# Three essays on banking

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# Chapter 3

# Strategic Loan Defaults and Coordination: An Experimental Analysis

## 3.1 Introduction

A wide literature in finance shows how coordination failure by depositors in the form of premature withdrawals and bank runs may lead to the collapse of weak banks, and sometimes of healthy banks.[1] Had depositors successfully coordinated on keeping their funds in the bank, it could have survived, with mutual benefits for bank and depositors. Banks can also be vulnerable to coordination failure from the asset side of their balance sheet, however (Bond and Rai 2009, De Luna-Martinez 2000, Krueger and Tornell 1999, Vlahu 2009). If solvent borrowers believe that the bank will become distressed because of defaults by others, they may delay or even default on their loans. For a bank with good fundamentals, a borrower's default on

[1] Bryant (1980), Calomiris and Kahn (1991), Chari and Jagannathan (1988), Diamond and Dybvig (1983), Goldstein and Pauzner (2005), Jacklin and Bhattacharya (1988), Rochet and Vives (2005) give theoretical models for bank runs. Kelly and O'Grada (2000), Iyer and Puri (2009), Saunders and Wilson (1996) provide empirical evidence.

a loan threatens her future relationship with the bank, providing strong incentives for timely and full repayment (Boot 2000, Brown and Zehnder 2007, Ongena and Smith 2000). Believing that the bank will become distressed, however, reduces the repayment incentive for solvent borrowers because of the expected loss of the benefits from the maintained relationship should the bank fail. Commonly held beliefs that other borrowers will default may therefore lead to a situation where solvent borrowers are unable to coordinate on repayment, and thus fail to ensure bank survival and future relational benefits. Borrowers' reluctance to repay their loans in a situation of expected distress has been identified by De Luna-Martinez (2000) and Krueger and Tornell (1999) as one of the main causes that exacerbated the 1994 Mexican banking crisis. More recently, a prominent example has been the delayed payments to Lehman by a number of other large banks (e.g., JP Morgan), in the wake of Lehman's demise on September 15, 2008. Lehman's creditors accused JP Morgan for having created a liquidity shortage on September 12, 2008, when denying access to \$8.6 billion in cash and other liquid securities.[2] Conversely, a large German borrower, KfW bank, was exposed to massive criticism because it made a €300M payment to Lehman on that day just before Lehman filed for bankruptcy (Kulish, 2008).

An important sector where banks may become subject to runs by their borrowers in times of distress is the mortgage market (Feldstein, 2008). US mortgage lenders in many states have no recourse to the borrower's wealth beyond the value of the house. Individuals with negative equity, many of them real estate speculators, therefore have a strong incentive to default. If many choose to do so, also borrowers with positive net value may decide to delay payments, anticipating a possible failure of their lender that would destroy their future relational value. This aggravates the lender's problems. In fact, hundreds of small lenders have failed during the 2007-2009 crisis (see, e.g. FDIC Bank Failures report 2010), and Guiso et al. (2009) provide evidence that

[2] Lehman Brothers Holdings Inc. et al., U.S. Bankruptcy Court, Southern District of New York, No. 08-13555.

approximately 1 in 4 defaults was driven by strategic behavior of solvent borrowers. Similarly, Hull (2008) claims that the downward trend in house prices during the credit crisis in 2007 was reinforced by the decision of many borrowers who exercised their "implicit put options and walked away from their houses and their mortgage obligations".

In contrast to depositors withdrawing their own money, coordination failure resulting from borrowers strategically delaying or defaulting on loan payments involves a breach of contract. It will therefore be confined to situations of diffused financial distress of either borrowers or banks or both, as in the recent crisis, and to situations characterized by slow and relatively costly law enforcement. By its mere nature, it is therefore difficult to study its causes empirically. Uncertainty regarding both bank fundamentals and borrower fundamentals may contribute to create coordination failure, but these effects are difficult to identify due to the lack of clear measurement and orthogonal variation. More generally, the causes of coordination failure in situations with multiple equilibria cannot easily be studied with real world financial data, and therefore little evidence is available yet.[3] Evidence on borrowers' behavior is confined to cross-countries studies of credit registries' role in dissipating information, showing that repayment rates are higher where credit registries are more developed (Jappelli and Pagano, 2002).

To overcome identification problems in empirical data, in this paper we separate the effects of uncertainty about bank fundamentals and borrower fundamentals on borrowers' coordination failure in an experimental credit market. Experiments have successfully been used to examine the impact of information sharing and long-term banking relationships on borrower and lender behavior (Brown et al. 2004, Brown and Zehnder 2007, 2010, Fehr and Zehnder 2009). Similarly, to study the causes of depositor and currency runs, theoretical accounts have been tested in controlled laboratory settings with clear identification of causal effects (Garratt and

[3] Degryse et al. (2009) review the empirical literature on individual bank runs and systemic risk.

Keiser 2009, Heinemann et al. 2004, Madies 2006, Schotter and Yorulmazer 2009). The borrowers' coordination problem has received less empirical attention yet. The harmful effects of strategic defaults have not become clear until the recent period of distress, with previous episodes limited to developing countries (De Luna-Martinez 2000, Krueger and Tornell 1999), and transition economies (Perotti, 1998). Because of its relevance to the stability of the banking system and its potential to amplify downward trends, a more thorough understanding of borrowers' coordination failure is warranted. Identifying the factors that drive borrowers' strategic default is important for bank stability and allows for improvements with respect to the choice and the timing of regulatory measures.

