An experimental exploration of self-fulfilling banking panics : their occurrence, persistence and prevention.

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Abstract

This paper tests the possibility and the degree of persistence of self-fulfilling banking panics through an experimental protocol. We confirm the possibility of pure-panic bank runs as first formalized by Diamond and Dybvig (1983) where all participants panic. However, this situation remains rare as Temzelides (1997) found out in an evolutionary game framework. But self-fulfilling bank runs, with a marked loss of confidence between depositors, are the most frequent cases in the experiment. This supports the idea of strong coordination failures as observed in the experimental literature on coordination games. Panics are proved to be persistent phenomena which are difficult to prevent. However, it seems to be possible to curb them through a learning effect caused by a temporary but long enough suspension of the deposit availability, combined to a "narrow banking solution" which makes banks more liquid. Lastly, panic prevention requires a full deposit coverage to be effective. Even a 75% deposit coverage rate is not sufficient, while lowering the coverage rate to 25% leads to more severe bank runs. This suggests that the moral hazard issue should not be tackled through a lower deposit coverage, especially in emerging countries' banking systems where depositors are likely to lose confidence.

Keywords : self-fulfilling banking panic – coordination failure – suspension of convertibility – "narrow banking" – deposit insurance – experiment –

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1. Introduction

In its history, the United States experienced many banking panics. Twelve of them took place between the beginning of the 19th century and the enactment of the Federal Reserve System in 1913 (Gorton (1988), Calomiris and Gorton (1991)). Six of them occurred during the Pre-civil War period and the six others took place under the National Banking System (from 1863 to 1912). Yet, the 1932-1933 banking panic is still the most striking event and it led president Roosevelt to set up a federal insurance of deposits for commercial banks and Savings&Loans associations (FDIC and FSLIC, the 1933 Banking Act), an unprecedented event on the international scene.[1]

Since 1933, the USA has known a few isolated and sporadic bank runs but no further banking panics. The enactment of the federal deposit insurance coincided with a panic-free period and was thus a source of stability for the banking system. So, there is a general agreement to recognize the efficiency of such systems in panic prevention and this idea is theoretically founded (Diamond and Dybvig (1983), Engineer (1989), Goldstein and Pauzner (2002)), even if other research, within the same trend (self-fulfilling banking panic or panic-based run), granted unquestionable virtues to mechanisms of (total or partial) suspension of the convertibility (Wallace (1988, 1990), Chari (1989), Almaos (1992), Selgin (1993), Cooper and Ross (1998), Goldstein and Pauzner (2002)).

But banking crises and deposit guarantee schemes are still topical issues, especially in emerging countries. Three quarters of IMF members banking systems suffered crises or significant troubles in the period 1980-1996 (Lindgren and *alii* (1996)). Likewise, thirty percent and forty percent of guarantee schemes were initiated during respectively the ‘80s and the ‘90s (Garcia (1998)).

Nevertheless, the commercial banks’ debacle and especially the S&Ls’, at the end of the eighties, has disclosed the limits of the US deposit guarantee scheme (White (1989), Dab (1992)). Most economists have thus criticized an overprotective deposit insurance with flat-rate premiums (not adjusted to the risk of each bank), responsible for moral hazard by leading banks to take higher risks. As a matter of fact, depositors whose deposit coverage is too high slacken their vigilance, and induce the bank management to make more adventurous moves.[2] Finally, on the whole, it can be concluded that the prevention of panics by means of a deposit guarantee scheme becomes too expensive or that at least a trade-off must take place between panic prevention and the adverse effects of moral hazard (Hazlett (1997)).

This accounts for new directions in research. First of all, theoretical works have been undertaken on information-based bank runs, i.e. runs of depositors driven by the perception of the future insolvency of their bank. They have completed and amended the precursory work of Diamond and Dybvig (1983), which has brought a theoretical foundation to the pure-panic bank runs (or self-fulfilling) and to the need for a protective deposit guarantee scheme to prevent them (Bryant (1980), Jacklin and Bhattacharya

(1988), Alonso (1996), Bourgheas (1999), Chen (1999)). Some of them have supported partial suspension of the deposit convertibility (Gorton (1985a), Chari and Jagannathan (1988)).[3]

Secondly, historical works have examined various previous panics to determine the origin and nature of the bank runs (self-fulfilling pure-panic runs or information-based runs) and the means of preventing them : a partial or total suspension of the deposit convertibility with the setting up of a clearinghouse, a deposit insurance scheme (Gorton (1985b), Gorton and Mullineaux (1987), Gorton (1988), Calomiris (1989, 1990), Calomiris and Gorton (1991), Grossman (1992), Wheelock and Kumbhakar (1995), etc.). Historically, during the National Banking Era (1863-1912), panics seem to have been, in most cases, information-based runs (Sprague (1910), Gorton (1988), Calomiris and Gorton (1991)) even if this issue and that of panic prevention still remain a controversial topic (Hoag (2002)).[4]

In addition to a confrontation between theoretical works and the historical facts, this paper proposes a new way to test the existing models, as allowed by experimental economics. The lack of data on the behavior of individual depositors in the real-word bank runs makes the experimental approach useful in shedding light on this phenomenon. This paper experimentally studies panic-based runs and does not deal with information-based runs. So it does not aim to settle in favor of one or the other theory on bank runs, which can actually be jointly examined (Goldstein and Pauzner (2002)).[5] However, this experimental study proves the relevance of the notion of self-fulfilling panic-based bank runs. And, although this paper focuses on bank runs, it also provides some insight into self-fulfilling behaviors observed in currency crises for example.[6]

To be more precise, this work tries to answer the following questions: are self-fulfilling banking panics (as in Diamond and Dybvig (1983)) possible, or at least can they be experimentally observed ? How persistent are such phenomena ?

Do suspension of deposit convertibility or/and a "narrow banking" solution make it possible to prevent or to curb this type of panic ?

Can partial deposit insurance be as effective as full insurance in preventing bank runs ?

In our experiment, the suspension of deposit convertibility works as a short or a long suspension of deposit availability**.** Once the run has started (which is the most frequent case), depositors are given a period of time to think before deciding either to stay in the line in front of their bank (i.e. panic) or to leave (and thus stop panicking). What we have here is a sequential decision by depositors which corresponds to what happens in a banking panic. We may refer to the historical literature's findings showing that banking panics observed in the USA in the 19th century lasted on average two to three months (Sprague (1910), Chari (1989)).[7]

The "narrow banking" solution consists in making the bank less illiquid and in changing the parameters of the demand deposit contract. Thus, the bank offers a higher return to participants (depositors) who demand late withdrawal. As proved by Goldstein and Pauzner (2002), doing this makes the bank less vulnerable to runs and it is possible theoretically to construct an optimal deposit demand contract that trades off the benefit from risk sharing against the costs of bank runs.

