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Parallels between financial regulation prior to the global financial crisis and lack of public health preparation prior to Covid-19

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Parallels Between Financial Regulation Prior to the Global Financial Crisis and Lack of Public Health Preparation Prior to Covid-19

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Parallels Between Financial Regulation Prior to the Global Financial Crisis and Lack of Public Health Preparation Prior to Covid-19

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Abstract:

In this paper, we discuss 10 parallels between the lack of preparation of financial system regulators prior to the GFC and the lack of preparation by public health authorities and governments prior to Covid-19. These parallels relate to: required stocks (of capital or equipment), data collection and sharing, lending facilities, stress testing and war games, early warning indicators and systems, contagion from abroad, operational risks, a system-wide approach (including effects on the real economy), models incorporating the heterogeneity of individuals, and effects on less-regulated parts of the system. We then go on to consider the steps that were taken to deal with each of the deficiencies in financial system regulation following the Global Financial Crisis as well as the parallel steps that now need to be taken to deal with the deficiencies in pandemic planning.

Keywords: Covid-19, economic policy, medical policy, pandemic models, financial regulation.

JEL Codes: I18, H12, H51, H84, G21, G28

1. Introduction

In an earlier paper (Longworth and Milne 2020a), we described substantial weaknesses in the preparation by public health authorities and governments for the Covid-19 pandemic. These weaknesses increased the health and economic costs of the pandemic relative to what they would have been if pre-existing recommendations had been followed and a wider set of plans and procedures had been put into place. There are a number of striking parallels discussed in this paper between these weaknesses and the weaknesses in financial system regulation prior to the Global Financial Crisis (GFC) of 2008-2009.

In section 2 of this paper, we discuss 10 parallels between the lack of preparation of financial system regulators prior to the GFC and the lack of preparation by public health authorities and governments prior to Covid-19. In each case, we start with a description of the lack of preparation by financial system regulators, followed by a parallel weakness in Covid-19 preparation. The 10 weaknesses that we consider concern:

1. Insufficient requirements for stocks (of capital and liquidity or equipment), as well as for their replenishment
2. Insufficient public disclosure of data consistent across entities regarding risks
3. Insufficient advance planning regarding various lender-of-last-resort facilities
4. Insufficient stress testing required by the authorities, including using historically stressful periods
5. Insufficient attention given to warning signs that trouble was on the way
6. Lack of appreciation of possible contagion from abroad
7. Lack of appreciation of certain operational risks, including those related to weaknesses in corporate culture
8. Lack of appreciation that appropriate regulation and planning needed to take a system-wide approach, including effects on the real economy and the interconnectedness of stresses
9. Lack of appreciation that models for looking at effects on the real economy need to incorporate heterogeneity of individuals or groups
10. Lack of appreciation of the effects of a crises on unregulated or less-regulated entities

After introducing each of the above weaknesses, we discuss the parallel lack of preparation prior to Covid-19.

In section 3 of the paper, we consider the steps that were taken to deal with each of the deficiencies in financial system regulation following the Global Financial Crisis; and the parallel steps that now need to be taken to deal with the deficiencies in pandemic planning.

2. Lack of preparation

The size and variety of problems encountered during the GFC in many advanced economies showed that financial regulators, especially bank regulators, and the institutions they regulated were not prepared to deal with substantial shocks. Five of the areas where there was a lack of preparation were where there were insufficient requirements, public disclosure, advance planning, stress testing, or attention to warnings. Another five areas were associated with lack of appreciation of what could go wrong or how problems could spread. Each of these ten areas had parallels in lack of preparation for Covid-19. In this section we discuss the ten areas where there was lack of preparation by financial regulators (and their regulated institutions) and the parallels in public health authorities and governments. In each subsection we denote part (a) for the financial problem and part (b) for the parallel Covid-19 problem.

2.1 Capital and liquidity requirements

(a) Banking regulators and other financial system prudential regulators are required to regulate the safety and soundness of financial institutions (and sometimes of the financial system as a whole). Thus, they are concerned with the solvency and liquidity of these institutions, which are often interrelated.

In good times at a financial institution, losses on some loans and other assets plus payments on deposits and liabilities are more than offset by earnings on other loans and assets. However, when the economy weakens net losses eat into bank equity capital. Therefore, bank regulators choose to impose requirements on bank equity capital, either in relation to risk-weighted assets

as in Basel I[1] and Basel II of the Basel Committee on Banking Supervision (2006) or overall assets (termed a "leverage ratio"), so as to increase the likelihood that the institutions will remain solvent. During the GFC, it became evident that the amount of capital that was required for many institutions in a number of countries was insufficient to prevent them from approaching insolvency, thus leading to government bailouts. Some countries that required higher capital than the international Basel standard performed better than those who did not.[2] As well, some countries went further than Basel by adding a requirement for a leverage ratio.[3]

Despite the fact that there were clear capital requirements, it was not quite clear what was expected of banks as their level of capital declined significantly (i) while still remaining above the requirement, (ii) while falling somewhat below the requirement and (iii) while approaching zero.

Perhaps surprisingly, given the importance of banking liquidity, there were no international standards for banks on either the requirements for bank liquidity plans or liquidity ratios prior to the Global Financial Crisis, although in 2008 there was significant discussion about what liquidity plans should contain (Basel Committee on Banking Supervision, 2008a, 2008b). Many individual jurisdictions, did, however, require some types of liquidity planning and did have at least notional requirements for the holding of liquid assets. For example, U.S. banking regulators have long had a CAMELS rating system for banks, where the "L" stands for liquidity (or asset liability management).

(b) There are some interesting parallels between these weaknesses in regulation and planning, and the weaknesses in the preparation of public health authorities for pandemics in the period prior to Covid-19. First, although there were typically numerical targets for appropriate stores of personal protective equipment, ventilators, and other equipment, it was not clear what was to happen when the amount of equipment that had not reached its expiry date fell below the

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[1] See "Basel I: the Basel Capital Accord" in "History of the Basel Committee," https://www.bis.org/bcbs/history.htm .
[2] For example, Canada had a higher required risk-weighted capital ratio, as well as requirements for higher quality Tier 1 equity capital (Longworth, 2014, p.92).
[3] This was true of Canada, as well as for U.S. commercial banks (Longworth, 2014, p.93).

requirement. Second, it was not always clear what the targets should be as a ratio of—for example, population. Third, it was not clear that all relevant senior policymakers in public health authorities and governments understood the existing plans for stores of equipment. Finally, it is not clear the detail in which plans were made for expanding intensive care units, the number of hospital beds, and the number of nurses when a pandemic struck. Some jurisdictions appeared to have limited understanding of the risks associated with running hospitals at beyond their normal capacity for extended periods of time.