The coordination game studied in the current paper involves two features which are specific to credit markets. First, borrowers have an imperfect signal about the fundamentals of their bank (i.e., the number of defaults that would trigger its failure). Second, borrowers are imperfectly informed about the fundamentals of other borrowers, and thus how many of these may be forced to default on their loans. These two sources of uncertainty are natural proxies for the regulatory rules for transparency and disclosure, and for the state of the economy. The design allows us to study whether transparency rules and economic environment affect the incidence of strategic default, and how the two factors interact. That is, we test whether public policy to improve disclosure has a different effect on repayment incentives in different stages of the business cycle, and vice versa, if the impact of changes in the economic environment depends on disclosure rules. Although the payoff structure studied here will be derived from a lending perspective, the potential interaction between uncertainties regarding the bank and the other borrowers is also relevant for depositors' coordination or currency runs. To our best knowledge, the interaction of these uncertainties has not yet been studied in either alternative setting, and our results therefore provide relevant insights beyond credit markets.

This paper complements the empirical literature on bank runs by departing from the traditional view of runs and focusing on the assets side of the bank balance sheet. We compare four coordination games (with 2 borrowers) that have the same multiple Nash equilibria – default by both borrowers versus repayment by both borrowers – but differ in terms of the uncertainty about fundamentals. Because of the future benefits of the maintained banking relation, coordination on repayment is always efficient for solvent borrowers. We explore the behavior of these borrowers, and how their coordination failure due to strategic default reduces bank stability. Our main findings are as follows. First, we find that both types of uncertainty affect the incidence of strategic defaults, and that this effect can be explained by a change in the risk dominance characteristics of the coordination setting (Schmidt et al. 2003, Straub 1995).[4] In particular, both disclosure and uncertain borrower fundamentals make the defaulting equilibrium relatively more risk dominant, leading to more coordination failures. Surprisingly, thus, more information about bank fundamentals is not always better. When full disclosure reveals bank weakness, it increases strategic non-repayment regardless of economic conditions. Similarly, solvent borrowers default strategically more during downturns when fundamentals of other borrowers are more uncertain, regardless of disclosure rules.

Second, analyzing individual borrower characteristics we find that risk attitudes, in particular attitudes toward financial losses, have a strong and robust influence on repayment decisions. Loss averse borrowers place a higher value on the available cash they hold than on the higher but uncertain future monetary outcome which is conditional on bank survival. Hence, they have a strong preference towards non-repayment, which allows them to avoid the immediate financial loss triggered by potential bank failure.

We also show that negative past experiences strongly affect individual repayment decisions. People who have experienced more defaults from other borrowers and

[4] Risk dominance measures in how far expected payoffs in one equilibrium are relatively less affected by uncertainty about the players' strategy choice than in the other equilibrium.

the subsequent bank failures, are more likely to default strategically. The role of negative experiences has been shown relevant in various financial decision settings (Malmendier and Nagel, 2010), and our results indicate that it will also affect behavior of borrowers who lost a banking relationship in times of crisis. While direct experiences of bank failures will mainly obtain in economies with weak institutions and repeated crises, the results also suggest a channel for contagious aggravation of beginning crises through observation or word-of-mouth (Guiso et al. 2009, Iyer and Puri 2009, Rincke and Traxler 2010).

Policy implications follow from our analysis. Clearly, the role of individual characteristics implies that credit markets in which participants do not self-select according to risk attitude, like the mortgage market, might be subject to more strategic default than those in which entrepreneurial types participate, like small business loans markets. Our results regarding experiences suggest some range for welfare improvements by not letting banks in distress fall in public. Hence, we provide a rationale for central banks' interventions as lender of last resort. Large scale intervention of financial authorities during the recent financial turmoil lead to immense liquidity support for banks and asset guarantees worth several trillions dollars. This support has helped most of the banks to avoid failure, and this, in the spirit of our paper, proved to have benefic impacts on the banking system. Keeping banks afloat, such interventions have buffered the impact of negative experiences and have mitigated the strategic default of borrowers. Further, disclosure may be harmful because it lays open the strategic uncertainty in the coordination problem. As we show in the experimental data, and as has also been observed in various cases during the current crisis, once the weakness of the bank is established, the coordination is too difficult a problem for market participants to solve. This will be particularly true in situations of a weak real economy and thus with a significant portion of borrowers potentially in genuine distress.

The chapter is laid out as follows. Section 3.2 introduces the model and Section 3.3 formulates our hypotheses. In Section 3.4 we describe the experimental design. Results are presented in Section 3.5, and discussed in Section 3.6. Section 3.7 concludes.

## 3.2 The Model

We consider a risk-neutral economy with two dates: 0 and 1. The economy is populated by a single bank and two borrowers. There is no time discounting. We model depositors as passive players without alternative investment opportunities beside costless storage and lending to the bank.

### 3.2.1 Agents

The bank finances its investments through deposits $Dep$ and equity $E$. We assume that deposits are fully insured at zero premium. The bank invests some of its funds in two identical risky loans of size $L$ each. The difference $C$ between the volume of liabilities (e.g., deposits $Dep$ and equity $E$), and the volume of loans $2 * L$ represents cash reserves. We normalize $L$ to 1, and all the other variables are normalized accordingly. Required nominal gross return per unit of loans is $R > 1$. Both deposits and loans are repaid at date 1. The balance sheet of the bank at date 0 is depicted in table 1.

