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Preparing for Future Pandemics: Stress Tests and Wargames

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Abstract

There is an important interdependence between economic, financial and health policy actions. The recent Covid-19 crisis has demonstrated that, apart from the direct economic consequences from illness and death from the virus, the main economic and financial costs have been due to the varying degrees of preventative measures taken by the public, firms, and governments that directly impacted economic and financial activity. This paper proposes the use of regular, combined medical, economic and financial stress tests and wargames in preparing for future pandemics and other major environmental shocks.

Keywords: Covid-19, Government Policy, Wargames, Stress Tests, Banking, Monetary Policy.

JEL codes: I18, H12, H51, H84, G21

There is an important interdependence between economic, financial and health policy actions. The recent Covid-19 crisis has demonstrated that, apart from the direct economic consequences from illness and death from the virus, the main economic and financial costs have been due to the varying degrees of preventative measures taken by the public, firms, and governments that directly impacted economic and financial activity.

In attempts to ameliorate the impact on the welfare of the population, governments have taken major interventions in real and financial markets. These policies can be very expensive, of varying degrees of effectiveness, and can have huge implications for the size of increases in unemployment, government deficits and debt levels.

In this paper we explore new methods in planning and preparing for such major events. They are designed to reduce the likelihood and severity of the medical and economic costs of a pandemic. These general planning methods have been used in the past as risk management tools in both the medical and financial fields, but they have not so far been considered as an integrated system. In particular, we describe the use of integrated stress tests and wargames to prepare for a future pandemic. Various versions of stress tests have been used widely in the financial sector, particularly after the Great Financial Crisis of 2007-9. Wargames have been used to prepare for extreme events that will stretch medical, economic and social physical and organisational resources. But there has been a major weakness in that these games have been played within sectors, but not across sectors. The key recommendation of this paper is that systemic wargames be played regularly to prepare for pandemics and other major societal disruptions.

The outline of the paper is as follows:

Section 1 discusses the history of wargames in the military and its methodology. This

approach has been used in corporate and government policy wargames to address policy responses for scenarios of extreme events.

Section 2 reviews pandemic reports and wargames (sometimes referred to as simulations or exercises) prior to the current crisis. We show that these wargames were flawed. The pandemic models that were used in these wargames prior to the Covid-19 epidemic displayed some severe limitations. Since the beginning of the pandemic there have been improvements in pandemic models that appear to be very promising in disaggregating demographic information and thus improving the effectiveness of policy decision-making. In addition, many epidemic wargames prior to this crisis appeared to have been restricted to medical responses and ignored the social, economic and financial consequences of various quarantine strategies and related policy measures.

Section 3 describes the methodology of financial stress tests for individual banks and the banking system. We describe financial stress tests used before the Great Financial Crisis (GFC), their development and widespread use after the GFC. We explore the limitations of this methodology, and the introduction of wargames as an attempt to address those limitations. We argue that wargame methodology, combined with improved pandemic models should improve policy responses in the medical and financial sectors.

Section 4 outlines lessons that we have learned from the current Covid-19 crisis. We cover medical, social, economic and financial implications of the crisis, emphasizing the limitations of many policies employed.

Section 5 proposes a serious program of wargame preparation for future pandemics. These

wargames would integrate medical, social, economic, financial and fiscal sectors in the game to test systems and policy strategies. In addition, these games provide an important educative and training role for decisionmakers and key employees in these sectors.

The paper concludes with a summary and policy recommendations.

1. Background on Wargames:

1.1 History and Methodology of Military Games:

War Gaming began to be used professionally in the German Army from the middle of the 19th Century. Other armies quickly copied the ideas - for a history see Thomas Allen (1987) (2015) and more recently Hershkovitz (2019). War Games are also known as Simulations or Exercises. They all share a common methodology.

There are three basic forms of war game:

- (a) Table-top war games with figures or counters etc. Civilian versions are Chess, Diplomacy, Risk, or far more sophisticated computer game versions. Strategic computer war games played by civilians are often spin-offs of Pentagon war games.
- (b) Field exercises using real troops and equipment.
- (c) Large scale strategic games using computer simulations and predictive models (NATO War games are a good example). Typically, these games have two sides (the Red enemy and the Blue home nation). There can be many players, allies etc. The games allow sophisticated play using intelligence evaluations of enemy and allied policies.

1.2. The History and Methodology of Corporate Wargames:

Corporate War-Gaming has been used for some time. For an excellent summary of the pitfalls and advantages, see Horn (2011).¹ These games incorporate strategic scenarios that try to avoid the simplifications and ambiguities (multiple equilibria etc.) of models based on game theory. War games go far beyond mathematical predictive models by incorporating the judgement and experience of professionals with detailed knowledge of various functions of complex organizations.

The game design is critical for meaningful learning. The game should help in analyzing corporate problems. This involves careful analysis of corporate financial and legal procedures, regulatory interactions and the strategic interactions of competitors. The game design should decide whether to concentrate on narrow tactical and procedural scenarios - or more general scenarios. This will determine the type of players (experience and relevance) involved.

Games should be repeated with different, but Plausible Worse Case (PWC) scenarios. This is a learning experience for decision-makers who in a real crisis will have to make major decisions – often under considerable uncertainty and severe pressure in real time.

1.3. Government and Policy Relevant War Games:

Government (civilian) wargames follow the same general methodology as explained in the McKinsey report (Horn (2011)), but can be far more complex in dealing with multiple institutions in the context of strategic, economic, health, financial and other emergencies.²

From history, we know that low probability/high cost (in the broadest sense) events

¹ Horn (2011) <https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/playing-war-games-to-win>

² For an early grand political/diplomatic/economic/financial war game see: Kubarych (2001).

resonate through the social and economic system, often inducing major problems and having long-run consequences for the private, public and political sectors.

Private sector and government policy responses can amplify or dampen the impact of the initial event: poorly prepared governments can amplify the impact – often with dire long-term implications. This implies that policy responses require careful analysis of possible “unintended consequences.” These consequences are important for designing the appropriate responses, conditional on the best information available at any time. Furthermore, strategies should be considered to be conditional on new information, so actions can adapt. Approaching strategic planning using this approach requires careful analysis so that adequate preparation is built into policy responses. Human and physical resources and their organization take time to build, so that lack of preparation in a crisis will induce costly actions and mistakes that could have been avoided.

Policy-relevant wargames are an important tool in preparing for these types of extreme events. They should be a normal method of planning responses to low probability-high cost events, and *not* an optional extra.

One important component in any wargame exercise is the use of lessons learned from previous extreme events. Detailed forensic reports from previous crisis should be used as guides in constructing scenarios and exploring strategies. Wargame reports should include accurate summaries of previous forensic reports, so that the wargame can be played and reviewed using the best historical experience.

1.4.Wargame Analysis: Cognitive Limitations:³

The role of a wargame is not to predict the future, but to explore various plausible worst case scenarios. The game requires experts and other players to interact and learn from the experience. Games are most productive when conventional or standard responses are found wanting, so that the players can experiment, trying novel solutions to problems without imposing heavy costs in real time due to a flawed strategy.

