New Technologies, Irrational Investors and Herding

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Abstract

This paper develops a rational expectations framework to explain how financial crises can emerge in an economy where some decision-makers are irrational. Investors choose between a new risky asset and a safe asset. Irrational investors always invest in risky assets, whereas rational investors only invest when they are confident enough that the asset holds high value. Investors cannot distinguish whether others' investments stem from private information or irrationality, creating a signal-confounding problem. This may lead uninformed rational investors to herd and invest, even in the absence of informative signals, thus leading to a crisis. Our model explains historical episodes where the advent of new technologies and the presence of novice investors lead to a bubble.

Key Words: Rational Expectations, Information and Knowledge, Financial Crises
JEL Classification: D83, D84, G01

"If we assume that investment opportunities arrive randomly, and if an investment opportunity happens to coincide with an influx of novices, we expect the likelihood of a bubble to increase..." Goldfarb and Kirsch (2020)

1 Introduction

Technological or financial innovations are often followed by a financial crisis. Recent examples include the IT bubble and the global financial crisis of 2008. Several commentators are now also worried about the possible buildup of a bubble in the AI industry. Given that financial crises can have large real consequences, it is important to understand the reasons why these crises occur so that regulators can take appropriate actions ex ante to avoid them. Several papers, both theoretical and empirical, have highlighted that crises happen because economic agents behave irrationally or optimistically and collectively make poor investment decisions. Shiller (2015), for example, has argued that both the dot-com crisis of 2000 and the real estate crisis of 2008 occurred because of the irrational exuberance of investors. In another interesting paper, Cheng et al. (2014) show that mid-level investors in the real estate industry were not only investing in real estate assets, but were also buying their own houses, which shows that they were unaware of a bubble in the market. Papers such as Jordà et al. (2021) and Baron and Xiong (2017) conduct long-run panel studies across several banking and financial crises, and show that crises occur due to behavioral reasons, while rejecting the incentive view of the crisis.[1]

While it is not unreasonable to assume that some agents in the economy may be irrational or optimistic about new investment opportunities that arrive in the market, the puzzle for economic theorists is how and why all (or most) economic agents behave in such an irrational way. A naive explanation would be to reject the homo economicus view and assume that,

[1]The incentive view of financial crisis is that banks take excessive risk because they expect themselves to be bailed out if they fail (Stern and Feldman, 2004; Rajan, 2009). This distortion in incentives is reduced if the banks are well capitalized, as the shareholders have more to lose if they fail. However, Jordà et al. (2021) show that a higher level of bank capital ex ante does not lead to a lower probability of banking crises, and thus conclude that crises must be happening because of behavioral reasons.

at least occasionally, most agents may behave in an irrational or optimistic way. However, this explanation is particularly untenable as several authors have argued that bankers are smart (Philippon and Reshef, 2012; Bond and Glode, 2014; Glode et al., 2012). Philippon and Reshef (2012) show that deregulation in the financial industry is followed by an inflow of high-skilled workers. If we juxtapose this against the fact that deregulation is often followed by a crisis (such as the global financial crisis or the Scandinavian banking crisis in the 1990s), then we arrive at the puzzling conclusion that smart bankers make systemic mistakes. Hence, in this paper, we attempt to provide an alternative explanation for collective irrational investment behavior by agents based on herding by rational agents with the irrational agents.

We model an economy with a continuum of investors who make investment decisions. A *new* investment opportunity or asset arrives in the market, and since the investment technology is new, there is no data about the historical performance of this asset. Hence, the investors cannot rely on statistical models to predict the future returns of this asset, and instead rely on their own private signals to make investment decisions. The asset under consideration has a negative net present value and is not worth investing in unless the investor receives a signal indicating that the asset is of high quality.