TABLE 1. BANK'S BALANCE SHEET AT DATE 0.

| | |
|---|---|
| Cash Reserves: $C$ | Deposits: $Dep$ |
| Loans: 2 | Equity: $E$ |

In this model the bank is simulated. Since the focus of our analysis is on the borrowers' repayment behavior, we assume the bank's quality (i.e., capital to assets ratio adequacy, quality of loans as result of screening and monitoring efforts) to be exogenously given. The bank fundamentals might be either strong or weak. If the fundamentals are *strong*, the bank survives if at most 1 loan is defaulted on. If the fundamentals are *weak*, the bank survives only if both loans are repaid. We denote by $F$ the number of defaulted loans the bank can stand, conditional on its type. For a bank with strong fundamentals, $F$ equals 1, while for a bank with weak fundamentals $F$ equals 0. The economic intuition behind this classification is as follows. As the recent financial crisis has shown, the debt leverage was a major determinant of the property bubble and subsequent liquidity problems in the banking sector. Many large banks had 30 times leverage at the beginning of the crisis, which was well above the allowed 12 times leverage introduced by the international standard of 8 percent for bank's capital ratio. Thus, highly leveraged banks resemble weak banks, which are more likely to become illiquid when the volume of non-performing assets is low. On the other hand, strong banks are those with appropriate level of capital which might survive to a higher degree of deterioration of their assets.

We examine two scenarios for bank transparency. In the first one the bank's fundamentals are weak, and both borrowers know the type of their bank. Hence, there is common knowledge about bank's fundamentals. This case corresponds to a full transparency regime regarding the bank's weakness, where all agents understand that the bank will fail if only one loan is not repaid. All uncertainty is due to the strategic uncertainty in the coordination problem (Heinemann et al. 2009, Van Huyck et al. 1990). In the second scenario, the borrowers do not know the quality of their bank's fundamentals, due to partial disclosure. The type of bank is drawn randomly, and can be either strong (with probability $p$) or weak (with probability $1 - p$). The borrowers know the probability distribution, but they do not know the true type of their bank. That is, uncertainty about the bank's financial health is added to the strategic uncertainty. We call the scenario with full disclosure about weak bank fundamentals *Transparent Weakness* (TW), and the scenario with uncertainty about bank's weakness *Uncertain Weakness* (UW).

There are two types of borrowers in this economy: solvent borrowers with good fundamentals and financially distressed borrowers with bad fundamentals. When fundamentals are *good*, the borrower has a positive income and can repay her loan in full. When fundamentals are *bad*, the borrower is in genuine distress and she has no option but to default on her loan. We denote by $K$ the borrower's available cash. For a borrower with good fundamentals, $K$ equals $R$, while for a borrower with bad fundamentals $K$ equals 0. Upon receiving information about the possible uncertain bank's fundamentals and other borrower's fundamentals, good borrowers may take either of two actions at date 1. They may decide to repay their loans in full, or to default. Both borrowers make their decisions simultaneously.

For borrowers we examine two cases. In the first case, the economic environment is characterized by robust growth, low unemployment, high prospects for corporate sector performance, rising assets prices including real estate, and stable personal income. Both borrowers have good fundamentals and they can repay their loans in full. In the second case, the economic environment is characterized by widespread weakness, contraction in business activity, rising unemployment, and falling assets prices including property prices. In such an environment many borrowers are faced with the lack of capability of repaying their debts. We model this uncertainty assuming that one of the borrowers' type is drawn randomly. We call her *Borrower B*. She can have either good fundamentals (with probability $q$) or bad fundamentals (with probability $1-q$). When making the repayment decision, the other borrower (called *Borrower A*) has no information regarding Borrower B's true fundamentals, except for the probability distribution. On the other hand, there is common knowledge about Borrower A's good fundamentals.

This approach builds on the recent literature on the strategic defaults of borrowers. The papers most closely related to ours are by Guiso et al. (2009) and Cohen-Cole and Morse (2009), who study the behavior of mortgage borrowers in US during the subprime crisis of 2007. Cohen-Cole and Morse (2009) show that in situations of financial distress, consumers often prefer defaulting on mortgages rather than on credit card debt to secure liquidity. They also find that individual mortgage defaults increase the likelihood of other home owners defaulting on their mortgage; such an effect is not found for credit card debt. Similarly, Guiso et al. (2009) also report strategic defaults and social spillovers in mortgage delinquency. A theoretical analysis is Vlahu (2009), who shows that banks with sound fundamentals may collapse due to collective strategic loan defaults. Vlahu (2009) argues that if solvent borrowers have imprecise private signals about bank fundamentals, they may claim inability to repay if they expect a sufficient number of other borrowers to do so as well, thus reducing bank's enforcement ability.