2.2 Insufficient public disclosure of comparable data on risks and lack of timeliness of data

(a) At the time of the GFC, banks in many jurisdictions had to disclose some key aggregate balance sheet data on a monthly and/or quarterly basis, as well as earnings data on a quarterly basis. However, they typically did not have to disclose much industrial and geographic data on their loans, nor did they have to disclose direct data on their credit and markets risks by industry or geographical region. Differences in national accounting standards[4] and regulatory reporting standards meant that these measures were often not consistent across countries, although the data were consistent within countries and some data were roughly comparable internationally.

Although some simple liquidity ratios could be calculated from the monthly balance sheet data, in many jurisdictions banks were not required to calculate their daily liquidity positions by currency (and thus be able to report them immediately to their regulators). In some cases, the lags in daily liquidity position calculation could extend to a week. This was very problematic during the GFC.

(b) Data disclosure problems also became very evident early in the Covid-19 pandemic as problems that were generally well known before the pandemic had never been remedied. These

[4] Although International Financial Reporting Standards (IFRS) issued by the International Accounting Standards Board (IASB) were first adopted in 2004 by many countries and subsequently by many more, the U.S. Financial Accounting Standards Board (FASB) still issues its own Generally Accepted Accounting Principles (GAAP). Although there has been convergence between these two sets of standards in some areas, there are other areas where there has been no significant convergence.

data problems had strong parallels with the data problems that were evident in the financial system during the GFC. First, some of the data that should have been collected from those tested for Covid-19 (such as race, age, comorbidity etc.) were not collected from day one. Second, often the data that were collected were not stored in comparable ways across jurisdictions (e.g., in Canada across provinces), and thus it was difficult to do comparative studies. Third, reporting systems had not been constructed in such a way that all data collected on-site at a hospital, testing centre, or laboratory on a given day could be aggregated by the following morning, meaning that there was a lack of timeliness in data. Fourth, lack of timeliness in reporting deaths from all causes, disaggregated by cause, meant that it was difficult to know the number of deaths indirectly resulting from the pandemic (e.g., more deaths from cancers and heart problems, fewer deaths from car accidents, and fewer or more suicides). Fifth, differences in defining what it means to die from or with Covid-19 (rather than from another condition that led the person to be in hospital in the first place, or from complications from Covid-19 such as breathing problems) made it difficult to interpret Covid-19 death data across jurisdictions.

2.3 Insufficient planning regarding lender-of-last resort facilities

(a) Prior to the GFC, central banks had informal statements of their lender of last resort facilities for banks and similar financial institutions, or even more formal "policies" (Bank of Canada, 2004; Daniel, Engert, and Maclean 2004-05). These were typically "narrow" in scope, considering loans to individual financial institutions (on a standing or extraordinary basis) or repo facilities (either standing or on a regular auction basis) available to a group of institutions (primary dealers in government debt, or banks and other deposit-taking institutions). They were generally designed to deal with funding liquidity of institutions and not generalized market liquidity problems. The experiences from the market problems in the asset-backed commercial paper market in August 2007 and through the GFC, made it clear that careful research and preparation for generalized market liquidity problems would have been helpful in the crisis.

(b) Jurisdictions with multiple governance levels which store health-related equipment to be used in pandemics (federal government, provincial/state governments, regional health authorities, and individual hospitals and other health facilities), need to have a clear understanding who is

responsible for maintaining those stores; and under what circumstances the equipment will be lent or given (by the health equipment "lender of last resort") to lower levels of authorities. In Canada, it is not clear that such an understanding existed prior to the Covid-19 pandemic.

2.4 Insufficient stress testing required by authorities

(a) Prior to the GFC, bank regulators and central banks had begun to require individual commercial banks to carry out regular stress tests, as well as to participate in system-wide stress tests on an annual, biennial, or less frequent basis. As part of their five-year Financial System Assessment Program (FSAP) reviews for advanced countries, the IMF required a system-wide stress test in which it played an important part in the design of the stress to be carried out. Unfortunately, the two largest countries in the world, the United States and China, did not agree to have FSAPs (Longworth, 2014, p.95). In addition, the stress tests assumed for market liquidity were not large enough to capture the extreme liquidity events in the GFC.

To make matters worse, the required value-at-risk calculations for the calculation of bank capital were typically based on very short time periods and did not include historically stressful periods. The period before the GFC had been dubbed "The Great Moderation" because of its lower variability in GDP growth and price inflation, but an expression that also captured the regulatory complacency of that period.

(b) In the case of pandemic planning, there had been significant studies in various countries about what had been learned from the SARs epidemic and the Ebola crisis (see the discussion in Longworth and Milne 2020a). Unfortunately, much of what was discovered was ignored in terms of ongoing pandemic preparation. Furthermore, there is little evidence of stress testing and wargames (Longworth and Milne 2020b), especially using large stresses relative to a long span of history (e.g., using the Spanish 'flu pandemic of 1918-19) and taking into account new scientific information on diseases passing from other animals to humans.

2.5 Insufficient attention given to warning signs

(a) Through the 1990s and early 2000s, there was growing evidence from academic and policy institution sources that rapid credit growth, especially against a background of growing asset price increases, was associated with a heightened probability of a financial crisis (Kaminsky and Reinhardt, 1999; Borio and Lowe, 2002; Rajan, 2005). It was evident that some innovations in mortgages in the United States (sub-prime mortgages, alt-A mortgages, no-down-payment mortgages, low rates on the first few years of a mortgage) had led to a sizeable increase in the supply of residential mortgages; and that house prices had peaked in 2006 and were starting decline. Although the Federal Reserve understood that there were risks associated with these developments, they (i) downplayed them because they felt that financial institutions were well capitalized; and (ii) even if there were a very sizeable decline in housing prices, the direct exposure of financial institutions to mortgage loans was not large relative to that capital. Unfortunately, this downplayed the indirect exposure of financial institutions (especially investment banks not directly supervised by the Federal Reserve) to the housing market and mortgages through securitized mortgages and derivative products. Given the warning signs, it is clear ex post that the Fed had not been prepared to entertain scenarios where bank capital was inadequate relative to the potential deleterious effects of indirect exposures, including potential market illiquidity and funding illiquidity.

(b) In the first two months of the Covid-19 pandemic, the WHO and national health authorities did not give enough attention to the warning signs from early reports of what was happening in China and in general, as well as to the early spread out of China to other countries. Canada had effectively gutted its early warning group, the Global Public Health Intelligence Network, in May 2019 and so was unable to properly evaluate the little that Canada was hearing. The WHO established the Independent Panel for Pandemic Preparedness and Response in 2020 to report in May 2021 to, among other things, ensure that the WHO would in the future address threats to health effectively.

2.6 Lack of appreciation of possible contagion from abroad

(a) Because national financial systems are highly integrated internationally, national credit losses and related liquidity events flow across countries. During the GFC, credit losses associated with the U.S. real estate market were transmitted to other institutions around the world, which held financial instruments whose payoffs reflected the real estate losses.