There are two kinds of investors: rational and irrational (or optimistic). The mass of irrational investors is a random variable. We assume that the subset of irrational investors always receives a favorable signal and chooses to invest. Unlike the irrational investors, the rational investors either receive a favorable or an unfavorable signal, if they receive it. Rational investors invest (do not invest) in the asset if they receive a favorable signal (unfavorable signal). However, some fraction of rational investors, which is also a random variable, do not receive any signal. Given this setup, if the random realization of the number of irrational investors is large, then the uninformed rational investors may find it rational to herd and also invest in the asset. This happens because of the confounding: a large number of investments in the asset may happen either because the number of irrational investors is large or because the rational investors see a favorable signal. If herding happens because the number of irrational investors is large, then this leads to social costs since the asset has a negative net present value ex ante. A simple signal extraction problem can result in herding and inefficient investment. Thus, our paper highlights that the presence of some irrational agents can lead the rational agents to behave in a manner that ex post appears irrational.

An important contribution of the paper to provide the precise parametric conditions that lead to herding. A key assumption is that the unconditional probability that there are many irrational agents in the economy is low. Under this assumption, if uninformed rational investors observe that many agents are investing in the new technology, they will believe that these investments are happening most likely because informed rational investors have observed a favourable signal. Hence, they find it optimal to herd and invest in the risky asset. However, in such an economy, if irrational investors are present, then it can lead to inefficient investments even when no rational agent in the economy has received a favourable signal. These results are consistent with the arguments made by Goldfarb and Kirsch (2020). They show that when a technological innovation is also accompanied by the entry of novices in the market, then a bubble may form. For example, Wankel engine, which was accompanied by many novices entering the market, led to the formation of a bubble. Contrarily, the Bell Telephone was not accompanied by the presence of novices in the market, hence it did not lead to a bubble.

This paper contributes to two strands of literature. First, this paper is related to the literature on herding. Generally, herding is defined as a behavioral pattern that is correlated across individuals (Devenow and Welch (1996)). Papers such as Banerjee (1992), Bikhchandani et al. (1992), Scharfstein and Stein (1990), Avery and Zemsky (1998), and Chamley (2004) have built theoretical models based on rational agents who systematically revise their probabilistic judgments by observing the actions of other agents, which generates herding. On the other hand, the irrational herding literature has highlighted the role of emotions, personalities, and limited cognitive ability in decision-making. Baddeley et al. (2004) argue that cognitive biases may lead to herding because, for many reasons, including cognitive constraints, environmental cues, and/or framing effects, individuals may be following the ill-judged decisions of a group. The key contribution of this paper is to build a rigorous model and provide the precise parametric conditions under which rational agents may herd with the irrational agents.

Secondly, this paper contributes to the large literature on financial crises. Prior research has underscored that the introduction of new technologies tends to elevate the likelihood of financial crises (Kindleberger (1978), Barberis (2013)). Building on different behavioural channels, Gennaioli et al. (2012) and Payzan-LeNestour and Woodford (2022) demonstrate how cognitive biases such as reliance on availability heuristics or ignorance of outliers contribute to irrational investments by agents. Our paper provides an explanation of the crisis based on herding behavior by rational agents with irrational agents.

Methodologically, our paper is closest to Chari and Jagannathan (1988). Chari and Jagannathan (1988) develops a rational expectations model of bank runs where uninformed depositors infer negative signals from others' withdrawal behaviour, even when no adverse information exists. This signal-extraction problem leads to panic equilibria and highlights how the suspension of convertibility can improve welfare by preventing inefficient liquidation of illiquid assets. We build on this to show how the presence of irrational investors leads to a signal extraction problem for uninformed rational investors, leading to inefficient decision-making in the equilibrium.

2 Model

We consider a model where investors live for two periods: time period 1 and time period 2. There is a continuum of investors whose mass is normalized to one. There is a single good that is used for consumption as well as for investment. Each investor is endowed with a unit of good in period 1. Each investor makes an investment decision (as described below) in the first period and consumes the output of that investment in the second period.

2.1 Technology

Each investor has two investment technologies: a risky asset and a safe asset. The output of the risky asset is given by the random variable R that takes the value H with probability p and L with probability $1-p$, where $H > 1 > L$. For simplifying calculations, we set $L = 0$. The safe asset is a storage technology, and the return on investment in storage technology is 1, i.e., a unit invested in period 1 will yield one unit of output in time period 2. We denote consumption in time period 2 by y, which is given by,

$$y = \begin{cases} H, & \text{if } R = H. \\ L, & \text{if } R = L. \\ 1, & \text{if storage technology.} \end{cases} \tag{1}$$

We assume that ex ante the risky asset has a negative NPV.

