

FINANCIAL CRISIS AND PANIC IN THE LABORATORY

Authors: Hubert J. Kiss, Ismael Rodriguez-Lara, Alfonso Rosa-Garcia

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Introduction

Thousands of depositors crowd in the door of a bank branch. "Where is our money? ", they shout enraged. "We want our money back! " The scene, beside forming a part of the classic movie " It's a wonderful life " (Frank Capra, 1946) reflects a reality that many people believed distant but that has re-arisen strongly in the last years. We speak about bank runs.

When one thinks about the economic crises, it is not complicated to associate them to bank runs. Bernanke (1983), in fact, argues that these were the cause of the major economic losses that took place in the time of the Great Depression during the decade of 1930. More recently, many experts have spoken about the massive withdrawals of deposits in September 2007 in the British bank Northern Rock as the event that was announcing what has ended being known as the Great Recession (2008-2015). Be it true or not that the event in Northern Rock marked the beginning of the current crisis, the massive withdrawals in this bank illustrate that bank runs, as well as the financial crises, are neither events of the past nor isolated phenomena, but they take place nowadays in advanced economies. In this same way, many countries have suffered similar problems during the past years. It is the case of the Bank of East Asia, of Bankia in Spain, or that of American entities as Mutual Washington, Bear Stearns or Lehman Brothers, in all them sudden money withdrawals of massive form have occurred during the last financial crisis.

Our aim in this chapter is to speak about financial crises. Our intention is to complement the discussion in Chapter 14 on Experimental Finance, where the reader could familiarize with the problem of bubbles and market risks, but with a different approach. In this chapter we will study the behavior of the depositors and investors during a financial crisis and will analyze (theoretically and experimentally) what can lead a depositor to withdraw his money in moments of crisis. In addition, we will discuss the literature on informational cascades and will see the mechanisms that may lead to the contagion of panic. In this sense, knowing how information is transmitted plays a key role, since there is no doubt we live in a globalized world, where both depositors and investors have information on anything that is happening. Our chapter will analyze, therefore if there is an effect, and how it takes place, in observing what others have done from an individual point of view (will I be going to withdraw my

money if I see that others are doing it?), as well as from a more global point of view (will it affect the depositors and the investors to know what is happening in a bank nearby or in a similar fund?).

Before beginning, we would like to point to three things. The first is that we will center our discussion on bank runs, even though the reasoning and the analysis that we will carry out can be extended to different financial areas. In fact, many of the studies that we are going to analyze argue that their findings are extensible to other markets and institutions that also fail during financial crises such as investment and pension funds, the repo market, markets of interbank loans or the stock market. That is why massive withdrawals of money, information transmission and contagion problems can all take place in these contexts, even affecting the economic stability of nations.¹ Secondly, though the topic that we treat could seem to be eminently practical, it is our intention to briefly introduce some theoretical notions that clarify the problems at hand. To do so, we will discuss some theoretical predictions of bank runs models and herd behavior models, before presenting the experimental evidence. The presence of a significant amount of experiments is, in fact, the third point that we would like to indicate. Though we have some intuition of how withdrawals may affect other depositors, observing this in real life it is certainly complicated. As we already know through this book, experiments can be very useful to separate different reasons and motives that influence behavior, turning out to be specially useful in such financial environment, given that in times of real crises it is impossible to observe and to separate all the aspects that can affect the behavior of the depositors. Do they all go to withdraw their deposits because they need the money, because of the information they receive, or because of what they see others do? To what extent do these explanations complement each other the way in which some tools (e.g. the existence of depositors with private information or the deposit insurance) mitigate the withdrawals?²

In the following section we will define what is a bank run, by means of an example, and will see the first theoretical explanations of the problem. In section 3 we study how experimental economics has analyzed the way the agents' behavior during the financial crises affects the availability of information on what is taking place. Concretely, we will see how it affects the *coordination* of the choices agents make to update their beliefs on what the others are doing. Subsequently, we will see how agents update their ideas about the bank's situation or about the available investments, so that *herds* form and determine its behavior. Finally, we will study how what happens on the market of an

¹ A recent example in this global context that the reader can think about is the Greek case, where many depositors decided to withdraw their deposits out of the country at the beginning of 2015 after the arrival the power of Alexis Tsipras, leader of the Radical Left Coalition (SYRIZA). Such financial instability in different countries, in fact, motivates the study of Trevino (2013) that we will discuss below, analyzing how the holders of bonds of a country can decide to withdraw their money out of the country.

² The interested reader can extend his vision of the financial crises with other recent reviews of the literature, with a slightly different approach to ours: Heinemann (2012) surveys a wide catalogue of financial problems, including bubbles and herds, and as Duffy (2014), surveys the first experiments on bank runs; and Dufwenberg (2014) surveys experiments on banking, including also bank runs.

asset or in a bank affects the rest, so that financial problems become contagious. In all these cases, recent experimental studies have been able to determine the underlying mechanisms. Finally, in the conclusion we briefly revise the above-mentioned results and suggest open questions that can be explored in further research.

Why are there bank runs?

Though the concept of bank runs will be made clear as we advance along this section, for now we can identify it with the scene opening this chapter: thousands of depositors come in mass to withdraw the money that they have deposited in their bank. The question is, what triggers such behavior in the depositors? Why do they massively come to the bank to withdraw their money?

The literature gives two polar explanations. The first one is related to the health and functioning of the economy, of the bank system and of the bank itself. This is known as bank runs for problems of the fundamentals. The second reason to explain bank runs is associated to coordination problems between the depositors. Below we introduce a simple illustration that should help the reader to well-identify both explanations.

Coordination problems and problems of the fundamentals: A simple example

Let's imagine that you live in an island and that some time ago you invested, together with other 4 friends, a certain amount of money into a company. Each friend contributed 100 Euros, thus the company's initial capital was 500 Euros. Recently, the company has decided to carry out a project of great profitability. The idea consists of investing 250 Euros in the purchase of cattle in nearby islands, to then selling its meat in their island, which has very poor production of meat. To this end, you and your friends chartered a boat a few days ago, for 50 Euros. It is known that when the ship returns, the shipment of meat will be sold without difficulty in the island up to quintupling its value. The benefit from selling the meat will be, therefore, 1000 Euros ($250 \times 5 - 250$).

After chartering the ship and acquiring the meat, the company has spent 300 Euros, so it still has 200 Euros to finance the return of the shipment, which would cost 50 Euros (the same price each way). You and your friends know that once the ship returns to the island, each one will not only receive his initial investment but also the part corresponding from selling the meat. In total, this would imply that you could receive 230 Euros. This amount corresponds to your share of net profits (a fifth of 1000 Euros), after adding your share for the money that has not been invested in financing the expedition (a fifth of 150 Euros). To receive your earnings, you and your friends only need to wait for the ship to return with the shipment. However, you signed with the company a contract against unforeseen events, which gives you the possibility of coming to the company and asking for the immediate return of your money. In gratitude

for having participated, the company will give you your initial 100 Euros, and also a small amount equal to 10 Euros as interests.

