ARC Centre of Excellence in Population Ageing Research

Working Paper 2021/15

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

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CAMA Working Paper 17/2021
January 2021

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Abstract

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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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ISSN 2206-0332

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Revised 21 January 2021

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ABSTRACT

This paper updates the analysis of the global macroeconomic consequences of the COVID-19 pandemic in McKibbin and Fernando (2020c) with data as of late October 2020. It also extends the focus to Asian economies and explores four alternative policy interventions coordinated across all economies. The first three policies relate to fiscal policy: an increase in transfers to households of an additional 2% of GDP in 2020; an increase in government spending on goods and services in all economies of 2% of GDP in 2020; 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.

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This paper was prepared for the 2020 Annual Asian Development Bank Institute Conference and originally appeared as an ADBI Working paper. We thank Professor Shin-ichi Fukuda, John Beirne and participants at the ADBI conference for helpful comments on a draft of this paper. We gratefully acknowledge financial support from the Australia Research Council Centre of Excellence in Population Ageing Research (CE170100005). We thank Ausgrid for providing electricity use data that assisted in the calibration of shocks and Peter Wilcoxen and Larry Weifeng Liu for their research collaboration on the G-Cubed model. We also acknowledge the contributions to earlier research on modelling of pandemics with Jong-Wha Lee and Alexandra Sidorenko.

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1 Introduction

The novel coronavirus called SARS-CoV-2 emerged in China in late 2019. Amidst increased global interconnectedness, SARS-CoV-2 soon spread worldwide, leading the World Health Organization (WHO) to recognise 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 has infected over 48 million individuals and claimed 1.22 million lives. The significant social and economic impacts have been widespread. There have been substantial changes in the behaviour 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 mortality and morbidity arising from infections, the lockdowns and uncertainty coupled with diminished confidence in many economies have significantly reduced economic activity. 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 of producing and distributing a vaccine globally, governments have found it challenging to return economic activity to pre-2020 levels.

McKibbin and Fernando (2020a) circulated a paper on global pandemic scenarios to policymakers in a range of countries in February 2020 before publicly releasing the research in March 2020[1]. They used other major global epidemics' historical experience to explore seven different scenarios for the world economy. They estimated epidemiological transmission across countries based on various indicators and then used these epidemiological outcomes to design a set of economic shocks. These shocks were then applied 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. The research was updated by McKibbin and Fernando (2020c) in June 2020. The second major paper used actual data for the COVID-19 pandemic and then applied this together with assumptions about different

[1] The was also summarized and quickly published by the CEPR in McKibbin and Fernando (2020b).
[2] See McKibbin and Wilcxoen (1999 and 2013) and the discussion below.

durations of pandemic waves and health and economic policies already announced by governments.

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 evaluating how the potential policy options could reduce the adverse macroeconomic consequences of the pandemic. The rest of the paper is organised as follows. Section 2 summarises the estimates of macroeconomic effects presented by our previous studies and international financial institutions' forecasts. Section 3 summarises the global macroeconomic model and its version used for this study, the epidemiological modelling approach, the base case scenario and policy packages simulated, and the formulation of economic shocks. We then discuss the pandemic's macroeconomic consequences and how the considered policy options could reduce their severity in Section 4 and present the key conclusions from our modelling exercise in Section 5.

2 Studies on Macroeconomics of COVID-19

In late 2019, when China started reporting infections from a virus similar to SARS-CoV, the global community expected that the outbreaks would be contained to China. This assumption was plausible because China was already experienced in managing similar outbreaks from coronaviruses and influenza viruses. However, due to delay in reporting by local officials and 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, infections had been detected around the world.

Early February 2020, the rapid spread in the outbreak caused infectious disease experts to express concerns about its potential to develop into a pandemic. Policymakers 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. We were prompted by requests from policymakers who were familiar with our earlier work on SARS (Lee and McKibbin [2004a]) and Avian influenza (Mckibbin and Sidorenko [2006]) to apply and extend the techniques from those studies to explore the macroeconomic consequences of a potential pandemic caused by COVID-19. McKibbin and Fernando (2020a, b), released in early March 2020, evaluated seven possible scenarios.

The first three scenarios assumed the outbreak would predominantly affect China, with different attack rates, but be contained in China with some spillover due to global risk assessment changes. The next three scenarios evaluated a pandemic –a virus transmitted to all countries- varying in 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 utilised the past global experiences in global influenza outbreaks to derive the potential attack rates.

Table 1 summarises the assumptions underlying the scenarios in McKibbin and Fernando (2020a, b). Shocks were introduced to mortality, morbidity, productivity by sector, consumption, government expenditure and equity risk premia. The last four scenarios used the experience in China as a benchmark for the shocks. These were adjusted by 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 severities. The results showed clearly 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 for China	Case Fatality Rate China	Nature of Shocks	Shocks Activated	Shocks Activated
						China	Other countries
1	China	Low	1.0%	2.0%	Temporary	All	Risk
2	China	Mid	10.0%	2.5%	Temporary	All	Risk
3	China	High	30.0%	3.0%	Temporary	All	Risk
4	Global	Low	10.0%	2.0%	Temporary	All	All
5	Global	Mid	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 policy responses by governments. The health policy responses mainly focused on raising awareness, encouraging behavioural changes and respiratory hygiene, elevating health system capacities for testing, contact tracing, isolating, quarantining, and treating infected individuals, amidst the absence of a vaccine. In many countries, movement restrictions were imposed, and lockdowns were enforced 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, lives were being lost, and the economic costs continued to soar. By June 2020, we had enough information to simulate the pandemic's six plausible scenarios to inform policymakers about the macroeconomic consequences of a prolonged pandemic.

By July 2020, in addition to the global economic forecasts produced by the international financial institutions, only a few studies were attempting to model the global macroeconomic consequences of COVID-19. The studies by the World Trade Organization (2020), Maliszewska et al. (2020) and the World Bank (2020a) utilise Computable General Equilibrium (CGE) models and mainly focus on the impact of mortality, morbidity and increased production costs on the economies. A study by IMF (2020a), which utilises a semi-structural Dynamic Stochastic General Equilibrium (DSGE) model, also includes 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 in McKibbin and Fernando (2020c). Table 2 summarises these scenarios. These differed by the intervals of surges and whether economies responded with or without lockdowns. One of the alternative scenarios consisted of 24 simulations where we assumed a given country responded well to the pandemic. In contrast, all other countries were unsuccessful and experienced high economic costs.

We imposed a range of shocks to labour 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 impacted on 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. These shocks were simulated in the G-Cubed modelling framework (detailed in Section 3.1), which combines the strengths of CGE and DSGE modelling 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, it is central to maintain economic activities. The approaches to formulate the shocks and results of the paper can be accessed at a dashboard found at

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 & Lockdowns in 2020		Number of Waves & 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 1	Yes No	1	No	Yes
6	Country of Interest - 1 Rest of the World – 2	Yes Yes	Country of Interest – 0 Rest of the World – 2	- Yes	No No

Source: McKibbin and Fernando (2020c)

Some of the economic forecasts released by the international financial institutions, contemporary to McKibbin and Fernando (2020c), have recently been revised. Table 3 summarises the economic forecasts relevant to the countries and regions, on which the current paper focuses. The estimates have been obtained 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 (Organization for Economic Cooperation and Development [OECD] 2020). Where forecasts for a particular country are not explicitly available, the country's economic forecast for the region to which it belongs has been used.

All of the global studies show that COVID-19 has likely created a global recession which could be as severe as the one 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 the policies to support this recovery. Even though a range of policy options are apparent in the literature, the potential economic trade-offs of various policy options have not yet been evaluated widely at a global level. McKibbin and Vines (2020) assess 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
USA	-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 Dynamic Stochastic General Equilibrium (DSGE) Models and Computable General Equilibrium (CGE) Models developed by McKibbin and Sachs (1991) and McKibbin and Wilcoxen (1999, 2013).

The version of the G-Cubed (M) model used in this paper can be found in Liu and McKibbin (2020) who extended the original model documented in McKibbin and Wilcoxen (1999, 2013). Version 6M of the model has 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 found in 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 labour (L) as well as the intermediate or production chains of inputs in energy (E) and materials (M). These linkages are both within a country and across countries.

McKibbin and Wilcoxen (1999, 2013) document the approach embodied in the G-Cubed model. 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, a long-run stock equilibrium obtains 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 towards each economy's long-run equilibrium can be slow, occurring over much of a century.

Second, firms and households in G-Cubed must use money issued by central banks 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 Henderson-McKibbin-Taylor monetary rules (Henderson & McKibbin 1993; Taylor 1993). These rules are designed to approximate actual monetary regimes in each country or region in the model. These monetary rules tie down the long-run inflation rates in each country and allow short-term adjustment of policy to smooth fluctuations in the real economy.

Table 4 - Overview of the G-Cubed (M) model

Countries (11)	**Sectors (6)**
Australia (AUS)	Energy
China (CHI)	Mining
India (IND)	Agriculture (including fishing and hunting)
Indonesia (INO)	Durable manufacturing
Japan (JPN)	Non-durable manufacturing
Korea (KOR)	Services
Malaysia (MYS)	
Philippines (PHL)	**Economic Agents in each Country (3)**
Thailand (THA)	A representative household
United States of America (USA)	A representative firm (in each of the six production sectors)
Vietnam (VNM)	Government

Regions (7)

Latin America (LAM)
Middle East and North Africa (MENA)
Other Asia (mainly South Asia excluding India) (OAS)
Rest of Advanced Economies (Canada & New Zealand) (OEC)
Rest of World (mainly Eastern Europe & Central Asia) (ROW)
Sub-Saharan Africa (AFR)
Western Europe (EUW)

Third, nominal wages are sticky and adjust over time based on country-specific labour contracting assumptions. Firms hire labour in each sector up to the points that the marginal product of labour equals the real wage defined in terms of that sector's output price level. Any excess labour enters the unemployed pool of workers. Unemployment or the presence of excess demand for labour causes the nominal wage to adjust to clear the labour 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 nominal stickiness caused by wage rigidities, costs of adjustment in investment by firms with physical capital being sector-specific in the short-run. The adjustment path is also affected by a lack of complete foresight in the formation of expectations and by monetary and fiscal authorities following particular monetary and fiscal rules. Short-term adjustment to economic shocks can be very different from the long-run equilibrium outcomes. The 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. Firms are modelled 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 base their decisions on forward-looking expectations. The other group follow simple rules of thumb which are optimal in the long-run.

3.2 Epidemiological Modelling

Even though the virus outbreak started in late 2019 in China, it reached other parts of the world at different times. Some countries experienced the pandemic early and appeared to have controlled the first waves. Other have experienced second surges. 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. We do this by using actual data up to late October 2020 and then project the remainder of 2020 and then into subsequent years.

To determine whether the first wave is continuing or has ended for a particular country or region, we analyse the daily cases via Our World in Data (2020) from late 2019 to 20 October 2020. We aggregate the infection numbers by countries and regions in the model and visually approximate whether the first wave is continuing or has ended. If there are more than one significantly observable waves, clearly distinguishable from surges or spikes, we estimate the likely day 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 inflexion points. Appendix 1 presents the infections in each model region up to 20 October 2020. Table 5 summarises 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 case a second wave has emerged).

Based on the pandemic status, whether the first or 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 the momentum the pandemic has demonstrated up to 20 October 2020 would continue. Due to this assumption, later emergence of new clusters of cases would not be reflected in the total number of cases. Table 6 summarises 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 currently continuing 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	2020/02/28	Continuing	307	
AUS	2020/01/25	Ended	119	222
CHN	2019/12/31	Continuing	366	
EUW	2020/01/25	Ended	163	178
IND	2020/01/30	Continuing	336	
INO	2020/03/02	Continuing	304	
JPN	2020/01/15	Ended	135	216
KOR	2020/01/20	Ended	108	238
LAM	2020/01/14	Continuing	352	
MEN	2020/01/27	Continuing	339	
MYS	2020/01/25	Ended	160	181
OAS	2020/01/21	Continuing	345	
OEC	2020/01/26	Ended	159	181
PHL	2020/01/30	Continuing	336	
ROW	2020/02/01	Continuing	334	
THA	2020/01/13	Continuing	353	
USA	2020/01/21	Continuing	345	
VNM	2020/01/24	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
OEC	105,373	374,124	479,497
PHL	401,533	-	401,533
ROW	3,559,084	-	3,559,084
THA	3,700	-	3,700
USA	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 of 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, behavioural changes of households and firms and government policy responses. In this base case, we assume that there is no vaccine available yet, and complete elimination of SARS-nCoV-2 might be ambitious (Heywood & Macintyre 2020). We assume that the pandemic would then recur at a declining rate over future years, giving rise to all the shocks declining at the same rate. The shocks developed in the base case scenario are discussed below. Appendix 3 contains flowcharts that present a schematic view of the way shocks are constructed.

3.3.1 Shock to Labour Supply

The shock to labour 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 we get from the epidemiological modelling, explained in Section 3.2. We then compute deaths as a percentage of the total population to estimate the epidemiological shock magnitude. As deaths would mean loss of existing and potential labour force for an economy, the shock is applied permanently in the simulations. The case fatality rates, the estimated number of deaths in 2020 and the magnitude of the mortality shock in 2020 are presented in Table 7.

The morbidity shock has two elements. Firstly, the labour force cannot work if they catch or get exposed to the infection. Therefore, we assume that the proportion of the labour force would not work for the standard isolation or quarantine period, as recommended by WHO, of 14 days. To estimate the proportion of labour force, within the 20-59 years old age group, being infected or being exposed to the infection, we use the reports from medical authorities of the countries (see Australian Government Department of Health [2020]; Cam [2020] & California Department of Public Health [2020]) and age breakdown of infections by Statista (2020a-j). For the model regions where this information is not available, we approximate them using a country or region that closely reflects its epidemiological characteristics. Using the proportion of labour force affected and the World Bank Data (2020b) on labour 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 a proportion of the labour force, equal to 70 per cent of its female labour force participation, would lose productive time due to caregiving for the dependent children from the 0-19 years old age group, catching the infection. Assuming the same isolation or quarantine period of 14 days and using the World Bank Data (2020c) on female labour 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. The magnitudes of the morbidity shocks are presented in Table 8.

Table 7: Case Fatality Rates, Deaths in 2020 & 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%
OEC	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%
USA	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%
OEC	0.0754%	0.0713%
PHL	0.0234%	0.0023%
ROW	0.0430%	0.0025%
THA	0.0004%	0.0001%
USA	0.2213%	0.1617%
VNM	0.0001%	0.0000%

3.3.2 Shock to Total Factor Productivity

The productivity shock is caused by the lockdowns imposed by governments 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 disrupted due to the lockdowns.

When calculating the duration of the lockdowns, we use the data on workplace closure across the world, provided by the Coronavirus Government Response Tracker (Blavatnik School of Government, 2020). The database reports the workplace closures at three levels of stringency, where at the third level only essential workplaces, such as grocery stores and pharmacies, would be operating. Thus, different days would have different stringency levels. To calculate an overall stringency level, we allocate a weight of 33.33% to days with a stringency of level 1, 66.66% to days with a stringency of level 2; and 100% to days with the stringency of level 3. Weighting different stringency levels enable 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 across 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 derived from the epidemiological modelling, we calculate the effective number of months with workplace closures except for essential production sectors.

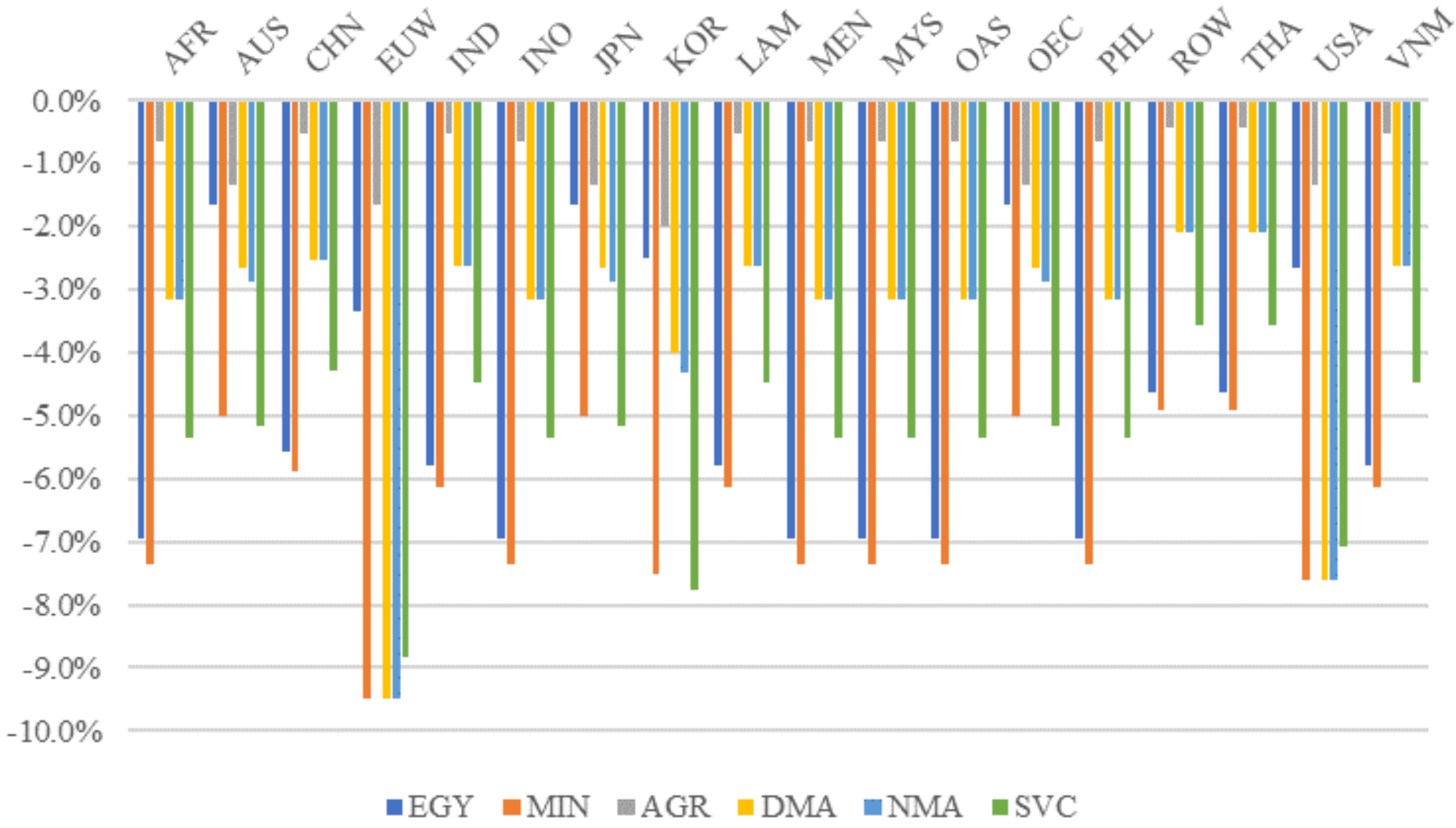
When determining the proportions of sectors not operating amidst lockdowns, we utilise the estimates by the Australian Bureau of Statistics (ABC 2020) and AUSGRID for Australia and by Statista (2020k-m) for Australia, the UK and India. We then multiply the sub-sectors' output shares in the broad sectors 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 behaviour across the world regarding proportions of sub-sectors not operating. Finally, we scale the proportions depending on the length of lockdown duration (as a proportion of a year) to obtain the productivity shocks for broad sectors.

Table 9 summarises the effective durations of lockdowns in months in 2020 for model regions. Figure 2 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
USA	4
VNM	5

Figure 2: Proportions of sectors not operating during the pandemic in 2020



3.3.3 Shock to Consumption

As described in Section 3.1, households maximise their life-long utility from consumption. In achieving this objective, the 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 relative prices of 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, consumer preferences for each broad sector and the risk premium on the discount rate used by households to discount their future income to calculate human wealth are exogenous to the model.

Using the data from consumer surveys conducted by Statista (2020n) in Australia, we map the changes in consumer preferences on 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 claimed by sub-sectors within aggregated sectors. Similar to the productivity shock discussed in Section 3.3.2, aggregation of consumer preference changes in the sub-sectors to the broad sectors, allows us to vary overall consumption in the aggregate sectors even though similar consumption changes have been assumed 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 aggregate consumption in the model regions by aggregating sector consumption changes using the overall sector consumption shares in overall consumption. Figure 3 presents the changes in consumer preferences in the model regions by broad sectors. Table 10 shows the changes in overall consumption by model regions aggregated from the sectoral preference shifts.

Figure 3: Changes in consumption preferences during the pandemic

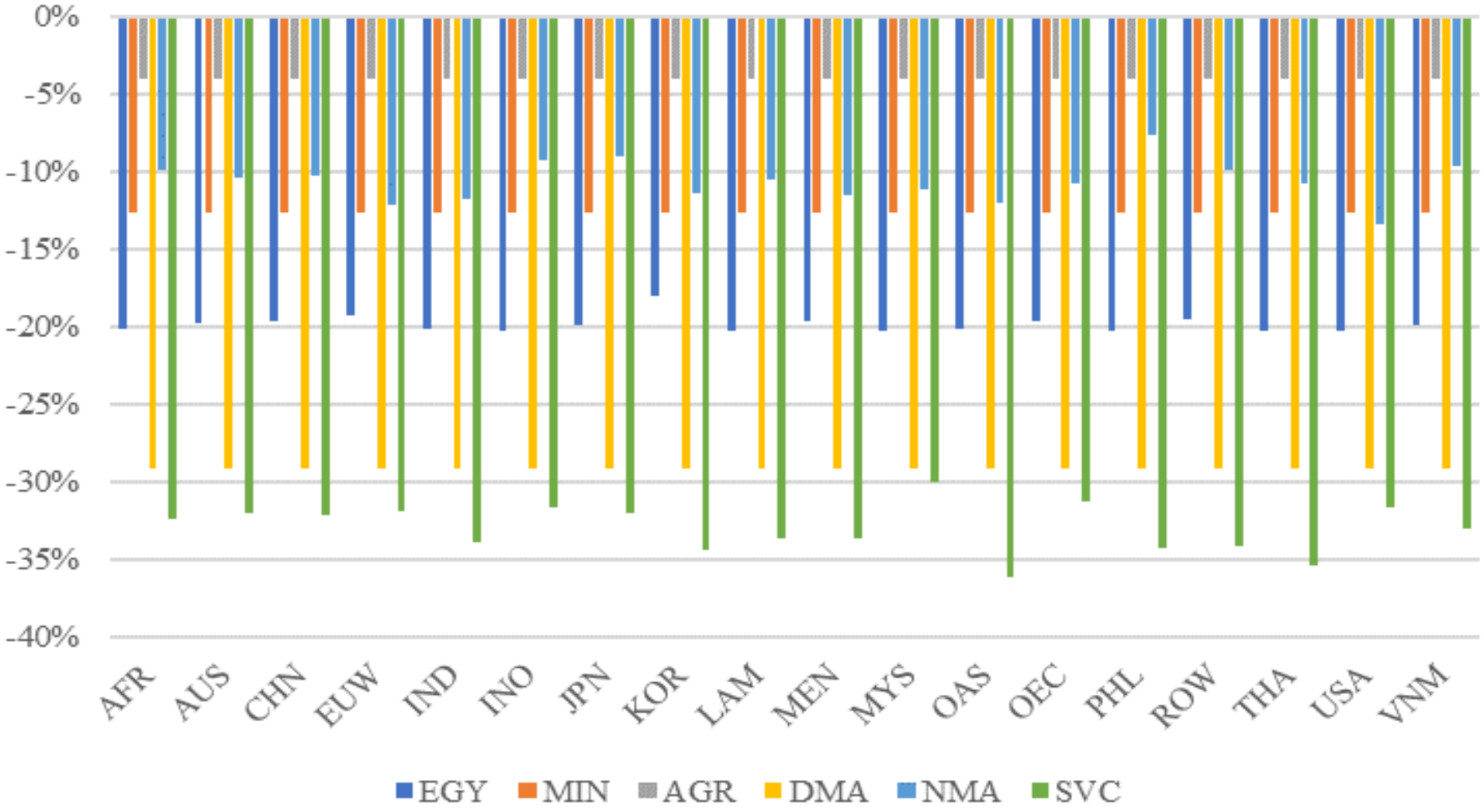


Table 10: Exogenous Shocks to Aggregate consumption from preference shifts in 2020

Model Region	Changes in Overall Consumption	Changes in Overall Consumption as a Proportion of 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%
USA	-12.03%	-2.94%
VNM	-7.67%	-1.70%

The second impact on consumption is modelled as a change in the risk premia used by households to discount future labour income to calculate human wealth. We approximate the changes in risk premia by using the movement of the US VIX (volatility) Index (WSJ 2020a), which give a measure of the change in market sentiment. We approximate the volatility in US VIX from March to October this year (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, developed by Gandelman and Hernández-Murillo (2014). For model regions where the index is not available, we approximate it using their closest peers in respect of economic characteristics. The shock to risk premia is then obtained by scaling the changes in risk premia by the effective durations of lockdown. Figure 4 presents the value of Index of Risk Aversion compared to the US for the model regions. Figure 5 shows the magnitude of the shock to risk premia in the model regions in 2020.