Assumption 1. $pH < 1$.

Therefore, it is not worth investing in the asset without any information. We describe the information structure below.

2.2 Preferences and signals

All investors in this economy are risk-neutral and maximize the expected utility of consumption $\mathbb{E}[y]$. There are two types of investors: irrational (or optimistic) and rational. Irrational investors always receive a positive signal (as described below) regarding the return from the risky asset. Investors do not know their type. We additionally assume that the fraction of irrational investors is a random variable denoted by t that takes values 0 and $\bar{t}$ with probabilities r and $1-r$ respectively.[2]

[2]The random variable t in our model takes two values only for simplicity. The same results can be obtained with more than two realizations of t.

Figure 1: Investments in $t = 1$ are realized at $t = 2$

At time 1, a random fraction α of rational investors receive a signal, high (h) or low (l), about the return from the risky asset. For simplicity, we assume that the signal gives perfect information, i.e., the probability of seeing h (l) given output H (L) is 1.[3] α is a random variable that can take values 0 or $\bar{\alpha}$ with probability q and $1 - q$ respectively.

Contrary to the rational investors, the irrational investors, if present in the economy, i.e., if $t = \bar{t}$, always receive the signal h, irrespective of the outcome of the risky asset. We assume that random variables R, t, and α are independent of each other. Let the state of nature be defined using the vector $\theta = (t,\ R,\ \alpha)$. The set of all possible states of nature is denoted by $\boldsymbol{\theta}$.

Now we assume that it is efficient to invest in the risky asset if an investor observes the high signal even though he knows that he may be optimistic.[4] Since investors are unable to identify their own type, it becomes necessary to introduce a parametric assumption guaranteeing that, upon observing the signal h, the investors choose to invest in the risky asset.

Assumption 2.

$$\frac{rp(1-q)\bar{\alpha}H + (1-r)(1-q)(1-\bar{t})\bar{\alpha}pH + (1-r)\bar{t}pH}{rp(1-q)\bar{\alpha} + (1-r)(1-q)(1-\bar{t})\bar{\alpha}p + (1-r)\bar{t}} > 1.$$

The assumption simply says that the expected future payoff for any investor from investing in the risky asset, conditional on observing h, is greater than the return from the storage

[3]This assumption is only made for algebraic simplicity. Alternatively, we could have assumed that $Prob(h|H) = Prob(l|L) = m$, where $m > 1/2$ is a parameter. Here, we simply assume $m = 1$.

[4]If an investor does not invest even after observing the high signal, this would imply that the signal is useless.

technology.

While the investors do not know their type, they observe the total aggregate investment in risky assets. Hence, while the overall level of risky investment is common knowledge, the reason behind such investment remains unobserved. However, by observing the aggregate investment in the risky asset, an investor can extract information about the true state of nature. To prevent a trivial signal extraction problem, we need confounding. Hence, we make the following assumption.

Assumption 3. $\bar{t} = \bar{\alpha}$.

Signal confounding will ensure that the investor can not always estimate the exact state of nature after observing the aggregate investment in the economy. The timeline is shown in Figure 1.

3 Equilibrium

The decision problem for irrational investors is straightforward due to assumption 2. If irrational investors exist in the economy, they will invariably invest in the risky asset upon receiving a signal h, even though the asset may yield a low payoff.

Continuing our discussion in model setup, a random fraction of rational investors, $\alpha \in \{0, \bar{\alpha}\}$, get a signal about the quality of the risky asset. The decision problem for rational investors who have received a signal about asset quality is also trivial. Informed rational investors will always invest if they receive a signal h because of assumption 2 , and will not invest if they receive a signal l. We denote the informed investors' investment in the risky asset by $k^I(R)$ as they receive the signal h (l) when $R = H$ ($R = L$). k^I takes the value 1 when the signal is h and 0 otherwise.

