost economic activities. Executing the fiscal transfers would also be straightforward as the necessary information to identify the qualifying households (e.g. annual income data) and the mechanisms to distribute the transfers (e.g. welfare schemes) already exist. Thus, the first package assumes that governments would spend an additional 2% of the respective country's GDP on transfers to households in 2020, gradually decreasing it for three more years until 2023.

3.4.2 Policy Package 2: Increase in the Current Stimulus

The second package assumes that an additional 2% of the GDP would increase the stimulus packages that governments have already declared across all countries in 2020. They would distribute the additional spending among households and production sectors, maintaining the current composition (Table 11).

3.4.3 Policy Package 3: Increase in Infrastructure Investments

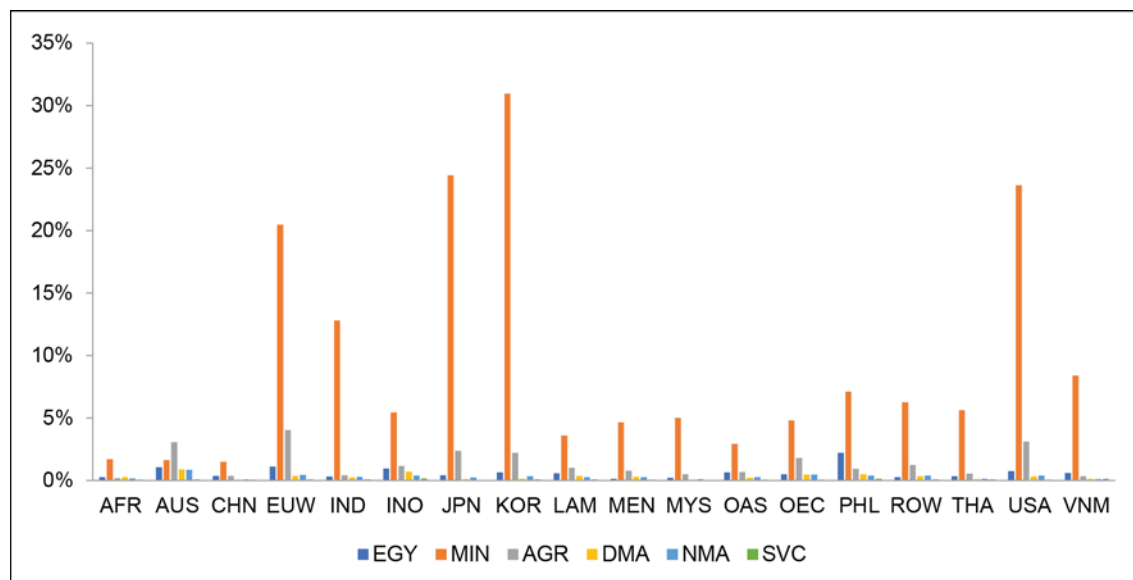
Another popular fiscal measure to support economic recovery is to increase government investments in public infrastructure. In addition to expanding the capital available for the labor force and boosting labor productivity, additional infrastructure investments could eliminate the constraints to increasing the broader economic productivity (Aschauer 1989; Henckel and McKibbin 2010; McKibbin, Stoeckel, and Lu 2014). While a large body of empirical literature since the 1930s has supported the significance of the fiscal multiplier associated with an increase in infrastructure investments, more recent studies, such as those by Gechert (2015) and Whalen and Reichling (2015), have demonstrated the currency of the argument.

In the third policy package, we introduce an increase in government infrastructure investments of the same percentage as the additional fiscal stimulus and transfers (2% of the GDP). We use the IMF (2020d) data on government investments in infrastructure as a percentage of the GDP in the model regions and distribute the increased investment across sectors depending on the governments' preferences for sectors for investments. These preferences for production sectors are a function of the observed impact of COVID-19 on those sectors and those sectors' potential to contribute to economic recovery compared with other sectors. We follow McKibbin, Stoeckel, and Lu's (2014) work in modeling the impact of public infrastructure capital on the productivity of each sector. We base this approach on Calderón, Moral-Benito, and Servén (2015), who found that productivity in the economy increases by 0.08% per 1% of additional infrastructure capital. We distribute this gain across the individual sectors depending on their relative contribution to the GDP (Figure 11).

Table 12 presents the government capital changes in the model regions for additional infrastructure investment of 2% of the GDP. Figure 15 shows the resulting boost in productivity in the broad sectors, with the distribution of the increase in government spending across them according to government preferences.

Table 12: Changes in Government Capital with an Additional Investment of 1% of the GDP

Model Region	Government Capital (% GDP) (IMF 2020d)	Change in Government Capital from an Additional Investment of 1% of the GDP
AFR	95.70%	1.04%
AUS	40.20%	2.49%
CHN	137.50%	0.73%
EUW	48.12%	2.08%
IND	63.50%	1.57%
INO	31.60%	3.16%
JPN	106.90%	0.94%
KOR	59.70%	1.68%
LAM	56.73%	1.76%
MEN	78.70%	1.27%
MYS	146.60%	0.68%
OAS	71.44%	1.40%
OECD	55.75%	1.79%
PHL	34.60%	2.89%
ROW	53.58%	1.87%
THA	87.60%	1.14%
US	63.00%	1.59%
VNM	70.90%	1.41%

Figure 15: Increase in Productivity due to Additional Government Infrastructure Investments

3.4.4 Policy Package 4: Early Production and Distribution of a Vaccine

According to the New York Times Vaccine Tracker (2020), as of November 2020, 11 vaccines are in Phase 3 or undergoing large-scale efficacy tests, while six vaccines have gained approval for early or limited use. While there is no guaranteed timeline for

a vaccine's availability, people widely believe that an effective vaccine will become available across the world in 2021.

The fourth policy package assumes the widespread distribution of a vaccine by the second half of 2021 combined with the adoption of public health measures, similar to the Australian and New Zealand approach, in all countries. As a vaccine would reduce the mortality and morbidity arising from the infection and the uncertainty about when the vaccine will be available next year, we reduce the 2021 morbidity and mortality rates to 50% of the base case and those from 2022 to zero. We also reduce all shocks in 2021 to 50% of the base case and assume that, from 2022, the shocks, except mortality, will become zero.

4. RESULTS AND DISCUSSION

4.1 Baseline Scenario

We generate the model's baseline following the same assumptions as McKibbin and Fernando (2020a, b, c). However, the numbers for specific countries and regions differ from those in our earlier papers because the current model uses a different disaggregation of the global economy.

We first solve the model from 2016 to 2100 under the assumption of no COVID-19 pandemic. The base year for calibrating the parameters is 2015. The key inputs into the baseline are the initial dynamics from 2015 to 2016 and subsequent projections from 2016 onward for labor-augmenting technological progress by sector and country. The approach and the empirical results of Barro (1991, 2015) provide the basis for the projection of labor-augmenting technological change assumptions about productivity catch up.

4.2 Base Case Scenario and Policy Packages

Starting with the baseline, we run another simulation incorporating the range of shocks that we discussed above. We call this the "base case scenario." This base case scenario includes the epidemiological and economic shocks in 2020 and beyond that stylize the pandemic. The presentation of all the results commences for 2020. These results are the difference between the COVID-19 base case scenario and a baseline of the model in which there is no COVID-19 pandemic. It is important to stress that, because the results are either the percentage change or the percentage of GDP difference from the non-COVID situation, it is easy to misinterpret the numbers. For example, suppose for country X that the change in GDP in 2020 is -20%. This number means that the GDP in 2020 is 20% lower than it otherwise would have been in 2020. If the country was growing at 5% in the baseline, then the GDP change from 2019 to 2020 is -15% relative to 2019.

In the tables and figures of results, we also explore the four different policy scenarios. We add each policy variant separately to the base case scenario and calculate the combined scenarios' difference relative to the baseline of no pandemic.

A comprehensive set of results for the main macroeconomic variables for all the model regions are available via: <https://cama.crawford.anu.edu.au/cama-publications/asian-development-bank-institute-modelling-results-dashboard>.

The results for selected main macroeconomic variables are in Tables 13 to 23 for all countries and regions. We first present the results for 2020 and 2021 for all countries. We

then provide the dynamic results for two representative countries (the PRC and Viet Nam) to show the differences that each scenario implies over time and across sectors.

Table 13 contains the results for the real GDP in 2020 and 2021. The first two columns of numbers are the results for the base case scenario in 2020 and 2021. These are our estimates of the impact of the COVID-19 pandemic and policies in place by November 2020 on each economy. We express these as relative to what would have been the case in 2020 and 2021. The two columns of numbers labeled policy package 1 are the base case results plus the first policy package. Subtracting the base case from the policy scenario gives the impact of the policy package alone.

Table 13: Percentage Change in the Real GDP in 2020 and 2021 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-9.44	-4.20	-8.49	-4.32	-8.50	-4.25	-8.13	-4.21	-7.25	-2.51
AUS	-8.69	-4.22	-7.88	-4.97	-8.10	-4.83	-4.68	-1.93	-6.67	-4.05
CHN	-9.05	-5.64	-8.65	-6.00	-8.68	-5.94	-7.98	-5.75	-6.79	-3.37
EUW	-17.21	-11.63	-16.40	-12.11	-16.51	-12.01	-12.28	-8.40	-15.54	-7.40
IND	-6.12	-3.18	-5.66	-3.54	-5.69	-3.48	-4.73	-3.02	-5.42	-2.68
INO	-7.27	-4.07	-7.01	-4.48	-6.98	-4.43	-5.93	-3.79	-6.38	-2.94
JPN	-9.09	-6.18	-8.35	-6.61	-8.39	-6.55	-4.17	-2.77	-8.18	-5.22
KOR	-11.45	-8.43	-10.99	-8.76	-11.01	-8.70	-6.39	-4.36	-11.00	-6.46
LAM	-6.82	-3.45	-6.29	-3.85	-6.35	-3.77	-5.33	-3.26	-6.33	-3.03
MEN	-10.02	-6.01	-9.71	-6.32	-9.69	-6.25	-9.25	-6.13	-8.94	-4.23
MYS	-12.97	-8.87	-12.47	-9.20	-12.51	-9.13	-11.52	-8.72	-11.98	-5.94
OAS	-7.61	-4.59	-7.11	-4.78	-7.15	-4.72	-6.47	-4.46	-6.47	-3.15
OECD	-6.69	-3.48	-5.81	-4.06	-6.07	-3.99	-4.00	-2.64	-4.78	-3.66
PHL	-5.30	-3.26	-4.99	-3.47	-5.02	-3.43	-4.28	-3.01	-5.11	-2.70
ROW	-4.19	-1.65	-3.54	-1.68	-3.67	-1.69	-2.79	-1.21	-3.01	-1.01
THA	-6.20	-4.01	-5.88	-4.20	-5.92	-4.17	-5.32	-3.93	-5.48	-3.06
US	-11.34	-6.52	-10.21	-7.05	-10.43	-6.94	-8.07	-5.14	-8.91	-4.98
VNM	-5.59	-2.98	-5.23	-3.30	-5.26	-3.25	-4.67	-3.02	-4.95	-2.46

It is clear from these results that additional transfer payments (policy package 1) and additional government stimulus (policy package 2) reduce the impact of the pandemic in 2020 but do not come close to eliminating the recession resulting from the pandemic. Additional infrastructure spending is more effective than the other fiscal measures in reducing economic losses, particularly in the second year, when the private sector productivity gains begin to feed into the economy. The most significant improvements come from a strong and effective public health policy, including the rapid deployment of a vaccine (policy package 4).

Table 14 contains the impact of the pandemic and the four policy packages on employment. These results show that the pandemic causes large falls in employment—that is, a large increase in unemployment—in all countries in 2020.

Table 15 shows the response of private consumption. There is an exogenous shift in consumers' preferences, which explains part of the large drop in consumption. There is also an endogenous fall in financial wealth due to the sharp decline in equity prices and a fall in human wealth due to the increase in unemployment, which, together with a sharp decline in real wages, reduces the present value of future labor income. A lower

real interest rate partly offsets the negative effect on human wealth. Still, a rise in the exogenous risk premium that households use to discount future income streams counters this positive discounting effect.