In addition, large international financial institutions are linked by interbank financial transactions; and in the case of the very largest institutions, subsidiaries operating across national borders. These connections can allow losses and fear of losses in a jurisdiction to cross borders and appear in another country's financial system.[5]

Finally, given the international nature of finance, risky lending practices were copied in other countries to a greater or lesser extent. Within the U.S., less prudent financial institutions were bankrupted (or bailed out), while more prudent institutions survived. Ireland also had a major real estate boom, loose lending, weak bank supervision and a major banking crisis. Conversely, in Canada, the large commercial banks with strong risk management traditions and with strict regulatory supervision survived the GFC.

(b) When the virus appeared in Wuhan, the Chinese government prevaricated in informing other nations. The WHO was also implicated in not providing sufficient warning to countries around the world. As the virus spread to Europe and the U.S., lack of governmental preparation added to the spread of the disease and an increasing death rate. In contrast, because of better preparation, geographic isolation and other factors, some countries were better able to contain or reduce the impact of the virus. For example, South Korea, Japan and Taiwan had experience with previous viruses emanating from China, and had preventative measures in place. In particular, these countries can only be entered by sea or air, so that timely introduction of effective quarantine measures, testing and contact tracing contained the spread of the virus.

[5] See the IMF (2008). Although this international contagion occurred during the GFC, earlier financial crises had similar impacts.

Australia provides another example that is instructive in terms of both strong and weak preparation. The Australian Federal government, with the cooperation of the states, introduced very restrictive travel arrangements whereby travellers arriving in Australia were quarantined in supervised hotels. The quarantine system was arranged and supervised by the military, with one exception - the state of Victoria, which chose a private contractor. Behaviour of this contractor led to a breakdown in the Victorian quarantine system and exposed a weak testing and contact tracing system. By the end of 2020, of the 900 odd deaths in Australia due to the Covid-19 virus, 90 % were in Melbourne, the capital of Victoria.[6]

A further complication arose due to many countries outsourcing their supplies of PPE, vaccines and other products critical to combating the virus. With international supply chains disrupted and countries at the manufacturing source of the supply chain hording supplies, severe shortages appeared. Similar supply chain problems have occurred for other imported commodities. Lockdown and quarantine restrictions have disrupted some international supplies and the provision of services.

A good example of disruption of services has been the lack of planning and risk management associated with an event that led to a major contraction in the number of foreign students entering tertiary education in many Western countries. In the case of Australia, large universities were funded by up to 40% from foreign fee-paying students. Since the pandemic and the associated severe restrictions on incoming flights, the Australian universities have suffered a major decline in funding, leading to significant layoffs of academic staff.

2.7 Lack of appreciation of certain operational risks, including those related to weaknesses in corporate culture and governance

(a) The GFC revealed major problems in the analysis of mortgage credit. Credit risks were estimated by models calibrated by past data. The model predictions during the great moderation period 2002-2006 had forecasted manageable credit risks on securitized mortgages. The

[6] See Longworth and Milne (2021) for a fuller discussion and references.

mathematical/computer model predictions lulled financial markets and regulators into a false sense of security surrounding the system of writing and packaging high-risk mortgages. There were economists, regulators and bankers who were only too well aware of the dangers[7] associated with underwriting these high-risk mortgages and their packaging into securitized tranches, but in too many cases they were ignored. The problem was exacerbated by fraudulent and reckless lending, and misleading selling of the securitised products to naïve investors. When U.S. house prices plateaued and then declined in 2006-7, the credit risks rose quickly catching many bankers, regulators and investors unaware. Investment banks and commercial banks with large investment and trading operations were heavily exposed to securitized mortgages. Investment banks, who had been in the securitization chain, found few buyers for their securitized mortgage products, as their securitized investor market dried up. They were faced with very large inventories of risky assets with rapidly declining valuations. Investment bank insolvency (and fears of insolvency) created a panic that led to an international financial and economic recession only partially moderated by massive bank bailouts by US and European governments.

Although fraud was an element in creating the GFC, a more common failing was corporate myopia, and complacency. These failings were reinforced by compensation packages for CEOs, senior executives, and traders that gave incentives to emphasize short-term results (profits—not adjusted for risk—and "sales"/new business) over long-term risk-adjusted profits. There were many instances where companies had CEO's and Boards who ignored the warnings of competent risk managers. Complacency and arrogance were not just isolated in private financial institutions, but was amplified by the main stream media in reporting to the public; and worst of all, by poor preparation of a number of financial and bank regulatory systems around the world. Too many regulators relied on "box-ticking" as opposed to looking at some of the major underlying risks. The Basel I bank regulatory framework, which was extremely simplistic, was

[7] The models suffered two major risks: model risk and estimation risk. Model risk occurs when the models omit risks – especially severe infrequent downside events. Estimation risk occurs because model parameters are estimated with error, and in the worst situation can be very biased when based on periods with asset booms. For a discussion in the context of the GFC see Milne (2009).

still being used in some jurisdictions. The more comprehensive Basel II framework was just starting to be used in other jurisdictions.

(b) A parallel in lack of government preparation has been revealed by the Covid-19 pandemic. It became clear in 2020 that many governments had been complacent and ill-prepared for a pandemic. There were failures in maintaining stores of PPE equipment; and serious weaknesses of oversight in the governance of age-care homes. Other examples were the Canadian government having effectively dismantled an important pandemic warning organisation; and Canada having no capacity to produce vaccines, so that it had to rely on foreign suppliers for vaccines.

These examples demonstrate serious failures of governance in not responding to previous reports warning of the stresses that a pandemic would impose on key sectors. In turn, these stressed sectors would have serious flow-on effects to other sectors of the society, health system and the economy.

For many jurisdictions, there were failures in not developing sophisticated media and communication policies in explaining to the public the uncertainties concerning the virulence and lethality of the virus, and the various strategy options that could be chosen by policy makers. As policy makers introduced new restrictions, they often appeared panicked and inconsistent, leading to increasing scepticism of their competence. Few policy makers explained conditional strategies based on a constant inflow of new or more reliable data.

2.8 Lack of appreciation that appropriate regulation and planning needed to take a system-wide approach including effects on the real economy and the interconnectedness of stresses

(a) One of the major lessons learned from the GFC was the importance of regulation and planning, especially when considering system-wide implications of major credit events across national and international real and financial markets. Warning signs were there for all to see in the rapid increase in U.S. real estate debt over the 2002-2007 period. The credit boom was concentrated in various geographic locations in the U.S., with high credit risk characteristics and

credible reports of poor credit underwriting standards e.g. No Income No Job (NINJA) loans. These high risk loans were concentrated in the temporary inventory of a small number of large investment banks operating in the shadow banking sector.[8] This sector was lightly regulated. Most of the models used by the public and private sectors did not take into account the systemic nature of the risks. Given the network of interbank/institution exposures, losses would be magnified by fears of contagion and further losses. Financial disruption, wealth losses and unemployment would impact other real sectors of the economy where demand for durable products declined.