In these circumstances both you and your friends have two options:

- You can wait together with all your friends and receive 230 Euros when the ship returns;
- You can go immediately to the company and ask for the reimbursement of your 110 Euros.

In this context, if a person decides to withdraw his funds, he will receive his 110 Euros, and those who wait will obtain a benefit of 260 Euros.³ But what would happen if two of them go and withdraw their investments before the ship returns with the shipment? The company has promised 110 Euros to each of them, but it has only 200 Euros.⁴ Facing such situation, the company can give 110 Euros to the first who comes to withdraw his money and 90 Euros to the second one, or it can return 100 Euros to each of them.⁵ The only certain thing is that it cannot pay 110 Euros to each of them and that, regardless what the solution is, it would have important consequences upon those who have chosen not to withdraw their money: since the company will have to face two immediate payments, it will not be able to finance the return of the shipment. Thus, the purchased meat will rot in the nearby islands without it being sold, and all those who have chosen to wait for the ship would lose their investment and would not receive anything.

Though it could seem strange, the functioning of the banking system has much to do with the simple example we have just discussed. The banks invest their money in projects that turn out to be profitable for its investors, but the investors must wait for a certain period of time until the assets are mature. What happens if many investors demand their money in the short term? These projects will not be able to be carried out. Therefore, banks face a problem between the profitability in the long term and the demand of liquidity in the short term and, though its health is good, they can end up suffering massive withdrawals of money, still without there being what are known as problems of the fundamentals. These problems take place when the doubts cause the massive withdrawals are not doubts on the actions of the rest, but doubts on the viability of the business. For example, imagine that you think that the ship can sink, that a storm is approaching or that pirates can steal the shipment. Though these possibilities were low, would you decide to withdraw your money? And if you see that a friend has withdrawn his money, what would you do? Would you think that your friend has some

³ Let's see why: because now there are only 4 people to divide the net profits with for the sale of meat, each would receive 250 Euros. In addition, the company has 40 Euros after financing the return of the ship and paying the person who has withdrawn his money, thus it would get 10 additional Euros.

⁴ Because the company had 500 Euros, this is the amount it has after having bought the meat (250 Euros) and having financed the expedition (50 Euros).

⁵ Notice that the difference between both cases is that depositors can be served in the order they come (110 Euros for the first one and 90 Euros for the second one), or it could be waited until they all have claimed their money before satisfying their demand. In the literature, the first alternative is known as *sequential service constraint*.

information about the shipment and that probably he has withdrawn his money because there are problems with it? All these situations would suppose problems with the capacity the company has to make the payments, for it could end up in a situation of insolvency. In our example, nevertheless, there is no uncertainty on the profitability of the project. It is known that all the depositors are going to receive 230 Euros if they decide to wait. The problem arises when some investor thinks that the others are going to withdraw their money, which induces him to fear for the profitability of his project. Like, in certain contexts, withdrawing can result in one receiving more than if choosing to wait, the depositors can end up coming to the bank for their deposits. As contained in the spirit of the phrase declared by J. P. Morgan, referring to the financial crisis: " If the people would only leave their money in the banks instead of withdrawing it ... everything would work out all right. " (See *Bankers Calm; Sky Clearing*. New York Times, October 26, 1907). In this context thus arises what is known as bank runs due to coordination problems.

Coordination problems and problems of the fundamentals are the main explanations of why bank runs happen, even though it is true that these two explanations can also be combined. Next, we center the discussion on the problems of bank runs to introduce in more detail these two explanations and the main contributions made to the literature in this area.

Bank runs due to problems of the fundamentals

The emergence of economic problems in a country is directly linked to the solvency and the liquidity of the bank system. In consequence, the depositors can alter their beliefs on the solvency and liquidity of the bank system when facing a worsening of the level of GDP of an economy, a significant increase in the level of unemployment, an important decrease in the rate of growth, or a sudden decrease in the valuation of the companies' managers. Such instability or distrust can make the depositors end up coming to the bank to withdraw their deposits. Thus arises what is known as bank runs by problems of the fundamentals: panic caused by problems related to the *health* of the economy or of the bank system.

The works of Gorton (1988) or Calomiris and Mason (2003) - among many other studies - are useful to better understand what can provoke this type of bank runs, and how can one react to them. Gorton (1988), for instance, supports quantitatively the hypothesis that the economic cycle explains the appearance of bank runs. Calomiris and Mason (2003) complement these findings by empirically studying how certain specific attributes of the bank system (e.g. geographical fragmentation) or the types of shocks (at a local or national level) could have affected the probability that the American banks failed during the years of the Great Depression (1930-1933). In their study, Calomiris and Mason analyze, in addition, which bank characteristics could have made them more inclined to fail, and discuss the determinants of contagion at the local level (a question we will return to at the end of this chapter). Their results show that the fundamentals

explain well why the banks failed, especially during the first part of the Great Depression.

In real life, there is evidence supporting bank runs due to problems of the fundamentals. We can speak about the problem that recently took place in Bankia (the third biggest Spanish bank in number of deposits), which suffered massive withdrawals when it became public knowledge that there were some failures with accounts, or the massive withdrawal of deposits at the beginning of 2015 in Greece, after the change of government. These examples make evident that depositors are concerned with the health of the economy and of the financial institutions, and they can react to such instability or bad news by withdrawing their deposits.

Though the works of Calomiris, Mason and Gorton represent very important contributions in this setting, their macroeconomic foundation separates them from the approach of this book, centered on experimental evidence.⁶ On this regard, Klos and Sträter (2013) have conducted experiments to study how different beliefs on the condition of the economy can affect the withdrawals of deposits. In their model, the depositors have a private and imprecise signal on the quality of the bank, following the theoretical line of global games by Morris and Shin (2003) and Goldstein and Pauzner (2005).⁷

Klos and Sträter claim that the subjects tend to follow a threshold strategy, choosing to withdraw or to wait depending on the type of signal they obtain, and of whether such signal is above or below a certain value. In addition, they fit their evidence to a k-level model, putting in evidence that the depositors have bounded rationality at the moment of deciding. The experimental evidence in problems of contagion, which we will discuss below (e.g. Trevino 2013), supports the idea that the better the signal the agents receive on the fundamentals of their bank, the fewer the number of withdrawals taking place.

Bank runs due to coordination problems

Before we study bank runs due to coordination problems, it would be necessary to ask if these problems are important or not. As we have already mentioned, Calomiris and Mason find that the fundamentals can explain well why some banks failed during the Great Depression. The authors, nevertheless, have problems to explain a considerable part of the problems the banks had during the last stage of the Great Depression. Ennis (2003) cites some examples that have occurred in history and argues that although the

⁶ The reader interested in knowing more on bank runs due to problems of the fundamentals can see the review of the literature in Gorton and Winton (2003).