In our model, the economic intuition behind the asymmetry in solvency and information (i.e., Borrower B knows with certainty that Borrower A is solvent while Borrower A has only an expectation about Borrower B's fundamentals) follows from typical patters in economic crisis. For instance, during the recent financial crisis, some sectors in the economy (e.g., the financial, real estate, and car industry) were strongly hit in the beginning, while others (e.g., pharmaceuticals, transportation and utilities) were quite resilient at the onset of the crisis. Borrower A is employed in a strong sector of the economy. Everybody knows that her line of business is doing fine and believes that she is solvent and capable to repay her loan. Borrower B works in a sector which was severely affected by the crisis. There is a lot of uncertainty about her employment situation and a positive probability that she will experience financial distress. We call the economic environment with solvent borrowers *Good Economy* (GE), and the one with uncertainty about Borrower's B fundamentals *Bad Economy* (BE).

### 3.2.2 Payoff Functions

The borrowers' payoff structure is as follows. If a solvent borrower chooses to repay her loan she will get either 0 if the bank fails or $V > R$ otherwise, where $V$ represents the present value of future long-term relation between the firm and the borrower. As Diamond (1991) argues, debtors that have been successful in repaying their loans in the past are able to obtain better credit terms since they are more likely to be successful in the future. We assume that the bank breaks off the relationship if a borrower defaults. If a solvent borrower chooses to default she keeps the contractually agreed repayment $R$. The intuition behind this is twofold. On one hand, the evidence suggests that due to its collection skills, the original lender is the most efficient in extracting any hidden cash from defaulting borrowers. Hence, if the bank fails, a new entity which takes over the bank's assets will recover less than $R$. Without loss of generality we set the recovery rate to zero. On the other hand, if the bank survives it might force the repayment $R$. Nevertheless, as evidence from recent credit crisis suggests, this might not happen. Guiso et al. (2009) analyze the behavior of mortgage borrowers and report two reasons for low recovery.

First, some states in US have mandatory non-recourse mortgages, and as a result the lenders can not pursue the house's owner beyond the value of the house. Second, the legal cost of enforcing the contract is usually high enough to make lenders unwilling to sue a defaulted borrower. The first reason is specific to mortgage loans. The second one has a broader interpretation. Lenders find it difficult to recover their loans in circumstances where the financial environment is characterized by inadequate bankruptcy laws and an inefficient judiciary system in which creditor rights are poorly defined or weakly enforced. The recovery rates are very low and the process is slow and bureaucratic as evidence from banking crises in Latin American countries in the mid 80's and transition economies in Eastern Europe in the early 90's show. According to the World Bank,[5] the recovery rate in non-OECD countries averages

[5] World Bank's Statistics for Closing Business Indicators (2009); based on methodology discussed

$$\Pi_i(K_i, D_i, D_{-i}, F) = \begin{cases} K_i D_i + V(1 - D_i) & \text{if } F \geq D_i + D_{-i} \quad \text{(bank survives)} \\ K_i D_i & \text{if } F < D_i + D_{-i} \quad \text{(bank collapses)} \end{cases}$$

below 30%, while the recovering process may lasts between 3 and 4 years. The cost of proceedings is substantial, averaging 17% of the assets value. Even though for the OECD countries the statistics are not as dramatic (i.e., recovery rate 68%, average period 2 years and recovery costs 8.5% of assets), due to the collapse in asset prices following the turmoil of 2007-2010, and the subsequent erosion in value of collateral backing access to funds for many borrowers, there is an increased likelihood that these numbers will be worse. Thus, due to limited legal punishment, we can assume without loss of generality that a defaulting borrower ends up with a positive payoff $R$.

We denote by $\Pi_i$ and by $D_i$ the payoff and the action of borrower $i$, respectively, with $i \in \{A, B\}$. The available set of actions for borrower $i$ at date 1 is to either repay the loan ($D_i = 0$), or to default ($D_i = 1$). The borrower's payoff depends not only on her fundamentals ($K_i$, with $K_i$ either 0 or $R$) and her action ($D_i$), but also on the other borrower's action ($D_{-i}$) and bank's fundamentals ($F$, with $F$ either 0 or 1). Further, if $K_i$ =0, $D_i = 1$ follows. The payoff function for borrower $i$ is then given by:

Tables 2 and 3 provide the payoff matrices for the cases when the bank is strong and weak, respectively. If the bank has strong fundamentals ($F = 1$) it collapses only if both borrowers default. As a consequence, the borrowers' payoff matrix when both debtors are solvent (i.e., both borrower A and borrower B have good fundamentals) is given by:

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in Djankov et al. (2008).

TABLE 2. THE BORROWERS' PAYOFF MATRIX FOR THE CASE OF A STRONG BANK AND SOLVENT BORROWERS

| Borrower A \ Borrower B | Repay ($D_B = 0$) | Default ($D_B = 1$) |
|---|---|---|
| Repay ($D_A = 0$) | $V, V$ | $V, R$ |
| Default ($D_B = 1$) | $R, V$ | $R, R$ |

If the Bank has weak fundamentals ($F = 0$) it collapses if either debtor defaults. If both borrowers are solvent we then have:

TABLE 3. THE BORROWERS' PAYOFF MATRIX FOR THE CASE OF A WEAK BANK AND SOLVENT BORROWERS

| Borrower A \ Borrower B | Repay ($D_B = 0$) | Default ($D_B = 1$) |
|---|---|---|
| Repay ($D_A = 0$) | $V, V$ | $0, R$ |
| Default ($D_B = 1$) | $R, 0$ | $R, R$ |

### 3.2.3 Scenarios of Interest and Extensive Form of the Game

The combination of full vs. partial disclosure and subsequent uncertainty regarding bank fundamentals, and a good vs. a bad economy implies four scenarios of interest. These scenarios are as follows: (1) *Good Economy – Transparent Weakness* (GE-TW), (2) *Good Economy – Uncertain Weakness* (GE-UW), (3) *Bad Economy – Transparent Weakness* (BE-TW), and (4) *Bad Economy – Uncertain Weakness* (BE-UW). Figure 1 gives the extensive form of the game for each scenario.