U.S. regulators faced serious gaps in responsibility and supervision. Commercial banks were supervised primarily by the Federal Deposit Insurance Corporation (FDIC). But the investment banks, who had been acting as conduits for the securitized mortgage market, were regulated by the Securities and Exchange Commission (SEC). The latter regulator had little expertise in prudential regulation of credit risks. Because of these regulatory gaps, the crisis caught the U.S. government unprepared. Indeed, the Federal Reserve seemed to be unaware of the serious systemic risks over the first year of the crisis. The Lehman Brothers bankruptcy and resulting panic ended that complacency. No one U.S. institution had been charged with looking at overall financial system stability.

Because international financial markets are so connected, weaknesses in regulatory oversight and supervision spill over into other national financial systems. For example, the Greek financial system became seriously impaired, but many of the losses appeared on bank balance sheets in other countries (e.g., French and German banks).

(b) The parallels in the experience with the pandemic are striking. Many countries in the West had not prepared for the systemic impacts of pandemics and associated policy responses. Their public health regulators were slow to analyse the lethality and virulence of the virus, especially its serious consequences for the elderly and/or people with comorbidities. Age-care home

[8] The temporary inventories were required for packaging loans into securitized debt. When the crisis hit in mid-2007, the market for these securitized loans dried up and the investment banks were left holding this inventory of bad loans.

supervision in many jurisdictions was perfunctory and ineffective: the consequences were deadly. This was compounded by shortages of PPE and other supplies.

Analysis and preparation for pandemics should consider broader consequences than purely medical issues relating to quarantine, tracing, and various versions of lock-downs. For example, planning and exercises prior to the pandemic appear to have ignored broader health, economic, social and fiscal consequences of major, lengthy lockdown policies. Some of the economic costs could be ameliorated by various government subsidy schemes. The costs of these schemes, would imply dramatic increases in private and government borrowing. Better pandemic preparation would have introduced protocols and systems to ensure that financial support was used as effectively as possible.

Part of pandemic preparation would include plans for a balanced political dialogue with the populace about policy options and their consequences. As a pandemic is socially and economically stressful it is critical that communication be clear and honest, with revised policies carefully explained.

2.9 Lack of appreciation that models for looking at effects on the real economy need to incorporate heterogeneity of individuals or groups

(a) Major financial crises usually originate in: credit supply shocks that affect a subset of real sectors (where they often go hand in hand with asset bubbles), major increases in environmental risks (e.g., tsunamis, earthquakes, pandemics), trade disputes or major wars. The costs are not borne equally across the economy: some households and sectors are hard hit, while others prosper. The ability of households to buffer shocks will depend importantly on shocks to their income and wealth, as well as the sectors in which they work; there are important differences across income and wealth deciles. Thus, heterogeneities in microeconomic behaviour, as well and financial-real linkages need to be taken into account by macroeconomic authorities, financial regulators, and the financial institutions themselves.

Prior to the GFC, macroeconomic theories and models used by most central banks relied largely on overly aggregated theories of the economy with primitive additions to deal with financial markets.[9] Macroeconomics used aggregates for consumption, investment and GDP.

Many risk managers in financial institutions and their regulators did not take a microeconomic (sectoral) view of credit risk, nor did they appreciate the many feedback mechanisms between the real and financial sectors.

Given the microeconomic factors at work, policy frameworks that just concentrate on macro aggregates will miss the critical causes and triggers of an economic/financial crisis. This theoretical (and related empirical analysis) creates blindness in prudential preparation; and when a financial crisis hits, lack of preparation leads to inappropriate policy implementation with major excess costs. For example, blanket programs could be introduced that miss the critical microeconomic differences across sectors and their behavioural responses.

(b) The outbreak of the Covid-19 pandemic caught most jurisdictions unprepared. In particular, policymakers largely relied on models that did not discriminate across demographic and geographic characteristics. The Imperial College macro-models predicted extremely high death rates for the U.K., leading to panic in the media and pressure on the U.K government to institute widespread lockdowns. But within weeks, Covid-19 statistics demonstrated that deaths were concentrated in the elderly and/or those with comorbidities. The virus was contagious, but very much less deadly for the younger population, where the virus was often asymptomatic.

2.10 Lack of appreciation of the effects of a crisis on unregulated or less-regulated entities

(a) One of the major problems that emerged in the U.S. during the GFC was the often ineffective patchwork regulation of financial institutions. While the FDIC regulated deposit-taking commercial banks, the SEC regulated investment banks. The large investment banks played a key role in distributing securitized mortgages. When the U.S. housing market turned down and

[9] Other statistical models were used, but they also had major limitations.

mortgage defaults mounted, the less prudent investment banks (Bear Sterns, Lehman Brothers), and a major insurance company (AIG) writing default insurance were exposed to huge losses. Given the highly integrated interbank market, these losses threatened to bring down much of the financial system in the U.S. and the Western world.

A major problem was the SEC and prominent government advisors' inability to understand the risks taken by the investment banks and associated financial institutions. One of the reasons that securitized credit expanded so rapidly in the 2000-2006 period was its ability to avoid prudential regulation imposed on commercial banks.

One of the downsides in no regulator taking a system-wide approach to the financial sector was a lack of realization that other financial institutions that had close relationships with banks would be hard hit by the weaknesses elsewhere in the financial sector, especially the banking sector and financial markets. In the global financial crisis, this showed up in a few ways. One example was that finance companies, even those whose assets were sound, were unable to raise funds easily from parent banks or in the commercial paper market. As a result, their credit-granting abilities diminished. A second example is that hedge funds were often unable to carry out the types of transactions with banks that they were used to doing, such as securities borrowing. As a result, they could not contribute to market liquidity.

Since the crisis, investment banks are now supervised under the prudential regulatory system. But there is always an incentive for risky lending to find ways to avoid prudential regulation. A major policy issue is to anticipate these incentives and devise methods for reducing systemic risks, so that institutions bear the costs of their risk taking and do not benefit from bail-out subsidies.

(b) Similar regulatory problems occurred in the pandemic. In many jurisdictions, ongoing poor supervision of long-term care homes left residents to die in appalling conditions. Because there were no regulatory restrictions, staff often worked across a number of homes, increasing the risks of cross infection. Other jurisdictions acted more promptly, requiring stringent protection of the

aged and careful supervision of carers. Clearly good regulatory and supervisory practices that may have been regarded as overzealous in normal times, paid off in the pandemic.

3. Steps to deal with deficiencies

Even before the GFC was over, international standards setters, such as the Basel Committee on Banking Supervision (BCBS) and the Financial Stability Board (formerly Financial Stability Forum) and domestic financial regulators began taking steps to deal with the deficiencies that had been noted. The large government bailouts that had taken place during the crisis and the significant effects on the real economy both heightened the need for such steps. Over several years, the deficiencies in the ten areas we noted in section 2 were dealt with in one way or the other by regulators. The BCBS initially was looking at a major revision to Basel II, but as it became more and more evident that a larger number of fundamental changes were required, the changes were packaged as Basel III (Basel Committee on Banking Supervision, 2017). The steps to deal with these ten deficiencies are described below together with their parallels in what should be required in planning and preparing for future pandemics.