Figure 4: Index of Risk Aversion (US = 100)

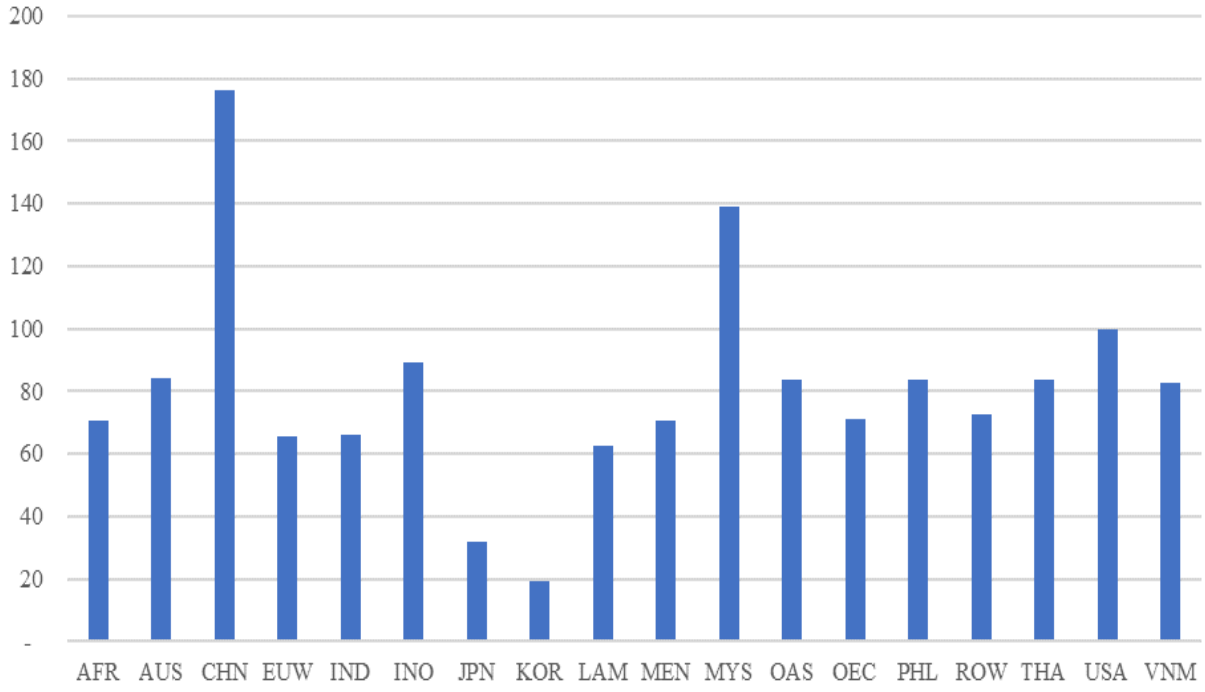
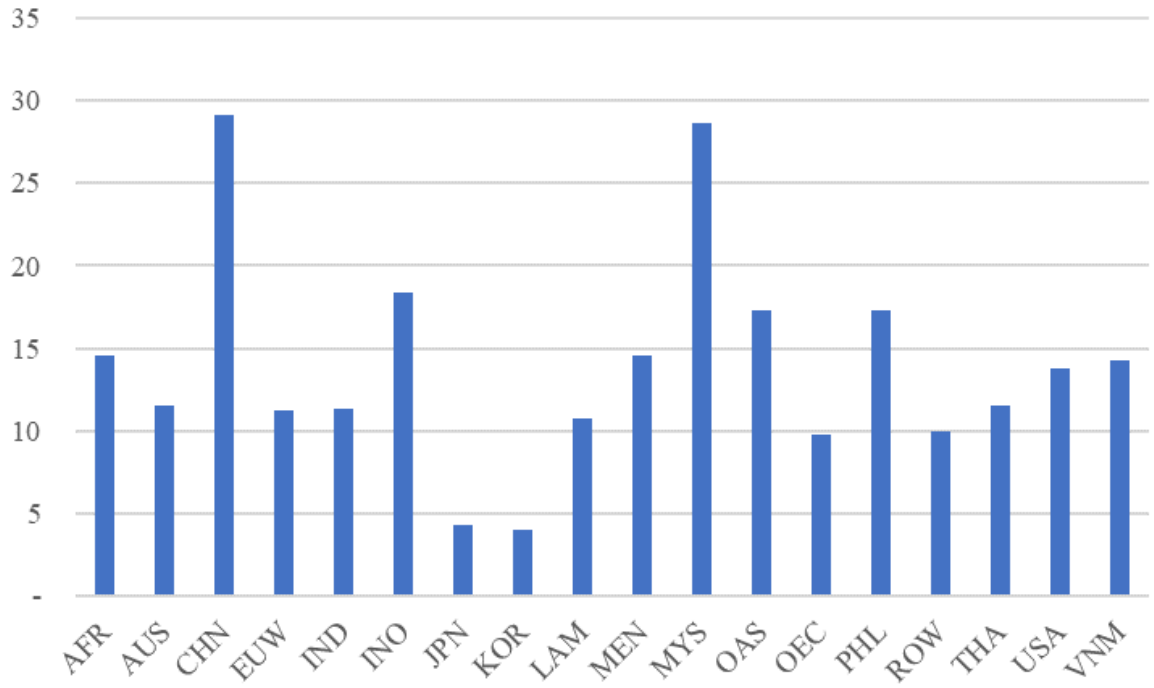


Figure 5: Shock to Risk Premia in the Discount Rate for Human Wealth in 2020



3.3.4 Shock to Country and Sector Risk Premia

While all countries have responded to the pandemic, the actual policy responses have differed across countries. These differences have been reflected in financial markets when investors rebalanced their portfolios to diversify the risks. We map these changes in relative risks in different countries and sectors into shocks for the model using Country and Sector Risk Premium shocks.

When constructing the shock to country risk premia, we follow the approach introduced by Lee & McKibbin (2004a, b) and McKibbin & Sidorenko (2006, 2009), and further improved in McKibbin & Fernando (2020a, b, c). 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, constructed using the health expenditure per capita data from WHO (2019). The Index of Health Security is created using the Global Health Security Index by the Nuclear Threat Initiative, Johns Hopkins University and The Economist (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 6 presents the Index of Health Risk for the regions in the model. A higher value indicates a higher health risk.

The Index of Governance Risk is calculated using the International Country Risk Guide (ICRG) (PRS Group, 2012). The ICRG Index scores countries based on performance in 22 variables categorised under political, economic and financial dimensions. The political dimension accounts for government stability, the rule of law and the prevalence of conflicts. The economic aspect is composed of 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 7 presents the Index of Governance relative to the US. A higher value indicates a higher governance risk.

The Index of Financial Risk utilises the IMF (2019) data on Current Account Balance as a proportion of GDP to calculate the countries' financial risk. Figure 8 presents the value of the index relative to the US.

Figure 6: Index of Health Risk

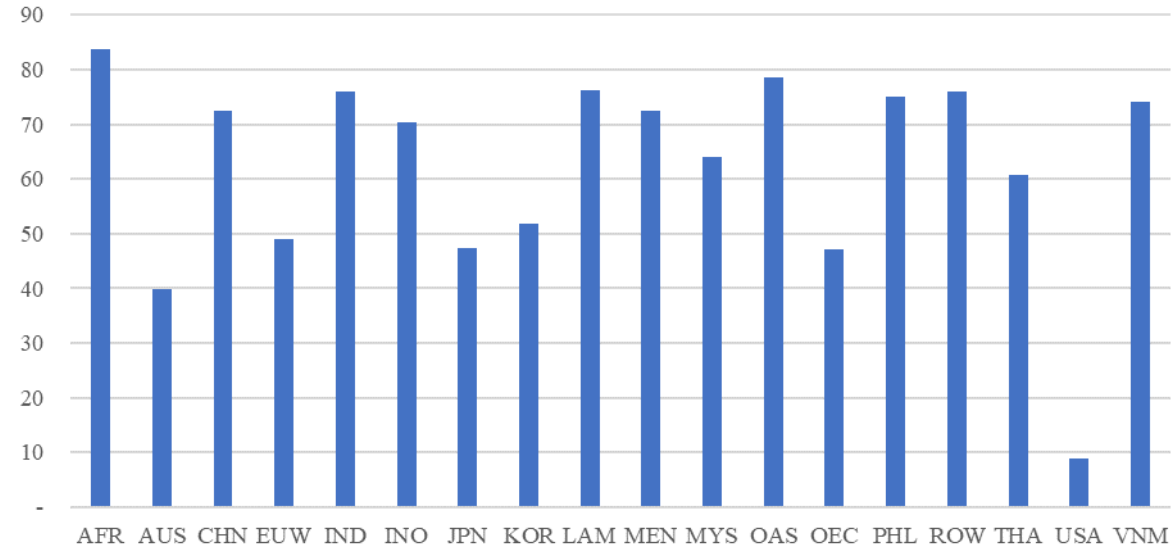


Figure 7: Index of Governance Risk

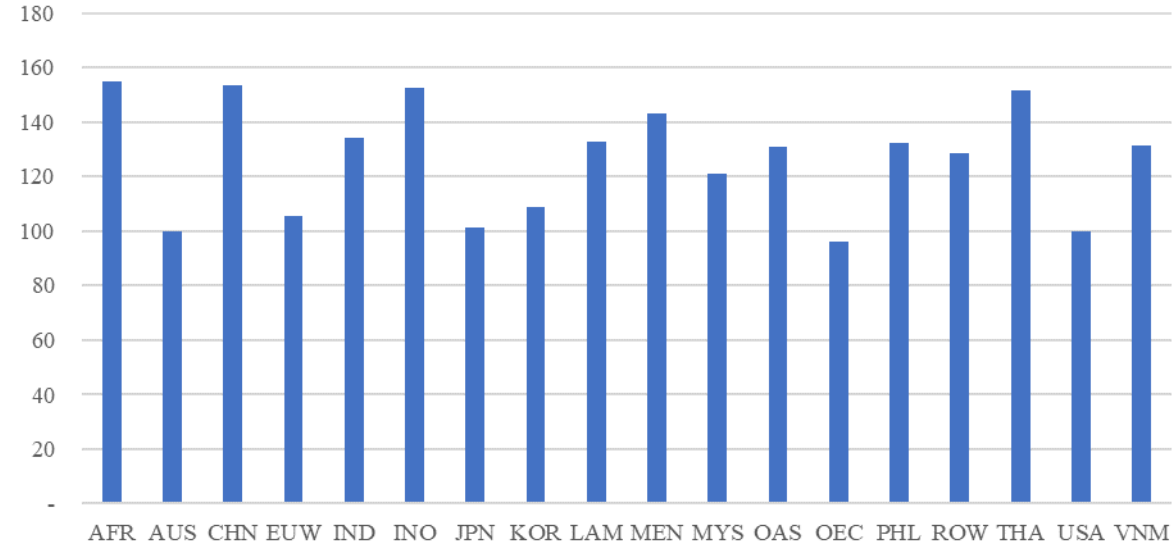
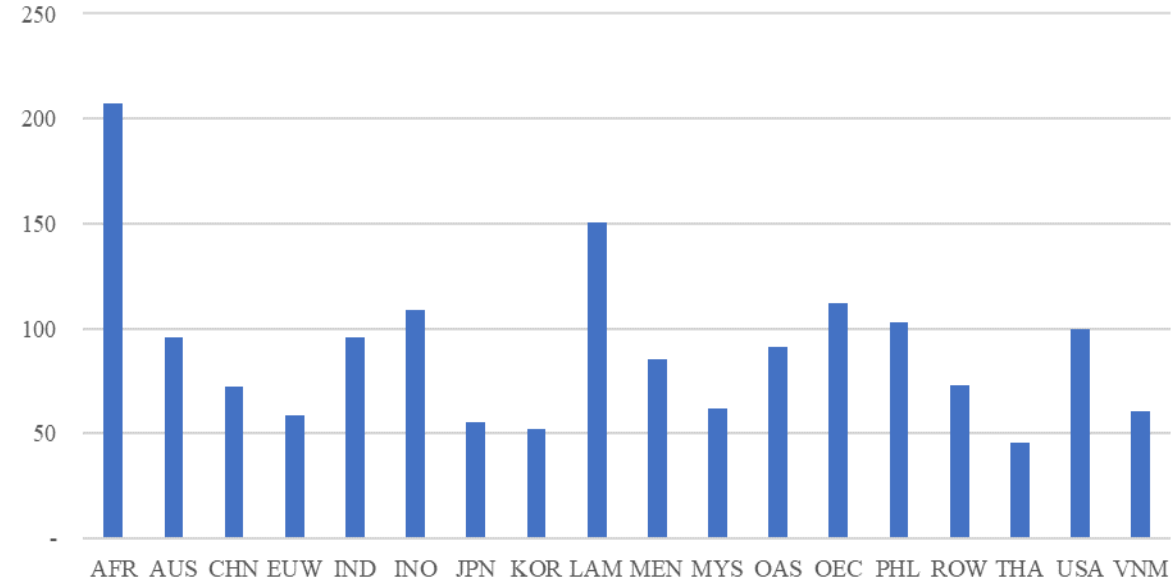


Figure 8: Index of Financial Risk



Although somewhat arbitrary we calculate, the Index of Country Risk as the arithmetic average of the three indices. Figure 9 shows the index's value relative to the US (=100), due to the prevalence of well-developed financial markets there (Fisman & Love 2004).

We then estimate the average volatility of the Nasdaq's daily returns, 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 10 shows the magnitude of the country risk premium shock in the base case scenario in 2020 for the model regions.

Figure 9: Net Country Risk Index (US=100)

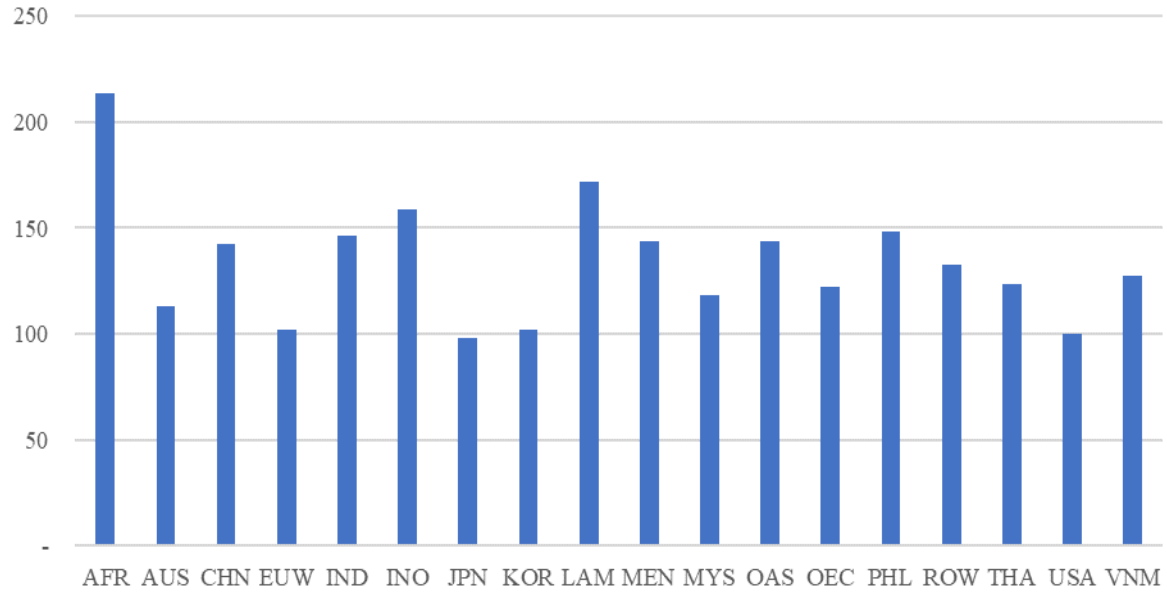
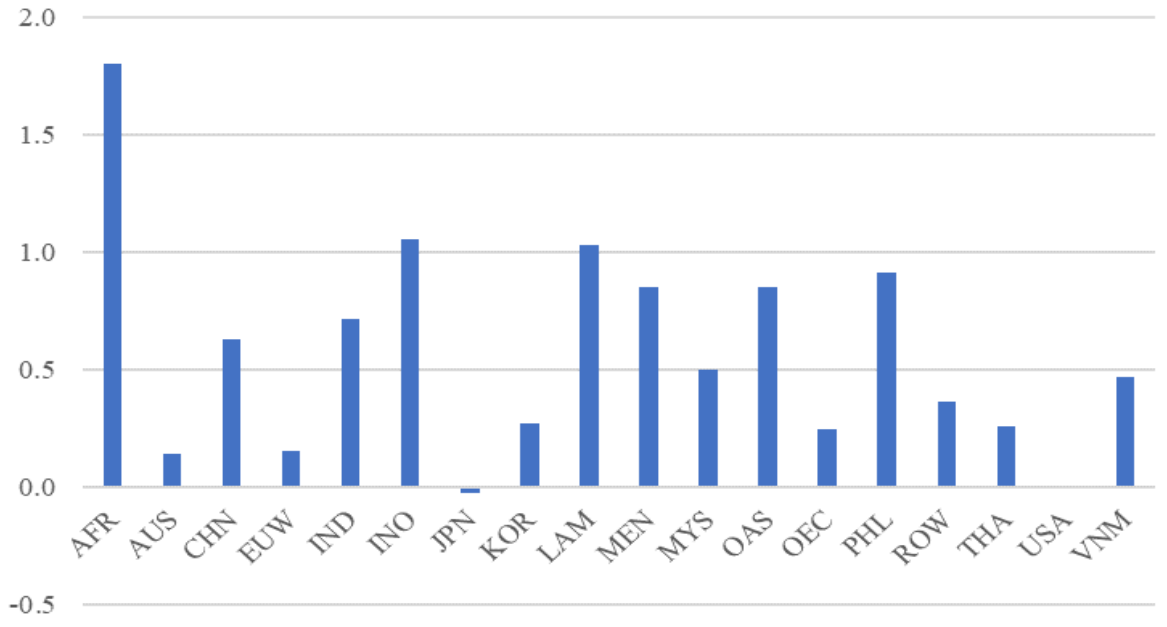


Figure 10: Country Risk Premium Shock in 2020 relative to the US



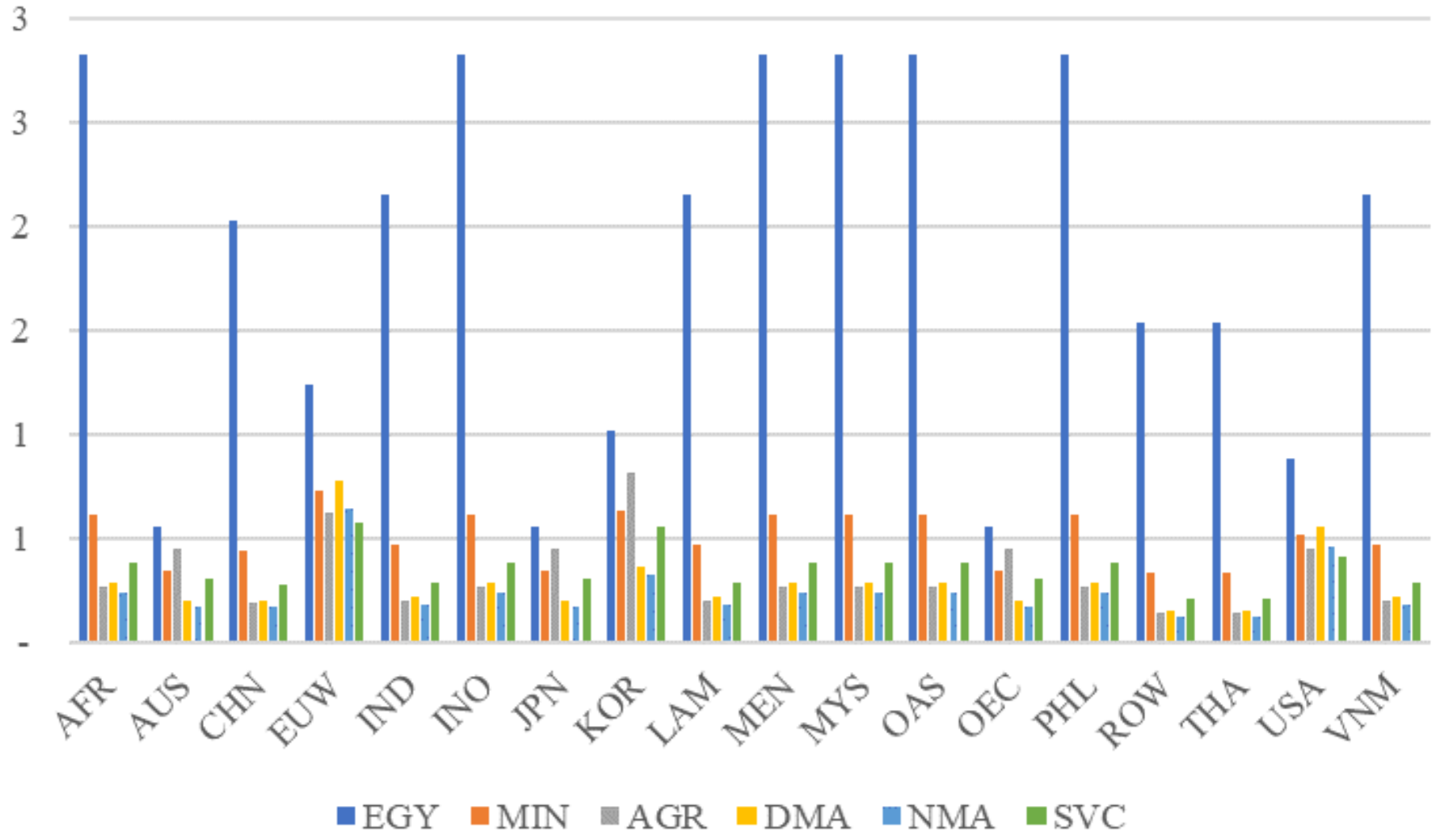
When calculating the equity risk changes in different sectors, we use the daily returns for the S&P 500 sector indices for the US (WSJ 2020c-m). We calculate the average volatility of the sector indices' daily returns during the eight months from March to October 2020. We map the changes in sector equity beta to the sub-sectors and then, using the sub-sector shares in 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 11 presents the magnitude of the sector equity risk premia in the base case scenario in 2020 for the model regions.

3.3.5 Shock to Government Expenditure, Transfers, Wage Subsidies & 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 a lump sum tax is levied on all households to cover additional interest servicing costs of changes in net government debt caused by a change in the fiscal deficit in response to the shocks we impose on the model. Government debt can permanently change after a shock, but debt levels eventually stabilise. National government expenditure is exogenous, while transfers respond to change in economic activity as do 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 stabilisers 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 behaviour and the economic shutdowns. The IMF (2020b) compilation of the policy responses of different countries to COVID-19 reveals that the fiscal measures to support firms include deferring or relieving firms from paying tax and social contributions, targeted subsidies to hard-hit sectors, exemptions for paying utility bills, providing liquidity via subsidised 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 in the assortment of fiscal measures worldwide. As well as supporting targeted firms and households, governments have also reallocated their current budgets to accommodate priority sectors and increased spending on the healthcare sector. Some governments have also increased expenditure on infrastructure projects.

Figure 11: Shock to Sector Equity Risk Premia in 2020



The IMF (2020c) Fiscal Monitor Database, updated in October 2020, summarises 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 foregone revenue in the health sector, additional expenditure and foregone 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, 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 the governments.

As the last two categories and their sub-categories have not yet been fully accessed, and there is no certainty about the proportions of those categories that would be realised, 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, listed in IMF (2020c) for 66 countries under 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 were not available, we distribute the aggregate amount across the groups attributing reasonable weights depending on the total number of measures and resembling those of closest peers. Table 11 presents the total increase in government expenditure as a proportion of GDP, aggregated for the model regions, and its reclassification into the four groups.