Table 14: Percentage Change in Employment in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-10.73	-0.90	-8.60	-1.09	-8.63	-0.94	-8.26	-1.00	-5.86	0.31
AUS	-6.17	0.16	-4.62	-1.22	-5.06	-0.91	-3.86	0.45	-2.37	-2.05
CHN	-8.19	-3.13	-7.40	-3.79	-7.46	-3.67	-6.81	-3.74	-3.53	-1.33
EUW	-12.02	-5.15	-10.35	-6.07	-10.57	-5.84	-8.48	-3.67	-8.54	-2.45
IND	-3.84	-0.06	-2.84	-0.72	-2.88	-0.60	-2.47	-0.65	-2.34	-0.84
INO	-5.67	-0.89	-5.09	-1.66	-5.03	-1.53	-4.71	-1.44	-3.62	-0.85
JPN	-3.09	-1.10	-1.64	-1.89	-1.68	-1.77	-0.28	0.32	-1.56	-2.47
KOR	-4.45	-2.69	-3.45	-3.33	-3.48	-3.18	-3.39	-1.49	-3.56	-3.06
LAM	-4.78	0.06	-3.59	-0.69	-3.71	-0.50	-3.09	-0.44	-3.77	-1.08
MEN	-9.67	-1.74	-8.70	-2.37	-8.69	-2.20	-8.35	-2.38	-6.30	-1.14
MYS	-7.25	-2.31	-6.07	-2.87	-6.17	-2.72	-5.06	-2.53	-4.79	-1.41
OAS	-4.89	-0.63	-3.74	-0.94	-3.83	-0.81	-3.31	-0.85	-2.27	-0.33
OECD	-3.40	0.83	-1.70	-0.22	-2.22	-0.06	-0.58	0.68	0.20	-1.78
PHL	-2.20	-0.02	-1.40	-0.38	-1.48	-0.26	-1.24	-0.25	-1.83	-0.73
ROW	-5.99	-0.20	-4.25	-0.29	-4.60	-0.28	-3.48	0.07	-2.89	0.20
THA	-2.98	-0.74	-2.17	-0.99	-2.27	-0.94	-1.79	-0.91	-1.16	-0.87
US	-6.53	-1.30	-4.76	-2.12	-5.10	-1.93	-3.90	-1.04	-2.75	-1.76
VNM	-4.89	-0.29	-3.90	-1.02	-3.98	-0.87	-3.22	-0.70	-3.20	-0.93

Table 15: Percentage Change in Consumption in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-8.83	-2.81	-7.02	-1.75	-7.54	-2.09	-8.08	-2.41	-6.61	-0.65
AUS	-11.42	-4.25	-9.70	-3.37	-11.45	-4.38	-10.86	-4.49	-9.60	-2.59
CHN	-19.96	-9.31	-17.72	-7.58	-18.12	-7.88	-19.66	-8.86	-10.22	-0.62
EUW	-18.92	-6.80	-16.94	-5.41	-18.38	-6.38	-16.55	-5.92	-16.81	-2.26
IND	-7.67	-2.81	-5.65	-1.28	-6.07	-1.60	-7.26	-2.39	-7.19	-1.34
INO	-13.23	-6.52	-12.52	-6.01	-13.08	-6.41	-14.28	-7.37	-10.15	-2.75
JPN	-1.89	1.15	-0.22	2.64	-0.85	2.17	-0.19	1.78	-4.26	4.18
KOR	-6.62	0.11	-4.92	1.28	-6.25	0.31	-5.97	-1.15	-12.35	-3.18
LAM	-6.65	-1.97	-5.36	-1.37	-6.25	-1.90	-6.83	-2.29	-8.10	-2.81
MEN	-11.55	-4.97	-10.05	-3.89	-11.02	-4.59	-11.00	-4.62	-9.83	-2.16
MYS	-27.16	-14.80	-26.26	-14.39	-26.98	-14.81	-28.41	-16.11	-18.37	-5.91
OAS	-12.89	-5.27	-11.24	-4.25	-12.21	-4.91	-13.17	-5.55	-9.83	-2.03
OECD	-9.13	-2.67	-7.08	-1.58	-9.18	-2.92	-8.04	-2.35	-8.13	-2.62
PHL	-4.42	-1.57	-3.57	-1.27	-4.66	-1.98	-5.53	-2.61	-7.43	-3.18
ROW	-7.23	-1.31	-4.55	0.49	-5.91	-0.46	-5.90	-0.63	-4.66	0.20
THA	-6.09	-3.04	-5.03	-1.83	-6.49	-3.04	-7.93	-3.98	-7.39	-2.79
US	-12.20	-2.65	-10.33	-1.97	-11.72	-2.73	-11.17	-2.56	-10.09	-1.53
VNM	-3.42	-0.59	-2.95	-0.42	-3.34	-0.65	-5.00	-1.73	-5.10	-1.47

Table 16 shows that the pandemic leads to a sharp fall in private investment. The significant economic slowdown reduces firms' expected future profits because of shutdowns that have negative productivity (positive costs) implications and a drop in sales. This expected economic contraction causes equity markets to fall, which signals, through a decline in Tobin's q across all sectors, that there is reason to invest substantially less than previously anticipated. The fall in investment causes a further decrease in the aggregate demand, which, through an accelerator mechanism, reduces investment further. In 2020, the sharp decline in investment was a demand shock, but the fall in physical capital accumulation becomes an additional negative supply shock over time.

Table 16: Percentage Change in Investment in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-12.82	-9.62	-13.48	-11.72	-13.50	-11.60	-15.58	-14.03	-11.49	-8.38
AUS	-15.24	-13.51	-18.92	-22.66	-20.04	-22.67	-12.61	-12.95	-23.75	-27.46
CHN	-21.82	-20.63	-22.93	-22.82	-22.75	-22.50	-24.49	-24.79	-12.27	-9.76
EUW	-60.02	-62.06	-62.85	-69.62	-63.68	-69.71	-49.43	-52.99	-50.69	-40.67
IND	-4.20	-2.59	-5.99	-5.46	-5.70	-5.07	-7.17	-6.63	-9.76	-8.00
INO	-13.79	-9.56	-16.29	-12.50	-16.36	-12.51	-17.36	-13.26	-13.30	-8.35
JPN	-6.31	-4.88	-8.35	-10.92	-8.63	-10.87	5.78	5.74	-28.49	-32.24
KOR	-17.51	-17.72	-19.90	-22.00	-19.86	-21.80	-7.26	-6.16	-26.82	-24.14
LAM	-7.38	-4.09	-11.06	-8.73	-11.00	-8.42	-13.39	-10.74	-18.82	-12.72
MEN	-20.86	-15.68	-25.15	-20.94	-24.88	-20.48	-27.03	-22.83	-23.15	-16.65
MYS	-34.64	-29.77	-38.01	-33.62	-37.73	-33.20	-39.05	-34.73	-25.56	-17.22
OAS	-17.51	-14.99	-19.40	-18.15	-19.42	-17.95	-21.62	-20.42	-16.98	-13.23
OECD	-13.68	-17.93	-16.89	-26.98	-18.49	-27.68	-15.19	-24.78	-23.55	-33.13
PHL	-4.93	-3.19	-7.48	-6.23	-7.64	-6.17	-9.12	-7.45	-13.48	-9.49
ROW	-8.08	-5.85	-7.30	-6.79	-7.91	-7.04	-7.71	-7.29	-6.85	-5.31
THA	-6.32	-5.86	-9.80	-9.74	-9.52	-9.36	-12.00	-11.70	-14.12	-11.95
US	-40.46	-45.97	-41.26	-53.05	-42.80	-53.65	-38.28	-48.81	-37.26	-39.05
VNM	-6.04	-2.67	-9.75	-7.90	-9.65	-7.58	-13.85	-11.87	-17.83	-14.02

Table 17 contains the results for fiscal deficits and Table 18 those for trade balances. The pandemic and the different policy responses affect countries differently. An increase in the budget deficit is a decline in government saving. If all else is held constant, borrowing from overseas will partly finance an increase in government deficits. However, because private saving and investment also change, whether national savings rise or fall relative to investment will vary across countries. The current account (and the trade balance) reflects the difference between national saving and national investment. A country where investment falls by more than nationwide savings will experience a trade surplus. A country where saving falls by more than the fall in investment will experience a trade deficit. The movement of trade balances also partly reflects the global reallocation of financial capital in response to changes in the expected rates of return on different activities resulting from the pandemic. Countries with relatively bad economic outcomes will tend to lose financial capital, causing exchange rate depreciation that makes exports cheaper and imports more expensive. This movement of exchange rates driven by capital flows improves the trade balance.

Countries that receive foreign capital experience exchange rate appreciation, which worsens the trade balance. Table 19 shows the movements in exchange rates.

Table 17: Percentage Change in Fiscal Deficit in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	2.65	2.80	4.29	3.59	4.12	3.50	4.10	3.53	1.86	0.86
AUS	5.83	4.70	7.75	5.58	6.90	5.13	8.68	6.86	5.64	2.05
CHN	2.55	2.29	4.29	3.31	4.08	3.19	4.28	3.37	2.10	0.58
EUW	0.81	-0.22	2.65	0.68	2.12	0.41	3.74	2.10	0.62	-0.84
IND	0.25	-0.10	1.90	0.82	1.77	0.75	2.04	1.00	-0.20	-0.69
INO	1.04	0.66	2.68	1.66	2.69	1.69	2.76	1.84	0.80	0.03
JPN	7.56	4.61	9.34	5.43	9.23	5.42	11.45	7.79	6.90	1.37
KOR	1.22	-0.02	2.91	1.03	2.85	1.04	4.72	3.13	0.62	-0.65
LAM	2.51	1.43	4.27	2.49	3.95	2.31	4.39	2.69	2.33	0.82
MEN	2.82	1.88	4.46	3.07	4.21	2.90	4.00	2.82	1.96	0.76
MYS	-0.86	-1.08	0.78	-0.17	0.18	-0.55	0.71	-0.21	-1.00	-1.14
OAS	2.08	1.18	3.83	2.21	3.43	1.97	3.77	2.19	1.73	0.17
OECD	8.47	6.11	10.35	7.15	9.42	6.59	10.67	7.61	8.10	3.22
PHL	1.29	0.62	3.02	1.75	2.62	1.50	3.08	1.85	1.00	0.14
ROW	2.90	2.14	4.55	3.17	4.12	2.90	4.45	3.12	2.34	0.93
THA	5.95	3.69	7.52	4.81	7.17	4.57	7.36	4.75	5.20	1.99
US	4.66	3.42	6.88	4.20	6.32	4.00	8.02	5.54	5.05	1.17
VNM	0.54	0.51	2.42	1.65	2.37	1.65	2.47	1.75	0.44	-0.01

Table 18: Percentage Change in the Trade Balance in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	1.38	0.80	0.94	0.43	0.94	0.42	0.90	0.43	1.25	0.39
AUS	-3.58	-2.64	-2.99	-2.08	-2.80	-1.97	-2.47	-1.82	-0.86	0.51
CHN	7.01	6.87	7.04	6.92	7.02	6.89	7.15	7.15	1.88	1.27
EUW	1.49	1.14	1.69	1.18	1.71	1.22	1.35	0.89	0.41	-0.24
IND	-0.76	-0.87	-0.82	-0.85	-0.94	-0.94	-0.48	-0.60	1.46	1.05
INO	3.59	2.53	4.35	3.17	4.06	2.98	4.92	3.59	2.70	1.59
JPN	-9.77	-7.97	-9.56	-7.92	-9.77	-8.05	-10.34	-8.71	-3.10	-2.10
KOR	-5.50	-4.62	-5.22	-4.24	-5.74	-4.60	-5.56	-4.88	0.10	1.13
LAM	-2.41	-2.12	-1.89	-1.62	-2.00	-1.73	-1.38	-1.26	1.41	1.42
MEN	0.89	0.37	0.97	0.57	0.87	0.47	0.61	0.38	1.26	0.71
MYS	10.81	9.47	11.84	10.47	12.01	10.51	12.37	10.91	4.75	3.51
OAS	2.78	1.32	2.63	1.31	2.62	1.29	3.04	1.59	1.90	0.72
OECD	-6.70	-4.85	-6.41	-4.58	-6.16	-4.37	-6.34	-4.58	-3.59	-0.63
PHL	-2.00	-1.93	-1.70	-1.44	-1.73	-1.52	-1.16	-1.10	2.14	1.65
ROW	0.51	-0.37	-0.50	-1.21	-0.35	-1.07	-0.84	-1.43	0.00	-0.44
THA	-4.94	-3.02	-4.19	-2.32	-4.44	-2.51	-3.54	-1.79	-1.52	0.76
US	-1.78	-1.71	-1.78	-1.62	-1.73	-1.60	-1.55	-1.46	-1.32	-0.66
VNM	-2.23	-2.10	-1.32	-1.14	-1.61	-1.39	-0.37	-0.37	2.23	2.03

Table 19: Percentage Change in the Real Effective Exchange Rate in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-1.96	-2.50	-1.36	-1.78	-1.39	-1.77	0.03	-0.48	-2.39	-1.53
AUS	3.39	1.95	2.56	1.23	2.31	1.04	1.30	0.28	-0.51	-1.55
CHN	-11.11	-11.89	-11.13	-12.01	-11.16	-11.99	-10.04	-11.20	-2.41	-2.22
EUW	-0.37	-0.17	-0.88	-0.37	-0.89	-0.42	-1.91	-1.37	1.12	0.99
IND	0.49	1.05	0.71	1.09	0.86	1.25	0.80	1.25	-2.29	-1.56
INO	-6.09	-4.83	-7.14	-5.97	-6.69	-5.60	-7.23	-5.97	-4.90	-3.47
JPN	16.54	13.64	16.18	13.65	16.52	13.89	15.55	13.12	6.15	4.75
KOR	6.23	5.58	6.00	5.23	6.33	5.47	3.17	2.73	2.34	0.58
LAM	-0.21	0.79	-0.61	-0.01	-0.51	0.18	0.18	0.84	-4.88	-3.77
MEN	-1.94	-1.36	-1.81	-1.78	-1.82	-1.69	0.24	-0.06	-2.05	-1.63
MYS	-4.22	-3.14	-4.50	-3.67	-4.60	-3.68	-3.48	-2.75	-2.02	-1.56
OAS	-0.41	1.07	-0.11	1.30	-0.11	1.30	-0.16	1.43	-0.54	0.47
OECD	2.41	1.61	2.31	1.29	2.03	1.08	3.22	2.17	-0.05	-0.98
PHL	4.29	4.66	4.20	4.23	4.22	4.32	3.83	4.16	-1.73	-1.23
ROW	-5.06	-2.67	-2.79	-0.82	-3.13	-1.13	-0.91	0.85	-3.73	-1.16
THA	0.20	0.10	0.10	-0.26	0.21	-0.15	0.53	0.18	0.05	-0.80
US	7.06	6.23	6.82	6.34	6.80	6.27	5.62	5.32	5.05	3.31
VNM	0.89	1.05	0.52	0.59	0.63	0.70	0.78	0.90	-1.44	-1.18

