The Philippine Review of Economics

ARTICLES IN THIS ISSUE

A joint publication of the
University of the Philippines
School of Economics
and the **Philippine Economic Society**

The Philippine Review of Economics

A joint publication of the UP School of Economics (UPSE)
and the Philippine Economic Society (PES)

The Philippine Review of Economics

Diamond and Dybvig in developing economies and in a digital world

Margarita Debuque-Gonzales*

Philippine Institute for Development Studies

The Nobel prize-winning article of Douglas Diamond and Philip Dybvig, entitled "Bank runs, deposit insurance, and liquidity" and published by the *Journal of Political Economy* in 1983, has spawned a large literature, including on emerging markets and developing economies. In a nod to Diamond and Dybvig, this paper reviews this subset of the literature, which has received relatively less attention than the rest despite the greater risk of banking crises in these economies; it then examines whether the seminal article remains relevant against the rapid digital transformation of financial systems today. Models that adopted their basic ideas helped drive home the importance of maintaining sound macroeconomic fundamentals and keeping confidence levels high in bank-centered economies. Similarly applying their framework to assess the impact of the current evolution of financial systems also reveals valuable insights, such as low risk from financial technology, for now, but possible shadow banks in those settings, and allows for generally better analysis, including pointing out possible blind spots when adopting new concepts, such as central-bank-issued digital currencies.

1. Introduction

The theoretical paper entitled "Bank runs, deposit insurance, and liquidity", written by Douglas Diamond and Philip Dybvig and published by the *Journal of Political Economy* in 1983, earned them the Nobel Prize in Economics in 2022.[1] The award came as no surprise to colleagues and "students", in classrooms worldwide, as their research had become a staple in the field of financial economics, and in the study of banking, liquidity, runs, and financial crises. Today, 40 years later, it remains, as Prescott [2010:1] put it, in the introduction to the special issue of the *Economic Quarterly* focusing on the model, a "workhorse

---

[1] Two other research papers—Diamond [1984] and Bernanke [1983]—were also recognized by the Nobel prize committee during the year.

of banking research" and "one that researchers and policymakers consistently turn to when interpreting financial and market phenomena". Yet while the general influence of the Diamond and Dybvig (DD for short) paper has been well-chronicled and examined,[2] the significance of the model for studying developing economies has received much less attention.

There are a few reasons why such a microfounded model that focuses on banks as liquidity providers, with inherent bank fragility as an offshoot of maturity transformation, would be particularly useful for analyzing less developed economies. There is, at the most basic, a greater need for liquidity in these countries than in more advanced ones, as households have relatively smaller incomes and may be more reluctant to directly fund long-term investments [Eichengreen and Rose 1998]. In the aggregate, this naturally increases dependence on transformation services offered by financial intermediaries such as banks. Banks also play a bigger role in channeling savings to investments in developing economies (as opposed to equity and debt mechanisms), so that bank runs will tend to have severe macroeconomic consequences in these settings. Constrained access of emerging markets to world capital markets compared to that of more mature economies, meanwhile, further amplifies concerns about illiquidity in the banking system, which only increases bank fragility [Chang and Velasco 2001].

However, applying the DD framework to developing countries may also be quite difficult. This would require having to consider the unique conditions of emerging market economies, where banks typically function under weaker contractual conditions and severe information asymmetries and face greater financial frictions and higher intermediation costs. Operating within small open economies and typically carrying foreign-currency debt, they also face greater challenges in managing their balance sheets because of the various mismatches (maturity and currency) and may be prone to greater risk-taking under poor regulation. More specifically, observers have expressed reservations about applying the DD framework to emerging markets, for failing to consider moral hazard and similar issues in such environments, as it assumes riskless technology.

The DD framework *purposely* excludes currency and risky technology (and hence risky bank assets) as factors in the many problems in banking, and the authors have stated that "a general model will require their introduction" [Diamond and Dybvig 1983:416].[3] DD acknowledge that introducing risky assets and moral hazard would be interesting, though hard to model, admitting that while some form of government-backed deposit insurance would remain necessary, this

---

[2] Coverage of the paper include the special issue of the *Economic Quarterly* published by the Federal Reserve Bank of Richmond in 2010, the scientific background paper written by the Committee for the Prize in Economic Sciences in Memory of Alfred Nobel in 2022, and numerous other papers, blog posts and web articles over the years.
[3] In an interview, Dybvig [2017] emphasized that assuming riskless assets in banks was a "feature" and not a "bug" of their model, which only served to highlight how banks tend to be (intrinsically) unstable—that is, even in the complete absence of risk.

would now have to be accompanied by some form of bank regulation to discipline risky behavior.

Despite the challenges, studies have successfully built on DD's basic model in the context of emerging markets and developing economies, considering their more complex arrangements and circumstances, and gaining deeper insight in the process. Due to the nature of the problem that the original paper addressed, subsequent research naturally focused on modeling financial crises and shaping financial regulation and policy. This paper provides a review of this interesting literature on emerging markets, and how it has helped strengthen financial regulatory and policy frameworks, written not only in a nod to the Nobel prize winners, but also to gain better understanding of these economic systems.

The line of inquiry is extended in the paper to see if the DD framework remains relevant even as the financial system transforms because of advances in digital and information technology, which have ushered in new instruments and players. The paper explores how the DD framework may provide guidance in foretelling the impact of the dramatic rise in financial technology (fintech) worldwide on financial stability. It also provides a quick assessment of how the basic DD model has figured in new theoretical models on central bank digital currencies (CBDCs), a concept that with the emergence of cryptocurrencies has become of special interest to policymakers and policy observers.

The paper is organized as follows. To provide some background, Section 2 offers a summary of the prize-winning article of DD, discusses the model's policy implications and influence, and presents a snapshot of continuing research in the area. Section 3, meanwhile, examines how DD's framework has influenced research on developing economies, including a discussion of relevant policy responses in recent crises, with reference to the work of Ben Bernanke, DD's co-winner of the 2022 Nobel Prize. Section 4 investigates the continuing relevance of DD's research under a rapidly evolving financial environment due to massive digital transformation, while Section 5 concludes.

2. DD in a nutshell (and in retrospect)

The DD paper was the first to provide a detailed framework explaining why banks exist, and why the optimal arrangement for banks—short-term liquid liabilities invested in long-term illiquid assets—also makes them inherently fragile.[4] Illiquidity of assets, according to DD, provided both the rationale for "the existence of banks *and* for their vulnerability to runs" [Diamond and Dybvig 1983:403]. As close observers have noted [He and Ma 2022], this insight from the

---

[4] Earlier research by Bryant [1980] also modeled banks as providers of liquidity and insurance against the risk of early death (generating demand for liquidity) through their offering of demand deposits. However, the paper featured a pure consumption-loans model (based on Samuelson [1958]) that did not consider productive investment and the role of banks in maturity transformation.

model would prove to be extremely valuable, as it spotlighted the critical tradeoff financial regulators face when dealing with banks, as traditionally defined, or any similar financial institution or arrangement.

In the DD model, bank assets (loans) are safe but illiquid, reflecting riskless production technology in the economy that requires time to generate returns. A simple depiction of bank assets (see Figure 1) would be that they yield R for every unit initially invested (in period 0) if held to maturity (until period 2) but just recover the investment if liquidated early (in period 1). Bank liabilities (deposits), in contrast, are short-term and more liquid, yielding more than the unit investment ($r_1 > 1$) for an investor (depositor) if instantly withdrawn but less than R ($r_2 < R$) if held for the full period. Some investors may have short-term liquidity needs in this model and will have to withdraw early, but it is not known beforehand (at period 0) who will experience such a shock.