The transfers to households feed into the model as a separate shock. Government spending on the firms and reduced revenue due to tax concessions are distributed across the sectors based on each sector's overall GDP share. Figure 12 presents the output shares of the broad sectors. Figure 13 and 14 show the increase in government expenditure and tax concessions granted for each sector in the base case scenario in 2020.

As there is no information 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) assumptions, we assume the overall reduction in unemployment due to the wage subsidies would be 5 per cent. We then scale the shock across the model regions according to the size of the wage subsidy compared to

Australia, the output shares of the broad sectors relative to Australia, and the model regions' effective pandemic duration. Figure 15 presents the wage subsidy shock size for each sector in the model regions in 2020.

Table 11: Increase in government expenditure in 2020 due to fiscal stimulus measures

Model Region	Additional Government Spending & Foregone Revenue	Transfers	Wage Subsidies	Fiscal Expenditure on Sectors	Foregone 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%
USA	11.77%	1.21%	3.04%	5.44%	2.08%
VNM	1.24%	0.35%	0.00%	0.32%	0.56%

Figure 12: Output Shares of the Broad Sectors

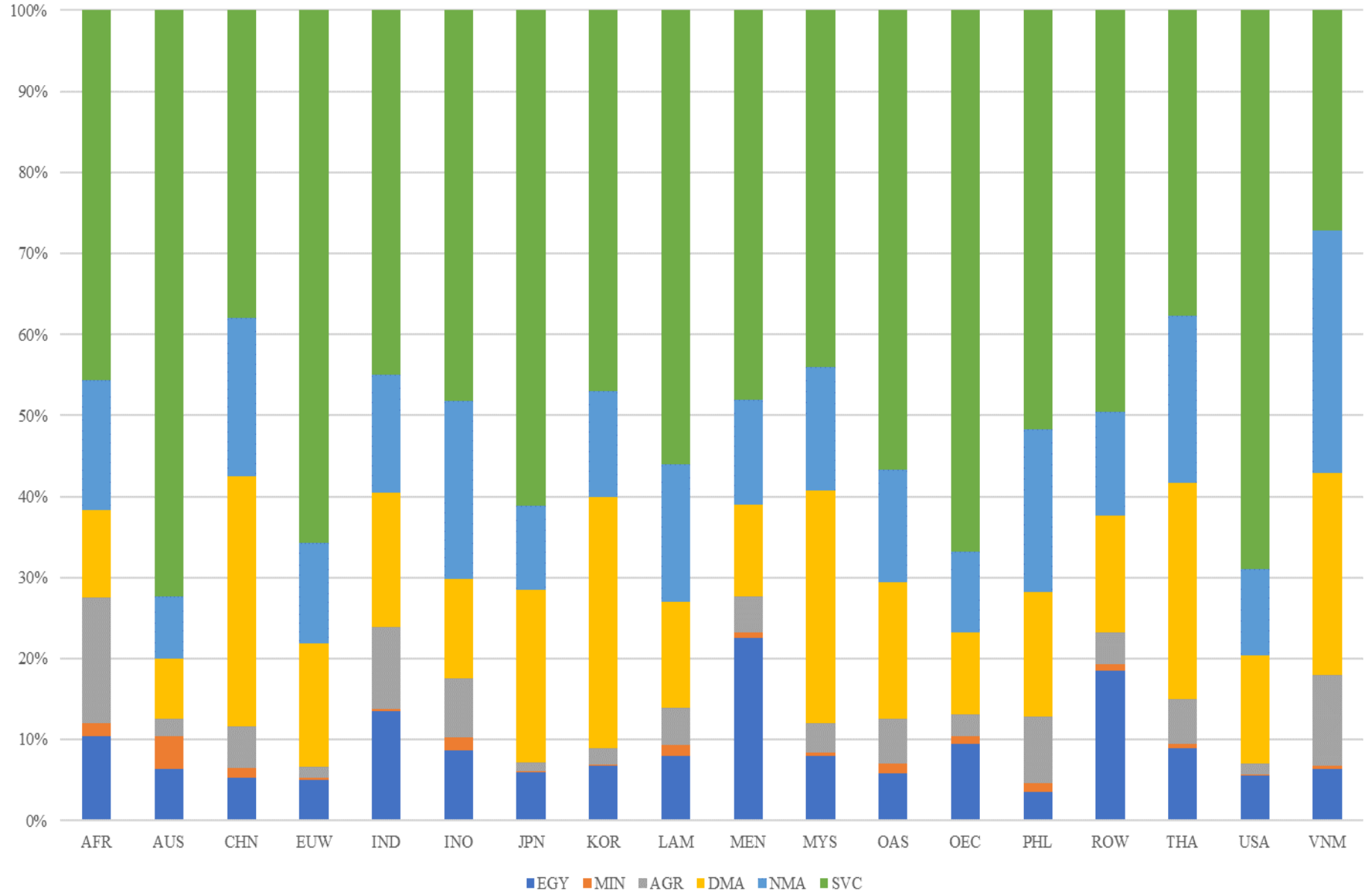


Figure 13: Increase in Government Expenditure by Sector in 2020 (%GDP)

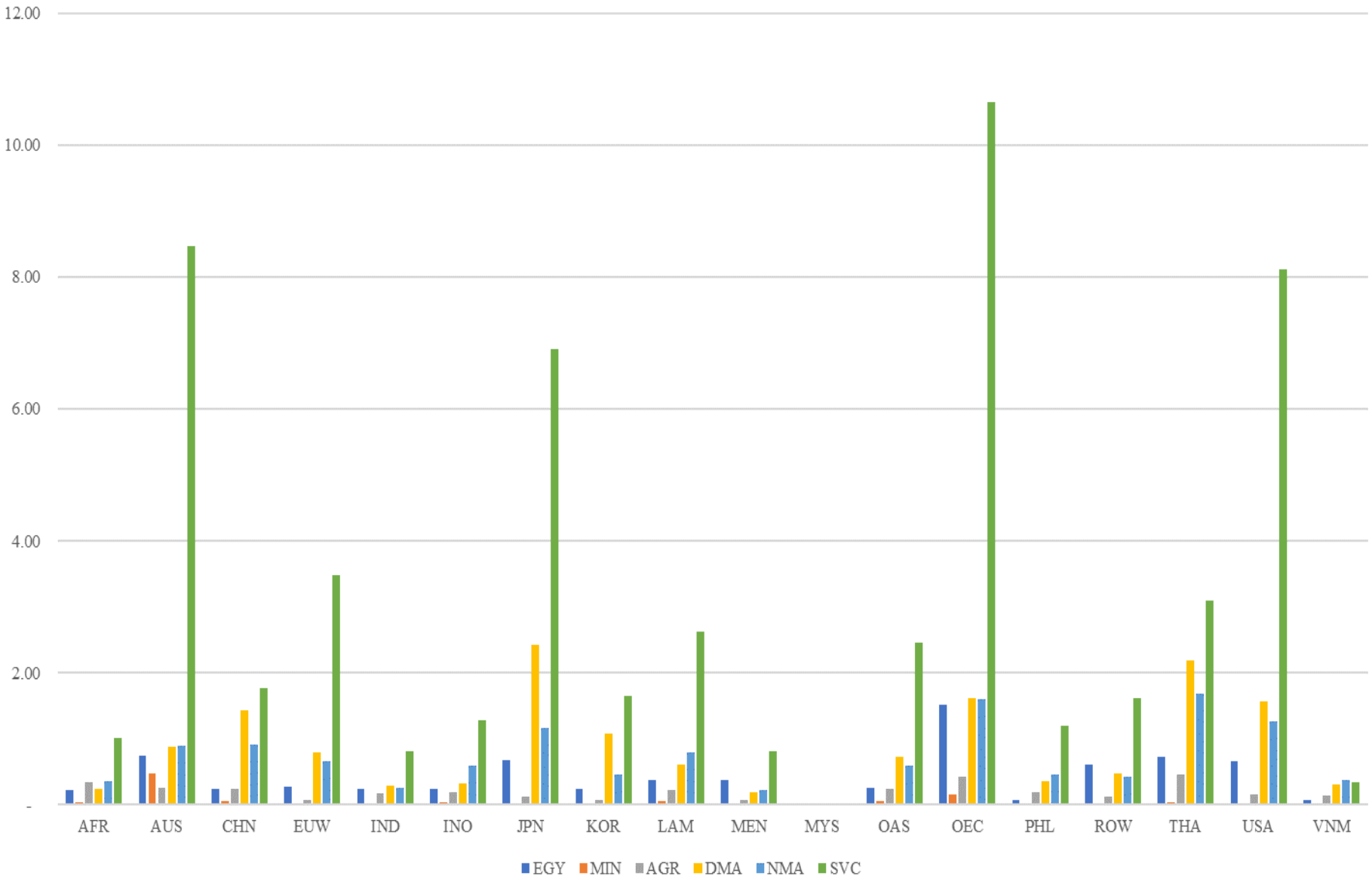


Figure 14: Tax Concessions Granted to each Sector in 2020 (%GDP)

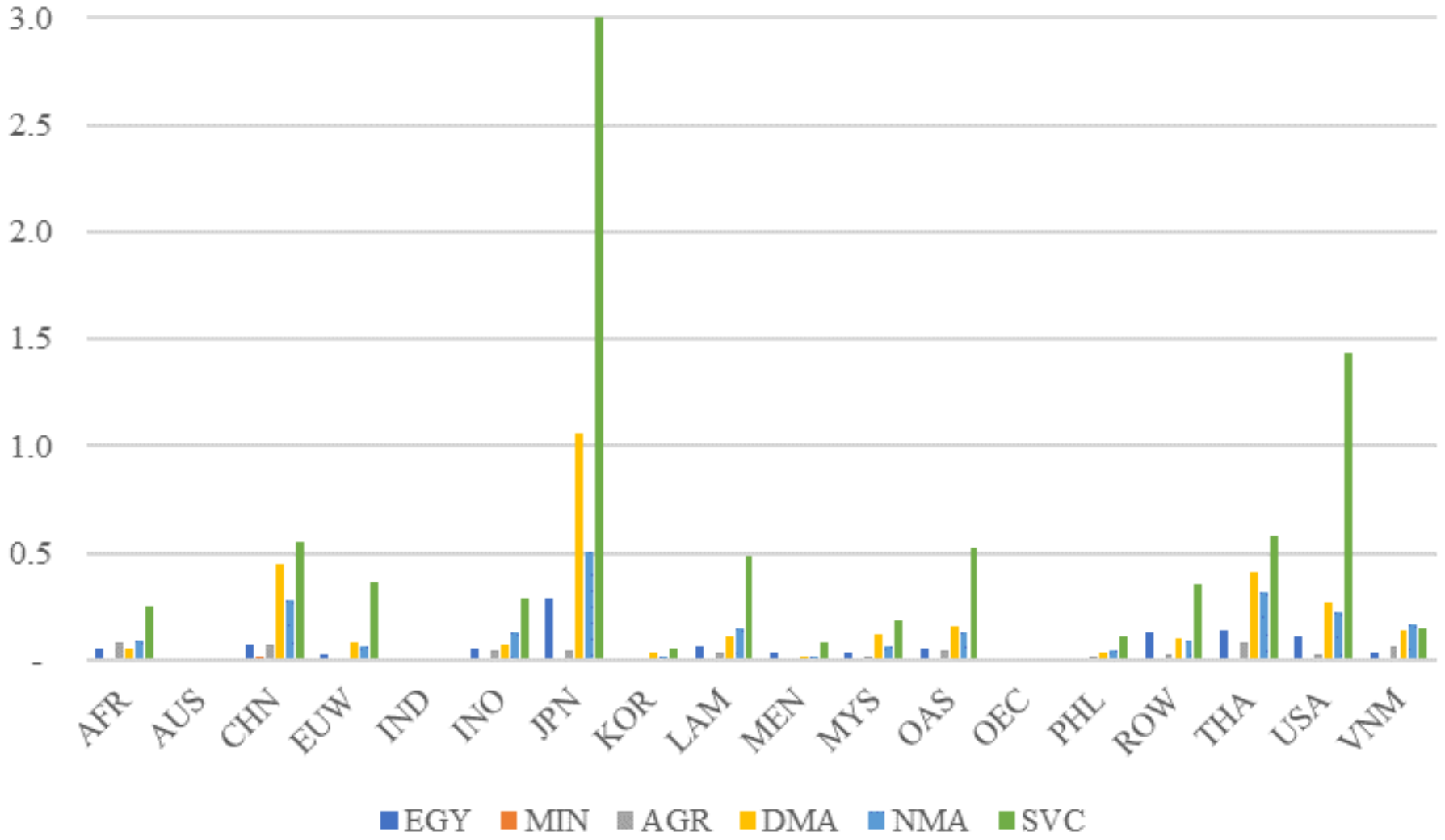
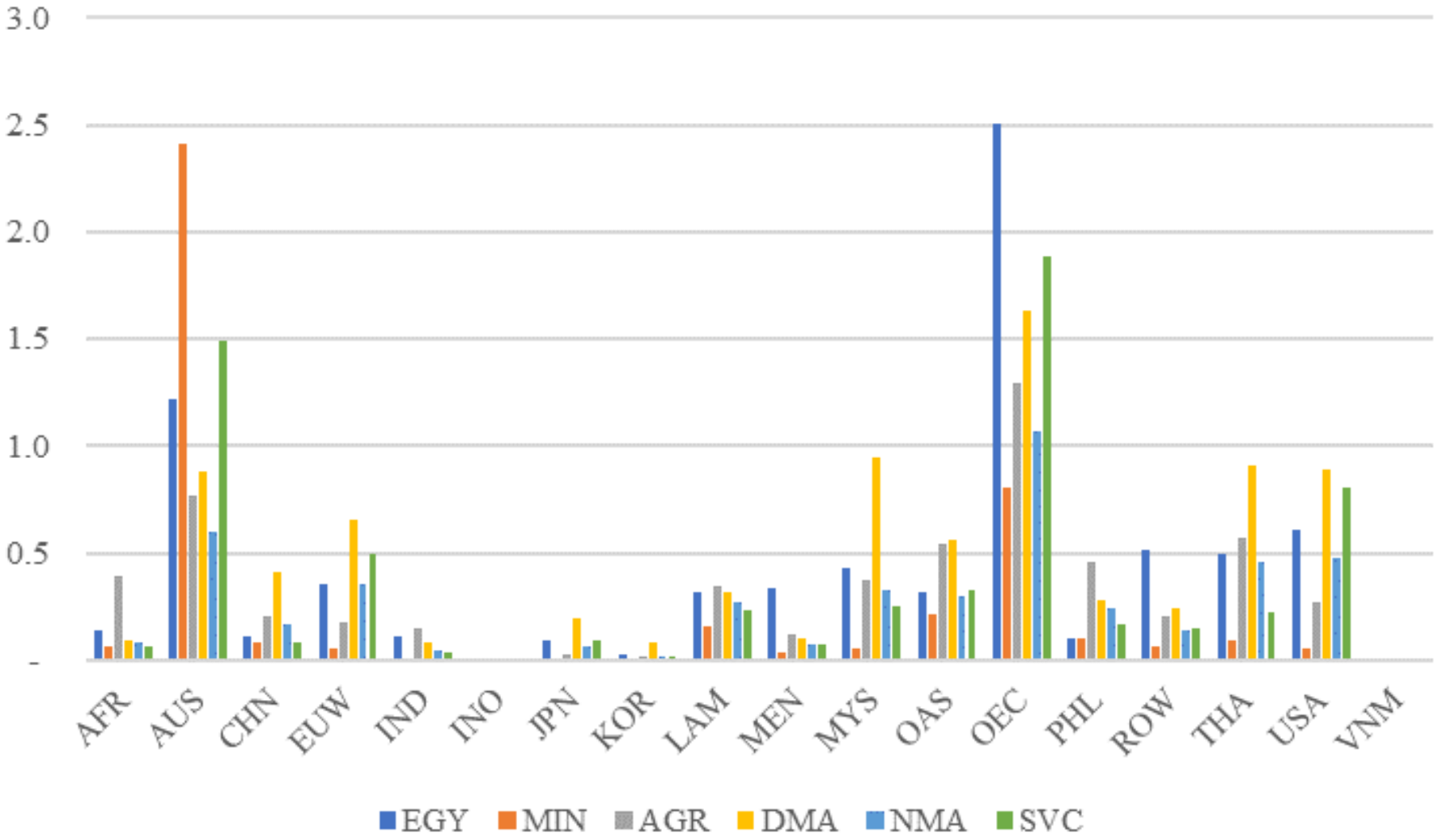


Figure 15: Wage subsidy shock to each sector in 2020 (% Increase)



3.4 Policy Packages and Additional Shocks

The COVID-19 pandemic and policy response has triggered an economic downturn. There is a continuing debate about the most appropriate measures to manage the pandemic moving forward and 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 rapid distribution of a vaccine.

3.4.1 Policy Package 01: Increase in Fiscal Transfers

Fiscal transfers to households would increase households' disposable income and enable them to utilise the transfers in a manner that maximises their utilities. These would thus be a timely intervention to boost economic activities. Executing the fiscal transfers would also be straightforward as the information required 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 governments would spend an additional 2% of the respective countries' GDP on transfers to households in 2020 and gradually declining for three more years until 2023.

3.4.2 Policy Package 02: Increase in Current Stimulus

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

3.4.3 Policy Package 03: Increase in Infrastructure Investments

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

In the third policy package, we introduce an increase in government infrastructure investments by the same percentage as the additional fiscal stimulus and transfers (2% GDP). The increased investment is distributed across sectors depending on the preferences of sectors by the governments 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 to other sectors. We follow McKibbin et al. (2014) 's work in modelling the impact of public infrastructure capital on the productivity of each sector. This approach is based on Calderon et al. (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 the relative contribution of the sectors to GDP (Figure 12).

Table 12 presents the government capital changes in the model regions for additional infrastructure investment of 2% GDP. Figure 16 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.

3.4.4 Policy Package 04: Early Production & Distribution of a Vaccine

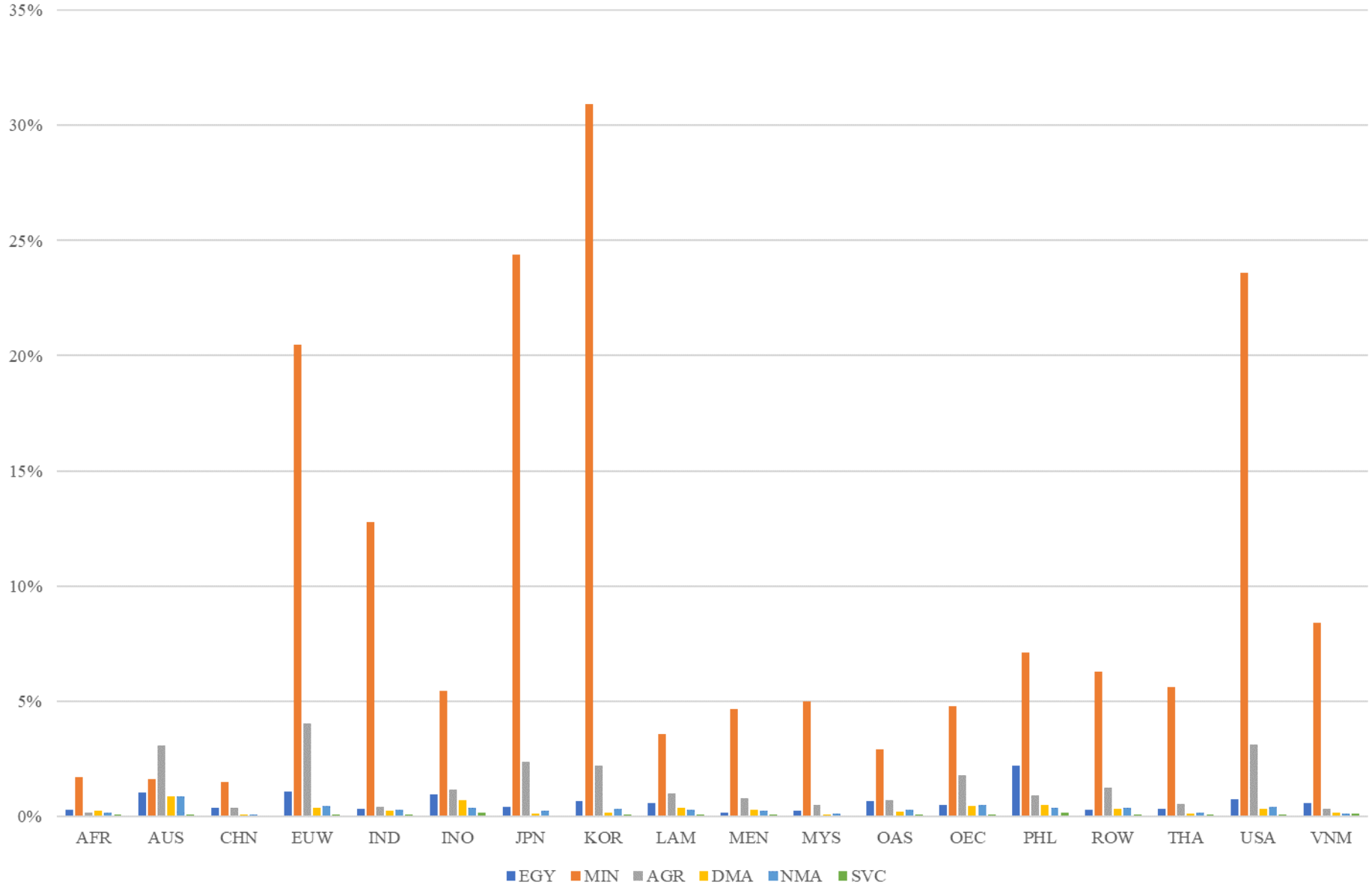
According to the New York Times Vaccine Tracker (2020), as of November 2020, there are 11 vaccines in Phase 3 or large-scale efficacy tests, while there are six vaccines approved for early or limited use. While there is no guaranteed timeline for a vaccine's availability, it is widely believed an effective vaccine would become available and be distributed across the world in the next year.

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 zero from 2022. We also reduce all shocks in 2021 to 50% of the base case and assume from 2022 the shocks, except mortality, are expected to go to zero.

Table 12: Changes in government capital by an additional investment of 1% GDP

Model Region	Government Capital (%GDP)	Change in Government Capital by an Additional Investment of 1% 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%
OEC	55.75%	1.79%
PHL	34.60%	2.89%
ROW	53.58%	1.87%
THA	87.60%	1.14%
USA	63.00%	1.59%
VNM	70.90%	1.41%

Figure 16: Increase in productivity due to additional government infrastructure investments



4 Results & Discussion

4.1 Baseline scenario

The model's baseline is generated following the same assumptions as in McKibbin and Fernando (2020a, b). However, the numbers for specific countries and regions will differ to those in the earlier papers because we have a different disaggregation of the global economy in the current model.

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

4.2 Base case scenario and Policy packages

Starting with the baseline, we run another simulation incorporating the range of shocks discussed above. We call this the “base case scenario”. This base case scenario included the epidemiological and economic shocks in 2020 and beyond that stylize the pandemic. The presentation of all results commences in 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 percentage change or per cent of GDP difference from the non-COVID, the numbers' interpretation can easily be misunderstood. 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 separately add each policy variant to the base case scenario and calculate the combined scenarios' difference relative to the baseline of no pandemic.

The results are in tables 13 to 23 for the main macroeconomic variables for all countries and regions. We first present results for 2020 for all countries. We then present dynamic results for several representative countries (China and Vietnam) to show the differences each scenario implies over time and across sectors.

Table 13 contains the results for 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 COVID19 pandemic and policies in place by November 2020 on each economy. These are expressed as relative to what would have been the case in 2020 and 2021. The two columns of numbers labelled policy package 01 are the base case results plus the policy package number one. Subtracting the base case from the policy scenario gives the impact of the policy package alone.

It is clear from these results that additional transfer payments (policy 01) and additional government stimulus (policy 02) reduce the impact of the pandemic in 2020 but do not come close to eliminating the recession caused by 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 strong and effective public health policy, including a vaccine's rapid deployment (policy 04).

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

Table 15 shows the response of private consumption. There is an exogenous shift in preferences by consumers which explain 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 labour income. The negative effect on human wealth is partly offset from a lower real interest rate. Still, this positive discounting effect is countered by a rise in the exogenous risk premium that households use to discount future income streams.

Table 16 shows that the pandemic leads to a sharp fall in private investment. The significant economic slowdown reduces expected future profits of firms because of shutdowns that have negative productivity (positive costs) implications and a fall 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 fall in aggregate demand which through an accelerator mechanism reduces investment further. In 2020 the sharp decline in investment was a demand shock, but over time the fall in physical capital accumulation becomes an additional negative supply shock.