In the first two experiments, it is supposed that depositors cannot withdraw anything when the bank is illiquid. There is therefore no deposit insurance. But it is possible to introduce a partial coverage preventing depositors from losing everything even when the bank is no longer in a position to face up to its commitments, i.e. when it is illiquid. In this third experiment, two coverage levels (25% and 75%) are compared to the full coverage case which is trivial in this experiment and constitutes a benchmark (as it is pointless for participants to panic).

This experimental protocol tests a contextual repeated n-player coordination game with two Pareto-ranked Nash equilibria, which illustrates the depositors' behavior as regards the withdrawals from their bank. The bank run is supported by the Pareto-dominated Nash equilibrium and results from a coordination failure. The first experiments tested repeated 2-player games with two or several Pareto-ranked Nash equilibria (for a survey see Ochs (1995) and Cooper (1999)). The seminal experiments on coordination games with strategic complementarities have been carried out by Van Huyck, Battaglio and Beil (1990, 1991). They have shown that with perfect information subjects coordinate rather quickly on an equilibrium between maximin strategies and payoff dominant equilibrium. There are many environments in which coordination failure does occur. The convergence to the payoff dominant equilibrium depends on the experimental design and notably on group size. Contrary to groups of two players, groups of 14 to 19 participants reach the payoff dominant equilibrium only after experiencing efficient coordination in precedent treatments. Cooper and *alii* (1992) conclude from their experiments that preliminary communication (in which both players make their choice known) is the most effective way for players to coordinate on the Pareto-dominant Nash equilibrium. They prove that the resolution of the coordination failure raised by a coordination game can only be achieved through mutual trust building up between players.[8]

More closely related to our paper, in a subsequent experimental study, Schotter and Yorulmazer (2003) test the severity of bank run in a sequential game on a four period horizon. They basically look at two types of interventions : informational and insurance. More precisely, they show that when insiders who know the quality of the bank their money is invested in exist, subjects tend to withdraw their money later than they would if no such insiders existed. Moreover, a deposit insurance, even of a limited type, can also help to dampen the severity of bank runs.[9]

We propose experiments on a 10-depositor repeated coordination game, without the presence of insiders, in an evolutionary framework with perfect information (the game is repeated on 30 or 60 rounds). So this experimental study permits a dynamic analysis of bank runs and panics.[10] Recent experiments have studied equilibrium selection in coordination games with incomplete information (Cabrales, Nagel and Armenter (2002)), testing the global game approach by Carlson and Van Damme (1993).

They found no significant difference in behavior between the treatment with common or public information and the one with private information about payoffs.[11]

As earlier experimental works demonstrate, in certain experimental environments two kinds of coordination failure occur : a Pareto-inferior Nash equilibrium is reached or ex post disequilibrium outcomes are observed.[12] The present experiment reinforces the relevance of the second kind of coordination failures. Self-fulfilling banking panics are recurrent and persistent phenomena. However, it seems to be possible to curb them through a learning effect caused by a temporary but long enough suspension of the deposit availability, combined to a "narrow banking solution" which makes banks more liquid. We have here a new experimental result for which the standard theory of learning does not prove relevant. Lastly, this paper shows that panic prevention requires a full deposit coverage to be effective. This experimental result is interesting in so far as it has policy implications on the deposit insurance design. It differs from the results of Schotter and Yorulmazer (2003) who conclude that a low deposit coverage is needed to stop bank runs.

Section 2 presents Diamond and Dybvig's theoretical framework (1983) and its developments. We highlight their conception of a Pareto-dominated Nash run equilibrium for the stage game which becomes an evolutionarily steady state in the repeated game (Temzelides (1997)). Section 3 explains the experimental protocol and its ability to test the previous models. Section 4 reports results and discusses them. Section 5 concludes.

2. The theoretical framework[13]

The theory of banking intermediation, and with it that of banking panics, experienced a renewal at the beginning of the eighties thanks to Diamond and Dybvig's work (1983). Along those lines, subsequent studies confirmed the effectiveness of the deposit guarantee in the prevention of panics (Engineer, 1989). But they are outnumbered by those which, while improving on the initial model, rehabilitate the partial suspension of deposit convertibility (Chari (1989), Wallace (1988, 1990), Armaos (1992), Selgin (1993)).

Diamond and Dybvig (1983) insist on the instability of the banking activity insofar as the liquidity service (socially beneficial) provided by the bank to its depositors leads intrinsically to a possible banking panic. That is due to the fact that the bank enables depositors to smooth their consumption plan by giving them the possibility of consuming more goods sooner and, on the other hand, fewer goods later. Such a system works only if the depositors (of type 2), inclined to a late withdrawal and consumption (in period 2) do not come to withdraw immediately, i.e. at period 1. In that case, the bank won't be able to refund all the depositors, but only a part of them, slightly higher than the number of depositors (of type 1) normally coming to withdraw in period 1.

Initially, when the deposit contract is decided ($T = 0$), the depositor does not know if he/she will prefer to withdraw his funds quickly (type 1 depositor) or if he/she will prefer to withdraw later (type 2 depositor). The type of investment (or technology), which is available to the depositor individually, allows him/her to obtain only 1 unit (of consumption good), in period 1 ($T=1$), and $R>1$ units, in period 2 ($T=2$). However the depositor, who is risk adverse with a coefficient of relative risk aversion higher than 1, wishes to be insured against the risk of belonging to type 1, i.e. prefers to smooth his consumption plan over the two periods. The depositors, all supposed to be identical *ex ante*, then rely on their bank.[14] The latter allows the t % of them turning out to be of type 1 to withdraw a sum x_1 higher than 1, in period 1, and the $(1-t)$ % of them turning out to be of type 2, to obtain a sum lower than R, in period 2. The bank, which has the same possibilities of investment as a simple depositor, will therefore not be able to pay back more than N/x_1 depositors ($<N$) in period 1 if the economy includes N agents. As a consequence, expecting that the other depositors will come to withdraw in period 1 is enough for each type 2 depositor (or patient depositor) to behave in the same way.[15] Once in this logic of self-fulfilling panic, each depositor does not find it beneficial to change his/her strategy if the others don't do it. Indeed, he/she knows that the bank provides a sequential service of the liquidity, i.e. the first to arrive will be the first served and that those last arrived will not be able to withdraw anything more. This panic constitutes a pure and strict strategy Nash equilibrium (pareto-dominated) and it is not based, contrary to information-based runs, on any particular information showing a future insolvency of the bank. Fundamentally, this type of panic is the consequence of a loss of confidence which entails a coordination failure between depositors.

Another strict Nash equilibrium (pareto-dominant) happens when type 2 depositors do not become impatient to withdraw and thus do it in period 2. Such equilibrium occurs if each of them expects that the others will withdraw in period 2. In Diamond and Dybvig's model, type 2 depositors derive the same utility from an immediate or a later consumption. Consequently, as their level of withdrawal or consumption can be higher by waiting, they increase their level of utility (by no means reducing that of the others) by consuming in period 2.

