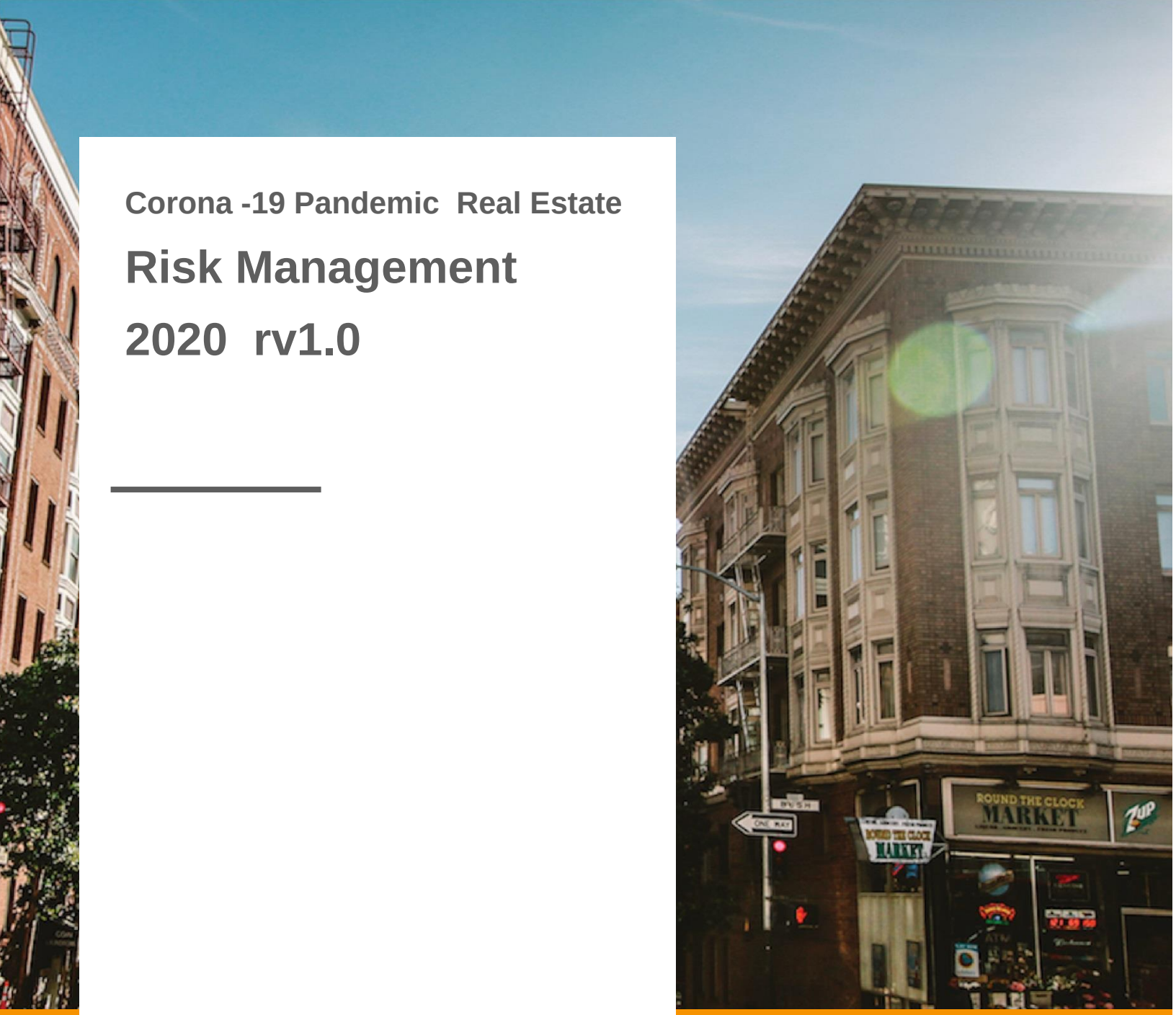

Corona -19 Pandemic Real Estate

Risk Management

2020 rv1.0

MARCH 25 **2020**

AMGhome +JV

Authored by: Michael Chan

AMGhome
+asset management

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CRISIS PLAN

It is March 25, 2020. We are currently one week into Ottawa's city-wide quarantine and into a partial shut down. Schools are cancelled. Restaurants are take out only. Museums are closed. By the end of this week, we will have access to essential services only. These are the necessary steps in containing COVID-19 and buying us the time to produce a vaccine. These are the facts. It is because of uncertainty we present these series of whitepapers with our plan to help protect our tenants, clients, and assets.

"It is our goal to prevent, protect and preserve the communities where we live and invest."

This is what we do. *Know, learn, communicate and execute.* Should you have any question in regards to our operations and analysis, do not hesitate to contact us.

Sincerely

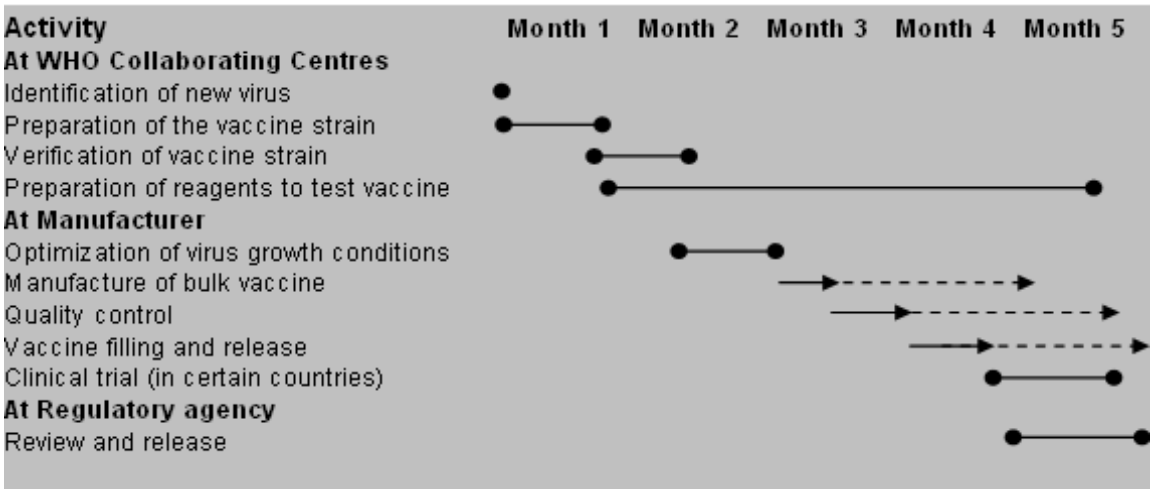
Michael Chan B.Arch, PMP, MRAIC
Managing Partner
AMGhome +asset management

Have we been here before?

We have been. 2012 MERS, 2009 H1N1, 2002 SARS. All of these pandemics were eventually managed and contained. Based on previous management and outcomes, the most realistic conclusion one should draw; a return to normal day to day activities in August - September of 2020.

"For a while it will feel like nothing is working, but it takes time," said Caitlin Rivers, an epidemiologist at Johns Hopkins University, on Twitter. "Any interventions we make today will not show up in our data for one or two weeks. The time it takes to show symptoms after being infected is about five days, and then it takes a few more days to get diagnosed and counted."

Developing a CoVID – 19 Vaccine:



Portfolio Risk Management

1. More Communication
2. Being proactive
3. Learning to be patient

No quick decisions are made in real estate. The result of any action are measured in weeks and months. We are still gathering information, so we can be proactive. Learning what information to monitor in this evolving situation is critical.

We will make decisions based on tenant and financial institution communications; government intervention and/or programs as they are introduced and implemented. We are currently looking at creating several options and applying solution(s) based each individual asset and tenant profile need(s). The goal is protecting tenants, employees, reducing financial risk and capital preservation.

Consultation and Communication

Financial Institutions / Mortgage Brokers / Government of Canada
Are being consulted and the option at deferred mortgage payments, in which the payment vacation will be applied to the end of the term or the amortization period. This option is preferred over using lines of credit or reserve capital.

The Government has announced plans for Unemployment Insurance and institutional credit easing. We are waiting for the first payment to tenants in the first week of April after they applied for financial stress/loss to EI.

With the credit easing, there is still a patch work of answers in regards to mortgage payment deferrals. Any property which has been in our portfolio for longer than two years would usually qualify.

Tenants
All tenants being called to discuss their current situation. We can assess if they may need assistance from running grocery errands to accessing government programs. In the later situations, we are encouraging them to apply for federal assistance that have been created for them to help pay the rent temporarily. We also have two programs to help them out. 1. Full Rental Deferral (4 months deferral and 12 month payback) 2. Lowered Rent Payments with Partial Deferred Rental Payment Program (6 months deferral + 8 months payback).

Real Estate Law
After consulting legal, we are still going to issuing notices of non-payment and partial receipts of payment. At this point in time we will not be issuing eviction notices as per the provincial guidelines.

Community - Action

1. We have dedicated eight beds in three separate units to help our existing tenant(s) isolate from their current rental units should they develop symptoms and test positive for COVID-19. These units will be maintained and held vacant until this pandemic is over.

2. We have donated our surplus of protective masks and gear from our construction maintenance repair operations (CMRO) to a local multi doctor clinic in an effort to bolster their front-line protection. We have also reached out to our construction suppliers to purchase existing inventories to help local medical clinics with distribution of protective gear.

Review of systems

Currently we are suspending all operations other than emergency construction and repairs. All work is being completed in single staff isolation. All protective gear and equipment usage are being enforced.

We are no longer purchasing or assisting in asset acquisitions. This will prevent unnecessary travel by our engineers, inspector, sales representatives and appraisers.

