CONTENTS

INTRODUCTION

A financial crisis is a devastating event for people and for firms. Without swift action a financial crisis leads to a collapse of the financial system, dragging down the real economy. Firms fail. People lose their jobs and their homes. There is no bigger disruption in the functioning of economies. Indeed macroeconomics was motivated, and founded as a discipline, by the sudden, and puzzling, Great Depression. Keynes and his contemporaries put a lot of emphasis on the role of financial markets in explaining that damaging event. We saw this again in the Financial Crisis of 2007–2008, when macroeconomics, now a more mature discipline, was taken by surprise.

Even more surprising was that the recent financial crisis, as well as crises in other countries and other times, was rationalized as an unexpected unique event. But financial crises occur in all economies, over and over again, and will occur again in the future. It is important then that macroeconomics treat financial crises as an inherent and structural element in the functioning of market economies, incorporating them explicitly. In this book we ask questions that will lay the groundwork to do that. How can macroeconomic models accommodate financial crises? Financial crises are usually preceded by credit booms. Does the model need to explain credit booms? What is a "credit boom"? How do booms start? Do they always end in crises? How should the model relate booms and crises to technology and productivity? Are cycles exogenous or determined by the linkages between technology and finance? All these questions should be at the forefront of efforts to understand fluctuations in an economy.

Here we identify and expand on common elements that are present in all financial crises: *short-term debt, collateral, and information*. Short-term debt is a critical element needed for market economies to function. It is needed to store value over short periods of time without fear of loss, and as such it becomes important to sustain transactions. As documented by Gorton (2010), Gorton, Laarits, and Metrick (2020), Gorton and Metrick (2012), Covitz, Liang, and Suarez (2013), and Gorton, Laarits, and Metrick (2020), *short-term debt* was at the heart of the Great Depression and the Financial Crisis of 2007–2008. Short-term debt is, however, a promise and must be backed by collateral. The basic problem in a growing market economy is, however, a lack of good collateral, which, as discussed in Gorton, Lewellen, and Metrick (2010) and Krishnamurthy and Vissing-Jorgensen (2012), is not necessarily provided by the government (see Planck 1968).

To be more concrete, and using a painful recent example, the Panic of 2007–2008 was a bank run in the sale and repurchase market (the "repo" market; see Gorton and Metrick

2012 and Gorton, Laarits, and Metrick 2020). Repo is a form of short-term debt. Institutional investors lend to banks for short periods. Banks also lend to other banks for short periods, usually overnight. These loans are collateralized with bonds and other securities. A lender may lend, for example, $500 million overnight, and receive collateral in the form of bonds with a market value of $500 million. The loan might even be over-collateralized, so the lender might receive $550 million worth of bonds, for instance. Every morning trillions of dollars of repo loans are "rolled," that is, the lender agrees to lend for another twenty-four hours. This implies that trillions of dollars in collateral are needed.

If credit risk analysis was required for such a volume of collateral every time that short-term debt was renewed, the market would simply not be feasible. If the lender said that it would take a week to study the proposed collateral, overnight loans would not be possible. This is where information enters into the picture. The operation of this market is only possible when nobody is informed. Is it a mistake, or a miscalculation, that a trillion-dollar market operates every day with *opacity* and without due diligence? The answer is no. In fact, what happens is that the collateral is designed so that it pays no party to investigate the collateral, and all parties know this. So, this market is possible not only when nobody is informed but also when everybody knows that. In other words, it is beneficial that collateral is *information insensitive*. If the collateral is accepted without questions, then repo can work as a short-term store of value. The next morning the lender can receive the cash back if needed, no questions asked.

All short-term debt works this way: it is backed by collateral and sustained by opacity. Bank debt, such as demand deposits, is backed by portfolios of loans and the deposits are over-collateralized to the extent that the bank has equity. Other forms of privately produced short-term debt, such as private banknotes and asset-backed commercial paper, are also backed by portfolios of collateral. Similar to repo, if you need cash in the morning you go to an ATM and get money from your checking account. And just like the collateral that backs repo contracts, banks' portfolios are complex and opaque, that is, they are information insensitive. (See Dang et al. 2017.)

A *financial crisis* occurs when holders of short-term debt rationally come to suspect that the backing collateral is insufficient to protect that debt. This suspicion usually arises from a public signal that is interpreted to mean this. In that case the debt becomes *information sensitive*, which means that agents produce information about the backing collateral or suspect that other agents are secretly producing this information. Then agents run on the repo contracts, not renewing the loans, or run to the banks and demand to "see the cash." The switch from not producing information to producing information is an economy-wide event. Why? Because by the construction of opacity no agent knows which are the weak assets and they have to examine them all. But under what conditions is there a switch from an information-insensitive regime to an information-sensitive regime?