⁷ The experiments we will discuss in detail when we speak about informational cascade models also propose beliefs on the fundamentals, assuming that each depositor has a signal on the health of the bank which he can use when making his decision.

deterioration of the fundamentals could have been the most relevant factor, the explanation of bank runs due to coordination motives cannot be discarded as a possible explanation, which makes both of them seem relevant. More recent empirical analyses (see Davison and Ramirez, 2014; De Graeve and Karas, 2014) suggest that banks with weaker fundamentals are more inclined to suffer bank runs, but there is also evidence that banks with good fundamentals could experience massive withdrawals. Therefore, it is suitable to propose another route to explain the withdrawals; bank runs due to coordination problems.

The depositors of a bank can choose to come in mass to withdraw their deposits, even in the absence of problems of the fundamentals, if they think that other depositors are going to do it. During the panic in the bank Northern Rock a depositor, when asked about her reasons to withdraw her money, replied: *“It’s not that I disbelieve Northern Rock, but everyone is worried and I don’t want to be the last one in the queue. If everyone else does it, it becomes the right thing to do.”*⁸

The pioneering work of Diamond and Dybvig (1983) models this decision on the withdrawal of deposits as coordination problem between the depositors who decide simultaneously, without knowing the decision of other depositors. In their model, Diamond and Dybvig show that there can be two types of equilibria. In one of them, the depositors (as it would happen in the example of the company that we have discussed above) will wait and leave their money deposited in the bank, with the expectation of receiving a greater benefit in the future. In the other equilibrium, however, a bank run will happen: the depositors will be afraid that other depositors would come to the bank to withdraw their money, so they will end up coming to withdraw as well. This happens because the model assumes that those who leave their money deposited will not receive anything if the bank ends up without funds; thus it is always better to withdraw if others do it than to deviate and wait alone.

In the model of Diamond and Dybvig, it is assumed that there are three periods: the first period in which money is invested, the second one in which it is decided whether to wait or to withdraw, and the third one in which those depositors who have waited receive their earnings (those who withdraw their money, receive their earnings immediately). One of the major contributions of the model, and which supposes a fundamental difference with classic coordination problems that the reader has seen in Chapter 4 this book, lies on the introduction of two types of depositors, so called patient and impatient. What makes the difference between patients and impatient are their preferences, given that the impatient ones will receive utility only if consuming in the first period, whereas the patient ones value consumption in both periods.

In the model, there is a production technology that transforms any unit initially invested in a unit in the first period and in $R > 1$ units in the second period, which makes the

⁸ See <http://www.bloomberg.com/apps/news?pid=newsarchive&sid=ax6oy1MsuSXA&refer=home>

socially optimal solution that in which only the impatient ones withdraw in the first period, and the patient ones wait to receive their (greater) earnings in the second one.

Multiple theoretical works have been developed after Diamond and Dybvig, showing how bank runs can take place in different environments. The basic experimental model to study bank runs á la Diamond and Dybvig consists in a coordination game (in the style of a stag hunt game) where there are players interested in coordinating (patients) and others not interested in doing so (impatient). For instance, Arifovic et al. (2013) propose a model following the above-mentioned tradition, where the probability that each of the equilibria occurs will depend on how of complicated it is to coordinate. The above-mentioned *difficulty to coordinate* depends on the proportion of patient depositors who must wait for it to be beneficial to wait.⁹ By means of experimental evidence and simulations, Arifovic et al. (2013) demonstrate that this parameter determines if either one or the other equilibrium would take place, even when the fundamentals of the economy are kept constant. Said differently, the more depositors are necessary for the payment in the last period to be greater than the payment for withdrawing immediately, the more bank runs will take place.

Bank runs and information about the behavior of other depositors

The essence of the model of Diamond and Dybvig (1983) constitutes the fundamental basis on which most of the later articles in the literature of bank runs are built. Though multiple researchers have used the model to relax some of its assumptions, or to study for example what happens if the bank incurs a cost of liquidation if it leaves the project where it invested the money initially, we can say that experimental economics has turned out to be tremendously useful to shed light on some aspects that are not easy to model: what happens when the depositors, instead of deciding simultaneously what they want to do with their money, make decisions sequentially.

Most models of bank runs have traditionally chosen an approach of the problem in which agents *simultaneously* decide. However, the descriptions of bank runs (Sprague, 1910; Wicker, 2001 and Northern Rock's case) and some empirical studies (e.g., Starr and Yilmaz, 2007) indicate that many depositors have information about what other depositors have chosen, and can react to this information at the moment of making their own choices (Iyer and Puri, 2012; Kelly and O Grada, 2000). The possibility of observing actions is obtained through many sources: the news on how other depositors are behaving, personal relations with friends who tell us what they have done with their deposits. To adequately discern how the behavior of the depositors is affected by the received information, experiments become essential, given that in real life it is very

⁹ In our example of the company, we have not introduced patient and impatient types for this would complicate in excess the illustration; but it is easy to see that just one person should withdraw before the ship returns (what we have denoted below as period 1) so that it is worth waiting. Notice that if two of them decide to withdraw their money from the company, they will receive part of their investments, whereas those who wait will not receive anything. If only one person withdraws (and gets 110 Euros), it is still beneficial for the rest to wait (and get 230 Euros) instead of withdrawing.

complicated (if not impossible) to know if the withdrawals are or not affected by the type of information that the depositors possess.

In their experimental study, Garratt and Keister (2009) form groups of 5 subjects, who have the opportunity to withdraw their deposits immediately or to wait. As in our example of the ship, the depositors maximize their earnings if they choose to wait (in their experiment, every subject gets \$1.50 for every \$1 deposited) but it is also possible to withdraw their money immediately. The bank is prepared to absorb two withdrawals (paying \$1 to every depositor who withdraws immediately, and \$1.50 to those who wait). If three depositors withdraw their money, they will receive \$1 but those who wait will end up without money, and will not get anything. If there are more than three withdrawals, the bank has to liquidate its assets to face these demands: it would pay \$0.60 to all those who have withdrawn; once more, those who wait do not receive anything. By slightly changing these payments, Garratt and Keister (2009) compare the case where the depositors have only one option to withdraw, with another in which they receive up to three options. In the second case, the subjects know before the opportunity to withdraw their deposits is offered to them, how many persons in their bank have come to withdraw. The authors show that information about what has happened can increase the probability of withdrawals and, therefore, the existence of bank runs. In addition, Garratt and Keister consider a treatment in which some subjects are forced to withdraw, so that when others observe what has happened in their bank they see withdrawals but do not know if these have been forced or not. This characteristic in their model rescues the idea of the model of Diamond and Dybvig (1983) where there are impatient depositors who need their money urgently. In addition, the authors consider *aggregate uncertainty* by not informing about the number of group participants that will be forced to withdraw. Their findings demonstrate that this type of uncertainty is also key to explain bank runs due to coordination problems, given there is a greater probability of withdrawing when the aggregate liquidity demand is unknown (when it is known, bank runs are in fact rare).