With all site work suspended we will be dedicating time and resources to evaluate current operational procedure and standards. In addition to this operation pivot, we will be researching and monitoring options, programs, policies as they present themselves in this new economic environment.

Review of revenue streams

Current Fixed Stream:	Variable Stream:
Rental Income(s)	Tenant Service(s)
Insurance	Employee(s)
Property Tax	Capital Investment(s)
Utilities	Lines of Credit(s)

The main goal of this review is to reduce capital expenditures in order to preserve and increase reserve funds. The period of this operation is expected to last the next 12-18 months.

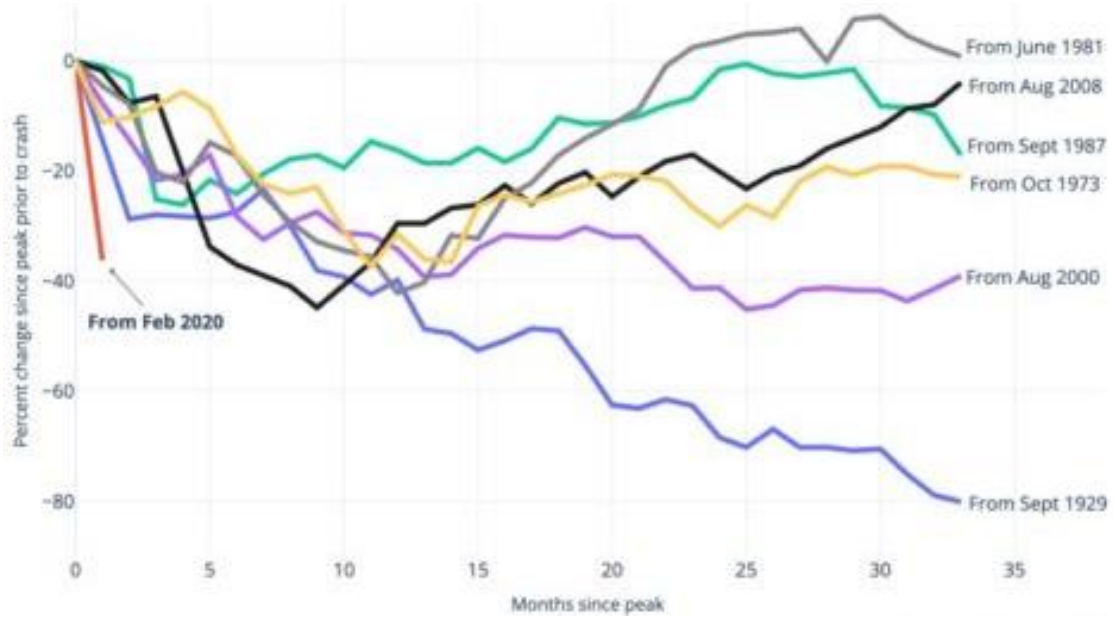
In an effort to preserve capital in this period of high volatility, we have increased our reserve funds by 3x the normal amount. In order to achieve this, we have cancelled all planned capital expenditures for the remainder of the 2020 calendar year. In addition to the capital reduction, we have laid off 3 staff members. The main goal of the lay offs was to ensure the staff could apply for EI, prior to the government imposed full mandatory shut down of operations. These collective efforts will ensure we can maintain our mortgage obligations for a minimum of 6 months based on severely reduced revenues of 50% or less.

Review of business cycle

New Market Reality

The economic implications of this pandemic can be predicted through several previous market drops and government (re)actions.

COVID-19 vs other market incidents



Micro Economics

1. There will be more renters.

    a. Renters will be financially stressed. As a consequence, they will move less and they will also be looking for more value in their rentals.

    b. With the massive lay-offs we expect companies to make some of those permanent as they will not have the financial capacity to rehire.

    c. The stock market to date has wiped out 30% of value. Many renters will not be able to transfer their portfolios to make a house purchase.

    d. We expect the capital markets to continue into its decline into 40% loss territory while real estate values drop by 10%. In periods of transition and change, investors will change

mindsets and economic views. The result of this action will have investors converting asset classes. Some investors will be looking to leave real estate market and some will be looking to leave the stock market. (Losses from Rental Markets vs Losses from the Capital Markets). Based on the volatility there will be financial opportunities for investors enter/exit those asset classes.

2. ***Residential values are going to depress. Depending on the severity of the economic downturn we are expecting a 5-8% equity loss for the next 18 months. The recovery is expected to take 48 months.***

3. Commercial real estate is the most exposed asset class. In this economic downturn businesses will look to contract or need to close locations. Commercial properties will lose equity value in the near and mid term.

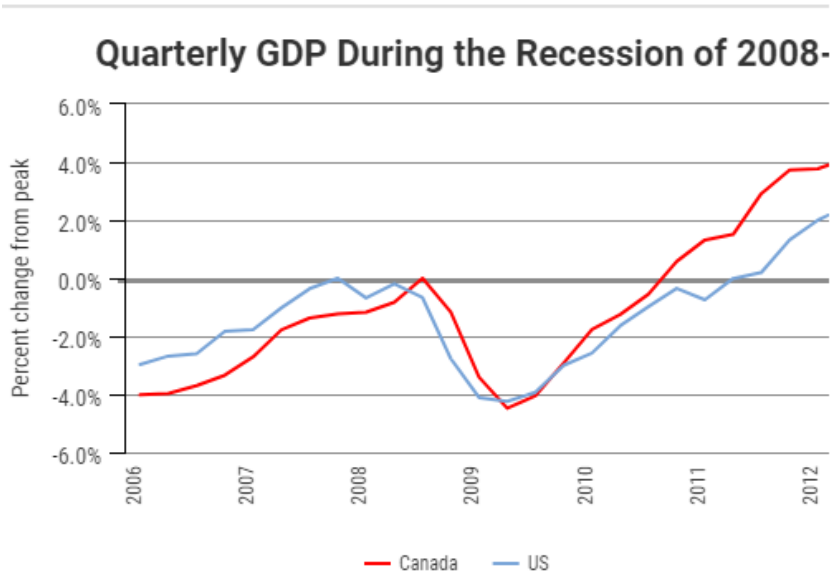
Information and Research of Historical Market Forces and Outcomes

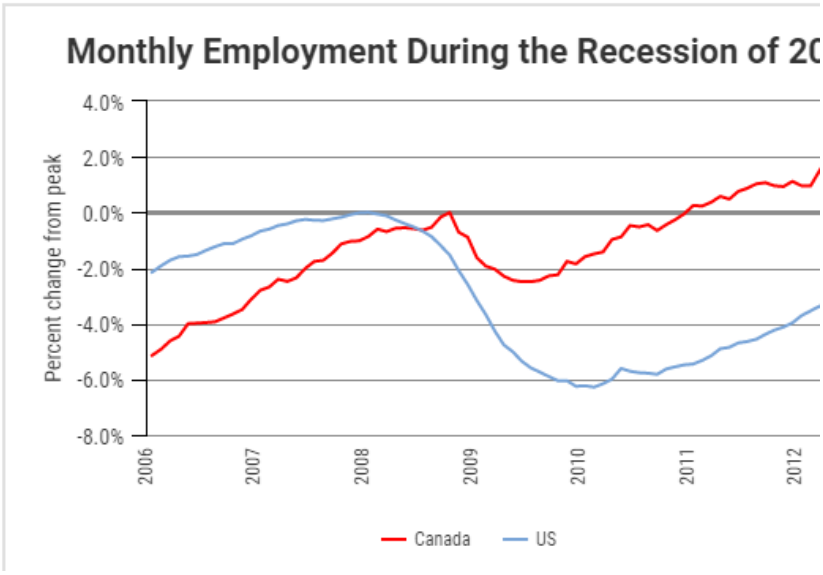
Macro Economics

1. The interest rate will remain low for next five years (3%) and the next five years following (below 5%).

The government has reduced interest rate(s) and will (re)introduce quantitative easing measures to stimulate the economy once the pandemic restrictions are lifted. The last recession in 2008, the IMF had recommended most countries globally spend 2% of GDP on such counter measures for global recession. This action for the most part stopped the economic free fall and stabilized the global economy.

Today we are looking at an unprecedented injection of government funds for restarting economies around the world. In March 2020, United States is earmarking 1 trillion dollars of stimulus compared to 152 billion dollars in 2008. Based on historical economics to date, this is expected to last for the next 18-36 months. Total economic recovery from baseline may take 3-8 years.





source: STATS CAN

Infomatics and Research – Appendix

By RBC Economics
March 23, 2020

Canada's economy faces hit from COVID-19 and oil price plunge

In early March we released a forecast that looked for Canada's economy to suffer a short, sharp decline in activity. The spread of COVID-19, the imposition of social-distancing measures and plunge in oil prices means we have reassessed the depth and duration of the downturn. The economy has already entered a deep downturn that we expect will rival the worst year of the Great Recession. The pressure on the economy will be widespread with the services sector hit by a severe demand shock as social distancing keeps consumers and workers at home. On the goods producing side of the economy, the disruption of supply chains and collapse in the energy sector will exert further downward pressure on growth. No provinces will be spared with some provinces like Ontario and Quebec locking down all but essential services and oil-producing provinces like Alberta suffering from the additional shock of sharply lower energy prices.

Realistic confidence bands around economic forecasts at the moment are exceptionally wide – and much depends on the extent to which social distancing measures will be successful in slowing the spread of the virus. But at this point we think it is reasonable to pencil in a 2.5% drop in Canadian GDP for the year, including a decline in Q2 that will likely dwarf any other drop since at least the 1960s. The unemployment rate will rise alongside. Indeed, the rate currently is probably already 10% and we expect will peak at north of 11% on a monthly basis, perhaps reaching that level as soon as April.