Table 20: Percentage Point Change in Inflation in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-8.69	5.93	-5.77	5.52	-6.12	5.61	-6.30	5.56	-2.58	5.45
AUS	-1.43	3.70	0.18	3.24	-0.37	3.44	-1.60	2.98	2.22	1.64
CHN	-8.27	7.58	-5.93	6.91	-6.25	7.00	-6.45	6.92	-0.35	5.19
EUW	2.13	6.12	3.93	5.81	3.47	5.91	1.30	5.22	4.26	3.92
IND	-2.49	5.20	-0.13	4.55	-0.41	4.62	-0.66	4.48	1.12	3.66
INO	-4.55	6.89	-2.75	6.27	-3.00	6.37	-3.56	6.31	-0.76	4.78
JPN	1.96	2.09	3.38	1.91	3.19	1.93	1.21	1.29	4.76	2.54
KOR	3.22	4.06	5.18	3.50	4.78	3.59	0.87	2.54	5.62	1.58
LAM	-1.14	4.40	0.59	3.70	0.24	3.87	-0.01	3.68	0.78	2.11
MEN	-8.63	6.78	-6.42	6.13	-6.73	6.22	-6.80	5.92	-3.10	5.54
MYS	-2.33	7.61	-0.40	6.98	-0.80	7.13	-0.50	6.82	1.31	4.26
OAS	-1.99	5.85	-0.04	5.25	-0.48	5.39	-0.14	5.18	1.77	3.54
OECD	-0.73	4.02	1.04	3.56	0.48	3.72	0.06	3.38	3.26	1.30
PHL	-0.87	3.95	1.16	3.17	0.65	3.38	0.58	3.24	2.09	2.15
ROW	-10.98	9.01	-5.91	7.92	-7.01	8.16	-6.30	7.76	-2.51	6.45
THA	-0.95	3.71	1.00	3.19	0.65	3.28	0.96	3.04	3.18	1.49
US	2.43	4.85	3.93	4.62	3.52	4.72	2.24	4.44	5.34	1.78
VNM	-1.02	4.01	0.86	3.43	0.51	3.55	0.04	3.65	2.21	2.43

Table 20 presents the very different inflation experience across countries. It is important to stress that these results are not the actual inflation rate but **the change in the inflation rate relative to the no Covid-19 baseline**. For example, the Japanese

inflation of 1.96% in 2020 is the change in inflation relative to the no-Covid-19 baseline. If inflation was -2.0% in 2020 in the no-COVID baseline, then the actual inflation rate would be 0.04% in 2020. To the extent that the fall in demand is larger than the fall in supply, the shocks can be deflationary in 2020. The shock is inflationary for countries that experience a fall in supply that is greater than the reduction in the aggregate demand. There are also significant relative price shocks and overall aggregate price shocks from the pandemic and policy responses. Given the model's structure, the relative price shocks in each economy mostly drive the initial inflationary outcome in 2020. Over time, the central banks' reactions in balancing the inflation changes with the output contractions determine the aggregate inflation outcome.

Table 21 shows the impact on real short-term interest rates in 2020 and 2021. As in the previous papers, real interest rates drop sharply in 2020 and 2021. At the global level, there are excess savings relative to investment. The various fiscal policies considered in policy packages 1 to 3 reduce the extent of the fall in real interest rates because these policies reduce government saving and stimulate private investment. Interestingly, the public health policy (package 4), by being so successful in 2021, leads to a rise in real interest rates in 2021 because of the substantial economic recovery in the latter part of 2021.

Although dependent on a range of assumptions, these results suggest a note of caution to countries that have incurred substantial increases in government debt. The sustainability of the enormous amount of government debt depends on the economy's growth rate and the interest rates on this debt. The worst position for a country to be in would be a vaccine-driven recovery in other countries but no recovery domestically. In that world, all countries would face higher real interest rates but only the successfully growing economies would cope with the debt overhang.

Table 21: Percentage Point Change in the Real Interest Rate in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-3.32	-3.18	-2.40	-1.61	-2.55	-1.83	-1.52	-0.81	-1.06	1.79
AUS	-3.78	-2.12	-2.88	-0.95	-3.04	-1.27	-2.45	-0.81	-0.54	2.29
CHN	-4.06	-5.06	-2.93	-3.69	-3.07	-3.89	-1.96	-2.91	-1.37	1.43
EUW	-6.09	-4.09	-5.24	-2.71	-5.32	-2.96	-4.43	-2.30	-2.19	3.41
IND	-5.43	-2.88	-4.19	-1.47	-4.31	-1.61	-3.47	-0.88	-2.03	1.46
INO	-5.59	-3.61	-4.42	-2.56	-4.44	-2.59	-3.79	-2.06	-2.20	0.34
JPN	-2.56	-1.03	-1.85	0.11	-1.86	0.02	-1.19	0.75	-0.39	6.19
KOR	-4.22	-1.69	-3.08	-0.43	-3.10	-0.52	-2.64	-0.39	0.29	3.86
LAM	-5.06	-1.63	-3.76	-0.40	-3.94	-0.58	-3.09	0.20	-1.33	1.18
MEN	-5.48	-3.33	-3.91	-2.02	-4.12	-2.22	-2.81	-0.90	-1.64	2.09
MYS	-6.04	-3.92	-4.73	-2.72	-4.92	-2.92	-3.91	-1.91	-1.89	1.43
OAS	-5.72	-2.88	-4.59	-1.52	-4.71	-1.70	-3.97	-0.94	-1.87	3.03
OECD	-4.02	-1.23	-2.92	0.12	-3.08	-0.21	-2.22	0.66	0.21	3.97
PHL	-4.56	-0.75	-3.18	0.52	-3.34	0.36	-2.76	0.91	-1.17	1.86
ROW	-7.88	-4.60	-6.47	-2.52	-6.60	-2.85	-5.44	-1.66	-4.29	2.03
THA	-4.73	-2.26	-3.46	-1.09	-3.56	-1.21	-2.73	-0.44	-0.59	2.70
US	-4.59	-1.31	-3.86	0.03	-3.93	-0.22	-3.26	0.16	-0.10	5.55
VNM	-4.87	-2.50	-3.70	-1.32	-3.79	-1.44	-3.02	-0.76	-1.47	1.61

Table 22: Percentage Point Change in the Real 10-Year Interest Rate in 2020 Relative to the No-COVID-19 Baseline

Model Region	Base Case Scenario		Policy Package 1		Policy Package 2		Policy Package 3		Policy Package 4	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
AFR	-1.97	-1.83	-1.38	-1.33	-1.46	-1.40	-1.00	-1.02	0.33	0.47
AUS	-1.89	-1.72	-1.48	-1.39	-1.58	-1.48	-1.32	-1.27	0.34	0.40
CHN	-2.68	-2.50	-2.16	-2.10	-2.24	-2.16	-1.82	-1.85	0.20	0.36
EUW	-2.29	-1.89	-1.78	-1.46	-1.87	-1.54	-1.55	-1.29	0.37	0.61
IND	-2.14	-1.78	-1.60	-1.36	-1.66	-1.41	-1.30	-1.13	0.14	0.38
INO	-2.64	-2.30	-2.23	-2.00	-2.25	-2.02	-1.98	-1.80	-0.04	0.20
JPN	-0.93	-0.85	-0.49	-0.48	-0.53	-0.51	-0.28	-0.32	0.89	0.94
KOR	-1.70	-1.48	-1.22	-1.11	-1.26	-1.15	-1.11	-1.03	0.67	0.65
LAM	-1.97	-1.66	-1.50	-1.32	-1.57	-1.37	-1.20	-1.08	0.17	0.32
MEN	-2.32	-1.94	-1.79	-1.56	-1.87	-1.62	-1.33	-1.20	0.18	0.39
MYS	-2.52	-2.11	-2.04	-1.76	-2.12	-1.82	-1.69	-1.48	0.19	0.41
OAS	-2.10	-1.72	-1.56	-1.30	-1.63	-1.36	-1.30	-1.08	0.39	0.60
OECD	-1.57	-1.37	-1.09	-1.00	-1.19	-1.09	-0.80	-0.77	0.64	0.63
PHL	-1.71	-1.45	-1.21	-1.08	-1.27	-1.13	-0.98	-0.89	0.36	0.50
ROW	-2.58	-1.96	-1.83	-1.35	-1.95	-1.45	-1.40	-1.01	-0.05	0.43
THA	-1.99	-1.71	-1.51	-1.34	-1.56	-1.39	-1.20	-1.10	0.44	0.52
US	-1.52	-1.29	-1.04	-0.88	-1.12	-0.95	-0.87	-0.76	0.82	0.83
VNM	-2.15	-1.87	-1.68	-1.52	-1.74	-1.56	-1.41	-1.30	0.26	0.42

4.3 Dynamic Results

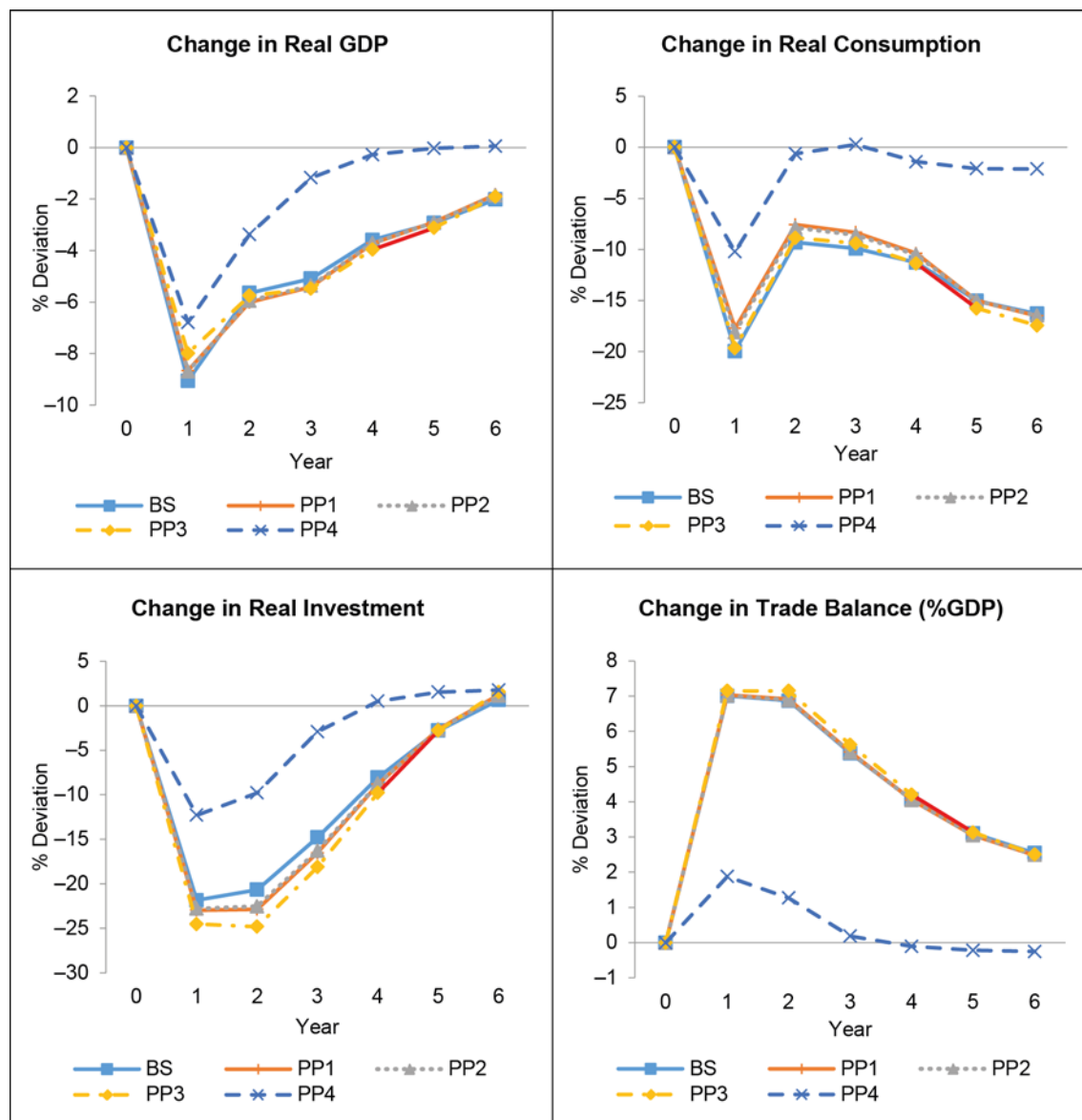
We now consider the dynamic adjustment in economies in the base case and four policy scenarios. While each country experiences different sectoral and aggregate outcomes, it is instructive to consider two countries in more detail. The results for the PRC are in Figure 16 and those for Viet Nam are in Figure 17.

Figure 16 shows that, by year 6 (or by 2025), the real GDP has not returned to the no-COVID-19 baseline in each policy scenario, although the public health intervention that eliminates the virus shows the GDP returning to the baseline by 2023. Each of the fiscal responses assists in reducing the loss of investment and consumption. The patterns are very similar for the fiscal responses in the two countries. There is a significant difference in the impacts of the public health policy across the two countries. Viet Nam has managed to contain the COVID-19 virus well relative to the rest of the world in the base case. By being so effective in the public health response, significant capital inflow mitigates the fall in investment and consumption. The trade balance deterioration reflects this capital inflow. When the world follows a significant public health policy, the difference relative to Viet Nam is much smaller. The capital that would have flowed into Viet Nam in the base case remains in the rest of the world. Thus, the trade balance does not deteriorate and Viet Nam does not attract the investment that occurs in the base case. The real GDP in Viet Nam (Figure 17) still improves with the global public health response, but the GDP's composition is different. Trade is the main driver for Viet Nam in the global public health response. In contrast, investment is critical in the base scenario in which Viet Nam makes much better public health responses relative to many countries in the rest of the world.