Table 13: Percent Change in Real GDP in 2020 & 2021 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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

Table 14: Percent Change in Employment in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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: Percent Change in Consumption in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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: Percent Change in Investment in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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 results for fiscal deficits and Table 18 for trade balances. Countries are impacted differently by the pandemic and the different policy responses. An increase in the budget deficit is a decline in government saving. If all else is held constant an increase in government deficits will partly be financed by borrowing from overseas. But because private saving and investment also change, whether national savings rises or falls relative to investment will vary across countries. The current account (and the trade balance) reflects the difference between national saving and investment. A country where investment falls by more than nationwide savings will experience a trade surplus. A country where savings 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 expected rates of return on different activities caused by the pandemic. Countries with relatively bad economic outcomes will tend to lose financial capital, causing an 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 are receiving foreign capital experience an exchange rate appreciation which worsens the trade balance. The movements in exchange rates are shown in Table 19.

Table 20 shows 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 Covid19 baseline**. For example, the number for Japanese inflation of 1.96% in 2020 is the change in inflation relative to the no Covid19 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 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 initial inflationary outcome in 2020 is mostly driven by the relative price shocks in each economy. Over time, the aggregate inflation outcome is determined by the central banks' reactions in balancing the inflation changes with the output contractions.

Table 17: Percent Change in Fiscal Deficit in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	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
USA	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: Percent Change in Trade Balance in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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: Percent Change in Real Effective Exchange Rate in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	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
USA	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 no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	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 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 01 to 03 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 04), 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 Real Interest Rate in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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 Real 10-year Interest Rate in 2020 relative to no-COVID19 baseline

Model Region	Base case Scenario		Policy Package 01		Policy Package 02		Policy Package 03		Policy Package 04	
	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
OEC	-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
USA	-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

4.2 Dynamic Results

We now consider the dynamic adjustment in economies under 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. Results for China are contained in Figures 17 to 20 and for Vietnam in Figures 21 to 24.

Figure 17 and 21 show that by year 6 (or by 2025) real GDP has not returned to the no-COVID-19 baseline for each policy scenario. Although the public health intervention that eliminates the virus show GDP returning to 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 both countries. There is a significant difference in the impacts of the public health policy across the two countries. Vietnam has done well in containing the COVID-19 virus relative to the rest of the world in the base case. By being so effective in the public health response, significant capital inflow dampens 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 Vietnam is much smaller. The capital that would have flowed into Vietnam in the base case remains in the rest of the world. Thus, the trade balance does not deteriorate, and Vietnam does not attract the investment that occurs in the base case. Real GDP in Vietnam (Figure 21) still improves with the global public health response, but GDP composition is different. Trade is the main driver for Vietnam in the global public health response. In contrast, investment is critical in the base scenario where Vietnam does much better public health responses relative to many countries in the rest of the world.

Figure19 shows the change in output by sector in China. 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. The employment losses by sector in China, shown in Figure 20 also show a widespread loss of jobs.

The sectoral results for Vietnam are noticeably smaller than China, mostly because of Vietnam's effective public health response. The infrastructure policy also boosts output and employment in the mining sector in Vietnam (see Figures 23 and 24).

Figure 17: Dynamic Results for China

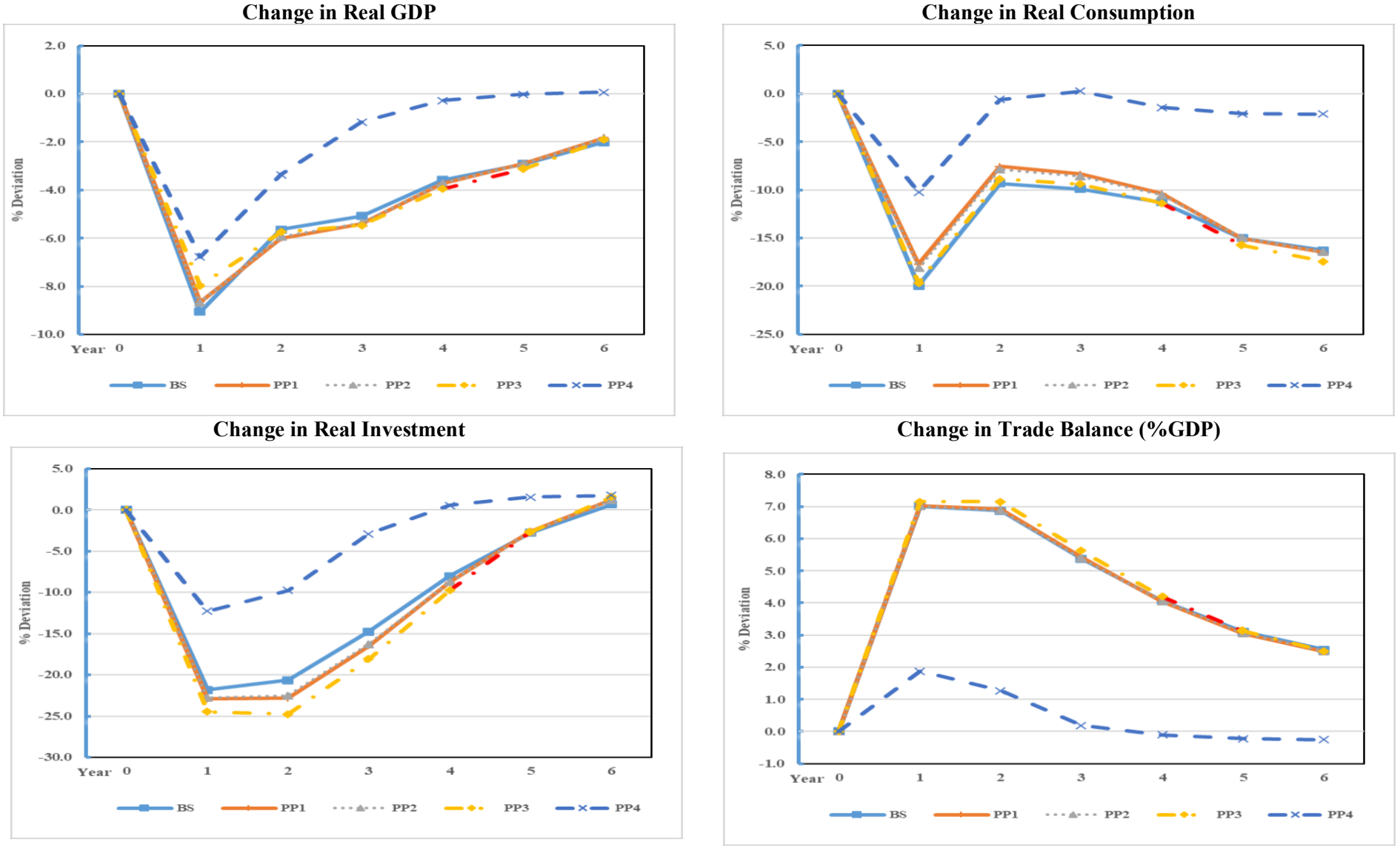
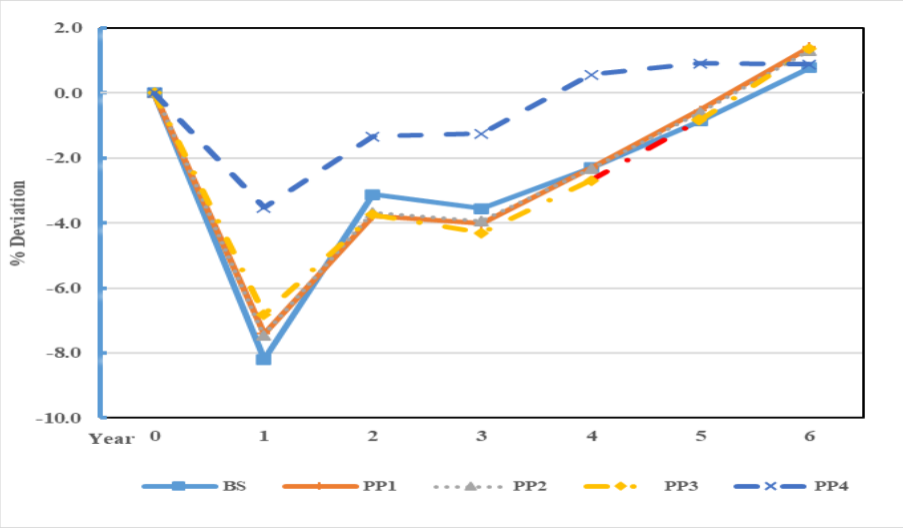


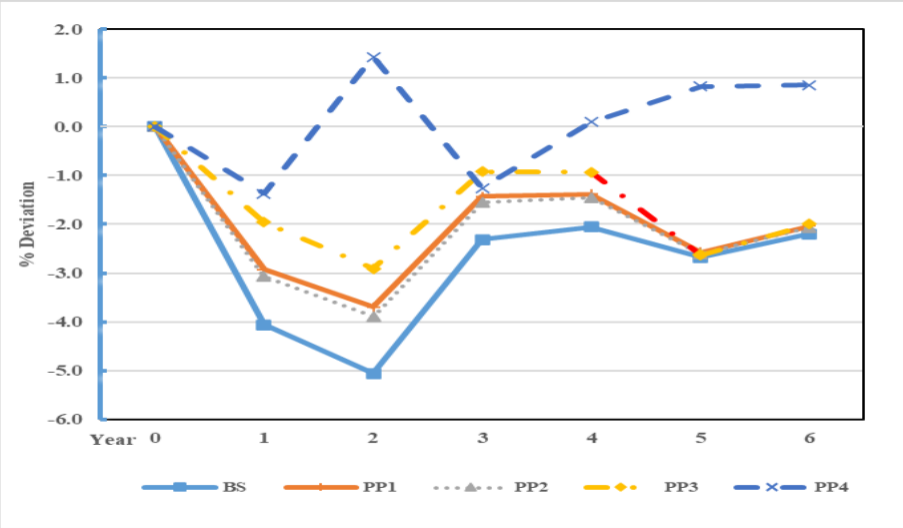
Figure 18: Dynamic Results for China (Contd.)

Change in Employment



Change in Inflation

Change in Real Short-term Interest Rate



Change in Real Effective Exchange Rate

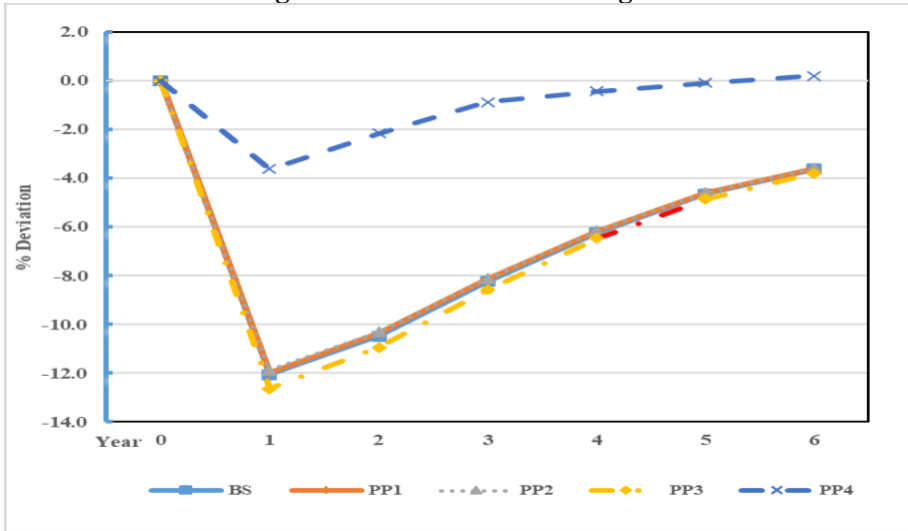
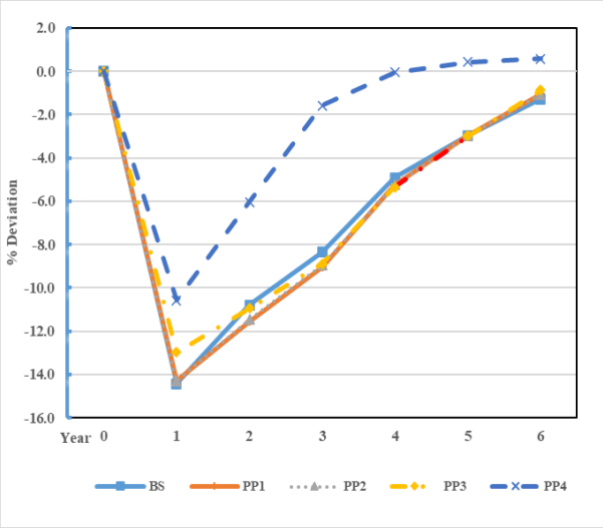
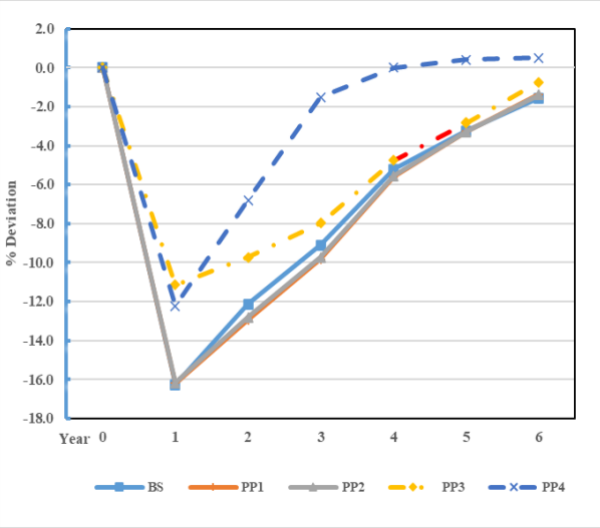


Figure 19: Dynamic Results for China (Contd.)

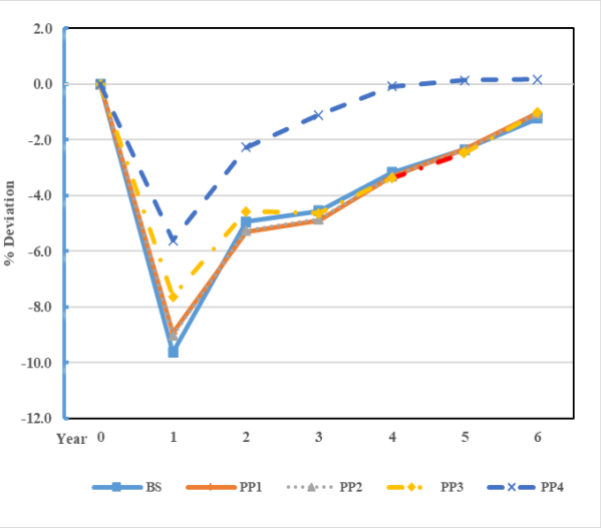
Change in Output: Energy Sector



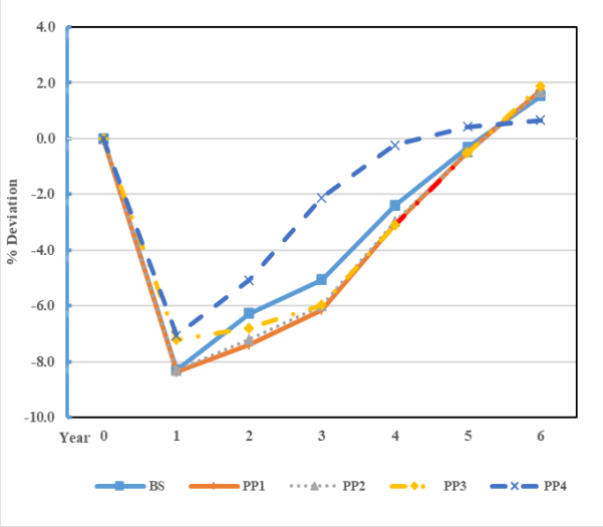
Change in Output: Mining Sector



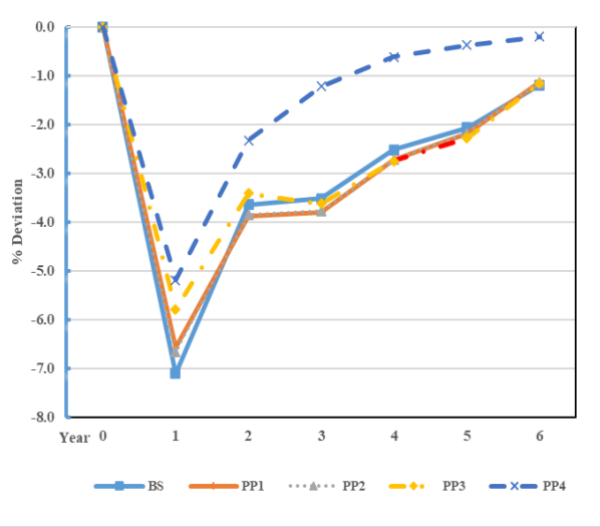
Change in Output: Agriculture Sector



Change in Output: Durable Manufacturing Sector



Change in Output: Non-Durable Manufacturing Sector



Change in Output: Service Sector

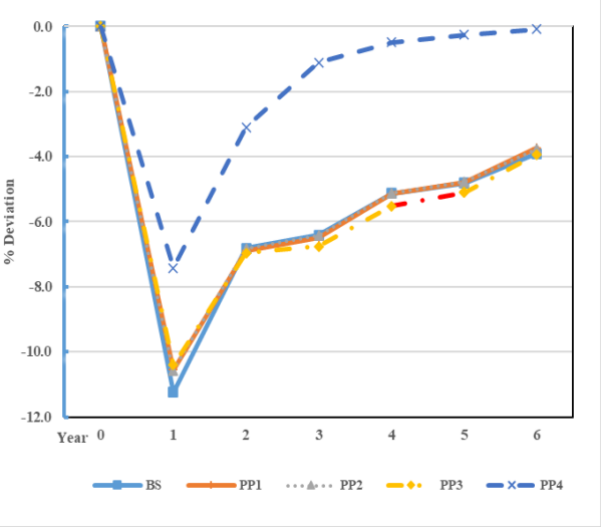
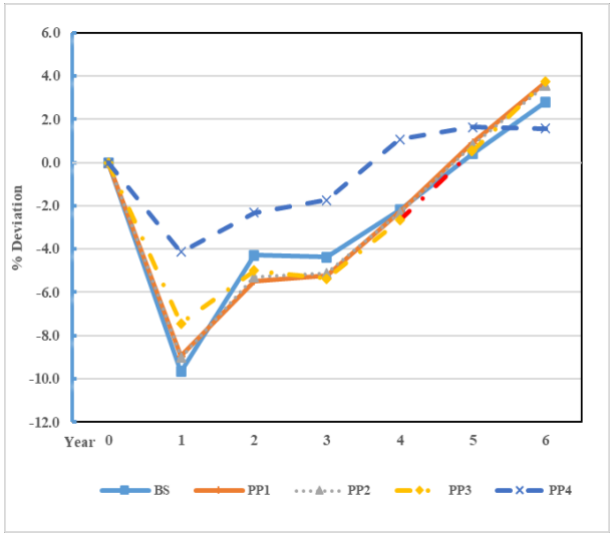
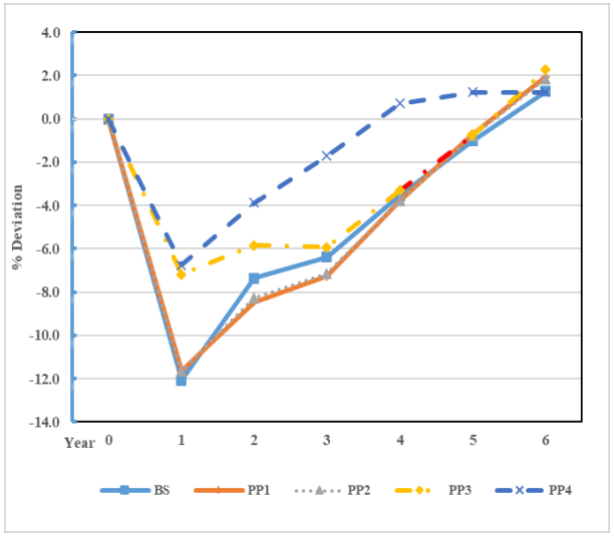


Figure 20: Dynamic Results for China (Contd.)