FIGURE 1: EXTENSIVE FORM OF THE GAME FOR DIFFERENT SCENARIOS

| | t=0 | t=1/2 | t=1 |
|---|---|---|---|
| GE-TW | $F$ and $K_i$ are exogenously given | $F$ and $K_i$ become common knowledge | Borrowers decide simultaneously to repay their loans or not |
| GE-UW | The nature draws $F$ from $(p, 1\text{-}p)$, $K_i$ are exogenously given | $(p, 1\text{-}p)$ and $K_i$ become common knowledge | Borrowers decide simultaneously to repay their loans or not |
| BE-TW | $F$ and $K_A$ exogenously given, nature draws $K_B$ from $(q,1\text{-}q)$ | $F$, $K_A$ and $(q, 1\text{-}q)$ become common knowledge | Good borrowers decide to repay their loans or not; bad borrowers default |
| BE-UW | $K_A$ exog. given, nature draws $K_B$ from $(q,1\text{-}q)$ and $F$ from $(p,1\text{-}p)$ | $K_A$, $(p, 1\text{-}p)$ and $(q, 1\text{-}q)$ become common knowledge | Good borrowers decide to repay their loans or not; bad borrowers default |

## 3.3 Theoretical and Behavioral Predictions

### 3.3.1 Theoretical Predictions

In this section we discuss the equilibria in different scenarios. Each scenario is defined by a combination of uncertainty about bank's fundamentals and about the second borrower's solvency. We begin by describing two additional benchmark scenarios involving unique equilibria, the first involving a credit market with a strong bank, and the second scenario involving a credit market with one good borrower and one bad borrower. Because of the unique equilibria we will not study these scenarios in the experiment. We next describe the theoretical predictions for the scenarios of interest defined in Section 3.2.3 that we examine empirically. Assuming risk neutrality, it will be shown that these four scenarios involve the same multiple pure Nash equilibria. Table 4 summarizes the pure Nash equilibria for all possible scenarios.

TABLE 4: THEORETICAL PREDICTIONS

| Bank Fundamentals / Borrower Fundamentals | Strong<br>$F = 1$ | Uncertain (UW)<br>$Prob(F=1) = p$ | Weak (TW)<br>$F = 0$ |
|---|---|---|---|
| Good (GE)<br>$K_A=R$<br>$K_B=R$ | [Repay, Repay] | [Repay, Repay]<br>or<br>[Default, Default][a] | [Repay, Repay]<br>or<br>[Default, Default] |
| Uncertain (BE)<br>$K_A=R$,<br>$Prob(K_B=R) = q$ | [Repay, Repay if $K_B=R$] | [Repay, Repay if $K_B=R$][c]<br>or<br>[Default, Default][a] | [Repay, Repay if $K_B=R$][b]<br>or<br>[Default, Default] |
| Bad<br>$K_A=R$,<br>$K_B=0$ | [Repay, Default] | [Repay, Default][d]<br>or<br>[Default, Default][a] | [Default, Default] |

*Notes:* [a]Equilibrium depends on the condition $pV<R$; [b]Equilibrium depends on the condition $qV>R$; [c]Equilibrium depends on the condition $(q+p-pq)V>R$; [d]Equilibrium depends on the condition $pV>R$

All proofs are in the Appendix. We focus on pure strategy equilibria in this paper, thus mixed equilibria are given in the Appendix and are not discussed in detail. In the Appendix we also show that our data imply that participants did not play these mixed equilibria.

### Benchmark scenarios

In the benchmark scenario with strong bank fundamentals both borrowers know that the bank collapses only if both default. If at least one borrower repays, the bank survives and can maintain the relation with her loyal customer. It is therefore the dominant strategy for Borrower A to always repay, and for Borrower B to repay if she is solvent. Intuitively, if repaying her loan keeps the bank afloat, the future value of the relation is always more valuable than the repayment. In the other benchmark scenario, Borrower B is in financial distress for sure, and will therefore not repay.

Borrower A will repay if the bank is strong and default if the bank is weak. With uncertainty about to the bank fundamentals, defaulting is an equilibrium strategy for Borrower A if the expected value from repaying, $pV$, is smaller than the value of the loan, $R$. Intuitively, if the other borrower is in distress for sure, only a high probability $p$ of the bank having strong fundamentals will induce the solvent borrower to repay. With low probability $p < R/V$ the expected value of the future relationship is too low compared to the immediate gain from defaulting strategically.

**Scenarios of interest**

We next describe the pure strategy equilibria for the four scenarios that we investigate experimentally. In Good Economy – Transparent Weakness both borrowers are solvent and everybody knows this, and the credit market is transparent, hence, both borrowers know that their bank is weak. Consequently, with one default enough to let the bank fail, borrowers' actions depend on their beliefs about the other borrower's action. This case is similar to the standard multiple equilibria bank runs model (Diamond and Dybvig, 1983). There are two pure Nash equilibria: one in which both borrowers choose to default on their loans and to keep the gross value of the repayment $R$, and one in which both borrowers repay and participate in the higher payoff $V$. The bank survives if the repayment equilibrium prevails, and fails otherwise.