With the aim to understand better how the depositors react to the information they receive, Kiss, Rodriguez-Lara and Rosa-Garcia (2014a) conduct an experiment where the players form banks in triads. Two of the depositors of the bank are participants in the experiment, whereas the third depositor is simulated by the computer and has been programmed to always withdraw his money from the bank. The subjects know of the existence of the computer so there is no aggregate uncertainty on the number of forced withdrawals. In the experiment, decisions are sequential (each of three depositors knows his position in the line) and it is possible to observe what has happened depending on the assigned information network: in some cases the decisions are simultaneous; in other they are sequential and what has happened in the bank is known, and in other there is partial information (for example, the third depositor knows what the first one did, but the second one does not know it; or the second one knows that the third one will see his choice, but he does not know if the first one withdrew his money). Following the tradition of Diamond and Dybvig (1983) the subjects also know that both

of them want to maximize their payoffs, but a depositor at the beginning of the line may be tempted to withdraw his money if he thinks that the subject choosing after him, and whose decision he cannot observe, will do the same. The theoretical prediction in Kiss, Rodriguez-Lara and Rosa-Garcia (2014a) demonstrates that if decisions are simultaneous (and every depositor decides without knowing what has happened in his bank), there is equilibrium multiplicity, as in the model of Diamond and Dybvig. However, if the depositors know that they are being observed and can observe what others have done, there is only one equilibrium without bank runs. The reasoning behind it is simple. Any patient depositor who acts first is going to leave his money deposited to induce the other patient depositor to act in the same way. Following this argument, if the first depositor decides to withdraw, any patient depositor acting later should infer that the withdrawal is due to the impatient player (simulated by the computer), thus he should wait, even when observing a withdrawal. The subjects' behavior, nonetheless, does not seem to correspond with this theoretical prediction as it is shown in the figure below. The evidence demonstrates that patient subjects react by withdrawing on having observed withdrawals, even if this was not an equilibrium.

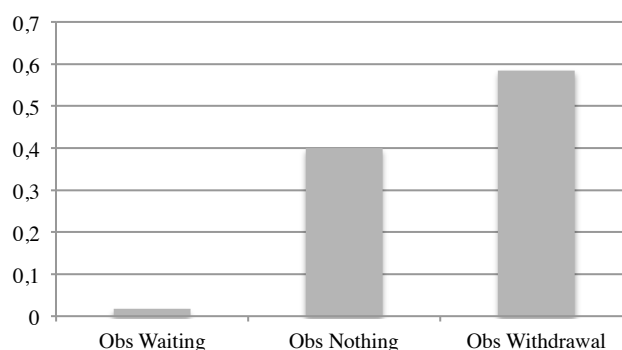


Figure 20.1. Graph based on Kiss, Rodriguez-Lara and Rosa-Garcia (2014)

The relevance of this article comes from having demonstrated not only that subjects can run to withdrawing their money after observing what others have done, but also that they do it out of panic, even in situations where the theory predicts that no bank run should happen at all. These results are in line with the experimental evidence of Schotter and Yorulmazer (2009), who already mentioned the importance that sequential decision-making has on behavior during bank runs. In their case, nevertheless, both environments (sequential and simultaneous) produce the same prediction; something that does not happen in the model of Kiss et al. (2014a) where the possibility of observing what other depositors have decided should produce a unique equilibrium without bank runs.

Other factors influencing the withdrawal of deposits

Already we have seen that the difficulty to coordinate, the presence of impatient depositors, or the possibility of observing actions can affect, among many other factors,

the withdrawals of deposits. With the aim of studying what factors affect the dynamics and severity of bank runs, Schotter and Yorulmazer (2009) consider different treatments where they vary not only the way in which the decisions are made (simultaneous or sequential), but also the type of information subjects have on the "quality" of the bank that determines, at the end, how difficult it is to coordinate. The depositors know that the money they have invested is going to provide them a given profitability, and that the bank is prepared to assume a certain number of withdrawals, depending on its quality. The experiment demonstrates how uncertainty on the bank's quality, and how the presence of insiders (subjects with information about the profitability of the deposits) can influence the withdrawals of funds (concretely, the insiders make bank runs less frequent and that withdrawals are delayed in those settings where the depositors have various chances to withdraw their money). In addition, Schotter and Yorulmazer study how deposit insurances can affect the results, and find that even partial deposit insurance significantly reduces the rate of withdrawals. In this respect, Kiss, Rodriguez-Lara and Rosa-Garcia (2012) re-emphasize on the importance of deposit insurances and on the possibility of observing past actions, by arguing that both aspects are imperfect substitutes (i.e., the optimal deposit insurance should depend on how the information network is, that is, on the type of information that the depositors may have).¹⁰ Davis and Reilly (mimeo) study how the behavior of the depositors should be influenced by the attitude the authority has (firm or indulgent) at the moment of suspending the payment to the depositors and renegotiating the terms of the agreements. Closely in line with the above-mentioned studies, the possibility of observing past actions and the attitude adopted by the authority they will influence the probability of bank runs. For example, observing previous decisions will debilitate the positive effect that a firm attitude has, reducing the occurrence of bank runs in case of indulgent attitudes.

An interesting contribution trying to explain why withdrawals happen is that of Dijk (2014) who studies if situations of fear, in and of themselves, are really capable of producing bank runs. To do so, before the subjects face a game of bank runs, they are induced to different psychological situations. Dijk observes that in the treatment with induced fear (where subjects must remember and describe with some detail the event of their lives in which they experienced most fear) the incidence of withdrawals is significantly higher than in other treatments (in those where they are asked to describe their happiest event or, simply, any random event). This opens the door for the interpretation of bank runs due to fear. The question is, are bad news spread by the mass media during times of crisis a way of inducing fear and provoking more panic? We leave the reflection on this question to the reader.

Herd behavior and financial markets

¹⁰ These authors have also studied how the gender or the cognitive skills can influence subjects at the moment of withdrawing their deposits in such situations of panic (see Kiss et al. 2014b, 2015).

The possibility to observe actions can affect depositors but does not need to be related only to coordination problems. The sequencing of actions may also relate to problems of the fundamentals, as demonstrated by the theoretical analysis of Gu (2013). Gu analyses how observing what the other depositors do affects the *beliefs* of the following depositors concerning the state of their bank. In this context, it shows how processes of *herds* are generated.

To observe what others do and to update our impression of an issue is something that happens in many areas of our day-to-day lives. Before buying a new television or changing our mobile phone, for example, we are in the habit of looking at the list of the most sold products. " If it is most sold, there must be a reason for it ", we tend to think. And it is curious but this is not only the reasoning we use when we want to buy an object for which we do not have information (how many times have we had to buy a gift for a friend and asked the salesman which the best selling product is?), but it also happens when we have certain information (though probably incomplete) about the product that we want to buy or the market that we are in. In general, we tend to assume that the *majority* possesses certain information that can be useful at the moment of deciding.

