

BANKS' INCENTIVES TO OVER-HERD

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Abstract

This paper evaluates the incentives that banks have to herd. It includes a complete literature review that focuses on papers from the last fifteen years, and a model of several banks and infinite time periods. The literature review looks at recent academic papers that have examined the different causes of bank herding. The model is discussed theoretically and then a numerical example explores the significance of its coefficients. The model section concludes that any policy that reduces the costs of overinvestment increases the incentives of banks to herd.

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1 Introduction and Literature Review

Economists and policy makers have spent much of last couple years debating ways to avoid another financial crisis. The Dodd-Frank act that passed in the US congress is a framework under which new rules and regulations must be written to re-shape the financial sector. Most economist and politicians accept that the rules must be changed, however the possible consequences of most of the proposals are subject of debate. Some even argue that in the attempt to reduce risk, regulators may actually be increasing it.

One of the most recognized problems that increase risk in the banking sector is the incentive to be big. A bank that is considered “too big to fail” will most certainly be rescued and will bear a small cost for excessive risk taking. Another less discussed incentive problem is the fact that banks tend to “herd,” or behave very similar to each other, so as to be “too many to fail.” This article intends to explore the causes of this second problem, namely, bank herding.

There is a vast academic literature that studies herding in the financial sector. Of that literature, only a few papers study this problem as it concerns the banking sector. This overview focuses on those papers that study why banks herd, and that were published in the last fifteen years¹³. The literature that evaluates herding in banks can be separated into four main categories: banks may herd as a response to institutional incentives, such as expectations of government intervention or the structure of the market itself; spillover fears, these refer mostly to the effects of the information revealed by the failure of a

bank, but also includes recessionary spillovers (changes in costs during a recession); principal-agent problems, in particular the concern of managers to protect their reputation; and other more general papers, such as empirical papers that search for evidence of herding under different circumstances.

The papers that look at institutional incentives, including the model set forth later in this paper, are concerned mostly with the following problem: If one small bank fails, the deposit insurance can guarantee all the depositors receive their savings back and the economy will not suffer from the bankruptcy. If many small banks fail at the same time, the consequences are different. The banking sector is crucial for the existence of any modern economy, so the failure of several banks can disrupt the normal functioning of the real economy. As a consequence, the government is compelled to rescue the banks. In other words, if many small banks fail together, it is equivalent to when one big bank fails. This is the main reason why banks have incentives to copy the actions of its competitors. If a bank is going to fail, it prefers to do so with company so the chances of being rescued are higher.

There are several papers that explore this explanation. Acharya and Yorulmazer (2007) carefully evaluate the government's time inconsistency problem that leads it to bail out banks that fail. The paper's main argument is that when many banks fail, it is ex-post optimal to bail out the banks, whereas when few banks fail, the banks that survive acquire those that fail. This leads to herding behavior for the reasons explained above. This paper also shows that small banks have stronger incentives to herd than large banks. When a small bank imitates a large bank, the probability of being bailed out is higher when there is failure than if it differentiated

¹³ For a study of the literature before this period see Devenow and Welch (1996).

itself. However, big banks have little extra benefit from copying a small bank's behavior.

This paper presents an extension to Acharya and Yorulmazer (2007). It allows for many banks and infinite time periods, as well as an optimal herding level. In other words, herding is not always undesirable, but excess of such behavior is. The model in this paper is also simulated so as to explore in more detail the relevance of each of its parameters.

Acharya and Yorulmazer (2008a) proposes a solution to the time-inconsistency dilemma: When too many banks fail, surviving banks may not have the liquidity necessary to purchase the failed banks at a price high enough that avoids less efficient investors from entering the market (assuming there are such willing investors). Hence, some action is required. Providing liquidity to surviving banks so they can purchase the failed banks is equivalent, *ex-post*, to a bail-out policy. However, it offers a reward to surviving banks, providing incentives to differentiate rather than to herd. As a consequence, aggregate banking crises become less likely.

An example of literature discussing the spillovers cause is Acharya and Yorulmazer (2008b). That paper presents the issue as an information contagion problem. The incentives to herd are now caused by the adverse information that emerges about one's investments when another bank with similar exposures fails. Given the higher costs that result from this adverse information, a bank owner with limited liability prefers failing together with other banks to doing so alone. Consider the following example. Two banks have access to two different projects. Each bank must choose one project to invest in. Also assume that each project has a probability of failure p , and they are subject to the same macroeconomic conditions. If the banks invest in the same project, when this one project succeeds both banks have high returns, \bar{R} . If it fails, both banks get zero. Now, if the banks invest in different projects, when one project fails and the other succeeds, the bank that invested in the good project will get lower returns, \underline{R} , because the costs increased as a consequence of the failure of the other project. The expected returns in the first case are $(1-p)\bar{R}$, whereas in the second case they are $(1-p)[(1-p)\bar{R}+p\underline{R}]$. Hence, bank returns are highly correlated.