In addition, by using the evolutionary game theory, Temzelides (1997) introduces a dynamic process in this framework by proposing a repeated version of Diamond-Dybvig's game on an infinite horizon. He studies equilibrium selection by an evolutionary process in an environment with multiple equilibria, one of which involves a banking panic. In each period, there are m possible states, where a state represents the number of (type 2) individuals who withdraw in period 2. The evolutionary framework implies that the best strategy in the previous period is imitated and so its occurence increases in the population of patient agents. Temzelides (1997) shows that, in this coordination game, the deterministic dynamic system has two pure steady states which correspond to the optimal and the panic equilibrium of the stage game.

To solve the problem of multiplicity, a Markov dynamic system is used. One comes to the conclusion that banking panics remain rare events insofar as the fraction of impatient people (type 1) is low, that the banking asset (or the technology) is not too illiquid and that the individuals'risk aversion is not too strong (so that they do not ask for a marked smoothing of their consumption). The combination of the last two conditions conveys the idea that the “transformation” activity of banks should not be too marked. In this case, the optimal equilibrium is also risk dominant.

This repeated version of the Diamond-Dybvig model provides the theoretical foundation for our experimental protocol. The latter proposes a dynamic study of bank runs, i.e. a study of their propagation over a period of time. In that respect, it is an experimental study of banking panics as defined in our introduction.

More recently, Goldstein and Pauzner (2002) propose an interesting development of Diamond-Dybvig’s framework. Their model has a unique equilibrium in which a run occurs if and only if the fundamentals of the economy are below some threshold level.[16] In this model, panic-based runs occur when the fundamentals are sound enough to deter agents from running if they believe that others would not. The optimal demand deposit contract arises from the trade off between risk sharing and cost of bank runs. So when the bank offers a higher return to participants (depositors) who demand late withdrawal, it reduces the probability of bank runs.

Our experimental protocol makes it possible to change the parameters of the demand deposit contract and so to study its impact on the bank runs. It is what we will call the “narrow banking”solution.[17]

3. The experimental framework

The object of this section is to show how the theoretical model can be tested by the experiment and how the experiment is able to answer our questions on banking panics.

3.1 The general description of the protocol

Let us specify beforehand that the three independent experiments (experiment 1, 2 and 3), operated on a computer terminal, were respectively undertaken on 8 (7, 6) groups of 10 participants. A total of 210 students have taken part in the experiment. They were students from the Economics Department and from the Technology Institute of the University of Lyons (Université Lumière Lyon II), from the Lyons Business School (Ecole de Management de Lyon) and from the Engineering School (Ecole Centrale de Lyon). They had therefore fairly different backgrounds, attending either business school, engineering school or university courses. Subjects did not have any knowledge whatsoever of games theory and microeconomics of banking.

Unlike experiment 3 which is made up of two experimental sessions, experiments 1 and 2 include 4 successive experimental sessions, but we only use the first two experimental sessions.[18] As each session is made up of 30 rounds, the gain of the participants at the end of a session corresponds to the average withdrawal on the 30 rounds. All information is common knowledge for participants who cannot communicate with the other people taking part in the experiment and are thus in discrete places.[19]

The experiment focuses only on the strategic depositors, according to the expression of Temzelides (1997), i.e. on the depositors likely to panic (those of type 2, “patient depositors”). The participants have the choice to withdraw an amount of money from their current account, open in the same bank, at one of the two opening periods of the bank windows: “period 1” or “period 2”. In the first session of experiment 1 (session 1.1), for example, if less than three of them withdraw in period 1, they receive 40 ECUS[20] in period 1 and 45 ECUS in period 2. If withdrawals in period 1 exceed the number of three, the bank can no longer satisfy any additional withdrawal, in period 1 or in period 2. The bank is then illiquid. In this context, only the first three participants who chose to withdraw in period 1 will be able to do it and the others will lose everything. This rule of « first arrived, first served » accurately accounts for the sequential service of the liquidity which is retained by Diamond and Dybvig (1983). In experiment 3, we alter this rule by offering participants a partial insurance, i.e. when more than three participants withdraw in period 1, the others do not lose everything but can take out 30 ECUS or 10 ECUS (corresponding to a coverage rate of 75% or 25%). This allows us to assess the effectiveness of a partial insurance in preventing any banking panic.

In the experiments, the amount received by the participants, in each period, is set by the experimenter (institutional parameters). Therefore, the point is not to test the willingness of the depositors to smooth their withdrawal plans (i.e. their willingness of risk sharing), all the more so as in our experiment “period 1” and “period 2” are simultaneous. It is supposed, as in Diamond and Dybvig (1983), that the depositors are *a priori* indifferent between the two periods, but that, preferring more than less, they will wish to withdraw (45 ECUS or 60 ECUS according to sessions) in period 2 rather than (40 ECUS) in period 1 (from the moment when they anticipate that the others will act in the same way). The payoff-dominant Nash equilibrium is reached when all the participants withdraw in period 2.

Insert Table 1

3.2 The classification of bank runs

It is supposed that a **“partial run”** occurs when at least one participant withdraws in period 1. This panic is caused by the expectation of this or these individuals, sometimes wrongly, that the other participants will panic as well, leading the number of withdrawals in period 1 beyond three. When less than 3 or 7 participants (according to the sessions) choose period 1, the “partial run” is described as **non self-fulfilling** because all the participants are repaid and so the “bank is liquid”. This run becomes **self-fulfilling** when more than 3 or 7 participants withdraw in period 1 so that some of them cannot be paid back (so the “bank is illiquid”). A **total and self-fulfilling run**, also called **«pure panic» bank run**, takes place when the 10 participants withdraw in period 1. This situation corresponds to the run equilibrium of Diamond and Dybvig (which is a pure and strict Nash equilibrium). It is also an evolutionarily steady strategy which leads to a steady state for the repeated game (Temzelides (1997)). The diametrically opposed situation, where no withdrawal in period 1 is observed, has the same characteristics of equilibrium and long run stability (**« non-panic » situation**). Table 2 below gives more details about the classification of bank runs in this experimental protocol.

Insert Table 2

3.3 The design of experiment 1

As each session of the experimental protocol includes 30 rounds, it becomes possible to test the dynamics of the Diamond and Dybvig's model experimentally, as proposed by Temzelides (1997). The first session of experiment 1 (session 1.1) puts the individual under conditions which, according to Temzelides, increase the probability of a panic : a slight differential between the withdrawal in "period 1" (40 ECUS) and the withdrawal in "period 2" (45 ECUS), a low number of withdrawals in period 1 from which the bank can no longer refund anybody (3 withdrawals). These two elements constitute the experimental parameters, which vary during experimental sessions and which characterize the banking institution. The space of time between two rounds (or rather between two successive choices) corresponds to a suspension of the deposit availability.[21] It is in fact the moment when individuals learn from former rounds.[22]

In our experimental protocol, the theoretical solution of the suspension of deposit convertibility, as presented in Diamond and Dybvig (and similar models), implies that any run is ruled out (the theoretical prescription being thus necessarily valid). With a suspension of convertibility, the promised amount in period 1 is paid to all the depositors as long as the bank is in a position to provide payment in period 2. It is then clear that panics cannot take place since it is pointless for « type 2 » depositors to run on the bank.

