13 An Epidemiologic Approach of Financial Markets

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The current financial crisis is comparable to a pandemic (an epidemic which has spread to the entire world). Diamond and Rajan warned that local bank failures could lead to a "contagion" (domino effect or knock-on defaults) and financial crisis showing astonishing resemblances to disease propagating like an epidemic.[1] Both disease contagions and financial contagions are induced by one or a limited number of "infected" entities.[2] In the case of disease contagions, the infected entity is an individual incubating a micro-organism (e.g., a virus or bacteria) who eventually spreads the infection to the community the individual is connected to. The entity, in the case of financial crisis, is a financial institution committing fraud, internal irregularities or facing losses due to risky loans and investments.[3] The consequences of either an infectious disease pandemic or a financial crisis are dramatic, the former potentially leading to millions of deaths. The flu pandemic in 1918 was estimated to have killed between 50 and 100 million people in about six months, while the latter eventually resulted in millions of ruined shareholders and job losses.[4] An additional consequence of both disease and financial epidemics is that the remaining sensitive individuals (non-infected) become suspicious toward other individuals, considering them as infected and refusing to enter relationships with them. Allen and Gale focused their work on claim emissions that occurred against suspected institutions or regions, with the consequence of value loss of this claim, potentially leading to contagion.[5]

The first section of this article describes the global epidemic disease surveillance system; the second section provides details on network models and connectivity. In the discussion section, I will make recommendations for an integrated surveillance system of financial institutions (FIs).

O. Hieronymi (ed.), *Globalization and the Reform of the International Banking and Monetary System*

13.1 The international epidemic and outbreak surveillance

Global centralized systems, to detect outbreaks, were developed and managed by the World Health Organization (WHO) since the 1950s. The two pillars of this system are the WHO Epidemic and Pandemic Alert and Response (EPR), which centralizes data collected worldwide, and the Global Outbreak Alert and Response Network (GOARN), which helps to identify outbreaks and provide appropriate interventions.

The surveillance systems are based on indicators, such as the number of new cases of specific diseases per unit of time, and events, such as unofficial local reports or news. Data is collected at the local level; in the case of EPR, data is collected by 100 regional centers worldwide and transmitted to the Collaborating Centres such as the Centre for Diseases Control and Prevention (CDC) based in Atlanta, United States or the European Centre for Diseases Prevention and Control (ECDC) based in Stockholm, Sweden.

The Collaborating Centres analyze the data and communicate the outputs to the World Health Organization (WHO), which in turn diffuses reports to governmental agencies and other private institutions for appropriate actions. In the case of the flu epidemic, the Collaborating Centres help to identify the flu strain on a yearly basis and organize the production of an appropriate vaccine.

Another role of the surveillance system is to search for cases of infectious disease that will potentially lead to an epidemic (human flu, avian flu, SARS). These cases are the epidemic sources. After the identification of these epidemic sources, they are followed up by targeted interventions, such as the destruction of the poultry in the case of avian flu or quarantine or containment of the infected individuals in the case of human flu. These measures are being utilized to curb or eliminate the risk of epidemic spread. Supranational coordination using appropriate indicators have been claimed to improve local policy.[6, 7]

In the case of financial markets, signals of contamination by risky assets or wrongful practices must be detected in the early stages (low signals), before they spread to large communities (strong signals) and eventually lead to financial panic and market collapse. These low signals can be associated with disease outbreak. Low signals of financial distress, confined to one financial entity, are not usually detected by the agents or dissimulated in cases of fraud. Neural networks, a concept that was originally used in the nineteenth century to describe the functioning of the human brain, are a powerful tool to detect the low signals of distress or fraud within financial institutions. Authors have described neural networks, also called expert systems, to extract information from accounting reports.[8] However, to provide an efficient support to financial institution surveillance systems, the expert systems should incorporate appropriate indicators and thresholds. These two elements have been pinpointed as critical components of financial systems surveillance.[9]

As a result of surveillance, FIs can be found in three statuses: non-infected (e.g., FIs possessing no or a minimal amount of risky assets), infected (e.g., possessing large quantities of risky assets, having committed fraud) or immune. We assume that a FI's "immunity" is based on three factors: their liquidity level, risk management system, and ethics. It is important to note that free riders exist in both human communities (e.g., individuals refusing vaccination) as well as in financial communities, where, in bank conglomerates, free riders take risks as they feel sheltered within the conglomerates.