3.1 "Capital and Liquidity"

(a) In Basel III, the definition of capital was improved and the required amounts of capital (including by more appropriately calculating some of the risks that the capital was supposed to cover) were raised. As well, international banks were required to meet both a risk-weighted capital requirement and a leverage requirement. Banks are now required to have recovery plans which would enable them to restore their viability—including having sufficient capital—relatively quickly. These plans must be updated regularly and assessed by domestic regulators. Basel III also introduced two liquidity standards: the liquidity coverage ratio to deal with short-term liquidity problems and the net stable funding ratio to deal with the funding of longer-term assets (Basel Committee on Banking Supervision, 2013, 2014). Domestic regulators also require banks to have liquidity plans, for example the Office of the Superintendent of Financial Institutions (2020) in Canada.

(b) In addition to having requirements for the stocks of personal protective equipment, ventilators, and other equipment (which likely already existed in most jurisdictions), there needs to be "recovery planning" for the replacement of equipment when it reaches its expiry date. As well, the required stocks of such equipment should rise with the population as well as with the share of the population that is most likely to be more susceptible to serious problems from pandemics, such as those with comorbidities, the elderly, and perhaps infants as well. Just as in the case of capital requirements, the actual stocks of equipment relative to requirements need to be reported to the most senior policymakers (including cabinet ministers) and reviewed by a designated review body.

Intensive Care Units (ICU), hospital beds, and nurses are somewhat like "liquidity" in the sense that either their numbers can be raised or they can be re-allocated to areas set aside for pandemic patients. A clear "liquidity plan" is, however, needed in advance that would specify how in detail overall ICUs, beds and nurses could be increased at short notice and/or the fashion in which, and implications of, reallocating these resources to pandemic patients would affect the health of those waiting for surgeries or treatments.

3.2 Insufficient public disclosure of comparable data on risks and lack of timeliness of data

(a) By the very end of the GFC, large banks were typically able to produce their liquidity positions daily. Required liquidity plans of banks have to include how a bank will "actively monitor and control risk exposures and funding needs" (Basel Committee on Banking Supervision, 2008b). Disclosure of more disaggregated balance sheet data and key risks on a uniform basis across international banks is now required as part of pillar 3 of Basel III. The principles of the new requirements of pillar 3 are that disclosures should be clear, comprehensive, meaningful to users, consistent over time, and comparable across banks (Basel Committee on Banking Supervision, 2015, para. 12 and 13).

(b) Uniformity of detailed data collection in a timely manner needs to be given high priority and included in pandemic planning. The principles of pillar 3 would seem to be applicable.

Jurisdictions need to be in a position from day one of a potential pandemic to collect important detailed data on those tested, those admitted to hospital with the disease, and those who die of the disease. These should include, but not be limited to: race, age, occupation, address, and comorbidities. In countries with provincial/state or regional health authorities, these data need to have common definitions and be easily collected and shared in systems that can produce reports in a timely manner. Timeliness should mean that all data collected on a given day, whether at a hospital, testing centre, or laboratory, should be available to be aggregated the following morning.

Data on deaths from all causes in all jurisdictions should be collected and made available in a timely manner so that indirect effects of the pandemic on deaths by cause can be readily known. In addition, there needs to be the active use of a uniform definition of what it means to die from a pandemic disease.

3.3 Insufficient planning regarding lender-of-last-resort facilities

(a) The experience of the design and use of lender-of-last-resort facilities during the GFC led to some central banks writing about the principles regarding such facilities. For example, the Bank of Canada wrote and spoke about such principles (Engert, Selody and Wilkins 2009; Longworth 2010). Subsequently, this led the Bank of Canada to describe its ongoing facilities (Bank of Canada 2020).[10] Although this did not cover all the facilities used during the market liquidity problems at the beginning of the Covid-19 pandemic, it and the description of principles surely guided the Bank's behaviour.

More generally, central banks reviewed the lessons from their overall experience with lender-of-last resort facilities during the GFC, as evidenced by the workshop held by the Bank for

[10] See also https://www.bankofcanada.ca/markets/market-operations-liquidity-provision/framework-market-operations-liquidity-provision/emergency-lending-assistance/ and https://www.bankofcanada.ca/markets/market-operations-liquidity-provision/framework-market-operations-liquidity-provision/#providing-liquidity .

International Settlements Monetary and Economic Department (2014)[11] for central bankers and academics. The areas discussed included the stigma of drawing on facilities, the pros and cons of transparency (especially about individual institutions), moral hazard, governance and international dimensions of the lender-of-last-resort role.

(b) In Canada and other countries with multiple health jurisdictions, there needs to be a clear understanding of which jurisdictions are ultimately responsible for providing health equipment, which levels are going to acquire and store equipment for lower jurisdictional levels, and which principles and rules are going to guide the way in which such stores will be made available. Such principles and rules should be made public.

3.4 Insufficient stress testing required by authorities

(a) Stress testing took on a much more important role following the GFC. Central banks constructed models that could be used to carry out top-down stress testing[12] and both bottom-up and top-down testing were used. Stress tests were used by banks in their capital planning exercises and U.S. regulatory authorities put much emphasis on the results of their prescribed stress tests in the capital requirements for the banks under their supervision (Federal Reserve Board, 2020)[13]. Historically stressful periods were used as one input into the size of stresses and they were required to be used in value-at-risk calculations related to capital requirements.

(b) Stress testing and wargames should be used in pandemic planning, at regional, provincial/state, and especially national levels. They would also be useful at an international level. Longworth and Milne (2020b) describe how these would be helpful after post-mortems of the Covid-19 pandemic are held and new pandemic plans are put into place.

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[11] See https://www.bis.org/publ/bppdf/bispap79.pdf

[12] These include the Risk Assessment Model of Systemic Institutions (RAMSI) model at the Bank of England (Burrows, Learmonth and McKeown, 2012) and the MacroFinancial Risk Assessment Framework (MFRAF) at the Bank of Canada (Gauthier, He, and Souissi, 2004; Fique, 2017).

[13] See https://www.federalreserve.gov/publications/files/2020-dec-stress-test-results-20201218.pdf

3.5 Insufficient attention given to warning signs

(a) Since the GFC, there has been much more attention to warning signs and financial system weaknesses. The analysis done by the Financial Stability Board Standing Committee on Assessment of Vulnerabilities, by the International Monetary Fund (in its *Global Financial Stability Report*), and by various central banks in their financial stability reports has become much more sophisticated and wide ranging. As part of this effort, there has been more attention paid to credit, especially household credit—and within that to residential mortgage credit, as a longer-run leading indicator of financial crises and economic downturns (Borio and Drehmann, 2009; Gourinchas and Obstfeld, 2012; Schularick and Taylor, 2012; Mian, Sufi and Verner, 2017; Mian and Sufi, 2018; and Krishnamurthy and Muir, 2020). The role of household debt service ratios as a shorter-run leading indicator has also been noted (Drehmann and Juselius, 2013; Drehmann, Juselius and Korinek, 2018. This attention has been driven largely by research in academia, the Bank for International Settlements, and the International Monetary Fund.