In the real world, the seminal work of Sprague (1910) - along with subsequent works - confirms that when a bank or the whole banking system suspends deposit convertibility (with gold or currency) reserves are so far depleted that they do not make it possible for the bank to meet depositors' demands in the near future (especially patient depositors). They cannot play the part which is theoretically assigned to them.

Besides, such banking panics usually last several months, with more or less severe runs. Suspension of convertibility consists in making deposits unavailable until depositors' confidence in the banking system has been restored. In a bank run, people actually line up in front of the bank windows and depositors may at any time either stay in the line and try to withdraw their money, or go home and come back later. Our experimental protocol replicates those dynamics as depositors are told at the end of each round the amount which they have been able to withdraw and the number of people in the line (number of withdrawals in period 1). Moreover, in each session, payoffs correspond to the average withdrawal on the whole session (and this payoff is known at the end of the session and not at the end of each round). We can thus test how persistent the run is : a steady run or a run which becomes more severe with each round becomes a panic. This is what we have found out in the first session of each experiment.

The second experimental session (session 1.2) repeats the first one in an identical way. This session aims at testing the effectiveness of a longer suspension of deposit convertibility (like the « banking holiday » during the 1932-33 banking crisis in the United States). All the first experimental sessions have finished on a strong panic, except for one group. The additional reading of the instructions by the participants, for a new experimental session, is used for a break. The objective is to test if this suspension enables participants to reach the payoff-dominant equilibrium, one of the two steady states in the long run. This mechanism corresponds in reality to a more or less long period of bank closure. By giving us the possibility of dissociating the learning effect from a modification of the institution, this session makes it possible to evaluate the capacity of a suspension of convertibility to stimulate a « non-panic » behavior among depositors.

However, the long suspension is more tricky to interpret than the short one. Each agent knows about his/her payoff at the end of the session even if he/she is not paid at the end of the session but at the end of the experiment. The answers collected in the post experimental questionnaires (in which students accounted for their decisions and changes of behavior) indicate that reading the instructions a second time was for them an opportunity to wind down and think again about the strategy they would follow. Panicking has actually been an uncomfortable experience for them as they realized they had not acted in the group's best interests**.** As we will see in section 4 where we present a more detailed analysis, data confirm this interpretation.

3.4 The design of experiment 2

The first session of experiment 2 (session 2.1) is the same as the first session of experiment 1 (session 1.1) except for the withdrawal in period 2 which is now 60 ECUS. Participants are therefore steeped in an environment which is less conducive to panic. Thus, the purpose is to test if the same phenomenon of banking runs is observed even if the payment in "period 2" increases (60 ECUS). Our concern is to know whether the panic behavior recorded in experiment 1 is connected to the fact that the withdrawal amounts in period 2 (45 ECUS) and in period 1 (40 ECUS) were too close to each other. In further experiments, it will be necessary to test other withdrawal amounts in period 2 (70 or 80 ECUS) and to bring the number of rounds to 50 or 60 for instance, to see if at a certain stage panic does not die down by itself.

In the second session of experiment 2 (session 2.2), the bank becomes less illiquid, the illiquidity threshold being now set at 7 withdrawals (see appendix 1). It is what we have called the "narrow banking" solution in which the bank is less likely to experience bank runs as it can meet the demands of more participants in period 1. This enables us to assess whether a long suspension of deposit availability, combined to a "narrow banking" solution , makes it possible to prevent any panic behavior from the first round of the session or at least whether such a combined solution works better than a single long suspension as tested in session 1.2.

3.5 The design of experiment 3

This experiment takes place within a framework which was used for the two previous experiments. The first experimental session aims at testing the impact of a partial deposit coverage on depositors' inclination to give in (engage in) to a self-fulfilling run. The experimental framework is the one used in the first session of experiment 1, with one exception. Once beyond the 3 withdrawals threshold in period 1, those participants who take out their money in period 1 after the first three agents do not lose everything as in session 1.1.[23] They can benefit from a partial withdrawal of 30 ECUS, like those who have chosen period 2. In order to allow comparisons with some sessions from experiments 1 and 2, we have settled for a similar amount for both periods so that depositors who have chosen period 1 and who are not among the first three to withdraw, are given the same amount as those who have chosen period 2. If the sum of 30 ECUS is referred to the withdrawal available in a non panic situation for each of these two periods, we reach a 75% coverage rate of their deposit in period 1 and a 67% coverage rate in period 2.

The experiment does not provide for an explicit deposit insurance scheme : the bank itself takes on the part of co-insurer.[24] In session 3.1, damages are shared in the following way : 30 ECUS are paid by the bank and 10 (respectively 15) ECUS are owed by depositors in period 1 and in period 2.

The second experimental session tests the impact of a lower deposit coverage when the previous session has ended up on a self-fulfilling run situation, expressing a mutual lack of confidence between depositors. For that purpose, session 3.2 changes an experimental parameter as compared to the previous session : the deposit coverage rate falls from 75% to 25%, bringing down the partial withdrawal available to participants from 30 ECUS to 10 ECUS.

4. Results and discussion.

The results are presented in the form of 12 observations some of which are inferred from earlier ones. For each of these observations, using tools of descriptive statistics, one shows first how they are proved correct as far as the samples or groups of participants are concerned. This first stage gives results which remain however valid only for the 80 (70, 60) participants of experiment 1 (2, 3). The second stage consists in extending these results to the population of students from which the groups are drawn (statistical inference). Only nonparametric tests are used because they do not make it necessary to rely on strong assumptions on the observations (Siegel and Castellan, 1988). The results are significant at the 95 % significance level.

4.1 Self-fulfilling bank runs : recurrent and persistent phenomena

OBSERVATION 1: whatever the experimental sessions, the “pure panic” run, as described by Diamond-Dybvig (1983), is an unusual phenomenon. That means that

the situation, corresponding to an evolutionarily steady state supported by a strict and pareto-dominated Nash equilibrium and where the coordination failure is strongest, is seldom observed.

Even in sessions 1.1 or 2.1, a total run (of the 10 participants) only occurred respectively during 8 (11) rounds. As presented above in table 2, this makes up 3% (5%) of the rounds played by the 8 (7) groups of participants, that is to say on the whole 240 (210) rounds. In each experiment, this number decreases between the two successive sessions (2% of the rounds in session 1.2 and 0 % in session 2.2).