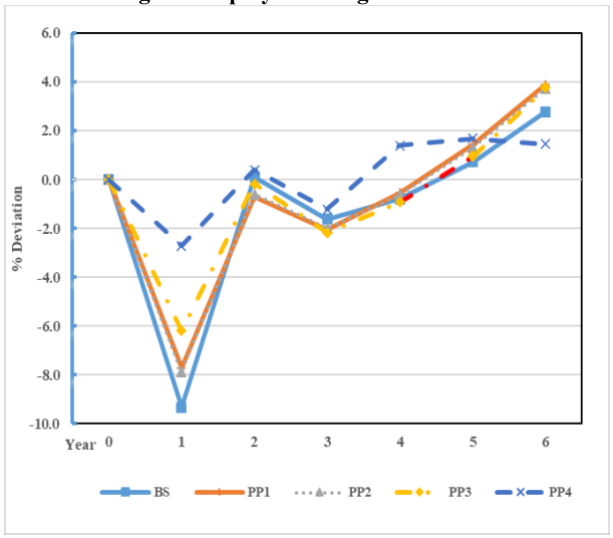
Change in Employment: Energy Sector



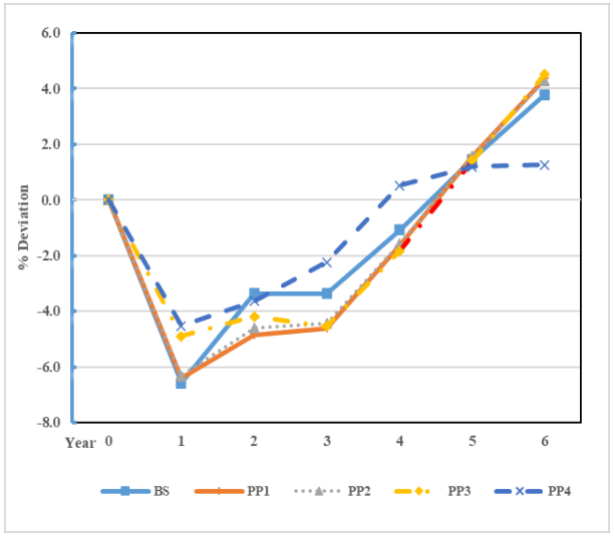
Change in Employment: Mining Sector



Change in Employment: Agriculture Sector



Change in Employment: Durable Manufacturing Sector



Change in Employment: Non-Durable Manufacturing Sector

Change in Employment: Service Sector

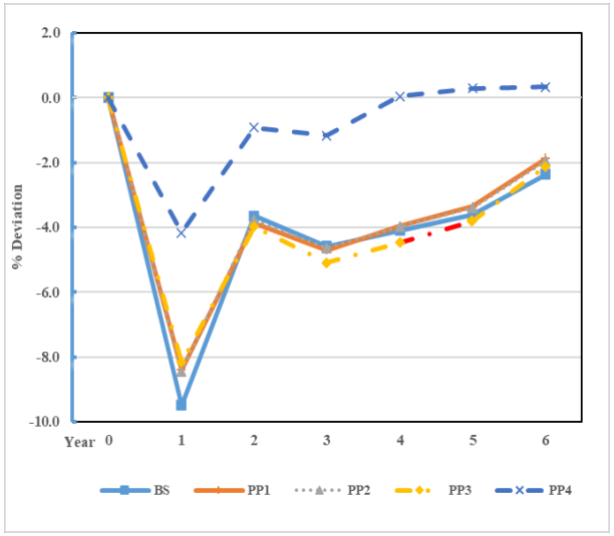


Figure 21: Dynamic Results for Vietnam

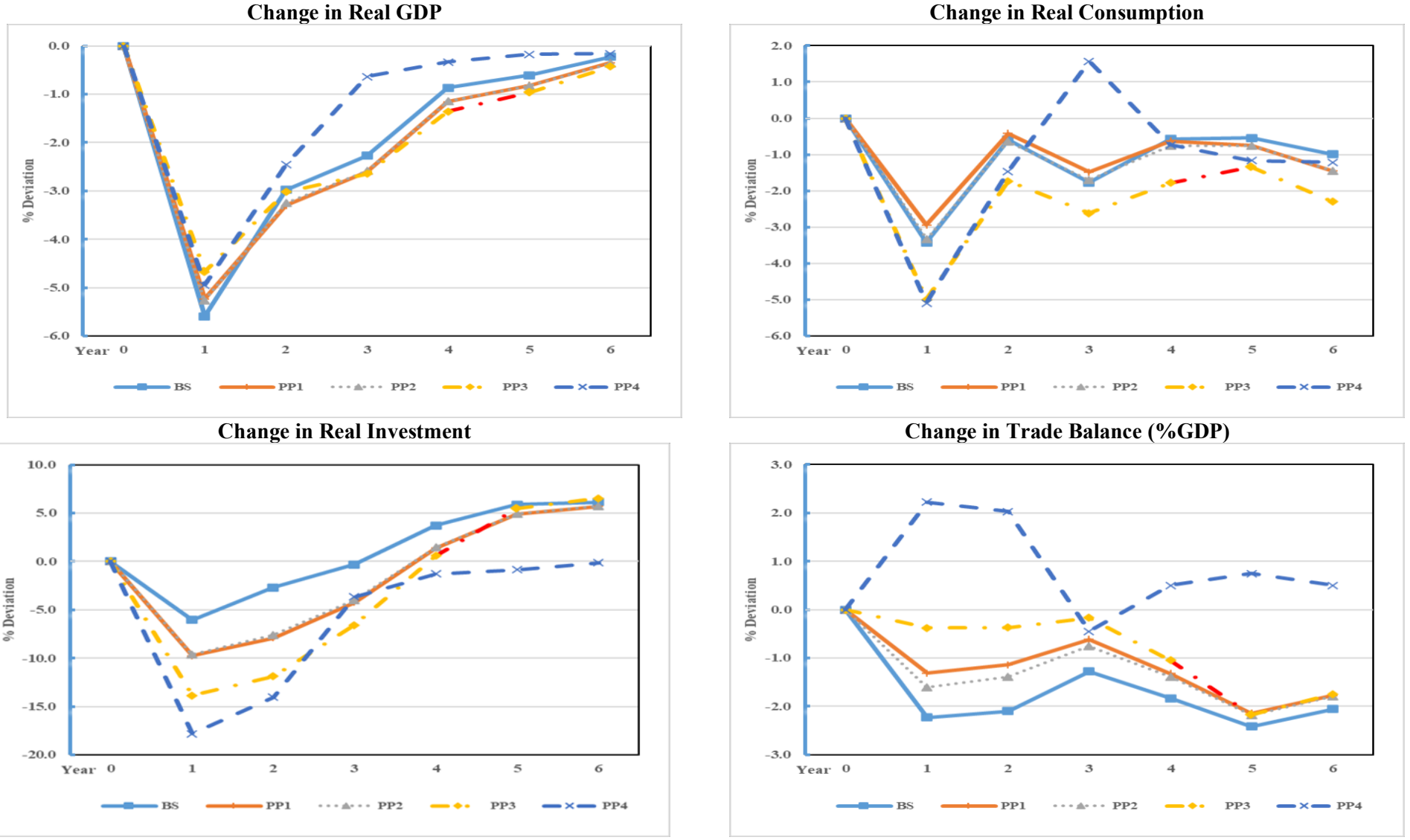
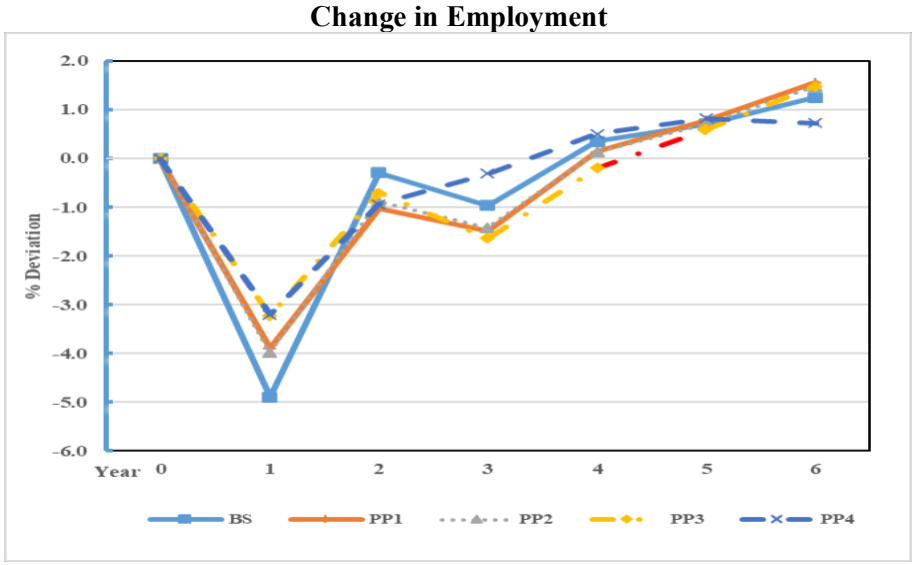
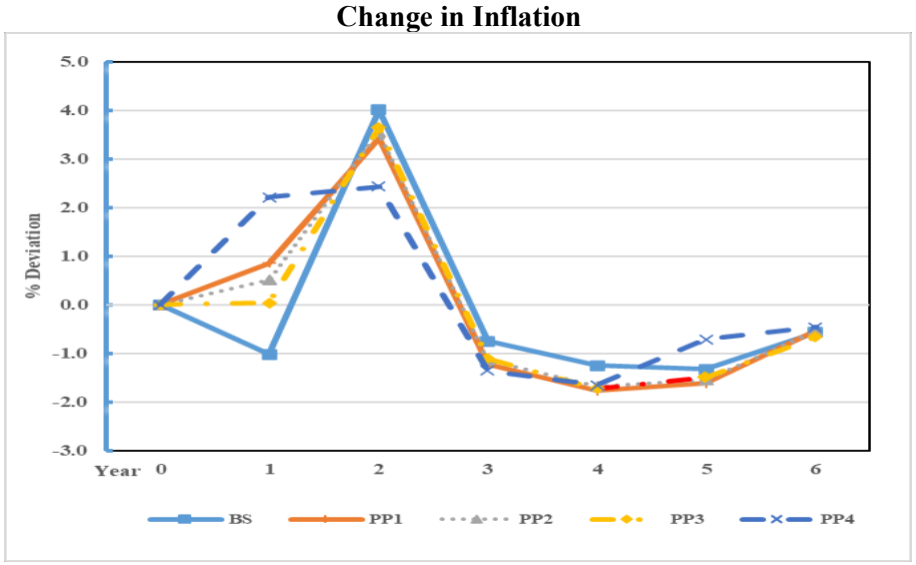
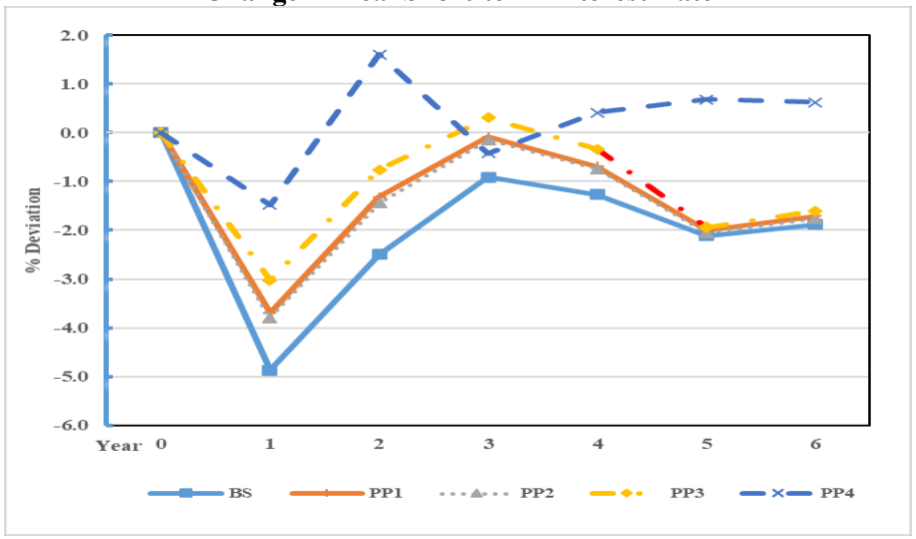


Figure 22: Dynamic Results for Vietnam (Contd.)







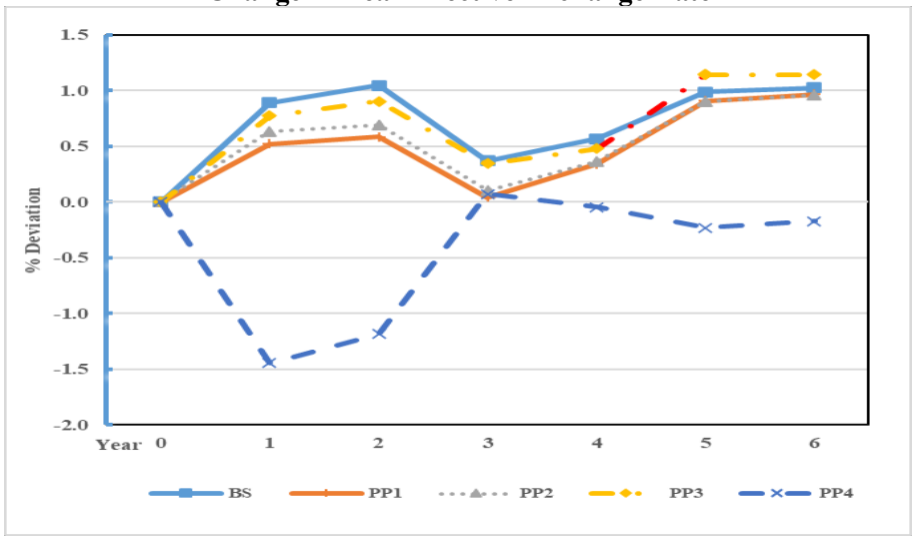
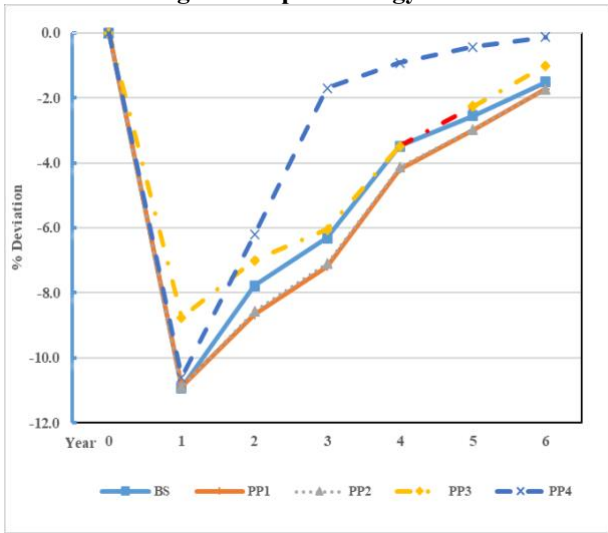
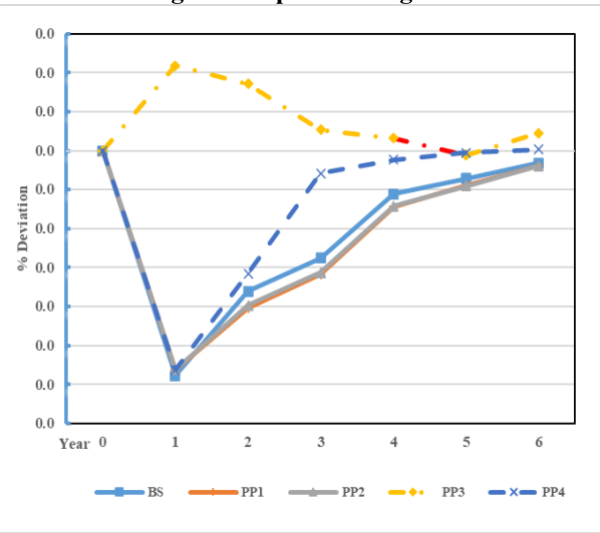


Figure 23: Dynamic Results for Vietnam (Contd.)

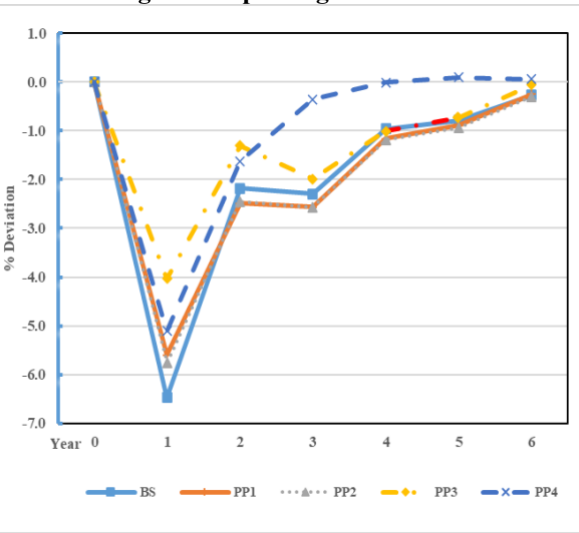
Change in Output: Energy Sector



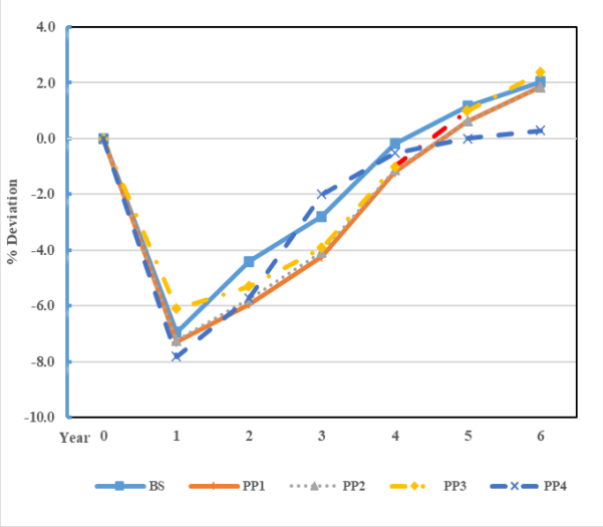
Change in Output: Mining Sector



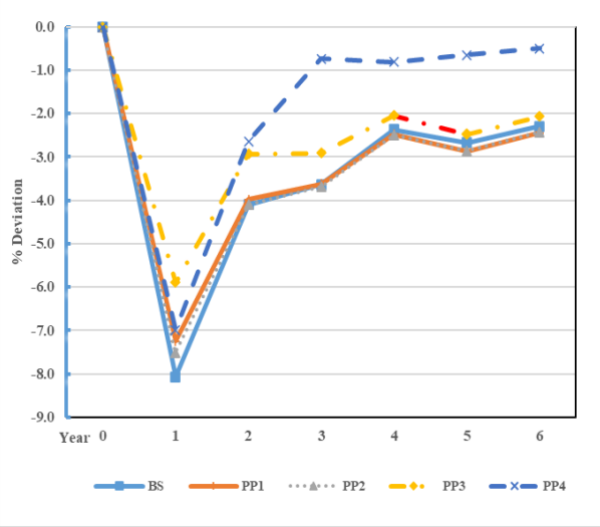
Change in Output: Agriculture Sector



Change in Output: Durable Manufacturing Sector



Change in Output: Non-Durable Manufacturing Sector



Change in Output: Service Sector

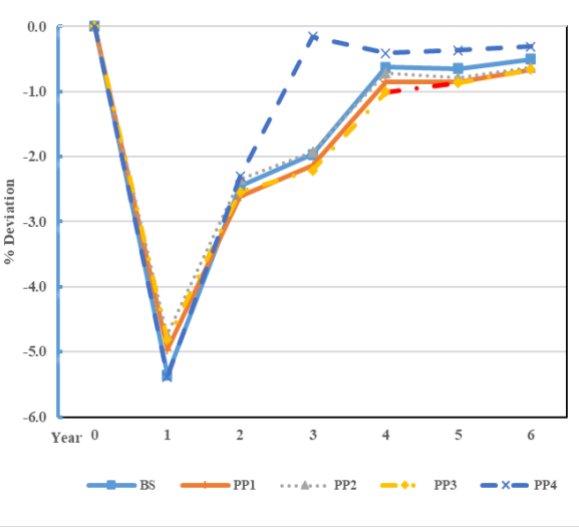
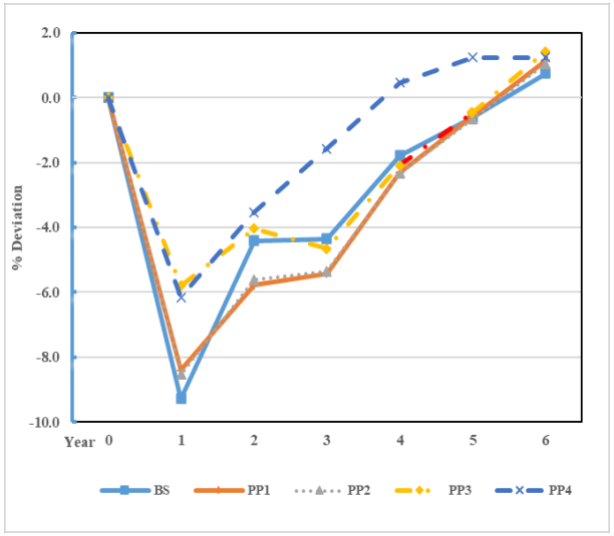
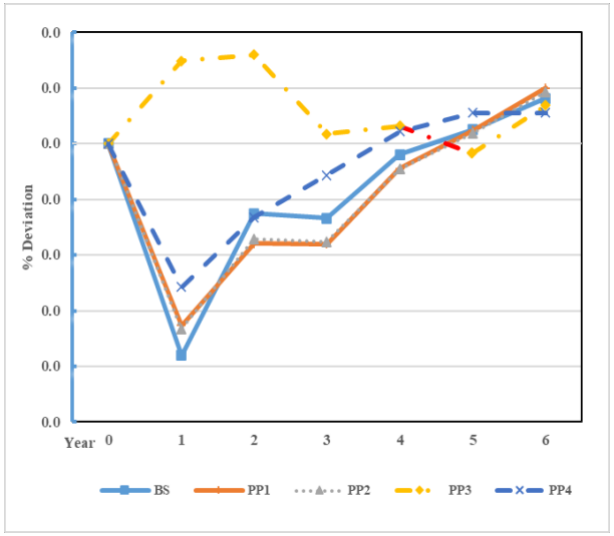


Figure 24: Dynamic Results for Vietnam (Contd.)

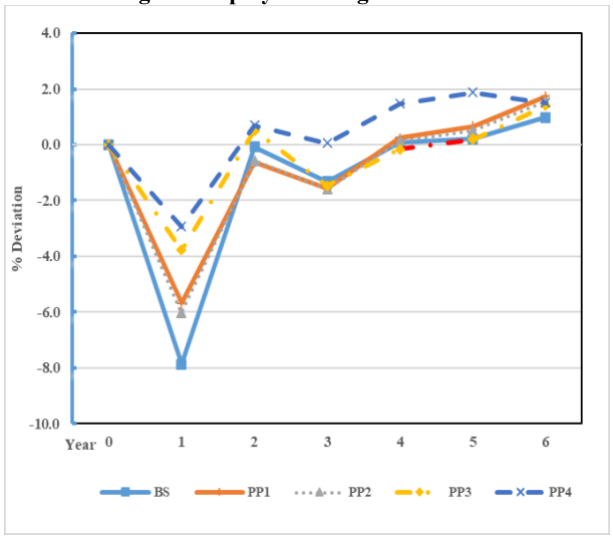
Change in Employment: Energy Sector



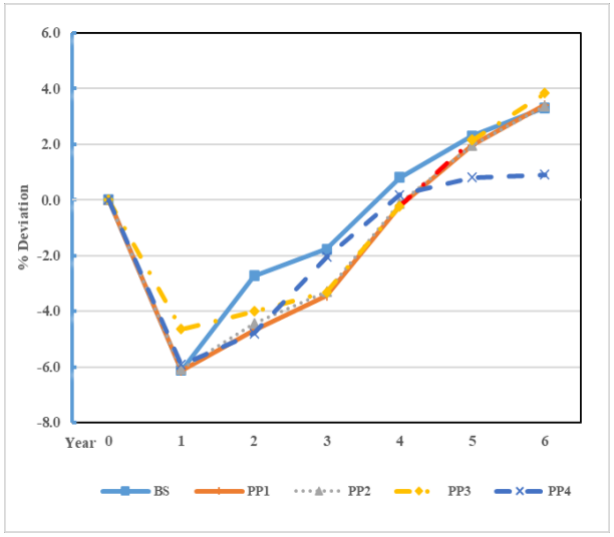
Change in Employment: Mining Sector



Change in Employment: Agriculture Sector

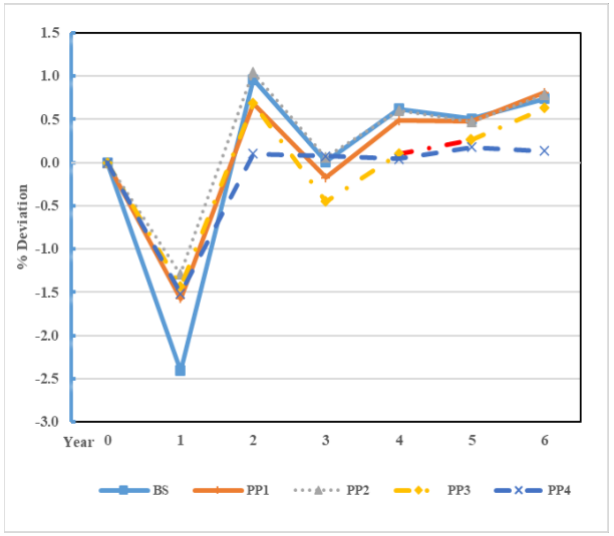


Change in Employment: Durable Manufacturing Sector



Change in Employment: Non-Durable Manufacturing Sector

Change in Employment: Service Sector



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; increase in infrastructure spending; and a much better public health response including rapid deployment of a vaccine. These results are intended to be illustrative since the exact magnitudes on 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 rapid deployment of a vaccine. The other policy programs help alleviate the macroeconomic impact of the COVID-19 pandemic, and perhaps a combination of each policy would have a significant effect.