(b) The absence of key groups to look for warning signs of a pandemic on a daily basis has been noted in Canada and the United States and by the WHO. As a result, such groups will be created or re-established. It is important that these groups be also charged with looking for new types of warning signs.

3.6 Lack of appreciation of possible contagion from abroad

(a) Since the GFC there have been increased cooperation by international financial bodies and central banks to reduce the risks from international contagion.[14] This cooperation operates at two levels: First, major financial centres have cooperated by introducing what is regarded as best practice prudential supervision of their domestic banking systems. One of the major tools used by regulators for increasing the financial resilience of their banking systems is the use of stress tests, where banks are required to ensure their solvency when hit by a major economic downturn.

[14] The Financial Stability Board (FSB) and the Bank for International Settlements (BIS) are just two of several international organizations that sponsor conferences, international meetings, and research, etc. to enhance best practice for national and international financial stability.

In addition, banks were ordered to increase their equity and liquidity cushions through the use of mandated minimal ratios. If a banking crisis does occur, there are new procedures for dealing with weakened Systemically Important Financial Institutions (SIFI's). These include Living Wills, Resolution Procedures and Bail-in Debt to ensure that institution can continue operating, limiting contagion through interbank markets.

Second, international banks operating in different countries are required to accommodate national stress tests, and to integrate these tests into their risk management practices. Thus, there is international integration and cooperation at the firm *and* regulatory levels.

But the current system is not perfect: there will be other feedbacks from national banks and non-banks that will interact with the international banks. A further problem is that national stress tests run the danger of being inconsistent across borders; and with international cooperation, there is a danger of groupthink where certain risks are regarded as unimportant – "That event will never happen."

Although these tests have major benefits, there have some major weaknesses trying to incorporate real economy feedbacks, international feedbacks, etc. that create added complexity. This complexity is difficult to model with limited information, especially the estimation of key model parameters that will be severely impacted in a crisis.[15]

International cooperation is laudable, but there are doubts that in a crisis, cooperation will falter, as national political systems will place their own interests above that of other nations. There are no easy solutions to this problem.

In summary there has been extensive work trying to reduce the risks from international financial contagion. While the system has become more resilient, it is far from perfect.

[15] See Haldane (2017) and the survey by Herring and Schuermann (2019) for detailed discussions.

(b) There is much work to be done dealing with national and international pandemic preparedness. Many domestic health systems have been unprepared. Plans and procedures had been either inadequate, or where they had indicated weaknesses, recommendations had been ignored. Domestic systems need to be strengthened with credible procedures in the case of a new pandemic. At the international level, the WHO has failed on several occasions to inform or coordinate national pandemic policies. There have been failures at three levels: the provision of timely technical advice and information on international infections; international cooperation on international travel restrictions; and the distribution of vaccines. There has been policy confusion over the effectiveness of national responses, taking into account important national differences in demography, the quality and effectiveness of health organisations and national preparedness. It is clear that international cooperation can reduce infection rates through timely testing, quarantine etc. for international travellers, thus reducing the likelihood of contagion from abroad.

3.7 Lack of appreciation of certain operational risks, including those related to weaknesses in corporate culture and governance

(a) Since the GFC, there have been many studies of its causes, and discussions of lessons to be learned. Subsequent changes in regulations of financial institutions have been designed to make the system more stable and less likely to be susceptible to a future financial crisis. Model and estimation risk are now better understood. Corporate and executive incentives have been changed to reduce incentives for reckless risk-taking.

But shrewd regulators and risk managers are only too well aware that as the memory of the GFC fades, corporate and regulatory complacency can create unrecognised risks in the system. The regulatory system must be anticipatory and prepared. For example, cyber risk is a constant threat to the financial system. Financial institutions have been under attack for years, as hackers and fraudsters have been trying to access information, blackmail the institution, etc. But more disturbing is the growing threat of cyberwarfare, instituted by aggressive states as one component of major political, economic, social and cyber warfare just short of kinetic warfare.[16] This threat to financial stability transcends the usual boundaries of financial supervisory analysis.

[16] Elliott and Jenkinson (2020).

(b) The pandemic has revealed extremely serious deficiencies in health planning and preparedness in many countries and jurisdictions. Although there had been pandemic exercises in many countries, they had not incorporated health and non-health consequences of policy responses. For example, the economic, fiscal and social consequences of severe lockdown policies had not been modeled or included in political policy playbooks. Even worse, there seemed to have been a casual disregard for a number of the early lessons in the pandemic by senior politicians and bureaucrats. The first pandemic wave in February – April 2020 had revealed the vulnerability of age-care homes and quarantine hotels to waves of infections due to lax health and safety regulation. In some jurisdictions, these lessons were not learned, so that unnecessary second wave infections and deaths occurred. The major policy responses after the GFC are an indication of what *should* happen after the Covid-19 pandemic subsides.

3.8 Lack of appreciation that appropriate regulation and planning needed to take a system-wide approach including effects on the real economy and the interconnectedness of stresses

(a)Since the crisis, the national financial regulators have been devising systems that attempt to reduce the risks of international and domestic financial contagion and its impact on the rest of the economy. This is a complex process that is necessarily a work in progress.[17] The real and financial systems are closely interlinked, so that regulation and policy responses should take that fact into account.

To illustrate the interconnectedness of the real and financial sectors, consider the evolution of the GFC. It was created by a real estate boom, fueled by poor underwriting in the mortgage market. As the U.S. real estate market declined in 2006-8, borrowers defaulted, the losses and bankruptcies flowed into defaulting mortgages and into the shadow banking system, where credit risk had been securitised. As the losses flowed through some of the highly exposed financial

[17] For example, see the discussion in Haldane (2017).

system, lending became more cautious. Consumers reduced expenditure on durable goods, firms laid off workers and the recession rippled through both the real and financial sectors.[18]

Since the GFC, financial institutions have been more prudent in lending, restricting exposures to credit risks, both directly and indirectly. The regulatory system is attempting to build in real and financial feedbacks into their systems.

(b) A similar approach is needed in post Covid-19 reforms of the medical and pandemic control systems. Prior to the pandemic, planning was narrowly focussed on medical responses without considering the wider impact of policies that could be implemented to combat the pandemic. It is well-known that lockdown strategies were controversial, especially given the severity and length of any lockdown policy. If lockdown policies were regarded as feasible in prior planning, then why were the broader health, economic, social consequences and costs not part of the exercises? Policy makers should have been better prepared in understanding collateral medical, social and economic costs when choosing over the portfolio of responses. This is a lesson that should be learned in future preparations.