A classic example is that of the restaurant in an unknown town. Let's imagine that we are visiting a tourist city and a friend has recommended a restaurant to us to have dinner at. Though our taste is not totally like that of our friend, we can consider his opinion to be useful information so we decide to go to the restaurant. But when we get to the door we see that the place is practically empty, though there is another place just to the side replete with people. On having looked at the menu, we see that the menu and the prices are very similar in both restaurants. How many of us would we leave the information we have aside (the advice of our friend) to follow what the see the majority is doing? How much weight should the decision of the majority hold when we offset it against our private information?

These are the questions considered by the literature on *herd behavior*, referring to the tendency agents have to ignore their private information to follow the majority. In financial literature it has been suggested several times that the herd behavior might serve to explain the excessive volatility of prices (excess price volatility) in the financial markets and the fragility of the financial systems. Seeing many people buy an asset (stocks of a company) can make a person follow the herd and also buy one, even though that person has unfavorable information about the asset.

Herd behavior and types of informational cascades

The theory of herd behavior begins with the seminal studies of Abhijit Banerjee (1992) and Sushil Bikhchandani et al. (1992). In their models, the agents have private information about a good that they are interested in acquiring and must make their decisions in a sequential manner after observing what the other agents have done. The

authors demonstrate that in certain environments, after a finite number of decisions, the agents will end up making the same decisions that the predecessors made, ignoring their private information. This situation is known as *informational cascades*, and although on occasion they could lead the agents to making an incorrect decision (for example, to go to the inferior restaurant, to buy an article of low quality or to invest in an asset that does not have value), they turn out to be rational decisions from the individual's point of view, provided that the information given by the herd can be evaluated as more valuable by an individual than his own private information.

In an informational cascade, the agent decides to ignore his private information and to follow the pattern established by the market. At first, we can distinguish three types of cascades depending on the behavior of the agent:

1. ***Behavior of the herd*** (herding): The agents ignore their private information and follow the pattern established by the market. For example, after observing many purchases, an agent decides to also buy also the asset, regardless of his private information.
2. ***Inconformity*** (contrarianism): In this case, the agents decide to ignore his private information to act in opposition to the pattern established by the market. For example, after observing many purchases, the agent decides to sell, and does so independently of his private information.
3. ***Non-trade cascades***: These occur when the agents decide to abstain from the exchange, so they decide to neither buy nor sell the asset, regardless of their private information.

As we will see later, a key factor to determine if herd exist or not is the existence of an exchange price. In the example that we have provided of the restaurant, the exchange price is fixed, as the number of people that decide to go would not influence the price of the menu. In financial markets, however, the exchange price is affected by the decision of the agents to buy or sell the financial assets. In both contexts, the agent's decision to follow his signal or to behave in accordance with the herd will depend on the measure known as trade imbalance. This refers to the difference between the number of purchases and sales that have taken place before an agent makes a decision. In this way, when we speak about a trade imbalance in a market of 2, we want to say that there were two more purchases than sales prior to the decision of the agent (in the same way, an imbalance of -2 implies that the number of sales is great than number of purchases by two).

Informational cascade models in financial markets: The importance of exchange prices

To better understand the formation of informational cascades, let's consider the following model based on the work of Cipriani and Guarino (2005). Let's suppose that an asset exists that the agents can exchange with a market maker. The fundamental value of the assets (V) is a random variable, with two equally probable values: 0 or 100.

The agents make their decisions sequentially in an exogenously determined order, after finding out the exchange price. The agents also have a signal regarding the assets. This (private) signal is informative so that if the value of the assets is $V = 100$, the probability that the agent has the signal that indicates a value of 100 is 70 % (if the value of the assets is $V = 0$, there is a 70 % probability that the agent has received the signal that the value is 0). The agents begin with an initial amount of money $K > 0$, and the final payment will depend on the difference between the actual value of the assets (V) and the price at which it the asset has been bought or sold (P_t). Therefore, if an agent decides to buy it will receive $V - P_t + K$, obtaining $P_t - V + K$ if it decides to sell (if his decision is to do nothing, then the agent will receive K).

Agents not only have their private signal and price, but they also have information on the history of exchanges and of prices. The pioneer studies originating the literature of herd behavior (Banerjee 1992, Bikhchandani et al. 1992) did not have a price mechanism reflecting previous decisions, thus price P_t was not affected by the decisions of the depositors (this is what happens in case of the restaurants). To capture this idea, Cipriani and Guarino (2005) study the case of *fixed prices*.

Given the assets can take both values (0 and 100) with the same probability, the market maker fixes a price equal to the expected value ($P_t = 50$) in a context of fixed prices. The price does not change during the experiment, regardless of the decisions the agents make. Based on the logic derived from Bikhchandani et al. (1992) it is possible to demonstrate that in such an environment, an informational cascade can result after a trade imbalance, greater or equal to 2 or lower or equal to -2, is formed. To understand this result, imagine that the third agent in deciding observes that both previous agents have bought the assets (that is, there is a trade imbalance of 2). Also suppose that the third agent has a signal telling him that the value of the assets is 0. Should the agent follow his private signal and sell the assets for a price $P_t = 50$ or should he buy the assets, though his signal indicates that the price is zero? Notice that after observing two purchases, the third agent will deduce that the signals corresponding to both previous agents were of 100. Bearing in mind these inferred signals and his own private information, the agent might apply Bayes' rule to deduce that the asset's expected value is 70.¹¹ Provided that the exchange price is 50, the third agent should ignore his private signal and buy, thus beginning a cascade because the next agent (though he has a negative signal) will see that there were three previous purchases, and will end up buying as well.

A characteristic of financial markets is that agents' decisions reflect on the assets' price. If many of them decide to purchase (to sell) assets, its price raises (falls). This idea appears in case of *flexible prices*, in which the market maker is not forced to keep the

¹¹ To observe this outcome we denote by $(b, b, 0)$ the information set indicating the first and second trader have bought (that is the reason for the two b's) and the third has received a signal that the assets is worth 0. Therefore, the asset's expected value is

$$E(V | (b, b, 0)) = 100 * \Pr(V = 100 | (b, b, 0)) = \frac{100 * \Pr((b, b, 0) | V=100) * \Pr(V=100)}{100 * \Pr((b, b, 0) | V=100) * \Pr(V=100) + 100 * \Pr((b, b, 0) | V=0) * \Pr(V=0)} = 70$$

same price in all periods, but he can update the price according to Bayes' rule, bearing in mind which have been the decisions made by the agents. Following the idea of Avery and Zemsky (1998) it can be shown that when the market maker establishes the price according to Bayes' rule, agents will follow their private signal, and therefore informational cascades cannot take place. The intuition behind this result is quite evident. Since the market maker updates the market price using Bayes' rule, *the price contains all the information from the previous transactions*. Therefore, a rational agent should act following his private signal, which has additional information on the value of the asset. Given this information is unknown to the market maker, the agent can capitalize on this informational advantage to benefit.