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

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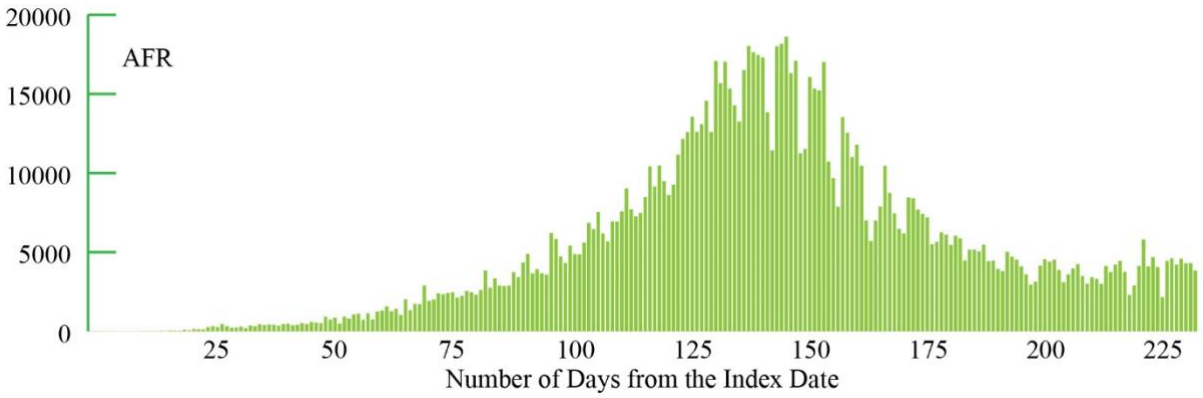
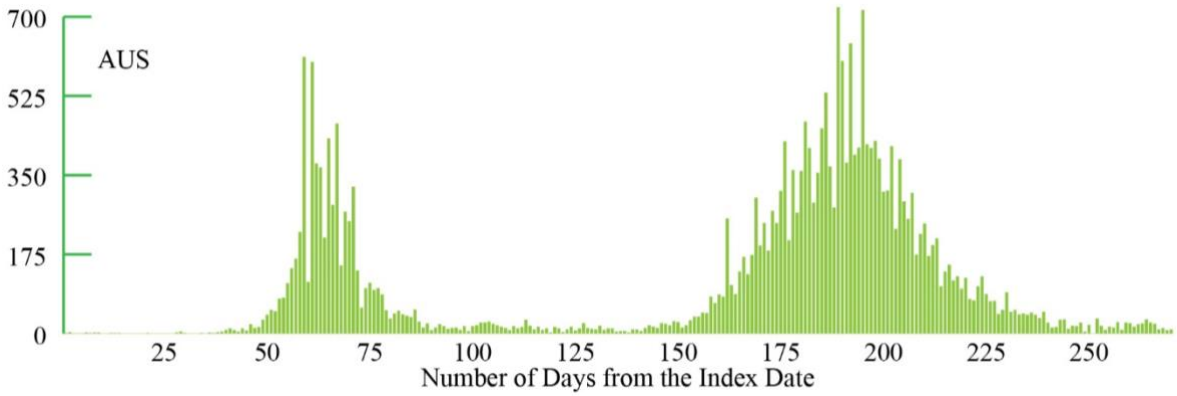
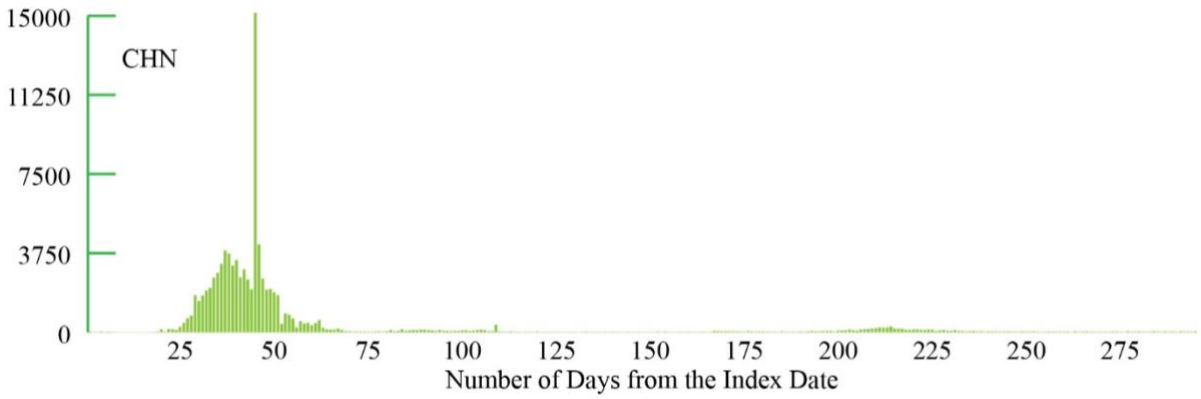
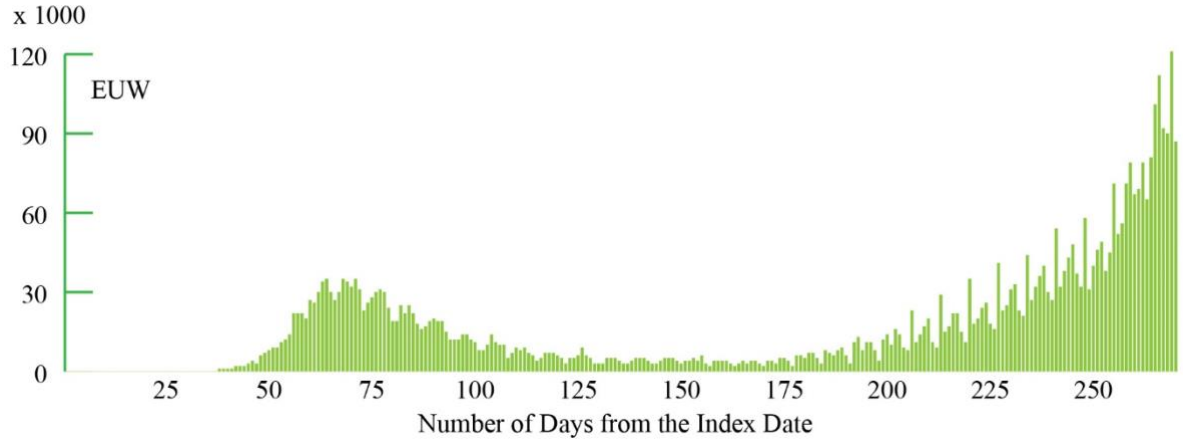
Appendix 1a: Infections from the Index Date until 20 October 2020