The decision problem for rational investors who do not receive a signal is more interesting. Before making an investment decision, uninformed investors observe the aggregate investment in the risky asset at period 1. Let K be the aggregate investment in the risky asset at $t = 1$. In our model, the aggregate investment could be high either because of irrational investors who always invest or because of informed rational investors who receive a h signal.

Uninformed investors choose their investment level k in the risky asset to maximize their expected utility conditional on observing the aggregate investment K at $t = 1$, i.e, their problem is:

$$\max_{k} \int y dF(\theta|K), \tag{2}$$

where $F(\theta|K)$ is the distribution of θ conditional on knowing the aggregate investment K. We denote the optimal investment strategy of the uninformed agent by $k(K)$. For simplicity, we assume that the investor invests in only the safe asset if he is indifferent between the two assets. Now the aggregate demand for investment at time $t = 1$, which we denote by K_D, is given by:

$$K_D = t + \alpha(1-t)k^I(R) + (1-\alpha)(1-t)k(K). \tag{3}$$

The first term on the right-hand side of the equality is the investment done by irrational investors, the second term denotes investment by informed rational investors, and the last term is investment by uninformed rational investors. In the equilibrium, $K_D = K$. The aggregate investment demand for each state of nature is given in Table 1. Now we define the rational expectations equilibrium in the model.

Table 1: Aggregate Investment Demand Function

State No.	**State of Nature** $\theta = \{t, R, \alpha\}$	**Aggregate Investment Demand Function** $K_D(\cdot)$
1	$(0, R, 0)$	$k(K)$
2	$(0, H, \bar{\alpha})$	$\bar{\alpha} + (1-\bar{\alpha})k(K)$
3	$(0, L, \bar{\alpha})$	$(1-\bar{\alpha})k(K)$
4	$(\bar{t}, R, 0)$	$\bar{t} + (1-\bar{t})k(K)$
5	$(\bar{t}, H, \bar{\alpha})$	$\bar{t} + (1-\bar{t})\{\bar{\alpha} + (1-\bar{\alpha})k(K)\}$
6	$(\bar{t}, L, \bar{\alpha})$	$\bar{t} + (1-\bar{t})(1-\bar{\alpha})k(K)$

Definition 1. Rational Expectation Equilibrium: A rational expectation equilibrium is: (i) an aggregate investment function $K(\theta)$ that specifies the aggregate investment K for each state of nature θ ; (ii) an investment demand function $k(K)$ for each uninformed rational investor such that:

1. $K(\theta) = t + \alpha(1-t)k^I(R) + (1-\alpha)(1-t)k(K(\theta))$, for all θ,

2. $k(K)$ solves the maximization problem in equation (2),

3. if for any two states θ = (t, R, α) and θ' = (t', R', α'),

$$t+\alpha(1-t)k^I(R)+(1-\alpha)(1-t)k(K(\theta)) = t'+\alpha'(1-t')k^I(R')+(1-\alpha')(1-t')k(K(\theta')),$$

for all functions $k(\cdot)$, then $K(\theta) = K(\theta')$.

Condition 1 of the definition ensures that markets clear for all states in the rational expectation equilibrium. Condition 2 ensures that $k(K)$ maximizes the uninformed investor's utility given the information that he has. Finally, as discussed by Chari and Jagannathan (1988), condition 3 ensures that outcomes must be measurable with respect to the information actually available in the economy. This is analogous to the assumption that is imposed while analyzing rational expectations equilibrium in competitive markets, which is that the price function must be measurable with respect to the market excess-demand functions of the agents (Admati, 1985; Diamond and Verrecchia, 1981). If we do not impose this condition, then the market can reveal the information nobody in the economy has. Condition 3 ensures that if the aggregate demand functions are the same for two states of nature, then the equilibrium outcomes should also be the same. In our model, this condition implies that aggregate investment in states 2 and 4 (see Table 1) must be the same since $\bar{t} = \bar{\alpha}$.

We now define a crisis equilibrium.