An additional benefit is that standard ways of thinking about problems, group think and other cognitive biases can be challenged. This learning experience should be used to foster innovation in the structure of the organisation, updating procedures and equipment. The games should be used to challenge complacency: an emergency that occurred many years ago may have engendered procedures and equipment that have become obsolete, given current knowledge and technology. A well-designed game can reveal those weaknesses.

If the games are played regularly, then key players will be familiar with the other players, and their skills. This familiarity reduces the risk of player conflict and misunderstandings in a real crisis when time pressure and stress can lead to confusion, poor decision-making and flawed implementation.

1.5. How Do We Use Wargame Results?

The results and lessons learned from games should be written up in manuals, in playbooks, and implemented in changing organizations and procedures. Although military and strategic wargame results and briefing notes are top secret,⁴ there is no good reason why pandemic and

³ This discussion draws on Hershkovitz (2019), particularly pp.10-14.

⁴ See Allen (2015).

other environmental wargame results should be secret. The results should be carefully communicated to major players and experts in the private and public sectors for discussion. The discussions and feed-back can be used in later rounds of wargames, improving organizational and response strategies.

Wargames are excellent educational exercises for major players who will be involved in low probability /high cost events. Both private and public sectors in the related areas should be involved in planning and playing a game.

A crucial part of the wargame exercise is a serious review to ensure that reforms or actions recommended in the report have been implemented within 6 to 12 months. Otherwise the game and resulting postmortem studies of the wargame are just an expensive waste of time, ignored and filed to gather dust. The public dissemination of wargames and their results is a critical part of the wargame process. Open discussion and evaluation are important as an educational exercise.

2. Pre-Covid -19 Pandemic Stress Testing and Wargames:

2.1 A Partial History of Pandemic Wargames and Reports:

Since the onset of the Corin-19 virus, the media has discussed examples of previous epidemics, the public response, subsequent reports and preparations. These reports, and the lack of subsequent policy action do not make encouraging reading.

2.1.1. US Forensic Report on the 2014-15 Ebola Pandemic:

The Ebola epidemic was first diagnosed in West Africa in 2014. The World Health Organisation (WHO) did not have the resources to respond adequately. The US, realising this was potentially

a very dangerous international pandemic, responded to seal off the virus before it spread and provided aid to West Africa. A number of lessons, summarised in a forensic report by Kirchhoff (2016), were learned from this episode.

The report discussed several findings, dealing with lack of preparation in organizations, communication across agencies, lack of appropriate equipment and effective response strategies. Widespread international mobility made pandemic transmission an increasing risk. Kirchhoff observed that humanitarian, military and health responders were not prepared when running periodic wargames.

Another important finding was the limited use of pandemic modeling in predicting outcomes and strategies. The standard models in use at that time proved badly deficient in predicting the spread of the pandemic and incorporating social behaviour and its impact on the propagation and severity of the virus.

In a recent interview Kirchhoff (2020) observed that these deficiencies had not been rectified in the US.⁵ The deficiencies had become apparent when Covid-19 hit the US.

2.1.2. The US Pandemic War Game in 2019:

In March 2020, the New York Times leaked a report of a 2019 war game of a simulated “Crimson Contagion” in the US.⁶ The report dealt almost exclusively with the health, organizational and communication deficiencies that appeared in the game. This was an

⁵ See Kirchhoff (2020) <https://www.statnews.com/2020/03/24/chris-kirchhoff-ebola-coronavirus-response/>

⁶ See The New York Times 2020: <https://int.nyt.com/data/documenthelper/6824-2019-10-key-findings-and-after/05bd797500ea55be0724/optimized/full.pdf>

important war game that found organizational and communication weaknesses in the Federal and State agencies that would deal with a pandemic.

Both this game and the Kirchhoff Report make no mention of the economic, financial, fiscal and social implications of strategies to contain the virus. If economists and other experts had been consulted, the economic, social and fiscal consequences of various strategies should have been gamed. Future sections of this paper will explore this deficiency in detail.

Similar observations apply to many other countries. The US had at least made some preparations. Had other countries created forensic reports and/or acted on them?

2.1.3. The 2007 Ontario SARS Commission Report:

Another example of public policy failure was an Ontario-commissioned 2006 report on the SARS outbreak in Ontario in the early 2000's.⁷ The report was damning, arguing that the Ontario health system was underfunded and woefully unprepared for a major epidemic. It made a number of recommendations to increase preparedness in equipment, organisations and funding. In a Royal Society of Canada (2020) report, it has been alleged by experts in the area that these recommendations were ignored. Media reports have revealed disgraceful and tragic results in some Ontario nursing homes, where lack of preparation and public monitoring lead to many deaths and suffering in squalid conditions.

2.1.4. A History of National and International Pandemic Wargames:

The US and Ontario cases are not isolated examples: they are representative of a systemic problem. An April 2020 a Canadian magazine article revealed a long history of national

⁷ See SARS Commission Report, Ontario (2008).

and international pandemic wargames beginning with the HIV outbreak in the 1980's.⁸

The report summarized some of the games and responses. It is not clear that these games explored economic, financial and fiscal implications of various quarantine strategies. But it does quote several senior health and political figures involved in the games, saying that little had been done in many countries to use the games to influence policy and organizational structures. Neither were the games used consistently to prepare senior policy makers for implementing the best policy responses in various plausible strategic scenarios. These revelations should trigger a forensic report by an independent team of professionals in the relevant areas recommending remedial action.

2.2. Pandemic Computer Models: Strengths and Limitations:

Computer models are one of the major tools used in constructing strategies combatting an epidemic. There is a well-developed literature on computer simulation models of epidemics. A recent, detailed survey summarizes different pre-Covid-19 methodologies in constructing predictive models of pandemics, exploring their strengths and limitations.⁹ This class of models have a number of well-known limitations which modelers freely admit:

1. There are gaps in the data, e.g. estimates of the scale of benign or asymptomatic infection rates. Various historical episodes are used to estimate parameters that are inputs for

⁸ See Macleans <https://www.macleans.ca/news/world/the-doomed-30-year-battle-to-stop-a-pandemic/>

⁹ See Chowell et al (2016) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5348083/>
See also The Economist article reporting over- and under-estimation of the severity of the epidemic. Many of these pre-Covid-19 models were updated to fit the recent data.
<https://www.economist.com/graphic-detail/2020/05/23/early-projections-of-covid-19-in-america-underestimated-its-severity>

models. Biased or noisy data will make the best theoretical model's results suspect.

Either the results will be biased and predict too low or too high infection and mortality rates; or they will provide a wide range of contingent outcomes, giving little guidance for policy.

2. Particular model methodologies have their own theoretical and empirical strengths and weaknesses that can bias results.
3. The results provide a range of outcomes *conditional* on different estimated parameters, and social/health policies. The models predict time profiles of infection and mortality rates *conditional* on the parameters and policy responses. Unconditional predictions provide poor predictions and can be highly misleading.
4. Back-testing reveal the limitations of some of these predictive models.¹⁰ (Models are back-tested by using a number of predictions at previous periods and then comparing those sample predictions with subsequent observations. This standard methodology will reveal any systematic biases or other limitations of the predictive power of the model.)

