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The Global Macroeconomic Impacts of COVID-19: Seven Scenarios

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CAMA Working Paper 19/2020
February 2020

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The scenarios in this paper demonstrate that even a contained outbreak could significantly impact the global economy in the short run. These scenarios demonstrate the scale of costs that might be avoided by greater investment in public health systems in all economies but particularly in less developed economies where health care systems are less developed and popultion density is high.

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Pandemics, infectious diseases, risk, macroeconomics, DSGE, CGE, G-Cubed

JEL Classification

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ISSN 2206-0332

The Global Macroeconomic Impacts of COVID-19: Seven Scenarios[*]

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The outbreak of coronavirus named COVID-19 has disrupted the Chinese economy and is spreading globally. The evolution of the disease and its economic impact is highly uncertain which makes it difficult for policymakers to formulate an appropriate macroeconomic policy response. In order to better understand possible economic outcomes, this paper explores seven different scenarios of how COVID-19 might evolve in the coming year using a modelling technique developed by Lee and McKibbin (2003) and extended by McKibbin and Sidorenko (2006). It examines the impacts of different scenarios on macroeconomic outcomes and financial markets in a global hybrid DSGE/CGE general equilibrium model.

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[*] We gratefully acknowledge financial support from the Australia Research Council Centre of Excellence in Population Ageing Research (CE170100005). We thank Renee Fry-McKibbin, Will Martin, Louise Shiner and David Wessel for comment and Peter Wilcoxen and Larry Weifeng Liu for their research collaboration on the G-Cubed model used in this paper. We also acknowledge the contributions to earlier research on modelling of pandemics undertaken with Jong-Wha Lee and Alexandra Sidorenko.

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1. Introduction

The COVID-19 outbreak (previously 2019-nCoV) was caused by the SARS-CoV-2 virus. This outbreak was triggered in December 2019 in Wuhan city in Hubei province of China. COVID-19 continues to spread across the world. Initially the epicenter of the outbreak was China with reported cases either in China or being travelers from China. At the time of writing this paper, at least four further epicenters have been identified: Iran, Italy, Japan and South Korea. Even though the cases reported from China are expected to have peaked and are now falling (WHO 2020), cases reported from countries previously thought to be resilient to the outbreak, due to stronger medical standards and practices, have recently increased. While some countries have been able to effectively treat reported cases, it is uncertain where and when new cases will emerge. Amidst the significant public health risk COVID-19 poses to the world, the World Health Organization (WHO) has declared a public health emergency of international concern to coordinate international responses to the disease. It is, however, currently debated whether COVID-19 could potentially escalate to a global pandemic.

In a strongly connected and integrated world, the impacts of the disease beyond mortality (those who die) and morbidity (those who are incapacitated or caring for the incapacitated and unable to work for a period) has become apparent since the outbreak. Amidst the slowing down of the Chinese economy with interruptions to production, the functioning of global supply chains has been disrupted. Companies across the world, irrespective of size, dependent upon inputs from China have started experiencing contractions in production. Transport being limited and even restricted among countries has further slowed down global economic activities. Most importantly, some panic among consumers and firms has distorted usual consumption patterns and created market anomalies. Global financial markets have also been responsive to the changes and global stock indices have plunged. Amidst the global turbulence, in an initial assessment, the International Monetary Fund expects China to slow down by 0.4 percentage points compared to its initial growth target to 5.6 percent, also slowing down global growth by 0.1 percentage points. This is likely to be revised in coming weeks[4].

[4] See OECD(2020) for an updated announcement

This paper attempts to quantify the potential global economic costs of COVID-19 under different possible scenarios. The goal is to provide guidance to policy makers to the economic benefits of globally-coordinated policy responses to tame the virus. The paper builds upon the experience gained from evaluating the economics of SARS (Lee & McKibbin 2003) and Pandemic Influenza (McKibbin & Sidorenko 2006). The paper first summarizes the existing literature on the macroeconomic costs of diseases. Section 3 outlines the global macroeconomic model (G-Cubed) used for the study, highlighting its strengths to assess the macroeconomics of diseases. Section 4 describes how epidemiological information is adjusted to formulate a series of economic shocks that are input into the global economic model. Section 5 discusses the results of the seven scenarios simulated using the model. Section 6 concludes the paper summarizing the main findings and discusses some policy implications.

2. Related Literature

Many studies have found that population health, as measured by life expectancy, infant and child mortality and maternal mortality, is positively related to economic welfare and growth (Pritchett and Summers, 1996; Bloom and Sachs, 1998; Bhargava and et al., 2001; Cuddington et al., 1994; Cuddington and Hancock, 1994; Robalino et al., 2002a; Robalino et al., 2002b; WHO Commission on Macroeconomics and Health, 2001; Haacker, 2004).

There are many channels through which an infectious disease outbreak influences the economy. Direct and indirect economic costs of illness are often the subject of the health economics studies on the burden of disease. The conventional approach uses information on deaths (mortality) and illness that prevents work (morbidity) to estimate the loss of future income due to death and disability. Losses of time and income by carers and direct expenditure on medical care and supporting services are added to obtain the estimate of the economic costs associated with the disease. This conventional approach underestimates the true economic costs of infectious diseases of epidemic proportions which are highly transmissible and for which there is no vaccine (e.g. HIV/AIDS, SARS and pandemic influenza). The experience from these previous disease outbreaks provides valuable information on how to think about the implications of COVID-19

The HIV/AIDS virus affects households, businesses and governments - through changed labor supply decisions; efficiency of labor and household incomes; increased business costs and foregone investment in staff training by firms; and increased public expenditure on health care and support of disabled and children orphaned by AIDS, by the public sector (Haacker, 2004).

The effects of AIDS are long-term but there are clear prevention measures that minimize the risks of acquiring HIV, and there are documented successes in implementing prevention and education programs, both in developed and in the developing world. Treatment is also available, with modern antiretroviral therapies extending the life expectancy and improving the quality of life of HIV patients by many years if not decades. Studies of the macroeconomic impact of HIV/AIDS include (Cuddington, 1993a; Cuddington, 1993b; Cuddington et al., 1994; Cuddington and Hancock, 1994; Haacker, 2002a; Haacker, 2002b; Over, 2002; Freire, 2004; The World Bank, 2006). Several computable general equilibrium (CGE) macroeconomic models have been applied to study the impact of AIDS (Arndt and Lewis, 2001; Bell et al., 2004).

The influenza virus is by far more contagious than HIV, and the onset of an epidemic can be sudden and unexpected. It appears that the COVID-19 virus is also very contagious. The fear of 1918-19 Spanish influenza, the "deadliest plague in history," with its extreme severity and gravity of clinical symptoms, is still present in the research and general community (Barry, 2004). The fear factor was influential in the world's response to SARS – a coronavirus not previously detected in humans (Shannon and Willoughby, 2004; Peiris et al., 2004). It is also reflected in the response to COVID-19. Entire cities in China have closed and travel restrictions placed by countries on people entering from infected countries. The fear of an unknown deadly virus is similar in its psychological effects to the reaction to biological and other terrorism threats and causes a high level of stress, often with longer-term consequences (Hyams et al., 2002). A large number of people would feel at risk at the onset of a pandemic, even if their actual risk of dying from the disease is low.

Individual assessment of the risks of death depends on the probability of death, years of life lost, and the subjective discounting factor. Viscusi et al. (1997) rank pneumonia and influenza as the third leading cause of the probability of death (following cardiovascular disease and cancer). Sunstein (1997) discusses the evidence that an individual's willingness to pay to avoid death increases for causes perceived as "bad deaths" – especially dreaded, uncontrollable, involuntary deaths and deaths associated with high externalities and producing distributional inequity. Based on this literature, it is not unreasonable to assume that individual perception of the risks associated with the new influenza pandemic virus similar to Spanish influenza in its virulence and the severity of clinical symptoms can be very high, especially during the early stage of the pandemic when no vaccine is available and antivirals are in short supply. This is exactly the reaction revealed in two surveys conducted in Taiwan during the SARS outbreak in 2003 (Liu et al., 2005), with the novelty, salience and public concern about SARS contributing to the higher than expected willingness to pay to prevent the risk of infection.

Studies of the macroeconomic effects of the SARS epidemic in 2003 found significant effects on economies through large reductions in consumption of various goods and services, an increase in business operating costs, and re-evaluation of country risks reflected in increased risk premiums. Shocks to other economies were transmitted according to the degree of the countries' exposure, or susceptibility, to the disease. Despite a relatively small number of cases and deaths, the global costs were significant and not limited to the directly affected countries (Lee and McKibbin, 2003). Other studies of SARS include (Chou et al., 2004) for Taiwan, (Hai et al., 2004) for China and (Sui and Wong, 2004) for Hong Kong.

There are only a few studies of economic costs of large-scale outbreaks of infectious diseases to date: Schoenbaum (1987) is an example of an early analysis of the economic impact of influenza. Meltzer et al. (1999) examine the likely economic effects of the influenza pandemic in the US and evaluate several vaccine-based interventions. At a gross attack rate (i.e. the number of people contracting the virus out of the total population) of 15-35%, the number of influenza deaths is 89 – 207 thousand, and an estimated mean total economic impact for the US economy is $73.1- $166.5 billion.

Bloom et al. (2005) use the Oxford economic forecasting model to estimate the potential economic impact of a pandemic resulting from the mutation of avian influenza strain. They assume a mild pandemic with a 20% attack rate and a 0.5 percent case-fatality rate, and a consumption shock of 3%. Scenarios include two-quarters of demand contraction only in Asia (combined effect 2.6% Asian GDP or US$113.2 billion); a longer-term shock with a longer outbreak and larger shock to consumption and export yields a loss of 6.5% of GDP (US$282.7 billion). Global GDP is reduced by 0.6%, global trade of goods and services contracts by $2.5 trillion (14%). Open economies are more vulnerable to international shocks.

Another study by the US Congressional Budget Office (2005) examined two scenarios of pandemic influenza for the United States. A mild scenario with an attack rate of 20% and a case fatality rate (.i.e. the number who die relative to the number infected) of 0.1% and a more severe scenario with an attack rate of 30% and a case fatality rate of 2.5%. The CBO (2005) study finds a GDP contraction for the United States of 1.5% for the mild scenario and 5% of GDP for the severe scenario.

McKibbin and Sidorenko (2006) used an earlier vintage of the model used in the current paper to explore four different pandemic influenza scenarios. They considered a “mild” scenario in which the pandemic is similar to the 1968-69 Hong Kong Flu; a “moderate” scenario which is similar to the Asian flu of 1957; a “severe” scenario based on the Spanish flu of 1918-1919 ((lower estimate of the case fatality rate), and an “ultra” scenario similar to Spanish flu 1918-19 but with upper-middle estimates of the case fatality rate. They found costs to the global economy of between $US300 million and $US4.4trillion dollars for the scenarios considered.

The current paper modifies and extends that earlier papers by Lee and McKibbin (2003) and McKibbin and Sidorenko (2006) to a larger group of countries, using updated data that captures the greater interdependence in the world economy and in particular, the rise of China’s importance in the world economy today.