The higher costs that result from a bank failure do not only occur as a consequence of information spillovers, but also because of "recessionary spillovers," such as a lower overall level of deposits. This would happen when not all deposits from the failing bank find their way back to the banking system. This negative externality on surviving banks' health is evaluated in Acharya (2009). Just as in Acharya and Yorulmazer (2008b), higher costs from other banks failing and limited liability provide the incentives for bank managers to prefer high bank returns' correlations.

In the principal-agent-problem category we find papers concerned with the fact that managers want to protect their reputation. In other words, bank managers are not only interested in the performance of their employer, but in their professional careers. In trying to protect their image, bank managers are affected by group psychology: It is safer to err together than individually. This occurs because judgment is less harsh when most other managers in the market made the same mistake. A classic example of this line of thought is Scharfstein and Stein (1990). They call this behavior the "sharing the blame" effect¹⁴.

In the empirical literature managers and financial analysts have been proven to herd, even when doing so contradicts the private information known by some. One such example is Sias (2004). Sias shows some evidence that implies institutional investors herd as a result of deducing information from each other's trades. His paper measures correlations between institutional demands across adjacent quarters. He concludes that institutional demand is more strongly related to lag institutional demand than to lag results.

A study more related to the banking sector can be found in Uchida and Nakagawa (2007). This paper evaluates data from 1975 to 2000 in search for evidence of herding by city banks in Japan. Its main conclusion is that banks in Japan do herd, but for most of the years studied the behavior could be explained by macroeconomic factors. Given the information at the time, all banks were acting as it was optimal. The authors call this "rational herding." Only during the bubble period in Japan in the late 1980s, banks seemed to exercise "irrational herding."

Also empirical, but belonging to the first category, is Nicolo and Kwast (2002). This paper looks at how systemic risk can change according to the market structure. The paper shows that increases in consolidation contribute to increases in interdependencies among large and complex bank organizations.

2 Model set up

This model generalizes those in the previous literature that belong to the first category; it looks at the institutional incentives that may promote herding. It allows for w banks and infinite periods, there are K possible projects looking for loans. For simplicity, all projects have the same probability function of success, which depends on the amount of capital invested in it. Let $f(n)$ be such function. It is continuous and

¹⁴ For a more detailed study on psychological factors that may explain behavior in the financial sector see Gärling *et al* (2009).

$$\exists n^* \text{ s.t. if } n < n^* \text{ then } f'(n) > 0 \text{ and if } n > n^* \text{ then } f'(n) < 0$$

This means that there is an optimal level of capital that maximizes the probability of success. Less capital than the optimal is not enough to take all the necessary precautions, and too much capital leads to overinvestment (such as in bubbles). It is through this function that one bank's investment decision has an externality on the payoffs of other banks.

Although not common in the literature, the reason for this probability of success function is that initially, *ceteris paribus*, more investment funds means there is more liquidity and access to capital. In addition, more assets loaned send a signal to customers of the project that many banks, or big institutions, believe the project is good (this may turn into even more lines of credit in the future if needed). Too much credit may lead to overinvestment and overheating of a sector in the economy caused by too big of a project and low returns. Too much debt may also lead to misuse of resources. In sum, the assumption states that levels of investment above or under the optimal level increase the probability of default.

For ease in the analysis, although not a determinant of the results, $f(x)$ is assumed to be symmetric around n^* . Initially let all banks have one unit of funds available for investment. So, there are w units of investment available in the economy. Each bank must put its unit of investment in only one project (the units are not divisible). In addition, there is deposit insurance, so that depositors are risk neutral. Banks must pay a unique interest rate of r . The relevance of this assumption and its effects on the model will be explained below.

For simplicity, assume all projects have the same rate of return. Each project either pays back R in case of success or zero in case of failure. This assumption is common in related literature.

Upon a bank's failure, the government can either liquidate a bank (pays depositors and closes the bank) or bail it out¹⁵. In a bailout, the government intervenes when the amount of failing financial assets crosses certain threshold. There is some evidence that such a threshold does exist. Governments tend to seek bailin solutions to bank failures, or allow liquidations, when only a small amount of (small) banks fail. However, when enough banks fail so as to put the entire banking system at risk, governments all over the world have consistently stepped in. The ongoing financial crisis is one testimony of this. Other empirical evidence includes Hoggarth, Reidhill and Sinclair (2004).