Definition 2. Crisis Equilibrium. A rational-expectation equilibrium is a crisis equilibrium if the equilibrium aggregate investment is one for at least one state of nature in which

Table 2: A Crisis Equilibrium in the Described Economy

State No.	**State of Nature** $\theta = \{t, R, \alpha\}$	**Probability**	**Aggregate Investment** $K(i)$
1	$(0, R, 0)$	rq	0
2	$(0, H, \bar{\alpha})$	$r(1-q)p$	1
3	$(0, L, \bar{\alpha})$	$r(1-q)(1-p)$	0
4	$(\bar{t}, R, 0)$	$(1-r)q$	1
5	$(\bar{t}, H, \bar{\alpha})$	$(1-r)(1-q)p$	1
6	$(\bar{t}, L, \bar{\alpha})$	$(1-r)(1-q)(1-p)$	$\bar{t}$

$\alpha = 0$, i.e, aggregate investment is one even when there is no information (signal) about asset quality.

In our model, we have assumed that the risky asset has a negative expected NPV, implying that in the absence of any information, it is not profitable to invest in the risky asset. Hence, a crisis equilibrium may lead to an inefficient outcome. A crisis equilibrium may arise because it is unclear whether investors are investing due to irrational behaviour or in response to receiving a positive signal. Theorem 1 below establishes sufficient conditions for all rational expectations equilibria to be crises equilibria.

Proposition 1. For any economy in which $\alpha \neq 1/2$ and condition (4) is satisfied,

$$\frac{r(1-q)pH + (1-r)qpH}{r(1-q)p + (1-r)q + (1-r)(1-q)(1-p)} > 1, \tag{4}$$

1. There exists a rational-expectation equilibrium that is also a crisis equilibrium;

2. Every rational expectation equilibrium is also a crisis equilibrium.

Proof. Given our model structure, there are six possible states. Table 2 shows these states and a possible outcome. Each row shows a state of nature characterized by (t, R, α) and the corresponding aggregate investment. We denote each state by i (column 1), and the aggregate investment in state i by $K(i)$ (column 4), where $i \in N$ and $1 \leq i \leq 6$. The probability of each state is shown in column 3. The investment by uninformed rational investors in the state i is denoted by $k(K(i))$. We will argue that the outcome in Table 2 is an equilibrium outcome.

First, it can be easily verified that the outcome in the table satisfies condition 1 of the equilibrium. It also satisfies condition 3 as the aggregate investments in states 2 and 4 are the same. We now show that it also satisfies condition 2. Since the uninformed investors observe the aggregate investment, they update their beliefs after they do so. The information partition is as follows. If $K(i) = 0$, it implies that the state is either 1 or 3. Similarly, $K(i) = 1$ implies that the state is 2, 4, or 5; and $k(i) = \bar{t}$ implies that the state is 6.

Consider the case when $K(i) = 0$. The expected payoff of the risky asset given this state is given by

$$\frac{rqpH}{rq + r(1-q)(1-p)}.$$

Clearly, given the assumption 1, this term is less than 1. Hence, the uninformed investor refrains from investing in the risky asset, which is consistent with the equilibrium outcome.

Now consider the case when $K = 1$. Given that the state could be 2, 3, or 5, the conditional expected payoff from the risky asset is then given by

$$\frac{r(1-q)pH + (1-r)qpH + (1-r)(1-q)pH}{r(1-q)p + (1-r)q + (1-r)(1-q)p},$$

which is greater than 1 if condition (4) is satisfied.[5] Hence, investment in the risky asset is optimal for the investor, which is the equilibrium outcome.

Finally, after observing $K(i) = \bar{t}$, an investor infers that the state is 6, where $R = L$. Therefore, he will not invest, which is also consistent with the equilibrium. Hence, Table 2 constitutes an equilibrium, which is one among the many possible equilibria. Moreover, since all investors invest in state 4, the state in which no information regarding the asset

[5]From equation 4, we know that $[r(1-q)pH+(1-r)qpH] > [r(1-q)p+(1-r)q]$. By adding $(1-r)(1-q)pH$ to LHS and $(1-r)(1-q)p$ RHS, where $[(1-r)(1-q)pH] > [(1-r)(1-q)p]$, we get the conditional expected payoff given the states could be 2, 3 or 5. This confirms that the conditional expected payoff when the state could be 2, 3, or 5 is indeed greater than 1.

returns is available to any rational investor, this equilibrium is a crisis equilibrium.