3.9 Lack of appreciation that models for looking at effects on the real economy need to incorporate heterogeneity of individuals or groups

(a) The GFC taught many lessons for regulators and policy makers. One of the lessons was that there is considerable heterogeneity across individuals and firms. Academics and central banks have improved their models by incorporating differences across household behaviour that depend on their income, wealth, and indebtedness. These models have also incorporated richer linkages between financial and real sectors. For example, some households and firms were prudent and not directly implicated in highly risky borrowing. Banks were not homogeneous in their lending and risk management practices. Some risky and/or incompetent financial institutions failed; while others survived without any direct government assistance. Indiscriminate policy responses were financially and fiscally wasteful. But even worse they can

[18] See Mian and Sufi (2014).

create moral hazard in banks' risk management behaviour anticipating future financial crises. Regulators and bank supervisors have introduced procedures and regulations to reduce moral hazard and poor policy responses. For example, the widespread use of stress tests, and minimum liquidity and leverage ratios are policies that can be used to force banks to reform poor risk management practices.

There was geographic heterogeneity in the housing bubble and the wave of defaults.[19] For the U.S. this was not only at the state level, but extended down to postcodes. Some areas were hard hit, whereas other areas survived with minor losses. These geographic indicators were proxies for homogeneity in credit risk in economically exposed communities. Microdata is a standard source of information in any competent bank credit system.

(b) Early in the pandemic, governments appeared to rely on highly aggregated models with population average transmission and mortality rates. These models exaggerated the impact of the virus in predicting extreme death rates, not taking into account many relevant factors: e.g., individual behaviour that reduced infection in vulnerable populations; or at the other extreme, the high risks for residents of long-term care homes.

Within months, more micro-based models were developed that incorporated important demographic characteristics of the virus. These predictions should provide more effective and less costly policy responses. For example, the lethality of the virus for the elderly, especially in age-care homes or in multi-generational households, should have led to concentrated early responses targeting those high risk demographics.

Future viral pandemics may have very different demographic characteristics from the Covid-19 virus. Consequently, the timely collection of micro-data and the application of micro-based models based on that data, should improve predictive power and allow more targeted policies.

[19] See Mian and Sufi (2014).

It became clear by late April 2020 from the statistics where the vulnerabilities lay, and the direction that more nuanced policies should take. But many governments blundered in not implementing more effective policies, creating undue deaths and hardship.[20] Policymakers largely relied on models that did not discriminate across demographic and geographic characteristics. Macro-models using system-wide reinfection rates (R) predicted extremely high death rates for the U.K., leading to panic in the media and pressure on the U.K government to institute widespread and lengthy lockdowns. But within weeks, Covid-19 statistics demonstrated that deaths were concentrated in the elderly and/or those with comorbidities. The virus was contagious, but very much less deadly for the younger population, where the virus was often asymptomatic.

It is critical that detailed forensic analyses of the pandemic are implemented. The lessons learned should be incorporated in subsequent exercises or wargames

3.10 Lack of appreciation of the effects of a crisis on unregulated or less-regulated Entities

(a) From the GFC, we observed that the U.S. investment banks were regulated by the Securities and Exchange Commission (SEC). The SEC regulated securities trading and had no capacity as a bank regulator. During the late 1990's until the crisis, credit was migrating from commercial banks into securitised markets which were lightly regulated. In the U.K. similar light touch regulation allowed some banks to take on high credit risk. The Crisis revealed the folly of this approach.

[20] In Longworth and Milne (2021), we describe the blunders in the State of Victoria where 90% of Australian Covid deaths were located in the state capital, Melbourne. These deaths occurred over a period from June – September. The neighboring state, NSW with similar demographics had a far more effective and responsive health system for dealing with pandemics. The NSW death rate was a small fraction of the Victorian death rate.

Since the GFC, investment banks have been regulated under the same rules as the deposit-taking commercial banks. A problem has arisen where financial risks have migrated to the less regulated sectors. There is a constant battle in regulating and defending the core banking system, while monitoring fringe financial institutions: it is critical to create mechanisms to reduce the risk of contagion migrating from the fringe to the core system. But there is always an incentive for risky lending to find ways to avoid prudential regulation. A major policy issue is to anticipate these incentives and devise methods for reducing systemic risks, so that institutions bear the costs of their risk taking and do not benefit from bail-out subsidies.

(b) From our recent experience with Covid-19, we have seen disturbing parallels. The most obvious has been failures of age-care regulation in many jurisdictions. There have been too many cases where health and pandemic preparation have been rudimentary. For example, staff have been allowed to work at multiple locations, so increasing risk of infection. Some regulatory authorities moved quickly to guard against these risks: the results in terms of reduced infections and deaths were laudatory. The jurisdictions that acted promptly required stringent protection of the aged and careful supervision of carers. Clearly good regulatory and supervisory practices that may have been regarded as overzealous in normal times, paid off in the pandemic. Similar precautions prevented quarantine hotels from becoming infections centres.[21] Other jurisdictions had far laxer regulations and weak response mechanisms in place, implying a series of medical disasters.

We assume that there will be policy action to remedy the age-care problems. But the larger problem is that no pandemic is quite the same, so preparations should be flexible enough to move quickly when the demographic and geographic risks are discerned, so that responses are targeted, effective and commensurate with the risks.

Because pandemics and viruses can differ markedly in terms of their impact on different demographics, contingency plans should include strains that attack other demographics. For

[21] See Longworth and Milne (2021).

example, consider a virus (unlike Covid-19) that is far more lethal for children and far milder for adults. The micro response should concentrate on protecting children and may well avoid general societal lockdowns. This would require regulatory bodies to be prepared for such an event, requiring close cooperation of school governance with medical authorities.

4. Conclusion

It was clear by the first half of 2008 that most regulators and many banks had not undertaken enough preparation for the possibility of a financial crisis. However, both internationally and domestically, most of the problems that needed attention were noted in late 2008 and early 2009. It did nonetheless take about 10 years until most of the major regulatory changes, such as some elements of Basel III, were formally adopted and, even now, some regulatory requirements are effectively still tightening as institutions were given a number of years to meet those major changes. Fortunately, even given these lags, the more stringent regulations and better risk management by banks, meant that the banks were in relatively good shape to face the shock of Covid-19 in 2020.

By very early in the Covid-19 pandemic it was clear that public health authorities and governments had not undertaken enough preparation. It turns out that ten of the areas where there had not been enough preparation had strong parallels with areas where bank regulators and banks had not done enough twelve years earlier. These were: stocks of equipment, data collection and sharing, lending facilities, stress testing and war games, early warning indicators and systems, contagion from abroad, operational risks, a system-wide approach (including effects on the real economy), models incorporating the heterogeneity of individuals, and effects on less-regulated parts of the system.