To illustrate possible multiple (Nash) equilibria, suppose that there are 100 investors (depositors), of which only a portion will withdraw early. Without a run (the *good* equilibrium)—when only those investors who really need to withdraw their deposits on demand do so—the bank would be stable and succeed in creating liquid deposits out of illiquid loans (implying maturity transformation). However, the bank would not be able to completely service withdrawals if *all* investors decide to get their funds early (in this case, the total amount needed, r_1*100 with $r_1 > 1$, would be greater than the liquidation value of the banks' assets, which is just 100). In fact, the bank would fail even before meeting this scenario, as the number of investors who would be able to withdraw would be clearly less than 100 (again, since $r_1 > 1$). Thus, if confidence is low, a bank run may occur (the *bad* equilibrium), as investors panic and rush to withdraw their deposits ahead of the others before this critical number is reached.[5]

FIGURE 1. Transformation services of banks
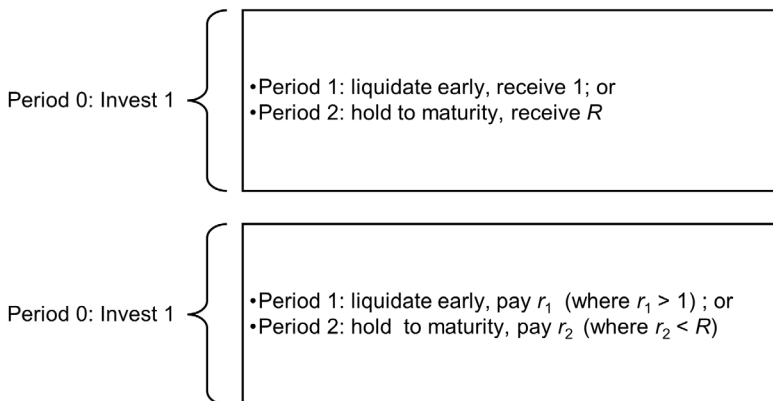
Source: Author's depiction, based on Diamond [2022] and Diamond and Dybvig [1983]

---

[5] The demand deposit contract satisfies a sequential service constraint in the model—a first come, first served feature where depositors seeking to withdraw get paid by the bank for as long as there are remaining funds.

The DD paper shows that demand deposits, by providing liquidity, offer better risk sharing among savers with random consumption needs across periods. DD conclude that banks provide "optimal insurance contracts" where those who need to withdraw early get more than their initial deposit, while those who hold their deposits for a longer period would get a higher return, though less than what they would have received if they had invested directly in the production technology. The twist is that a bank's special function, which is to create liquidity (i.e., offer liquidity services by paying out more than the initial investment in the short term, since $r_1 > 1$) also makes it susceptible to a panic, as depositors may fail to coordinate towards the good outcome.

Briefly stated, bank fragility in the DD model essentially derives from banks' reason for existing. Moreover, since bank assets are assumed to be riskless, there is initially no solvency reason for banks to falter. This further emphasizes how damaging bank runs can be in causing "unneeded bank failures" [Diamond 2022]. Bank failures, not to mention unnecessary ones, are detrimental to the economy, as they lead to premature liquidation of long-term investments, such as through a recall of loans that interrupts production, and ultimately, output loss.

2.1. Policy implications and influence

The need to protect an economy from bank runs, specifically through government-backed deposit insurance, is the key policy implication of the DD paper (e.g., according to Dybvig in Walker [2017]). The paper argues that deposit insurance can provide superior contracts for stability in the banking system, eliminating the bad equilibrium (a run) while still allowing banks to create liquidity.[6]

Using their model, DD contrasted deposit insurance with suspension of convertibility, the other traditional device used to stop or prevent bank runs, in which deposit withdrawals are, at some point, strictly disallowed. This prevents even depositors with legitimate liquidity needs from withdrawing their deposits, making the strategy costly and unpopular.

While deposit insurance worked similarly to a central bank serving as a "lender of last resort" (LOLR) and can be modeled along the same lines, DD argued that unlike central bank lending, it is a (legally) "binding commitment" and *not* discretionary. Distinguishing between illiquidity and insolvency may be hard even for a central bank, as DD also already analytically demonstrated how even healthy banks may be pushed to insolvency because of a loss of confidence, which is quite hard to reverse in a panic.[7]

---

[6] Deposit insurance provides a guarantee, backed by the government's power to tax, that the promised return will be paid to all depositors who withdraw their funds. Note that no payout is needed if it works (i.e., if a bank run does not occur).

[7] A borrower is illiquid if it is short on cash to pay current obligations. It is insolvent if it has insufficient assets to pay outstanding debts. Central banks are normally allowed to step in as LOLR, and provide temporary liquidity, when banks are illiquid but not insolvent.

In their seminal work, DD were transparent in stating that the assumption of riskless loan portfolios (or riskless technology) precluded moral hazard problems. They confessed that such issues may exist if bank managers can choose the risk settings of loan portfolios and if this information can be kept private, or at least largely unobserved. In this scenario, deposit insurance can result in banks taking on excessive risk to bump up profits, with taxpayers left to foot the bill if bankers lose their bets.

However, DD asserted that bailouts can also introduce perverse incentives. If the LOLR always bails out banks with liquidity problems, for example, banks may make unwise gambles knowing they will be saved. If bailouts are not unconditional in the end, runs may occur with even just a shift in expectations about bank creditworthiness or about the willingness of the central bank to rescue failing institutions.

In their later work on banking theory, deposit insurance, and bank regulation, the authors argued that deposit insurance remains as "the only known effective measure to prevent runs without curtailing liquidity creation" and therefore "bank policy issues should be considered in the context of deposit insurance" [Diamond and Dybvig 1986:67]. In that paper, DD advised against the following, which they considered bad policy: limiting deposit insurance to impose market discipline on banks or requiring them to have uninsured subordinated short-term debt; using insured deposits to invest in speculative businesses that are unrelated to liquidity provision (e.g., real estate and equities underwriting); and moving towards 100-percent reserve banking, which prevents banks from fulfilling their fundamental role as liquidity provider. They also recommended tying deposit insurance premiums to the riskiness of loan portfolios, assuming risk can be somehow observed and measured, to lessen banks' incentive for excessive risk-taking.[8]

Some of the theoretical work that followed centered on extending the DD model by including risky investment choice to incorporate moral hazard effects generated by deposit insurance. These include papers by Hazlett [1997] and Cooper and Ross [2002], whose main takeaway had likewise been the importance of good regulatory design to minimize incentive problems. The latter study, for instance, finds that complete deposit insurance alone will not achieve the first best allocation and will have to be paired with additional capital regulation, as banks may opt to invest in excessively risky projects in the absence of adequate incentives for monitoring by depositors.

Over time, the fundamental policy message of DD has been interpreted to be the need for deposit insurance or access to a LOLR to avoid coordination failure and reduce vulnerability to panics, which are a natural consequence of maturity transformation [Committee for the Prize in Economic Sciences in Memory

---

[8] They proposed, for example, higher deposit insurance premiums for banks with many nonperforming loans, banks that previously underestimated loan losses, and banks offering above-market interest rates to gain funding.

of Alfred Nobel 2022]. Although finding the right combination of regulatory tools that will allow financial intermediaries to channel savings to productive investments while maintaining discipline in the sector remains a challenge, deposit insurance systems have already been widely established across the globe. A majority of countries have explicit deposit insurance schemes—over 80 percent of high-income countries, nearly 65 percent of middle-income countries, and about 70 percent of low-income countries—with the rest assumed to have some form of implicit deposit insurance [Anginer and Demirguc-Kunt 2018]. Meanwhile, most central banks are allowed to provide liquidity to the banking sector, albeit temporarily, to relieve frictions and avert a financial crisis.