The well-oiled functioning of short-term debt markets sometimes leads to rapid credit growth. These *credit booms* tend to precede financial crises. As a credit boom advances there is an endogenous depreciation of information and an endogenous reduction of productivity and the return on financed investments. More and more firms and

households get loans because their collateral appears to be good enough. When the quality of investments remaining is low enough, a crisis occurs when short-term debt turns information sensitive. The crisis comes from an endogenous increase in systemic risk, and it is a function of the length of the credit boom: the longer the preceding boom, the larger the crisis will be.

Our conception of a financial crisis is very different from the view that a crisis is a manifestation of multiple equilibria. Such theories do not explain how or why there is a switch from one equilibrium to another. This standard view is based on the idea that runs on short-term debt are coordination failures among depositors (due to an assumed sequential service constraint where depositors must line up to withdraw at the bank). What creates the coordination friction is that all depositors have rights to a portion of the portfolio but no right to a specific portion. In other words, each depositor has a claim on a common pool of assets. The weakness of this view was revealed in the recent financial crisis. Repo contracts do not face a common pool problem. Instead, each investor has a claim on a contractually specified amount of collateral that the lender gets possession of. The sunspot coordination failure view cannot explain the recent crisis.

Our informational view of crises can, however, accommodate both standard bank runs and the recent run on repo. If lenders have suspicions about the backing collateral, they will not roll over bank deposits or repo loans. Even though with repos short-term debt is not contractually backed by a portfolio pool, all collateral is "informationally pooled" as there is no information about which collateral is of good quality and which is not. When there is a run on banks or on repo, throughout the banking system, the economy is on the verge of a systemic collapse of the financial system. But even taking this into account the debt is still an optimal arrangement. When there is such a crisis, the central bank must act *to restore information insensitivity to the entire banking system*.

Financial crises occur in all market economies, those with and without central banks, with and without deposit insurance. All have common fundamental elements. And studying financial crises requires studying the forces that are bound up with crises. These forces include credit booms, technological change, and information dynamics. In particular, the amount of information in the economy varies depending on the state of the macroeconomy. It is not only the sudden shift of information-insensitive debt to information-sensitive debt, which is a volcanic eruption of information production. The stock market is always information sensitive, producing information about individual companies. We will see that information in the stock market can affect the behavior of lenders in the credit market. There will be a dynamic interaction between these two markets. As we will show, information from the stock market may be able to prevent a financial crisis from happening, but it may also choke up credit markets and growth.

One might reasonably ask why traditional macroeconomics did not include financial crises and credit booms prior to the Panic of 2007. In 1977 Lucas laid out the post-Keynesian macro research program, including the idea that business cycles are deviations from trend. The deviations were taken to be caused by "shocks." But this created a difficulty. Was the Great Depression a deviation from trend? A big "negative shock"?

The answer provided by Prescott (1983) was that the Great Depression could safely be excluded from thinking about aggregate dynamics. It seemed like an extraordinary event. The previous history of financial crises was deemed irrelevant because they were in the "past." Financial crises in emerging economies were deemed irrelevant because they happened in "immature" economies. In this book we bring back past crises and crises in all countries, and combine them with modern crises. We will see that they all have a common structure, namely short-term debt.

When compared to financial crises in the previous century, one problem in studying modern financial crises is the confusion that expectations about potential central bank or government actions create. Gorton (1988) claimed that without a central bank, there would have been panics starting in June 1920 and December 1929. There was no panic in 1920 because banks had availed themselves of the Federal Reserve discount window. But because of the introduction of stigma by the Fed, banks did not borrow from the discount window in 1929 and 1930. Depositors thought that the banks had gone to the window, but the banks knew that they had not. The banks "ran on themselves" by shrinking, cutting off credit, and ramping up U.S. Treasuries. The economy shrank, although the bank runs only came later when depositors saw large banks fail. (See Gorton, Laarits, and Muir 2020.) Indeed, the Great Depression was different from the earlier panics in the pre-Fed era. The mistake of not understanding the Great Depression meant that macroeconomics developed without considering the possibility of financial crises. This was then apparently confirmed when deposit insurance eliminated bank runs, reinforcing the theoretical view of runs as coordination failures. It also seemed to rule out the idea that other forms of short-term debt are also subject to runs. Indeed, deposit insurance did not, and could not, prevent bank runs on modern repos.