Now we prove the second part of the proposition and show that a rational expectations equilibrium that is not a crisis equilibrium does not exist. Let us assume that an equilibrium exists that is not a crisis equilibrium, which implies that if no rational agent observes any signal ($\alpha = 0$), then aggregate investment is less than one, i.e., $K(t, R, 0) < 1$ for any t. This implies that $K(i) < 1$ for $i \in \{1, 4\}$. Further, from condition 3 of Definition 1, we know that $K(2) = K(4)$ as their aggregate investment demand functions are the same in states 2 and 4. Therefore, $K(2) < 1$. We now argue that under our assumptions, $K(2) = K(4) < 1$ can not be true in an equilibrium.

Since $K(2) = K(4) < 1$, we must have $k(K(2)) = k(K(4)) < 1$. Also, since the investor invests in the safe asset if he is indifferent between the two assets, it implies that $k(K(4))$ they must be equal to $\bar{t}$. Now from Table 1, we can easily see that $K(i) \neq K(4)$ for $i \in \{1, 3, 5\}$ because $\bar{\alpha}$ is not equal to 1/2. Now, in equilibrium, either $K(2)$ and $K(4)$ are equal to or not equal to $K(6)$. If $K(2) = K(4) \neq K(6)$, then upon observing the aggregate state $K(2)$, the expected payoff for the uninformed investors from the risky asset equals

$$\frac{r(1-q)pH + (1-r)qpH}{r(1-q)p + (1-r)q},$$

which is greater than 1 by condition 4. Therefore, $k(K(2))$ =1, which in turn implies that $K(2)$ can not be less than 1. Now consider the case where $K(2) = K(4) = K(6)$. Upon observing the aggregate investment $K(2)$, the expected payoff for the uninformed investors from the risky asset is given by the LHS of condition 4, which is greater than 1. Therefore, again $K(2)$ can not be less than 1. □

The proposition shows that a crisis can occur due to the signal confounding problem in the presence of irrational investors. Condition 4 ensures that we have an economy where herding occurs. Note that the condition is satisfied if r is close to 1, i.e, the probability of irrational investors being present in the economy is very low. This is intuitive. If the ex ante probability of irrational investors being present in the economy is low, then the rational uninformed investors, upon observing investments in the risky asset, conclude that these investments are most likely happening because rational informed investors have seen a high signal. Hence, they also invest in the risky asset. However, in such an economy, if irrational investors are present, then this leads to inefficient investments.

Our results are consistent with the arguments made by Goldfarb and Kirsch (2020). They argue that bubbles and crises arise not merely because technologies have uncertain returns, but because unsophisticated investors misinterpret narratives and overestimate their understanding, leading to inefficient investments. Many technologies with high uncertainty did not produce inefficient investments simply because they arrived in periods without any novice or irrational investors. Goldfarb and Kirsch (2020) contrast the Wankel engine, which generated intense speculative activity when novices entered the market, with the Bell Telephone, which exhibited no comparable escalation. Although both technologies were characterized by considerable uncertainty, the presence of inexperienced investors in the former and their absence in the latter produced markedly different investment outcomes. We have modeled and explained this phenomenon in our paper.

4 Conclusion

We model crises as an equilibrium phenomenon. The essence of our model is that crises occur even when no investor has any positive signal about the asset, which has a negative expected net present value in the absence of any information. An investors seeing other investors' investments wrongly infer positive prospects for an asset, ultimately causing a crisis in one of the states in equilibrium. This idea is similar to the "long-lines bank run" phenomenon discussed in Chari and Jagannathan (1988).