This result means that some agents (those that did not run) end up sessions getting zero. This is somewhat puzzling as one would expect that subjects would learn over time that by not running they get no payment. Data on each agent's choice sequence together with the "post experimental" questionnaire provide answers to this question. In the questionnaire, agents were asked to account for their choices all through the experiment. There is one student (two at the most) in some groups who won't give in to panic, and won't do so in nearly all rounds. Their comments betray a moral stand which discards any non-cooperative behavior even if it brings them no financial reward. The economist has to deal here with a case of agents who do not interact with others.

Other participants (three to five according to rounds and groups) no longer panic during some rounds in order to show their goodwill and prompt others to make a choice which benefits everyone. But as they realize that choosing "period 2" during a few successive rounds does not make it possible to halt the panic, they choose “period 1” again to point out to others that they are not willing either to loose money each time.

OBSERVATION 2: the most frequent outcome in session 1.1 is that of rounds where a partial and self-fulfilling run occurs (number of withdrawals in period 1 between 4 and 9). It is at the same time a situation of strong coordination failure and disequilibrium which prevails in this session. This observation is the same even if the withdrawal in period 2 increases from 45 ECUS to 60 ECUS (session 2.1).

As mentioned above in table 2, respectively in experiment 1 and experiment 2, this case is found in 196 (165) rounds, that is to say in 82 % (79%) of the rounds of session 1.1 (session 2.1). Moreover, the average number of withdrawals per round reaches 6.23 (6.26) with a standard deviation at 2.45 (2.34) and a median at 7 (7). The coordination failure is thus relatively strong considering that the typical case is close to a total run.

In the first session of experiment 2 (session 2.1), the subjects can withdraw 60 ECUS in period 2 (instead of 45 ECUS in session 1.1) if fewer than 3 participants withdraw in period 1. The Wilcoxon-Mann-Whitney test proves that the average number of withdrawals in period 1 (per round) is the same between sessions 1.1 and 2.1 (appendix 2). Thus, self-fulfilling bank runs with a strong coordination failure do occur even when payment in period 2 rises from 45 to 60 ECUS. Of course, in further experiments, payment should be raised in period 2 so as to find out at what stage participants no longer panic.

Let us point out that the coordination failure grows with the average and the median of the number of withdrawals in period 1 and reaches its peak when these two indicators lie at 10. In these two sessions (session 1.1 and 2.1), one seems to be in a situation of medium period under the influence of the basin of attraction of the (long-run) panic steady state. So, if a steady state is possible to reach, it requires a series of rounds higher than thirty. Moreover, it is necessary to be careful about the nature of the long run steady state, i.e. to know if a “pure panic” or a “non-panic” situation is reached.

OBSERVATION 3: partial and self-fulfilling runs tend to be more severe as rounds proceed in session 1.1. In a corollary way, the coordination failure increases between individuals as the rounds go by. However, session 2.1 shows a growth of panic during the first part of the session, followed by a decline. So Self-fulfilling runs are persistent phenomena.

As shown on the rising trend on graph 1, the number of withdrawals of the 80 participants in period 1 increases steadily during the 30 rounds of session 1.1. However, the 70 subjects of experiment 2 increase their withdrawals in period 1 during the first fifteen rounds and reduce them after (Graph 2).

Insert Graph 1 and Graph 2

As specified in appendix 3, the Cochran test detects a difference in individuals' behavior on the first 15 rounds of session 1.1 and beyond. Over a shorter period, i.e. on a number of rounds lower than 15, the test does not show any significant change. That expresses the progressive tendency of individuals to choose period 1, an inclination recorded by a Cochran test on a set of at least 15 rounds. In the Cochran test interpretation, it means that the probability for an individual of choosing "period 1" varies from round to round when one takes into account at least the first 15 rounds of the session. However, for session 2.1, the Cochran test finds a significant change only if at least the first 25 rounds are taken into account.

These first results are supported by appendix 4 which gives the results of the one-tailed McNemar applied to the comparison of the individuals' behavior between the first round and the following rounds of sessions 1.1 and 2.1. For session 1.1, this test detects a statistically significant change in individuals' decision from period 2 to period 1 between the first round and all rounds subsequent to the 9th. However, the McNemar test does not detect any change in behavior between each successive round of session 1.1 and that from the first round of the session (appendix 5). For session 2.1, no change in behavior is found, except between the first and the sixteenth round.[25] It confirms the growth of panic behaviors during the first part of the session.

These results as a whole strengthen the idea of a perceptible change in behavior during session 1.1. It is by no means a strong change in behavior, but a simple reinforcement of a present trend in favor of period 1 choice. Besides, no change is globally observed during session 2.1.

4.2 Self-fulfilling bank runs are easier to stop than to prevent

OBSERVATION-COROLLARY 4: From observations 1 to 3, one concludes that a short suspension of deposit availability applied to the banking institution of sessions 1.1 or 2.1 is an ineffective means to prevent and stop a bank run.

Both experiments show that a short suspension of deposit availability does not entail a convergence towards a non-panic situation in the 30 rounds of the first session of experiments 1 and 2. But nothing indicates that beyond this number such a mechanism cannot be effective to stop a panic.

OBSERVATION 5: session 1.2 proves that a suspension of greater extent after a short suspension, repeated 29 times (in session 1.1) makes it possible to definitively stop the panic started in the banking institution of session 1.1, or at least to do so during 22 consecutive rounds.

As illustrated on graph 3, the change-point test used on the series of the (80) participants' decisions during session 1.2 shows the strong concentration of the changes in individuals' behavior between the first and the seventh round. As a matter of fact, 85 % of the changes in behavior happen during this period, including 37 % only for the second round. In order to support these results, the change-point test, used for the number of withdrawals in period 1 of the 80 participants during the 30 successive rounds of session 2, shows a lasting and significant change in individuals' choice starting from the eighth round (appendix 6).

Insert Graph 3

As detailed in appendix 7, the McNemar test, applied to the first 10 rounds of session 1.2 taken by pairs, detects a change from period 2 to period 1 between the first round and following rounds only beyond the 6th round (at the 95 % significance level). Appendix 4 extends this last result by showing that the change in behavior between round 1 and almost all the later rounds after the 6th round is significant.

From the second to the 6th round, the change is statistically significant only between these rounds and the 9th or the 10th round (appendix 7). From the 7th round, no change in behavior occurs between these rounds and the following ones since almost all participants maintain their choice of period 2 (appendix 7). However, the McNemar test shows a certain progressiveness of the change. As a matter of fact, when one applies this test to compare the individuals'choice between two successive rounds, no change is detected, even for the first 10 rounds (appendix 5).

OBSERVATION 6: a long suspension of deposit availability applied to the banking institution of session 1.1 (or 1.2) does not permit to prevent any run.