If we return to the previous example, in which the third agent observes a trade imbalance of 2, and we use Bayes' rule, we can calculate that the market price offered by the market maker will be 84.48 (not 50, as in the fixed price case). Since the agent has a private signal telling him that the value of the assets is 0, he will use this additional information (applying Bayes' rule) to calculate that the asset's expected value is 70 and consequently what he must sell the asset.

In the following figure, we represent the Bayesian updates. We begin on 50, the asset's unconditional price. In the first period, after receiving a positive (negative) signal, the updated price using Bayes' rule will be 70 (30), thus the first agent should buy if the signal is good and sell if it is bad. This decision directly reveals the first agent's signal. In the second period, if the trader receives a different signal from the one received by the first agent, then the update gives a price equal to 50. If an identical signal to that of the first agent is received (which, as above-mentioned, can be inferred from the decision he has made), then the agent can be certain that the price is either 100 or 0. Therefore, we move towards the extremes. One could see that prices are located on a grid and opposite signals are cancelled. What really matters in these cases is the trade imbalance, that is, how many more purchases than sales have taken place.

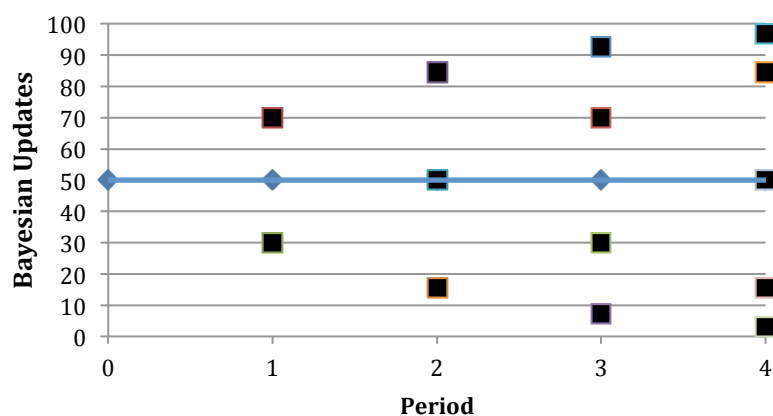


Figure 15.2. Bayesian updates in markets with fixed and flexible prices

In the fixed price case, if at some moment the number of purchases is higher than the number of sales by 2, in spite of receiving a negative signal, the price updated á la Bayes will be higher than the price established by the market maker (50). This motivates the agent to buy, affecting with his behavior all those who act after him. Using the same argument, a trade imbalance of -2 makes agents, who still have not made their choice; sell, independently of their private information. When the price is flexible, the market price after two purchases is 84.48. If the third agent receives a positive signal, he will buy because by apply Bayes' rule with his private information it will lead him to calculate an expected value of 92.7 for the assets (as above-mentioned, the third agent will sell if his signal is negative because his updated value will be 70, which is lower than the market price offered by the market creator, 84.48).

Experimental evidence of herds in financial markets: fixed and flexible prices

Empirically, it is difficult to test herd models, because there is no data on the private information of the agents. In addition, it is difficult to know if the agents react differently depending on whether the exchanged asset's price is fixed or flexible. This can be done in the laboratory, where subjects can receive private information on value of the asset and observe the history of exchanges.

Cipriani and Guarino (2005) used 216 subjects to test differences in herd behavior depending on prices. Their experiment consisted of 10 rounds, in each of which 12 subjects had to make their choices sequentially. Before every round, an experimenter would toss a coin to determine whether the value of the asset was going to be 0 or 100. The participants did not know the result of the tossed coin, but they received an informative signal. There were two bags in the experiment. One contained 30 blue tokens and 70 white tokens the other contained the opposite. The bags were identical. Each subject, when asked to make his choice, had to draw a token from the bags. If the coin toss resulted in heads (tails), the participant will draw a token from the first (second) bag, so that the color of the token was an informative signal on the asset's value in that round.

Each participant, after privately observing the color of the token, was to return the token in the sack and to announce out loud if he wanted to buy, to sell or to not do anything with the assets. The price of exchange was determined by the asset's price, fixed on the board. Also, the decisions and prices that had taken place up to the date were registered on the board, so that participants were not only receiving their private signal, but they were also obtaining information about the history of transactions and prices. The experimenter depending on the treatment updated these prices.¹² Remember that in the fixed price treatment the price is constant and equal to 50, while in the flexible price treatment it changes according to the decisions made. In the table below, adapted of

¹² At the end of every round, the realized asset's value was revealed and each subject received his earnings, paid once the experiment had finished. In this experiment, subjects could not lose money because in each round they received 100 lire (the experimental currency) and the value of the asset was always between 0 and 100.

Cipriani and Guarino (2005), we see a summary of the participants' behavior in the different treatments.¹³

	Fixed Price	Flexible Price
Act against the private signal (herd)	52%	12%
Do nothing	26%	42%
Act according to the private signal	22%	46%
Relevant periods	58	66

Table 15.1. Table extracted from Cipriani and Guarino (2005). The relevant periods are those where it is possible for informational cascades to be produced, for the trade imbalance is at least 2 (or at most -2) and subjects receive a negative (positive) signal.

The theory predicts informational cascades when the price is fixed, as long as the trade imbalance is at least 2 (in absolute value). Along the experiment there were 58 opportunities for potential informational cascades to emerge. In 52% of the cases, informational cascades occurred, where subjects stopped following their private signal to act in line with the behavior of the majority. In this treatment, subjects decided to do nothing 26% of the cases, whereas 22% of the times they followed their private signal. As illustrated in the table, things were very different when the price was flexible. In this treatment, there was 66 periods in total where the trade imbalance was at least 2 and subjects received an opposite signal. An informational cascade was formed in only 12% of the cases, with subjects ignoring their own signal. In 42% of the cases, subjects decided to do nothing and in 46% of the cases they followed their private signal.

These results are in line with the theoretical prediction, according to which we should not observe herds with flexible prices but only with fixed prices.¹⁴ In general, this directly highlights the importance that an asset's price has to aggregate or transmit the information different subjects has on the asset's value.

Inconformism and no-trade cascades

¹³ To elaborate the table, only the last 7 rounds of the experiment have been considered, and the relevant cases in which (theoretically) it is possible to observe an informational cascade. That is, we focus on cases where the trade imbalance was at least 2 (or at most -2) and the subjects received a negative (positive) signal.

¹⁴ In the experiment, there was a third treatment (called "*without history*") used as control to better understand the effect history has. This treatment was identical to the flexible price treatment, but subjects could not observe the decisions made previously. In this treatment, only 24% of the subjects observing a trade imbalance of at least 2 decided against their signal, indicating that it was not history what was behind the results in the flexible price treatment. In a last treatment (called of "*endogenous price*") the update of prices was not realized following Bayes' rule, but it was endogenously realized by some participants in the experiment, who were designated to do so (and who were competing between them). The results of the latter treatment are very similar to those obtained in the flexible price treatment.