Figure 16 shows the change in output by sector in the PRC. The virus hits all sectors but to varying degrees. Services decline because of the sharp fall in demand for some service sector activities. Durable manufacturing and mining and energy also experience a fall in demand for capital goods for investment purposes. Furthermore, the employment losses by sector in the PRC, shown in Figure 16, show a widespread loss of jobs.

The sectoral results for Viet Nam are noticeably smaller than those for the PRC, mostly because of Viet Nam's effective public health response. The infrastructure policy also boosts the output and employment in the mining sector in Viet Nam (see Figure 17).

Figure 16: Dynamic Results for the PRC



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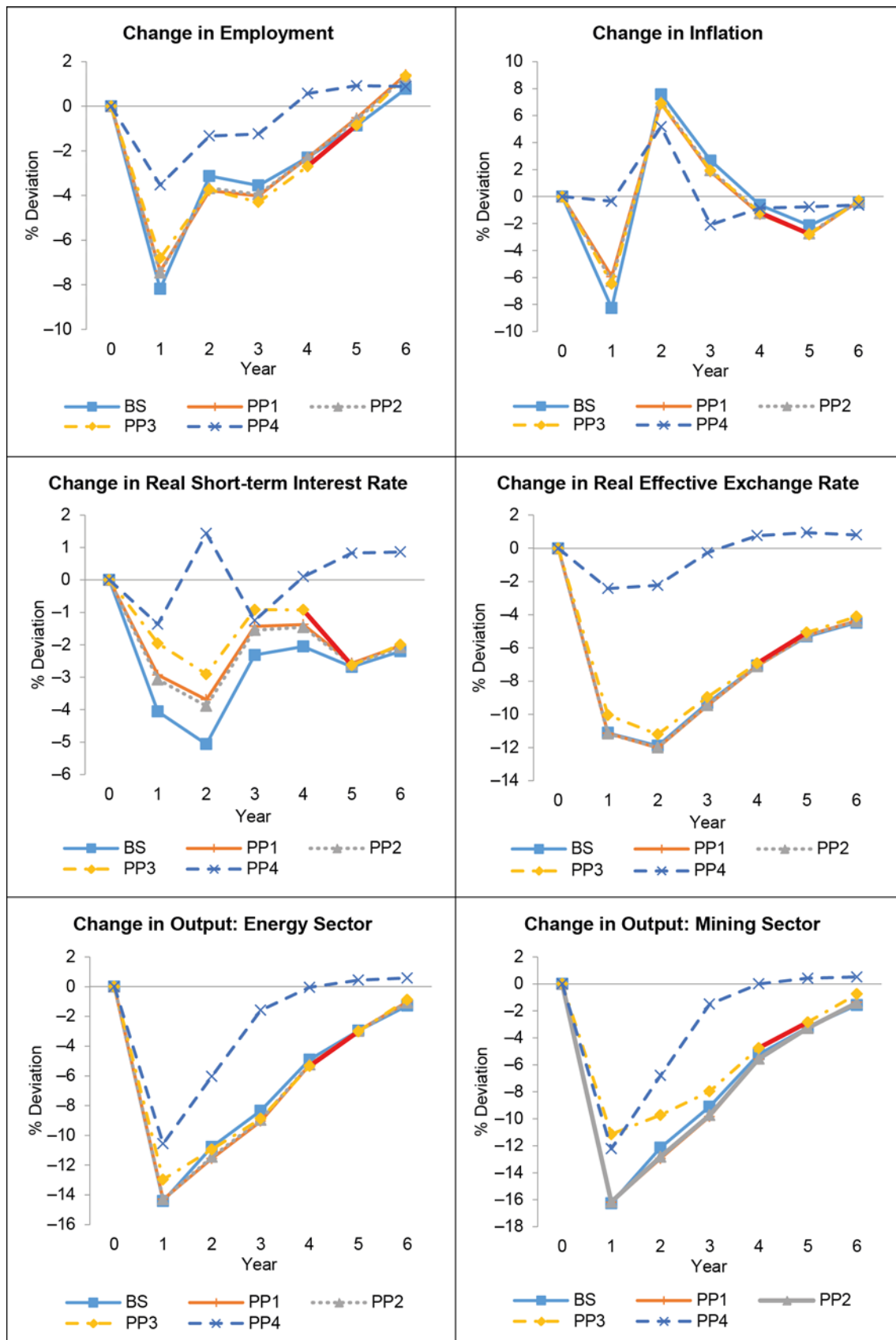
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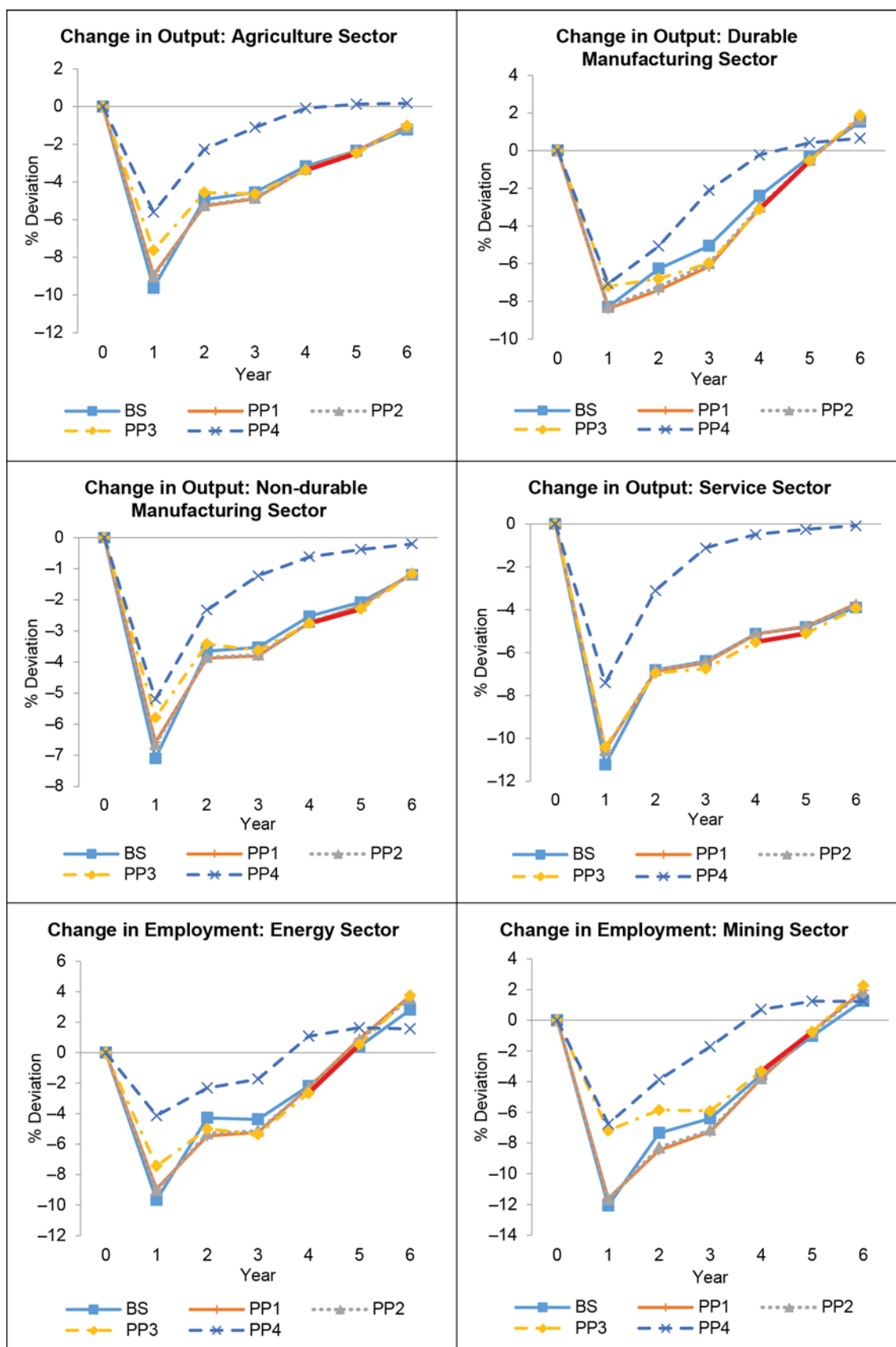
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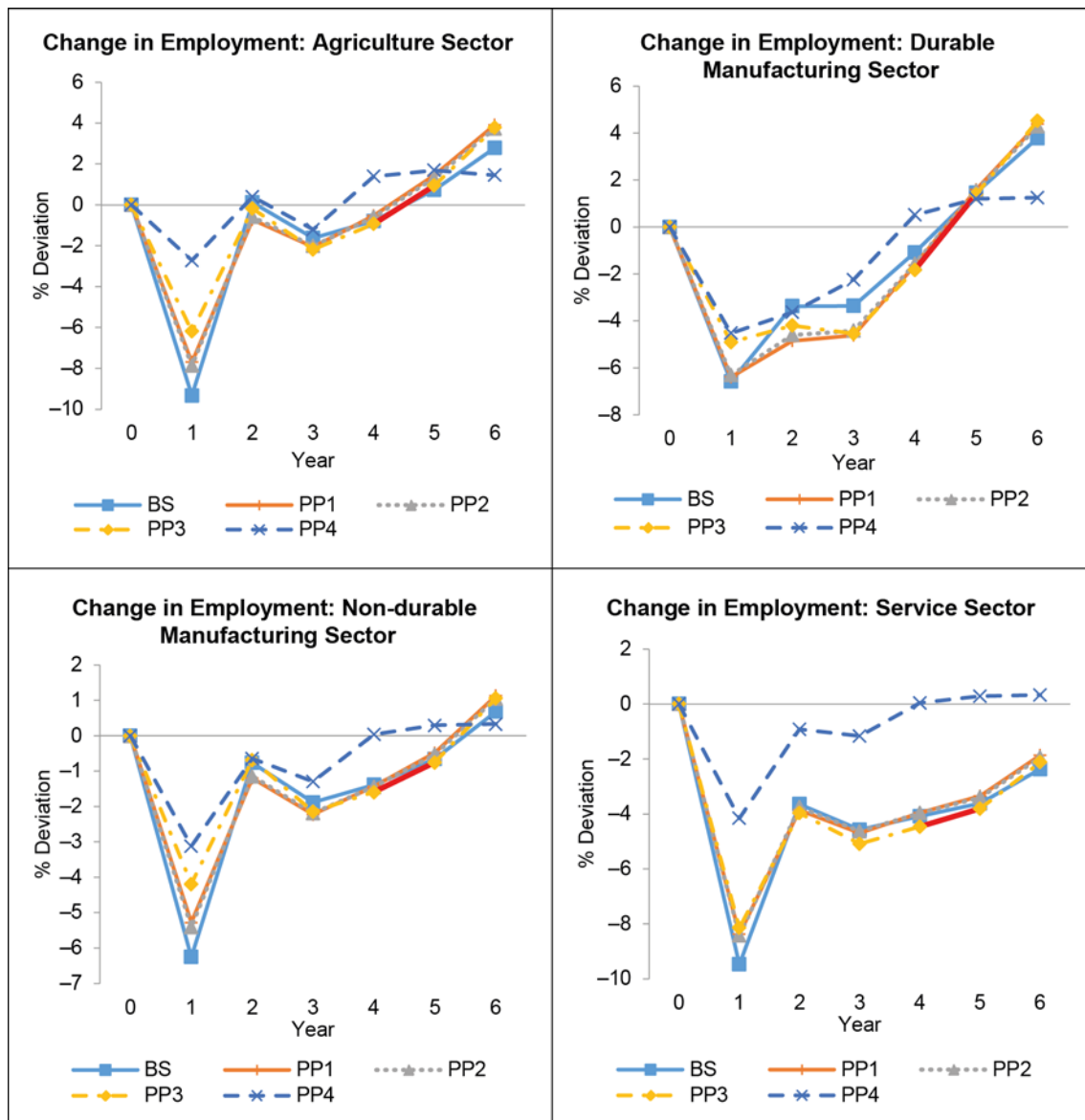
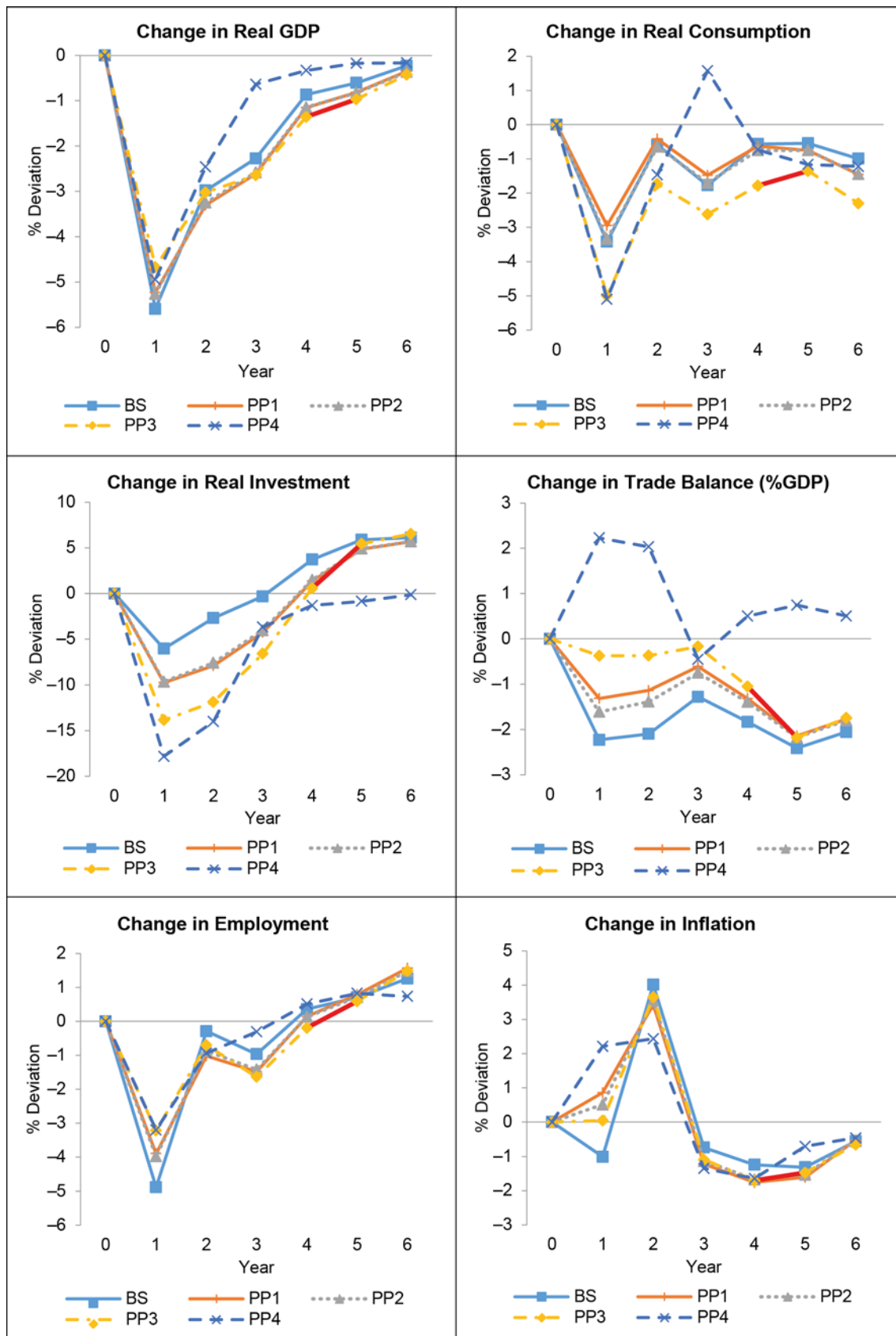
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Figure 17: Dynamic Results for Viet Nam