The limitations of pandemic models are not restricted to this class of predictive models, but are common in other areas of science and economics where predictive models are used. We will give two examples to illustrate the limitations of predictive models. The limitations of predictive

¹⁰ A recent study by Funk et al (2019) used the Ebola virus outbreak in 2013-16 to test the reliability of standard models. This study showed reliable predictions out to one or two weeks, but there was increasing unreliability for longer periods, reflecting the high degree of uncertainty in the processes driving the models:
<https://journals.plos.org/ploscompbiol/article/file?id=10.1371/journal.pcbi.1006785&type=printable>

See also the paper by Ioannidis, Cripps and Tanner (2020) which is highly critical of many forecasting models used in the crisis.

model methodology is common across fields.¹¹ Understanding the strengths and limitations of predictive models are extremely important for their use in forming public policy strategies.

2.3.1. Example 1: Financial Risk Management Models:

Risk managers and financial regulators have long grappled with the limitations of modeling financial markets, credit, market funding, liquidity and systemic risks.¹² The fundamental issues that we saw in pandemic models have long been recognised in financial risk management models: data limitations, model choices, strategic choices impacting outcomes, etc.

Model back-testing is standard practice in attempting to validate financial models. Many models show their limitations in back-tests, especially in Plausible Worst Case (PWC) events. PWC events are extremely difficult to predict with statistical models because extreme data points are sparse and/or non-stationary, and model predictions often lack statistical and predictive robustness.

Some statistical models attempt to accommodate PWC events by modeling distributions with “fat tails”. But these models rely on few data points in the tail, so that distribution parameters are estimated with a serious lack of precision.

To complement the statistical models used for “normal” times, financial stress tests are widely used to deal with PWC tail events. In some limited cases, financial war games are used for PWC

¹¹ See the excellent discussion by a mathematician, economist and climate scientist:

https://www.youtube.com/watch?time_continue=1&v=5MoE1-Fi-Ko&feature=emb_logo

¹² See the text book discussion of market risk modeling by Dowd (2005), *Measuring Market Risk*, Second Edition, Wiley 2005. See also Milne (2008), (2009) for detailed discussions of the problems with risk management models, particularly credit, liquidity and systemic risks since the financial crisis of 2007-9. <https://www.bankofcanada.ca/wp-content/uploads/2010/06/milne1.pdf>

downside scenarios. We will explore these techniques in more detail below.

2.3.2 Example 2: Climate Models:

There is a lively debate between Climate Change modelers over the strengths and limitations of models used by the IPCC in recommending policy on Global Warming or Climate Change.¹³

The same methodological issues that are raised in the epidemic and financial risk management models appear in the climate models: data limitations, parameter estimation, theoretical model choices and policy choices that impact climate outcomes.

Back-testing shows that many climate models have significantly over-predicted global warming over the last two decades. There are similar problems with models predicting sea level rises,¹⁴ weather extremes, hurricane frequency,¹⁵ etc. Predictions from these models cover very long periods in the future. It has only been recently that sufficient time has elapsed from early predictions to compute more reliable back-testing. Many previous models predicting strong temperature increases have been falsified by back-testing: predictions of temperature increases have been too high.¹⁶

3. Financial Stress Testing:

¹³ For example, see the readable survey by Curry (2017): <https://www.thegwpc.org/content/uploads/2017/02/Curry-2017.pdf>

And a for more detailed, technical version, see Curry (2016): <https://curryja.files.wordpress.com/2016/11/climate-models.pdf>

¹⁴ See Curry (2019a) <https://curryja.files.wordpress.com/2018/11/special-report-sea-level-rise-3.pdf>

¹⁵ See Curry (2019b) <https://curryja.files.wordpress.com/2019/09/sr-hurricanes-6-v2.pdf> and Alexander (2020) <https://www.thegwpc.org/content/uploads/2020/06/Alexander-Weather-Extremes.pdf>

¹⁶ Moreover, when models have provided a range of predictions, the media often report only the most alarming and sensational results.

3.1 The History and Methodology of Stress Tests:¹⁷

Stress tests have a long history in engineering where structures are tested for their durability under extreme conditions. The idea has been adapted in banks and other financial institutions where stress testing refers to modeling exercises where extreme events are used to test for the size of losses in trading, credit or other areas of the institution. Before the 2007-2009 global financial crisis, most bank stress tests were conducted within banks. But since the crisis regulators have conducted stress tests at various levels: at the individual bank level and in some cases, simultaneously across banks.

A stress test for a bank begins by outlining a financial and economic scenario which implies losses in the trading and credit books of the bank. The aim of the exercise is to estimate the potential losses due to such a scenario. Banks will try various scenarios over time adjusting the scenarios that they think are possible but have a low subjective likelihood. The scenarios will often use empirical data or experience from previous crises. This methodology was widely used in the banking sector before the Great Financial Crisis, but its use was limited to particular sections of banking operations and rarely as bank-wide, integrated tests. Most regulators ran stress tests of banks, relying on older methods to monitor bank risks. The Great Financial Crisis provided strong evidence of failures in many standard risk management practices, particularly in banks with weak risk management systems. The failures occurred in both the private sector and the regulatory system.

3.2. Risk Management Practices and the GFC:

¹⁷ See Dent and Westwood (2016) for an excellent introduction to stress testing methodology:

3.2.1 GFC Failures in Risk Management and Subsequent Innovations:¹⁸

Risk managers and financial regulators have long grappled with the limitations of modeling financial markets, credit, liquidity and systemic risks.¹⁹ Before the GFC, risk management models were regarded as being accurate, protecting banks from major losses. For example, market risk are the risks that investment banks and trading arms of commercial banks were exposed to in their financial trading operations. These trading operations were based on theoretical and statistical models that required strong assumptions for their pricing and hedging.

Model limitations were described as model risk. Different models were used to try to deal with real complexity. Astute risk managers attached to trading floors were constantly back-testing models for accuracy by observing outcomes. Using experience and knowing the limitations of specific models were crucial to avoid large trading losses. The models rely on important parameters that can only be estimated with error. Therefore, the models should have been run with a range of plausible parameter estimates to detect possible hedging losses. The risks associated with parameter estimation were described as estimation risks.

One of the major errors that risk managers can make is to rely solely on models that seem to work well in “normal times”, where price movements are relatively small and described well by well-known stochastic process models and their estimated parameters. But if there are major disruptions with large price movements, especially when different asset prices, rather than

¹⁸ This section draws upon Milne (2008) and (2009).

https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed//commentary_26_9.pdf

<https://www.bankofcanada.ca/wp-content/uploads/2010/06/milne1.pdf>

¹⁹ See Dowd (2005) for a text book discussion. For a more general discussion of risk management modeling used before the GFC, see Crouhy, Mark and Galai (2000).

moving independently begin to move together, normal time hedging strategies can fail dramatically with large losses. An additional concern is that hedging strategies that rely on liquid markets can discover that, in a crisis, markets can become “thin” so that trading even at normal levels will move prices against the trader and, in extreme cases, it will be difficult to find traders on the other side of the trade. This lack of functioning markets in key financial assets can destroy hedging strategies, creating heavy losses for banks and other institutions.