2.2. Continuing research

Research has continued in areas considered to be the main weakness of the DD model. One pertains to the self-fulfilling nature of bank runs (or "sunspot" equilibria), which may be unrelated to economic fundamentals. In the DD model, any commonly observed random variable (e.g., a negative government forecast, a bad earnings report, or a run in another bank) can be a trigger for a panic, and this need not have anything to do with the bank's condition or the economy.

Yet empirically, banking panics have been strongly linked to weak fundamentals and the business cycle (e.g., Calomiris and Gorton [1991]; Gorton [1988]). By introducing uncertainty in the payoffs of long-term assets and the imperfectly correlated signals of these payoffs to investors, the DD model is found to produce a unique equilibrium where bank runs occur only when the expected payoffs fall below a certain threshold (e.g., Morris and Shin [2000]; Goldstein and Pauzner [2005], based on global games analysis of Carlsson and Van Damme [1993]). However, bad equilibria may still be self-fulfilling in such models, and panic-based runs may still occur even when economic fundamentals are good or when changes in these fundamentals are small. Key policy implications of the DD model therefore also remain valid.

Another key area was carved out by Jacklin [1987], who argued that introducing financial markets to the DD model would undermine banks' dominance as liquidity providers, since the social optimum could also be reached by trading in securities. This led to a study of the interplay between banks and markets. Diamond [1997] sidestepped the Jacklin critique by assuming that not everyone has access to markets and was able to show that banks and markets together can generate more liquidity than if they operate alone. This strand of research has also helped inform thinking on financial regulation, about the right amount of liquidity in the economy and particularly about the right amount of liquid reserves for banks (e.g., Farhi et al. [2009]).

The DD paper has been able to provide a solid framework for a broad spectrum of research. It has since been used to study financial contagion, sovereign debt and currency crises, and most anywhere coordination failure may play a role,

as well as various financial regulation issues. The relatively simple but logically consistent model has been able to capture the basic elements of a financial panic, which apply not just to banks, but all bank-like arrangements. These elements can be seen in almost every crisis that has occurred since the DD paper was written, and in any part of the world.

In his Nobel prize lecture, Diamond [2022] stated their findings more generally, referring to "short-term debt runs" that can bring down a solvent financial intermediary in the bad equilibrium (of multiple Nash equilibria, or multiple self-fulfilling prophesies).[9] This offered a blueprint for (private) financial crises, which he said are "everywhere and always" due to the problems of short-term debt. He pointed out that contract structure mattered a lot, as panics inherently occur if one finances long-term illiquid assets with short-term liquid liabilities.[10] Thus, runs are not limited to traditional banks; they also apply to shadow banks, a point not lost on other researchers (e.g., Prescott [2010]; Calvo [2012]; Adrian and Ashcraft [2016]), who have cited the role of runs on such institutions in the Global Financial Crisis (GFC) of 2008/2009.[11]

3. DD in developing economies

This section summarizes the important research adapting the DD framework to emerging-market settings, which mostly focus on financial crises, to gather insights from the literature.[12] It also discusses the implications of this line of research for financial regulation and policy, and how the DD model influenced policy responses in recent crises, including the COVID-19 pandemic.

The latter discussion cites the contribution of Ben Bernanke, the other Nobel laureate for economics in 2022, who provided the rigorous empirical analysis needed to show how bank failures and a credit crunch could leave deep economic scars [Bernanke 1983]. In the policy realm, as similarly observed by Kashyap [2015], he may be cited for recognizing the basic elements of a crisis, as sketched out by the DD model, apart from sharing his vast knowledge from his own research, prompting policymakers (including himself) to quickly address panics even among bank-like institutions during the GFC.[13]

---

[9] The authors acknowledged this in the original paper—i.e., that the potential for multiple equilibria did not apply solely to banks. They chose to focus on banks, as banks were known to account for a large portion of corporations' short-term debt.

[10] A panic may occur if creditors start to lose confidence in the borrower and pull out their funds or if they worry that other creditors would respond that way.

[11] Shadow banks refer to non-depository institutions that engage in maturity transformation but are not subject to traditional bank regulation. They include the different types of funds (e.g., structured investment, hedge, and money market mutual funds), securities companies, and consumer finance institutions.

[12] This is not meant to be an exhaustive literature review. Rather, the aim is to get a flavor of the research that the DD framework has spawned in the context of emerging markets and developing economies.

[13] Ben Bernanke served as the Chair of the US Federal Reserve during 2006-2014.

3.1. Modeling financial crises

The DD paper has been pivotal in the context of emerging markets by providing the workhorse model that enabled the development of liquidity and bank-run models of financial crises during the 1990s (Masson [1999]; Frankel [2010]). Related studies were mostly motivated by a series of emerging market crises that marked the period, such as the Mexican Crisis in Latin America in 1994 and the Asian Financial Crisis (AFC) in 1997/1998.[14]

One of the earlier papers that surfaced in that era was written by Sachs [1996], who argued that one possible cause of financial crisis in emerging markets was a self-fulfilling panic, the most familiar case being the self-fulfilling *banking* panic outlined by the DD model. Other known triggers then included exogenous shocks to markets, inadvertent policy shocks, and exhaustion of borrowing limits.

Subsequent research in the area included the study of Radelet and Sachs [1998], who depicted the crisis in Mexico as essentially a creditor run on government debt, while characterizing that in Argentina, which occurred a year later, as a creditor run on the banking system. The authors further suggested that the AFC, was similarly, in essence, an international variant of a bank run—this time, with international bank debts owed mainly by the financial and nonfinancial corporate sectors (in Korea and Thailand, and Indonesia, respectively).

DD helped set the theoretical basis for their analysis, with the Asian crisis analyzed as being, in large measure, due to self-fulfilling tendencies in the financial system. Radelet and Sachs [1998] noted the DD model offered a "much more complete theory" to explain self-fulfilling panics (i.e., crises with multiple rational equilibria) in the context of banking institutions than its precursors. Presumably guided by this literature, they claimed that it had been the refusal of foreign lenders to roll over short-term credit, rather than any fundamental weakness in Asian economies, that triggered the AFC.

Like Radelet and his coauthors, Chang and Velasco [1998;2001] attempted to reinterpret the financial crises of the 1990s as international versions of a bank run. The authors made theoretical advances by developing an open economy version of the DD framework, which focused on the microeconomics of banking, allowing them to formally model financial fragility in emerging market economies. Their version basically embedded banks in a small open economy. The main departure from the original framework was that it allowed access to international capital markets, with a domestic bank permitted to borrow abroad, to help fund both long-term investment and immediate withdrawals.

---

[14] Other explanations for the financial crises in emerging market economies during the period are of course available, though we do not discuss them in here. Other well-known papers on so-called third-generation models motivated especially by the AFC emphasized the role of: hidden subsidies and moral-hazard lending resulting in overborrowing (e.g., McKinnon and Pill [1997]; Dooley [2000]; Burnside et al. [2004]), and corporate balance sheet effects and capital flows and their impact on the real exchange rate [Krugman 1999].