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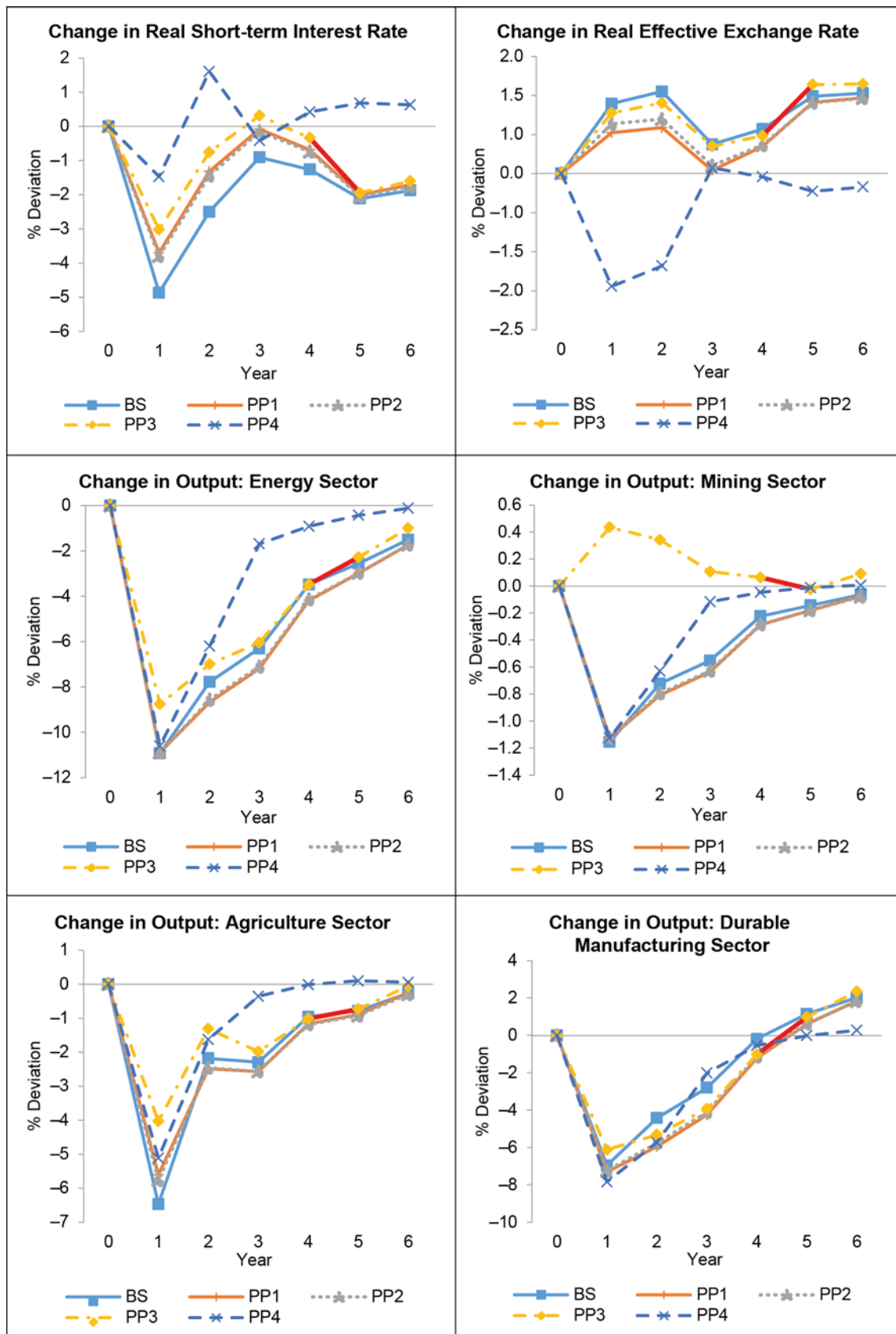
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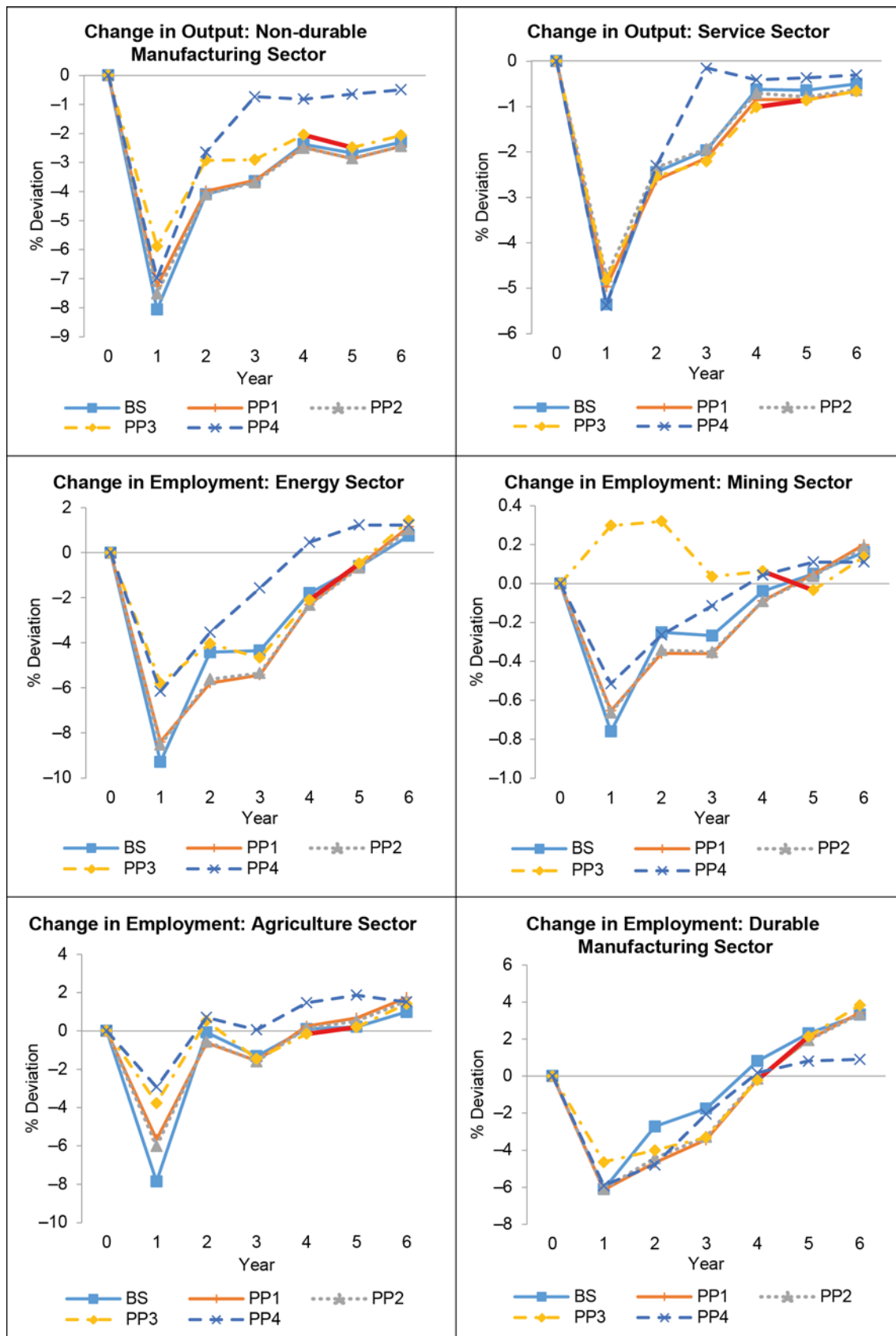
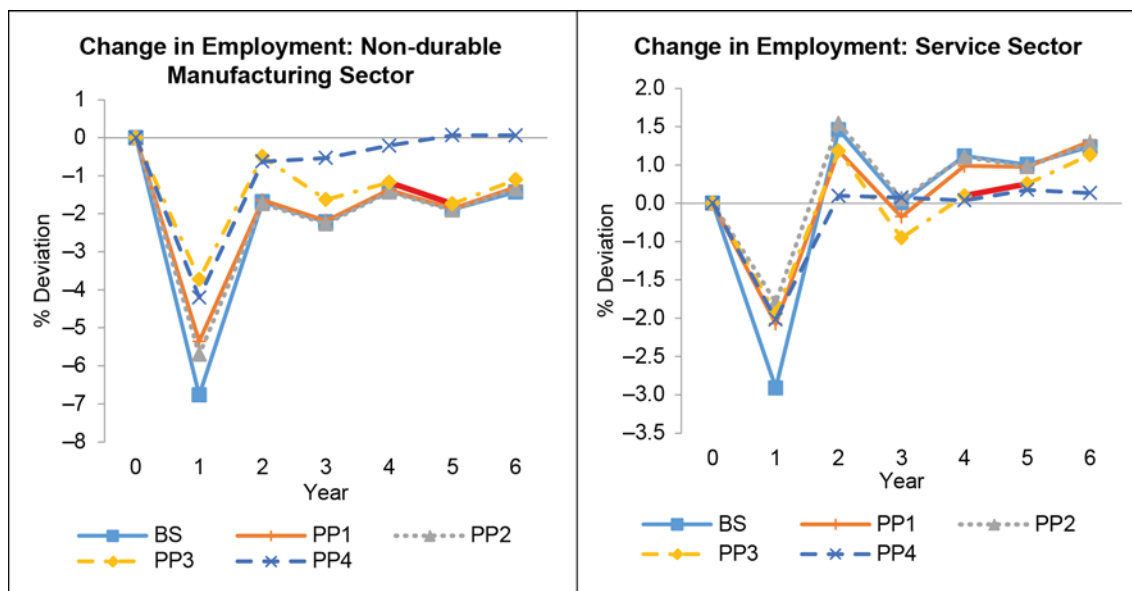
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Figure 17 *continued*

5. CONCLUSION

This paper has extended the approach of McKibbin and Fernando (2020a, c) to explore the impact on Asian economies of the COVID-19 pandemic and four different policy responses: an increase in transfer payments to households; additional government spending on goods and services; an increase in infrastructure spending; and a much better public health response, including the rapid deployment of a vaccine. We intend these results to be illustrative since the exact magnitudes of any policy in a particular economy will depend on the package's precise details.

The results suggest that most benefits would come from a robust public health response and the rapid deployment of a vaccine. The other policy programs help to alleviate the macroeconomic impact of the COVID-19 pandemic, and perhaps a combination of the policies would have a significant effect.

A key issue that we did not explore in this paper but that McKibbin and Vines (2020) explored further is the need for global coordination of macroeconomic policies. Coordination requires concerted action from the Group of 20 (G20) economies and the International Monetary Fund (IMF). As of November 2020, the coordinated response that previously occurred during the Great Recession with international leadership from the US and the UK has not been forthcoming. While we have shown the additional fiscal stimulus to be helpful in the short run, it may not be possible for many countries to issue the government debt necessary to finance budgetary expansion because of the institutional restrictions or the financial market pressures on them. The additional benefits of global coordination in facilitating fiscal responses and reducing risk premia would provide an additional stimulus to the global economy and those economies on which this paper focused.