Another example revealed in the GFC was the misuse of credit and trading models, especially for mortgage-backed securities. In the lead-up to the GFC, housing markets in key areas of the US, Ireland and some other countries showed all the signs of an asset bubble, with poor credit underwriting standards on many mortgages. When the real estate markets peaked in 2006 and began to fall in 2007, the losses appeared in derivative asset prices based on the failing mortgages. By the middle of 2007, the market losses began to work their way through the financial markets, until the magnitude of the losses became apparent on the balance sheets of major banks and financial institutions around the world.²⁰

One technique that attempts to address the problems inherent in model and estimation risk is to use stress tests. A financial model stress test imposes an extreme scenario using either past data or constructed data to test the accuracy and reliability of the models. This can be extended to models in related areas in the bank to check for interactions in trading and credit strategies, checking for potential large losses.

During the GFC it became obvious that some banks had been prudent in their use of models,

²⁰ The insurance company IAG, had a large business insuring defaults on mortgage -backed securities. Using flawed models, IAG suffered huge losses when mortgage defaults increased dramatically.

understanding their limitations and acted to remedy deficiencies. Other banks had been imprudent and suffered accordingly.

To summarize:²¹

- (a) Back-testing is standard practice in attempting to validate models. Many models show their limitations in back-tests, especially in extreme market conditions.
- (b) Stressed market conditions are extremely difficult to predict with statistical models. Data is often sparse and non-stationary, so that model predictions often lack statistical robustness.
- (c) To complement the statistical models used for “normal” times, stress tests are widely used – or in some limited cases financial war games, for extreme downsides.

3.2.2 Concurrent Financial Stress Tests Run by Regulators:²²

A more ambitious stress test used by regulators is a concurrent stress test where the regulators present several banks under their jurisdiction with the same scenario. The banks will each use the scenario to run their own stress tests independently. Then the regulator checks the results comparing how each bank fares, looking for inconsistencies or weaknesses in banks’ balance sheets and income statements.

Stress tests play an important role checking for weaknesses in the banking system and educating risk managers and regulators. It is important that the stress tests be used constructively so that

²¹ The methodological modeling issues that we saw in pandemic and climate models reappear in financial risk management models: data limitations, model choices, strategic choices impacting outcomes, etc.

²² This is a complex topic and we will merely sketch the main points. For a detailed discussion of this material see the report by the BIS (2017).

any bank weaknesses can be rectified promptly. Stress tests have a number of well-known weaknesses. We will mention three of the most important.

- (a) Stress tests rely heavily on models of assets returns and credit losses. As noted earlier these models can be quite reliable in “normal” times where the data falls well in the range of past observations: the distribution of returns can be estimated with some confidence. But in a stress test scenario, the asset returns will be from the extreme tail of the assumed probability distribution; correlations can change dramatically, so that the estimates of returns in the scenario will lack statistical significance.²³
- (b) Stress tests of a single bank do not consider the impact of a single bank’s insolvency on the rest of the banking system, where losses are transmitted through the interbank market. Some central banks use top-down models of bank networks to consider solvency issues that arise in interbank markets.²⁴
- (c) A weakness of the basic top-down network model is it does not allow for bank reactions in trading, adjusting their assets and liabilities when reacting to a severe economic and/or financial scenario. Central bank models have attempted to accommodate this criticism of their network models by appending liquidity modules that allow for price movements induced by large asset trades by banks in the network.²⁵ Given the complexity of this modification, it requires a number of modeling short-cuts that are not entirely satisfactory.

²³ For a detailed analysis and strong critique of modeling issues in two concurrent stress tests by the US Federal Reserve and the Bank of England, see Dowd (2014) (2016)

²⁴ For the Bank of England’s RAMSI model see: Burrows, Learmonth, McKeown and Williams (2012).

²⁵ For example, see the discussion of the Bank of Canada’s MFRAF model in Figue (2017).

Another approach that exploits agent interactions and reduces the heavy reliance of models, is to use wargames or exercises. Wargames often use modeling as an input, but their use requires understanding of their limitations. Specialists in various areas who play the game, provide professional experience and judgement that models can seldom achieve.

4. Pandemic, Economic and Financial Crises: Joint Stress Testing and Wargames:

In this section we discuss the use of wargames that integrate the lessons from the GFC and the medical wargames prior to the Covid-19 crisis. It has become obvious that many of the policies attempting to reduce the spread of the virus have had significant social, economic, financial and fiscal consequences. At times, decision-makers have been ill-prepared for dealing with the various consequences of their policy actions. For decision-makers to have a better understanding of the consequences of various policy options, we advocate the implementation of regular, integrated wargames that test these aspects of a pandemic.

4.1. Medical Lessons from the Covid-19 Crisis:

The current pandemic has been evolving rapidly with increasing discussion of appropriate policy responses. The results of the Crimson Contagion game, the Kirchhoff Report and other wargames were useful guides pointing to the failures in national health responses. There are serious discussions by epidemiologists concerning weaknesses in current medical data on comorbidity rates, mild/unreported infections and their impact on estimated mortality rates. In turn this has resulted in a professional debate on the predictive power of pandemic models that were used in the early months of the crisis. Some models had major problems predicting the course of the virus and its fatality rates. These limitations added to the uncertainty

over the choice of appropriate responses to the virus.²⁶ In the last few months, there have been some advances in modeling the spread of the virus and fatality rates by using more disaggregated data and modeling strategies. Although it is early days, these developments are very welcome.²⁷

The medical sector has come under serious stress with increased workloads in key areas.

Resources have been switched from lower priority areas to pandemic related areas. These areas were constrained in the short run because specialized capacity took time to adapt. For example, there were shortages of surgical masks, ventilators, and other equipment. Supplies of critical drugs, testing kits and physical equipment have been in very short supply, requiring rapid increases in production, sometimes from non-standard suppliers. Vaccine development and production are very time consuming: as a rule of thumb, the more effective the vaccine, the longer the period of development, requiring careful testing for effectiveness and serious side-effects. A number of potential vaccines are being fast-tracked in emergency programs.²⁸

There have been strong incentives to slow the spread of the virus by distancing rules, testing, and increasingly severe quarantine regulations. (The extreme quarantine strategies are known as the social and economic lockdown strategy).

Some countries and regions had their medical systems severely stressed; whereas many other regions had idle pandemic medical capacity. Ongoing data analysis is trying to identify key economic, demographic and geographic variables that explain these variations. Some authorities

²⁶ See Adam (2020) and <https://www.economist.com/graphic-detail/2020/05/23/early-projections-of-covid-19-in-america-underestimated-its-severity>

²⁷ For example see Ellison (2020).