With this twist in DD's banking story, Chang and Velasco concluded that a bank run may occur in an emerging market when a domestic bank experiences *international* illiquidity. While fundamental weakness underlies crises in this model, foreign creditor panics, which can occur if local banks cannot commit to preserve enough resources for foreign debt payments, can trigger runs on domestic deposits in their model (and vice versa), with the likelihood depending on the maturity of foreign debt and the possibility of international default. Financial liberalization and short-term capital inflows can worsen bank illiquidity and increase financial vulnerability in the model. Their theoretical findings generally appeared to match empirical observations in Latin America and Asia during the period, when short-term foreign debt notably increased financial fragility in some countries by heightening rollover risk.[15]

Research on financial crises in developing countries seemingly stalled in the 2000s, as the epicenter shifted to advanced economies, owing to the suddenness and severity of the GFC in 2007/2008. New studies have since emerged, lengthening the research thread that made use of the DD model to analyze developing-economy crises or as a building block for macroeconomic models designed after emerging markets.

While not concentrating on developing economies, Calvo [2012] built a model that could explain some of the central stylized facts not just of the subprime crisis in the US, which spread to other global markets during the GFC, but also of the sudden stops and previous emerging market crises, with the DD model's intuition at its core. In the model, which encompasses bank-like arrangements such as "shadow banks", financial development is cast as a mechanism that endows real assets (such as land and capital) with liquidity, which may be impaired by shocks that are analytically equivalent to a bank run. This setup allows for bubble-like episodes that are not driven by fundamentals but may be fully rational. Although Calvo [2012] deemed the model to be still highly incomplete, he argued that it nevertheless bared new insights about the effects of liquidity creation and destruction.[16]

To study banks and liquidity crises in emerging market economies, Matsuoka [2018] later extended the model of Chang and Velasco [2001] by incorporating interbank asset markets, as well as the models of Allen and Gale [1998;2004a;2004b], which are also based on a DD economy but with aggregate shocks and aggregate uncertainty introduced to the system. The resulting banking model generates two types of equilibrium: a no-default equilibrium and a mixed equilibrium. In the latter, *risky* banks default, while *safe* banks meet their commitments and ultimately purchase the long-term assets of risky banks. Matsuoka [2018] states that the model generally succeeds in capturing the basic

---

[15] Furman and Stiglitz [1998] remarked that the ratio of short-term debt to reserves, by itself, was able to predict the East Asian crisis.

[16] It can show, for instance, the possibility of "excessive" financial innovation, where an increase in capital liquidity may lower individual welfare. An extension of the basic framework, meanwhile, finds support for the conjecture that low policy interest rates may have provided further incentives to "shadow banks".

features of banking crises in emerging market economies (e.g., internationally illiquid domestic banks and bank assets traded at fire-sale prices), particularly after financial liberalization, where large capital inflows intensify asset price volatility and exacerbate banking crises.

3.2. Shaping financial regulation and policy

The DD framework highlighted the importance of having deposit insurance and a LOLR, combined with bank regulation that reduces moral hazard, to avoid a financial crisis. Expanding the DD model to better match conditions and capture issues in emerging market economies, as chronicled above, helped point to the need for further refinements in financial regulation and policy in these countries.

Framing financial crises in emerging markets as international versions of a bank run held important policy implications, especially for managing capital flows and regulating banks and other domestic financial institutions.[17] It underscored, for instance, the wisdom of avoiding a buildup of short-term debt—particularly short-term foreign debt—which could increase the likelihood of coordination failures among creditors, heightening vulnerability to runs (Chang and Velasco [2000;2001]).[18] It also reinforced the argument for better management of capital account liberalization and capital flows, precisely referring to large loan volumes contracted at short maturities and in foreign currency, which can worsen maturity and currency mismatches and bank illiquidity.

Considering the self-fulfilling nature of panics, a major policy lesson supported by bank-run models revolved around the avoidance of triggers that could lower the confidence of creditors and coordinate them towards a bad equilibrium. As past emerging market crises featured undercapitalized banks, greater attention was placed on strengthening regulation and supervision of banks and raising capital adequacy standards (e.g., Sachs [1996]; Radelet and Sachs [1998]; Roubini [2000]).[19]

In Asia after the AFC, for instance, major reforms included cleanup of nonperforming loans of banks (through special purpose vehicles and other bad-debt resolution mechanisms), stronger macroprudential policies, more intensive bank monitoring, establishment of better risk management practices and prudential controls among banks, and the drive for greater accountability and

---

[17] It should be mentioned that the possibility of international bank runs also provides a rationale for an international LOLR. This paper does not discuss such issues, though they are clearly important, but focuses instead on domestic-level policies over which local policymakers have some control.

[18] The oft cited and logical policy solution was to lengthen debt maturities. However, this was not without caveats. Some argued that short-term debt fulfills a function by serving as a commitment device for the borrower (Rodrik and Velasco [1999]; Jeanne [2009]), while others contended that shifting toward longer debt maturities may have a destabilizing effect on the banking system [Matsuoka 2018].

[19] Commonly cited proposals included proper sequencing of financial liberalization reforms, with steps to strengthen regulation of the financial system coming first, and during the time, taxation to slow down capital flows (such as that used by Chile, which imposed a 30-percent reserve requirement on dollar deposits in the banking system), respectively.

transparency in corporate boards.[20] Deposit insurance was also adopted around the 2000s in many economies in the region.[21] Altogether, these efforts helped raise public confidence in the region's banking systems and protect Asian economies from the harsh effects of succeeding global crises.

Other possible policy-related triggers of banking crises in emerging markets that were often cited included overly expansionary monetary and fiscal policies that could fuel a lending boom and fixed exchange rates [Eichengreen and Rose 1998]. The latter made a bank run more likely as it prevents the central bank from acting as a LOLR when needed, as doing so (providing liquidity to distressed banks) may threaten the currency peg.[22] As emphasized in the DD paper, credibility as well as capacity of authorities was crucial to maintaining bank stability, whether in the case of deposit insurance or a LOLR. Based on this analysis, preserving confidence and reducing vulnerability to financial panics would require having sound macroeconomic fundamentals, notably including greater exchange rate flexibility and a healthy level of foreign reserves, particularly where short-maturity foreign debt may be a concern.

While deposit insurance has been taken as the standard policy recommendation of the DD paper, such systems have not always worked exactly as intended, especially in poor institutional environments. Under weak settings (such as uncertain rule of law and widespread corruption) and if poorly designed, they may serve to erode market discipline, destabilize the banking system, and hinder growth and financial development (see Anginer and Demirguc-Kunt [2018] for a discussion of the empirical findings). Increasing attention has therefore been placed on improving the design of these systems, specifically by incorporating features that internalize risk-taking by banks to reduce moral hazard.

3.3. Policy responses to more recent crises—shoutout to Bernanke

While DD provided the theoretical explanation for the existence of banks, their vulnerability to runs, and the damaging nature of runs, it was Ben Bernanke, their fellow Nobel laureate in 2022, who provided the empirical evidence on the problem. In his prize-winning empirical research on the Great Depression, bank failures were revealed to be largely responsible for the exceptional depth and duration of that historical downturn. DD cited Bernanke [1983] in their paper, which was written during the same year, emphasizing how Bernanke's research

---

[20] Other explanations for the Asian crisis—such as moral hazard lending and overborrowing, including by related parties, which represented hidden deficits—also helped encourage reforms in this area. There had been a strong push to lessen the dependence of Asian financial systems on banks and the implicit guarantees offered by governments to these financial institutions, particularly through the development of local-currency bond markets.

[21] Explicit deposit insurance was unavailable in the original ASEAN-5 during the AFC, except for the Philippines [Noman et al. 2022]. It was soon introduced in Indonesia (in 2004), Malaysia (2005), Thailand (2008), and Singapore (2010).

[22] That is, a bank run may spur a run on the domestic currency if the central bank tries to fulfill this role [Masson 1999].

supported their thesis by showing that bank runs were indeed a better predictor of distress than money supply.