Some post mortems on what has gone wrong during the pandemic have already begun. These include the study by the Independent Panel for Pandemic Preparedness and Response set up by the WHO, which has a broad remit, down to provincial examinations of what went wrong in long-term care facilities in Ontario and Quebec. It will be important for all ten areas discussed in this paper to be examined, where appropriate, internationally, nationally, provincially, and

regionally. Moreover, these examinations should start by the end of 2021 with the aim of having recommendations in 2022 that governments and public health authorities can begin to implement in that year. Memories fade quickly. Thus, one needs to make decisions and act relatively quickly—more quickly than financial regulators did following the GFC.

Important areas that cannot be omitted are governance (see Longworth and Milne, 2021), stress testing and war games (see Longworth and Milne, 2020b).

References

Bank for International Settlements Monetary and Economic Department (2014) "Re-thinking the lender of last resort," BIS Papers No 79, September.

Bank of Canada (2004) "Bank of Canada Lender-of-Last Resort Policies," *Financial System Review*, September.

Bank of Canada (2020) "Rules Governing Advances to Financial Institutions," 11 August.

Basel Committee on Banking Supervision (2006) "Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework—Comprehensive Version," 30 June.

Basel Committee on Banking Supervision (2008a) "Liquidity Risk Management and Supervisory Challenges," 21 February.

Basel Committee on Banking Supervision (2008b) "Principles for Sound Liquidity Risk Management and Supervision," 25 September.

Basel Committee on Banking Supervision (2013) "Basel III: The liquidity coverage ratio and liquidity risk monitoring tools," 07 January.

Basel Committee on Banking Supervision (2014) "Basel III: the net stable funding ratio," 31 October.

Basel Committee on Banking Supervision (2015) "Standards: Revised Pillar 3 disclosure requirements," January.

Basel Committee on Banking Supervision (2017) "Basel III: Finalizing post-crisis reforms," 07 December.

Borio, Claudio and Matthias Drehmann (2009) "Towards an operational framework for financial stability: "fuzzy" measurement and its consequences," BIS Working Papers No 284, June.

Borio, Claudio and Philip Lowe (2002) "Asset prices, financial and monetary stability: exploring the nexus," BIS Working Papers No 114, 02 July.

Burrows, Oliver, David Learmonth and Jack McKeown (2012) "RAMSI: a top-down stress-testing model," Bank of England Financial Stability Paper No. 17, 11 September.

Daniel, Fred, Walter Engert and Dinah Maclean (2004-05) "The Bank of Canada as Lender of Last Resort," *Bank of Canada Review*, Winter, 3-16.

Drehmann, Mathias and Mikael Juselius (2013) "Evaluating early warning indicators of banking crises: Satisfying policy requirements," BIS Working Papers No 421, August.

Drehmann, Mathias, Mikael Juselius, and Anton Korinek (2018) "Going with the Flows: New Borrowing, Debt Service, and the Transmission of Credit Booms," NBER Working Paper 24549, April.

Elliott, J. and Jenkinson, N. (2020) "Cyber Risk is the New Threat to Financial Stability". IMF Blog. https://blogs.imf.org/2020/12/07/cyber-risk-is-the-new-threat-to-financial-stability/

Engert, Walter, Jack Selody, and Carolyn Wilkins (2009) "Financial Market Turmoil and Central Bank Intervention," *Bank of Canada Financial System Review,"* June, 71-78.

Federal Reserve Board (2020) "Federal Reserve Board Announces individual large bank capital requirements, which will be effective on October 1," press release, 10 August.

Fique, José (2017) *The MacroFinancial Risk Assessment Framework (MFRAF), Version 2.0*, Bank of Canada Technical Report No. 111, September.

Gauthier, C., Z. He and M. Souissi (2004) "Introducing Funding Liquidity Risk in a Macro Stress-Testing Framework," *International Journal of Central Banking* V.10(4), 105-141.

Gourinchas, Pierre-Olivier and Maurice Obstfeld (2012) "Stories of the Twentieth Century for the Twenty-First," *American Economic Journal: Macroeconomics*, V. 4(1), January, 226-265.

Haldane, A. (2017) "Rethinking Financial Stability". Speech at 'Rethinking Macroeconomic Policy IV' Conference, Washington, D.C., Peterson Institute for International Economics, 12 October.

Herring, R. and Schuermann, T. (2019) "Objectives and Challenges of Stress Testing", To appear in J. Doyne Farmer, Alissa Kleinnijenhuis, Til Schuermann, Thom Wetzer (eds.), *Handbook of Financial Stress Testing*, Cambridge University Press.

IMF (2008) Global Financial Stability Report, "Market and Funding Illiquidity: When Private Risk Becomes Public," Chapter 3. World Economic and Financial Surveys (Washington, April).

Kaminsky, Graciela L. and Carmen M. Reinhart (1999) "The Twin Crises: The Causes of Banking and Balance of Payments Problems," *American Economic Review*, V.89(3), June, 473-500.

Krishnamurthy, Arvind and Tyler Muir (2020) "How Credit Cycles across a Financial Crisis," NBER Working Paper 23850, revised, September.

Longworth, David (2010) "Bank of Canada Liquidity Facilities: Past, Present and Future," Speech given at the C.D. Howe Institute, Toronto, 17 February.

Longworth, David (2014) "The Global Financial Crisis and Financial Regulation: Canada and the World," in Rohinton Medhora and Dane Rowlands, *Crisis and Reform: Canada and the International Financial System*, Canada Among Nations 2014, Centre for International Governance Innovation, Waterloo.

Longworth, David and Frank Milne (2020a) "Covid-19 and the Lack of Public Health and Government Preparation," QED Working Paper No. 1436, August.

Longworth, David and Frank Milne (2020b) "Preparing for Future Pandemics: Stress Tests and Wargames," QED Working Paper No. 1437, August.

Longworth, David and Frank Milne (2021) "Public Health and Government Preparations For Future Pandemics," QED Working Paper No. 1451, January.

Mian, A. and Sufi, A. (2014) *House of Debt: How They (and You) Caused the Great Recession, and How We Can Prevent It from Happening Again*. University of Chicago Press.

Mian, Atif and Amir Sufi (2018) "Finance and Business Cycles: The Credit-Driven Household Demand Channel," *Journal of Economic Perspectives,* V.32(3), Summer, 31-58.

Mian, Atif, Amir Sufi, and Emil Verner (2017) "Household Debt and Business Cycles Worldwide," *The Quarterly Journal of Economics*, V.132(4), November, 1755–1817.

Milne, F. (2009) "The Complexities of Financial Risk Management and Systemic Risks"*, Bank of Canada Review*, Summer.

Office of the Superintendent of Financial Institutions (2020) "Liquidity Principles," January.

Rajan, Raghuram G. (2005) "Has Financial Development Made the World Riskier?" NBER Working Paper 11728, November.

Schularick, Moritz and Alan M. Taylor (2012) "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," *American Economic Review,* V.102(2), April, 1029-61.