²⁸ Uncertainty over the timing, effectiveness and availability of a vaccine is critical in developing strategic responses. Wargames should explore various scenarios where vaccines are available early or late in a pandemic.

have asserted that a lockdown was the optimal strategy.²⁹ But this strategy is open to question, given the experience of some regions or countries with lower death rates, which did not implement a full lockdown strategy, using a more targeted quarantine and testing strategy³⁰. Some countries used a combination of aggressive testing and intermediate restrictions concentrating on sections of the population that were most vulnerable.³¹

It has become apparent in many countries that lack of testing and the availability of appropriate tests hampered a clear evaluation of the virulence and lethality for various demographic groups. A number of eminent epidemiologists questioned the quality and interpretation of existing data used to inform policy.³² Many governments made statements that lockdowns would last for many months. Such unconditional statements ignored the high uncertainty relating to the spread of the pandemic, and the lethality/virulence of the virus. The evolution of knowledge and appropriate data can make unconditional statements obsolete within a few days, diminishing respect for the integrity and competence of government policy.

Changes in information and confusion about what is going on can and should be incorporated into wargames. For example, as the Covid-19 epidemic spread, more accurate data, and testing

²⁹ Lockdown is a generic name for a range of quarantine policies of varying degrees of severity. Media reports often do not discriminate between the various policies, leading to public confusion.

³⁰ For example, see Germany, South Korea, Japan and Taiwan. Within the USA, the highly varied experience of different states will require careful study, exploring quarantine and testing strategies, demographics, time of onset of the epidemic, etc. See this site for USA state data: <https://www.worldometers.info/coronavirus/country/us/>

³¹ Japan, South Korea and Taiwan are examples using this strategy. It is important to note that these countries had previous experience with viruses that emanated from China. They appear to have been well prepared. Careful study of these countries' policies and experience with the Covid-19 virus would be prudent.

³² For example, see Roussel et al (2020); and Ioannidis (2020).

has revealed patterns that have allowed more targeted responses and reduced the worst fears of massive numbers of deaths.

Deaths appear to be overwhelmingly concentrated in the very elderly and those with immune deficiencies. There has been confusion – whether due to current medical evaluations, or media reporting - on the likelihood of transmission of the virus by carriers. It was not clear that people who were infected in the past, and have antigens in their system, were benign or silent carriers. This is important information as a clear answer either way has major implications for quarantine policies.

4.2 Economic Lessons from the Covid-19 Crisis:

Lockdown policies extending over months severely stress social, economic and financial systems in a profound and complex manner. To understand those consequences, one requires detailed microeconomic and institutional analysis. Partial equilibrium economic models help in evaluating industry impact. But there are profound systemic effects that require explicit or implicit general equilibrium analysis. This analysis requires ex ante and ex post tactics and policies that are far beyond conventional – and inadequate – conventional macroeconomic and financial macroprudential policy analysis.

For example: uncertainty about the length of the emergency measures substantially reduce consumer expenditures and firm sales as consumers and firms become increasingly cautious in their consumption and investment plans.³³ This prudence leads to dramatic falls in some durable

³³ Labour law also requires that employers have a safe workplace for their employees. Indeed, in Canada (and elsewhere) employees who believe their workplace is unsafe can refuse to work until it is inspected by the relevant authorities. Firms may also have legal risk if they are totally negligent in taking steps to ensure the safety of customers entering their premises.

good purchases, luxuries and firm investment. Unemployment has risen rapidly to levels that far exceed unemployment in the GFC.³⁴ These unemployment levels have obvious social and economic consequences.

Many governments have introduced large increases in current expenditure on social welfare payments, loans and various employment subsidy schemes. These economic measures require governments to run large deficits, with commensurate dramatic increases in government debt. The expenditure and loan schemes have been put into place quickly, in many cases without adequate safeguards and preparation prior to the pandemic. In some cases, there will be unfortunate consequences:

- (a) obvious major anomalies in application will surface in future audits.
- (b) The schemes will be more open to fraud than typical government programs because safeguards will be inadequate.
- (c) By the time the schemes are fully operational, the main crisis may well have passed, so that expenditure may be inappropriately targeted before the schemes are wound down.
- (d) Loan schemes fed through banks, create major conflicts with prudent credit procedures and bank supervisory rules. This is especially true for schemes that fail to discriminate between standard loans, simple wealth transfers or combinations of both.³⁵

Central banks have used unconventional monetary policy to support fiscal policy and buffer the output and employment losses. This policy has often meant large increases in the central bank balance sheet and concerns about the monetization of the increased government debt. Such

³⁴ Many countries have implemented employment subsidies which imply seriously understatement of official unemployment figures.

³⁵ When loan officers are making credit decisions, they will consider government loans, querying the bank's priority in the list of creditors. For example, if the government loan is prior to the bank loan, then the bank loan will attract higher credit risk and a commensurate higher interest rate. Conversely, if the "loan" is a wealth transfer, that will reduce the credit risk of the bank loan.

monetization is likely only in central banks which lack independence or are not committed to price stability.

Shutdowns and quarantines have been instituted to contain the pandemic. Sectors of the economy have been graded from “essential” sectors through to “inessential” sectors. Inessential real sectors were partially or completely shut-down by government fiat – these sectors suffered a collapse in revenue. They operated for weeks with drastically reduced operations, cutting employment and variable costs. Some firms in these sectors may never reopen. Shutdowns induced a dramatic increase in lay-offs and unemployment as companies struggle to keep valued employees, unsure when they will be allowed to resume operations. Government agencies dealing with unemployment have come under stress as they struggle with the increased workload.

Companies are restricted by their reserves of working capital. Banks have been struggling to analyse extensions of credit given the uncertainty surrounding the length of time that government quarantine restrictions will be enforced, and the terms of government loans and subsidies.

Reductions in private sector activity will work their way through collapsing supply chains, retailing and wholesale sectors. While many inessential services have shut down, other sectors have seen increased demand for their services. This has implied a dramatic redistribution of income and wealth within the economy.

Given the speed of the evolution of the pandemic, and market reactions, governments have tried to keep pace with economic policies. Government departments have tried to obtain appropriate and timely data: in some cases, the data had not been collected, or was difficult to collate

from various systems. There are the inevitable lags with bureaucracies struggling with new procedures and programs.

Attempts to predict which sectors would be badly impacted by lockdown policies have been hampered by the complexity of the modern economy. There are many subtle economic connections between different real and financial sectors of the economy and the labour force.

4.3 Stressed Domestic and International Supply Chains:

Domestic supply chains have been disrupted. Some products (e.g. food) so far have been exempt, but manufactured products dependent on various component manufacturers have suffered major or minor disruption. Disruption in a single key component can halt production of an end-product. Just-in-time warehousing policies, designed to minimize normal time costs, will be highly vulnerable to broad-based lockdown policies. International supply chains – largely originating in China – were disrupted for the first couple of months, but now appear to be coming back on-stream.

How reliable these suppliers are, in terms of providing the quantity and quality of goods ordered, is an open question, depending upon Chinese government policy and changes in Western government trade and strategic policies. More generally there is a lively debate on the reliability of foreign suppliers, especially in key strategic commodities e.g. pharmaceuticals, which are largely supplied by Chinese manufacturers.³⁶

³⁶ See this June 2020 article in the Financial Times discussing the EU problems with international supply chain reliability: <https://www.ft.com/content/af39c6d2-ae1e-4d0b-ba5b-121d12b22647>

4.4 Financial Market Responses:

Until early this year, the US stock market was regarded as overvalued by astute investors. Valuations had been boosted by the popularity of share buy-backs, resulting in increased leverage and elevated stock prices. Thus valuations were highly sensitive to major declines in profits. Indeed, many of these highly levered companies have seen heavy reductions in revenues and profits during the pandemic.