This would seemingly be mirrored a couple of decades later. In a speech he made as US Federal Reserve Chair in 2009, Bernanke noted that while economic fundamentals played a role in triggering the GFC or Great Recession, the ongoing crisis also exhibited features of "a classic panic", which the DD paper was able to break down. In 2018, he provided further empirical evidence that the Great Recession was primarily due to a financial panic in funding and securitization markets (essentially shadow banks engaged in maturity transformation), which eventually spread and led to a disruption of credit supply.[23] He argued in that article that this finding helped "justify the [US] government's extraordinary efforts to stem the panic in order to avoid greater damage to the real economy" [Bernanke 2018:251].

Following the lead of the US Federal Reserve and the European Central Bank—with the US Fed acting as LOLR of both traditional and shadow banks following the collapse of Lehman Brothers—other central banks intervened to avoid short-term debt runs and preserve credit supply. In each country, the end goal was to avoid a deep and lasting recession. The Bank of Japan (BOJ) also took steps to secure the stability of the country's financial system, including stock purchases from and provision of subordinated loans to banks, and to facilitate corporate financing [Bank of Japan 2023]. Remarkably, Asian banking systems, which had undergone a regulatory and policy overhaul after the AFC, were then much less exposed to US subprime assets. Although output in Asia also contracted during the period, it did so to a lesser degree, and economies recovered much faster than the rest of the world [Jeasakul et al. 2014].

With the relative success of these strategies during the GFC, similar interventions were applied during the COVID-19 pandemic, and on a bigger scale in many countries given the nature of the crisis. Public health concerns then led to the closure of contact-intensive sectors of the economy, leading to large drops in output and high unemployment. The pandemic had been loosely interpreted as a natural disaster that froze economic activity—and the ensuing economic crisis as *not* being due to bad fundamentals such as fiscal recklessness or excessive financial risk-taking. Therefore, emphasis was placed on protection, and not punishment, as had been deemed warranted to prevent moral hazard in the light of past (financial) crises.

Amid the uncertainty of the COVID-19 pandemic, central banks again sought to ensure continued flow of credit to the economy and prevent a credit squeeze from developing into a full-blown financial crisis that could fuel a deeper recession. Several measures were again taken to supply liquidity to financial institutions

---

[23] Runs in different markets were recorded during the GFC, including in asset-backed commercial paper [Covitz et al. 2013], money market mutual funds [Schmidt et al. 2016], and the repo market [Gorton and Metrick 2009]. See also Prescott [2010].

(e.g., by lending to these institutions, purchasing their assets, or switching their illiquid assets with more liquid securities) so they in turn could help firms and households, especially the smaller or weaker ones, weather the pandemic.[24] Authorities in many countries also displayed regulatory forbearance during the COVID-19 crisis, particularly for banks, in a bid to further ease credit conditions.

The BOJ, for example, introduced a new "funds-supplying" measure that provided liquidity to private financial institutions, in substantial amount and on favorable terms, to facilitate lending to small and medium-sized firms [Kuroda 2020]. Meanwhile, among the developing economies in Asia that experienced the AFC, the central banks of Malaysia, the Philippines, and Thailand likewise launched measures that supported lending to smaller enterprises [IMF 2021]. Similarly, the central bank of Mexico, which also suffered a crisis in the 1990s, was able to open financing facilities for banks allowing them to channel funds to micro, small, and medium-sized enterprises and individuals affected by lockdowns. Indonesian authorities provided regulatory relief to domestic banks, as did most of its neighbors in the developing ASEAN region. In addition, the Bank of Indonesia was allowed by presidential decree to finance the country's deposit insurance agency through repo transactions and purchases of government bonds owned by the agency.

Hence, policymakers apparently still take a leaf from the DD paper, including in developing economies. Didier et al. [2021] observed though that banks did not experience major liquidity problems during the pandemic crisis, unlike in a typical financial crisis. Instead, there appeared to be limited appetite, as firms faced heightened credit risk on account of the uncertain nature and path of the COVID-19 virus. Central banks worldwide had difficulty in this regard, as extending liquidity lines and similar policies worked only if the funds were indeed passed on to and utilized by firms.

The DD framework nevertheless suggests that such policies to preserve credit supply still had great merit, as the alternate scenario may have been far worse. A key feature of the model, after all, was the critical role of confidence and credibility in avoiding a bad equilibrium (a run) for banks and bank-like arrangements. Such stability, in turn, is needed for a smooth and steady functioning of the real economy.

4. DD in a digital world

Finally, it would be interesting (and useful) to ask if it is likely that the DD paper, which looked at the microeconomics of "banking", will remain relevant even as the financial system evolves and reveals new actors. While we know this

---

[24] Brunnermeier and Krishnamurthy [2020] argued that policy should focus on the survival of viable firms, and advocate for a pause (not bankruptcy as was the policy in past crises), particularly for small and medium-sized enterprises (SMEs). Since SMEs were less able than larger firms to withstand a liquidity crunch, they would benefit from ample provision of low-cost refinancing for rolled-over loans to stabilize existing businesses. The authors stated that the more beneficial goal was to "evergreen" the SME loans until the pandemic subsided.

is likely to be so, how exactly can the policy lessons from the DD framework help authorities navigate the fast-changing financial intermediation landscape? In which areas of the fintech environment can it provide illumination and guidance? This section focuses on the development of fintech to provide at least some (partial or first-pass) answers to these questions. It also provides a glimpse of how the DD framework has figured in the analyses of CBDCs, which emerged after the advent of cryptocurrencies to become a much-debated topic.

4.1. Rise in fintech

Recent years have seen rapid technological change in the financial industry, with the rise in fintech accelerating during the COVID-19 pandemic, which stimulated demand for digital services and the adoption of digital finance. Over time, fintech has evolved from traditional financial institutions simply using information technology (IT) to improve products and services (e.g., electronic payments and clearing systems, ATMs, and online banking) to the entry of new players, also aided by IT, providing *non-intermediated* financial services directly to customers and creating a whole new environment for financial institutions [Thakor 2020]. A wide variety of online models soon started to compete with traditional "brick-and-mortar" banks in key areas such as payments, remittances, and lending, among others [Murinde et al. 2022].

Fintech's fluid development has made it hard to classify, prompting broad definitions. The Financial Stability Board, for example, defines fintech as "technology-enabled innovation in financial services that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services". The Basel Committee on Banking Supervision (BCBS), meanwhile, has categorized fintech innovations into three broad product sectors—namely, credit, deposit, and capital-raising services; payments, clearing, and settlement services; and investment management services—in addition to market support services [BCBS 2018].

The DD framework tells us that financial fragility exists whenever illiquid assets are financed by short-term debt (or whenever transformation services are offered). It may therefore shed light wherever borrowing and lending (or financial intermediation) occurs, such as in the credit, deposit, and capital-raising space of fintech.

There are two concerns about this rapidly changing area. The first relates to the impact of fintech players on incumbent banks, and the possible effects on financial stability, as the former may exert competitive pressure on the latter, pushing them to take greater risks to recover their profits, or replace them completely. The second pertains to the vulnerability of the fintech players themselves.

As the DD model has helped crack the code on financial fragility, one can look at the key assumptions and mechanisms and see if they are present in the problem at hand. For instance, comparing the differences between banks and peer-to-peer

lending (P2P) platforms, currently the largest form of fintech financing [Bollaert et al. 2021], can be quite informative. Based on such an exercise, Table 1 from Thakor [2020] seems to suggest that one need not worry so much (yet) about the latter's impact on financial stability.[25]

There are many reasons from the literature explaining why fintech lenders may not eliminate banks.[26] From the DD model, the most crucial would be that they do not offer many of the services provided by banks, particularly risk sharing, liquidity creation, and consumption insurance.