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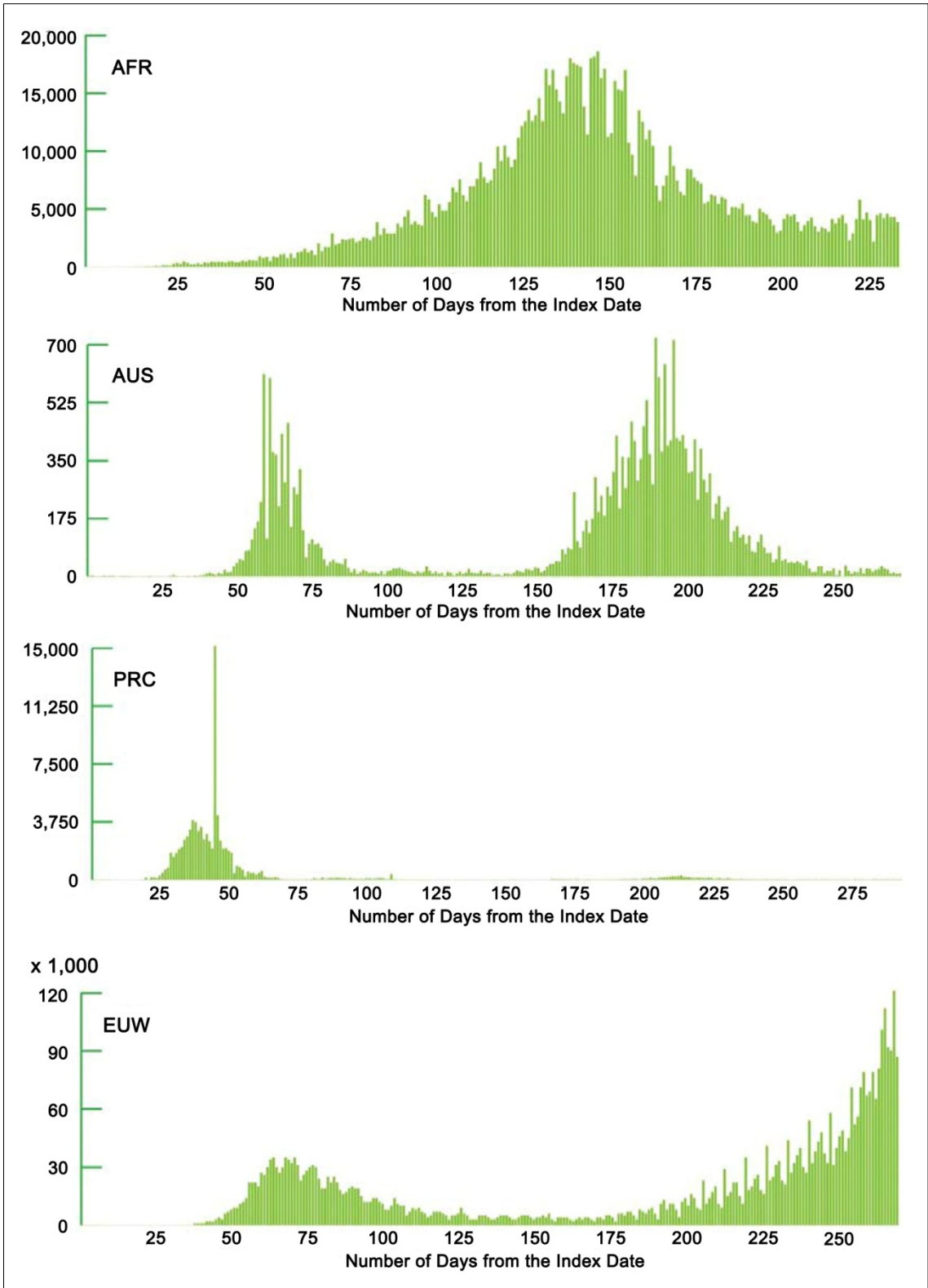
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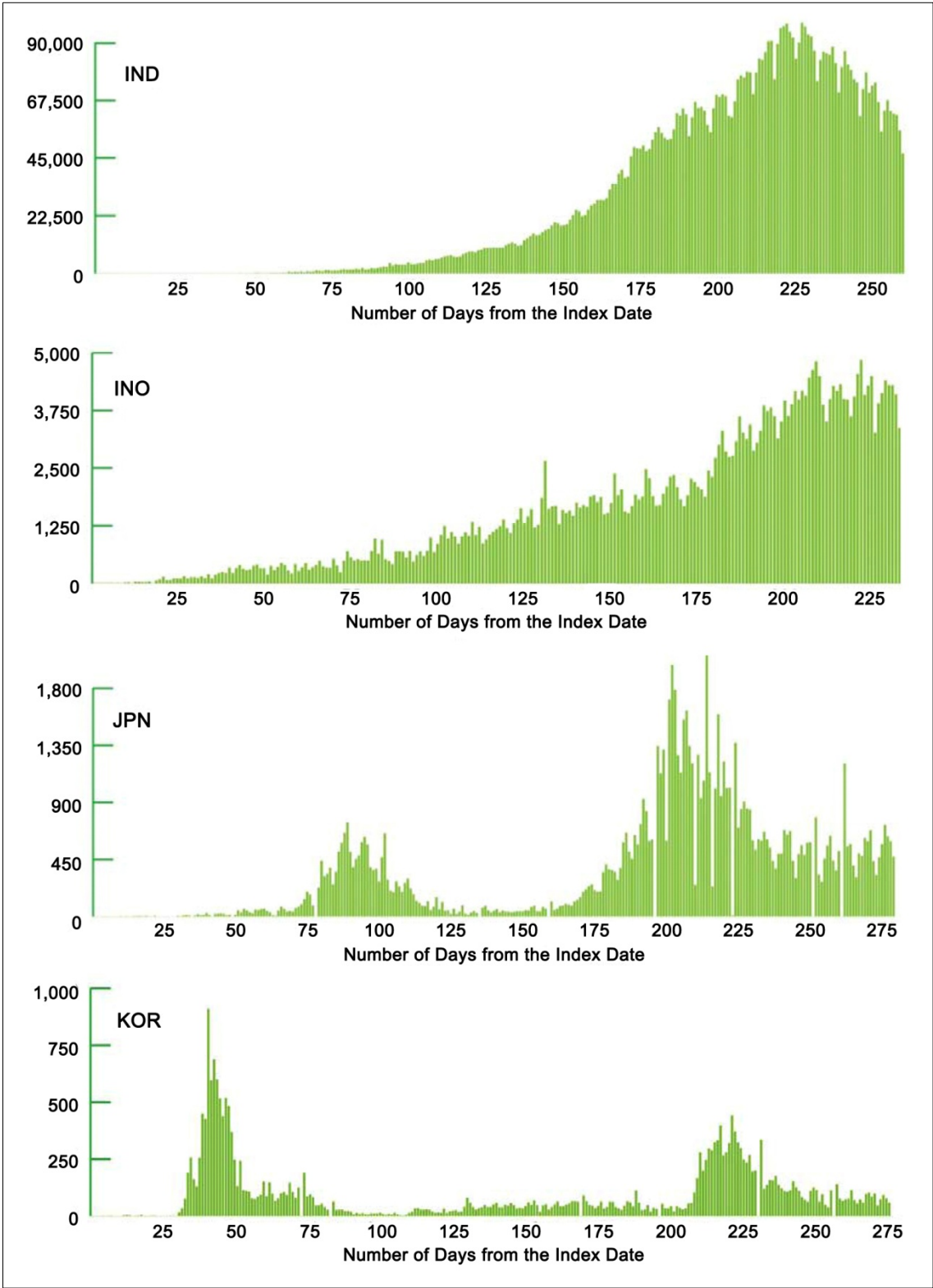
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**APPENDIX 1: INFECTIONS FROM THE INDEX DATE
UNTIL 20 OCTOBER 2020**



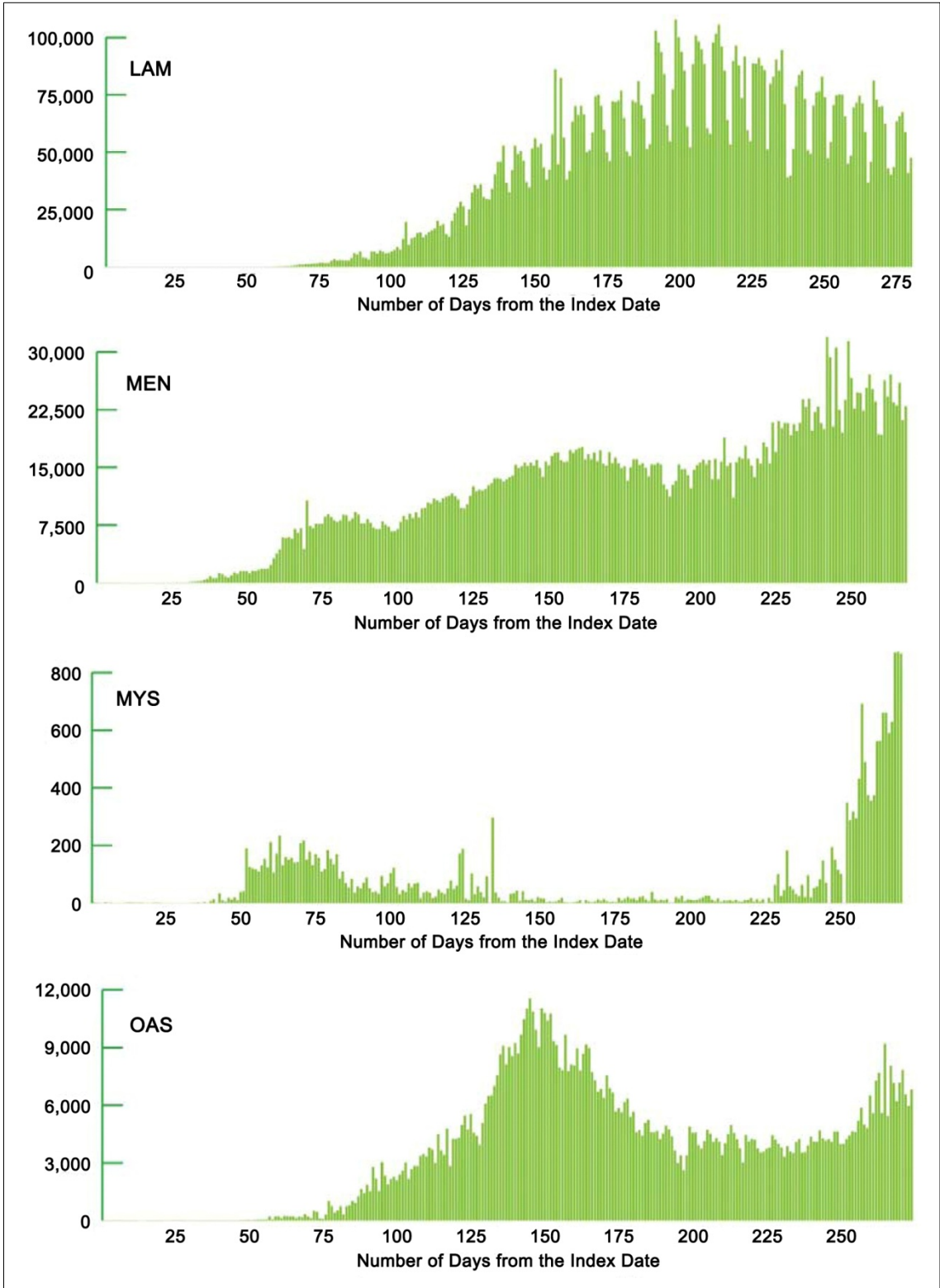
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Appendix 1 figure continued



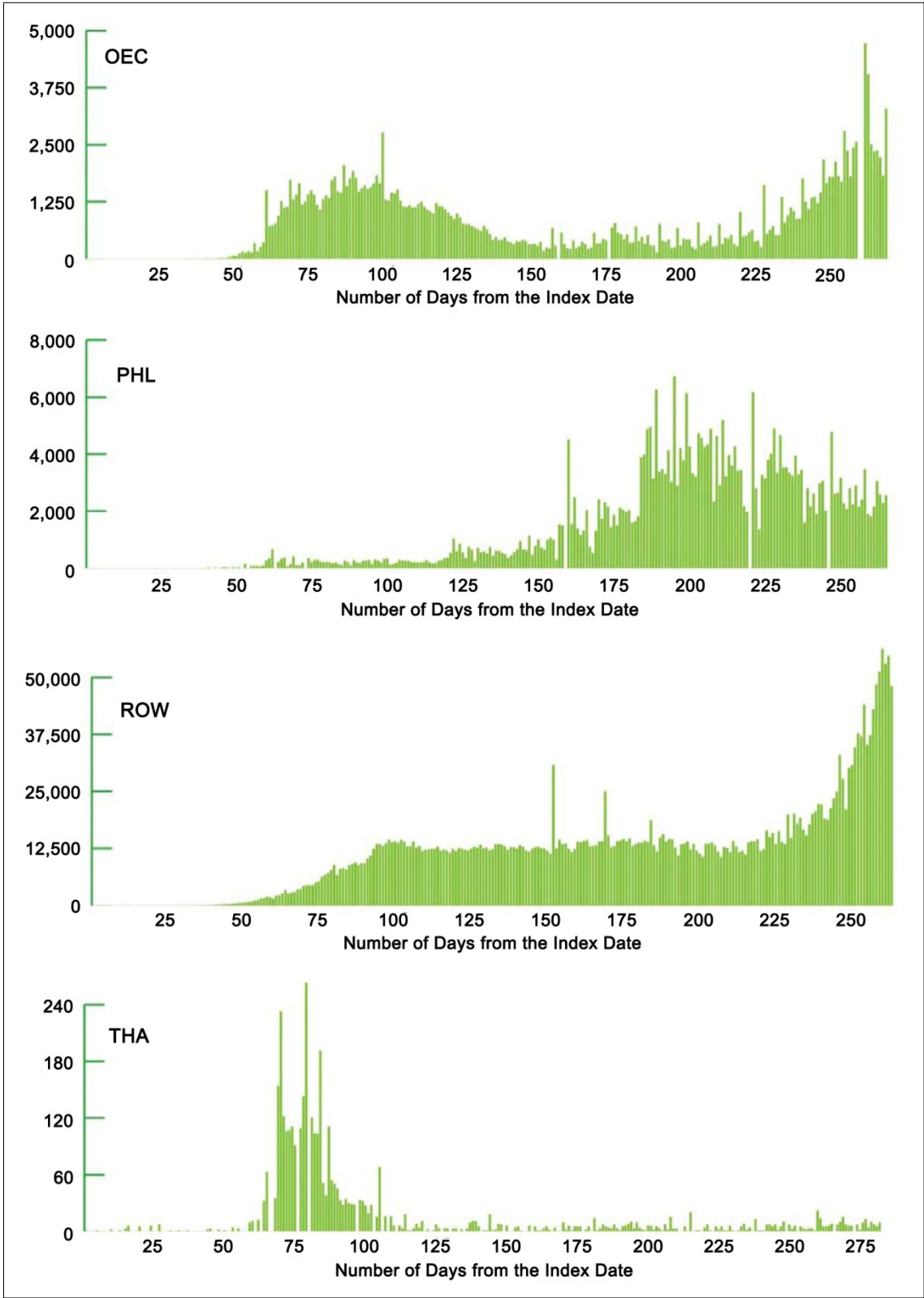
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Appendix 1 *figure continued*