In Good Economy – Uncertain Weakness the borrowers are not perfectly informed about the quality of their bank as a result of partial disclosure. With some probability $p$ the bank has strong fundamentals and it might survive if only one loan is not repaid. On the other hand, with probability $1 - p$ the bank is weak and fails if at least one loan is not repaid. In this market, borrowers' actions depend on their beliefs about true bank fundamentals rather than only on the beliefs about the other borrower's action. For low enough probability $p < R/V$ of the bank having strong fundamentals, the multiple equilibria (repay, repay) and (default, default) obtain again.

In the Bad Economy – Transparent Weakness scenario, there is common knowledge about the bank weakness. As a result, market participants know that the bank fails if at least one loan is defaulted on. In this scenario bank failure can be caused by the financial distress of one of the borrowers, irrespective of repayment intentions. With probability $(1-q)$ Borrower B is insolvent and forced to default, such that the bank fails. Therefore, borrowers' actions depend not only on their beliefs about the other borrower's action but also about their beliefs about the borrowers' fundamentals. In particular, if the probability that the second borrower is solvent is not too low, $q > R/V$, the multiple equilibria (repay, repay) and (default, default) obtain. Note that repayment of Borrower B in the former equilibrium is conditional on her being solvent (i.e., $K_B = R$).

In the Bad Economy – Uncertain Weakness scenario both uncertainties prevail. Repayment by both borrowers, conditional on their solvency, is an equilibrium if Borrower B's insolvency risk $(1-q)$ is not too high or if bank fundamentals are likely to be good. Default by both borrowers is an equilibrium if, as above, the probability of strong bank fundamentals is not too high. Thus, under the joint condition $pV < R$ and $qV > R$, we obtain the multiple equilibria (repay, repay) and (default, default). We are now ready to state our main hypothesis.

HYPOTHESIS 1 (IDENTITY OF EQUILIBRIA): *For any configuration of parameters $p$, $q$, $R$ and $V$ satisfying simultaneously the restrictions $pV < R$ and $qV > R$, the four scenarios GE-UW, GE-TW, BE-UW, and BE-TW involve the same multiple equilibria. We therefore predict no differences in loan repayment across scenarios.*

### 3.3.2 Behavioral Alternative Hypotheses

Hypothesis 1 has been derived from risk neutral Nash equilibrium and provides the null hypothesis for our experimental investigation. In this section we state alternative behavioral hypotheses based on variation in payoff and risk dominance properties of the equilibria, individual risk attitudes, and negativity bias in the effect of experiences.

HYPOTHESIS B1 (PAYOFF DOMINANCE): *Uncertainty affects the payoff dominance properties of the two multiple equilibria across treatments. We predict that stronger payoff dominance for the (repay, repay) equilibrium leads to more coordination on repayment.*

HYPOTHESIS B2 (RISK DOMINANCE): *Uncertainty affects the risk dominance properties of the equilibria across treatments. We predict that stronger risk dominance of the (default, default) equilibrium leads to less coordination on repayment.*

Hypothesis B1 and B2 derive from the literature on behavior in coordination games. Dominance criteria have been studied to predict actual play in situations where Nash equilibrium does not allow us to give a unique prediction (Schmidt et al. 2003, Straub 1995, van Huyck et al. 1990). Payoff dominance measures the degree that an equilibrium is more Pareto-efficient than the other equilibrium, while risk dominance measures in how far expected payoffs in an equilibrium are relatively less affected by uncertainty about the players' strategy choice than in the other equilibrium. Both risk dominance and payoff dominance are expected to increase the likelihood of an equilibrium to be selected, although the empirical evidence is stronger for risk dominance (Cabrales et al. 2000, Schmidt et al. 2003). In contrast to prior literature, in our setting the variation in payoff dominance and risk dominance emerges endogenously from differences in the uncertainty about fundamentals in the different scenarios. For our parameterization of the coordination problem, we derive rank orderings in terms of the payoff and risk dominance criteria for the strength of the repayment equilibrium, using the definitions in Schmidt et al. (2003, p.284). In Section 3.4.1 we show that the two criteria predict different orderings, allowing us to distinguish them empirically.

HYPOTHESIS B3 (LOSS AVERSION): *Individual aversion to losses influences equilibrium selection. In particular, because repayment involves the risk of losing* *all value after a default by the other borrower if the bank is weak, and defaulting guarantees the lower sure payoff, higher loss aversion is predicted to lead to a higher probability of default.*

People's risk attitudes have been found to influence play in coordination games (Heinemann et al. 2009). In particular, Cachon and Camerer (1996) and Rydval and Ortmann (2005) provide evidence that aversion to downside risk and losses influences equilibrium selection in coordination games. In our setup, losses provide a relevant economic intuition for the borrowers' coordination problem also, as stated in hypothesis B3. Repayment involves the loss of the cash paid on top of the lost relational continuation value. While not normative, a potentially costly overweighting on losses in default decisions is empirically supported by recent evidence on irrational default decision in the mortgage market. Gerardi et al. (2010) found that lower numerical ability is correlated with a higher incidence of mortgage borrowers becoming delinquent. The above discussed Cohen-Cole and Morse (2009) result of liquidity preference at high economic cost can similarly be interpreted as an irrational focus on the downside.