¹⁵ The bailin option, when another bank or institution buys the failing bank, if performed as suggested by Acharya and Yorulmazer (2008a), does not present herding incentives. In fact, it is an alternative that would reduce such behavior as explained in the literature review.

Each bank observes what other banks did in previous periods, then they simultaneously choose in which project to invest in the current period. Next, projects either fail or pay back. In case of failure, the government decides for each bank whether to bail it out or not.

3 Solution to the Benchmark Problem

If there was no government intervention when banks fail but the banks were instead liquidated, then the maximization problem for one bank would look as follows:

Let $I_t^j(n) = 1$ if the bank invests in project j at period t , and 0 otherwise; n_t^j represents the total units of capital invested in project j at period t . $n_{-i,t}^j$ is the total investment units in project j by all other banks at time t . The value function for bank i at time t is

$$V(n_{1,t}, n_{2,t}, \dots, n_{k,t}; t, \text{liquidate}) = \sum_{j=1}^k I_t^j(n) [f(n_{-i,t}^j + 1)(R - r) + \delta f(n_{-i,t}^j + 1)V(t + 1)]$$

for $n_{i,t}$ representing the vector of decisions by i regarding each project¹⁶, δ is the discount factor, and

$$V(t + 1) = V(n_{1,t+1}, n_{2,t+1}, \dots, n_{k,t+1}; t + 1, \text{liquidate}).$$

$n_{i,t}$ is a vector of zeros if the bank has failed in the past. If a project fails, all the banks that gave loans to the project also fail.

Let w stay constant over the long run, otherwise the sector would disappear. In other words, each period new banks and projects may join the economy. This is not an assumption required for the results presented in this section. It is not relevant to specify when and how many banks fail or appear. An assumption regarding this process will be made for the numerical example. This is however an important logical statement, otherwise this model would be describing a sector bound to disappear in the long run.

Since the bank's decision at period t affects the future only in the probability that the bank will exist tomorrow, during each period the banks' decision is reduced to maximizing the probability of success,

$$f(n_{-i,t}^j + 1)$$

Proposition 1: When $w = n^* \times K$ (the total amount of investment funds available in the economy equals the amount of investment that minimizes the risk of failure times the amount of projects available)^[17] it is a Nash Equilibrium, and a first best, to invest in projects such that $n_t^j = n^* \forall j$.

¹⁶ This vector has only one entry of 1 (the project chosen to give the loan to), and the other entries are zeros.

¹⁷ The case of $w \neq n^* \times K$ is evaluated in section 6.

Proof:

i. n^* maximizes the probability of success, and hence maximizes the possible profits from an investment.

ii. By i., once banks have reached $n_c^j = n^*$ for all j , any deviation (both withdrawing funds from a project and investing in a different project) increases the probability of default in both projects in which the amount of funds was altered, and hence, decreases the payoff for all banks.

iii. By ii., no bank wants to deviate (it is a Nash Equilibrium) and any deviation decreases the payoff of all banks (it is also a first best).

4 Nash equilibrium with Bailout

Now assume that if a bank fails it will be bailed out with probability p . Starting on the period after the bailout, the bank only keeps a fraction s of the profits. Since in practice governments often let small banks fail, but intervene when the amount of assets failed exceed a “comfortable” level that may vary with time, in this model the government bails out banks if the level of assets that are compromised in the financial sector exceed a pre-established threshold. This threshold depends on many factors such as current and expected growth of the overall economy, government deficit, connectedness of the banking system, political sentiment, etc.

Let M be the threshold. If m bank-owned assets fail in one period and $m > M$, then a failed bank (owning 1 unit of investment) will be bailed out with probability $\frac{m-M}{m}$. In other words, all banks are equally likely to be bailed out, given that only $m-M$ assets will be rescued.

In this case, each bank’s objective function is:

$$V(n_{i,t}; n_{-i,t}, t, \text{bailout}) = \sum_{j=1}^K r_i^j(n) [f(n_{-i,t}^j + 1)(R - r) + \delta \{ [1 - f(n_{-i,t}^j + 1)] p(n_{i,t}) s + f(n_{-i,t}^j + 1) \} V'(t + 1)]$$

Where

$$V'(t + 1) = V(n_{i,t+1}^j; n_{-i,t+1}^j, t + 1, \text{bailout})$$

and $p(n_{i,t})$ is the probability of being bailed out given failure¹⁸.