Policy actions have been quick and wide ranging

The Bank of Canada and governments have been quick to respond to the crisis unveiling a wide range of policies aimed at helping companies and workers stay afloat. However additional measures are needed and we anticipate the Bank of Canada will cut its policy rate further to just 0.25% and turn to large scale asset purchases also known as quantitative easing, a tool that has not been used in Canada. We expect the bank will start by buying government of Canada securities. Governments are also expected to unveil more programs aimed at ensuring businesses remain solvent and workers have jobs to return to once the crisis has passed.

Economic Forecasts

Canada	2020				2021				2020A	2021A
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
GDP 1	-3.0	-18.0	9.0	8.0	2.8	2.5	2.2	2.2	-2.5	2.9
Unemployment Rate 2	6.8	10.7	8.9	8.5	8.0	7.5	7.2	7.0	8.7	7.4
Overnight rate 3	0.75*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
10-year yield 3	0.83*	0.30	0.40	0.55	0.70	0.85	1.00	1.10	0.55	1.10
Unites States	**2020**				**2021**				**2020A**	**2021A**
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
GDP 1	-1.0	-16.0	8.0	7.0	2.7	2.4	2.2	2.0	-1.3	2.7
Unemployment Rate 2	3.7	9.7	7.9	7.3	6.8	6.5	6.3	6.1	7.2	6.4
Fed Funds 3,4	0.25*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
10-year yield 3	0.84*	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.10	1.50

1 – QoQ annualized % change | 2- %, period average | 3 – %, end of period | 4 – upper bound of 25 basis point range | * current level

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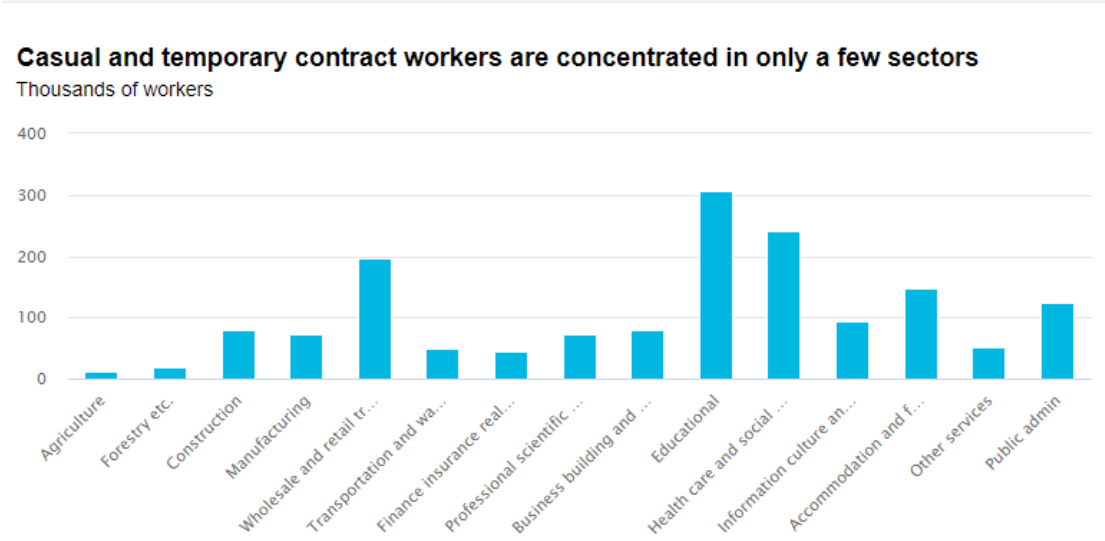
The staggering impact of social distancing

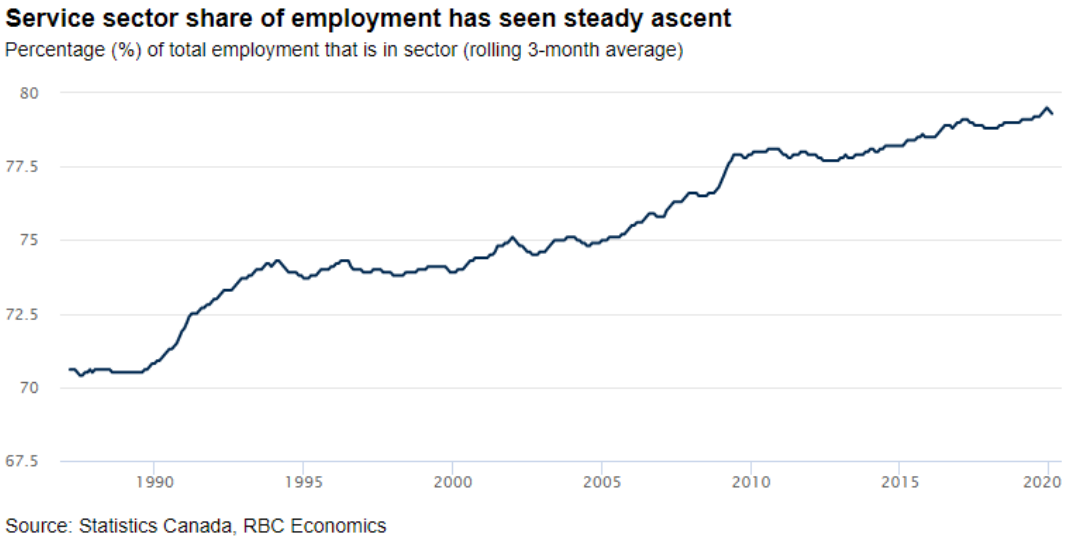
Social distancing, which all experts assure is a necessary action to save lives and prevent the spread of COVID-19, represents an unprecedented economic shock for all countries. Many of the service-sector industries that typically act as an 'economic buffer' in a recession will be dramatically impacted by social distancing. The drop in service sector activity and the oil price shock, combined with ripples from slower global demand and supply-chain disruptions that will hit the industrial sector, means we are headed for a period of unprecedented softness in economic activity. Some of that lost activity will bounce back relatively quickly when schools and other businesses reopen. And the more that can be done from a policy perspective to bridge-the-gap and get workers and businesses through the coming months, the quicker the growth bounce-back could be. But the reality is that with the duration of the virus' impact unknown and ongoing fear of a recurrence of the outbreak, a return to 'normal' is unlikely to occur quickly.



Source: Statistics Canada, RBC Economics

Service-sector to lead the downturn

The service sector normally acts as a buffer in an economic downturn. Most recessions start with a drop in the goods sector and it is the spillover from softer spending from laid off goods sector workers that accounts for a lot of the pullback in service-sector activity. In the 2008/09 downturn, for example, goods-sector employment fell by almost 8% peak-to-trough. Overall private service-producing employment fell 1.7%. Retail employment by about 2%. Accommodation and food services employment fell a larger 5%, but still less than goods employment. And all of those layoffs occurred over time, spread over about a year.



This time around is very different. Social distancing efforts are shutting down wide swaths of the service-sector. By our count, the sharp fall in activity in just five industries, education, retail trade, accommodation & food services, and arts & entertainment alone could produce a drop in GDP that rivals the record economy-wide plunge recorded in 2009 of 8.7%. Falling global demand, disrupted supply chains, and lower global oil prices will see goods producing sectors slump as well. Absent a dramatic and unexpected easing in the spread of the virus, the Canadian economy is headed for a double-digit decline in GDP in the second quarter of this year. We are now penciling in an 18% drop in Q2 GDP. This could underestimate the decline if the number of new virus cases does not begin to ease relatively quickly.

Canada's energy sector is a casualty not only from plunging demand as the virus cuts into activity at home and abroad but from the price war that erupted in early March. The combined impact pushed prices down by about 50% over two weeks. The low level of prices will add even further downward pressure on the industry which was only just emerging from severe downturn of 2015-16. Investment activity had already fallen significantly and any prospect of a rebound in 2020 has been dashed with companies cutting capital budgets aggressively. Low oil prices and a strong US dollar sent the Canadian currency tumbling below 70 US cents. Even after the peak of the virus impact, low oil prices are likely to continue to weigh on Canada's currency.

After one month of declines, 10,000 points off the Dow and a lot of "announcement indigestion," RBC's Chief Economist Craig Wright says markets are still searching for a bottom. They're unsure of how to price so much new risk, all at once. Central banks are also struggling to assert themselves, while governments have not been able to get enough new money into the economy. Even when the trillion-dollar checks are cut, will consumers spend and businesses invest?