HYPOTHESIS B4 (NEGATIVE EXPERIENCES): *Negative experiences increase the likelihood of coordination failure more strongly than positive experiences reduce this likelihood.*

The role of personal experiences in financial decisions has been shown for instance by Malmendier and Nagel (2010) for macroeconomic shocks and portfolio choices. In repeated coordination games, a convergence to the payoff dominated equilibrium, thus mutual default in our study, has often been observed (Schmidt et al. 2003, Van Huyck et al. 1990). In repeated play, participants will collect positive experiences in case of coordination success, and negative experiences in case of coordination failure and out of equilibrium play. The psychological literature suggests that the negative experiences will impact future play more strongly than positive experiences (Baumeister et al. 2001, Rozin and Royzman 2001), explaining the downward trend in coordination observed before. We therefore hypothesize that for the borrowers' problem under uncertainty negative experience has the stronger impact.

## 3.4 Experimental Design and Procedures

### 3.4.1 The Experimental Credit Market

We study repayment decisions in the two player coordination games shown in tables 1 and 2 under the four scenarios of interest defined in Section 3.2.3. The parameterization of the games in terms of experimental units is such that $V = 55$ and $R = 40$ in all conditions. Further, under uncertainty the probabilities for strong bank and for good borrower fundamentals, respectively, are set to $p = 0.5$ and $q = 0.75$. Note that these numbers satisfy the conditions for multiplicity of equilibria shown in Table 4.

We have four treatments based on the four scenarios of interest defined by orthogonal variation in the uncertainty about borrower fundamentals, good economy (GE) vs. bad economy (BE), and about the bank fundamentals, uncertain weakness (UW) vs. transparent weakness (TW). In all treatments players made their decisions simultaneously and were informed about the implemented coordination decisions and the outcome after each round.

In GE treatments both borrowers are solvent. Their decisions will be implemented for sure. In BE treatments, one of the two borrowers, Borrower A, will be solvent for sure and the other borrower, called borrower B, will be solvent with probability 0.75. It is common knowledge among players who will be solvent for sure and who might be insolvent in a game. Both borrowers always make a repayment decision. For borrower B that decision may then not be implemented. In particular, after having made their repayment decision, borrower A's decision will always be implemented for sure while borrower B's decision will be implemented only if she is solvent. If B is insolvent, her decision will be forced to be default. From the information given

TABLE 5. PAYOFF AND RISK DOMINANCE EFFECTS OF UNCERTAIN FUNDAMENTALS

| | Payoff dominance | | Risk dominance | |
|---|---|---|---|---|
| | Level | Rank | Level | rank |
| GE-UW | 0.27 | 1 | 1.2 | 1 |
| GE-TW | 0.27 | 1 | -0.43 | 3 |
| BE-UW | 0.17 | 3 | -0.19 | 2 |
| BE-TW | 0.03 | 4 | -1.51 | 4 |

*Note:* Calculated according to Schmidt et al. (2003, p. 284)

about the decisions and the outcome it is not possible for borrower A to distinguish between strategic default by B, and a forced default because of genuine insolvency.

In TW treatments, the bank's weak status is common knowledge and the players therefore play the coordination game in Table 3 where one default is enough to let the bank fall. In UW treatments, the players know that they play either the game in Table 2 where the bank is strong or the game in Table 3 where the bank is weak. The probability of being in either game is 0.5, and this is common knowledge. After players have made their decisions, the relevant state of the world is revealed and the decisions are implemented for the selected game. Players learn the coordination decisions, the game, and the resulting outcome. Note that a repaying borrower may therefore observe a default by the other player that turned out to not affect his payoffs because the bank was strong.

As detailed in hypotheses B1 and B2, the variation in uncertainty affects the degree of risk and of payoff dominance for the repayment and the default equilibria. Table 5 shows the level of payoff dominance and the level of risk dominance of the repayment equilibrium given the experimental parameters, using the definitions in Schmidt et al. (2003). That is, both criteria measure how attractive the repayment equilibrium is relative to the defaulting equilibrium, across treatments. We always interpret payoff and risk dominance from the viewpoint of repayment, thus larger numbers indicate a stronger criterion for the repayment equilibrium. Positive numbers indicate that the repayment equilibrium is dominant in the respective sense. For example, in treatment BE-UW, repayment is *payoff dominant*, but less so than in GE-TW ($0.27 > 0.17$). Similarly, in BE-UW repayment is risk-dominated (negative value), but less so than in GE-TW ($-0.19 > -0.43$). We say that by moving from GE-TW to BE-UW, repayment becomes more *risk dominant*. As can be seen from the table, the two criteria predict a different ordering in terms of favorability of repayment, allowing us to differentiate between hypotheses B1 and B2.

### 3.4.2 Elicitation of Loss Attitudes

To test hypothesis B3 we need to measure borrowers' attitudes toward losses. Various measures of risk attitude have been used in the experimental literature, but these measures usually cannot separate different factors like variance aversion or loss aversion. Recently, a choice list method has been proposed that has been interpreted in terms of loss aversion and has a high external validity, that is, successfully predicting behavior outside the experiment that involves potential losses (Fehr and Götte 2007, p. 316, Fehr et al. 2008, Gächter et al. 2007).