First of all, the mean and the median of the number of withdrawals in period 1 observed in the first round on the 8 groups are respectively in session 1.1 and session 1.2 at 4.62 as against 3.75 and 4.50 as against 4.00. For each session, the standard deviation of the first round is the lowest of all the rounds and is almost equal between the two sessions (1.218 against 1.299). This outlines the strong concentration of the observations around the mean and thus the similar behavior of different groups in the first round of each session and between the first rounds of the two sessions.

This result can be extended to the population from which the samples are drawn thanks to the McNemar test which compares sessions 1.1 and 1.2 round by round. No change in individuals' behavior takes place between the first round of session 1 and the first one of session 2. On the other hand, the test confirms the change in individuals' choice in favor of period 2 for all the other rounds (appendix 8).

OBSERVATION-COROLLARY 7: from observations 3 and 5, it is deduced that the growth of a banking panic phenomenon happens in a more gradual way than its disappearance. Its disappearance requires a real abrupt change in the depositors' behavior: either this abrupt change occurs and panic dies out almost instantaneously (in some rounds), or it continues to spread. The learning effect on individuals thus depends on their capacity to cause such an abrupt change in behavior collectively (and without any preliminary communication). The "long suspension" proves to be an effective means of achieving this learning effect.

OBSERVATION-COROLLARY 8: from observations 6 and 7, one can conclude that a long suspension of deposit availability applied to the banking institution of session 1 (or 2) is a good curative means but that it fails in its preventive role.

4.3 the “narrow” banking solution : a way of improving panic prevention

OBSERVATION 9 : a long suspension of deposit availability, when it is associated to a better capacity of the bank to resist panic (“narrow banking” solution), permits a better prevention of panics, even if this prevention is not complete. But above all, such a framework succeeds in stopping the propagation of panic to all the rounds of the session.

If one compares, using a Wilcoxon-Mann-Whitney test, the average number of withdrawals in period 1 of the participants’ groups between session 2.2 and session 1.2, it is statistically identical (appendix 2). However, the McNemar test indicates that a change in individuals’ behavior, from the choice of “period 1” to that of “period 2”, is perceptible between the first round of session 2.1 and the first round of the session 2.2. Such a change has not occurred in experiment 1 (appendix 8). For all that, it should not be concluded that session 2.2 makes it possible to rule out any run from the outset. As a matter of fact, 39 % of the participants in experiment 2 still chose “period 1” in the first round of session 2.2. They are 37 % in experiment 1.

On the contrary, within session 2.2 the shift towards the choice of period 2 as rounds progress seems to take place more quickly than in session 1.2. The McNemar test actually shows that this change in behavior is significant between the first round and all the later rounds in session 2.2, whereas this change is perceptible in session 1.2 only between the first round and the following ones, starting from the 6th round (appendix 4). Nevertheless, the change-point test shows a significant shift in the individuals' behavior at the 8th round for experiment 1 as against the 11th round for experiment 2 (appendix 6). The major difference lies in the fact that 2 groups panicked all through the second session of experiment 1 whereas there was no such behavior in experiment 2. For experiment 1, it can be noted that 21 % of participants always choose period 1 during the last round of the second session, compared to 4 % for experiment 2.

Arguably, a proper assessment of the preventive character of the banking institution in session 2.2 would require another experiment in which this institution would be tested, as early as the first session.

4.4 the partial deposit insurance : an ineffective means to prevent panics

OBSERVATION 10 : Deposit insurance, in so far as it does not provide a complete coverage, does not make it possible to prevent the occurrence and to stop the propagation of a self-fulfilling run. Actually, depositors benefiting from a 75% coverage do not behave differently from depositors who cannot benefit from any

insurance. Self-fulfilling banking panics are still a persistent phenomenon (see graph 4).

The Wilcoxon-Mann-Whitney test measures the average number of withdrawals in period 1 for identical rounds between the groups in experiment 1 and in experiment 3 for sessions 1.1 and 3.1. Using the same comparison criteria, sessions 2.1 and 3.1 are regarded as statistically identical (appendix 2).

Insert Graph 4

This result seems to be the most unexpected. Firstly, the possibility of losing everything is not the most prominent feature in accounting for self-fulfilling runs. Indeed, when the bank offers a partial withdrawal in a situation of illiquidity depositors behave in the same way as if they lost everything, which implies that self-fulfilling runs, with a strong coordination failure, are still the most frequent outcome. Secondly, it can be argued that depositors benefiting from a high though not complete coverage react like uninsured depositors. It is then clear that in order to prevent panics effectively, deposit insurance should offer a complete coverage. The moral hazard issue should be solved by a different means from a lower deposit coverage, especially in unsound banking systems. The current prudential regulation , which results from an international standardization (Basel Committee on Banking Supervision) seems to offer an attractive alternative. Other experimental studies are required to support those findings.

Introducing a full insurance in our experimental framework would suggest to participants that they can lose their deposit once the number of withdrawals in period 1 has gone beyond the illiquidity threshold of the bank. But in such a situation they will get a refund which will be equal to the withdrawal level, in period 1 and in period 2, which would be available if the bank had remained liquid. As the withdrawal amount in period 2 is higher than in period 1, all agents have to coordinate on the choice of period 2. This is why we have not carried out such an experiment , as it seemed to be trivial. Nevertheless, the full insurance provides us with a benchmark.

OBSERVATION 11 : An increased deposit coverage (session 3.1) leading from a total lack of coverage to a situation in which depositors benefit from a 75% insurance coverage, is a far less effective way to prevent panics than a long suspension of deposit availability (session 1.2), the least so when the suspension is combined with a higher possibility for depositors to get paid back in period 1 – "narrow banking" solution – (session 2.2).

Appendix 2 shows that individuals are on average more likely to choose period 1 in session 3.1 than in session 1.2 and 2.2, as proved by a Wilcoxon-Mann-Whitney test.

OBSERVATION 12 : A lower deposit coverage, from 75% down to 25%, makes the panic more severe between sessions 3.1 and 3.2.[26] A long suspension of deposit availability no longer has any impact when it is combined with a change in the banking institution which results in a higher level of depositors'self-insurance. Hence the importance of sending depositors consistent signals, especially in a panic situation.