Without a banking license, fintech lenders can only raise the necessary funds but cannot offer transformation services [Navaretti et al. 2018]. Acting like brokers in an agency model, they match counterparties and receive fees for this service, but they cannot use the pooled funds to finance illiquid loans or less liquid assets. They are therefore much like "narrow" or full-reserve banks, which DD declared provided no liquidity services [Diamond and Dybvig 1986]. As they no longer hold credit risk on their balance sheets, fintech lenders also do not function as "delegated monitors", another important function of banks established by Diamond [1984], in his other prize-winning paper.[27] As equity holders, the investors will have to do the credit monitoring and collect the required information themselves.

The DD model tells us, however, that it is for the same set of reasons why bank-like fragilities may be less of a concern in the current fintech environment. The FSB [2017] observes that most P2P lending platforms are unleveraged, unlike banks, with only a small proportion of platforms using their balance sheets to fund loans. Moreover, the P2P lending model does not entail bank-like liquidity risks, as investments and loans are typically duration-matched. An investor may not liquidate their investment before maturity date and will need to find another investor to take their place before they can exit.

However, fintech lenders are more vulnerable than banks to operational risks (such as cyber risks, disruptions to outsourced IT services, and fraud-related risks, including money laundering and corporate misconduct) and misaligned incentives under an agency lending model adopted by most platforms. The FSB [2017] reports that the business models of these online lenders are more like the "originate-to-distribute" model of mortgage lenders prior to the GFC, indicating moral hazard risks, especially if higher fees are charged to higher-risk borrowers (such as with fees set proportional to interest rates) or to investors (upon loan collection).

---

[25] In P2P lending, P2P platforms, after preliminary credit analysis, combine loan bids by investors into loans but do not invest in these loans. Funds provided through these platforms are therefore closer to investor equity, with P2P lending considered as *non-intermediated* finance.

[26] These are apart from the regulatory advantage in terms of deposit insurance and LOLR guarantees that give banks a funding-cost advantage and allow them to meet investors' demand for safe assets.

[27] Simply stated, the theory implies that banks can obtain funding even for high-return but risky projects, as they can commit to pay their creditors (depositors) by monitoring borrowers on their behalf and through diversification of their loan portfolios.

TABLE 1. Banks vs. fintech lending (peer-to-peer platforms)

Banks	P2P lending platforms
A. Services provided	
• Improved risk sharing and consumption insurance	• No
• Screening	• Yes
• Monitoring	• No
• Funding liquidity creation	• No
• Loan commitments (credit rationing insurance) and other off-balance-sheet puts and guarantees	• No
B. Capital structure	
• High leverage with little bank equity capital	• All equity-financed: no equity capital invested by lending platform, so investors are equity holders in loans
C. Incentive problems	
• Insufficient screening	• Yes
• Insufficient monitoring	• No
• Insufficient funding liquidity creation	• No
• Excessive risk-taking due to high leverage and safety nets	• No
• Overlending and excessive growth due to incentives distorted by safety nets and too little capital	• Overlending and excessive growth due to profit-maximization motives.
• Insufficient capital due to safety nets	• No
• Incentives to renege on off-balance-sheet commitments	• No
D. Regulation	
• Deposit insurance and capital regulation	• No
• High regulatory costs and restrictions	• Lower regulatory burden
E. Objective function	
• Maximize bank equity value	• Maximize value of P2P platform's owners' claim consisting of origination and other fees plus fraction of borrower repayments

Source: Thakor [2020].

Many studies have correspondingly argued that fintech will not replace traditional finance any time soon. Based on a review of the literature, Thakor [2020] concludes that P2P lending may take some market share away from banks but will not replace bank lending "in the near future", with P2P lenders likely to take risky borrowers (those who lack collateral) away from capital-constrained banks. He expects banks to eventually build their own online lending platforms, acquire such platforms, or partner with existing platforms. Murinde et al. [2022],

Bollaert et al. [2021], and Navaretti et al. [2018] similarly share the view that fintech lenders are unlikely to supplant banks, but may coexist with them, cooperate with them, and/or evolve together to become more like each other (e.g., banks developing their own fintech platforms or working with fintech startups, and fintech lenders possibly engaging in maturity transformation to some extent, to provide greater liquidity services).

Yet that is as far as the benign evolution of the financial system goes. Based on lessons from the DD framework, there are two areas that may need to be watched. One connects to the existence and possible spread of shadow banks in the fintech lending space—financial intermediaries that are neither P2P lending platforms, though they use IT extensively in lending, nor banks, despite having similar balance sheets [Thakor 2020]. Like banks, they perform liquidity transformation and invest their own equity, but unlike banks, they obtain funding through uninsured debt financing or via securitization instead of deposits. As shadow banks, they are unregulated and inherently fragile entities that may be susceptible to runs, as had been the painful experience during the GFC.

The other area to watch refers to the potential for systemic importance of aggregators in finance, as they may become the default solution for accessing banks, when applying for new accounts and loans [FSB 2017]. Some now instantly link to digital banks or neobanks—a fintech innovation that shifts away from relationship banking—and not just to online versions of traditional banks.[28] While such an arrangement may improve financial inclusion as hoped, it may also create new risks, as loans and deposits become more sensitive to financial and real shocks [Gambacorta 2023]. Whether or not it will worsen financial fragility remains to be seen. From Diamond [1984], we recognize that much depends on how well loans may be selected, diversified, and monitored even without human interaction. From DD, we know that it will hinge on how confident (and trustful) depositors and other investors may turn out to be in such arrangements.

4.2. Emergence of CBDCs

As a final illustration, this subsection briefly notes how the DD model has contributed to the theoretical analysis of CBDCs, an idea spurred by the development of distributed ledger technology, which enabled decentralized settlement of electronic transactions and the creation of cryptocurrencies. CBDCs possibly eliminate the need for physical cash; allow the central bank to engage in large-scale intermediation, in competition with private banks for deposits and likely involving some form of lending of those deposits; and, in summary, permit consumers to directly hold a bank account with the central bank [Fernández-Villaverde et al. 2021].

---

[28] Digital banks, unlike their traditional counterparts, rely on a business model that is based mainly on technology and data. They have no "brick-and-mortar" facilities and rely solely on mobile phones and apps (i.e., no human interaction). To reduce the need for collateral, they make use of machine learning and non-traditional data as inputs to credit scoring.

CBDCs can improve welfare by reducing frictions in deposit markets and payments, encourage financial inclusion, and improve the transmission of monetary policy (Infante et al. [2022]; Ahnert et al. [2022]). However, they can also carry risks, such as possible bank disintermediation, as they may increase the funding cost of banks and reduce bank lending; and potentially greater bank fragility and higher likelihood of systemwide runs.

The DD model, considered to be the canonical model of bank runs, has proven vital in studying the potential impact of CBDCs, particularly on financial stability. The new models, in turn, have been informative especially for policymakers, who are also just grappling with the concept. Fernández-Villaverde et al. [2021], for instance, introduce a central bank and a CBDC to the seminal model, allowing them to investigate the implications of a CBDC account that potentially competes with traditional deposits in commercial banks.[29] Unlike commercial banks, a central bank can only invest in long-term projects through investment banks. In addition, it cannot terminate these projects prematurely (wholesale loans to investment banks are not callable and hence protected from early liquidation), and it can default without going bankrupt. There is therefore little incentive to run on the central bank in the resulting model, while commercial banks remain fragile for reasons outlined in the DD paper.