3. The Hybrid DSGE/CGE Global Model

For this paper, we apply 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 Wilcoxen (1999, 2013)

(9) The G-Cubed Model

The version of the G-Cubed (G20) model used in this paper can be found in McKibbin and Triggs (2018) who extended the original model documented in McKibbin and Wilcoxen (1999, 2013). The model has 6 sectors and 24 countries and regions. Table 1 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), which enables us to differentiate sectors by country of production within a DSGE framework. Each sector in each country has a KLEM technology in production which captures the primary factor inputs of capital (K) and labor (L) as well as the intermediate or production chains of inputs in energy (E) and materials inputs (M). These linkages are both within a country and across countries.

Table 1 – Overview of the G-Cubed (G20) model

Countries (20)	**Regions (4)**
Argentina	Rest of the OECD
Australia	Rest of Asia
Brazil	Other oil-producing countries
Canada	Rest of the world
China	
Rest of Eurozone	**Sectors (6)**
France	Energy
Germany	Mining
Indonesia	Agriculture (including fishing and hunting)
India	Durable manufacturing
Italy	Non-durable manufacturing
Japan	Services
Korea	
Mexico	**Economic Agents in each Country (3)**
Russia	A representative household
Saudi Arabia	A representative firm (in each of the 6 production sectors)
South Africa	Government
Turkey	
United Kingdom	
United States	

The approach embodied in the G-Cubed model is documented in McKibbin and Wilcoxen (1998, 2013). Several key features of the standard G-Cubed model are worth highlighting here.

First, the model completely 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 the long-run equilibrium of each economy 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. 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 as well as allowing short term adjustment of policy to smooth fluctuations in the real economy.

Third, nominal wages are sticky and adjust over time based on country-specific labor contracting assumptions. Firms hire labor in each sector up to the points that the marginal product of labor equals the real wage defined in terms of the output price level of that sector. Any excess labor enters the unemployed pool of workers. Unemployment or the presence of excess demand for labor causes the nominal wage to adjust to clear the labor market in the long run. In the short-run, unemployment can arise due to structural supply shocks or changes in aggregate demand 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, lack of complete foresight in the formation of expectations, cost of adjustment in investment by firms with physical capital being sector-specific in the short run, 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 important for assessing the impact over the initial decades of demographic change.

Fifth, we incorporate heterogeneous households and firms. Firms are modeled separately within each sector. There is a mixture of two types of consumers and two types of firms within each sector, within each country: one group which bases its decisions on forward-looking expectations and the other group which follows simpler rules of thumb which are optimal in the long run.

4. Modeling epidemiological scenarios in an economic model

We follow the approach in Lee and McKibbin (2003) and McKibbin and Sidorenko (2006) to convert different assumptions about mortality rates and morbidity rates in the country where the disease outbreak occurs (the epicenter country). Given the epidemiological assumptions based on previous experience of pandemics, we create a set of filters that convert the shocks into economic shocks to reduced labor supply in each country (mortality and morbidity); rising cost of doing business in each sector including disruption of production networks in each country; consumption reduction due to shifts in consumer preferences over each good from each country (in addition to changes generated by the model based on change in income and prices); rise in equity risk premia on companies in each sector in each country (based on exposure to the disease); and increases in country risk premium based on exposure to the disease as well as vulnerabilities to changing macroeconomic conditions.

In the remainder of this section, we outline how the various indicators are constructed. The approach follows McKibbin and Sidorenko (2006) with some improvements. There are, of course, many assumptions in this exercise and the results are sensitive to these assumptions. The goal of the paper is to provide policymakers with some idea of the costs of not intervening and allowing the various scenarios to unfold.

Epidemiological assumptions

The attack rates (proportion of the entire population who become infected) and case-fatality rates (proportion of those infected who die) and the implied mortality rate (proportion of total population who die) assumed for China under seven different scenarios are contained in Table 2 below. Each scenario is given a name. S01 is scenario 1.

Table 2 – Epidemiological Assumptions for China

Scenario	Attack Rate for China	Case-fatality Rate for China	Mortality Rate for China
S01	1%	2.0%	0.02%
S02	10%	2.5%	0.25%
S03	30%	3.0%	0.90%
S04	10%	2.0%	0.20%
S05	20%	2.5%	0.50%
S06	30%	3.0%	0.90%
S07	10%	2.0%	0.20%

We explore seven scenarios based on the survey of historical pandemics in McKibbin and Sidorenko (2006) and the most recent data on the COVID-19 virus. Table 3 summarizes the scenarios for the disease outbreak. The scenarios vary by attack rate, mortality rate and the countries experiencing the epidemiological shocks.. Scenarios 1-3 assume the epidemiological events are isolated to China. The economic impact on China and the spillovers to other countries are through trade, capital flows and the impacts of changes in risk premia in global financial markets – as determined by the model. Scenarios 4-6 are the pandemic scenarios where the epidemiological shocks occur in all countries to differing degrees. Scenarios 1-6 assume the shocks are temporary. Scenario 7 is a case where a mild pandemic is expected to be recurring each year for the indefinite future.

Table 3 – Scenario Assumptions

a) Shocks to labor supply

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

The shock to labor supply in each country includes three components: mortality due to infection, morbidity due to infection and morbidity arising from caregiving for affected family members. For the mortality component, a mortality rate is initially calculated using different attack rates and case-fatality rates for China. These attack rates and case-fatality rates are based on observations during SARS and following McKibbin and Sidorenko (2006) on pandemic influenza, as well as currently publicly available epidemiological data for COVID-19.

We take the Chinese epidemiological assumptions and scale these for different countries. The scaling is done by calculating an Index of Vulnerability. This index is then applied to the Chinese mortality rates to generate country specific mortality rates. Countries that are more vulnerable than China will have higher rate of mortality and morbidity and countries who are less vulnerable with lower epidemiological outcomes, The Index of Vulnerability is constructed by aggregating an Index of Geography and an Index of Health Policy, following McKibbin and Sidorenko (2006). The Index of Geography is the average of two indexes. The first is the urban population density of countries divided by the share of urban in total population. This is expressed relative to China. The second sub index is an index of openness to tourism relative to China. The Index of Health Policy also consists of two components: the Global Health Security Index and Health Expenditure per Capita relative to China. The Global Health Security Index assigns scores to countries according to six criteria, which includes the ability to prevent, detect and respond to epidemics (see GHSIndex 2020). The Index of Geography and Index of Health Policy for different countries are presented in Figures 1 and 2, respectively. The **lower** the value of the Index of Health Policy, the **better** would be a given country's health standards. However, a **lower** value for the Index of Geography represents a **lower** risk to a given country.

When calculating the second component of the labor shock we need to adjust for the problem that the model is an annual model. Days lost therefore must be annualized. The current recommended incubation period for COVID-19 is 14 days[5], so we assume an average employee in a country would have to be absent from work for 14 days, if infected. Absence from work indicates a loss of productive capacity for 14 days out of working days for a year. Hence, we calculate an effective attack rate for China using the attack rate assumed for a given scenario, and the proportion of days absent from work and scale them across other countries using the Index of Vulnerability.

The third component of the labor shock accounts for absenteeism from work due to caregiving family members who are infected. We assume the same effective attack rate as before and that around 70 percent of the female workers would be care givers to family members. We adjust the effective attack rate using the Index of Vulnerability and the proportion of labor force who have to care for school-aged children (70 percent of female labor force participation). This does account for school closures.

[5] There is evidence that this figure could be close to 21 days. This would increase the scale of the shock.

Table 4 contains the labor shocks for countries for different scenarios.

Table 4 – Shocks to labor supply

Region	S01	S02	S03	S04	S05	S06	S07
Argentina	0	0	0	- 0.65	- 1.37	- 2.14	- 0.65
Australia	0	0	0	- 0.48	- 1.01	- 1.58	- 0.48
Brazil	0	0	0	- 0.66	- 1.37	- 2.15	- 0.66
Canada	0	0	0	- 0.43	- 0.89	- 1.40	- 0.43
China	- 0.10	- 1.10	- 3.44	- 1.05	- 2.19	- 3.44	- 1.05
France	0	0	0	- 0.52	- 1.08	- 1.69	- 0.52
Germany	0	0	0	- 0.51	- 1.06	- 1.66	- 0.51
India	0	0	0	- 1.34	- 2.82	- 4.44	- 1.34
Indonesia	0	0	0	- 1.39	- 2.91	- 4.56	- 1.39
Italy	0	0	0	- 0.48	- 1.02	- 1.60	- 0.48
Japan	0	0	0	- 0.50	- 1.04	- 1.64	- 0.50
Mexico	0	0	0	- 0.78	- 1.64	- 2.57	- 0.78
Republic of Korea	0	0	0	- 0.56	- 1.17	- 1.85	- 0.56
Russia	0	0	0	- 0.71	- 1.48	- 2.31	- 0.71
Saudi Arabia	0	0	0	- 0.41	- 0.87	- 1.37	- 0.41
South Africa	0	0	0	- 0.80	- 1.67	- 2.61	- 0.80
Turkey	0	0	0	- 0.76	- 1.59	- 2.50	- 0.76
United Kingdom	0	0	0	- 0.53	- 1.12	- 1.75	- 0.53
United States of America	0	0	0	- 0.40	- 0.83	- 1.30	- 0.40
Other Asia	0	0	0	- 0.88	- 1.84	- 2.89	- 0.88
Other oil producing countries	0	0	0	- 0.97	- 2.01	- 3.13	- 0.97
Rest of Euro Zone	0	0	0	- 0.46	- 0.97	- 1.52	- 0.46
Rest of OECD	0	0	0	- 0.43	- 0.89	- 1.39	- 0.43
Rest of the World	0	0	0	- 1.29	- 2.67	- 4.16	- 1.29

b) Shocks to the equity risk premium of economic sectors

We assume that the announcement of the virus will cause risk premia through the world to change. We create risk premia in the United States to approximate the observed initial response to scenario 1. We then adjust the equity risk shock to all countries across a given scenario by applying the indexes outlined next. We also scale the shock across scenarios by applying the different mortality rate assumptions across countries.

The Equity Risk Premium shock is the aggregation of the mortality component of the labor shock and a Country Risk Index. The Country Risk Index is the average of three indices: Index of Governance Risk, Index of Financial Risk and Index of Health Policy. In developing these indices, we use the US as a benchmark due to the prevalence of well-developed financial markets there (Fisman and Love 2004).

The Index of Governance Risk is based on the International Country Risk Guide, which assigns countries scores based on performance in 22 variables across three categories: political, economic, and financial (see PRSGroup 2020). The political variables include government stability, as well as the prevalence of conflicts, corruption and the rule of law. GDP per capita, real GDP growth and inflation are some of the economic variables considered in the Index. Financial variables contained in the Index account for exchange rate stability and international liquidity among others. Figure 3 summarizes the scores for countries for the governance risk relative to the United States.