A strange phenomenon observed by Cipriani and Guarino is that many subjects decided to do nothing although in theory this is never optimal. In the treatment with flexible price, in addition, the frequency of not doing anything increased with the absolute value of the trade imbalance. The higher the trade imbalance, the closer the price was to the extreme values (0 or 100), so that not doing anything can be understood as a response to the great risk implied by making the wrong choice. That is, when the market price is close to 100, the subjects were afraid that such price was probably given by mistake and that the real value of the asset was 0.

Another phenomenon observed in the experiment was that of decisions "against the market", which has been denoted as contrarian behavior. In the flexible price treatment there were 132 occasions where subjects could act as inconformists. They behaved this way 19% of the cases, 18% decided not to do anything and 63% followed their private signal. In cases of contrarian behavior the market was not able to correctly aggregate information. In the fixed price treatment, subjects never adopted the contrarian behavior. These results go in line with the observations in Drehman et al. (2005). In their Internet experiment the flexible price made it unlikely for herd behavior to appear, though there was evidence of contrarian behavior in these types of markets.

Financial market professionals: External validity

When speaking about experimental economics a problem of the external validity arises. Will we be able to extrapolate what we observe in the laboratory to the real world, where the environment is less controlled and generally much more complex?

Though there is evidence suggesting that experimental subjects do not differ much from the rest of subjects in the population (Brañas et al. 2013), it is always good to contrast the evidence obtained in the laboratory against the decisions other subjects make, especially if the aim is to know how experts in financial markets behave. With this idea in mind, Drehman et al. (2005) study the behavior of 267 consultants of the company McKinsey to conclude that their decisions were not significantly different from those made other subjects of all kinds of backgrounds in a very similar experiment to that of Cipriani and Guarino (2005). In the environment of cascade formation, Alevy et al. (2007) study if there are behavioral differences between students and professionals of the *Chicago Board of Trade*. They find that the decisions students make are slightly more consistent with the theory (that is, they do not contradict what is predicted by a Bayesian Nash equilibrium). However, the rate of cascades formed is not different between students and professionals, though professionals use their private information much more than the students do, which leads them to *fewer wrong cascades*.

Cipriani and Guarino (2009) analyze the behavior of 32 professionals employed in financial institutions in London, to see if the results we have just discussed were robust

to this manipulation.¹⁵ Their results demonstrate that the professionals' behavior was not very different from that of students. Abstaining from trading kept arising as a relevant behavior and though the professionals had a low trend towards herd behavior, they tended to be less conformists than students.

The connected economy: Contagion problems

To this point we have studied what happens between participants in a specific market, or the depositors of a specific financial institution. But for instance, what would happen if Greece decides to leave the Euro? Would it affect to the rest of countries in the Eurozone? There is not doubt that the interdependency between agents and economic markets is one of the most relevant characteristics of the contemporary economies. One of the crucial aspects of the increasing globalization is the connection established between individuals, companies and countries connected across constant flows of trade and information. This causes phenomena to be rapidly transmitted from some individuals to others, from some zones to others. During the recent Great Recession we have experienced how problems in a certain country were rapidly propagating to neighboring countries, such as the bankruptcy of certain companies was transferred to different parts of the productive fabric, and how financial problems in a certain organizations made others, who were apparently robust, shake. In fact, the problems financial institutions suffered are regarded as one of the principal engines of the Great Recession. The initial trigger was the explosion of the sub-prime mortgages that, through toxic assets, unexpectedly flooded the financial system. The innumerable connections between banks caused problems to hop from one organization to another and one country to another.

The characteristics and problems generated by the different connections between economic agents have recently kept economists busy. Some studies (for example, Babus, 2014) have showed how certain connection structures between banks can have different effects when financial problems arise. In general, a greater bank interconnection allows the banks to have more diverse financing and investments, though a strong interconnection can make the bank system also more fragile against aggregate impacts. In such cost-benefit analysis it is fundamental to understand well which are the advantages provided by a certain network structure (Cabrales et al. 2014). Technically, this is a complex matter since the interactions between agents frequently leads to situations with multiple equilibria. Study what type of structures emerge and how different structures can affect outcomes is a question of interest from the experimental point of view.

¹⁵ In addition, Cipriani and Guarino studied the importance of informational uncertainty in the formation of herds, by introducing *informed agents* (with private information about the asset) and *noise traders* (who did not receive this information). In another study, Cipriani and Guarino (2008) studied the effect of transaction costs on the process of information aggregation by introducing a Tobin tax in the flexible price model. In this variation of their model, if an agent decided to buy or to sell he had to pay a fixed amount (lump-sum).

In their attempt to answer some of these questions, Corbae and Duffy (2008) study a setting where individuals first propose to form connections between them to, afterwards, play a coordination game with their connected neighbors. The formation about connections can be interpreted as the decision banks make when they want to minimize their risks. Confirming their theoretical prediction, the authors observe that bilateral structures are most frequent in the experiment. In their model, these connections are the most efficient and the ones allowing minimizing the changes of contagion.

Contagion problems are also the aim of study in two recent works, where Brown, Trautmann and Vlahu (2014) as well as Chakravarty, Fonseca and Kaplan (2014), explore how the existing problems in a bank can affect the depositors of another bank. In both cases, the structure is given. The depositors of a bank observe what the depositors of another bank have decided, where both bank may or may not be linked. If I hear the news that a bank has suffered problems, will this lead me to thinking that my bank could also have these problems and to withdraw my deposits from it? Both studies find that such contagion takes place when the banks are linked. That is, when the situation of another bank (good or bad) can be indicative of the situation of my bank, observing the problems in the other bank will lead the depositors to withdrawing their money. Though one could expect this to happen, Chakravarty and his co-authors also find that even if the depositors are fully aware that both banks are completely independent, observing problems in the neighboring bank can provoke that the depositors of the unrelated bank also run for their deposits. Let's see in more detail how these studies are conducted.

Brown, Trautmann and Vlahu study pairs of banks, each formed by two depositors. In each bank, depositors participate in every period in a bank run game, such that if both depositors wait, they get a high payment; if both withdraw they get a low payment; but if only one of them withdraws, he receives an intermediate payment and the depositor who waits does not receive anything (the bank ends up without funds). The banks can be in a good or a bad situation, characterized by a greater or a smaller payment in case both depositors choose to wait until the end. To study the possibilities of contagion, three experimental treatments were conducted. In the control *group*, the depositors of the second bank made their choices without knowing if their bank was in a good or a bad situation, and without knowing what had happened in the other bank. In the *treatment with link between banks*, the depositors of the last bank also ignored if their bank had good or bad fundamentals, though they decided what to do after observing what had happened in the first bank, knowing that the fundamentals of their bank were the same that those of the first bank. Finally, in the *treatment with no link between banks*, the depositors of the last bank to decide ignored whether their bank had good or bad fundamentals and made their choices after observing what had happened in the first bank, knowing that the fundamentals of their bank were completely independent from those of the first bank. To elicit information about the beliefs of the depositors, Brown and his co-authors used a 7-point Likert scale, to ask each depositor how likely or

unlikely was for them that their bank had good fundamentals, and whether they thought that the other depositors in the bank were to withdraw their deposits or not. Through this, the authors were able to identify the mechanisms through which panic becomes contagious between banks.