The authors further argue that the rigidity of the central bank's contract with investment banks will eliminate the run equilibrium, making the central bank more stable than the commercial banking sector. Realizing this, consumers choose to deposit exclusively with the central bank, and the latter becomes the "monopoly provider of deposits" in the economy, which possibly "endangers maturity transformation". This arrangement could jeopardize the independence of the central bank, which now has the power to invest in specific projects and may face political pressure as a result.

In a related paper, Schilling et al. [2020] create a nominal version of the DD model. It differs from the classic setup by considering central bank intermediation, which allows the monetary authority to control the price level. CBDC accounts are now nominal rather than real assets or claims. CBDC depositors may "run" on the central bank by rushing to spend their nominal balances, with such behavior possibly triggered by concerns that their holdings may start to lose value. In this model, real value is determined by the central bank's liquidation policy for its real investment, where selling more of the (illiquid) asset would place downward pressure on prices, and vice versa.

The central bank can thus deter runs by threatening high inflation when nominal spending is excessive—i.e., by limiting the supply of goods in the case of a run, making the run suboptimal.[30] This creates a CBDC trilemma, where the

---

[29] This is taken as an equivalence result where, in the absence of a banking panic, allocations met with private financial intermediation will also be met with a CBDC.

[30] This is true for the patient depositors, who would not receive utility from consuming goods in the present. However, the inflation threat must be credible for runs not to occur. Note also that high inflation only occurs off the equilibrium path, in contrast to the results of the DD model where runs can occur in equilibrium.

central bank can attain at most two out of the following three goals: efficiency (optimal ex ante risk sharing in the sense of DD), financial stability (the absence of runs), and price stability. If the primary goal is price stability, for example, then either the allocation will be suboptimal or there will always be the risk of destabilizing runs. The trilemma would tend to worsen as well under political-economy pressures. However, observers note that such an extremely centralized economy is unlikely at the present time, with no major central bank considering such features [Auer et al. 2021].

A variety of other models similarly derive from the DD framework, such as those by Skeie [2021] and Popescu [2022], offering insight into the possible effects of central bank issuance of their own digital currencies. The first argues that appropriate and dynamic management of policy rates paid on bank reserves relative to interest rates paid on CBDC support optimal investment and risk sharing and prevent disintermediation of banks and digital currency runs into CBDC. The second focuses on cross-border CBDCs and explores the implications of having a foreign CBDC that serves as an international safe asset, concluding that the presence of such an entity increases the risk of financial disintermediation of the banking system and financial instability marked by high and volatile capital outflows. The findings suggest the importance of coordination in the design of CBDCs at the global level. Other models have investigated the impact of CBDCs on financial stability without using the framework of DD but nevertheless acknowledge their pioneering framework (e.g., Bitter [2020]).

5. Concluding remarks

Evidently, the DD model has been a valuable theoretical contribution, with far-reaching intellectual and policy influence. It has become a solid building block for models featuring different settings and scenarios, yielding important insights for policymakers. Built in the early 1980s, it continues to have a profound impact on today's thinking, even as the financial system has evolved, with technological change introducing new instruments and actors.

Applying the DD framework to emerging markets and developing economies has helped drive home the necessity of certain policies and reforms to lower vulnerability to financial crises. These include broad strokes such as maintaining sound macroeconomic fundamentals (e.g., avoiding unhealthy booms in lending and building up foreign reserves); better handling of capital flows; and proper sequencing of capital liberalization. The expanded framework also points to the need to avoid specific triggers in developing economies—such as unhedged short-term foreign debt, rickety exchange rate pegs, and undercapitalized banks—which could increase the likelihood of coordination failures among investors and susceptibility to short-term debt runs.

Similarly applying DD's framework to modeling or even just examining the evolving financial system allows better analysis of the impact of such changes.

For now, it appears that the rapid rise in fintech may not entail too much risk, though there are worrisome areas, such as the possible re-emergence of shadow banks, which must be addressed. Formal models based on the DD model that seek to understand new financial concepts, such as CBDCs, provide a way to reveal possible blind spots, such as those that could ultimately work to undermine central bank independence.

Built on solid microeconomic foundations, the DD model will likely continue to be applicable despite a rapidly changing financial intermediation landscape. It has captured the key mechanisms in a form that is easy to incorporate in other models as well as to communicate to the layman. Thus, DD's ideas will likely remain an important component of future models. While the risk of a financial crisis will never go away, there is greater confidence about the future now that, with DD's solid research and others that followed, we have a better understanding of financial crises and how to prevent or handle them.

References

Allen, F. and D. Gale [1998] "Optimal financial crises", *Journal of Finance* 53(4):1245-1284.

Allen, F. and D. Gale [2004a] "Financial fragility, liquidity, and asset prices", *Journal of the European Economic Association* 2(6):1015-1048.

Allen, F. and Gale [2004b] "Financial intermediaries and markets", *Econometrica* 72(4):1023-1061.

Anginer, D. and A. Demirguc-Kunt [2018] "Bank runs and moral hazard", *World Bank Policy Research Working Paper No. 8589*.

Auer, R., J. Frost, L. Gambacorta, C. Monnet, and T.R. Shin [2021] "Central bank digital currencies: motives, economic implications and the research frontier", *BIS Working Paper No*. 976. Bank for International Settlements.

Bank of Japan [2023] "The Bank of Japan's policy measures during the financial crisis", https://www.boj.or.jp/en/mopo/outline/cfc.htm. Accessed November 15, 2023.

Basel Committee on Banking Supervision (BCBS) [2018] "Sound practices: implications of fintech developments for banks and bank supervisors", *Bank for International Settlements*. https://www.bis.org/bcbs/publ/d431.pdf.

Bernanke, B.S. [1983] "Nonmonetary effects of the financial crisis in the propagation of the Great Depression", *American Economic Review* 73(3):257-276.

Bernanke, B.S. [2009] "Reflections on a year of crisis", *Board of Governors of the Federal Reserve System*. https://www.federalreserve.gov/newsevents/speech/bernanke20090821a.htm.

Bernanke, B.S. [2018] "The real effects of disrupted credit: evidence from the global financial crisis", *Brookings Papers on Economic Activity* 49(2):251-342.

Bitter, L. [2020] "Banking crises under a central bank digital currency", *ZBW - Leibniz Information Centre for Economics*. https://www.econstor.eu/bitstream/10419/224600/1/vfs-2020-pid-40056.pdf.

Bollaert, H., F. Lopez-de-Silanes, and A. Schwienbacher [2021] "Fintech and access to finance", *Journal of Corporate Finance* 68(C):1-14.

Brunnermeier, M. and A. Krishnamurthy [2020] "COVID crisis response: 'evergreening proposal'", *World Bank*. https://thedocs.worldbank.org/en/doc/2785515881897738460050022020/original/20200429WorldBankCOVIDProposalbyMarkusb.pdf.

Bryant, J. [1980] "A model of reserves, bank runs, and deposit insurance", *Journal of Banking and Finance* 4(4):335-344.

Burnside, C., M. Eichenbaum, and S. Rebelo [2004] "Government guarantees and self-fulfilling speculative attacks", *Journal of Economic Theory* 119(1):31-63.

Calomiris, C.W. and G. Gorton [1991] "The origins of banking panics: models, facts, and bank regulation", in R.G. Hubbard (ed.), *Financial markets and financial crises* (109-174). National Bureau of Economic Research.

Calvo, G. [2012] "Financial crises and liquidity shocks a bank-run perspective", *European Economic Review* 56(3):317-326.