One of the most easily available indicators of the expected global economic impacts of COVID-19 has been movements in financial market indices. Since the commencement of the outbreak, financial markets continue to respond to daily developments regarding the outbreak across the world. Particularly, stock markets have been demonstrating investor awareness of industry-specific (unsystematic) impacts. Hence, when developing the Equity Risk Premium Shocks for sectors, we include an Index of Financial Risk, even though it is already partially accounted for within the Index of Governance Risk. This higher weight on financial risk enables us to reproduce the prevailing turbulence in financial markets. The Index of Financial Risk uses the current account balance of the countries as a proportion of GDP in 2015. Figure 4 contains the scores for the countries relative to the United States

Even though construction of the Index of Health Policy follows the procedure described for developing the mortality component of the labor shock, the US has been used as the base-country instead of China, when developing the shock on equity risk premium since the US is the center of the global financial system and in the model, all risks are defined relative to the US. Figure 5 contains the scores for the countries for the Index of Health Policy relative to the United States.

The Net Risk Index for countries is presented in Figure 6 and Shock on Equity Risk Premia for Scenario 4-7 are presented in Table 5.

Table 5 – Shock to equity risk premium for scenario 4-7

Region	S04	S05	S06	S07
Argentina	1.90	2.07	2.30	1.90
Australia	1.23	1.37	1.54	1.23
Brazil	1.59	1.78	2.03	1.59
Canada	1.23	1.36	1.52	1.23
China	1.97	2.27	2.67	1.97
France	1.27	1.40	1.59	1.27
Germany	1.07	1.21	1.41	1.07
India	2.20	2.62	3.18	2.20
Indonesia	2.06	2.43	2.93	2.06
Italy	1.32	1.47	1.66	1.32
Japan	1.18	1.33	1.53	1.18
Mexico	1.76	1.98	2.27	1.76
Republic of Korea	1.25	1.43	1.67	1.25
Russia	1.77	1.96	2.22	1.77
Saudi Arabia	1.38	1.52	1.70	1.38
South Africa	1.85	2.06	2.33	1.85
Turkey	1.98	2.20	2.50	1.98
United Kingdom	1.35	1.50	1.70	1.35
United States of America	1.07	1.18	1.33	1.07
Other Asia	1.51	1.75	2.07	1.51
Other oil-producing countries	2.03	2.25	2.55	2.03
Rest of Euro Zone	1.29	1.42	1.60	1.29
Rest of OECD	1.11	1.22	1.38	1.11
Rest of the World	2.21	2.51	2.91	2.21

c) Shocks to the cost of production in each sector

As well as the shock to labor inputs, we identify that other inputs such as Trade, Land Transport, Air Transport and Sea Transport have been significantly affected by the outbreak. Thus, we calculate the share of inputs from these exposed sectors to the six aggregated sectors of the model and compare the contribution relative to China. We then benchmark the percentage increase in the cost of production in Chinese production sectors during SARS to the first scenario and scale the percentage across scenarios to match the changes in the mortality component of the labor shock. Variable shares of inputs from exposed sectors to aggregated economic sectors also allow us to vary the shock across sectors in the countries. Table 6 contains the shocks to the cost of production in each sector in each country due to the share of inputs from exposed sectors.

a) Shocks to consumption demand

The G-Cubed model endogenously changes spending patterns in response to changes in income, wealth, and relative price changes. However, independent of these variables, during an outbreak, it is likely that preferences for certain activities will change with the outbreak. Following McKibbin and Sidorenko (2006), we assume that the reduction in spending on those activities will reduce the overall spending, hence saving money for future expenditure. In modeling this behavior, we employ a Sector Exposure Index. The Index is calculated as the share of exposed sectors: Trade, Land, Air & Sea Transport and Recreation, within the GDP of a country relative to China. The reduction in consumption expenditure during the SARS outbreak in China is used as the benchmark for the first scenario. The advantage is that this response was observed. The disadvantage is that other countries could behave differently. Given we don’t have observations of other epicenters start with this assumption and then adjust it as follows. This benchmark is then scaled across other scenarios relative to the mortality component of the labor shock and adjusted across countries through the different sectoral exposure. Figure 7 contains the Sector Exposure Indices for the countries and the shock to consumption demand is presented in Table 7. Note that CBO (2005) uses a shock of 3% to US consumption from an H5N1 influenza pandemic which is between S05 and S06 in Table 7.

Table 6 – Shocks to cost of production

Region	Energy	Mining	Agriculture	Durable Manufacturing	Non-durable Manufacturing	Services
Argentina	0.37	0.24	0.37	0.35	0.40	0.38
Australia	0.43	0.43	0.42	0.39	0.41	0.45
Brazil	0.44	0.46	0.44	0.42	0.45	0.44
Canada	0.44	0.37	0.42	0.40	0.41	0.44
China	0.50	0.50	0.50	0.50	0.50	0.50
France	0.38	0.31	0.36	0.40	0.42	0.46
Germany	0.43	0.37	0.40	0.45	0.45	0.47
India	0.47	0.33	0.47	0.42	0.45	0.43
Indonesia	0.37	0.33	0.31	0.36	0.40	0.38
Italy	0.36	0.33	0.38	0.42	0.44	0.46
Japan	0.45	0.40	0.45	0.47	0.47	0.49
Mexico	0.41	0.38	0.39	0.42	0.42	0.41
Other Asia	0.44	0.39	0.44	0.45	0.45	0.47
Other oil producing countries	0.49	0.41	0.47	0.40	0.43	0.45
Republic of Korea	0.39	0.30	0.37	0.43	0.42	0.43
Rest of Euro Zone	0.42	0.41	0.43	0.43	0.46	0.48
Rest of OECD	0.42	0.38	0.41	0.41	0.43	0.46
Rest of the World	0.52	0.46	0.51	0.45	0.49	0.48
Russia	0.54	0.37	0.43	0.41	0.42	0.45
Saudi Arabia	0.32	0.25	0.29	0.29	0.25	0.35
South Africa	0.40	0.35	0.39	0.41	0.43	0.38
Turkey	0.37	0.36	0.39	0.39	0.42	0.42
United Kingdom	0.39	0.37	0.39	0.39	0.42	0.46
United States of America	0.53	0.40	0.51	0.50	0.51	0.53

Table 7 – Shocks to consumption demand

Region	S04	S05	S06	S07
Argentina	-0.83	-2.09	-3.76	-0.83
Australia	-0.90	-2.26	-4.07	-0.90
Brazil	-0.92	-2.31	-4.16	-0.92
Canada	-0.90	-2.26	-4.07	-0.90
China	-1.00	-2.50	-4.50	-1.00
France	-0.93	-2.31	-4.16	-0.93
Germany	-0.95	-2.36	-4.25	-0.95
India	-0.91	-2.29	-4.11	-0.91
Indonesia	-0.86	-2.15	-3.86	-0.86
Italy	-0.93	-2.32	-4.18	-0.93
Japan	-1.01	-2.51	-4.52	-1.01
Mexico	-0.89	-2.22	-4.00	-0.89
Other Asia	-0.95	-2.38	-4.28	-0.95
Other oil producing countries	-0.92	-2.31	-4.16	-0.92
Republic of Korea	-0.89	-2.23	-4.01	-0.89
Rest of Euro Zone	-0.98	-2.45	-4.40	-0.98
Rest of OECD	-0.92	-2.31	-4.16	-0.92
Rest of the World	-0.98	-2.45	-4.42	-0.98
Russia	-0.92	-2.31	-4.16	-0.92
Saudi Arabia	-0.74	-1.86	-3.35	-0.74
South Africa	-0.82	-2.05	-3.69	-0.82
Turkey	-0.88	-2.19	-3.95	-0.88
United Kingdom	-0.94	-2.34	-4.22	-0.94
United States of America	-1.06	-2.66	-4.78	-1.06

b) Shocks to government expenditure

With the previous experience of pandemics, governments across the world have exercised a stronger caution towards the outbreak by taking measures, such as strengthening health screening at ports and investments in strengthening healthcare infrastructure, to prevent the outbreak reaching additional countries. They have also responded by increasing health expenditures to contain the spread. In modeling these interventions by governments, we use the change in Chinese government expenditure relative to GDP in 2003 during the SARS outbreak as a benchmark and use the average of Index of Governance and Index of Health Policy to obtain the potential increase in government expenditure by other countries. We then scale the shock across scenarios using the mortality component of the labor shock. Table 8 demonstrates the magnitude of the government expenditure shocks for countries for Scenario 4 to 7.

Table 8 – Shocks to government expenditure

Region	S04	S05	S06	S07
Argentina	0.39	0.98	1.76	0.39
Australia	0.27	0.67	1.21	0.27
Brazil	0.39	0.98	1.76	0.39
Canada	0.26	0.66	1.19	0.26
China	0.50	1.25	2.25	0.50
France	0.30	0.74	1.34	0.30
Germany	0.27	0.68	1.22	0.27
India	0.52	1.30	2.34	0.52
Indonesia	0.47	1.18	2.12	0.47
Italy	0.34	0.84	1.51	0.34
Japan	0.30	0.74	1.33	0.30
Mexico	0.43	1.07	1.93	0.43
Republic of Korea	0.31	0.79	1.41	0.31
Russia	0.49	1.23	2.21	0.49
Saudi Arabia	0.38	0.95	1.71	0.38
South Africa	0.43	1.08	1.94	0.43
Turkey	0.47	1.17	2.11	0.47
United Kingdom	0.27	0.68	1.22	0.27
United States of America	0.22	0.54	0.98	0.22
Other Asia	0.39	0.99	1.77	0.39
Other oil producing countries	0.54	1.35	2.42	0.54
Rest of Euro Zone	0.33	0.81	1.46	0.33
Rest of OECD	0.28	0.70	1.26	0.28
Rest of the World	0.59	1.49	2.67	0.59

5. Simulation Results

(a) Baseline scenario

We first solve the model from 2016 to 2100 with 2015 as the base year. The key inputs into the baseline are the initial dynamics from 2015 to 2016 and subsequent projections from 2016 forward for labor-augmenting technological progress by sector and by country. The labor-augmenting technology projections follow the approach of Barro (1991, 2015). Over long periods, Barro estimates that the average catchup rate of individual countries to the world-wide productivity frontier is 2% per year. We use the Groningen Growth and Development database (2018) to estimate the initial level of productivity in each sector of each region in the model. Given this initial productivity, we then take the ratio of this to the equivalent sector in the US, which we assume is the frontier. Given this initial gap in sectoral productivity, we use the Barro catchup model to generate long term projections of the productivity growth rate of each sector within each country. Where we expect that regions will catch up more quickly to the frontier due to economic reforms (e.g., China) or more slowly to the frontier due to institutional rigidities (e.g., Russia), we vary the catchup rate over time. The calibration of the catchup rate attempts to replicate recent growth experiences of each country and region in the model.

The exogenous sectoral productivity growth rate, together with the economy-wide growth in labor supply, are the exogenous drivers of sector growth for each country. The growth in the capital stock in each sector in each region is determined endogenously within the model.

In the alternative COVID-19 scenarios, we incorporate the range of shocks discussed above to model the economic consequences of different epidemiological assumptions. All results below are the difference between the COVID-19 scenario and the baseline of the model.