Stock market volatility has increased dramatically, so that it replicates the worst period of the 2007-9 crisis. The volatility is a result of continual revaluations driven by revelations about the disease, its prevalence, and death rates, as well as significant changes in information about the length of national lockdown strategies. Uncertainty about the length of the lockdown period, combined with many governments not being clear about conditions determining the length of the lockdown period, has created increased uncertainty surrounding projections of future revenue, costs and profits. In turn this is factored into financial valuations of stocks, corporate bonds, and derivative securities.

4.5 The Impact of Covid-19 on Credit:

Household credit is highly vulnerable to major declines in household income. Unemployment is a major factor in declines in household income, although this can be buffered by government transfer policies. Sudden increases in regional unemployment lead to credit stresses especially in consumer credit and mortgages. This in turn leads to increases in loan losses for financial institutions and, in extreme cases, failures of financial institutions. The GFC was an excellent example of the consequences of mortgage losses for unemployment, consumer spending and

wealth.³⁷

Corporate leverage and revenue declines lead to increased risks of corporate defaults. As firms see major declines in working capital, banks must attempt the difficult task of calculating loan losses contingent on government lockdown and recovery policies. These risks are compounded by the uncertainty surrounding various government loan subsidy programs, and pressure from bank regulators to relax prudent lending practices. As government policies in this area have changed rapidly, with considerable ambiguity, bank compliance departments and boards will face unenviable decisions.

Government loan policies are problematic as they increase corporate and household leverage and default risk, unless some of the government subsidised debt will be forgiven or interest rates are below (pre-existing) market rates. i.e. it is an effective subsidy. Any subsidy should be ex ante explicit so that private agents are not exposed to credit risks arising from uncertainty over the duration and size of subsidies that are difficult to compute with any accuracy. We are seeing the effects of such uncertainty playing out in the US.

In the EU, some countries, which have not recovered from the GFC, are in serious fiscal difficulty with heightened default risk on their borrowing. The structure of the EU and its fiscal and banking rules have compounded the difficulties.

4.6 The Limitations of Conventional Macroeconomic and Monetary Modelling:

Conventional macroeconomic modeling use “shocks” to drive variations in aggregate economic activity. These models are too aggregated and limited to deal with some

³⁷ See Mian and Sufi (2014).

of the most damaging effects of pandemics (and other major environmental “shocks”) to an economy. Microeconomic and financial details are critical in formulating policy responses to such external events.³⁸

To illustrate this argument, consider the following example. A major disruption to the real economy may *not* create a major banking crisis. That depends on the degree of leverage in the and financial system; and on the efficiency of the bankruptcy system. Consider an economy that has very low consumer, corporate and bank leverage. i.e. high equity capital ratios. Then consider a major decline in income for the real economy. Firms and households will suffer large equity losses long before defaults flow onto bank balance sheets.

Conversely, assume high financial leverage. Then moderate declines in income will create credit stresses in the financial system, appearing directly on bank balance sheets. If the bankruptcy resolution systems work quickly and efficiently for public companies, this will reduce economic losses that would have been induced by lengthy and uncertain resolution procedures. For private companies and individuals who are largely reliant on bank loans, the effectiveness of banks in speedy resolutions, will minimize additional economic losses and reduce the impact of the initial shock.³⁹ Corporate bankruptcy systems, if they are inefficient in dealing with resolutions, can introduce another layer of real losses, destroying economic value. Small businesses and consumers who become bankrupt can create value losses if banks and other creditors create inefficiencies in the resolution process.⁴⁰

³⁸ For example, see Kay and King (2020, Chapters 19 and 20). They discuss the limitations of standard Macro-Money models and their poor track record in many crises.

³⁹ These additional losses are sometimes described as “amplifiers”.

⁴⁰ See Crean and Milne (2020) forthcoming for a detailed discussion.

The losses imposed on the real economy are redistributed through the financial system to equity and debt claimants. At the same time, government policies will attempt to redistribute the real losses via subsidies, taxes and government borrowing to reduce inequality. The ultimate incidence of the losses will be transferred across classes of agents now and in the future in ways that can be difficult to compute with any accuracy – especially in a crisis. Another industry that is vulnerable to major economic disruptions is the insurance industry. For example, a major earthquake on the West Coast of North America would create major property insurance claims.⁴¹ But what may surprise many analysts are the major insurance claims for business disruption and cancellation or postponement of major events. Contracts have had definitional problems, creating confusion and legal claims by businesses. Lloyds of London estimated 2020 underwriting losses, as a result of Covid-19, to be approximately USD107 bn.⁴² The insurance industry and related government policy play an important role in dealing with catastrophic risks. In a world with full insurance markets, with government backstops for extreme events, the losses would be born much more equally across the populace, due to diversification. But if insurance markets are incomplete or function poorly, economic losses can be concentrated on a segment of the population with severe consequences for their economic welfare. In turn these losses can impact the banking system, and other related sectors.⁴³

4.7 Thinking Through the Microeconomics of Pandemic Disruptions:

A pandemic will heavily impact the health care and economic system. The appropriate actions require careful ex ante planning to prepare the critical linkages which will come under stress.

Highly restrictive lockdown policies that are enforced for several months will impact

⁴¹ See Le Pan (2016).

⁴² See BBC May 2020 https://www.bbc.co.uk/news/business-52659313?intlink_from_url=&link_location=live-reporting-story

⁴³ See Crean and Milne (2020) forthcoming for a detailed discussion.

different sectors of an economy with varying intensity, often in subtle ways that are not obvious for policy makers relying on conventional highly aggregated macroeconomic models. Here are some disparate examples that we have observed over the last few months:

- (a) 90% of Western medications are manufactured in China. Careful analysis should have revealed ex ante scenarios where this supply chain would create major strategic stresses in the medical system.
- (b) Lockdown policies can induce severe economic supply chain disruptions for manufacturing, commerce and consumers. This is true regionally, nationally and internationally.
- (c) Australia has 3 weeks reserve of gasoline and aviation fuel. A disruption of international fuel supply chains would have severe economic and social consequences. For many years, senior Australian officials have complained about this strategic risk but they were ignored by the politicians. The current government is now trying to respond.⁴⁴ The Covid-19 crisis has drawn attention to underlying risks that had been previously ignored.
- (d) Universities that rely heavily on Full Fee-Paying international students will suffer large losses and disruption from international quarantine regulations. Many of those universities had not considered these consequences in their planning.⁴⁵
- (e) Some countries or regions with formerly high immigration rates, that supported rapidly expanding and high-priced real estate markets, can suffer falls in house prices and house construction. Coupled with increased unemployment, credit losses can rise quickly, adversely impacting consumer, business, pension funds, banking and shadow

⁴⁴ See <https://www.aspistrategist.org.au/in-a-crisis-australians-might-soon-be-running-on-empty-2/>

⁴⁵ See Beach and Milne (2019).

bank balance sheets.⁴⁶

4.8 Systemic Wargame Playing: Two Canadian Examples:

We argue that with sufficient preparation with stress tests, wargaming, and improved information systems, estimates of the distribution of the economic losses and consequences can be improved. This should allow more targeted and effective policy strategies. There may be extreme situations that are very difficult to wargame as they lie outside even the most thoughtful and creative policy planners. But there are many situations – the current Covid-19 crisis is an example – which have been wargamed in the past, albeit in a far too limited fashion. Wargaming is not a panacea, but a serious tool to be applied by planners.