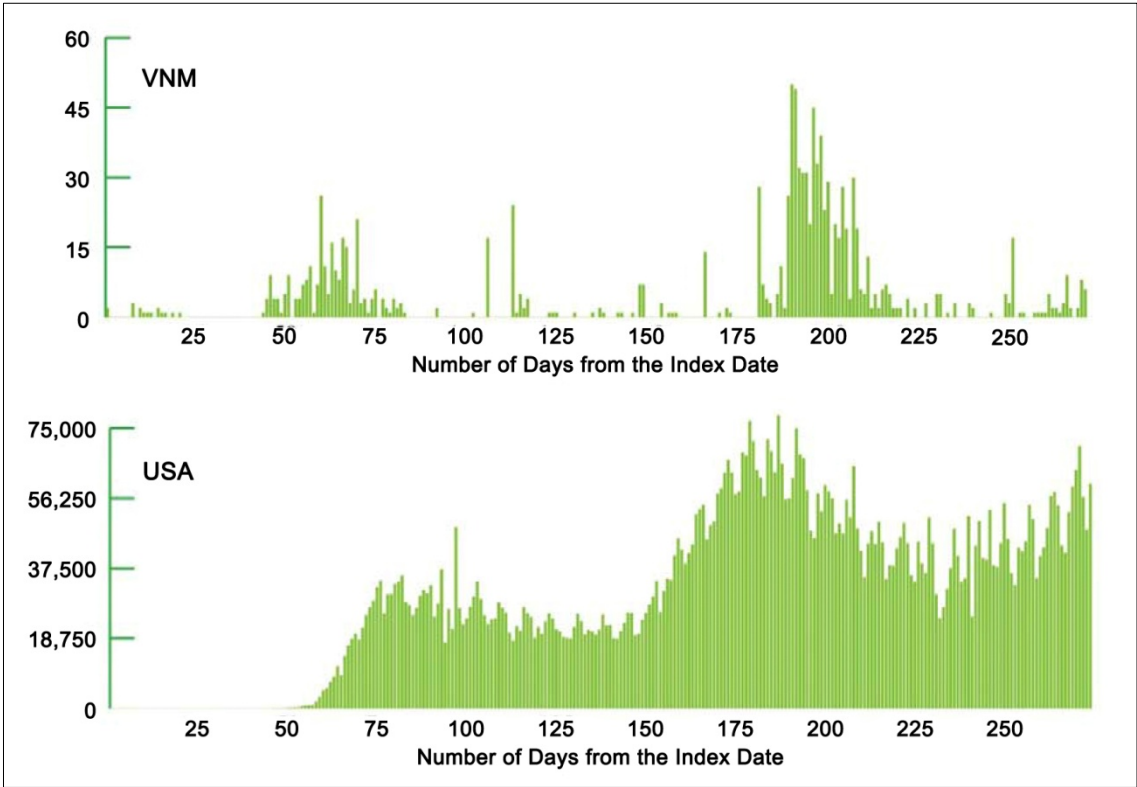
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Appendix 1 *figure continued*

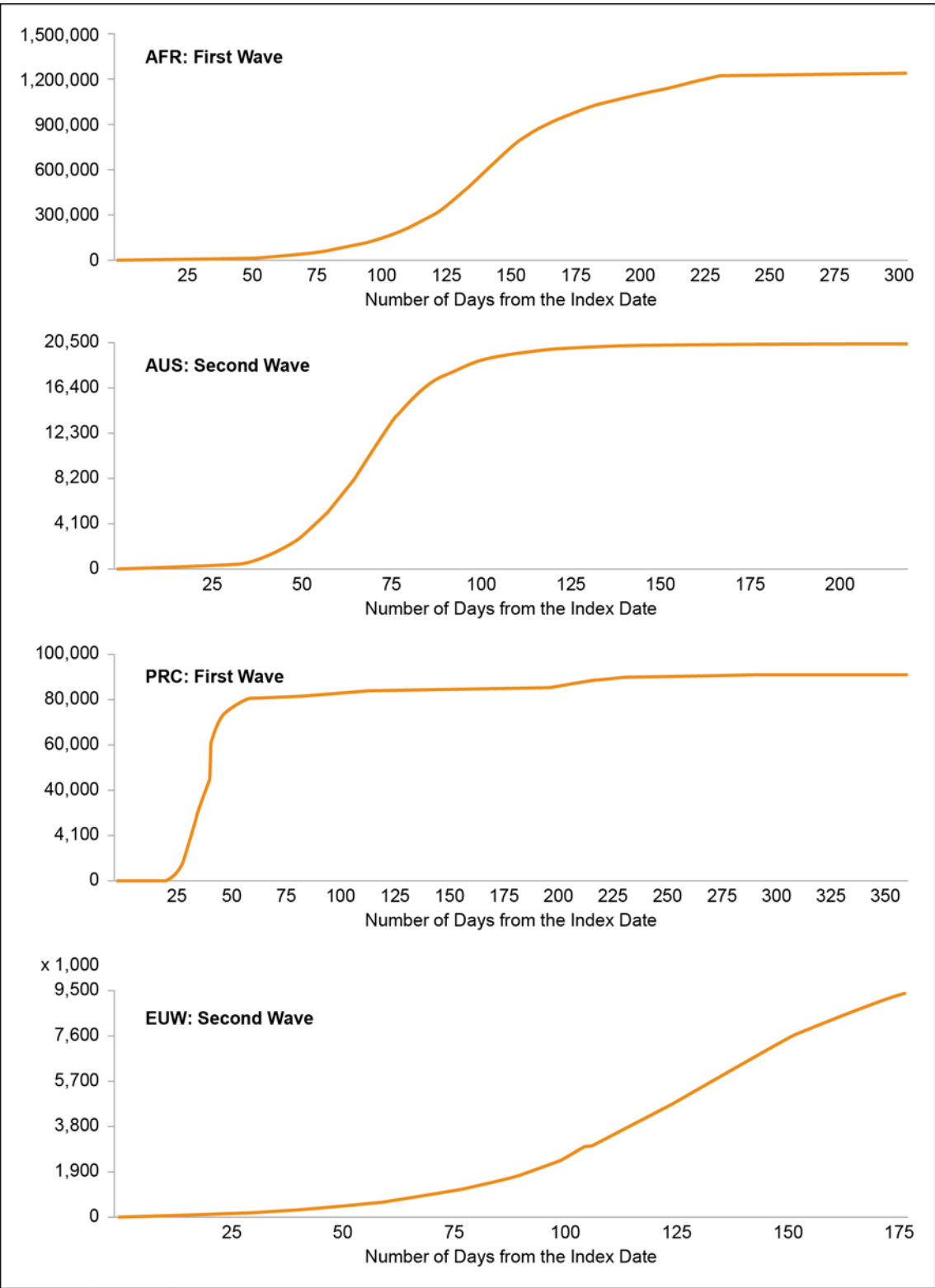


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Appendix 1 *figure continued*