(b) Results

Table 9 contains the impact on populations in different regions. These are the core shocks that are combined with the various indicators above to create the seven scenarios. The mortality rates for each country under each scenario are contained in Table B-1 in Appendix B. Note that the mortality rates in Table B-1 are much lower in advanced economies compared to China.

Table 9 – Impact on populations under each scenario

Country/Region	Population (Thousands)	Mortality in First Year (Thousands)						
		S01	S02	S03	S04	S05	S06	S07
Argentina	43,418	-	-	-	50	126	226	50
Australia	23,800	-	-	-	21	53	96	21
Brazil	205,962	-	-	-	257	641	1,154	257
Canada	35,950	-	-	-	30	74	133	30
China	1,397,029	279	3,493	12,573	2,794	6,985	12,573	2,794
France	64,457	-	-	-	60	149	268	60
Germany	81,708	-	-	-	79	198	357	79
India	1,309,054	-	-	-	3,693	9,232	16,617	3,693
Indonesia	258,162	-	-	-	647	1,616	2,909	647
Italy	59,504	-	-	-	59	147	265	59
Japan	127,975	-	-	-	127	317	570	127
Mexico	125,891	-	-	-	184	460	828	184
Republic of Korea	50,594	-	-	-	61	151	272	61
Russia	143,888	-	-	-	186	465	837	186
Saudi Arabia	31,557	-	-	-	29	71	128	29
South Africa	55,291	-	-	-	75	187	337	75
Turkey	78,271	-	-	-	116	290	522	116
United Kingdom	65,397	-	-	-	64	161	290	64
United States of America	319,929	-	-	-	236	589	1,060	236
Other Asia	330,935	-	-	-	530	1,324	2,384	530
Other oil producing countries	517,452	-	-	-	774	1,936	3,485	774
Rest of Euro Zone	117,427	-	-	-	106	265	478	106
Rest of OECD	33,954	-	-	-	27	67	121	27
Rest of the World	2,505,604	-	-	-	4,986	12,464	22,435	4,986
Total	**7,983,209**	**279**	**3,493**	**12,573**	**15,188**	**37,971**	**68,347**	**15,188**

Table 9 shows that for even the lowest of the pandemic scenarios (S04), there are estimated to be around 15 million deaths. In the United States, the estimate is 236,000 deaths. These estimated deaths from COVID-19 can be compared to a regular influenza season in the United States, where around 55,000 people die each year.

Table 10 - GDP loss in 2020 (% deviation from baseline)

Country/Region	S01	S02	S03	S04	S05	S06	S07
AUS	-0.3	-0.4	-0.7	-2.1	-4.6	-7.9	-2.0
BRA	-0.3	-0.3	-0.5	-2.1	-4.7	-8.0	-1.9
CHI	-0.4	-1.9	-6.0	-1.6	-3.6	-6.2	-2.2
IND	-0.2	-0.2	-0.4	-1.4	-3.1	-5.3	-1.3
EUZ	-0.2	-0.2	-0.4	-2.1	-4.8	-8.4	-1.9
FRA	-0.2	-0.3	-0.3	-2.0	-4.6	-8.0	-1.5
DEU	-0.2	-0.3	-0.5	-2.2	-5.0	-8.7	-1.7
ZAF	-0.2	-0.2	-0.4	-1.8	-4.0	-7.0	-1.5
ITA	-0.2	-0.3	-0.4	-2.1	-4.8	-8.3	-2.2
JPN	-0.3	-0.4	-0.5	-2.5	-5.7	-9.9	-2.0
GBR	-0.2	-0.2	-0.3	-1.5	-3.5	-6.0	-1.2
ROW	-0.2	-0.2	-0.3	-1.5	-3.5	-5.9	-1.5
MEX	-0.1	-0.1	-0.1	-0.9	-2.2	-3.8	-0.9
CAN	-0.2	-0.2	-0.4	-1.8	-4.1	-7.1	-1.6
OEC	-0.3	-0.3	-0.5	-2.0	-4.4	-7.7	-1.8
OPC	-0.2	-0.2	-0.4	-1.4	-3.2	-5.5	-1.3
ARG	-0.2	-0.3	-0.5	-1.6	-3.5	-6.0	-1.2
RUS	-0.2	-0.3	-0.5	-2.0	-4.6	-8.0	-1.9
SAU	-0.2	-0.2	-0.3	-0.7	-1.4	-2.4	-1.3
TUR	-0.1	-0.2	-0.2	-1.4	-3.2	-5.5	-1.2
USA	-0.1	-0.1	-0.2	-2.0	-4.8	-8.4	-1.5
OAS	-0.1	-0.2	-0.4	-1.6	-3.6	-6.3	-1.5
INO	-0.2	-0.2	-0.3	-1.3	-2.8	-4.7	-1.3
KOR	-0.1	-0.2	-0.3	-1.4	-3.3	-5.8	-1.3

Tables 10 and 11 provide a summary of the overall GDP loss for each country/region under the seven scenarios. The results in Table 10 are the Change in GDP in 2020 expressed as a percentage change from the baseline. The results in Table 11 are the results from Table 10 converted into billions of $2020US.

Table 11 - GDP Loss in 2020 ($US billions)

Country/Region	S01	S02	S03	S04	S05	S06	S07
AUS	(4)	(5)	(9)	(27)	(60)	(103)	(27)
BRA	(9)	(12)	(19)	(72)	(161)	(275)	(65)
CHI	(95)	(488)	(1,564)	(426)	(946)	(1,618)	(560)
IND	(21)	(26)	(40)	(152)	(334)	(567)	(142)
EUZ	(11)	(13)	(19)	(111)	(256)	(446)	(101)
FRA	(7)	(8)	(11)	(63)	(144)	(250)	(46)
DEU	(11)	(14)	(21)	(99)	(225)	(390)	(78)
ZAF	(1)	(2)	(3)	(14)	(33)	(57)	(12)
ITA	(6)	(7)	(9)	(54)	(123)	(214)	(56)
JPN	(17)	(20)	(28)	(140)	(318)	(549)	(113)
GBR	(5)	(6)	(9)	(48)	(108)	(187)	(39)
ROW	(24)	(29)	(43)	(234)	(529)	(906)	(227)
MEX	(2)	(2)	(3)	(24)	(57)	(98)	(24)
CAN	(3)	(4)	(6)	(32)	(74)	(128)	(28)
OEC	(5)	(6)	(10)	(40)	(91)	(157)	(36)
OPC	(10)	(12)	(18)	(73)	(164)	(282)	(69)
ARG	(2)	(3)	(5)	(15)	(33)	(56)	(11)
RUS	(10)	(12)	(19)	(84)	(191)	(331)	(81)
SAU	(3)	(3)	(5)	(12)	(24)	(40)	(22)
TUR	(3)	(4)	(6)	(33)	(75)	(130)	(30)
USA	(16)	(22)	(40)	(420)	(1,004)	(1,769)	(314)
OAS	(6)	(10)	(19)	(80)	(186)	(324)	(77)
INO	(6)	(7)	(11)	(45)	(99)	(167)	(46)
KOR	(3)	(4)	(7)	(31)	(71)	(124)	(29)
Total Change (USD Billion)	**(283)**	**(720)**	**(1,922)**	**(2,330)**	**(5,305)**	**(9,170)**	**(2,230)**

Tables 10 and 11 illustrate the scale of the various pandemic scenarios on reducing GDP in the global economy. Even a low-end pandemic modeled on the Hong Kong Flu is expected to reduce global GDP by around $SU2.4 trillion and a more serious outbreak similar to the Spanish flu reduces global GDP by over $US9trillion in 2020.

Figures 9-11 provide the time profile of the results for several countries. The patterns in the figures represents the nature of the assumed shocks which for the first 6 scenarios are expected to disappear over time, Figure 9 contains results for China under each scenario. We present results for Real GDP, private investment, consumption, the trade balance and then the short real interest rate and the value of the equity market for sector 5 which is durable manufacturing. Figure 10 contains the results for the United States and Figure 11 for Australia.

The shocks which make up the pandemic cause a sharp drop in consumption and investment. The decline in aggregate demand, together with the original risk shocks cause a sharp drop in equity markets. The funds from equity markets are partly shifted into bonds, partly into cash and partly overseas depending on which markets are most affected. Central banks respond by cutting interest rates which drive together with the increased demand for bonds from the portfolio shift drives down the real interest rate. Equity markets drop sharply both because of the rise in risk but also because of the expected economic slowdown and the fall in expected profits. For each scenario, there is a V shape recovery except for scenario 7. Recall that scenario 7 is the same as scenario 4 in year 1, but with the expectation that the pandemic will recur each year into the future.

Similar patterns can be seen in the dynamic results for the United States and Australia shown in Figures 10 an 11. The quantitative magnitudes differ across countries, but the pattern of a sharp shock followed by a gradual recovery is common across countries. The improvement in the trade balance of China and deterioration in the US trade balance reflect the global reallocation of financial capital as a result of the shock. Capital flows out of severely affected economies like China and other developing and emerging economies and into safer advanced economies like the United States, Europe and Australia. This movement of capital tends to appreciate the exchange rate of countries that are receiving capital and depreciate the exchange rates of countries that are losing capital. The deprecation of the exchange rate increases exports and reduced imports in the countries losing capital and hence lead to the current account adjustment that is consistent with the capital account adjustment.

These results are very sensitive to the assumptions in the model, to the shocks we feed in and to the assumed macroeconomic policy responses in each country. Central banks are assumed to respond according to a Henderson-Mckibbin-Taylor rule which differs across countries (see Mckibbin and Triggs (2018)). Fiscal authorities are allowing automatic stabilizers to increase budget deficits but cover addition debt servicing costs with a lump-sum tax levied on households over time. In addition, there is the fiscal spending increase assumed in the shock design outlined above.

6. Conclusions and Policy Implications

This paper has presented some preliminary estimates of the cost of the COVID-19 outbreak under seven different scenarios of how the disease might evolve. The goal is not to be definitive about the virus outbreak, but rather to provide information about a range of possible economic costs of the disease. At the time of writing this paper, the probability of any of these scenarios and the range of plausible alternatives are highly uncertain. In the case where COVID-19 develops into a global pandemic, our results suggest that the cost can escalate quickly.

A range of policy responses will be required both in the short term as well as in the coming years. In the short term, central banks and Treasuries need to make sure that disrupted economies continue to function while the disease outbreak continues. In the face of real and financial stress, there is a critical role for governments. While cutting interest rates is a possible response for central banks, the shock is not only a demand management problem but a multi-faceted crisis that will require monetary, fiscal and health policy responses. Quarantining affected people and reducing large scale social interaction is an effective response. Wide dissemination of good hygiene practices as outlined in Levine and McKibbin (2020) can be a low cost and highly effective response that can reduce the extent of contagion and therefore reduce the social and economic cost.