Insert Table 3

Table 3 describes the increase in coordination failure between session 3.1 and session 3.2 : no partial and non-self-fulfilling runs whatsoever take place in session 3.2 whereas they occurred in 13% of session 3.1 rounds. The percentage of rounds where a partial self-fulfilling run has been observed rises from 86 % to 89 %, but the proportion of rounds in which a total pure panic run takes place shoots up from 1 % to 11%, a much higher figure than what has been recorded in the two previous experiments. Thus, in session 3.2, the bank is in a position of illiquidity during the 180 rounds in which the 6 groups took part (as against 87% of the rounds in session 3.1). It is remarkable that in 69 % and 91 % of rounds respectively, in sessions 3.1 and 3.2, there should be a number of withdrawals in period 1 ranging from 6 to 10 (see above graph 4 and below graph 5).[27]

Insert Graph 5

Lastly, 78% of agents in session 3.2, as against 5% in session 3.1, have chosen period 1 in more than 60% of the rounds in their session. 31% of them in session 3.2 have actually chosen period 1 in more than 90% of the rounds, compared to 15% in session 3.1. Even more striking is the fact that 22% have chosen period 1 during the 30 rounds of session 3.2, compared to 3% in session 3.1. Those figures highlight a stronger inertia in the panic behavior of depositors in session 3.2 than in session 3.1. Besides, it is worth considering that the proportion of participants withdrawing in period 1 in the first round of session 3.2 equals the proportion of participants withdrawing in the last round of session 3.1.

Statistical tests confirm the intuition derived from the statistical study carried out on samples of participants : while the McNemar test does not detect any change in behavior between the first round and the following ones during session 3.1, the same test records a significant change in behavior in favor of period 1, between the first round and the following ones from the 22nd round onward, for session 3.2 (appendix 9). Besides, the McNemar test does show that there is no change in behavior between the first and the fifteenth round whereas participants change their minds in favor of period 1 between the fifteenth and the last round. This suggests a growth of panic at the end of the session. The Cochran test confirms this phenomenon and shows that the probability of choosing period 1 remains identical during the first 25 rounds whereas a difference in behavior can be detected when the 30 rounds of the session are considered (appendix 3).

5. Conclusion

This paper has experimentally explored the possibility and the degree of persistence of a self-fulfilling banking panic. Furthermore, we have tested some means to prevent or to curb panics : suspension of deposit convertibility (or availability), “narrow banking” solution and partial deposit insurance. This experiment bears on a particular repeated 10-player coordination game with two Pareto-ranked Nash equilibria, which illustrate the depositors' behavior as far as the withdrawals from the banking system are concerned.

We confirm the possibility of pure-panic bank runs (self-fulfilling and total bank runs) as formalized by Diamond and Dybvig (1983). However, it remains a rare phenomenon. Partial and self-fulfilling bank runs, which are due to strong coordination problems, represent a more frequent situation. This backs up the idea of coordination failures as it was observed in previous experimental literature. Panics are proved to be persistent phenomena which are difficult to prevent. However, it seems to be possible to curb them through a learning effect caused by a temporary but long enough suspension of deposit convertibility. A better prevention is possible when this suspension is combined with a "a narrow banking" measure which makes banks more liquid.

Even if this experiment does not deal with information-based runs, it mitigates the results of some historical studies which argue in favor of the theory of information-based runs developed by the same authors (Gorton, 1988 ; Calomiris and Gorton, 1991). In the latter, the depositors are not directly informed about their own bank asset risk. Consequently, they are inclined to panic when they perceive adverse news which modify the perception of this risk and so the probability of their bank failure. These news are generally a macroeconomic indicator of recession of the real activity and the panic occurs when this indicator goes beyond a threshold.

On the contrary, self-fulfilling panics are sunspot equilibria. This means that every piece of information, which leads to expect that the others will run, can trigger a panic. The problem is a loss of confidence in the behavior of the other depositors. As a matter of fact, this kind of panic is due to a strong coordination failure between depositors. The present study proves that self-fulfilling panics are a recurrent phenomenon in an experimental environment where participants do not lose any money but may be denied a potential gain. Of course, in order to support this result, it would be necessary to undertake this experiment with various kinds of banking institutions (payment in period 2, illiquidity threshold) and experimental environments (number of rounds per session, number of subjects per group).

Experiment 3 gives the most unexpected results. Firstly, the possibility of losing everything is not the most prominent feature in accounting for self-fulfilling runs. Indeed, when the bank offers a partial withdrawal in a situation of illiquidity depositors behave in the same way as if they lost everything, which implies that self-fulfilling runs, with a strong coordination failure, are still the most frequent outcome. Secondly, it can be argued that depositors benefiting from a high though not complete coverage react like uninsured depositors. It is then clear that in order to prevent panics effectively, deposit insurance should offer a complete coverage. This would imply that priority should be given to the prevention of banking panics when the regulator has to determine the level of deposit coverage. In other words, solving the moral hazard problem through lower deposit coverage does not seem to be a very relevant method. Two further arguments support this view. On the one hand, in most countries, deposit insurance provides for a compensation ceiling. This implies that smaller depositors, who are not in a position to monitor their bank, have full coverage. Conversely, « bigger » depositors (companies, institutional investors) are only given a limited coverage. On the other hand, a prudential regulation has been implemented at the international level and has been improved since the Cooke ratio thanks to the Basel Committee on Banking Supervision's successive proposals on bank solvency (see the latest Basle II reform which should lead to a new international accord on bank capital).

Obviously, such an issue calls for further, more comprehensive studies : this experiment should be repeated on different populations of participants and in other countries. The advantages offered by the reproducible character of the experiment are apparent here. Besides, this partial deposit coverage will have to be tested in various experimental environments.

This experimental study also emphasizes the importance of sending depositors consistent signals to help them coordinate on the non panic situation. Indeed, a long suspension of deposit availibily has devastating consequences when it is associated to a lower deposit coverage rate. To carry the argument further, we suggest to apply a new experimental protocol in which sessions will be reversed in comparison to the present experiment. Thus, in the first experimental session, depositors will have a 25% coverage rate and in the second one a 75% coverage rate. Firstly, it will be possible to compare the adverse effect of a lower deposit coverage rate in a case of panic by comparing the two sessions in which there is a 25% coverage rate. We will also be able to draw a parallel between this new first session and those in which the coverage rate was nil (experiment 1 and 2) and also that in which we had a 75% coverage rate (experiment 3). Last but not least, it will be possible to assess the effectiveness of a higher deposit coverage rate (rising from 25% to 75%) to prevent and halt a self-fulfilling banking panic.

To conclude, let us emphasize that only a total deposit coverage is effective in preventing bank runs. This gives us some insight on the kind of deposit guarantee which should be implemented. As far as deposit insurance compensation is concerned, a partial deposit coverage should be avoided in unsound banking systems, for example in emerging countries. In this prospect, the implementation of deposit guarantee should be entrusted to the authorities responsible for monitoring the banking system, as they have the institutional capacity through regulation to mitigate moral hazard.

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[1] Since FIRREA (1989), the FSLIC has disappeared. The FDIC is now in control of the S&Ls' insurance fund.