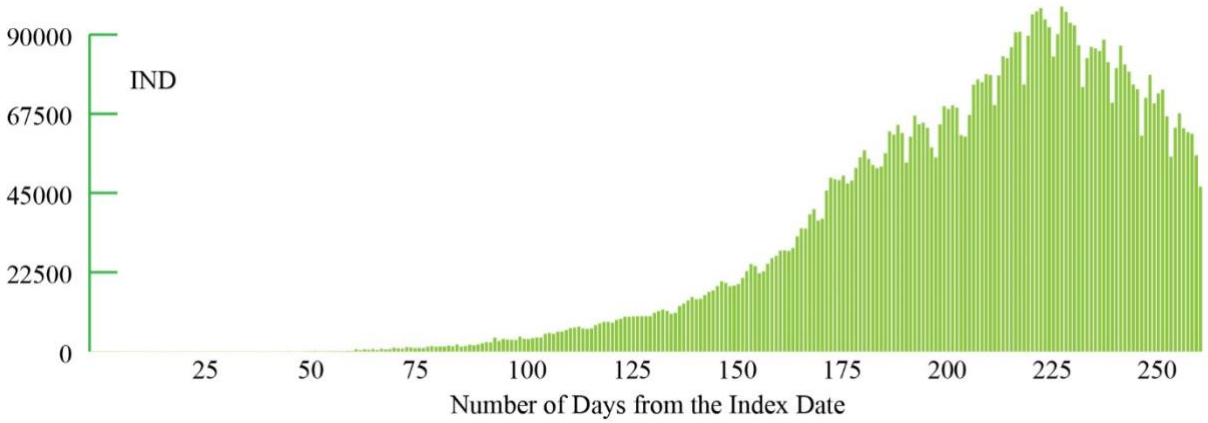


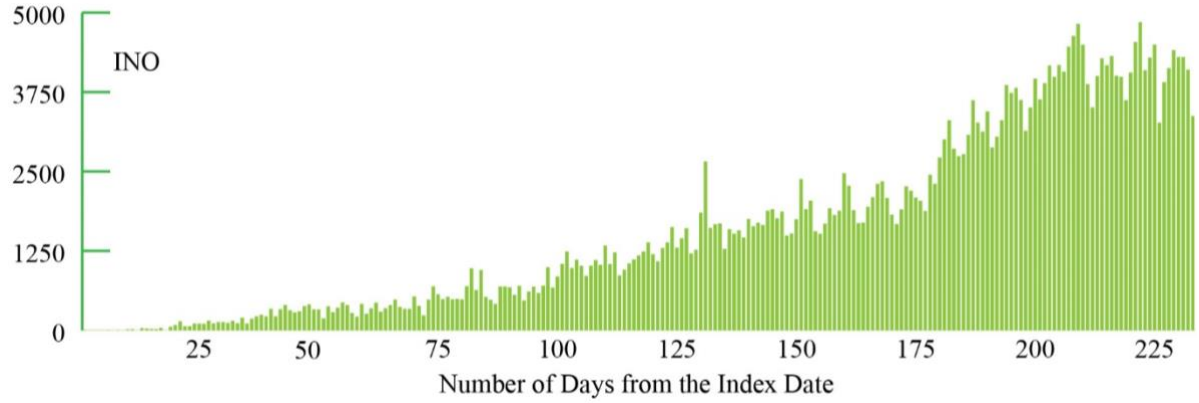


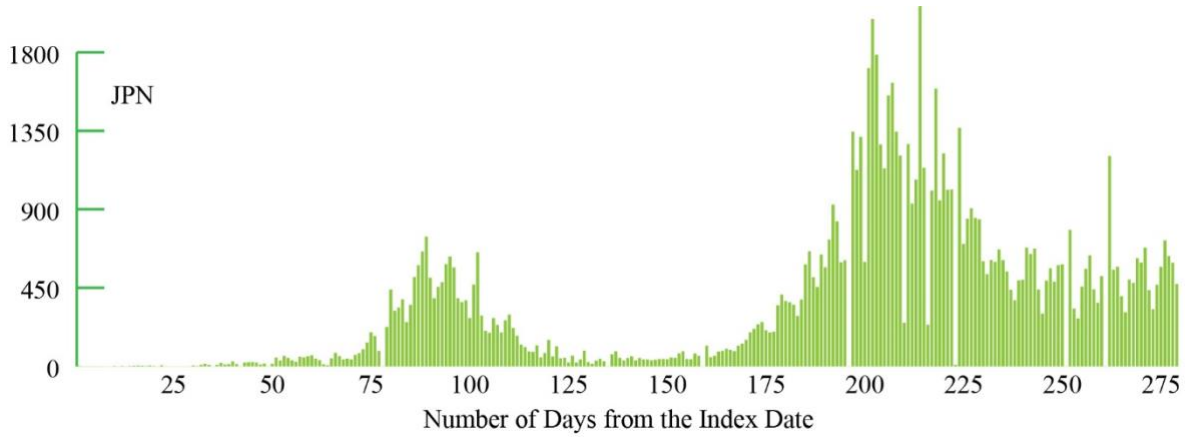


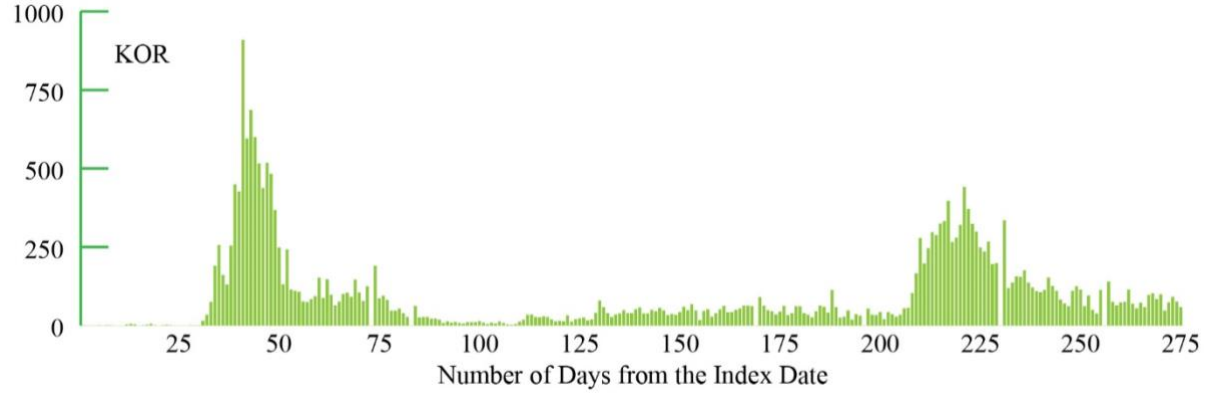


Appendix 1b: Infections from the Index Date until 20 October 2020

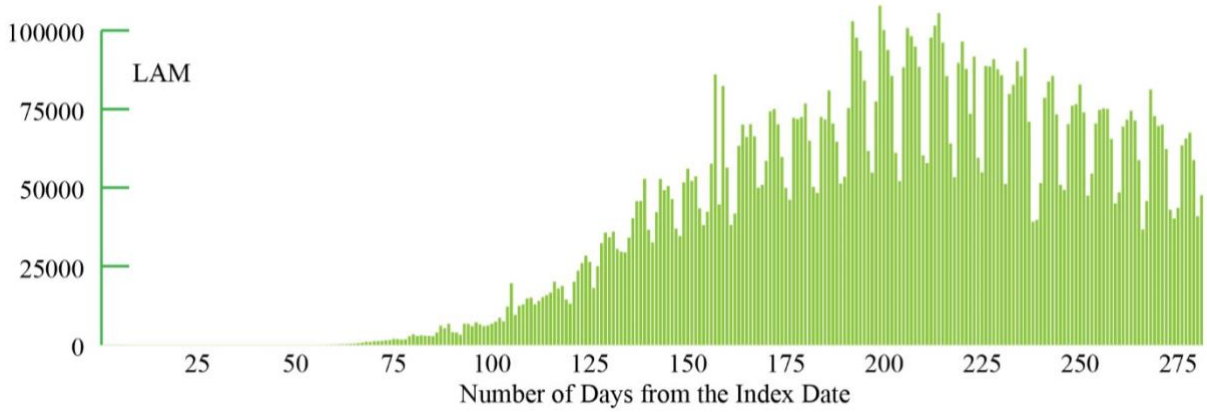


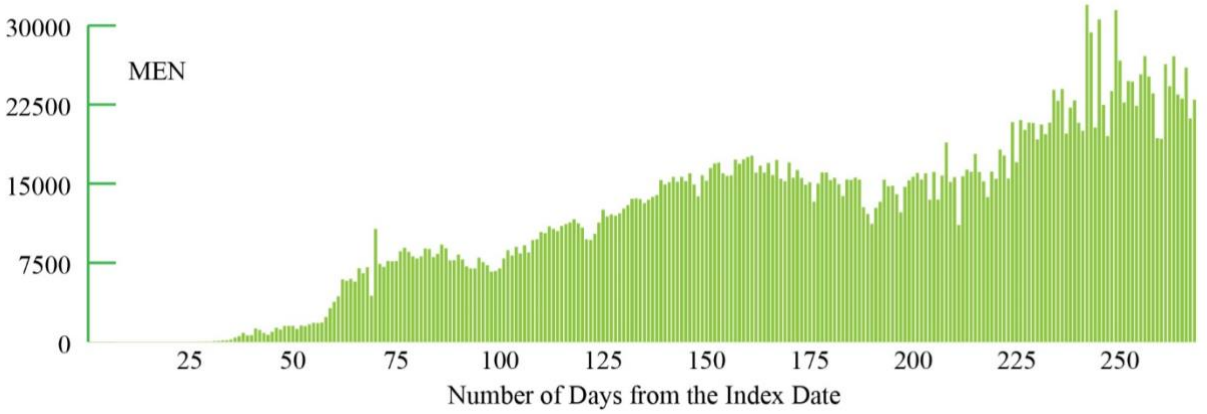


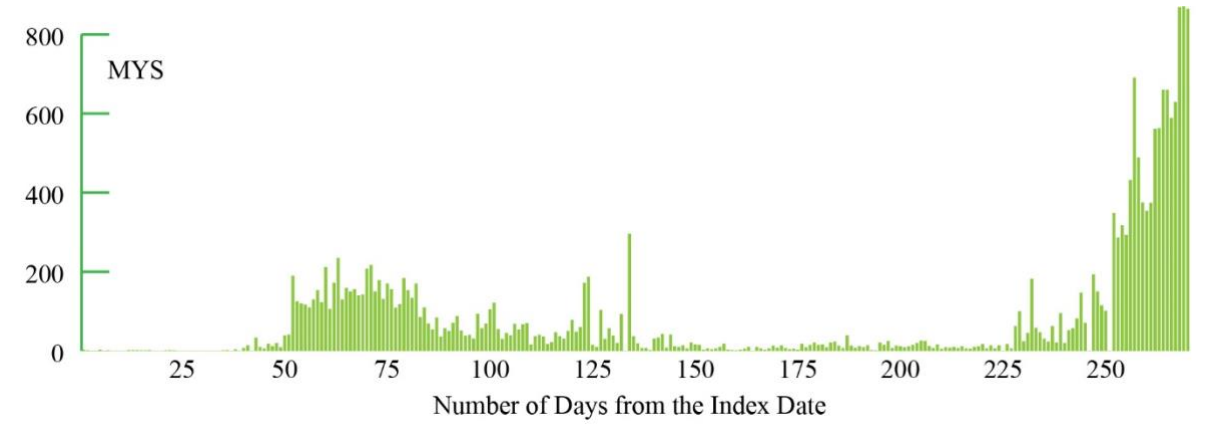


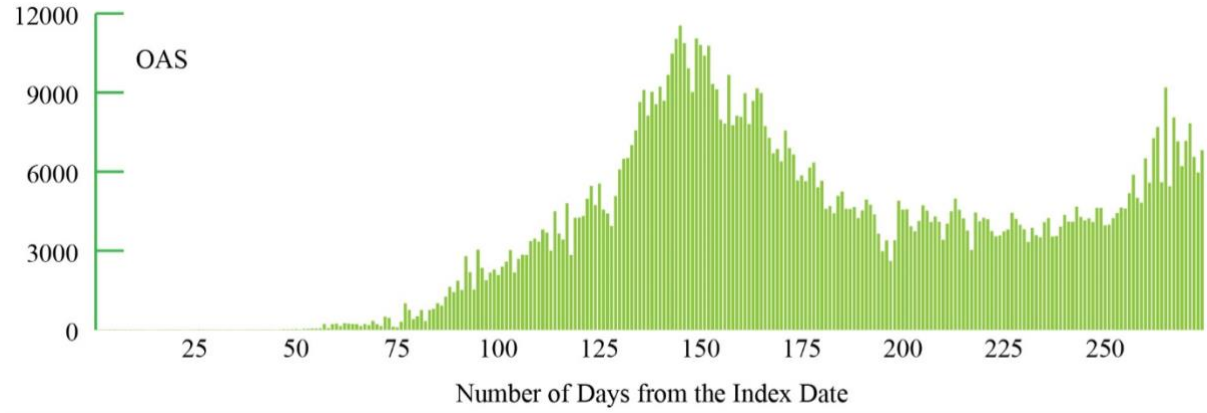


Appendix 1c: Infections from the Index Date until 20 October 2020

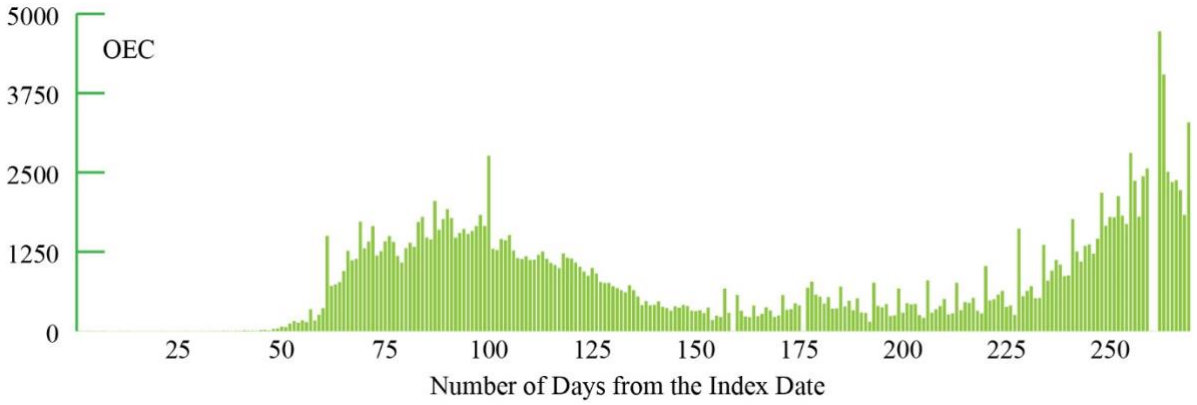


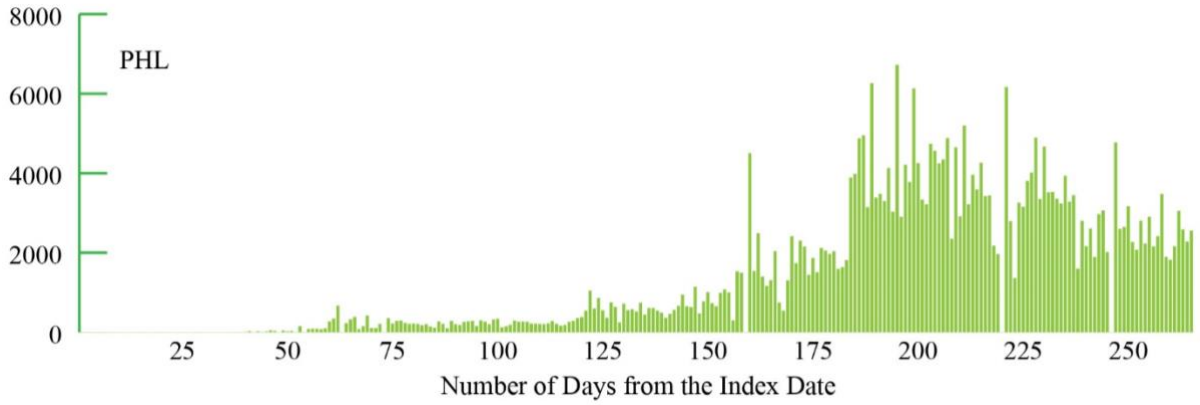


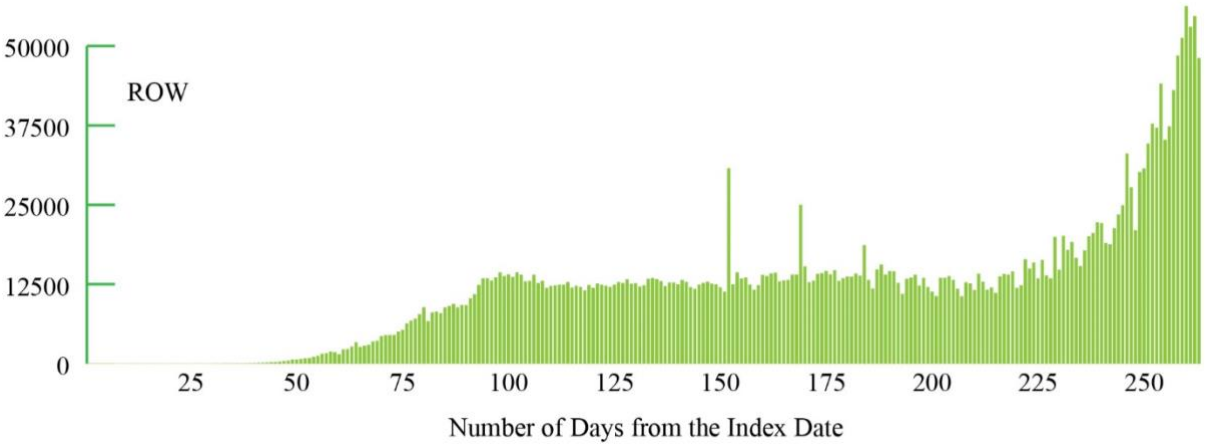


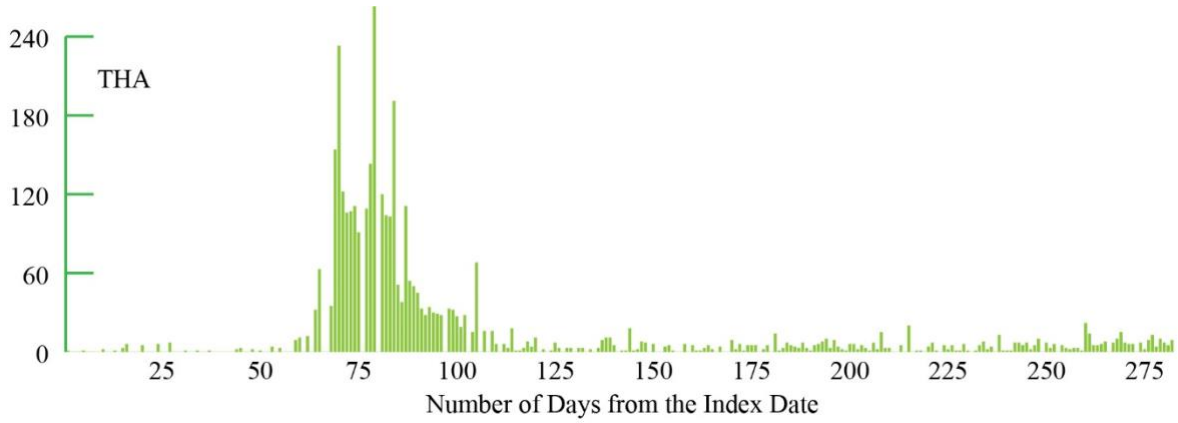


Appendix 1d: Infections from the Index Date until 20 October 2020

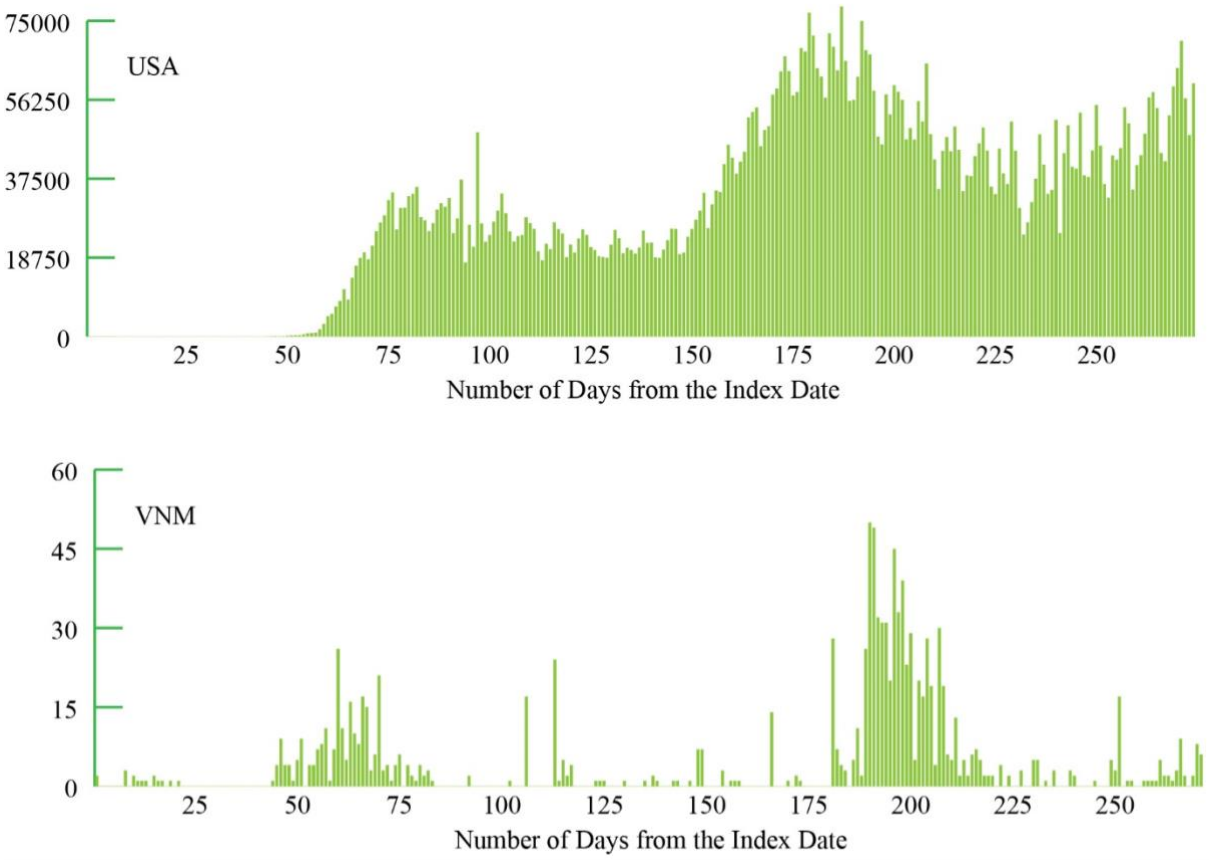




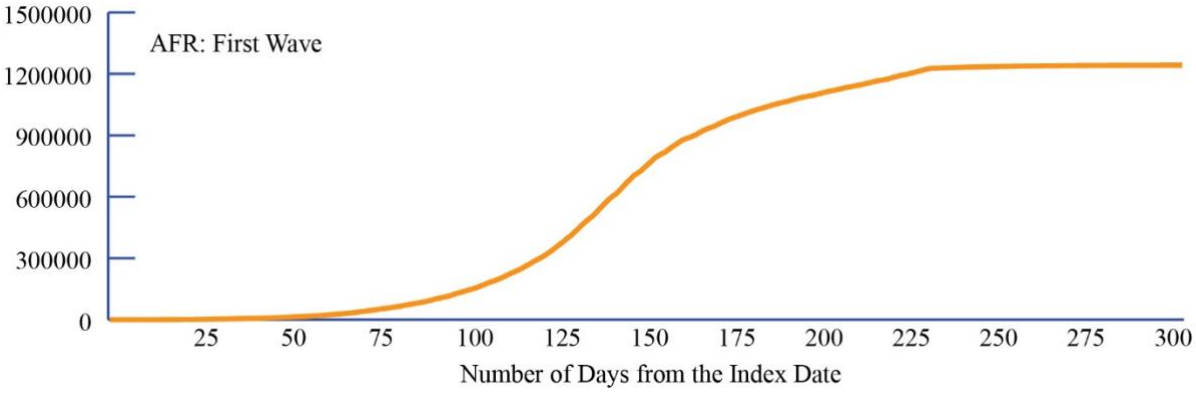


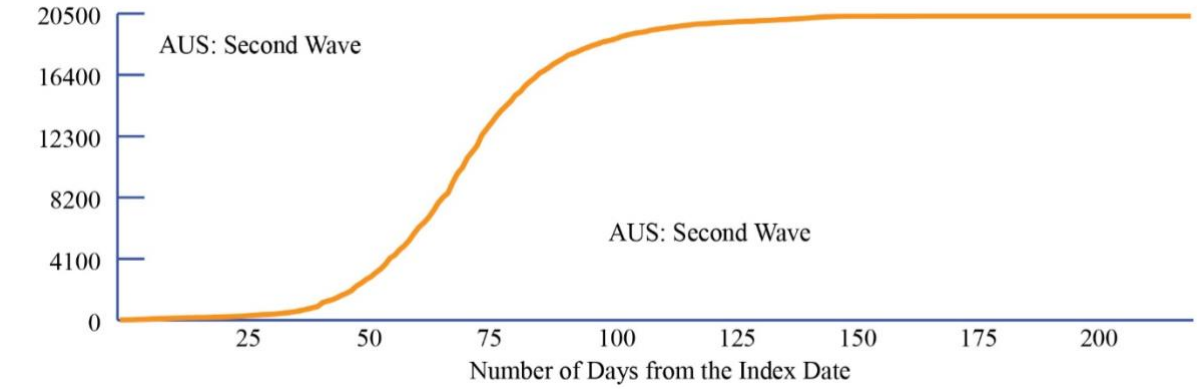


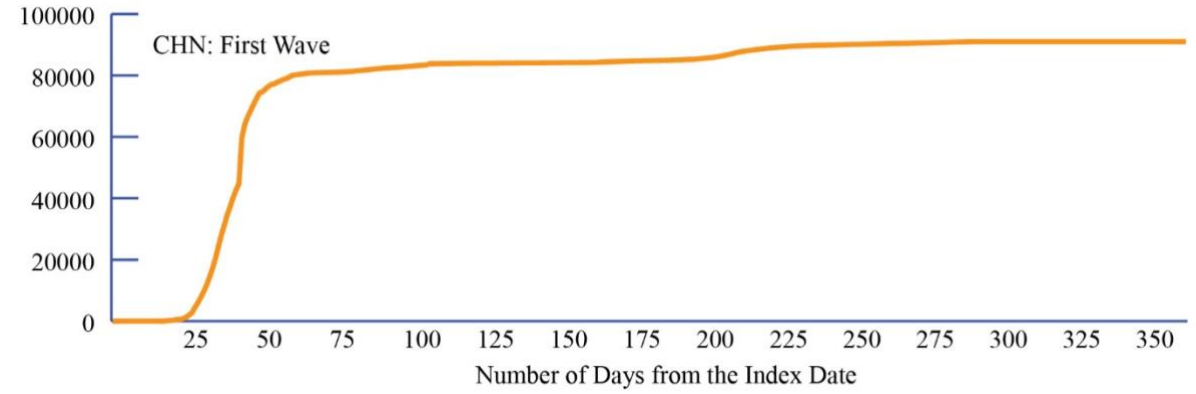
Appendix 1e: Infections from the Index Date until 20 October 2020