The Financial Crisis of 2007–2008 highlighted the need to broaden macroeconomics to include financial crises as one of the fundamental factors behind macroeconomic fluctuations. That is why we wrote this book.

Road Map

We start with data. Chapter 1 is devoted to laying out a set of stylized facts that a macro model must address when accommodating credit booms and financial crises. These are the facts that we will address with the subsequent models. This chapter highlights in particular macro facts associated with financial markets that have not been noticed or explored to date. First and foremost we discuss little-known regularities surrounding financial crises. They are not rare. Just looking at the U.S. post–World War II period, it would seem that financial crises are no longer a threat, or are a phenomenon of the past. This is inaccurate. While they do not necessarily happen at regular intervals, financial crises are an inherent feature of market economies, both developed and emerging.

After documenting how frequent and prevalent financial (and in particular banking) crises are, we study the relation between the movements of technology and productivity with credit booms. We show that booms tend to be triggered by positive technological improvements and can end suddenly and dramatically in a financial crisis if the

productivity boost is not large enough or gets exhausted (a bad boom), but it may persist or end without a crisis when accompanied by productivity growth (a good boom).

Chapter 2 lays out a static benchmark model that demonstrates the importance of information about collateral on the credit that firms can raise through debt. We show that debt is designed to be *information insensitive*: the benefit of producing private information about a security's payoff outweighs the cost; otherwise, the security is information sensitive.

In the book (except for Chapter 6) we abstract from including financial intermediaries explicitly, and instead we have households lending directly to firms. The debt we have in mind is short-term debt like repurchase agreements ("repo") or other money market instruments. In these cases, the collateral is either a specific bond or a portfolio of bonds and loans. Here we have called the collateral "land," but realistically we have in mind a mortgage-backed security (MBS) or asset-backed security (ABS), both of which are hard to value. This type of security does not trade in centralized markets where prices are observable.

Chapter 3 takes the model of Chapter 2 and turns it into a dynamic model. We show how a rational credit boom can occur and, while the boom evolves, systemic risk—the risk and size of a financial crisis—builds up. The credit boom happens because agents do not find it optimal to produce information about the collateral backing loans. But as this happens, information in the economy depreciates, tossing more and more collateral into an "informational pool." In this chapter we discuss how a small negative shock in the average quality of collateral can induce information acquisition. The longer the boom, the more collateral there is in the informational pool and the larger the crisis. Take a mortgage-backed security, for example. Such securities are complicated and investors cannot value them. They rely on ratings. The model shows that even a small "shock" can trigger a crisis. But we also show that the social planner likes credit booms because output and consumption go up. But the social planner does not want the boom to go on as long as private agents do.

What we call a shock that triggers the "financial crisis" is the arrival of public information, making a financial crisis an *aggregate information event* that triggers the fear of *idiosyncratic information acquisition*. It is triggered by some public news that induces debt holders (depositors and/or lenders) to run on all or many banks and/or repo contracts demanding to convert their (short-term) debt claims into cash to such an extent that this demand for cash cannot be met. The run is rational. The debt holders have reason to suspect the collateral backing the debt (which could be a portfolio of loans or a single bond), and the information about it by the rest, and this suspicion results in runs on both good and bad collateral, as by construction nobody knows what is what.

This chapter highlights a key factor driving macroeconomic variables and financial crises in particular: the amount of information about collateral in the economy. It also highlights that a crisis is an informational event in which the system travels from an information-insensitive to an information-sensitive regime. But there is no multiple equilibrium. The crisis is a sudden burst of information production (or incentives to produce information). In the credit models we study here there is always symmetry, either

symmetric information (everyone knows everything) or symmetric ignorance (no one knows anything). There is never asymmetric information and adverse selection. What drives moving from symmetric ignorance to symmetric information (a crisis), however, is the fear of adverse selection.