Near-term labour market weakness to be unprecedented

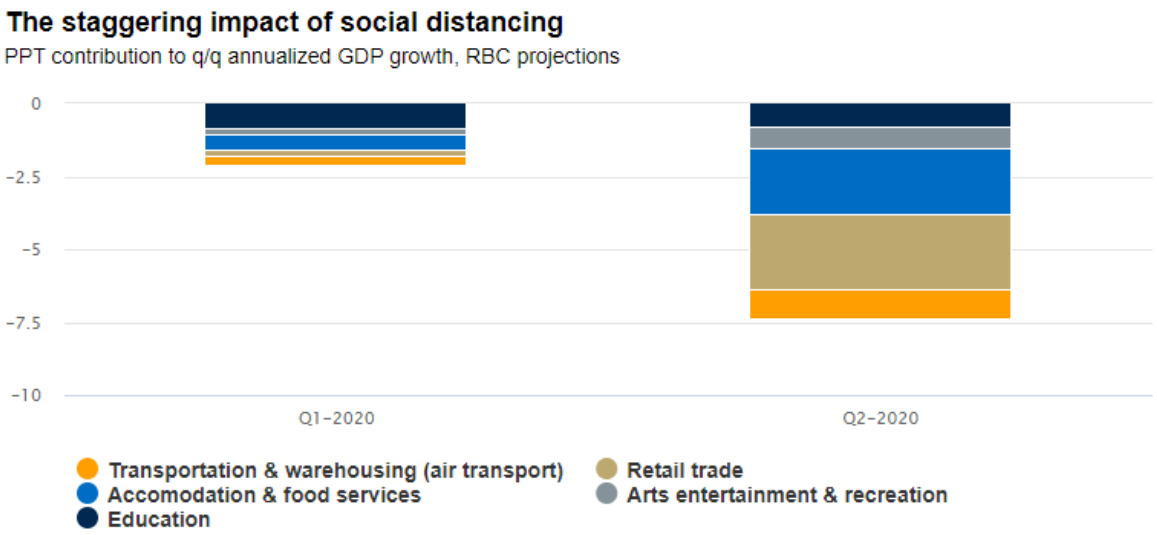
The labour market impact will also be dramatic – and unlike anything we have seen before in Canada. And that labour market pullback is already well under way. The largest increase in the unemployment rate in a single month in Canada was 1 percentage point, during the 1980s economic downturn. The 500k employment insurance claims Prime Minister

Trudeau reported were filed last week points to more than 2 percentage point increase, in just one week. The unemployment rate has already probably spiked above 10% in Canada.

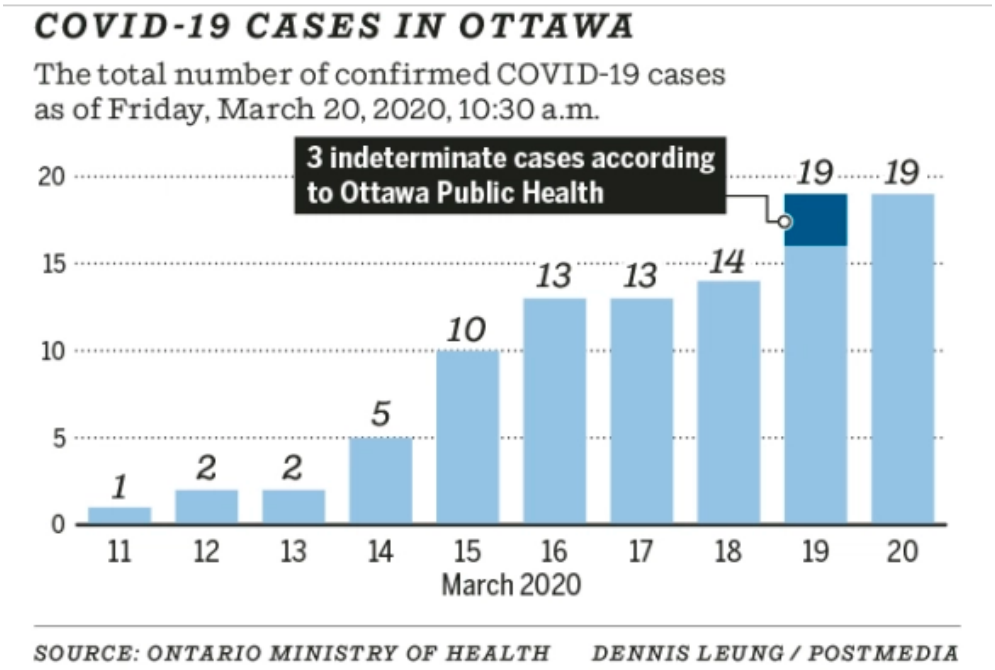
The service-sector industries most highly impacted by social distancing are largely made up of hourly workers. About 90% of workers in the retail and accommodation & food services sectors are hourly. That ratio is ~80% in the arts & entertainment sector. A higher share of education workers are salaried – and teachers are by-and-large still being paid at the moment. Some sectors might actually see jobs created in positions like couriers as more people shop online, or grocery stores and food manufacturers. Many of the jobs cut in the early days of the downturn will be workers closer to the lower-end of the pay scale. In other words, more vulnerable workers will bear the brunt of job market dislocations.

Light at the end of the tunnel – if the economy can bridge the gap

The light at the end of the tunnel is that social distancing is at its core is designed to trade off short-run economic and social pain with getting the spread of the virus under control. We have seen measures like these work in other parts of the world (mainlaind China, Hong Kong, South Korea, etc.). It is our expectation that as the virus is brought under control and social distancing measures ease, so will the economic drag. As the mantra on social distancing goes to 'flatten-the-curve', the economic mantra should be 'bridging-the-gap.' As long as businesses can weather the near-term storm, there is potential for a significant share of laid off employees to be re-hired relatively quickly, certainly in industries like education (as students return to school). The recovery in other areas will take longer – the damage to households psyche and fear of another outbreak of the virus means that sectors like retail, accommodation and food services, and arts & entertainment are more likely to see a gradual grind higher than a sharp bounce-back.



Source: RBC Economics



Fact From **F**iction 

Hannah Devlin, PhD | Guardian UK Science Editor

Claim: 'Face masks don't work'

Wearing a face mask is certainly not an iron-clad guarantee that you won't get sick – viruses can also transmit through the eyes and tiny viral particles, known as aerosols, can penetrate masks. However, masks are effective at capturing droplets, which is a main transmission route of coronavirus, and some studies have estimated a roughly fivefold protection versus no barrier alone (although others have found lower levels of effectiveness).

> **"However, masks are effective at capturing droplets, which is a main transmission route of coronavirus, and some studies have estimated a roughly fivefold protection versus no barrier alone"**

If you are likely to be in close contact with someone infected, a mask cuts the chance of the disease being passed on. If you're showing symptoms of coronavirus, or have been diagnosed, wearing a mask can also protect others. So masks are crucial for health and social care workers looking after patients and are also recommended for family members who need to care for someone who is ill – ideally both the patient and carer should have a mask.

However, masks will probably make little difference if you're just walking around town or taking a bus so there is no need to bulk-buy a huge supply.

Claim: 'It is mutating into a more deadly strain' – No

All viruses accumulate mutations over time and the virus that causes Covid-19 is no different. How widespread different strains of a virus become depends on natural selection – the versions that can propagate quickest and replicate effectively in the body will be the most "successful". This doesn't necessarily mean most dangerous for people though, as viruses that kill people rapidly or make them so sick that they are incapacitated may be less likely to be transmitted.

Genetic analysis by Chinese scientists of 103 samples of the virus, taken from patients in Wuhan and other cities, suggests that early on two main strains emerged, designated L and S. Although the L strain appeared to be more prevalent than the S strain (about 70% of the samples belonged to the former), the S branch of the virus was found to be the ancestral version.

The team behind this research suggested that this may indicate the L strain is more "aggressive", either transmitting more easily or replicating faster inside the body. However, this theory is speculative at this stage – there haven't yet been direct comparisons to see whether people who catch one version of the virus are more likely to pass it on or suffer more severe symptoms.

Claim: 'It is no more dangerous than winter flu' – It is 10x.

Many individuals who get coronavirus will experience nothing worse than seasonal flu symptoms, but the overall profile of the disease, including its mortality rate, looks more serious. At the start of an outbreak the apparent mortality rate can be an overestimate if a lot of mild cases are being missed. But Bruce Aylward, a WHO expert, who led an international mission to China to learn about the virus and the country's response, said this has not been the case with Covid-19. The evidence did not suggest that we were only seeing the tip of the iceberg. If borne out by further testing, this could mean that current estimates of a roughly 1% fatality rate are accurate. This would make Covid-19 about 10 times more deadly than seasonal flu, which is estimated to kill between 290,000 and 650,000 people a year globally.

Claim: 'It only kills the elderly, so younger people can relax' No

Most people who are not elderly and do not have underlying health conditions will not become critically ill from Covid-19. But the illness still has a higher chance of leading to serious respiratory symptoms than seasonal flu and there are other at-risk groups – health workers, for instance, are more vulnerable because they are likely to have higher exposure to the virus. The actions that young, healthy people take, including reporting symptoms and following quarantine instructions, will have an important role in protecting the most vulnerable in society and in shaping the overall trajectory of the outbreak.

Claim: 'You need to be with an infected person for 10 minutes' No

For flu, some hospital guidelines define exposure as being within six feet of an infected person who sneezes or coughs for 10 minutes or longer. However, it is possible to be infected with shorter interactions or even by picking the virus up from contaminated surfaces, although this is thought to be a less common route of transmission.

Claim: 'A vaccine could be ready within a few months' - Maybe

Scientists were quick out of the gates in beginning development of a vaccine for the new coronavirus, helped by the early release of the genetic sequence by Chinese researchers. The development of a viable vaccine continues apace, with several teams now testing candidates in animal experiments. **However, the incremental trials required before a commercial vaccine could be rolled out are still a lengthy undertaking – and an essential one to ensure that even rare side-effects are spotted. A commercially available vaccine within a year would be quick.'**

ESTIMATING THE GLOBAL ECONOMIC COSTS OF SARS*

Jong-Wha Lee and Warwick J. McKibbin.

Author Information

While the number of patients affected by the SARS coronavirus and its broader impact on the global public health community have been surveyed in considerable detail, the consequences of the disease in other areas are less well calibrated. The purpose of this paper is to provide an assessment of the global economic costs of SARS. Our empirical estimates of the economic effects of the SARS epidemic are based on a global model called the G-Cubed (Asia-Pacific) model. Most previous studies on the economic effects of epidemics focus on the economic costs deriving from disease-associated medical costs or forgone incomes as a result of the disease-related morbidity and mortality. However, the direct consequences of the SARS epidemic in terms of medical expenditures or demographic effects seem to be rather small, particularly when compared to other major epidemics such as HIV/AIDS or malaria. A few recent studies—including Chou et al. (2003), Siu and Wong (2003), and Wen (2003)—provide some estimates on the economic effects of SARS on individual Asian regions such as mainland China, Hong Kong (SAR), and Taiwan. But these studies focus mostly on assessing the damages by SARS in affected industries such as tourism and the retail service sector.