The longer-term responses are even more important. Despite the potential loss of life and the possible large-scale disruption to a large number of people, many governments have been reluctant to invest sufficiently in their health care systems, let alone public health systems in less developed countries where many infectious diseases are likely to originate. Experts have warned and continue to warn that zoonotic diseases will continue to pose a threat to the lives of millions of people with potentially major disruption to an integrated world economy. The idea that any country can be an island in an integrated global economy is proven wrong by the latest outbreak of COVID-19. Global cooperation, especially in the sphere of public health and economic development, is essential. All major countries need to participate actively. It is too late to act once the disease has taken hold in many other countries and attempt to close borders once a pandemic has started.

Poverty kills poor people, but the outbreak of COVID-19 shows that if diseases are generated in poor countries due to overcrowding, poor public health and interaction with wild animals, these diseases can kill people of any socioeconomic group in any society. There needs to be vastly more investment in public health and development in the richest but also, and especially, in the poorest countries. This study indicates the possible costs that can be avoided through global cooperative investment in public health in all countries. We have known this critical policy intervention for decades, yet politicians continue to ignore the scientific evidence on the role of public health in improving the quality of life and as a driver of economic growth.

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Figure 1 - Index of Geography

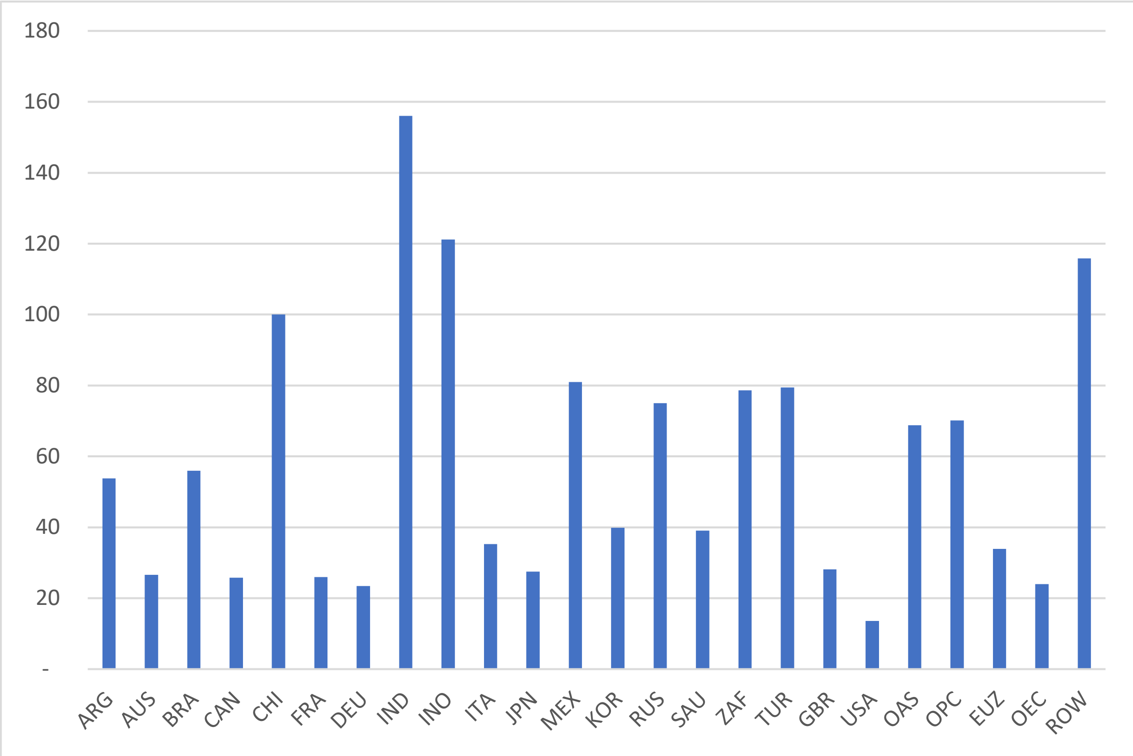


Figure 2 - Index of Health Policy

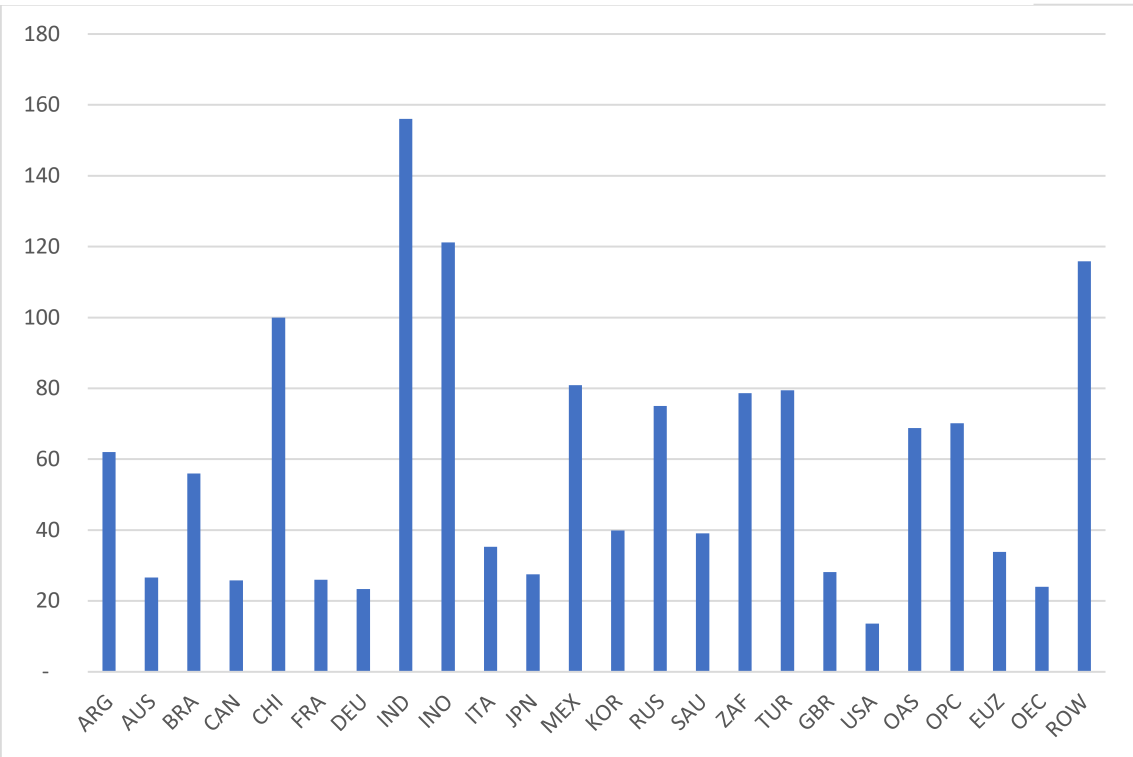


Figure 3 - Index of Governance

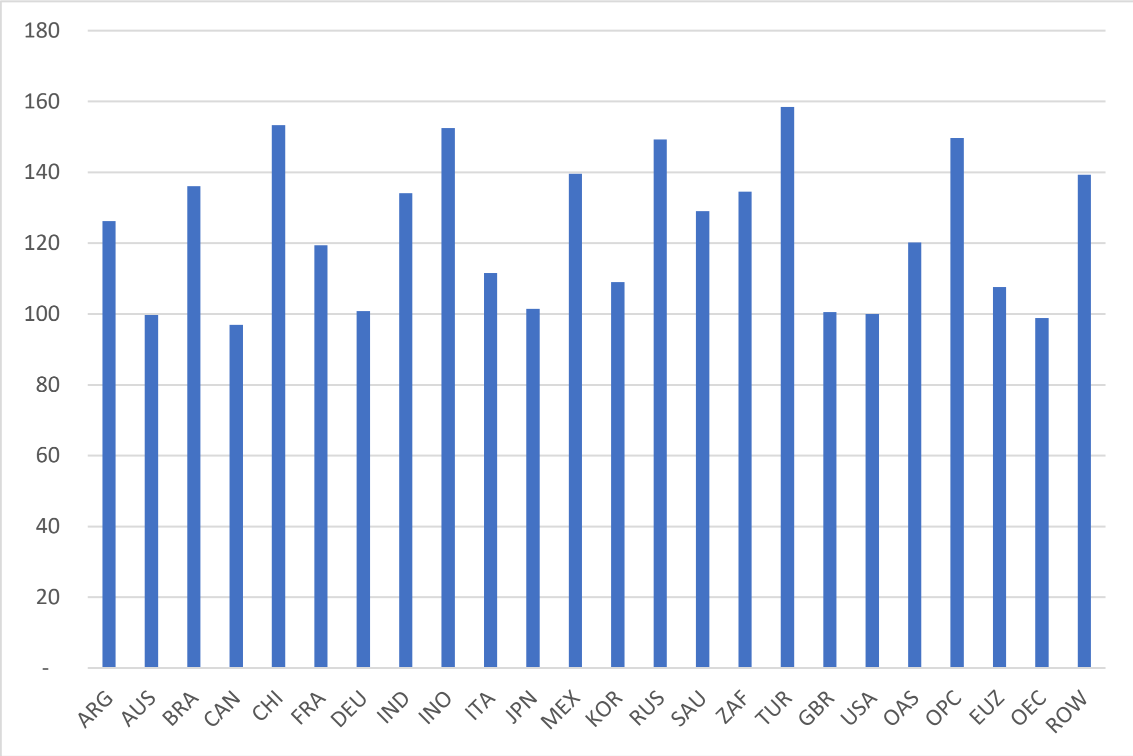


Figure 4 - Index of Financial Risk

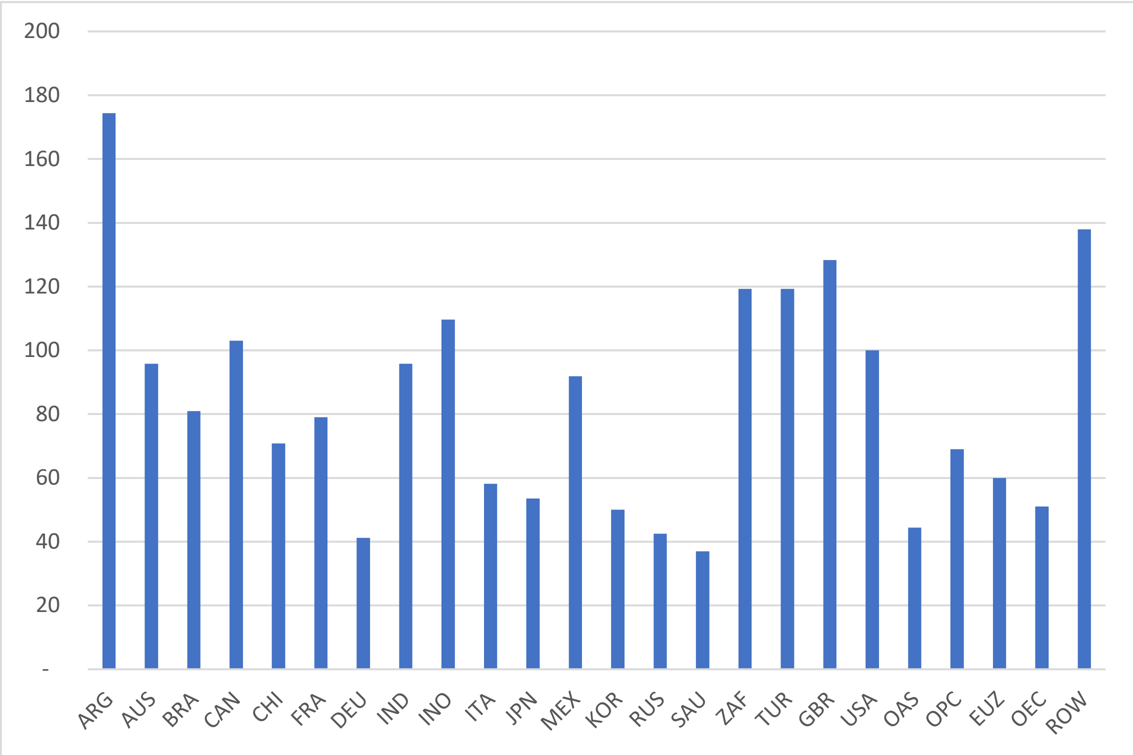


Figure 5 - Index of Health Policy

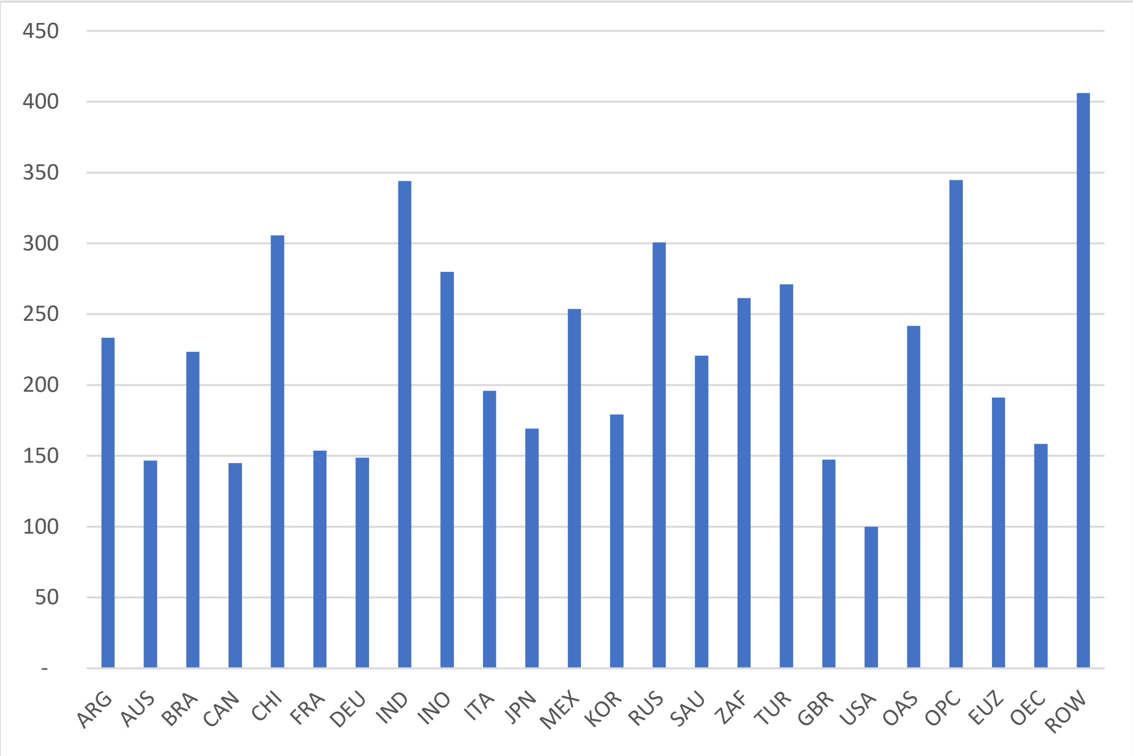


Figure 6 - Net Country Risk Index

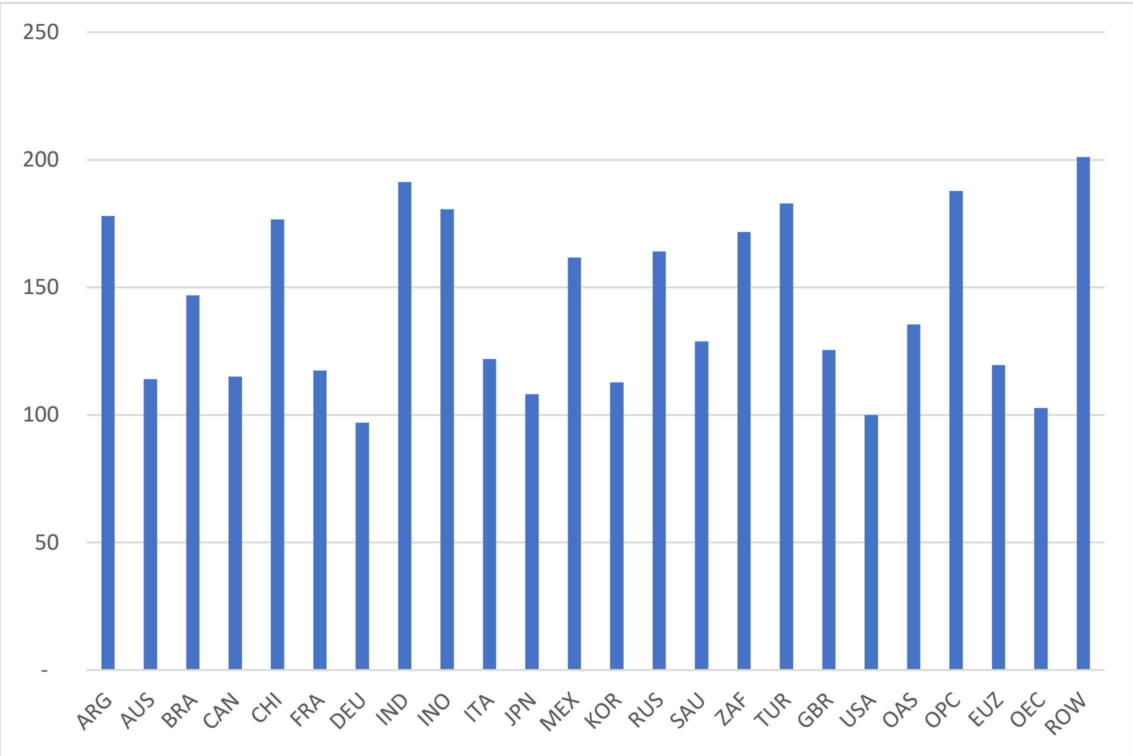


Figure 7 - Index of Sector Exposure to Exposed Activities

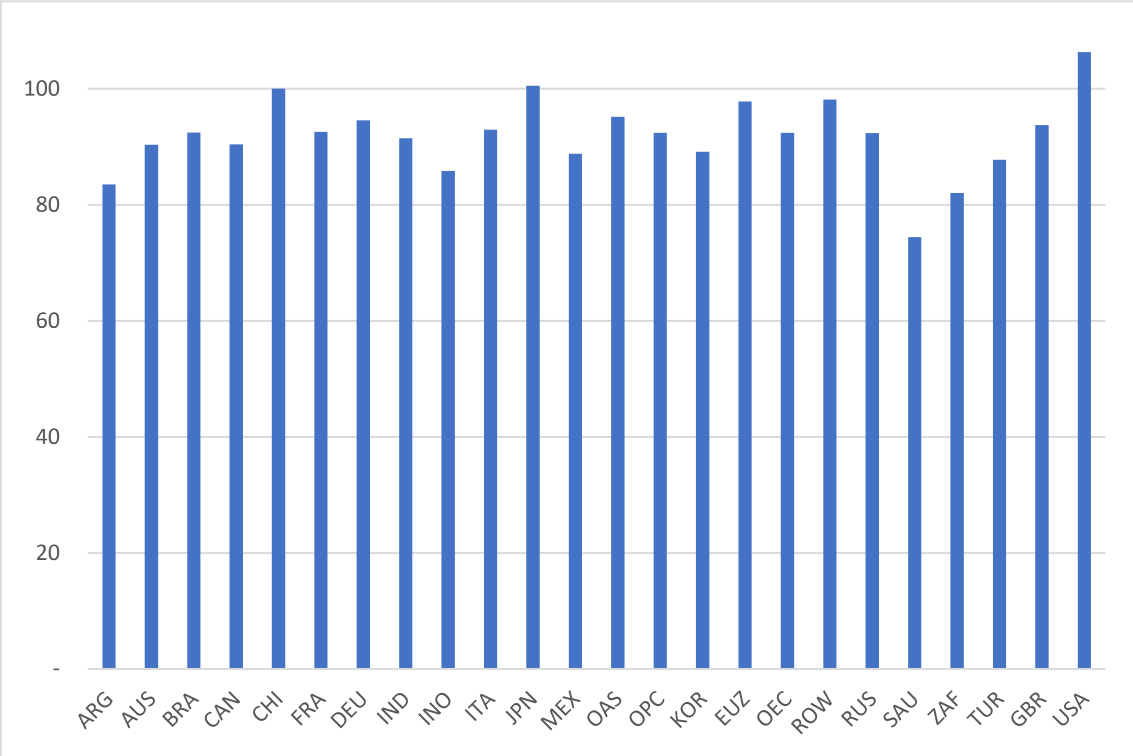


Figure 8: Dynamic Results for China

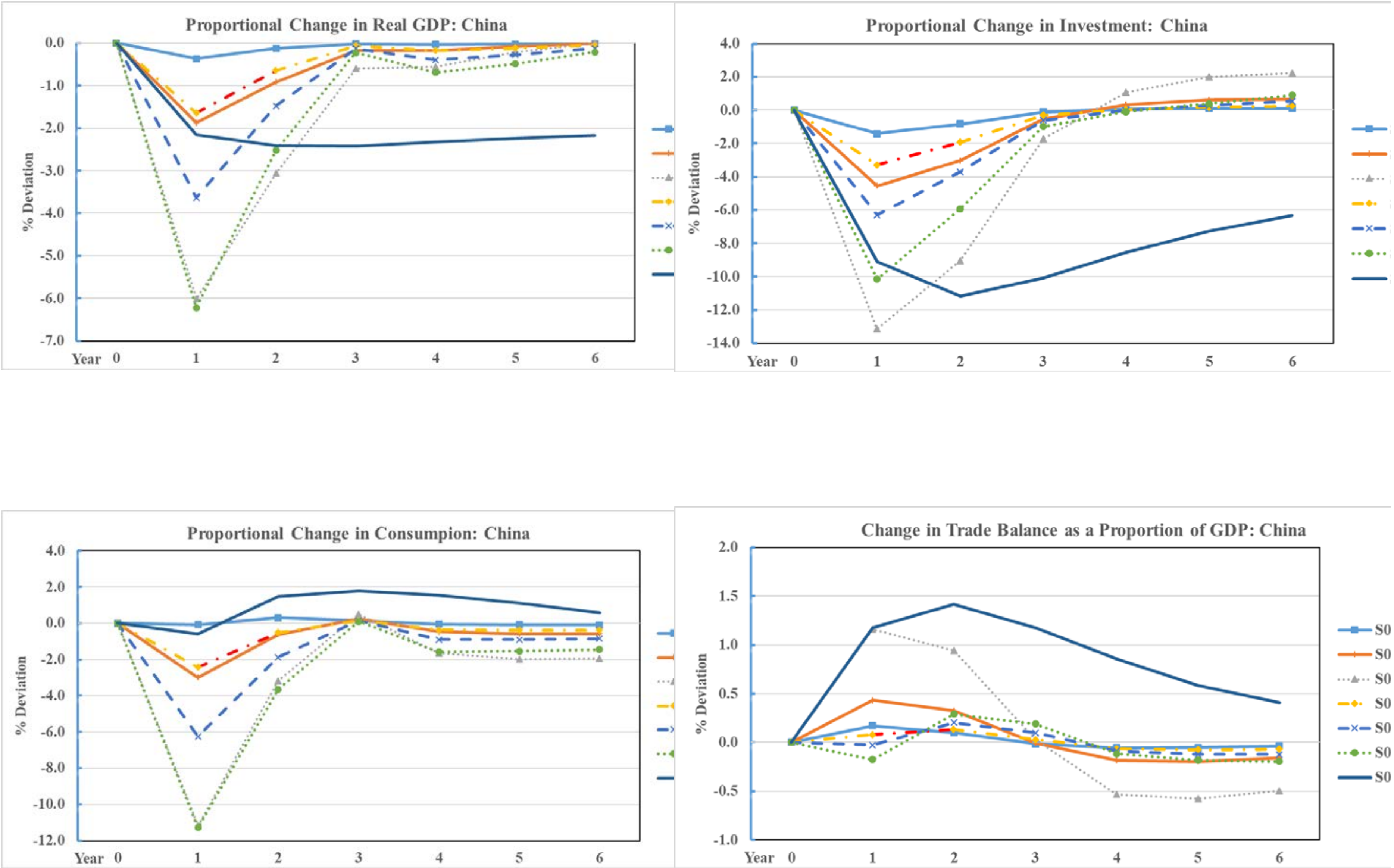


Figure 8 (continued): Dynamic Results for China

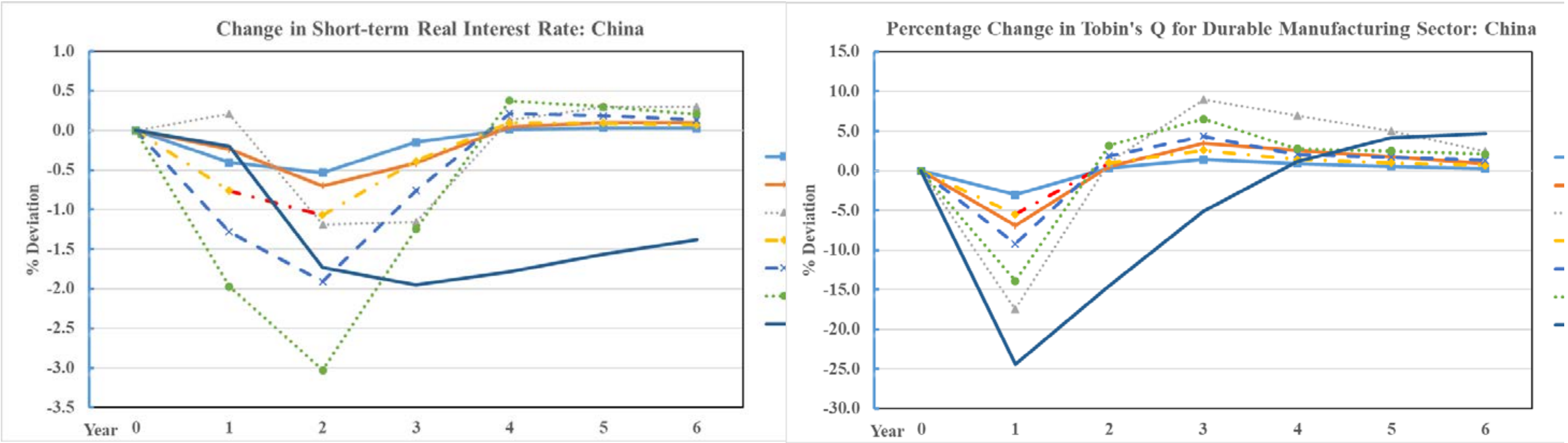


Figure 9: Dynamic Results for the United States

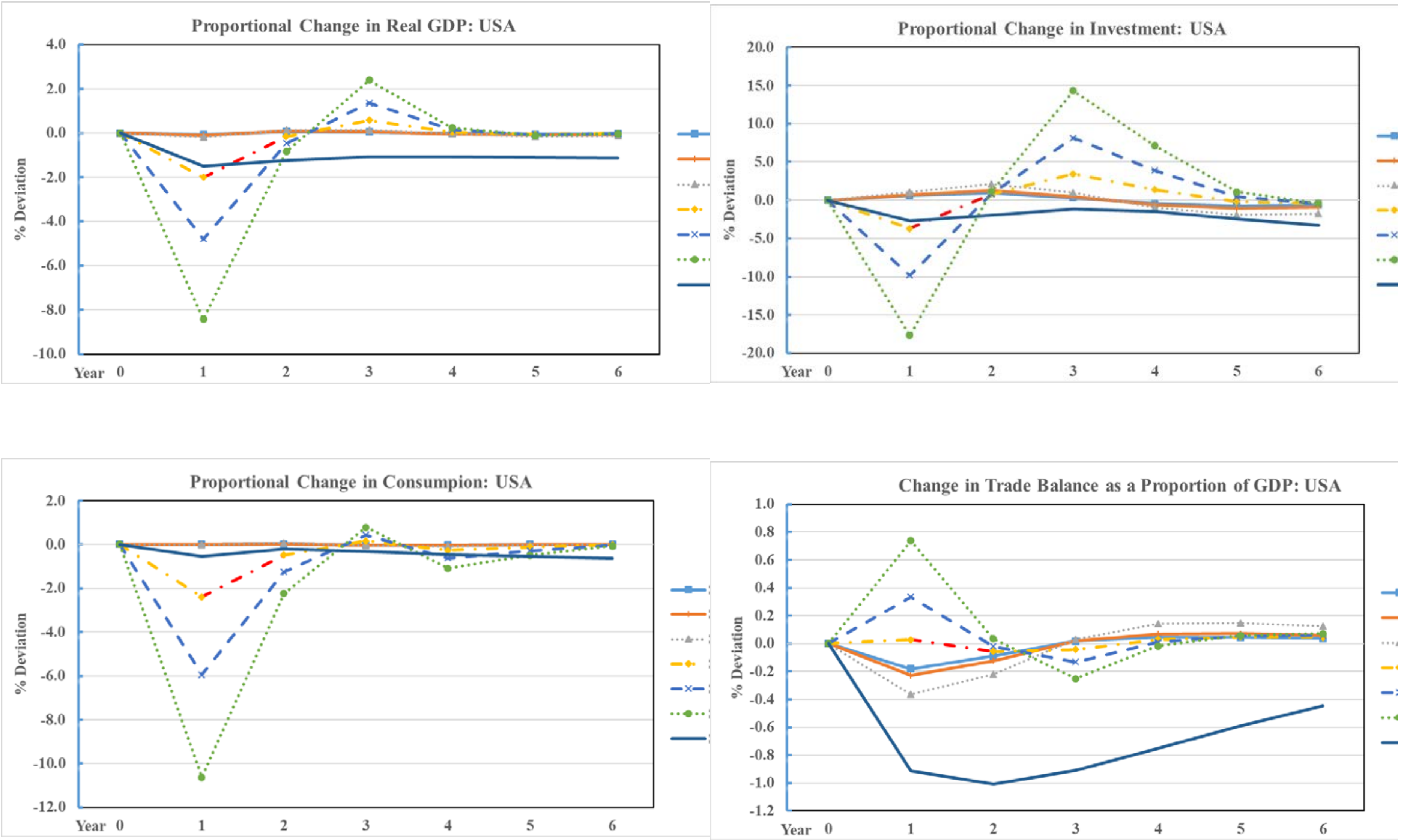
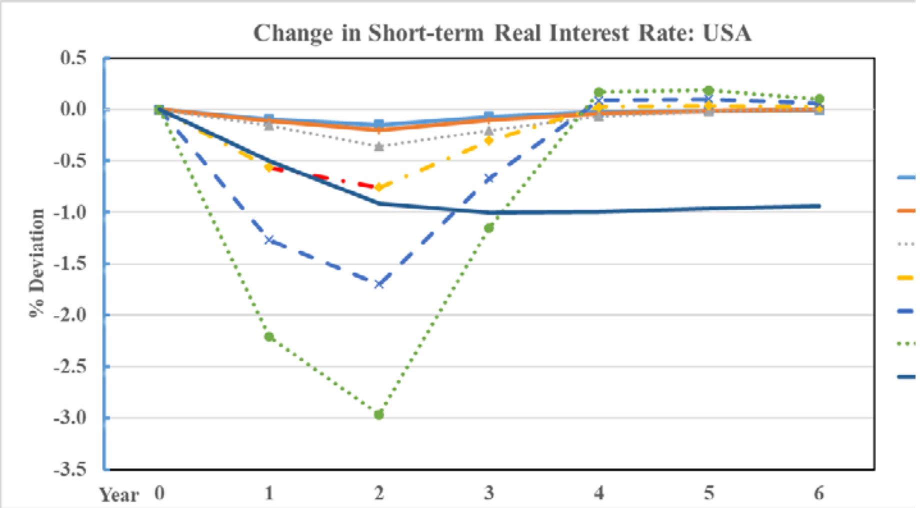