Systemic war games should be adapted to cover environmental and other systemic risks. Here To illustrate this argument, we discuss two Canadian examples:

4.8.1 Example 1: A Major Vancouver Earthquake:

The Le Pan study⁴⁷ provides a detailed analysis of the implications for the insurance industry, coinsurance, etc. and ultimately the key role of Government funding back-stops. A major earthquake would lead to severe damage to commercial and domestic real estate. Insurance companies would face major claims. Some of the claims would have been reinsured on the international market, but the amounts could be so large, the British Columbia Provincial and Canadian Federal governments would feel it necessary to provide financial subsidies to the insurance companies.

⁴⁶ There have been numerous discussions in Australia about credit losses relating to real estate price declines in the major cities.

⁴⁷ Our discussion here draws upon Le Pan's (2016).

Rather than face ex post actions, a well-prepared system of risk management would have the appropriate medical, civil engineering, financial and economic procedures in place and tested regularly. There should be government contracts that stipulate conditional payments that insurance companies and banks can use in their stress tests. In the case of banks, major damage, disruption of economic activity and stress on financial balance sheets will impact credit risks. Bank lending policies would take these contracts into account.⁴⁸

Although most households in British Columbia have earthquake insurance, other vulnerable regions of Canada are underinsured for major earthquakes. Federal and provincial government actuarial analysis should take these systemic risks into account.

A major Vancouver earthquake would not just create destruction of real estate properties, it would disrupt local and national commerce, especially as Vancouver is the Pacific port for Canadian Asian trade. These effects should be war-gamed, as the cost and disruptions can be subtle, creating major systemic losses that, to the unprepared, will appear as surprising.

4.8.2 Example 2: The Ontario SARS Pandemic Experience:

The Ontario SARS Report, which we referred to earlier ⁴⁹, should have been used as the basis for routine major war games on pandemics that would test not only the health system, but the related economic and financial systems, that would be impacted by various quarantine strategies of increasing severity. It should have been obvious that so-called lockdown policies

⁴⁸ See Le Pan (2016) and Crean and Milne (2020) for a detailed analysis.

⁴⁹ See SARS Commission Report, Ontario (2008).

and associated socially disruptive policies would have major implications for economic, financial and social activity.

The key players should have detailed playbooks for systemic environmental, pandemic and other events. These playbooks would be useful guides and invaluable for training regulators, politicians and senior management in the private and public sectors. But recent reports indicate that such games were not played. Indeed, many of the SARS Report recommendations were not implemented.

5. Covid-19: The Case for Wargame Preparation:

Many governments have struggled with the implications of the Coronavirus pandemic. Clearly most Western countries were poorly prepared and scrambling to respond. Taiwan, Singapore, Japan and South Korea have historical experience with viruses emanating from China. They have evolved far less disruptive policies and responses. Their preparation and experience during the current crisis should be studied very carefully.

Health care authorities should have tested procedures for dealing with pandemic surges. These procedures should be wargamed regularly to incorporate the latest techniques and strategies. Table-top and playbooks would be barely adequate. Periodic full war games are necessary.

Although pandemics have been wargamed by health care authorities in the past, as far as can be determined from public documents, there was no adequate gaming of economic, financial and fiscal consequences depending upon policy responses. The economic, social, strategic, fiscal and political implications of quarantine policies can have very adverse long-run effects on private wealth, unemployment and government balance sheets. Some effects are obvious, but just as

important are the subtle effects that flow through the microeconomic structure of the economy. In turn, economic disruption would flow through into financial markets, and through banking systems into credit losses. Inherent economic/financial weaknesses will act as amplifiers to the initial impact of quarantine policies.

Governments have acted to reduce private sector losses by providing very large fiscal and financial assistance to the private sector. But it is apparent that at times these responses have been not planned properly, with significant inconsistencies and waste. Careful wargame preparation should have reduced these inefficiencies.

5.1. Preparing a Medical and Economic Pandemic Wargame:

In planning a pandemic wargame, one should draw on the long experience of wargaming methodology and experience that we outlined in Section 1.

The wargame should use the experience of past medical wargames, improving their methodology drawing on the lessons that we have learned in the Covid-19 episode. As we observed earlier the earlier wargames did not provide adequate preparation for a pandemic. A major review should aim to improve medical wargames, and the medical preparations for periodic pandemics.

The economic, financial and fiscal consequences of the current pandemic have illustrated a serious lack of preparation in understanding subtle economic consequences of policies that have been implemented to combat the pandemic. Since the GFC, financial regulators and central banks have created a regulatory structure for reducing financial stability risks. This structure includes regular stress tests for institutions and system wide stress tests.

The next step is to incorporate periodic wargames, to test the institutional structures, procedures

and the effectiveness of key decisionmakers. Regular wargames train existing and new decisionmakers in the latest procedures. A system-wide wargame allows decisionmakers in different organisations to become familiar with the key players, so that in a real pandemic, communication channels have been forged in the wargame reducing confusion and increasing the efficiency of decision-making and implementation.

Finally, both the Medical and Economic wargames should be merged into a combined game so that both systems can be synchronised, allowing political, private and public sector decisionmakers a clearer understanding of the major issues and their consequences.

Such a wargame will be a costly exercise if it is done properly. But the costs of poor preparation are now only too evident. Regular wargames can reduce the costs of a real pandemic.

In the next subsections, we discuss some issues that have become apparent during this pandemic and should be incorporated into the combined game.

5.2 Government Communication Policies are of Critical Importance:

Communication policies are critical in managing public information, combatting rumours, lies and panics. These effects should be incorporated into systemic wargame. Social media and conventional media can amplify rumours and spurious stories, generating public panic and political pressure, inducing poor political policy choices. This does not imply that genuine open debate should be stifled – an open, informed analysis is crucial in formulating good policy. Government communication should be timely and avoid ambiguity. Where there is underlying uncertainty, governments should convey that information and explain the consequences for policies. The following example illustrates this argument.

5.2.1 An Example of Uncertainty Associated with an Effective Vaccine:

A good example of uncertainty is the discovery and introduction of a vaccine for the Covid-19 virus. The timing of an effective vaccine is fraught with uncertainty. Consider three scenarios that could be incorporated into a wargame. The first scenario describes a situation where an effective vaccine will be fully operational within a very short time span (e.g. three months). Now this scenario will provide incentives to have a short, strong lockdown policy to flatten the curve, because the economic and social costs will be relatively small. Conversely assume that a vaccine will take years to become operational. Now this situation could provide incentives for a sequence of strong lockdown policies with intervening relaxations; or conversely, a more restrained quarantine policy that is less socially and economically costly, hoping that herd immunity will eventually stem the spread of the virus.