13.2 Epidemic models

Having defined the three types of status that classify individual entities within a population, it is now essential to describe the various types of models that allow a representation of the epidemic. Several models have been developed to describe epidemic transmission. Models are either population based or individual based. Deterministic compartmental models fall in the former category while network models are part of the latter.

Deterministic models allow for determining R_0, which is defined as the number of people in a given population that a single infected individual can contaminate.[10] R_0 can be seen as a global measure of contamination, as it depends on the infected individual's network: the more connected an individual, the more individuals will be contaminated. When $R_0 > 1$, the epidemic develops; the epidemic usually stops when $R_0 < 1$. As a bank "population" is not homogenous, bank surveillance cannot be performed using only a general parameter such as R_0 but also needs network modeling, as explained further. While deterministic models are appropriate for assessing the impact of interventions against epidemics at a global level, under the assumption that populations are homogenous, these models are not appropriate for capturing the complexity of relations between-individuals.

Network models were described as the system of choice to capture the complexity of disease epidemics[11] in the early 2000s. Network models were developed to represent inter-bank connections.[12] This model uses homogenous connections where each bank is connected to the same number of banks. Later, network models were developed that better reflect the complex nature of inter-bank relations.[13]

Network models include nodes (e.g., individual banks) and inter-nodal links. As stated earlier, a node is either classified within one of the following three statuses: infected, non-infected/non-immune or immune (a representation of these three statuses for financial institutions is given below (see Figure 13.1)). According to its activities, the entity can evolve from one status to another.

In Figure 13.1, FIs are represented by nodes. A node is assumed to be, at a certain point of time, infected, non-infected or immune.

We assume that FIs' immunity status is only transitory. Depending on their activities, this "immune system" can be overflowed (e.g., when the institution does not possess enough liquidity to cover the risk). If this happens, the FI (or its partners) can take the necessary action, such as a capital raise, debt discharge or a bailout, which will bring the infected institution back to its immune status**.**

In banking networks, nodes are not connected in a homogenous way or equivalent in size. Each entity is connected to various and different types of institution (Figure 13.2). Network models should first help in identifying nodes that are statistically significant (connected with a large number of nodes and having a large number of risky assets/practices) and, second, support the decision for the most appropriate intervention or immunization strategy to avoid further contamination.

In Figure 13.2 each node develops a complex, connected network and includes cross-border and cross-sector connections (banking, insurance, security trading).

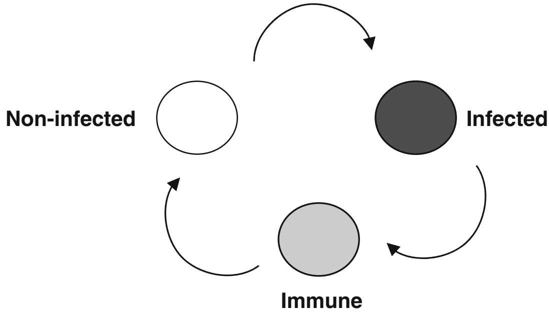

Figure 13.1 Element of a network: Node. Each network node can be in three possible statuses.

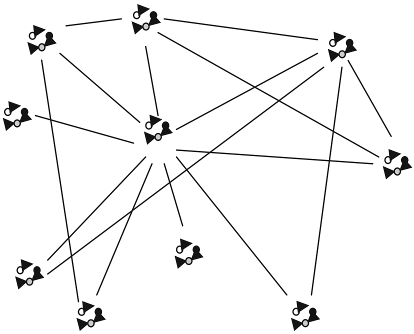

Figure 13.2 Node inter-connection.