Carlsson, H. and E. Van Damme [1993] "Global games and equilibrium selection", *Econometrica* 61(5):989-1018.

Chang, R. and A. Velasco [1998] "Financial crises in emerging markets: a canonical model", *Federal Reserve Bank of Atlanta Working Paper No*. 98-10:1-50.

Chang, R. and A. Velasco [2000] "Liquidity crises in emerging markets: theory and policy", in B.S. Bernanke and J.J. Rotemberg (eds.), *NBER macroeconomics annual 1999* (Vol. 14, 11-78). MIT Press.

Chang, R. and A. Velasco [2001] "A model of financial crises in emerging markets", *Quarterly Journal of Economics* 116(2):489-517.

Committee for the Prize in Economic Sciences in Memory of Alfred Nobel [2022] "Scientific background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2022: financial intermediation and the economy", The Royal Swedish Academy of Sciences.

Cooper, R. and T.W. Ross [2002] "Bank runs: deposit insurance and capital requirements", *International Economic Review* 43(1):55-72.

Diamond, D.W. [1984] "Financial intermediation and delegated monitoring", *Review of Economic Studies* 51(3):393-414.

Diamond, D.W. [1997] "Liquidity, banks, and markets", *Journal of Political Economy* 105(5):928-956.

Diamond, D.W. [2022] "Financial intermediation and financial crises (Nobel prize lecture)", *The Royal Swedish Academy of Sciences*. https://www.nobelprize.org/uploads/2022/11/diamond-lecture-slides.pdf.

Diamond, D.W. and P.H. Dybvig [1983] "Bank runs, deposit insurance, and liquidity", *Journal of Political Economy* 91(3):401–419.

Diamond, D.W. and P.H. Dybvig [1986] "Banking theory, deposit insurance, and bank regulation", *Journal of Business* 59(1):55-68.

Didier, T., F. Huneeus, M. Larrain, and S.L. Schmukler [2021] "Financing firms in hibernation during the COVID-19 pandemic", *Journal of Financial Stability* 53:1-14.

Dooley, M.P. [2000] "A model of crises in emerging markets", *Economic Journal* 110:256-272.

Eichengreen, B. and A.K. Rose [1998] "Staying afloat when the wind shifts: external factors and emerging-market banking crises", *NBER Working Paper Series No.* 6370.

Farhi, E., M. Golosov, and A. Tsyvinski [2009] "A theory of liquidity and regulation of financial intermediation", *Review of Economic Studies* 76(3):973-992.

Fernández-Villaverde, J., D. Sanches, L. Schilling, and H. Uhlig [2021] "Central bank digital currency: central banking for all?", *Review of Economic Dynamics* 41:225-242.

Frankel, J.A. [2010] "Monetary policy in emerging markets: a survey", *NBER Working Paper No.* 16125.

Furman, J. and J.E.Stiglitz [1998] "Economic crises: evidence and insights from East Asia", *Brookings Papers on Economic Activity* 1998(2):1-135.

Gambacorta, L. [2023] *Digital banking: opportunities and challenges.* Bank for International Settlements.

Goldstein, I. and A. Pauzner [2005] "Demand–deposit contracts and the probability of bank runs", *Journal of Finance* 60(3):1293-1327.

Gorton, G. [1988] "Banking panics and business cycles", *Oxford Economic Papers* 40(4):751-781.

Hazlett, D. [1997] "Deposit insurance and regulation in a Diamond-Dybvig banking model with a risky technology", *Economic Theory* 9(3):453-470.

He, Z. and Y. Ma [2022] "The insight and influence of Douglas Diamond", *Promarket*. https://www.promarket.org/2022/10/11/the-insight-and-influence-of-douglas-diamond/.

Jacklin, C.J. [1987] "Demand deposits, trading restrictions, and risk sharing", in E.C. Prescott and N. Wallace (eds.), *Contractual arrangements for intertemporal trade* (pp. 26-47). University of Minnesota Press.

Jeanne, O. [2009] "Debt maturity and the international financial architecture", *American Economic Review* 99(5):2135-2148.

Jeasakul, P., C.H. Lim, and E. Lundback [2014] "Why was Asia resilient? Lessons from the past and for the future", *IMF Working Paper No.* WP/14/38.

Kashyap, A.K. [2015] "Bank runs aren't madness: this model explained why", *Chicago Booth Review.* https://www.chicagobooth.edu/review/bank-runs-arent-madness-this-model-explained-why.

Krugman, P. [1999] "Balance sheets, the transfer problem, and financial crises", *International Tax and Public Finance* 6:459-472.

Kuroda, H. [2020] "Japan's economy and monetary policy: speech at a meeting with business leaders in Osaka", *Bank of Japan*. https://www.boj.or.jp/en/about/press/koen_2020/ko200923a.htm.

Masson, P.R. [1999] "Multiple equilibria, contagion, and the emerging market crisis", *IMF Working Paper No*. 99/164.

Matsuoka, T. [2018] "Banks and liquidity crises in emerging market economies", *Journal of Economic Dynamics & Control* 94(C):43-62.

McKinnon, R.I. and H. Pill [1997] "Credible economic liberalizations and overborrowing", *American Economic Review* 87(2):189-193.

Morris, S. and H.S. Shin [2000] "Rethinking multiple equilibria in macroeconomic modeling", University of Chicago Press on behalf of the The National Bureau of Economic Research.

Murinde, V., E. Rizopoulos, and M. Zachariadis [2022] "The impact of the FinTech revolution on the future of banking: opportunities and risks", *International Review of Financial Analysis* 81(11):1-27.

Navaretti, G.B., G. Calzolari, J.M. Mansilla-Fernandez, and A.F. Pozzolo [2018] "Fintech and banking: friends or foes?", https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3099337.

Noman, A.H., M.K. Hassan, S. Pervin, C.R. Isa, and C. Sok-gee [2022] "The mediating role of competition on deposit insurance and the risk-taking of banks in ASEAN countries", *Research in International Business and Finance* 59(C):1-19.

Popescu, A. [2022] "Cross-border central bank digital currencies, bank runs and capital flows volatility", *IMF Working Paper No*. WP/22/83.

Prescott, E.S. [2010] "Introduction to the special issue on the Diamond-Dybvig model", *Economic Quarterly* 96(1):1-9.

Radelet, S. and J.D. Sachs [1998] "The East Asian financial crisis: diagnosis, remedies, prospects", *Brookings Papers on Economic Activity* 1998(1):1-90.

Rodrik, D. and A. Velasco [1999] "Short-term capital flows", *NBER Working Paper No*. 7364.

Sachs, J. [1996] "Alternative approaches to financial crises in emerging markets", *Brazilian Journal of Political Economy* 16(1):202-216.

Samuelson, P. [1958] "An exact consumption-loan model of interest with or without the social contrivance of money", *Journal of Political Economy* 66(6):467-482.

Schilling, L., J. Fernández-Villaverde, and H. Uhlig [2020] "Central bank digital currency: when price and bank stability collide", *NBER Working Paper No*. 28237.

Skeie, D.R. [2021] "Digital currency runs", *WBS Finance Group Research Paper*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3294313.

Thakor, A.V. [2020] "Fintech and banking: what do we know?", *Journal of Financial Intermediation* 41(C):1-13.

Walker, M. [2017] "The enduring relevance of Diamond-Dybvig", https://olinblog.wustl.edu/2017/11/everyone-wants-piece-banks-fail/.

Working Group established by the Committee on the Global Financial System and the Financial Stability Board [2017] "Fintech credit: market structure, business models and financial stability implications", *Financial Stability Board*. https://www.bis.org/publ/cgfs_fsb1.htm.