Chapter 4 adds technological change, both exogenous and endogenous, to the picture. We show that a credit boom starts with a positive technology shock. Booms can be good booms, which do not end in a crisis, or bad booms, which do end in a crisis, depending on the contemporaneous endogenous evolution of productivity in the economy. There are no "shocks" in the model of this chapter and still there can be financial crises. The dynamics are driven by technological change and happen at a lower frequency than what is usually studied. The difference between a good boom and a bad boom lies in the rate of growth of technological change. If the growth dies off rapidly during the boom, it will result in a bad boom. Otherwise, it will be a good boom. Importantly, crises are not the result of exogenous shocks, as in Chapter 3, but instead the result of an endogenous buildup of fragility due to an endogenous depreciation of information about collateral. The amounts of good and bad collateral are fixed, but the perceptions of which collateral is good and which bad evolve with total credit, changing productivity and consequently the incentives to examine the collateral that sustains credit.

Both Chapters 3 and 4, considered together, show that financial crises may be generated by negative contemporaneous shocks, but this is not necessary. The seeds of a financial crisis can also be planted many years before the actual event, and the crisis is just an endogenous reaction to the endogenous evolution of productivity. In this sense, economic fluctuations depend on the evolution of productivity, but such productivity has exogenous components (as in standard macroeconomic models) and endogenous components (as credit determines the marginal quality of projects that are financed). Different patterns of productivity growth affect the likelihood and size of credit booms and crises. The business cycle depends on the trend.

Chapter 5 adds a stock market to the model of Chapter 4. This is because credit markets are not the only market for which information (or lack thereof) is a critical input. There is another one that works completely differently: the stock market. In stock markets agents produce information about firms' values, which is then impounded in prices, improving the allocation of resources in the economy. While the nature of stock prices is to be information sensitive, credit markets, particularly collateralized credit markets, work better when information about collateral is *not* produced—when debt is information insensitive. But the incentives to learn about collateral are determined partly by what lenders learn about firms, and they tend to learn that from stock prices. On the flip side, the incentives to learn about firms are also determined partly by what lenders learn about collateral and the availability of credit.

Ignorance in credit markets is the opposite of information-revealing prices in stock markets. These two systems, one an information-sensitive system (the stock market), where the price responds, and the other an information-insensitive system (credit markets), where quantities respond, interact. And it is the dynamics of this interaction that is of

primary importance for understanding the macroeconomy. Information in stock markets affects information in credit markets, hence booms and busts, and vice versa. The information in both markets depends, and shapes, other macroeconomic variables, such as productivity.

In the model of this chapter, information revealed in the stock market can identify firms with low productivity. Since they are more likely to default on their loans, lenders, having observed the stock price, may decide to investigate the collateral of these firms. If this happens to a sufficient extent, then lenders to the remaining firms do not find it optimal to produce information about their collateral. So, the stock market can act as an endogenous macroprudential mechanism in the sense that it slows down the depreciation of information about collateral, preventing financial crises. Information in stock markets, however, is not exogenous but also depends on the amount of credit in the economy, as credit affects productivity endogenously. This generates interesting dynamics depending on the technological state of the economy. The technological trend affects the information intensity in both stock and credit markets, and then the cyclical properties of economic activity.

In Chapter 6 we study central bank policy when a financial crisis is already happening. What should be done? What actions should a central bank take when such a crisis is informationally generated? In this chapter we explicitly introduce banks. When there is a bank run, the central bank wants to intervene, exchanging safe assets (government bonds) for private assets in their portfolio that are under suspicion and then under risk of examination (toxic assets). We show, importantly, that these programs should be conducted in secret, not revealing which banks have participated. What happens is this: A bank, knowing that it has a bad asset, can take it to the central bank and exchange it for a government bond. If this is kept secret, it creates an information externality by raising the average quality of assets in the whole banking system. Then, the program does not need to replace all assets under suspicion, which after a long credit boom is basically the assets of all banks. Increasing the expected quality of assets in the banking system mitigates the desire of depositors to examine all banks' assets, thereby avoiding a withdrawal of funds from those banks that are found to have less than average asset quality.

But if having government bonds in the portfolio is so effective to avoid runs, a bank that now has a government bond might want to reveal its participation in the program to depositors. If this were to happen, the information externality would be destroyed. What keeps a bank from doing this is "stigma." Stigma is the negative inference made about a bank's quality from its need to borrow from the government. Stigma then is the means that allows opacity to be maintained in the system, in clear opposition to the literature that considers opacity of the program as a means to prevent stigma.

Chapter 7 is not only the conclusion but also a road map for future endeavors in creating macroeconomic models that embrace financial markets and information dynamics as inherent elements of macroeconomic fluctuations. As we hope to make clear in this chapter, much more work is needed to connect these elements. This book is a first step.

Most proofs and empirical results are contained in the text, but some are reserved for the Appendix A.

INDEX