Figure 9 (continued): Dynamic Results for the United States



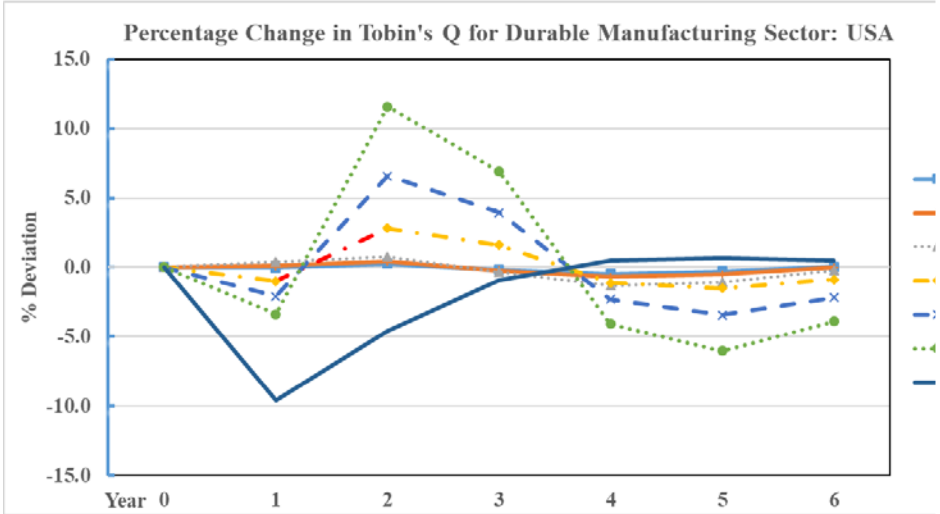


Figure 10: Dynamic Results for Australia

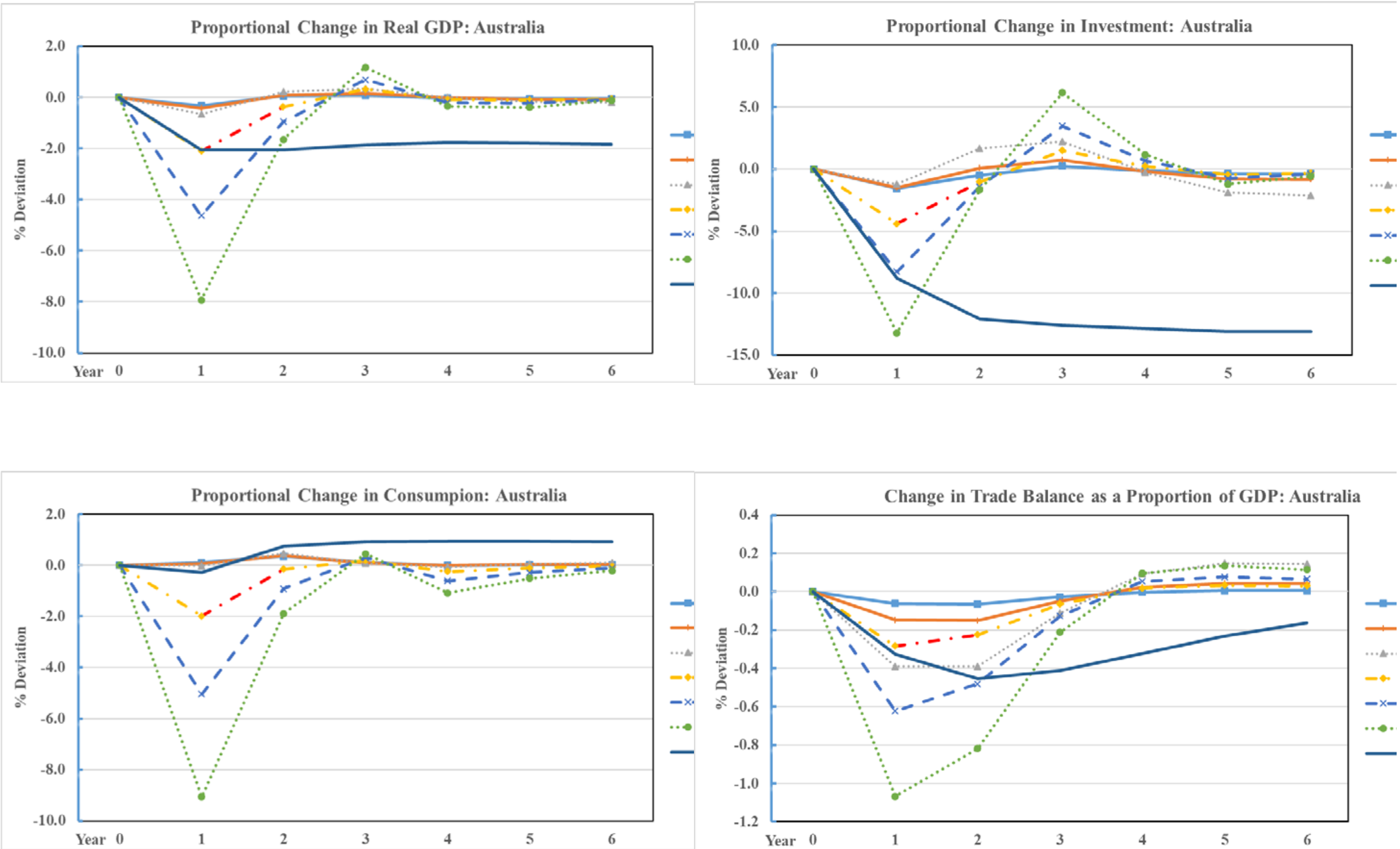
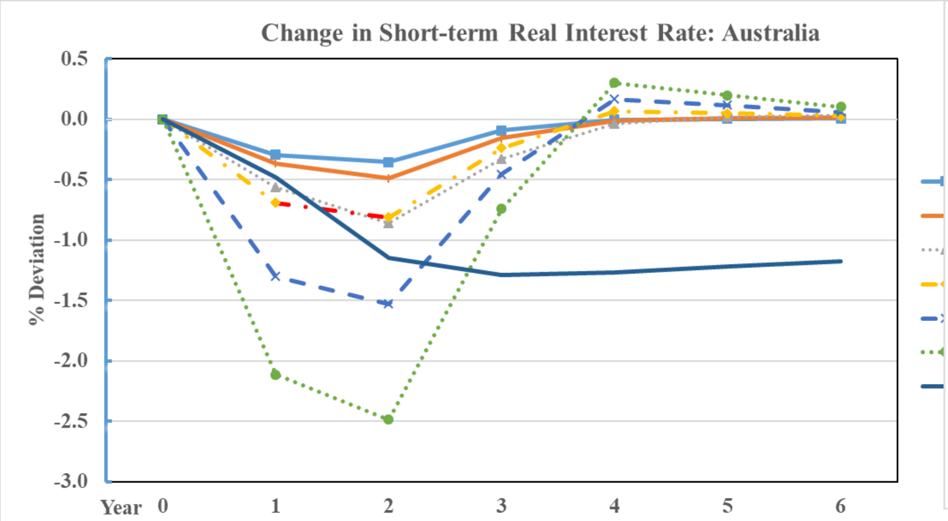
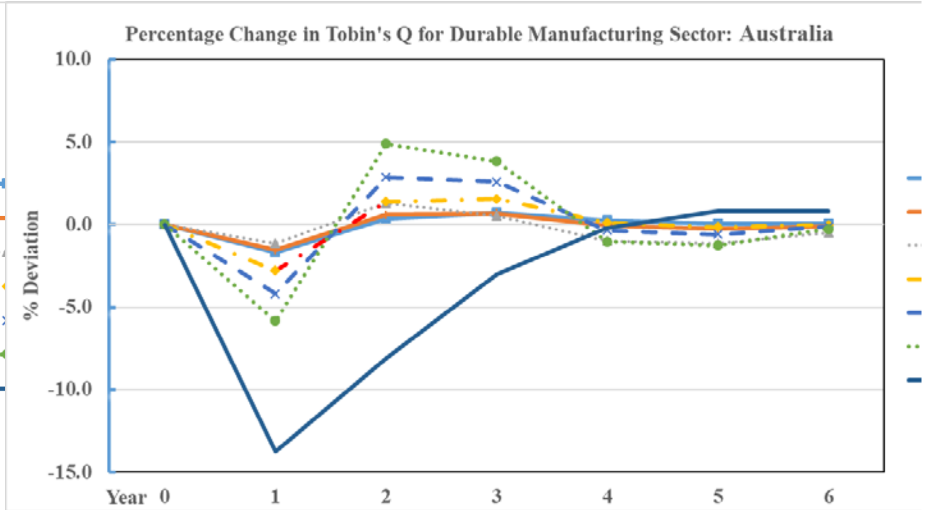


Figure 10 (continued): Dynamic Results for Australia





Appendix A. G-Cubed Regions

Version G20 (6)

United States
Japan
Germany
United Kingdom
France
Italy
Rest of Euro Zone
Canada
Australia
Rest of Advanced Economies
Korea
Turkey
China
India
Indonesia
Other Asia
Mexico
Argentina
Brazil
Russia
Saudi Arabia
South Africa
Oil-exporting and the Middle East
Rest of World

Rest of Euro Zone:
Spain, Netherlands, Belgium, Luxemburg, Ireland, Greece, Portugal, Finland, Cyprus, Malta, Slovakia, Slovenia, Estonia

Rest of Advanced Economies:
New Zealand, Norway, Sweden, Switzerland, Iceland, Denmark, Iceland, Liechtenstein

Oil-exporting and the Middle East:
Ecuador, Nigeria, Angola, Congo, Iran, Venezuela, Algeria, Libya, Bahrain, Iraq, Israel, Jordan, Kuwait, Lebanon, Palestinian Territory, Oman, Qatar, Syrian Arab Republic, United Arab Emirates, Yemen

Other Asia:
Singapore, Taiwan, Hong Kong, Indonesia, Malaysia, Philippines, Thailand, Vietnam

Rest of World:
All countries not included in other groups.

Appendix B: Additional results

Table B-112 - Mortality Rates for each Country under each Scenario

Country/Region	Mortality Rate						
	S01	S02	S03	S04	S05	S06	S07
Argentina	-	-	-	0.12%	0.29%	0.52%	0.12%
Australia	-	-	-	0.09%	0.22%	0.40%	0.09%
Brazil	-	-	-	0.12%	0.31%	0.56%	0.12%
Canada	-	-	-	0.08%	0.21%	0.37%	0.08%
China	0.02%	0.25%	0.90%	0.20%	0.50%	0.90%	0.20%
France	-	-	-	0.09%	0.23%	0.42%	0.09%
Germany	-	-	-	0.10%	0.24%	0.44%	0.10%
India	-	-	-	0.28%	0.71%	1.27%	0.28%
Indonesia	-	-	-	0.25%	0.63%	1.13%	0.25%
Italy	-	-	-	0.10%	0.25%	0.45%	0.10%
Japan	-	-	-	0.10%	0.25%	0.45%	0.10%
Mexico	-	-	-	0.15%	0.37%	0.66%	0.15%
Republic of Korea	-	-	-	0.12%	0.30%	0.54%	0.12%
Russia	-	-	-	0.13%	0.32%	0.58%	0.13%
Saudi Arabia	-	-	-	0.09%	0.23%	0.41%	0.09%
South Africa	-	-	-	0.14%	0.34%	0.61%	0.14%
Turkey	-	-	-	0.15%	0.37%	0.67%	0.15%
United Kingdom	-	-	-	0.10%	0.25%	0.44%	0.10%
United States of America	-	-	-	0.07%	0.18%	0.33%	0.07%
Other Asia	-	-	-	0.16%	0.40%	0.72%	0.16%
Other oil producing countries	-	-	-	0.15%	0.37%	0.67%	0.15%
Rest of Euro Zone	-	-	-	0.09%	0.23%	0.41%	0.09%
Rest of OECD	-	-	-	0.08%	0.20%	0.36%	0.08%
Rest of the World	-	-	-	0.20%	0.50%	0.90%	0.20%