13.3 The need for a macro-prudential approach in risk assessment

Influenced by the 1988 Basel Capital Accord, models used by FIs are mainly focused on assessing their own operational risk and are prone to bias.[14] A macro-prudential approach of risk is desirable in a sense that it leads to limit the risk of financial distresses and avoid spreading to the global community.[15] This directly relates to the argument that when each FI takes an aggressive position and mitigates their risk vis-à-vis other FIs, the global situation may worsen. In an attempt to analyze the relationship between supervision, regulation, and financial stability, Mitchener observed the difference in a number of bank failures and variations in prudential supervision and regulation within various states in the United States during the Great Depression.[16] He found that higher reserve requirements could lead banks to acquire riskier assets in order to increase return. Similarly, in a recent study, Nier et al. found that capital requirements alone may not suffice to protect bank networks from knock-on defaults.[13]

13.4 Discussion

We have exposed the WHO epidemic and pandemic surveillance systems as a comprehensive organization capable of detecting outbreaks and preventing a generalized epidemic. We believe that an efficient supervision system of financial markets should be developed beyond the Global Bank Insolvency Initiative (GBII) and mirror the system currently supervised by the WHO[1]. The body supervising financial markets should have the power to act in conjunction with state authorities to terminate fraudulent operators and reduce or stop the flow of risky operations in a timely manner. This body should also oversee the ratings of various FIs and help identify the riskiest ones. One of the problems affecting today's supervisory system is that each FI uses its own model to assess operating risks.[17] Global macro-prudential supervisory models should supersede micro-prudential models. In my opinion, FIs must be monitored by regional entities (e.g., central banks) that analyze the risks at a network (or conglomerate) level and the regional agencies must transmit their finding to a central international body.

The central body should, in turn, work with various local authorities to put intervention plans in place and work at reducing and stopping propagation. The supervision system must be developed in collaboration with FIs by determining the proper indicators and thresholds that need to be observed and applied in order to identify the riskiest practices and develop the most appropriate intervention mix.

Kanas demonstrated that the contagion effect might take place globally in conjunction with various effects on the supervision systems in various countries.[18] His work was based on the failure of a major international financial institution (BCCI) that occurred in 1990. Since that time the integration of the financial market has considerably developed. Nier et al. showed, with their network model, that when a network has a low degree of connectivity, an increase in connectivity increases the risk of knock-on defaults inversely – when a network is highly connected, a further increase tends to help dissipate losses. Similarly Leitner assumes that, among FI networks, large institutions have a tendency to bail out smaller institutions within the same network out of fear of contagion.[19] These findings confirm, de facto, the ambiguities in relation to FI connectivity and systemic shock within the FI networks. This conclusion leads me to assume that high connectivity between entities of various size and ethical codes increases the complexity of intra- and extra-network exchange, leading to free-rider problems and an overall increase in systemic risk.

However, FI supervision does have its limitations. Mitchener, in his observation of supervising activities during the Great Depression, did not find a significant relationship between supervisory activities and bank suspension rates. In a recent report, the Financial Stability Forum pointed out several weaknesses in the current prudential supervision system, in particular the definition of appropriate indicators and thresholds related to the scope and magnitude of public disclosures of on- and off-balance sheet exposures.[20]

13.5 Conclusion

In a global society, access to credit is a necessity for financial institutions, entrepreneurs, and consumers. Strengthening regulation seems to be the mainstream point of view among politicians. Considering that a wave of regulation will, a priori, consist of a set of measures to prevent wrongful practices, induce law infringement, strengthen tax havens, and ultimately lead, at a later stage, to a deregulation wave, we must aim for increased coordination between the surveillance agencies and for the creation of a central supervisory body, combined with the use of accurate and realistic models consisting of a superior model.

As a consequence of the current crisis, several politicians express the need to alter capitalism. I must argue that this point of view arises mainly from popularity-seeking reasoning and has little to do with economic rationale. More pragmatically, it is necessary to define a new approach to financial market supervision, primarily based on a global surveillance system. We must assume this system will help, in the long run, to develop a strong, universal code of ethics in the financial business world and increase the number of "immune" institutions while significantly reducing the occurrence of generalized crisis.

Notes

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    There are currently three types of FI supervision: the prudential supervision which observes the solvency and the business supervision which monitors the way FI manage their businesses and aim to ensure ethical and legal practices. The solvency supervision is currently performed on an institutional basis. A third type of supervision aims at maintaining an overall stability. Basel II aims at a more macroprudential approach.
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