Our key contribution lies in showing that the presence of even a small fraction of irrational investors can distort the informational content of aggregate investment behaviour, inducing herding among rational investors. This distortion creates a feedback loop where rational investors mimic investment patterns they perceive as informed, even when no such private information exists. This leads to inefficient investment and systemic risk, even in an economy where most actors are rational, and markets are otherwise frictionless.

The model underscores the fragility of inference based on observed actions in environments with bounded rationality or type heterogeneity. Policymakers and regulators may draw from this insight and keep an eye on the presence of novice investors in the economy. Future research could extend this framework by incorporating dynamics, richer information structures, or the endogenous formation of beliefs about others' rationality.

References

Admati, A. R. (1985). A noisy rational expectations equilibrium for multi-asset securities markets. *Econometrica: Journal of the Econometric Society*, pages 629–657.

Avery, C. and Zemsky, P. (1998). Multidimensional uncertainty and herd behavior in financial markets. *American economic review*, pages 724–748.

Baddeley, M. C., Curtis, A., and Wood, R. (2004). An introduction to prior information derived from probabilistic judgements: elicitation of knowledge, cognitive bias and herding. *Geological Society, London, Special Publications*, 239(1):15–27.

Banerjee, A. V. (1992). A simple model of herd behavior. *The quarterly journal of economics*, 107(3):797–817.

Barberis, N. (2013). The psychology of tail events: progress and challenges. *American Economic Review*, 103(3):611–616.

Baron, M. and Xiong, W. (2017). Credit expansion and neglected crash risk. *The Quarterly Journal of Economics*, 132(2):713–764.

Bikhchandani, S., Hirshleifer, D., and Welch, I. (1992). A theory of fads, fashion, custom, and cultural change as informational cascades. *Journal of political Economy*, 100(5):992–1026.

Bond, P. and Glode, V. (2014). The labor market for bankers and regulators. *The Review of Financial Studies*, 27(9):2539–2579.

Chamley, C. (2004). *Rational herds: Economic models of social learning*. Cambridge University Press.

Chari, V. V. and Jagannathan, R. (1988). Banking panics, information, and rational expectations equilibrium. *The Journal of Finance*, 43(3):749–761.

Cheng, I.-H., Raina, S., and Xiong, W. (2014). Wall street and the housing bubble. *American Economic Review*, 104(9):2797–2829.

Devenow, A. and Welch, I. (1996). Rational herding in financial economics. *European economic review*, 40(3-5):603–615.

Diamond, D. W. and Verrecchia, R. E. (1981). Information aggregation in a noisy rational expectations economy. *Journal of financial economics*, 9(3):221–235.

Gennaioli, N., Shleifer, A., and Vishny, R. (2012). Neglected risks, financial innovation, and financial fragility. *Journal of financial economics*, 104(3):452–468.

Glode, V., Green, R. C., and Lowery, R. (2012). Financial expertise as an arms race. *The Journal of Finance*, 67(5):1723–1759.

Goldfarb, B. and Kirsch, D. A. (2020). *Bubbles and crashes: The boom and bust of technological innovation*. Stanford University Press.

Jordà, Ò., Richter, B., Schularick, M., and Taylor, A. M. (2021). Bank capital redux: Solvency, liquidity, and crisis. *The Review of economic studies*, 88(1):260–286.

Kindleberger, C. (1978). Manias, panics, and rationality. *Eastern Economic Journal*, 4(2):103–112.

Payzan-LeNestour, E. and Woodford, M. (2022). Outlier blindness: A neurobiological foundation for neglect of financial risk. *Journal of Financial Economics*, 143(3):1316–1343.

Philippon, T. and Reshef, A. (2012). Wages and human capital in the us finance industry: 1909–2006. *The quarterly journal of economics*, 127(4):1551–1609.

Rajan, R. (2009). Too systemic to fail: consequences and potential remedies. In *Proceedings of a*.

Scharfstein, D. S. and Stein, J. C. (1990). Herd behavior and investment. *The American economic review*, pages 465–479.

Shiller, R. J. (2015). Irrational exuberance: Revised and expanded third edition.

Stern, G. H. and Feldman, R. J. (2004). *Too big to fail: The hazards of bank bailouts.* Rowman & Littlefield.