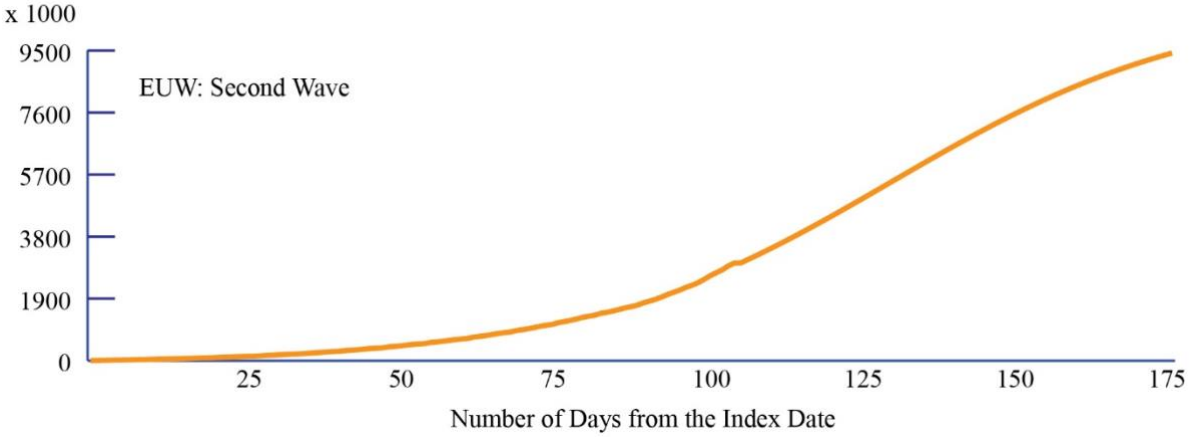


Appendix 2a: Cumulative Infections until 31 December 2020

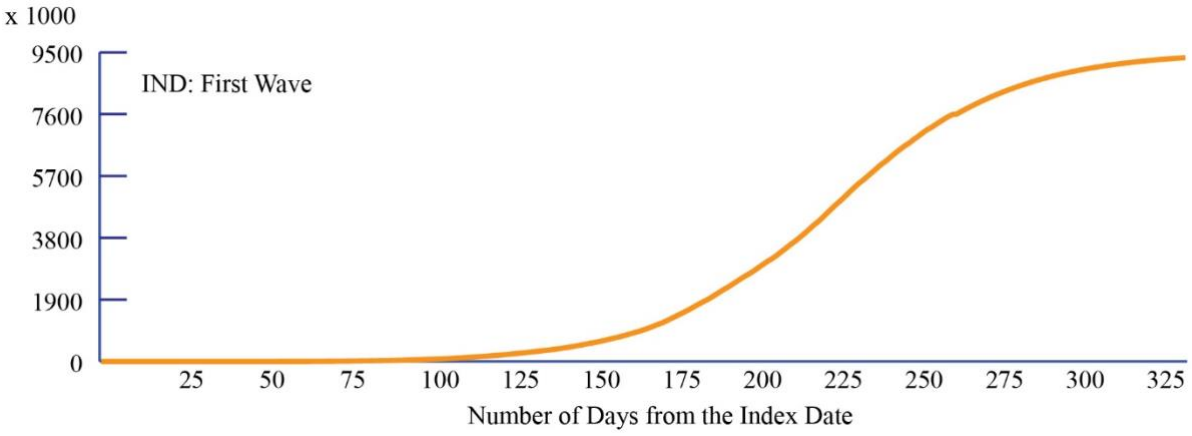


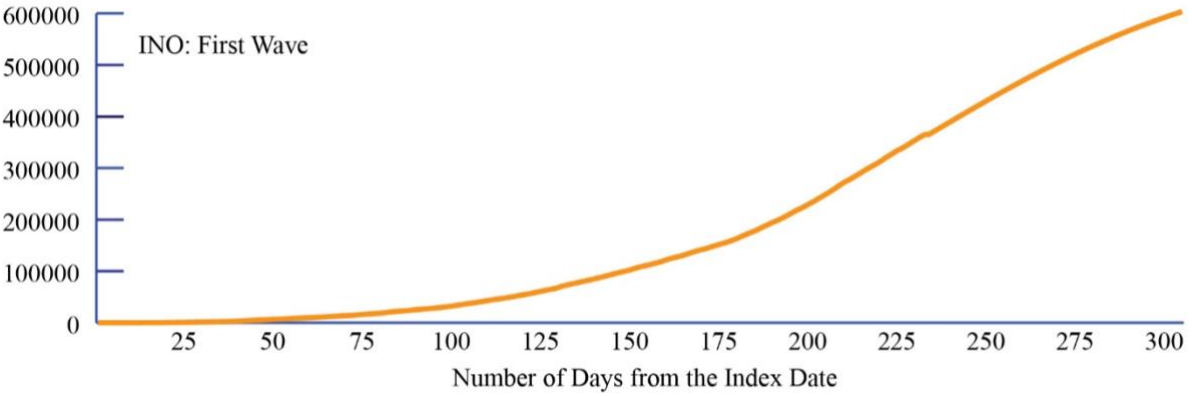


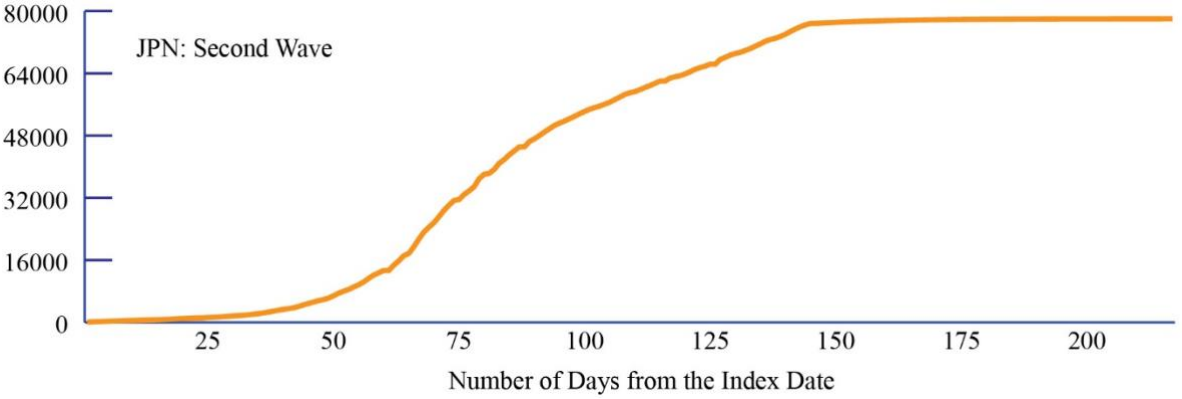


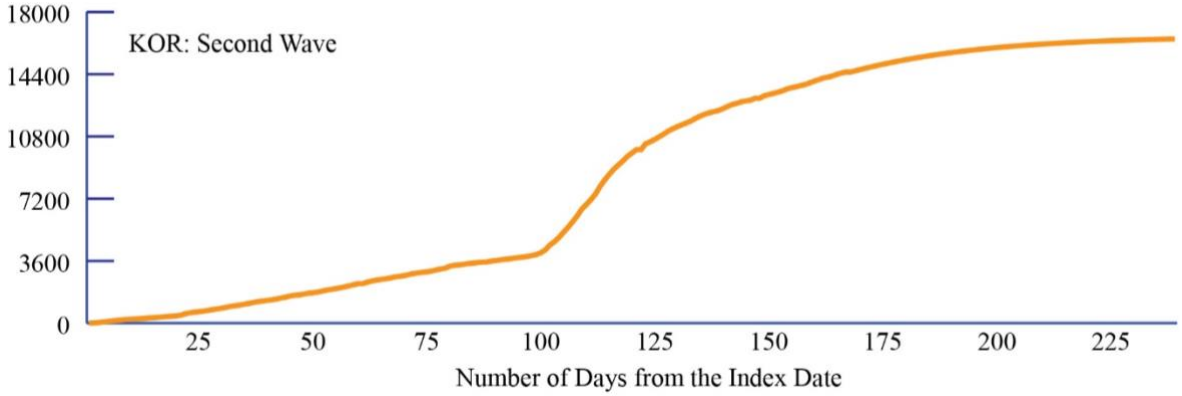


Appendix 2b: Cumulative Infections until 31 December 2020

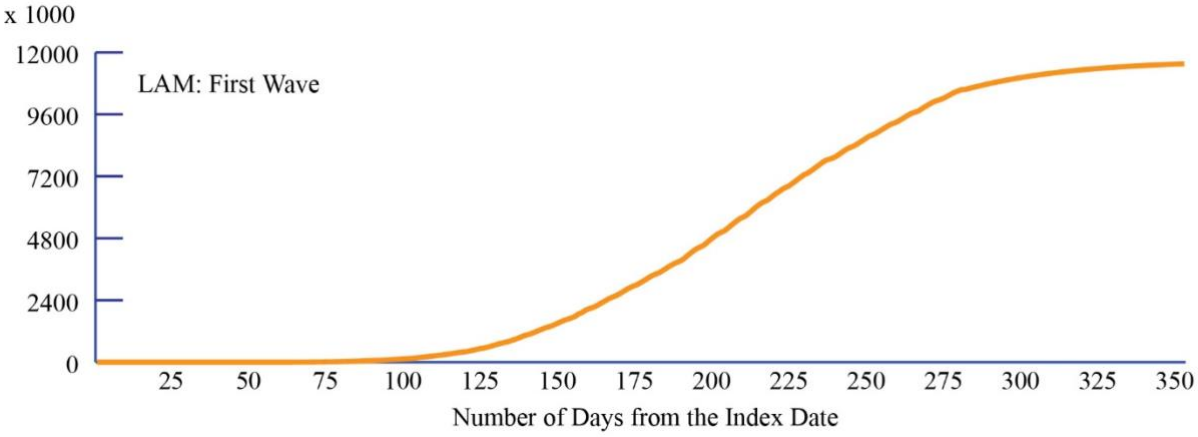


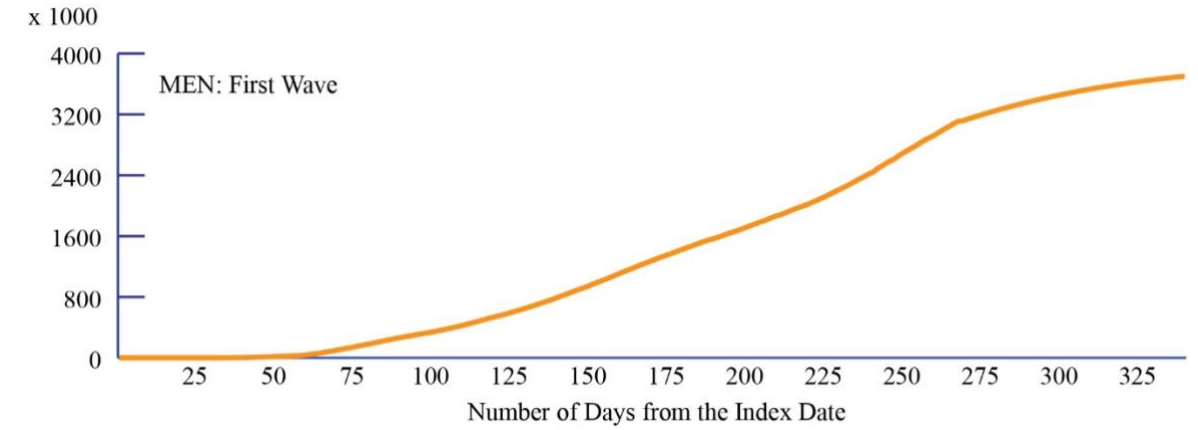


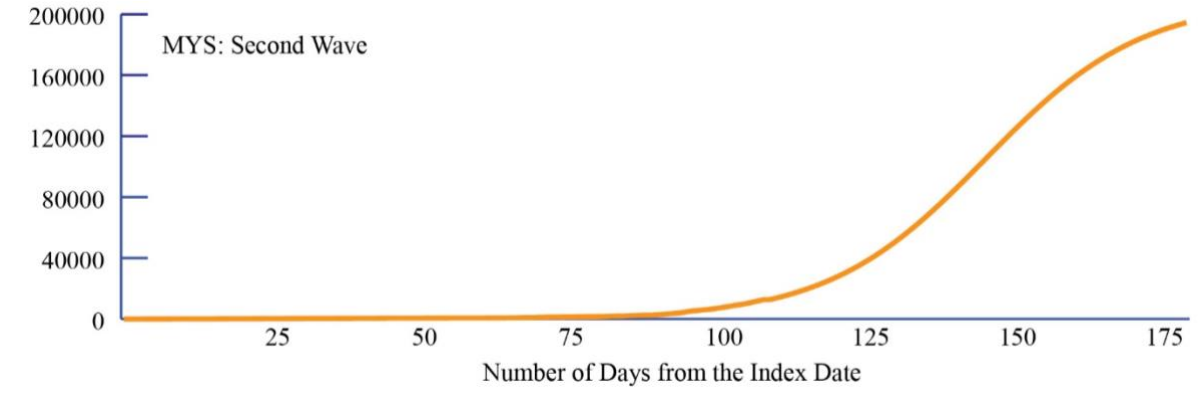


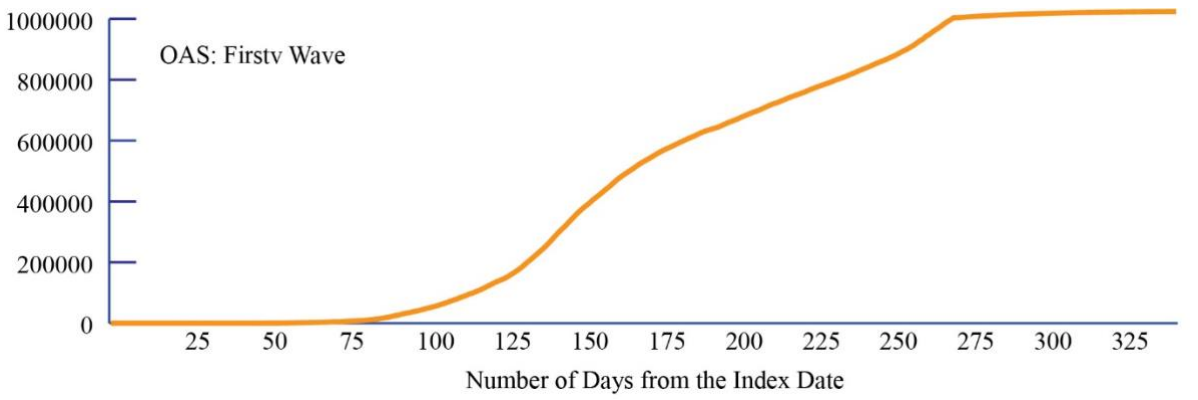


Appendix 2c: Cumulative Infections until 31 December 2020

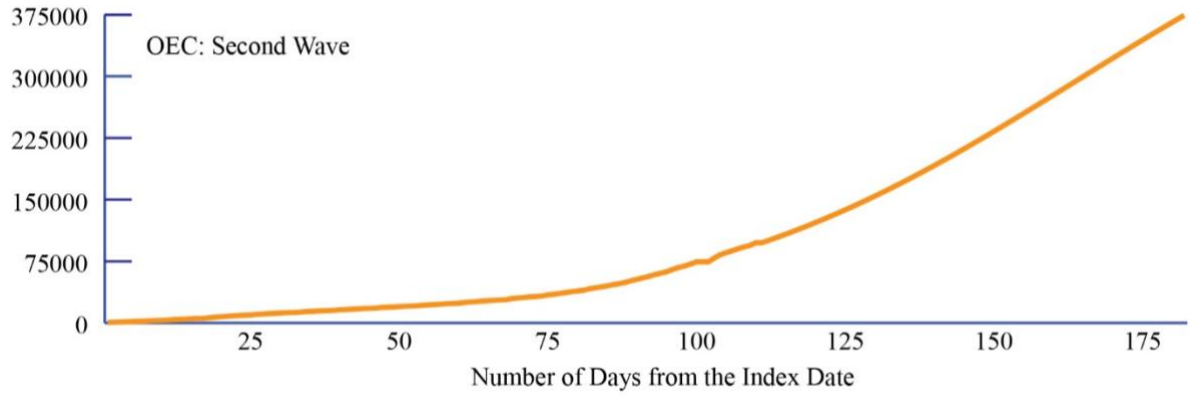


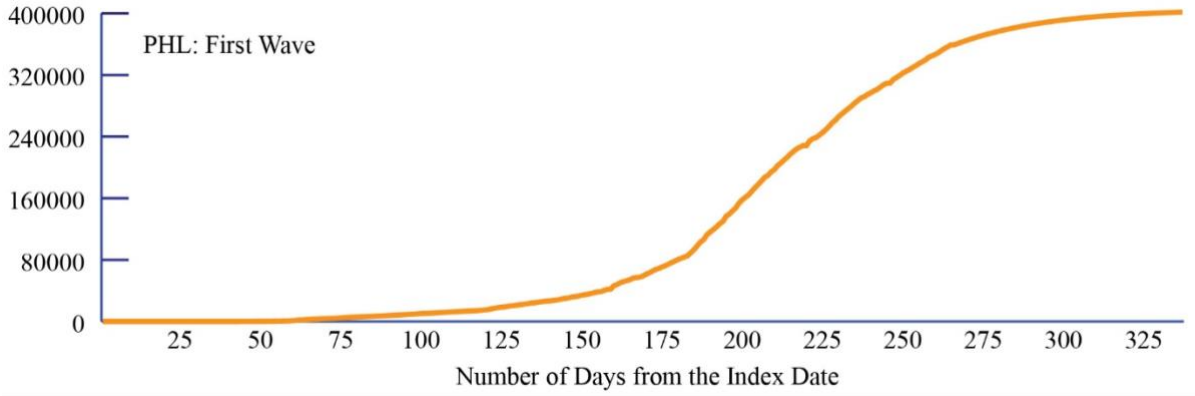


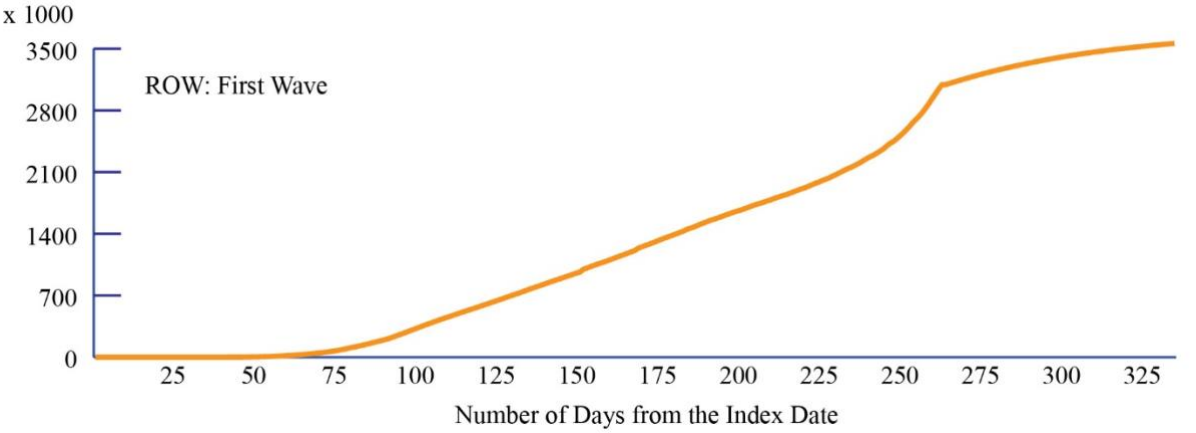


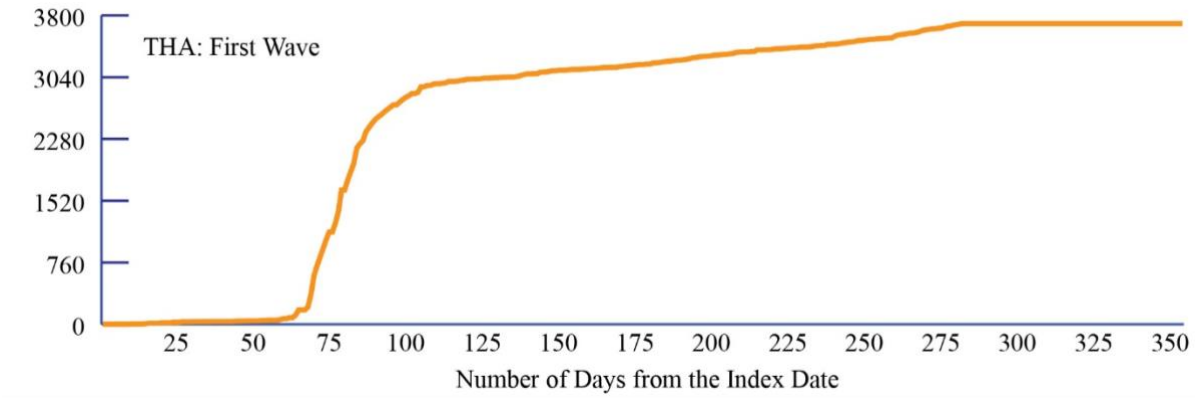


Appendix 2d: Cumulative Infections until 31 December 2020

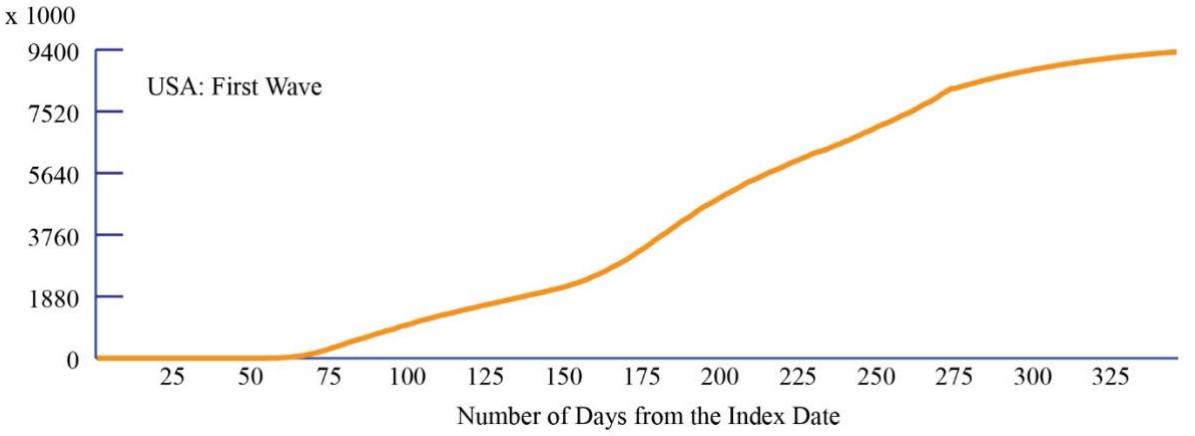


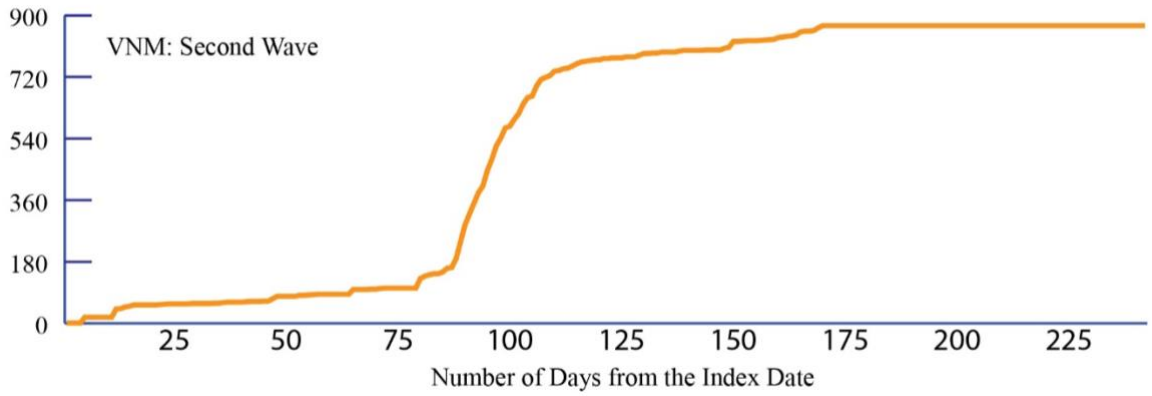




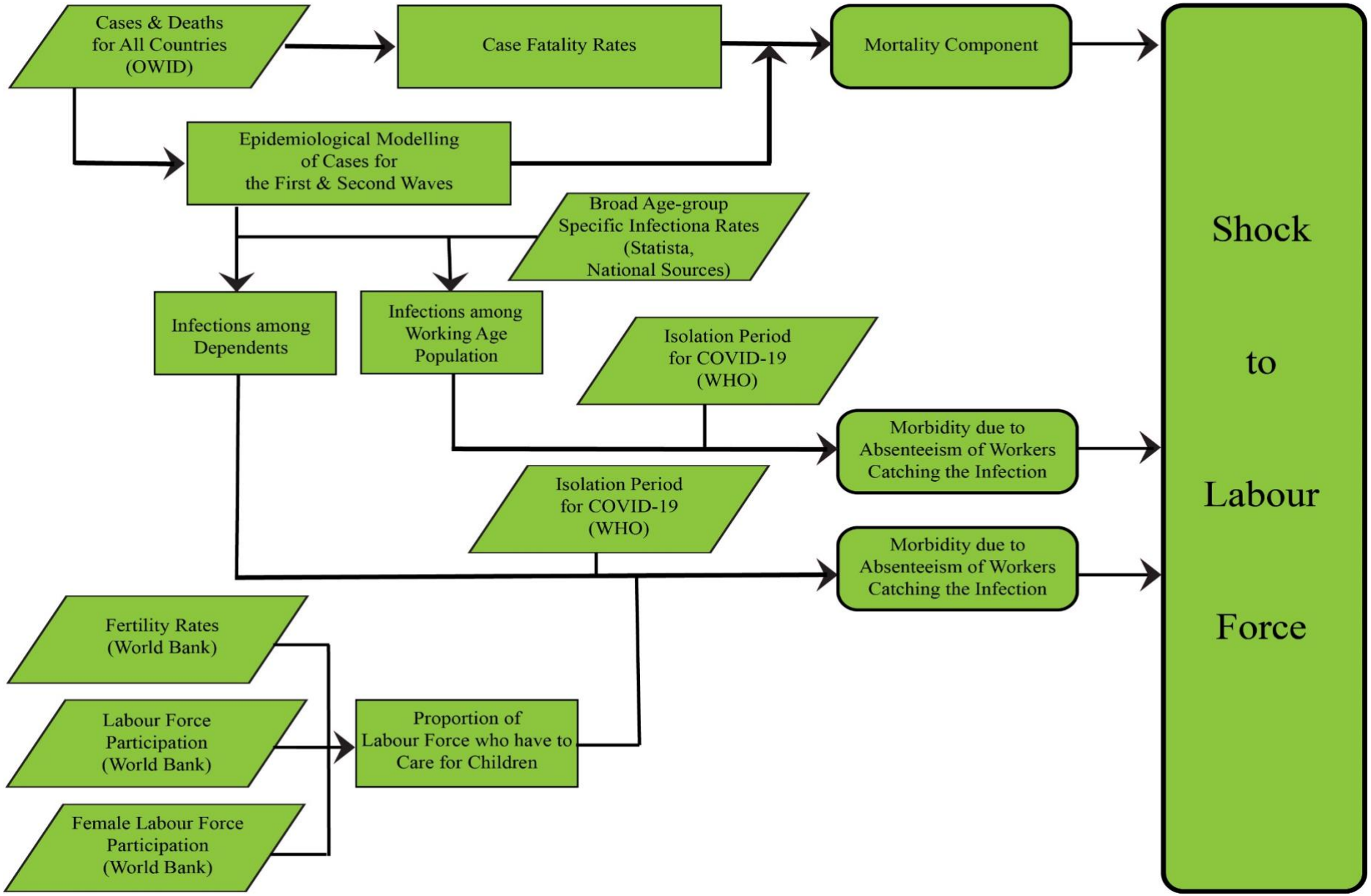


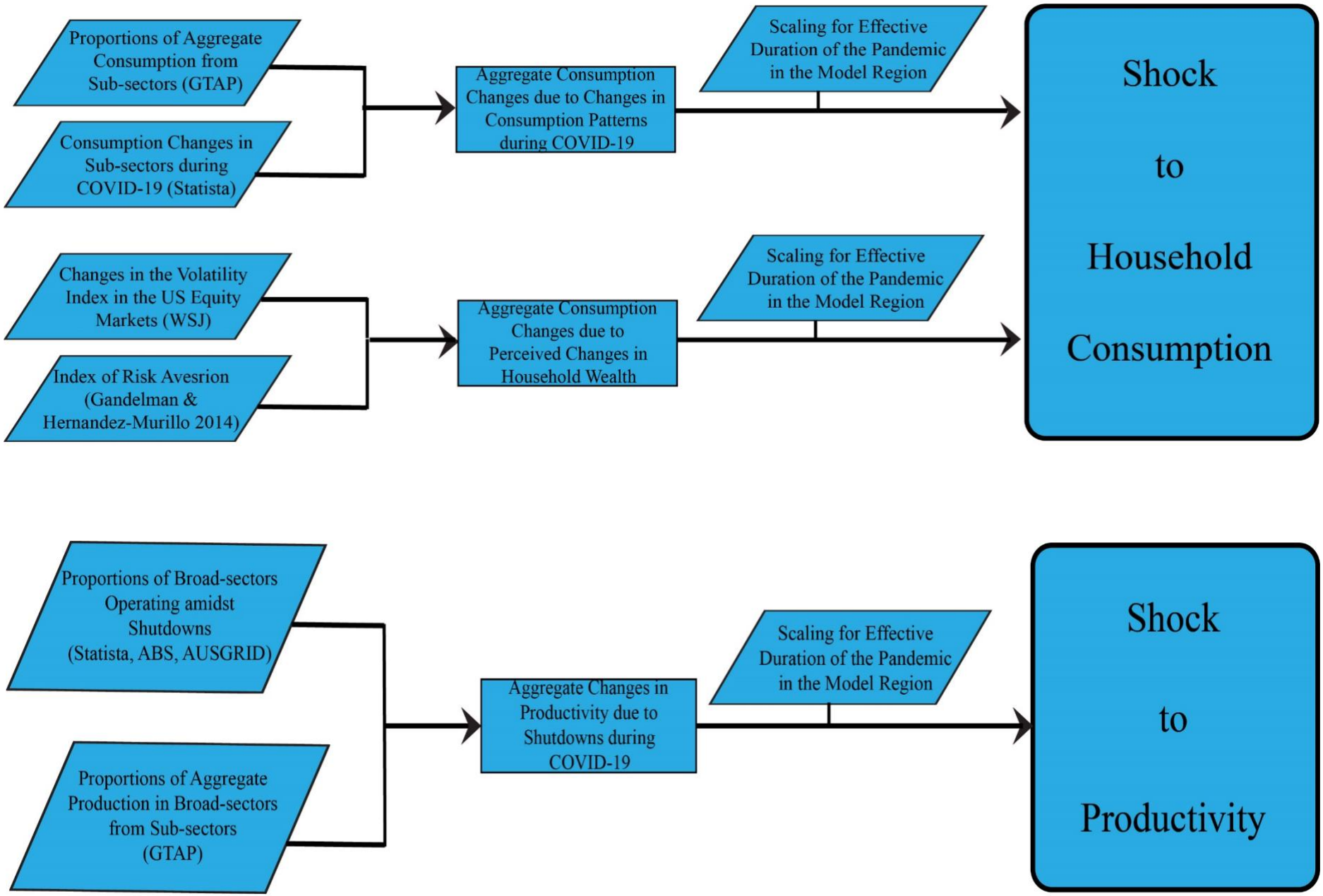
Appendix 2e: Cumulative Infections until 31 December 2020

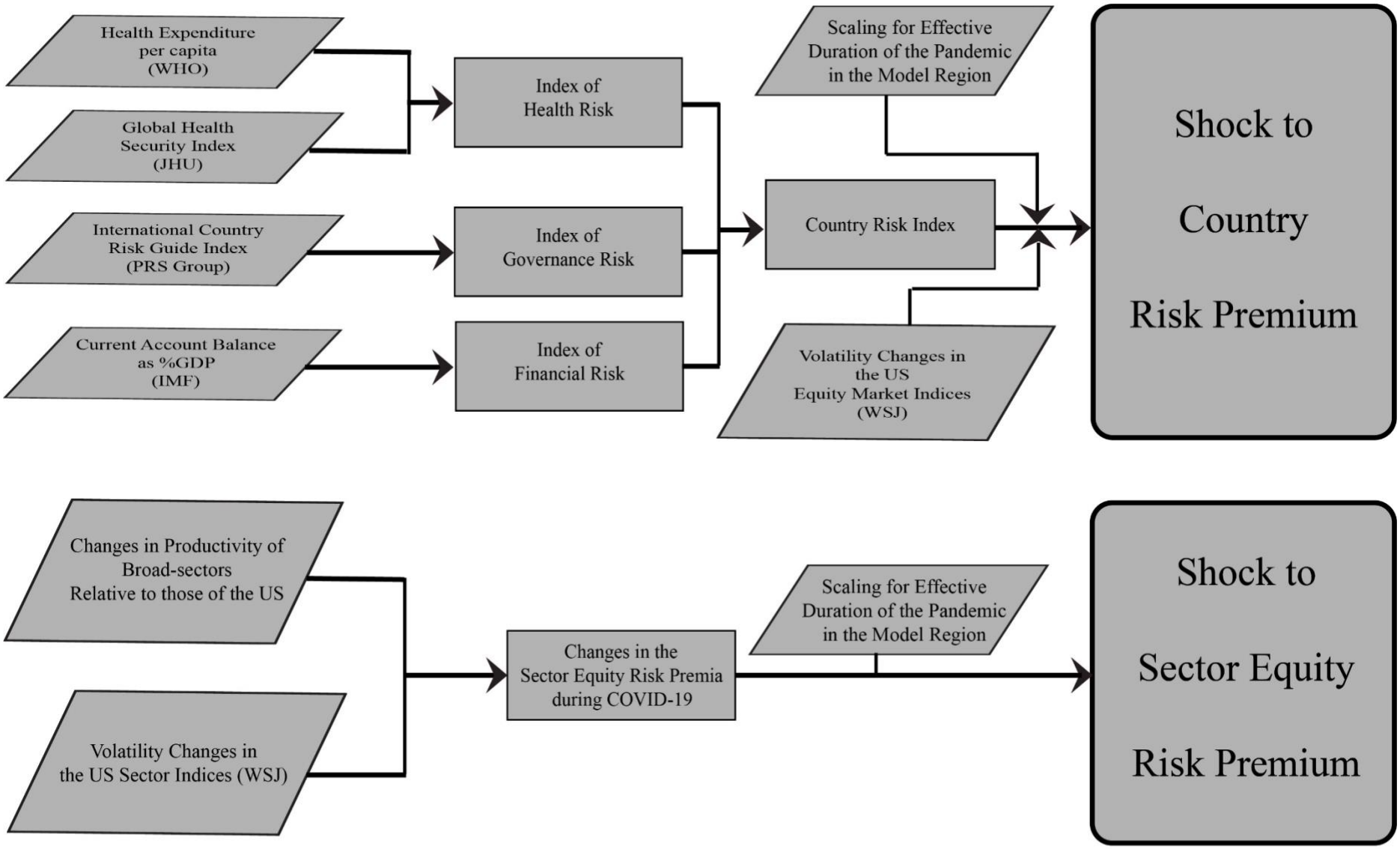


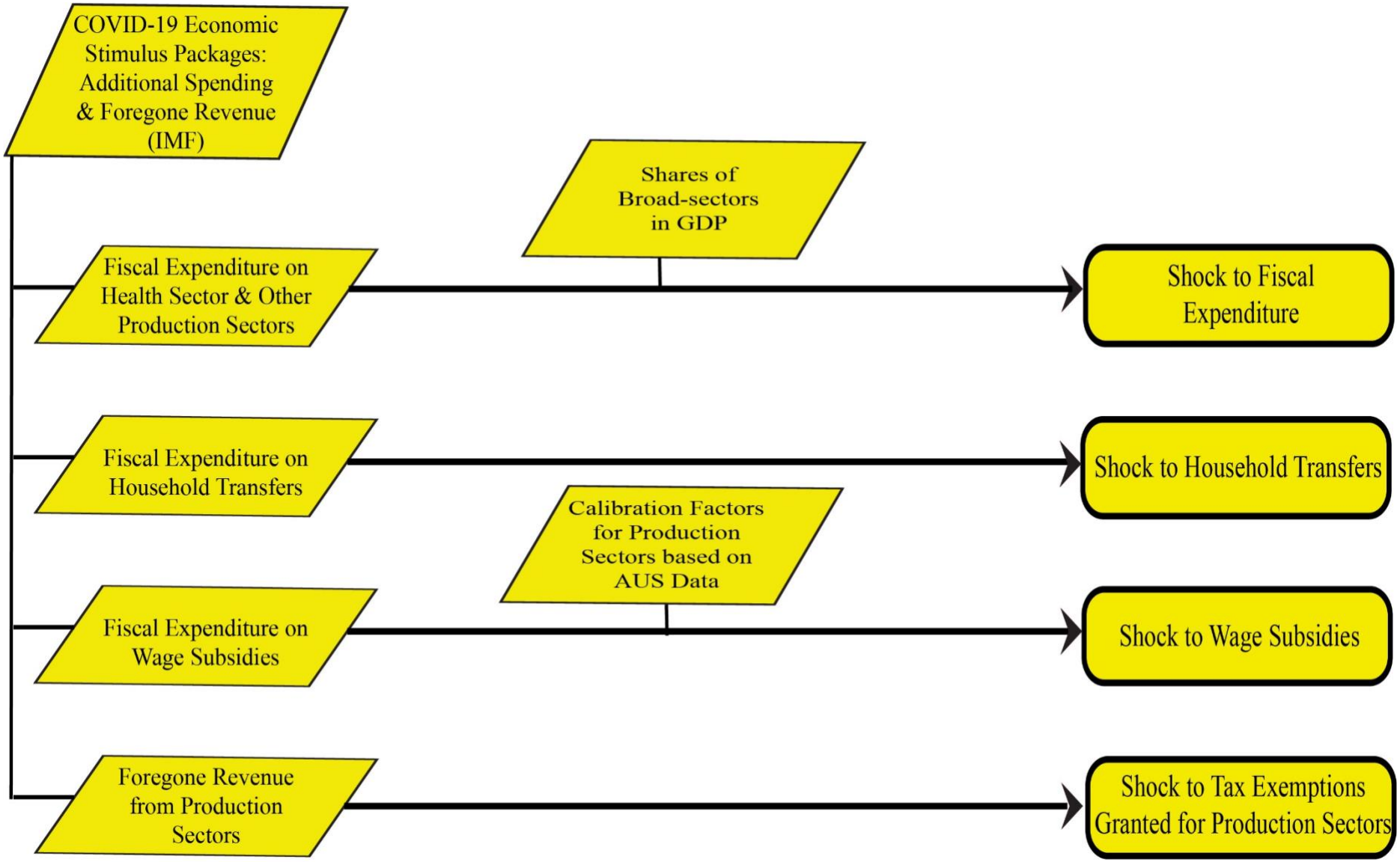


Appendix 3: Formulation of Shocks




Proportions of Aggregate Consumption from Sub-sectors (GTAP)
Consumption Changes in Sub-sectors during COVID-19 (Statista)
Aggregate Consumption Changes due to Changes in Consumption Patterns during COVID-19
Scaling for Effective Duration of the Pandemic in the Model Region
Changes in the Volatility Index in the US Equity Markets (WSJ)
Index of Risk Avesrion (Gandelman & Hernandez-Murillo 2014)
Aggregate Consumption Changes due to Perceived Changes in Household Wealth
Scaling for Effective Duration of the Pandemic in the Model Region
Shock to Household Consumption
Proportions of Broad-sectors Operating amidst Shutdowns (Statista, ABS, AUSGRID)
Proportions of Aggregate Production in Broad-sectors from Sub-sectors (GTAP)
Aggregate Changes in Productivity due to Shutdowns during COVID-19
Scaling for Effective Duration of the Pandemic in the Model Region
Shock to Productivity


Health Expenditure per capita (WHO)
Global Health Security Index (JHU)
International Country Risk Guide Index (PRS Group)
Current Account Balance as %GDP (IMF)
Index of Health Risk
Index of Governance Risk
Index of Financial Risk
Scaling for Effective Duration of the Pandemic in the Model Region
Country Risk Index
Volatility Changes in the US Equity Market Indices (WSJ)
Shock to Country Risk Premium
Changes in Productivity of Broad-sectors Relative to those of the US
Volatility Changes in the US Sector Indices (WSJ)
Changes in the Sector Equity Risk Premia during COVID-19
Scaling for Effective Duration of the Pandemic in the Model Region
Shock to Sector Equity Risk Premium


COVID-19 Economic Stimulus Packages: Additional Spending & Foregone Revenue (IMF)
Shares of Broad-sectors in GDP
Fiscal Expenditure on Health Sector & Other Production Sectors
Shock to Fiscal Expenditure
Fiscal Expenditure on Household Transfers
Shock to Household Transfers
Calibration Factors for Production Sectors based on AUS Data
Fiscal Expenditure on Wage Subsidies
Shock to Wage Subsidies
Foregone Revenue from Production Sectors
Shock to Tax Exemptions Granted for Production Sectors