The results of Brown and his co-authors show that when there is a link between the banks (they share fundamentals), the depositors, after observing withdrawals in the first bank, assign a higher probability both to the idea that the fundamentals of their bank must be bad, and to the expectation that the other depositor in the bank will withdraw her deposits. This shows that both routes of contagion, due to beliefs in the fundamentals and due to coordination, take place in linked banks. Another relevant finding is that when the banks were not linked, contagion was not observed, provided that the withdrawals and beliefs were not different from the control group.

Chakravarty, Fonseca and Kaplan, studied banks formed by ten individuals, who choose for 30 rounds whether to withdraw their money or to wait. In their model, half of the depositors were assigned to the impatient role, and they had a greater payment if they withdrew their money, whereas the other half were patient, and had a greater payment if a sufficient number of them decided to wait. The fundamentals of the bank could be good or bad. In case they were good, the payment for the patient depositors was higher if they waited even if other two patient depositors were to withdraw (out of 5). If they were bad ones, once a patient depositor withdrew his money, it was best for each participant to withdraw.

After the depositors in one of the banks made their choices (they knew the condition of their bank), the depositors of the other bank were to decide, after observing what had happened in the first one. Though they were not informed about the real condition of their bank, they did know that the fundamentals were good in each round with 80% probability. To understand the cause of contagion, they conducted two treatments. In the first one, the fundamentals were linked, so that both banks were in the same situation (and this was known by all the depositors). In the treatment with independent fundamentals, the situation of each bank was independent.

Chakravaty and his co-authors also find evidences for contagion. When it is observed that a bank run has happened in another bank, it increases the probability of withdrawals by the patient depositors. Though this happens to a greater extent when the fundamentals of both banks are connected, an increase in withdrawals is also observed when the depositors know that both banks are independent. This differs from the result found by Brown and his co-authors.

The sequential decision-making in the experiment of Chakravarty, Fonseca and Kaplan allows them to also observe how bank run situations are extended over time. A relevant finding in this regard is that, though observing a bank run in the other bank increases the chances of a bank run by the depositors, observing that the bank run stops does not

stop the panic the depositors feel. That is, the contagion occurs in one direction, provoking panic, but there is no such thing as "anti-panic contagion".

As a whole, these two works have been able to experimentally show that bank problems are contagious from some to others (it is not simply that the depositors respond to the same circumstances). A third recent study on contagions that complements very well the previous ones is that of Trevino (2013). In the above-mentioned work, the author explores the possible routes of contagion when it is not possible to accurately know what happens in another bank. In her model, Trevino considers the situations of sovereign debt holders in a country that depending on its real condition can end up suspending its payments or not. She suggests that another interpretation is that of bank runs. In her case, the bank or country can be in a good condition, in a bad condition or in a regular condition. The condition of the bank will determine whether it is best for a depositor to wait or to withdraw his money (when the condition of the bank is good, it is better to wait; when it is bad, the best thing is to withdraw; and if the bank is regular, it is best to withdraw if the depositor withdraws and to wait if the depositor waits).

To study contagion, Trevino assumes there are two banks, whose fundamentals can be linked or not. There is an a priori idea on whether the fundamentals are good or bad, common for both. To the above-mentioned information, a private signal given to the depositors of each bank is added, about the condition of their bank. The richness of the model comes from the fact that after the depositors of the first bank make their choices, the depositors of the second bank receive imperfect information about what has been decided in the first bank, which can help them to infer the condition of the first bank.

The experimental treatments used by Trevino to understand how contagions take place consist of varying how correlated (not at all, moderately, or perfectly) the fundamentals of both banks are, and how much the depositors of the second bank know (nothing, moderately, or perfectly) about the actions of the depositors of the first bank.

In line with the explanation of withdrawals due to fundamentals, Trevino finds that the depositors of the first bank withdraw less the better the signal they receive is. With regard to contagion, Trevino seems to support the idea of Chakravarty and his co-authors, finding that when withdrawals are observed in the other bank the probability for withdrawals increases, even when the individuals knew that the fundamentals from both banks were independent. An additional interesting discovery in case of Trevino is that this happens even when the depositors know that the information they receive on the bank run in the other bank need not be linked to their reality. That is, if they are informed of a bank run in the other bank, even when knowing that such information could be either true or false, this leads them to increasing their withdrawals. We can link these findings to the ones on psychological panic described by Dijk (2014).

Conclusions

In this chapter, we have surveyed some of the most relevant experimental studies on financial crises, emphasizing on bank runs and on how different information availability affects the agents' behavior. The experimental studies have showed the existence of bank runs both due to problems of the fundamentals as due to coordination problems. In addition, they have shed light on the existing dynamic mechanisms they have, which had not been deeply addressed in the theoretical literature. In fact, several studies have shown when people can decide after knowing what others have chosen increases the probability of withdrawing compared to simultaneous situations, which leads to thinking that an important part of why bank runs happen depends a fundamentally dynamic component. Coordination failures between agents, which lead to situations of panic are much more credible when individuals observe what others do or when their decisions are made in repeated occasions; in addition, their chances increase in situations of fear, when nobody has additional information or when facing less firm monetary authorities.

Observe what others do also leads to updating one's beliefs on the viability of the bank or the financial asset in which the agents take part. The experimental analyses have shown how herd behavior can emerge, which lead agents to make their decisions in similar ways between them, in spite of possessing different private information. In this respect, it has been shown that in situations like those of the financial deposits, where the expected payment is fixed, the emergence of herds is much more credible than in situations like those of other financial markets, in which the price of the asset is updated with the decisions of the agents.

Finally, we have analyzed the recent studies on the contagion of financial crises. These experiments have shown that when bank runs arise in a certain bank or massive sales of debt take place in a certain country it affects the rest, so that the crisis is transmitted from some assets to others. One of the most relevant findings in these experiments is that the above-mentioned contagion happens when either banks or countries are in similar situations, but also when they are completely independent. That is, financial crises in a certain bank or asset increase the instability in the rest of the system, even in those banks or assets isolated from the one that triggered the problem.

The experimental literature on financial crises is a relatively recent field and there are still many open questions. Most studies until now have focused on bank runs, but there are other markets where massive withdrawals of funds take place and they have not been experimentally studied, such as the case of the investment funds, the interbank market or the market of repos, among others. The study of sequential problems has revealed how influential is the information agents receive, but little is known about who starts these processes and how do they start. Finally, though some studies have revealed implications on what measures to take, there is still no a systematic study on the optimality of the different actions carried out by governments and central banks to stop these processes. All this opens the study of the financial crises, as a field in which there are still many questions to *experiment* with.

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