However, just calculating the number of canceled tourist trips, declines in retail trade, and similar factors is not sufficient to get a full picture of the impact of SARS because there are linkages within economies, across sectors, and across economies in both international trade and international capital flows. The economic costs from a global disease such as SARS go beyond the direct damages incurred in the affected sectors of disease-inflicted countries. This is not just because the disease spreads quickly across countries through networks related to global travel, but also because any economic shock to one country is quickly spread to other countries through the increased trade and financial linkages associated with globalization. As the world becomes more integrated, the global cost of a communicable disease like SARS can be expected to rise. Our global model is able to capture many of the important linkages across sectors as well as countries through capital flows and the trade of goods and services, thereby providing a broader assessment of disease-associated costs.

The G-Cubed model also incorporates rational expectations and forward-looking intertemporal behavior on the part of individual agents. This feature is particularly important when we are interested in distinguishing the effects of a temporary shock from those of a persistent shock. For example, when foreign investors expect that SARS or other epidemics of unknown etiology can break out in some Asian countries not just this year but persistently for the next few years, they would demand a greater risk premium from investing in affected economies. Their forward-looking behavior would have immediate global impacts.

Needless to say, our empirical assessment is preliminary and relies on our limited knowledge about the disease and constrained methodology. For instance, there is speculation that SARS could reemerge in an even deadlier form in the next influenza season. There is also no consensus yet on the likely developments of any future epidemic and the precise mechanism by which SARS affects economic activities. Although a global model is better than simple back-of-the-envelope calculations, it is a coarse representation of a complex world. Nonetheless, even simple calculations are important inputs into the model. We saw this with the Asian Crisis of 1997, when the transmission of shocks in Asia to the rest of the world and the adjustment within economies in Asia were poorly predicted when only trade flows were considered.[1] Thus it is important to go beyond the rough estimates that currently permeate commentary on the economic consequences of SARS. Because we take into account the interdependencies among economies and the role of confidence, our costs are larger than many of the estimates that currently appear in the media.

Go to:

Economic Impacts of SARS

Despite the catastrophic consequences of infectious diseases such as malaria and HIV/AIDS, the impact of epidemics has been considerably under-researched in economics.[2] Traditionally, studies have attempted to estimate the economic burden of an epidemic based on the private and nonprivate medical costs associated with the disease, such as expenditures on diagnosing and treating the disease. The costs are magnified by the need to maintain sterile environments, implement prevention measures, and conduct basic research. Such economic costs can be substantial for major epidemics such as HIV/AIDS. According to UNAIDS (the Joint United Nations Programme on HIV/AIDS), 42 million people globally are living with HIV/AIDS. The medical costs of various treatments of HIV patients, including highly active antiretroviral therapies (HAARTs), are estimated to be more than

$2,000 per patient per year. In the Southern African regions, the total HIV-related health service costs, based on an assumed coverage rate of 10 percent, ranges from 0.3 to 4.3 percent of gross domestic product (GDP) (Haacker, 2002).

The costs of disease also include income forgone as a result of disease-related morbidity and mortality. Forgone income is normally estimated by the value of workdays lost due to the illness. In the case of mortality, forgone income is estimated by the capitalized value of future lifetime earnings lost to the disease related death, based on projected incomes for different age groups and age-specific survival rates. This cost can be substantial for some epidemics. Malaria kills more than 1 million people a year, and HIV/AIDS is estimated to have claimed 3.1 million lives in 2002.

Previous researchers have also focused on long-term effects from the demographic consequences of epidemics. The first and foremost impact of epidemics is a negative shock to population and labor force. However, economic theory provides conflicting predictions regarding the economic effects of negative population shocks. A disease that kills mostly children and the elderly without affecting the economically active population aged 15 to 54 can lead to an initial increase in GDP per head. Even when the disease mostly attacks prime earners, its long-term economic consequences are not unambiguous. Standard neoclassical growth models predict that a negative shock to population growth can lead to a faster accumulation of capital and subsequently faster output growth (see Barro and Sala-I-Martin, 1995). Conversely, an exogenous, one-time reduction in labor force raises the capital-labor ratio and lowers the rate of return to capital, which subsequently leads to slower capital accumulation and thereby lower output growth.

Empirical studies also present conflicting results. Brainerd and Siegler (2002) show that the Spanish flu epidemic of 1918–1919, which killed at least 40 million people worldwide and 675,000 in the United States, had a positive effect on per capita income growth across states in the United States in the 1920s. In contrast, Bloom and Mahal (1997) show no significant impact of that epidemic on acreage sown per capita in India across 13 Indian provinces.

Epidemics can have further effects on demographic structures by influencing fertility decisions of households. According to the "child-survivor hypothesis," parents desire to have a certain number of surviving children. Under this theory, risk-averse households raise fertility by even more than expected child mortality. Evidence shows that high infant and child mortality rates in African regions of intense malaria transmission are associated with a disproportionately high fertility rate and high population growth (Sachs and Malaney, 2002). Thus, the increase in fertility has a further negative impact on long-term growth.

Aside from the direct demographic consequences of an epidemic, another important mechanism by which a disease has an adverse impact on the economy's long-term growth is the destruction of human capital. Human capital, the stock of knowledge embodied in the population, is considered an important determinant of long-term growth (Barro and Sala-I-Martin, 1995). Furthermore, the decline in "health capital," as measured in general by life expectancy, has negative effects on economic growth (Bloom et al., 2001). Epidemics also adversely affect labor productivity by inhibiting the movement of labor across regions within a country as well as across countries. Restricted mobility thus inhibits labor from moving to the places where it is most productive. Researchers simulating the effect of AIDS on growth in Southern African countries find that AIDS has had significant negative effects on per capita income growth mainly through the decline in human capital (Haacker, 2002).

While previous studies have emphasized the economic cost of disease associated with private and nonprivate medical costs, this doesn't seem to be the principal issue in the case of SARS. The number of probable SARS cases is still small in comparison to other major historical epidemics. Furthermore, unlike AIDS, the duration of hospitalization of the infected patients is short, with more than 90 percent of the patients recovering in a relatively short period, thereby rendering the medical costs comparatively very low. The SARS-related demographic or human capital consequences are also currently estimated to be insignificant. The fatality rate of the SARS coronavirus is high, but, with current estimates indicating fewer than 800 deaths from SARS worldwide, the death toll is tiny compared with the 3 million who died of AIDS last year or at least 40 million people worldwide who died in the Spanish flu epidemic of 1918–1919. Therefore, forgone incomes associated with morbidity and mortality as a result of SARS appear to be insignificant. If SARS became endemic in the future, it would substantially increase private and public expenditures on health care and would have more significant impacts on demographic structure and human capital in the infected economies. However, based on information to date, this is unlikely to happen with the SARS epidemic.

Although the medical expenditures and demographic consequences associated with SARS are insignificant, SARS apparently has already caused substantial economic effects by other important channels. We summarize three mechanisms by which SARS influences the global economy.

First, fear of SARS infection leads to a substantial decline in consumer demand, especially for travel and retail sales service. The fast speed of contagion makes people avoid social interactions in affected regions. The adverse demand shock becomes more substantial in regions that have much larger service-related activities and higher population densities, such as Hong Kong or

Beijing, China. The psychological shock also ripples around the world, not just to the countries of local transmission of SARS, because the world is so closely linked by international travel.

Second, the uncertain features of the disease reduce confidence in the future of the affected economies. This effect seems to be potentially very important, particularly as the shock reverberates through China, which has been a key center of foreign investment. The response by the Chinese government to the epidemic was fragmented and nontransparent. The greater exposure to an unknown disease and the less effective government responses to the disease outbreaks must have elevated concerns about China's institutional quality and future growth potential. Although it is difficult to measure directly the effects of diseases on decision making by foreign investors, the loss of foreign investors' confidence would have potentially tremendous impacts on foreign investment flows, which would in turn have significant impacts on China's economic growth. This effect is also transmitted to other countries competing with China for foreign direct investment (FDI).

Third, SARS undoubtedly increases the costs of disease prevention, especially in the most affected industries such as the travel and retail sales service industries. This cost may not be substantial, at least in global terms, as long as the disease is transmitted only by close human contact. However, the global cost could become enormous if the disease is found to be transmitted by other channels such as through international cargo.

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Simulations Using the G-Cubed (Asia Pacific) Model

Given the important linkages among affected countries in the region through capital flows and the trade of goods and services, any analysis of the implications of SARS on the global economy needs to be undertaken with a model that adequately captures these interrelationships. The G-Cubed (Asia Pacific) model, based on the theoretical structure of the G-Cubed model outlined in McKibbin and Wilcoxen (1998), is ideal for such analysis, having both a detailed country coverage of the region and rich links between countries through goods and asset markets.[3] A number of studies—summarized in McKibbin and Vines (2000)—show that the G-Cubed model has been useful in assessing a range of issues across a number of countries since the mid-1980s.[4] A summary of the principal characteristics of the G-Cubed model is presented as an annex at the end of this paper.