A more realistic scenario considers the two previous scenarios with subjective likelihoods associated with each scenario. Policy makers face a difficult situation, where a strategy taken with all due care ex ante, can appear to be incompetent with hindsight.

5.3 Developing Communication Policies for Contingent Strategies:

The previous example makes clear the uncertainty facing policy makers. What does this imply for communication strategies? Ambiguity and uncertainties should be communicated to the public as clearly as possible. Policies contingent on current and evolving information should be explained carefully to avoid the impression of incompetence that is tempting with 20-20 hindsight.

Given that early in the Covid-19 crisis, there was great uncertainty on the degree and severity of

the virus, the impact on various demographics, and the effectiveness of various treatments, policy communication should have outlined simple contingent policy responses. Although many governments attempted such contingent communication strategies, there were many examples of vacillation and changing objectives (mission creep in military jargon). A good example of the latter was the evolution of a policy of “flattening the infection curve” into “eradication of the virus”.⁵⁰ Why this policy objective evolved was never made clear.

Errors should be acknowledged in a timely fashion. Correction of errors should be explained carefully so that the public is informed, and critics using 20-20 hindsight can be combated. Political and bureaucratic dissembling and confusion will erode trust. Once public trust in authorities is lost, the public will be open to manipulation by unscrupulous political operators and demagogues.

Economic rent-seekers will attempt to shape policy to their advantage. With great uncertainty over possible treatments, the effectiveness of specialised equipment, exemptions from lockdowns, etc., rent-seekers have incentives to exploit the media, pushing politicians into making imprudent expenditures and policies. The rent-seekers should be exposed to the public.

Unscrupulous journalists and political opportunists will use sensationalism and the usual battery of dishonest tricks to attract fame and political leverage. All sorts of bizarre claims and policies

⁵⁰ The latter objective is effectively impossible in the near term. Governments that boasted that they had eradicated the virus, faced subsequent outbreaks – and embarrassing questions of competence. The State of Victoria in Australia is a classic example. The State government boasted that they had fully contained the virus with tough lockdown policies. Subsequently, international traveller quarantine procedures were bungled, creating a dangerous surge in virus infections and a dramatic reintroduction of a strong lockdown. The State government is facing accusations of incompetence.

have been advocated by fringe political activists and websites. They attempt to gain traction by fostering panic. This behaviour is hardly new. The best remedy is exposure by a calm government which refuses to be panicked.

During a pandemic, hostile countries will attempt to use social media to sow distrust and panic to weaken a government and the country's economy and strategic position. They too should be exposed using credible information, and the public warned of their nefarious activities. In certain extreme cases such websites could be banned on the domestic web or at least signalled to the reader in a bold statement as the site appears.⁵¹

5.4. The Results of a Pandemic Wargame: What Happens to the Results?

Having carefully constructed and executed a war game, the results should be analyzed and acted upon to correct equipment and employee deficiencies, change organizational structures, procedures, etc. Wargames should be played regularly to test new systems and technologies for their resilience under stress. New risks and uncertainties appear periodically – they should be wargamed in attempt to locate weaknesses or inconsistencies with existing procedures.

Complacency is dangerous. Major unexamined risks can be very costly as they impact unprepared systems and economies, inducing panicked and very costly responses. Areas of weakness will require strengthening and periodic testing for compliance. It is incompetent to let careful reports gather dust, ignoring the lessons that have been observed in previous crises or exercises. A one size fits all approach is not appropriate: each weakness will require an appropriate remedy.

⁵¹ The most sophisticated operations by foreign intelligence operatives will attempt to hide the real source of their attack. There are ways of combatting these types of operations.

5.5. Training for Pandemic, Economic and Financial Wargames:

Currently many policy economists are woefully unprepared for this type of analysis. Few understand sophisticated strategic wargaming methods that have been developed and used by foreign policy, strategic and military analysts. Also, most macroeconomists or monetary economists in government policy organizations do not understand the complexity and limitations of financial risk management practices used by the financial sector and regulators.

Similarly, the medical policy establishment have only a rudimentary training in appropriate economic and financial theory and practice. Risk management is seen, far too often, as being highly specialized for banking and financial institutions and their regulators - and not relevant for many other social and economic policy areas.

These weaknesses should be addressed by requiring appropriate courses and training. This training should be regarded as a serious prerequisite for bureaucratic and political policy makers.

The Covid-19 virus pandemic has provided graphic examples of uncoordinated risk management and planning failures across medical, social, economic, financial and government fiscal sectors. Far too often policies appear to have been developed in specialist medical/pandemic policy silos, with scant understanding or interest in the social, economic and financial consequences. When the social, economic and financial costs became apparent, governments responded with subsidy schemes of various types. The limitations of some of these hurried schemes are now appearing.

Coordinated wargaming for the medical and social and economic systems would have made

these limitations more apparent prior to a crisis, requiring careful preparation of playbooks and systems.

Regular wargames should involve not only public and private sector professionals, but also political leaders, so that they understand the costs and benefits of policies, and the strengths and weaknesses of their procedures. They need to understand the crucial role of managing uncertainty and the importance of public communication to avoid panic and nefarious activities which exploit weakness and fear.

Conclusion:

1. There has been a clear lack of preparation by many countries in dealing with the Covid-19 virus epidemic. The resultant economic and social costs have been very large.
2. Policy decisions were taken under considerable uncertainty about the virulence and lethality of the virus. The consequences of this uncertainty could have been reduced by playing wargames so that policy makers were better prepared.
3. Although pandemic war games had been played in the past, and reports on previous pandemics written, in most cases there appears to have been little action taken to implement lessons learned, or the creation of effective and cost-efficient responses.
4. We have argued that preparation for pandemic and other major exogenous events will require regular wargames. Previous exercises have been too limited, and have not taken into account very important social, economic, financial and fiscal factors that have become apparent in the current crisis.
5. These games or exercises should include medical, social, political, economic and financial components that prepare various agents in these sectors for a major systemic event. Coordination

and cooperation in these sectors are critical in managing a crisis.

6. The results of these exercises should be available publicly for critical examination by experts in associated fields. Open debate and analysis are crucial for drawing conclusions – especially for preparing realistic, future wargames and analysis.

7. The results from wargames should be summarized by an *independent* group. They - or a related group - should review actions taken from recommendations in the game summary. That review should take place within a year while the analysis is still fresh in the minds of the participants. Lack of action should be reported publicly. The greatest danger is that bureaucratic lethargy, turnover of experienced players, etc. can blunt the lessons and dilute future preparation. As time passes, history is forgotten, and the crises are neglected - until another crisis arises with its panicked, costly response.

8. One important role of wargames is to train individuals and organizations to prepare them for emergencies. This educative process must be conducted regularly to avoid loss of corporate and organizational memory.

9. Authorities should explore appropriate public communication strategies to reduce confusion and panic.

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