[2] Moreover, a non-actuarial pricing of deposit insurance strengthens such an adverse effect because, for banks, the cost of raising finance by insured deposits remains unchanged and equal to the unrisky rate, independently of the more or less risky use of deposits (see for example Kareken and Wallace (1978), Kane (1985, 1989, 1990), Chen and Mazumdar (1994, 1995), Kumbhakar and Wheelock (1995), Mazumdar (1996), Karels and McClatchey (1999)). Some works have used the arbitrage pricing method to determine an actuarial premium and to evaluate the split between this theoretical premium and those actually paid by U.S. banks, namely implicit subsidies (see for example Merton (1977), Marcus and shaked (1984), Ronn and Verma (1986), Pennachi (1987), Kerfriden and Rochet (1993), Morel and Nakamura (1999) for the French case). Others have discussed the efficiency of bank prudential regulation to curb this unwanted effect (see for example Kahane (1977), Kareken and Wallace (1978), Buser, Chen and Kane (1981), Koehn and Santomero (1980), Kim and Santomero (1988), Keeley and Furlong (1990), Rochet (1992a, 1992 b), Giammarino et al. (1993), Bensaïd et al. (1993), Freixas and Gabillon (1996). For a survey see Freixas and Rochet (1997)).

[3] Nevertheless, the run conception of Chari and Jagannathan (1988) and Chen (1999) is particular. For them, runs occur when uninformed agents interpret the fact that others run as a signal that fundamentals are bad.

[4] In the tradition of Calomiris and Gorton's (1991) work (and their "random withdrawal theory"), Hoag (2002) provides an econometric test of the seasonal interpretation of Diamond-Dybvig for the two bank panics of 1873 and 1893. Although this study does not reject a seasonal explanation of the panic of 1873, it does reject such an interpretation of the panic of 1893. But, as Hoag (2002) concludes, Diamond and Dybvig's (1983) model cannot be applied to the banking panic of 1893 if a seasonal withdrawal from the nation's agricultural interior is a correct interpretation of the exogenous liquidity shock of Diamond and Dybvig's (1983) theory of bank runs. Moreover, one may wonder whether the notion of "exogenous liquidity shock" lies at the heart of Diamond and Dybvigs' banking panic theory. Actually, our experimental study confirms that banking panics can result from a loss of confidence or a coordination failure between depositors, as first suggested by Diamond and Dybvig.

[5] Moreover the experimental proof of panic-based run does not mean the non existence of information-based run.

[6] On self-fulfilling currency crises, see for example Obsfeld (1986), Flood and Marion (1996), Obsfeld (1996), Jeanne (1997), Heinemann (1999), Heinemann and Illing (1999). For currency crises based on fundamentals, see the seminal work of Krugman (1979). For an analysis of the financial crises as "twin crises", where a Diamond-Dybvig's banking panic entails a currency crisis, see Goldfajn and Valdés

(1997). For also a study of interdependent banking and Currency crises in a model of self-fulfilling beliefs, see Goldstein (1999).

[7] A more detailed discussion of this interpretation will be proposed in section 3.

[8] Confidence is indeed what makes it possible to switch from the pareto-dominated equilibrium, which is less risky, to the pareto-dominant equilibrium. The choice between the two pareto-ranked equilibria appears to be conditional to the strategic uncertainty which depends on ex post desequilibrium outcomes. Cooper and alii (1994) emphasize the difference between the coordination game and the battle of the sexes game which are respectively confidence and conflict games. In the first game, it is a two-way communication between players (who stand then on an equal footing) which provides the solution to the coordination problem. Conversely, in the second game, an asymmetrical situation has to be introduced so that one player only can make his strategy known, in order to solve the conflict in the choice of equilibria.

[9] Corbae and Duffy (2003) experimentally study a repeated two-stage network formation game with multiple equilibria to get micro data on network formation and contagion. A possible interpretation of this environment is that of a regional banking system with an endogenously determined interbank network, where withdrawal decisions taken by depositors in one region affect payoffs faced by depositors in other regions. We may refer here to Temezelides (1997) who theoretically discusses local interaction and contagion effects that allow for a bank run to spread first among banks in the same geographic location and then throughout the entire population.

[10] A bank run is a sporadic event. It turns into a panic when it spreads over a large number of rounds.

[11] Along the same lines, Heinneman and *alii* (2002) propose an experimental analysis of speculative attacks. Their results suggest that there are no destabilizing effects due to public information and that the predictability of attacks is slightly higher with public than with private information.

[12] As shown in Cooper and *alii* (1990, 1993, 1994), one can witness a coordination failure linked to the selection choice of pareto-dominated equilibria in coordination games (equilibrium selection problem) while in the battle of the sexes game the most frequent coordination failure lies in the choice of ex post disequilibria.

[13] For the details on the formalization and the results proof, see Diamond and Dybvig (1983), Temzelides (1997) and Goldstein and Pauzner (2002).

[14] Each depositor gives the bank his endowment of 1 unit, which becomes a deposit of 1 unit. With N agents in the economy, the bank has N units.

[15] As impatient agents (type 1) always withdraw in period 1, only patient agents (type 2) are "strategic" players. Consequently, we study the coordination game played by m patient agents choosing either to withdraw in period 1 or to wait until period 2. So, there are $N-m$ impatient agents in this economy.

[16] The method used in this paper to obtain a unique equilibrium is closely related to Carlsson and Van Damme (1993) and Morris and Shin (1998). They show how the introduction of noisy signals to multiple-

equilibria games with full strategic complementarities leads to a contagion effect that generates a unique equilibrium.

[17] This model sheds light on what happens at the stage game level though not at the repeated game level.

[18] Indeed, the data collected in the last two experimental sessions will be dealt with in other papers (but are more difficult to interpret).

[19] The reader will find the instructions given to participants for experiment 1 in appendix 1. As for experiments 2 and 3, instructions are the same, except for charts which are different from experiment 1, so as to include changes in the banking institution. Those changes are featured in table 1 below.

[20] Experimental Currency Unit.

[21] As one of the referees suggests, this short suspension of deposit availability corresponds to a restoration of the bank capitalization.

[22] Moreover, the suspension joined to the repetition of the rounds allows the learning effect to take place and so suspension acts on participants'behavior by a learning effect. The goal of this experiment is not to study the learning effect thoroughly. A wide experimental literature exists on this topic. See for example the Handbook of Experimental Economics, Kagel and Roth (1995).

[23] It is worth noting that in all the sessions of experiments 1 and 2 it is assumed that the depositors who were slowest to react lost everything once the bank was illiquid.

[24] It would be a professional deposit insurance, but with the same credibility as a public insurer, a credibility which is the experimenter's.

[25] for a Type I error of 0.055.

[26] It can be underlined that, with a probability of a type one error at 0.07 and at 0.09 respectively, the average number of withdrawals in period 1 is statistically higher in session 3.2 groups than in session 1.1 and session 2.1 groups (see appendix 2).

[27] In addition, the average number of withdrawals per round reaches 7.59 in session 3.2 with a standard deviation at 2.41 and a median at 8 (in session 3.1, the mean is 6.13, the standard deviation 2.05 and the median 7).