We make two alternative assumptions in generating a range of possible scenarios under this model. In an earlier analysis, we assumed in the first scenario that the shock lasted for a year. To capture the fact that the shock lasted 6 months, in reality we now scale down the shocks by 50 percent to capture the shorter duration. This is called a temporary shock. The second assumption is that the shocks are the same magnitude in the first year as the temporary shock, but are more persistent in that they fade out equiproportionately over a 10-year period. This illustrates the impact of expectations of the future evolution of the disease on the estimated costs in 2003. It also gives some insight into what might happen to the region if the SARS virus is considered the beginning of a series of annual epidemics emerging from China.

Initial Shock to China and Hong Kong

We first calculate the shocks to the economies of mainland China and Hong Kong (SAR), which were hit most heavily by the disease, and then work out some indexes summarizing how these shocks are likely to occur in other economies. There are three main shocks, based on observations of financial market analysts about the existing data emerging from China and Hong Kong:[5]

- A 200 basis-point increase in country risk premium.[6]
- A sector-specific demand shock to the retail sales sector, amounting to a 15 percent drop in demand for the exposed industries in the service sector.
- An increase in costs in the exposed activities in the service sector of 5 percent.

These shocks are then scaled to last only 6 months rather than 1 year.

We could also consider several other shocks, such as the impact on health expenditures and fiscal deficits. It is not clear how large this shock should be for the persistent shock, nor even whether the schock should have a positive or negative sign. Because SARS kills a higher proportion of vulnerable people in a very short period, it may be that the large expenditure for these people will be reduced as a result of SARS. There might also be a reaction by medical authorities to substantially increase investments in public health. Given the current state of information, we would be forced to speculate concerning all of these potential effects on health expenditures. We therefore explicitly ignore such fiscal impacts of SARS in this version of the paper.

Shocks to Other Countries

The transmission of SARS, as distinct from the transmission of economic impacts through global markets, depends on a number of factors. We refer to this as the global exposure to SARS. The speed of spread is likely to depend on (i) tourist flows, (ii) geographical distance to China, (iii) health expenditures and sanitary conditions, (iv) government response, (v) climate, (vi) per capita income, (vii) population density, and so on. Table 2-1 presents indicators on health expenditures, tourist arrivals, and sanitary conditions for selected countries. There are more than 33 million annual visitors to mainland China. Hong Kong (SAR) has annual tourist arrivals that are more than 200 percent of the local population. Overall health expenditure as a ratio to GDP is not small in Asian countries, but health expenditure per capita is only $45 in China.

TABLE 2-1 Health Expenditures, Tourist Arrivals, and Sanitation Indicators for Selected Countries

	Health Expenditure, Total (% of GDP)	Health Expenditure per Capita (current US$)	Tourist Arrivals (million)	Tourist Arrivals Arrivals/Population (%)	Improved Sanitation Facilities (% of population
China	5.3	45	33.2	3	29
Hong Kong	4.4	950	13.7	203	100
India	4.9	23	2.5	0	16
Indonesia	2.7	19	5.2	2	47
North Korea	2.1	18	n.a.	n.a.	99
South Korea	6.0	584	5.1	14	63
Malaysia	2.5	101	12.8	53	n.a.
Philippines	3.4	33	1.8	4	74
Singapore	3.5	814	6.7	163	100
Thailand	3.7	71	10.1	16	79
Vietnam	5.2	21	1.4	2	29
United States	13.0	4,499	n.a.	n.a.	100
Japan	n.a.	n.a.	4.8	4	n.a.
High-income OECD	10.2	2,771	377.6	n.a.	n.a.
World	9.3	482	696.5	n.a.	55

TABLE 2-1

Health Expenditures, Tourist Arrivals, and Sanitation Indicators for Selected Countries.

With more data we could do some econometric estimation to capture these influences. Lacking that data, for the purposes of this paper we construct a rough measure of the intensity of exposures to SARS, based on the above information and the cumulative number of cases of SARS for each country. This index of "global exposure to SARS" is contained in Figure 2-1. This will be used to scale down the country risk shocks calculated for all other countries. For example, if a country has an index of 0.5, the country risk premium shock will be the Chinese shock of 2 percent adjusted by the "global exposure to SARS" index, which gives a shock of 1 percent.

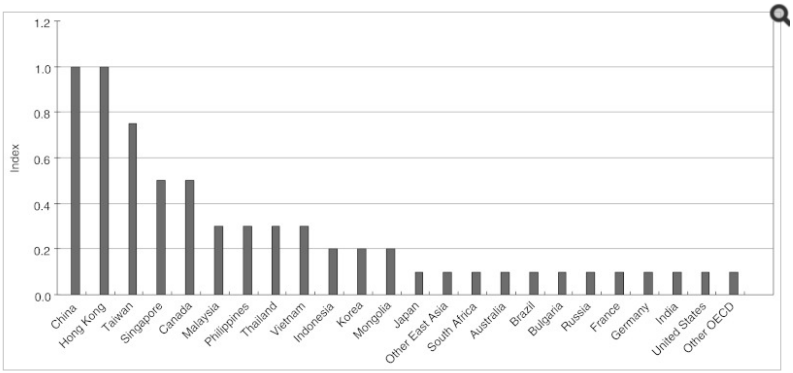

FIGURE 2-1 Global exposure to SARS

FIGURE 2-1

Global exposure to SARS.

For the shocks to the service industries, before applying the global exposure index to each country, we need to adjust the sector-specific shocks. Because we only have an aggregate service sector in the model, we need to take account for structural differences within the service sectors of each country. We do this by creating an "index of sectoral exposure to SARS." This index is assumed to be proportional to the share of industries affected by SARS within the service sector. Industries such as tourism, retail trade, and airline travel have been impacted severely. We use the GTAP5 database to calculate the share of exposed sectors to total services for each country.[7] We define the exposed sectors based on GTAP definitions as wholesale and retail trade (TRD, including hotels and restaurants), land transport (OTP), and air transport (ATP). The "index of sectoral exposure to SARS" is shown in Figure 2-2. This index is applied to the sector-specific shocks we developed for the Chinese economy. We then apply the "global exposure to SARS" to the resulting shocks.

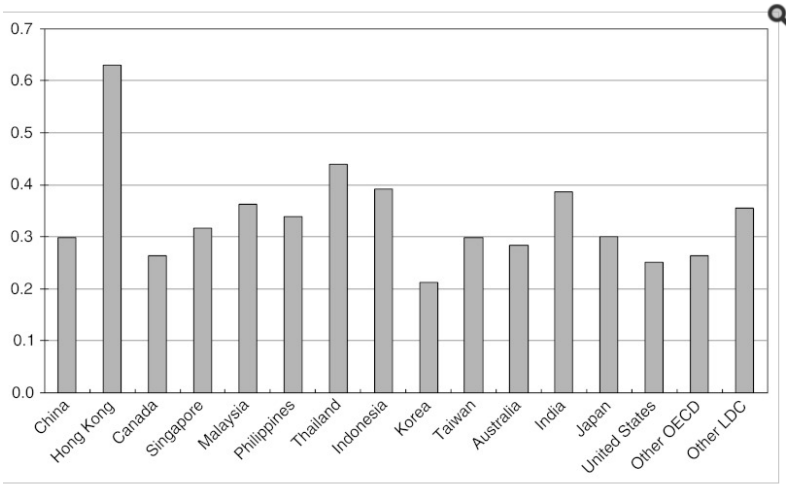

FIGURE 2-2 Sectoral exposure to SARS: share of retail sale and travel industry in service sector

FIGURE 2-2

Sectoral exposure to SARS: share of retail sale and travel industry in service sector.

The direct impact on any economy will be a function of a number of factors. An important aspect of the impact will be the size of the service sector in the economy as well as the relative indexes of exposure. Figure 2-3 shows the size of the service sector relative to total output in each economy in the model.

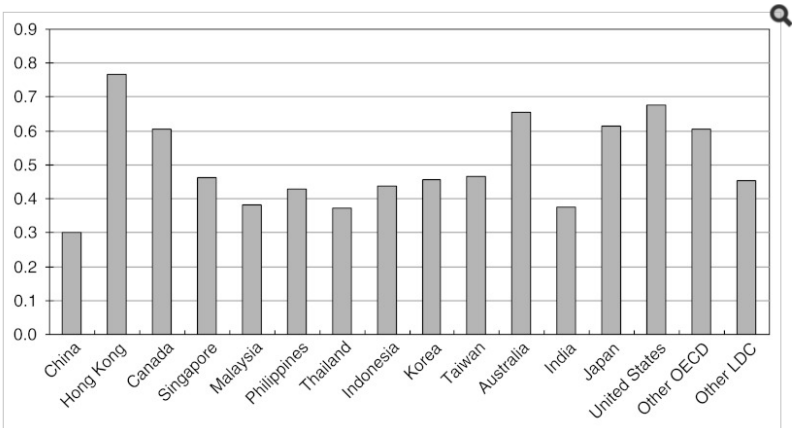

FIGURE 2-3

Share of service sector in total output.

Go to:

Simulation Results

We apply the shocks outlined in the previous section to the global economy. We begin the simulation in 2003, assuming in 2003 that the SARS outbreak was completely unanticipated. Both the temporary and persistent shocks are assumed to be understood by the forward-looking agents in the model. Clearly this is problematic when it comes to a new disease like SARS, when there is likely to be a period of learning about the nature of the shock. In this case, rational expectations might not be a good way to model expectations. Yet an alternative approach is not clear. In our defense, it is worth pointing out that only 30 percent of agents have rational expectations and 70 percent of agents are using a rule of thumb in adjusting to contemporaneous information about the economy. Table 2-2 contains results for the percentage change in GDP in 2003 as a result of the temporary and permanent SARS shocks as well as the contribution of each component (i.e., demand decline for services, cost increase for services, and country risk premium).