Proposition 2: Under a bail-out policy, there are conditions under which the maximum expected profits attainable for each bank occur when the bank invests in a project where a total investment of n^* has

¹⁸ let \vec{n} be the vector that indicates the number of assets invested in each project. The probability of failing and being bailed out is

$$[1 - f(n_{-i,t}^j + 1)] p(\vec{n}) = \sum_{i=M+1}^m pr(i \text{ banks fail given } \vec{n}) \frac{i-M}{i}$$

already been reached. Hence, there will be over-herding.

Proof:

If all banks invest in projects such that each project receives loans for a total amount of n^* and there is a bailout policy, each bank generates profits equal to

$$(1) \quad f(n^*)(R - r) + \delta \{ [1 - f(n^*)] p(n^*) s + f(n^*) \} V'(t + 1 | n^*)$$

Deviating and investing additional capital in a project that already has funding of n^* gives profits equal to

$$(2) \quad f(n^* + 1)(R - r) + \delta \{ [1 - f(n^* + 1)] p(n^* + 1) s + f(n^* + 1) \} V'(t + 1 | n^* + 1)$$

(2) is greater than (1) when

$$(3) \quad (R - r) \{ f(n^*) - f(n^* + 1) \} + \delta \{ f(n^*) V(t + 1 | n^*) - f(n^* + 1) V(t + 1 | n^* + 1) \} < \delta s \{ [1 - f(n^* + 1)] p(n^* + 1) V(t + 1 | n^* + 1) - [1 - f(n^*)] p(n^*) V(t + 1 | n^*) \}$$

The left hand side of (3) is the loss in expected gains from overinvestment, while the right hand side is the increase in expected profits that comes from a higher probability of being bailed out because of the deviation.

Note that the interest rate paid on deposits is independent of the probability of the bank’s failure. This can only be true with deposit insurance. If such insurance were not available, the benefits of taking more risk would be lower, since the cost of attracting capital is higher. As a consequence, (3) is less likely to be true (there would be less incentives to herd). In other words, it is not only the bail out policy that increases the incentives of banks to herd, but any policy that reduces the costs of overinvestment.

5 Numerical Example

In this section the functions in the model described above take specific forms in order to better understand the dynamics implied, and to show how easy it is to make over-herding optimal.

Assume there are 4 industries/projects and 12 banks. The number of banks and projects is the same in every period. If a bank fails in one period, it is either bought and recapitalized, or a new bank appears. In addition, an alternative to the failed project is found. This assumption is made to keep the state at each period equal and hence, make the problem easier to solve. In addition, if new banks and projects did not appear frequently, this model would

describe a disappearing economy. Each bank has 1 unit of capital to invest. Let $[R-r]=1$ and $\delta = 0.9$.

$$f(n) = \frac{4}{5} [1 - (\frac{4}{5})^n] \text{ so that } n^* = 3$$

a) No bailout and $n = n^*$

$V(t) = \frac{4}{5} + \delta \frac{4}{5} V(t+1)$ so, if all the banks always play $n^* = 3$, $V(t) = 2.857$.

b) Bailout.

Assume it is expected that the government will bailout some of the banks that fail. I evaluate whether one-time deviations from the above equilibrium are profitable for any one bank. In order to do that I assume $s=0.5$. $[1 - f(n^* + 1)]p(n^* + 1)$ (the probability of being bailed out and failing in one period) is evaluated as follows:

Define $p(x, \bar{n})$ as the probability of being bailed out and that x assets (or banks in this case) fail

(including the bank in question), given that banks invested in each of the four projects as vector \bar{n} indicates. Since the probability of being bailed out given that x units failed is $\frac{x-M}{x}$,

$$p(x, \bar{n}) = \Pr(x \text{ banks fail given } \bar{n}) + \frac{x-M}{x}$$

and

$$[1 - f(n^* + 1)]p(n^* + 1) = \sum_{x>M} p(x, \bar{n})$$

For $M=3$, the value of not deviating from $n^* = 3$ when there is a bailout policy is: 3.1199 ($V = \frac{4}{5} + \delta [1 - f(n^*)]p(n^*) + 0.5 + \frac{4}{5}V$). If one firm deviates to a project that is already funded by three other banks, only for one period, the present value of the deviation strategy is 3.1578. See table for more simulations:

Table 1. Benefit of deviation with bailout

			Non-deviation 1		Deviation 1	
			Prob fail & bail	Value	prob fail & bail	Value
M=3	s=0.5	$\delta=0.9$	0.0524	3.1199	0.0824	3.1578
M=4	s=0.5	$\delta=0.9$	0.0373	3.0395	0.0428	3.0429
M=5	s=0.5	$\delta=0.9$	0.0223	2.9632	0.0289	2.968
M=6	s=0.5	$\delta=0.9$	0.0072	2.8906	0.015	2.8968
M=3	s=0	$\delta=0.9$	0.0524	2.8571	0.0824	2.8532
M=3	s=0.25	$\delta=0.9$	0.0524	2.9827	0.0824	2.9988
M=3	s=0.75	$\delta=0.9$	0.0524	3.2702	0.0824	3.3321
M=3	s=1	$\delta=0.9$	0.0524	3.4358	0.0824	3.524

non-deviation 1= (3 3 3 3), or three assets in each project; deviation 1= (2 4 3 3), or bank one shifts to project 2

Effects of M: Recall that M is the maximum level of assets (or banks) that the government is willing to allow to fail. Then, greater M implies lower probabilities of bailout and hence, a lower value to any investment. Note that the benefits from deviating are not monotonic. The difference in values between non-deviation and deviation is the greatest when $M=3$. Then it decreases, but increases again between $M=4$ and $M=6$. Non-monotonicity occurs in this example because the probability of bailout depends

on the number of situations in which $x (>M)$ banks can fail. For example, in (3 3 3 3) 4 banks cannot fail since when a project fails, all the banks that invested in it must also fail. But in (2 4 3 3) it is possible to see 4 banks fail. So, as M increases, the probabilities of failure change at different rates for both cases.

Effects of s: Recall that s is the fraction of the bank that the owners keep after the bank has been rescued. When $s=0$, the owners lose all the assets (but do not have negative profits due to limited liability). In this case the policy of bailout is irrelevant for the bank owners, and there is no benefit from over-herding. However, increases in s increase the benefit from over-herding. In other words, the higher the fraction of the profits bank-owners get to

keep after a bailout, the greater the incentives to herd today. This result is consistent with Acharya and Yorulmazer (2008a). However, the authors in that paper warn that in practice very small values of s provide incentives to the bank managers to invest in very risky projects after the bailout. So that warning to rescue banks at a very high cost to the owners and managers is not a credible threat.

Now consider (0 4 4 4) as an equilibrium, and call it “bail equilibrium.” In this case all banks over-

herd and avoid one of the projects. The table below shows the value of playing this strategy in every period, and the value of the two relevant one-time deviations. These numbers show that there is no profitable deviation and hence over-herding this way is a Nash equilibrium of this game.

Consider the following parameters: $M=3$, $s=0.5$ and $\delta=0.9$.

Table 2. Nash Equilibrium with bailout

Bail equilibrium		Deviation 2		Deviation 3	
Prob. fail & bail	Value	Prob. fail & bail	Value	Prob. fail & bail	Value
0.0786	3.2525	0.1332	3.0609	0.0547	2.9461

Bail equilibrium= (0 4 4 4), or putting four assets on 3 out of 4 projects in every period; Deviation 2 and 3 are the two possible one-time deviations from bail equilibrium: deviation 2= (0 3 5 4) and deviation 3= (1 3 4 4). This is considering that, for purposes of this paper (0 3 5 4) is equivalent to (0 3 4 5), and to any permutation of these four digits.

6 Excess Capital

If there is not enough capital, it is straightforward to see that at least some projects will be under-capitalized. But, what if there is more capital in the market than is optimally needed for the existing projects/ industries? An extreme case of this situation is Greece and Ireland right after they joined the European union. The adoption of the Euro and the implicit support by the stronger countries in the union brought cheap capital to many of the smaller countries that joined.

Say bank $n^*K + 1$ comes into the market and in period t , $n_t^j = n^* \forall j$ holds true. If the best alternative investment has a return of z , as long as $f(n^* + 1)[R - r] > z$, the bank will invest in one of the existing projects i.e. there will be overinvestment. Hence, extra capital leads to overinvestment and increased risk, even as $f(n^* + 1)$ gets very small.

Conclusion

This paper explores previous literature that presents theories on why banks tend to herd. Then, it proposes a model that explains how government policies, although sometimes necessary, are important in explaining this behavior. The model is innovative in that it allows for several banks and time periods, as well as in its inclusion of an optimal level of herding and a flexible government policy. The model shows that it is not only the bail out policy that increases the incentives of banks to herd, but any policy that reduces the costs of overinvestment.

The model is simulated numerically to make further explore the model and prove the existence of functions that generate herding behavior.

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