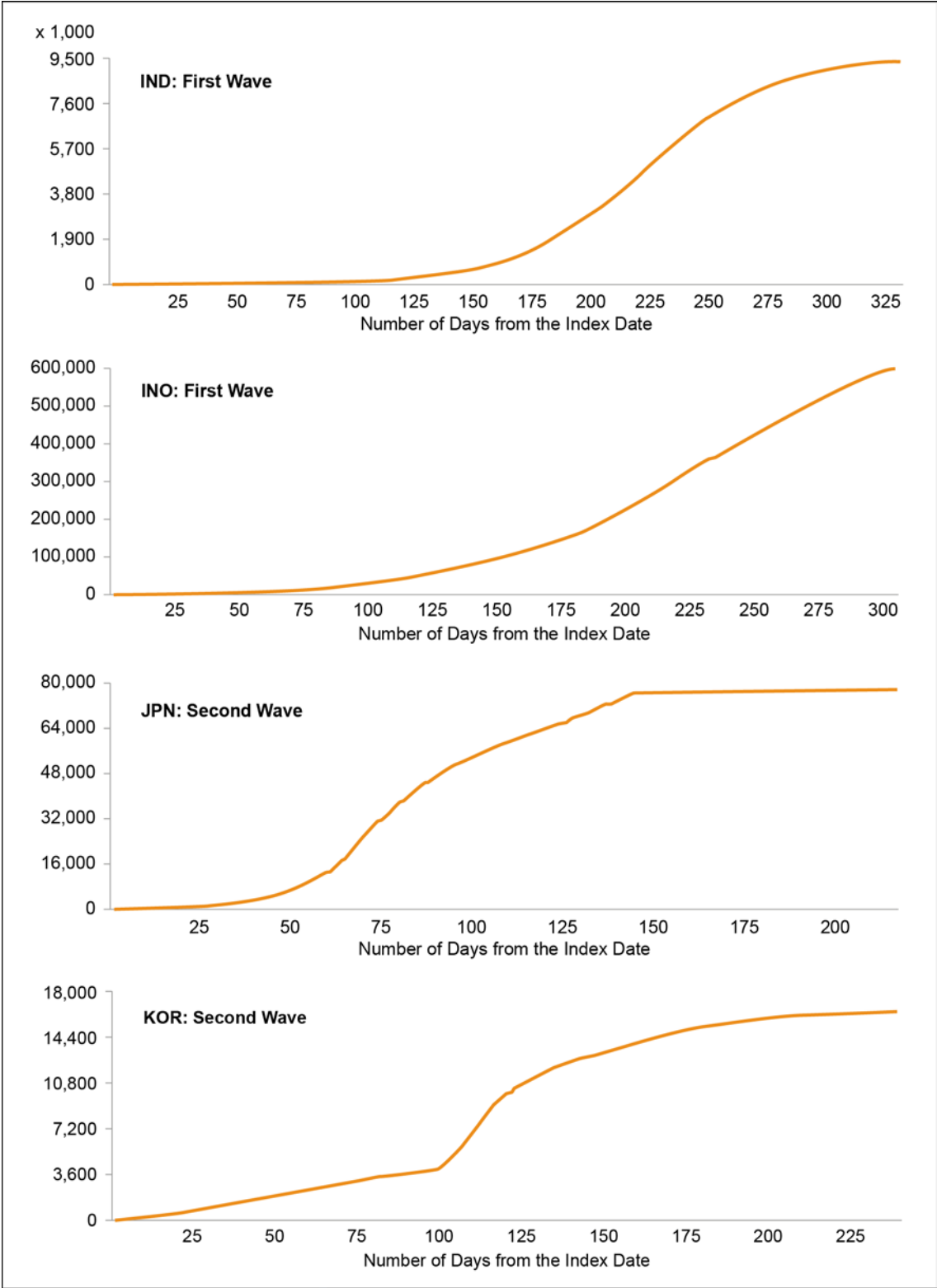


APPENDIX 2: CUMULATIVE INFECTIONS UNTIL 31 DECEMBER 2020



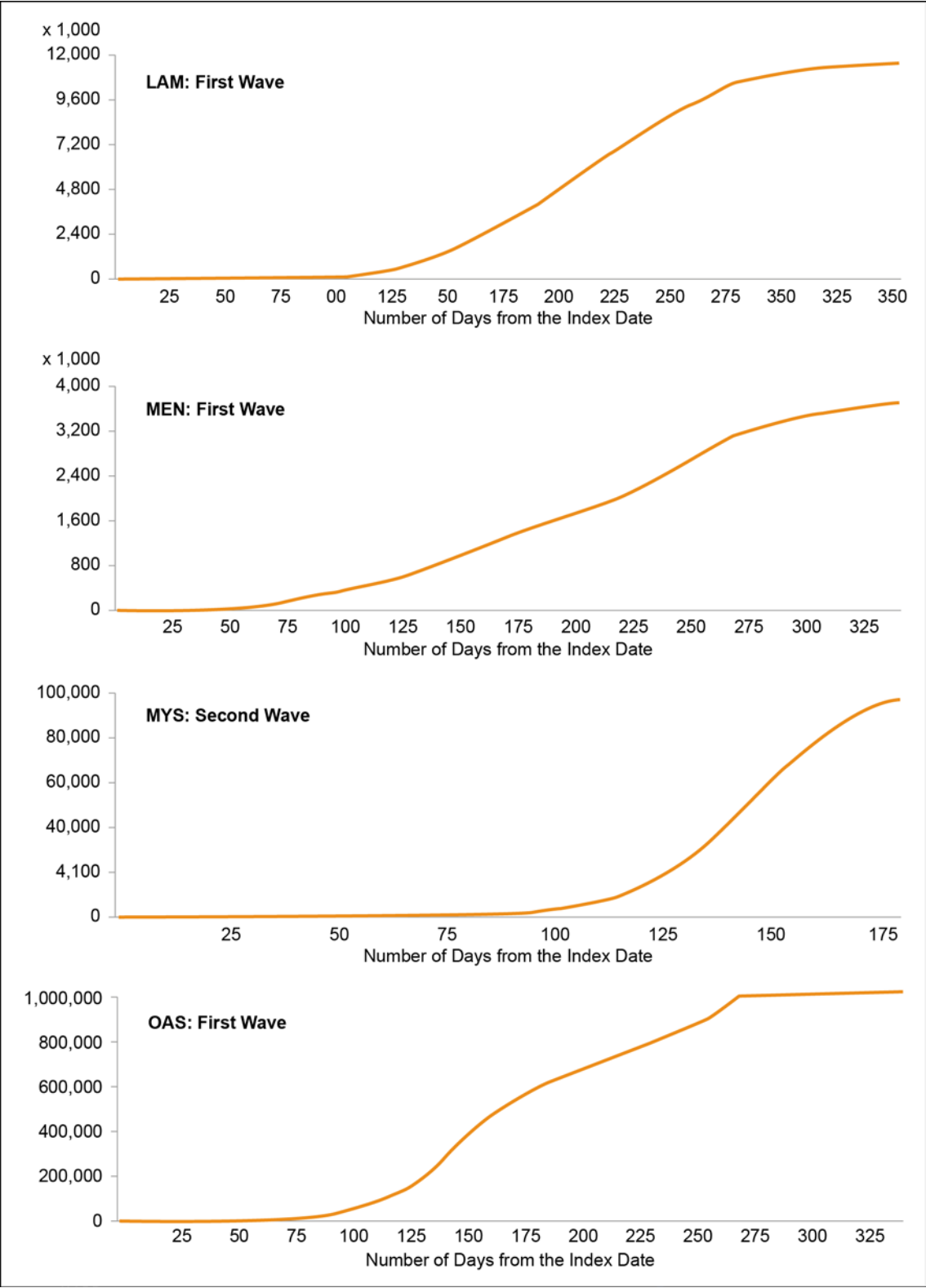
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Appendix 2 figure continued



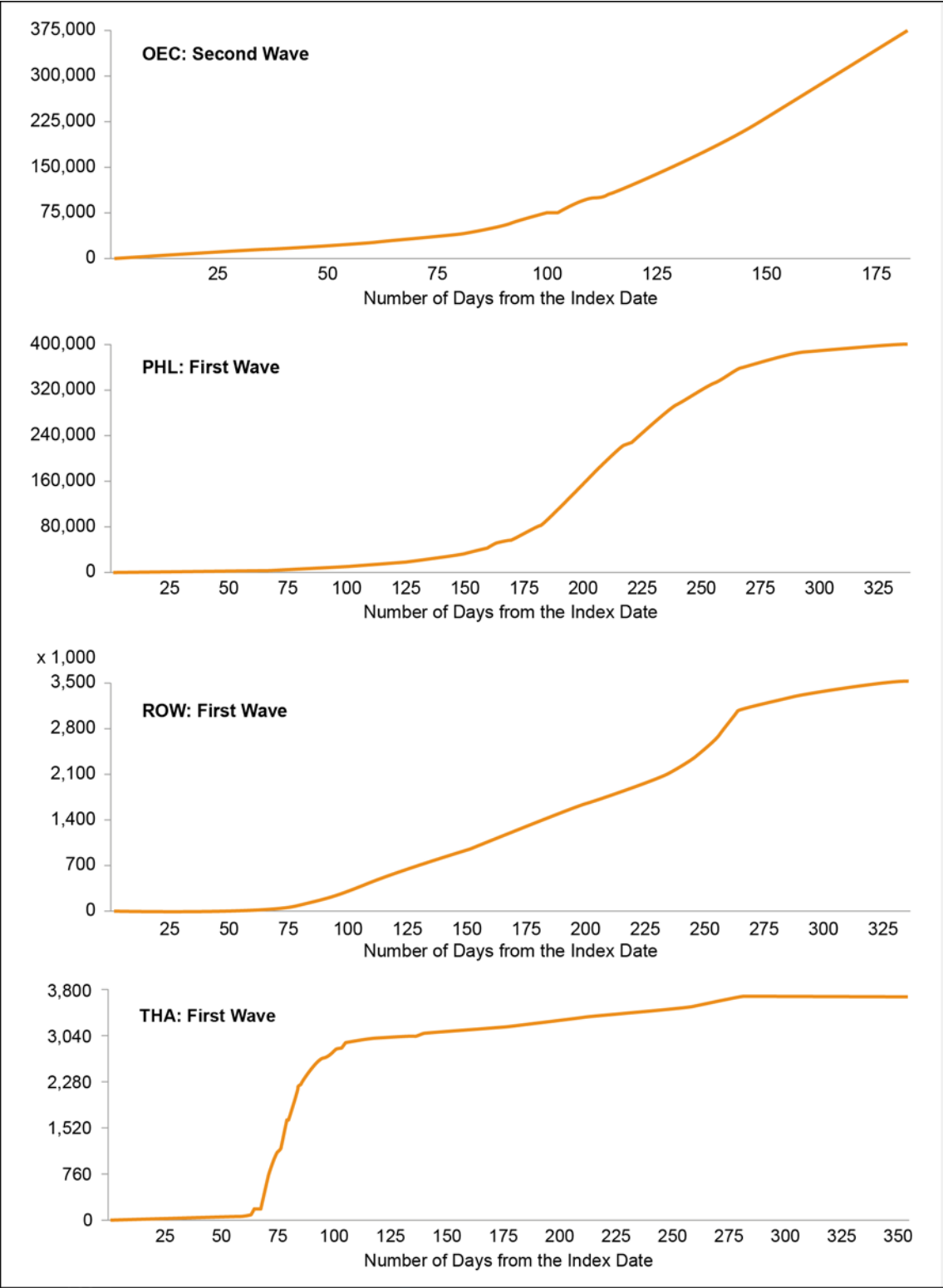
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Appendix 2 figure continued



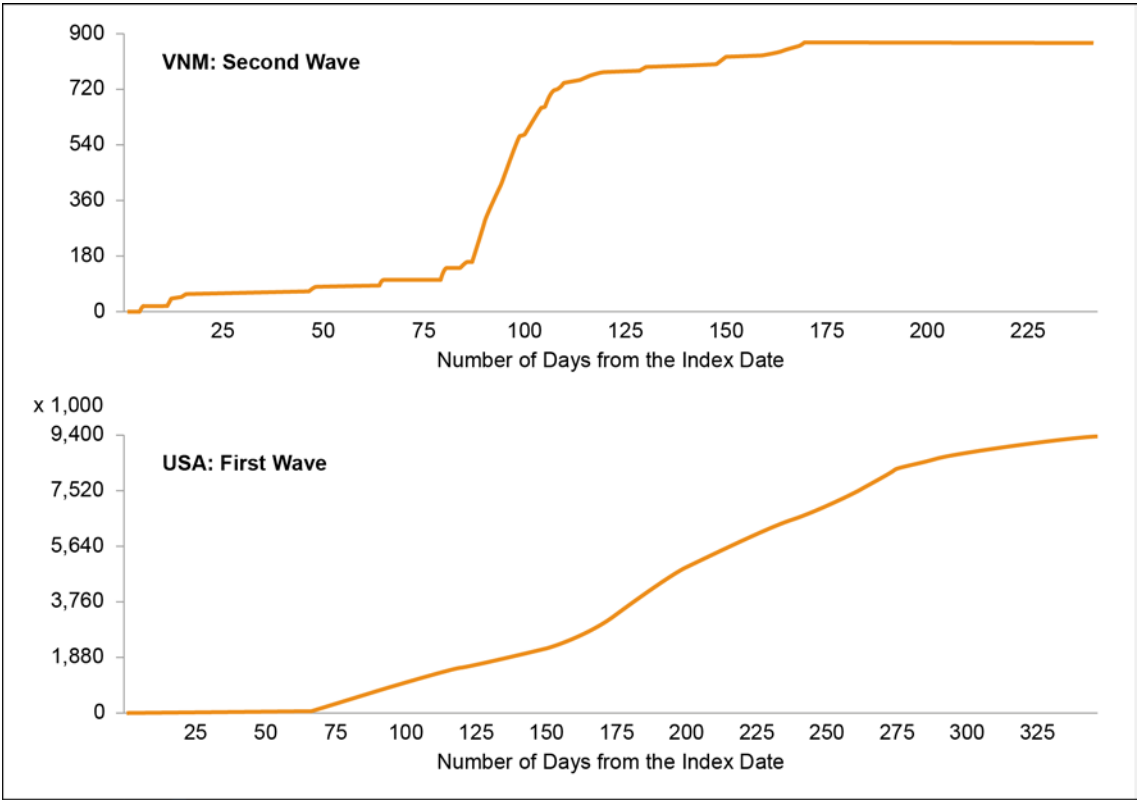
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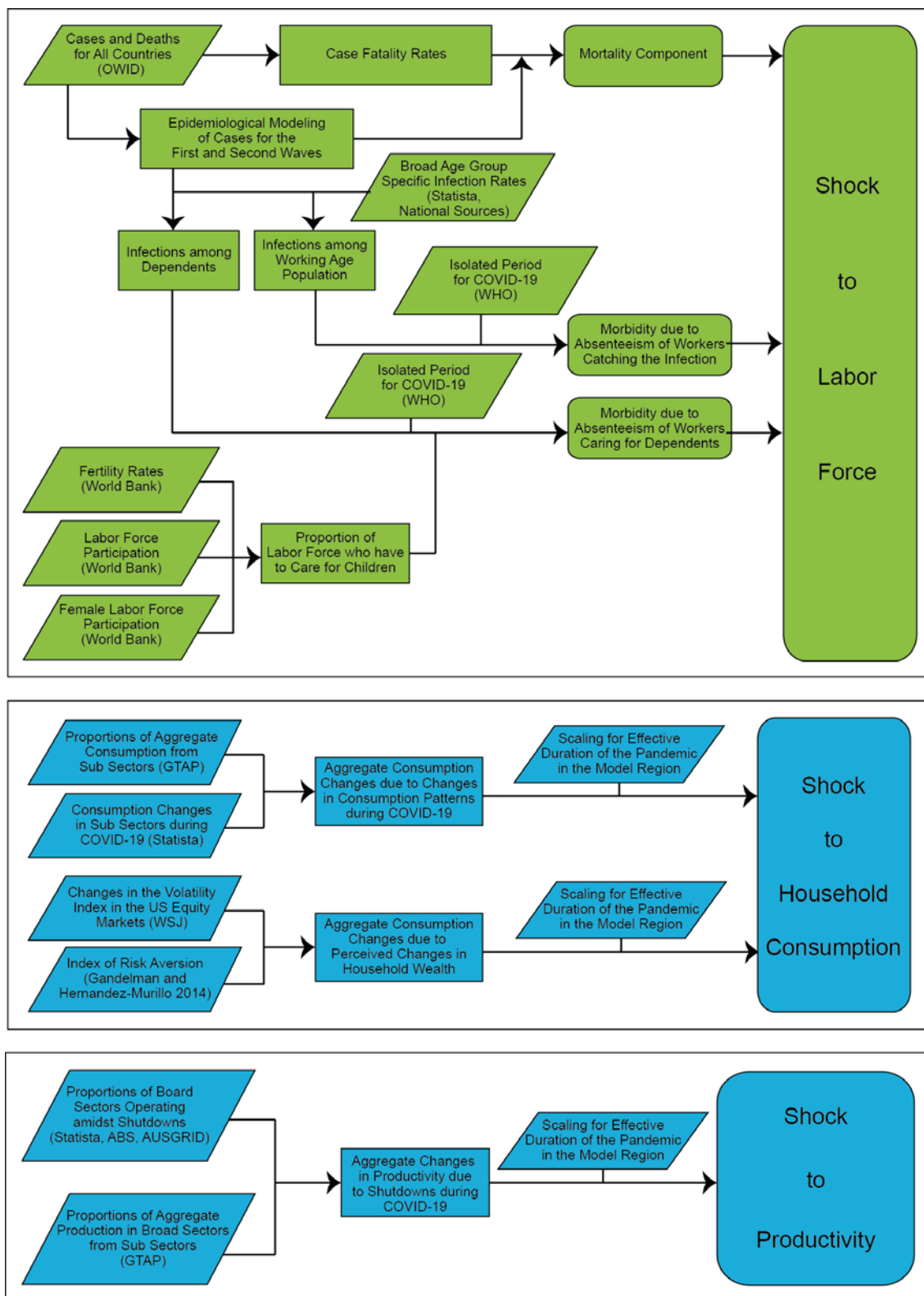


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Appendix 2 figure continued



APPENDIX 3: FORMULATION OF SHOCKS



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Appendix 3 figure continued