	Temporary Shock				Persistent Shock over 10 years			
	Total Effects	Demand Shift	Cost Rise	Country Risk	Total Effects	Demand Shift	Cost Rise	Country Risk
United States	−0.07	−0.01	−0.06	0.00	−0.07	−0.01	−0.06	0.00
Japan	−0.07	−0.01	−0.06	0.00	−0.06	−0.01	−0.06	0.01
Australia	−0.07	0.00	−0.06	0.00	−0.06	0.00	−0.06	0.01
New Zealand	−0.08	0.01	−0.08	0.00	−0.08	0.00	−0.08	0.00
Indonesia	−0.08	0.01	−0.09	0.00	−0.07	0.01	−0.08	0.00
Malaysia	−0.15	0.01	−0.16	0.00	−0.17	0.01	−0.15	−0.02
Philippines	−0.10	0.04	−0.14	0.00	−0.11	0.03	−0.13	−0.02
Singapore	−0.47	−0.02	−0.45	0.00	−0.51	−0.01	−0.44	−0.05
Thailand	−0.15	0.00	−0.15	0.00	−0.15	0.00	−0.15	0.00
China	−1.05	−0.37	−0.34	−0.33	−2.34	−0.53	−0.33	−1.48
India	−0.04	0.00	−0.04	0.00	−0.04	0.00	−0.04	0.00
Taiwan	−0.49	−0.07	−0.41	−0.01	−0.53	−0.07	−0.39	−0.07
Korea	−0.10	−0.02	−0.08	0.00	−0.08	−0.01	−0.08	0.00
Hong Kong	−2.63	−0.06	−2.37	−0.20	−3.21	−0.12	−2.37	−0.71
ROECD	−0.05	0.00	−0.05	0.00	−0.05	0.00	−0.05	0.00
Non-oil developing countries	−0.05	−0.01	−0.04	0.00	−0.05	0.00	−0.04	0.00
Eastern Europe and Russia	−0.06	−0.01	−0.05	0.00	−0.05	−0.01	−0.05	0.00
OPEC	−0.07	−0.01	−0.05	0.00	−0.09	−0.01	−0.06	−0.02

SOURCE: G–Cubed (Asia Pacific) Model version 50n.

TABLE 2-2

Percentage Change in GDP in 2003 Due to SARS.

The full dynamics of adjustment will be outlined shortly. Focusing on the GDP results, it is clear that there are interesting differences among the various components of the overall shock as well as between the temporary and permanent shocks. The temporary shock has its largest impact on China and Hong Kong (SAR), as expected. The loss to Hong Kong of 2.63 percent of GDP, however, is much larger than that of 1.05 percent for the remainder of mainland China. This primarily reflects the larger role of the service sector in Hong Kong, the larger share of impacted industries within the service sector in Hong Kong, and the greater reliance on trade within the Hong Kong region. Taiwan is the next most affected area, losing 0.49 percent of GDP in 2003, followed closely by Singapore, with a loss of 0.47 percent of GDP.

For Hong Kong, the increase in costs in the service sector is by far the largest contributing factor to the loss of GDP. In the rest of mainland China it is evenly spread across the three factors. The temporary increase in the country risk premium of 200 basis points is estimated to lower GDP by 0.33 percent for China and by 0.20 percent for Hong Kong. Interestingly, the risk premium shock has very negligible impacts, of less than 0.01 percent of GDP, on Taiwan and Singapore, which adopt floating exchange rate regimes, although they are also subject to a substantial rise in the country risk premium by 150 and 100 basis points, respectively.

The difference comes from the fact that exchange rate depreciation helps Taiwan and Singapore to avoid a rise in real interest rate and subsequent output decline.

The calculations when expressed as a percent of each country's GDP may appear to be small. However, when translated into an absolute dollar amount, these figures imply that the global economic loss from SARS was close to $US 40 billion in 2003. This is a figure much greater than any calculation of the medical costs of treating SARS patients.

The persistent SARS shock is also much more serious for China and Hong Kong. The primary impact is from the persistence in the rise of the country risk premium. Although the same in 2003 as for the temporary shock, the persistence of the country risk premium causes much larger capital outflow from China and Hong Kong. This impacts on short-run aggregate demand through a sharp contraction in investment, as well as a persistent loss in production capacity through a resulting decline in the growth of the capital stock, which reduces the desirability of investment. The extent of capital outflow will be discussed below.

Interestingly, the difference in GDP loss in 2003 when SARS is expected to be more persistent distinguishes between two regions. China, Hong Kong (SAR), Malaysia, the Philippines, Singapore, and Taiwan experience a larger loss in 2003, whereas the OECD economies and others experience a lower GDP loss. This reflects the greater capital outflow from the most affected countries into the least affected countries, which tends to lower the GDP of those countries losing capital and raise the GDP of those countries receiving capital. The countries in the first group that are less affected by SARS are nonetheless worse off with a more persistent disease because of their trade links with China, Hong Kong, and Singapore. The expectation of a more persistent problem with SARS leads to a total GDP loss of roughly $US 54 billion in 2003 alone (this ignores any future years' losses).

The results for GDP illustrate how the costs of SARS can be very different in 2003, depending on expectations of how the disease will unfold. It is also interesting to examine the change in economic impacts over time.

We present two sets of figures containing six charts within each figure. These results are all expressed as deviation from the underlying baseline of the model projections (which is described in more detail in the annex at the end of this paper). They show how key variables change relative to what would have been the case without SARS. Figures 2-4 and 2-5 describe simulation outcomes for the temporary SARS shock in the three panels on the left and simulation outcomes for the more persistent SARS shock in the three panels on the right. This enables a comparison between the two for the impacts on the real economy and trade flows.

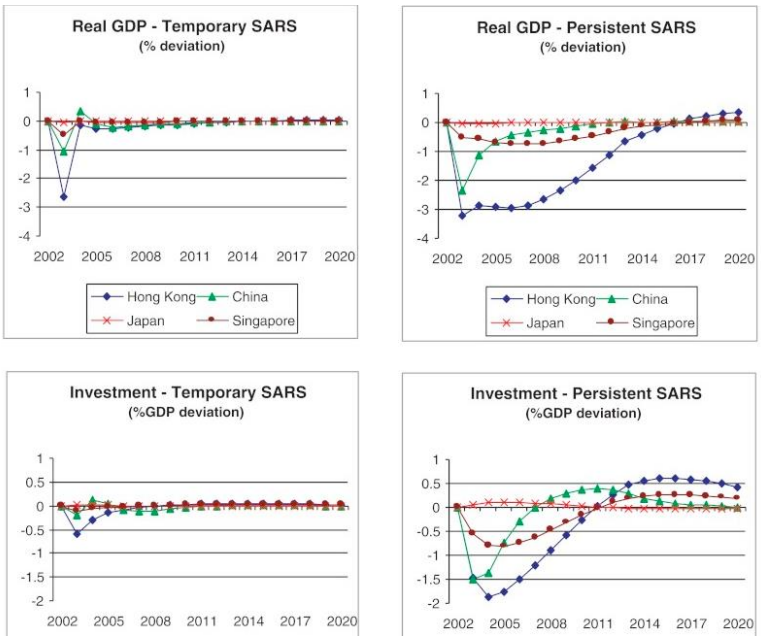

FIGURE 2-4

Real impacts of temporary versus persistent SARS shock.

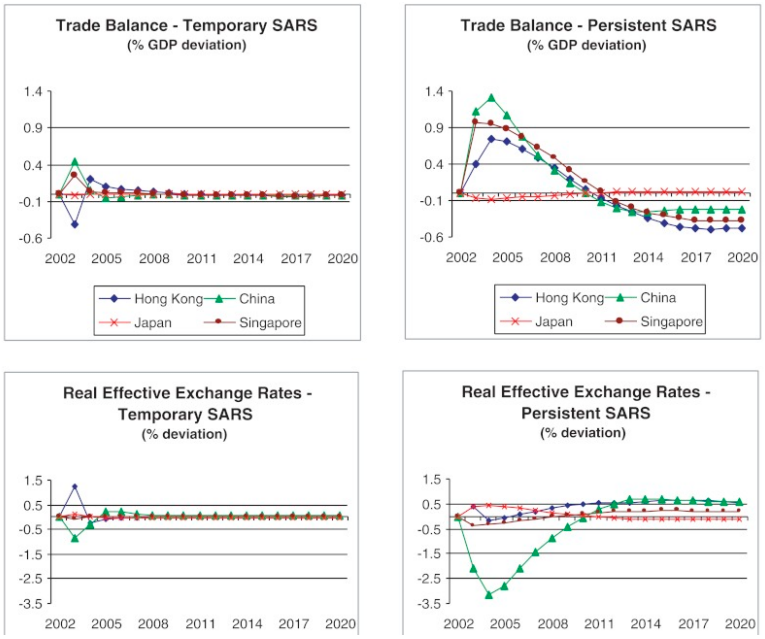

FIGURE 2-5

Trade and captial flow impacts of temporary versus persistent SARS shock.

Figure 2-4 contains results for real GDP, investment, and exports for both the temporary and persistent SARS shock. The loss in GDP from the temporary shock is largely confined to 2003. The persistent shock not only has a larger impact on GDP in 2003—because of expectations about future developments—but has a persistent impact on real GDP for a number of years afterward. Investment falls more sharply in 2003, which is the source of the larger GDP loss.

The results for exports are also interesting. In the case of the temporary shock, exports from Hong Kong fall sharply. Yet, in the more persistent case, exports from Hong Kong rise in 2003. The reason for this difference is that the more persistent the shock, the larger the capital outflow from affected economies. A capital outflow will be reflected in a current account surplus and a trade balance surplus. For this to occur, either exports must rise or imports must fall or both. This can be seen clearly in Figure 2-5.

In the case of the temporary SARS shock, the net capital outflow from China and Hong Kong (relative to base) is around 0.3 percent of GDP. However, when the shock is more persistent, this capital outflow rises sharply (top right panel of Figure 2-5), to 1.4 percent of GDP for Hong Kong and 0.8 percent of GDP for China. This capital outflow is reflected in the trade balance surplus in both. This shift in the trade balance is achieved by the capital outflow depreciating the real exchange rate of both China and Hong Kong substantially.

All of these linkages have many dimensions, but a global model is able to help untangle some of the more important factors. Under this model, the SARS outbreak is predicted to have widespread economic impacts beyond the regions immediately infected with the disease and beyond the decline in the most affected service industries.

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Conclusion

The impact of SARS is estimated to be large on the affected economies of China and Hong Kong (SAR). This impact is due not to the consequence of the disease itself for the affected people, but to the impact of the disease on the behavior of many people within these economies. It also depends on the disease-associated adjustment of expectations reflected in integrated real and financial markets. The more persistent SARS is expected to be, the larger the negative economic impacts in 2003 in affected economies, but the smaller the impact in countries outside the core countries. The calculations above suggest that the cost in 2003 of SARS for the world economy as a whole are close to $US 40 billion in the case where SARS is expected to be a single event, versus costs of close to $US 54 billion in 2003 if SARS is expected to recur (this does not include the actual costs of later years if in fact SARS did recur). The higher costs from a persistent shock relate to the loss of investment and the impact on confidence and therefore spending in 2003.

These results illustrate that the true cost of disease is far greater than the cost to a health budget of treatment of the cases involved. The more persistent shock in this paper can be thought of as SARS lasting longer than anyone hopes, but it can also be interpreted as a recurring series of annual epidemics emerging from China and infecting the world through increased globalization. This is not a new phenomenon, since influenza viruses have been emanating from China since at least the 1918–1919 Spanish flu. Fortunately, most have been less devastating than the well-known major outbreaks. A key point of this paper is an attempt to evaluate the true underlying global cost of these diseases. If the threat of recurring SARS or SARS-like diseases from China is real, then the estimated risk to economic activity in this region and the world, as calculated in this paper, might be very large. The estimates in this paper suggest that there is a strong economic case for direct intervention in improving public health in China and other developing countries where there are inadequate expenditures on public health and insufficient investments in research into disease prevention.

As we observed from the Asian financial flu in 1997 and SARS in 2003, there is an important role for global monitoring and coordination mechanisms in containing both economic and microbial epidemics.

Go to:

Annex 2-1. Characteristics of the G-Cubed (Asia Pacific) Model

Some of the principal features of the G-Cubed (Asia Pacific) model are as follows:

- The model is based on explicit *intertemporal* optimization by the agents (consumers and firms) in each economy.[8] In contrast to static computable general equilibrium (CGE) models, time and dynamics are of fundamental importance in the G-Cubed model.

- In order to track the macro time series, however, the behavior of agents is modified to allow for short-run deviations from optimal behavior either due to myopia or to restrictions on the ability of households and firms to borrow at the risk-free bond rate on government debt. For both households and firms, deviations from intertemporal optimizing behavior take the form of rules of thumb, which are consistent with an optimizing agent that does not update predictions based on new information about future events. These rules of thumb are chosen to generate the same steady-state behavior as optimizing agents, so that in the long run there is only a single intertemporal optimizing equilibrium of the model. In the short run, actual behavior is assumed to be a weighted average of the optimizing and the rule-of-thumb assumptions. Thus aggregate consumption is a weighted average of consumption based on wealth (current asset valuation and expected future after-tax labor income) and consumption based on current disposable income. Similarly, aggregate investment is a weighted average of investment based on Tobin's q (a market valuation of the expected future change in the marginal product of capital relative to the cost) and investment based on a backward-looking version of Q.

- There is an explicit treatment of the holding of financial assets, including money. Money is introduced into the model through a restriction that households require money to purchase goods.

- The model also allows for short-run nominal wage rigidity (by different degrees in different countries) and therefore allows for significant periods of unemployment depending on the labor market institutions in each country. This assumption, when taken together with the explicit role for money, is what gives the model its "macroeconomic" characteristics. (Here again, the model's assumptions differ from the standard market-clearing assumption in most CGE models.)

- The model distinguishes between the stickiness of physical capital within sectors and within countries and the flexibility of financial capital, which immediately flows to where expected returns are highest. This important distinction leads to a critical difference between the *quantity of physical capital* that is available at any time to produce goods and services, and the *valuation of that capital* as a result of decisions about the allocation of financial capital.

As a result of this structure, the G-Cubed model contains rich dynamic behavior, driven on the one hand by asset accumulation, and on the other by wage adjustment to a neoclassical steady state. It embodies a wide range of assumptions about individual behavior and empirical regularities in a general equilibrium framework. The interdependencies are solved out using a computer algorithm that solves for the rational expectations equilibrium of the global economy. It is important to stress that the term "general equilibrium" is used to signify that as many interactions as possible are captured, not that all economies are in a full market-clearing equilibrium at each point in time. Although it is assumed that market forces eventually drive the world economy to a neoclassical steady state growth equilibrium, unemployment does emerge for long periods due to wage stickiness, to an extent that differs between countries on account of differences in labor market institutions.

Baseline Business-as-Usual Projections for G-Cubed Model Simulations

To solve the model, we first normalize all quantity variables by each economy's endowment of effective labor units. This means that in the steady state, all real variables are constant in these units, although the actual levels of the variables will be growing at the underlying rate of growth of population plus productivity. Next, we must make base-case assumptions about the future path of the model's exogenous variables in each region. In all regions we assume that the long-run real interest rate is 5 percent, tax rates are held at their 1999 levels, and fiscal spending is allocated according to 1999 shares. Population growth rates vary across regions as per the 2000 World Bank population projections.

A crucial group of exogenous variables are productivity growth rates by sector and country. The baseline assumption in G-Cubed (Asia Pacific) is that the pattern of technical change at the sector level is similar to the historical record for the United States (where data are available). In regions other than the United States, however, the sector-level rates of technical change are scaled up or down in order to match the region's observed average rate of aggregate productivity growth over the past 5 years. This approach attempts to capture the fact that the rate of technical change varies considerably across industries while reconciling it with regional differences in overall growth. This is clearly a rough approximation; if appropriate data were available, it would be better to estimate productivity growth for each sector in each region.

Given these assumptions, we solve for the model's perfect-foresight equilibrium growth path over the period 2002–2081. This a formidable task: the endogenous variables in *each* of the 80 periods number over 7,000 and include, among other things: the equilibrium prices and quantities of each good in each region, intermediate demands for each commodity by each industry in each region, asset prices by region and sector, regional interest rates, bilateral exchange rates, incomes, investment rates and capital stocks by industry and region, international flows of goods and assets, labor demanded in each industry in each region, wage rates, current and capital account balances, final demands by consumers in all regions, and government deficits.[9] At the solution, the budget constraints for all agents are satisfied, including both intra-temporal and intertemporal constraints.

Go to:

Footnotes

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This paper is adapted from an article that will appear later this year in Asian Economic Papers (MIT Press). An earlier version of the paper was originally presented to the Asian Economic Panel meeting held in Tokyo, May 11–12, 2003, and the Pacific Economic Cooperation Council (PECC) finance forum, Hua Hin, Thailand, July 8–9, 2003. We have updated that original paper to include the last known case of SARS as well as adjusting the scale of some shocks given the knowledge that the SARS epidemic lasted approximately 6 months rather than the full year originally assumed. The authors particularly thank Andrew Stoeckel for interesting discussions and many participants at the conferences, particularly Ifzal Ali, Richard Dorbnick, George Von Furstenberg, Yung Chul Park, Jeffrey Sachs, Wing Thye Woo, and Zhang Wei for helpful comments. Alison Stegman provided excellent research assistance and Kang Tan provided helpful data. See also the preliminary results and links to the model documentation at http://www.economicscenarios.com. The views expressed in the paper are those of the authors and should not be interpreted as reflecting the views of the institutions with which the authors are affiliated, including the trustees, officers, or other staff of the Brookings Institution.

1

See McKibbin (1998) for a study of the Asia crisis that included the critical role of capital flow adjustment.

2

Exceptions can be found in the Commission on Macroeconomics and Health (2002).

3

Full details of the model, including a list of equations and parameters, can be found online at http://www.gcubed.com.

4

These issues include Reaganomics in the 1980s, German unification in the early 1990s, fiscal consolidation in Europe in the mid-1990s, the formation of NAFTA, the Asian crisis, and the productivity boom in the United States.

5

These are also consistent with other papers on particular countries presented at the Asian Economic Panel in May 2003.

6

In the May version of this paper we assumed a 300 basis-point shock. We follow the updated research of Australian Treasury (2003) in adjusting this shock to 200 basis points.

7

For more information on this database, see the website of the Global Trade Analysis Project at http://www.gtap.agecon.purdue.edu/.

8

See Blanchard and Fischer (1989) and Obstfeld and Rogoff (1996).

9

Because the model is solved for a perfect-foresight equilibrium over an 80-year period, the numerical complexity of the problem is on the order of 80 times what the single-period set of variables would suggest. We use software summarized in McKibbin and Sachs (1991), Appendix C, for solving large models with rational expectations on a personal computer.

The Coronavirus Explained & What You Should Do - **Kurzgesagt**

https://www.youtube.com/watch?v=BtN-goy9VOY