We elicit loss attitudes by offering subjects a series of risky lotteries that give an equal chance of either a gain or a loss in terms of experimental units. For each lottery, subjects could choose to play or not to play (see Table 6). Subjects were free to accept or reject any prospect, that is, we did not require single switching from acceptance to rejection as the loss increases along the list. They earned experimental units according to their decision in *all* six choices, depending on the outcome of the risky prospects.

For losses smaller than 45, rejecting to play the prospect implies a significant loss in expected value that may be explained more easily by a gain-loss framing and a kinked utility function of wealth changes, than by a concave utility of wealth. It

Table 6. Choice List Measure of Loss aversion

| Lottery (50%–50%) | Accept to play? |
|---|---|
| Lose 5 units or win 45 units | Yes O No O |
| Lose 15 units or win 45 units | Yes O No O |
| Lose 25 units or win 45 units | Yes O No O |
| Lose 35 units or win 45 units | Yes O No O |
| Lose 45 units or win 45 units | Yes O No O |
| Lose 55 units or win 45 units | Yes O No O |

has also been shown that the predictions of reference-dependent utility models hold mainly for people who reject many of the lotteries in this choice list (Fehr and Götte, 2007). We call subjects who reject more lotteries in this task *more loss averse*, in line with the alternative behavioral hypothesis we aim to test.[6] Note that the payoffs in this task were similar in size to the payoffs of the coordination task.

### 3.4.3 Laboratory Protocol and Procedures

Computerized experiments where run with 180 undergraduate students at the University of Amsterdam, using z-Tree software (Fischbacher, 2007).[7] A session consisted of two sets of five rounds of the borrowers' coordination game (part I and part II), followed by the loss aversion task. In each part, subjects were randomly matched in groups of 6 players and played five rounds of the two-person coordination game in a

[6]Keeping with the behavioral finance and games literature on which our alternative hypotheses are based, we interpret the results in terms of loss avoidance. Note, however, that an interpretation of the loss aversion results in terms of general risk aversion, and without reference to any specific psychological process, is obviously possible.

[7]Sample instructions and screenshots of the design are in the Appendix. We thank Center for Research in Experimental Economics and Political Decision-Making at University of Amsterdam (CREED) for allowing us to use their facilities.

strangers design, that is, meeting each other person exactly once. After part I was finished, subjects were reshuffled and matched in new groups of six. Within each part all subjects played the same treatment condition, and part I and II always involved different treatments as shown in Table 7. The treatment in part I of each session gives us observations that are unaffected by previous experiences (except obviously within-part experience). Part II gives us observations on behavior after a regime shift. In particular, in sessions 1 to 4 the shift was from transparent weakness to uncertain weakness of the bank, and vice versa. In sessions 5 and 6 the bank was always weak, and the shift regards the state of the economy.

Subjects received written instructions that were also read aloud to implement common knowledge. General instructions were distributed in the beginning, and for each part subjects received the specific instructions directly before the respective part (see the Appendix for details). Subjects therefore did not know about the details of the later tasks when making their decisions. Before each coordination game part, subjects received an example game situation on-screen and had to calculate the payoffs for both players to make sure that they understood the payoff structure and the effect of the uncertainties regarding bank and borrower fundamentals. Payoffs in these test questions were unrelated in size and structure to the game studied in the real task, but the game scenario was identical to the one studied in the respective part. Only after all subjects correctly calculated the payoffs did the program continue to the main task.

The experiment was framed in neutral terms. No reference to concepts like borrower or default was made to avoid any negative connotations with actions or social desirability effects that distort incentives. In each of the in total ten rounds of the experiment subjects chose between option A and option B, with A representing loan repayment and B representing default. Depending on the coordination outcome, subjects could earn between 0 and 55 experimental units in a round, and at the end of the experiment one round from each part was randomly selected for real payment

TABLE 7. SESSIONS AND TREATMENTS

| Session | Treatment Part I | Treatment Part II | Number of participants (groups) |
|---|---|---|---|
| 1 | GE-TW | GE-UW | 30 (5) |
| 2 | BE-TW | BE-UW | 30 (5) |
| 3 | GE-UW | GE-TW | 30 (5) |
| 4 | BE-UW | BE-TW | 30 (5) |
| 5 | GE-TW | BE-TW | 30 (5) |
| 6 | BE-TW | GE-TW | 30 (5) |

*Note*: All sessions were run in two groups of subjects with 12 and 18 people, respectively, due to lab size limitations.

to avoid wealth effects. In the loss aversion measurement task subjects could earn between $-180$ and $+270$, with extreme outcomes very unlikely. Each experimental unit translated into €0.05 at the end of the experiment for real payment, on top of a show up fee of €7. On average subjects earned €13 and the experiment lasted approximately one hour.

## 3.5 Results

We analyze the data at the group level and at the individual level. If not stated otherwise, group level analyses are based on part I choices only and all tests are two-sided.

### 3.5.1 Group Level Analysis

Table 8 shows coordination results at the group level. The pattern of equilibrium selection is similar if we analyze first round, last round or average repayment. GE-UW elicits higher rates of coordination than the other conditions, and BE-TW elicits

TABLE 8: FIRST ROUND, LAST ROUND, AND AVERAGE PERCENTAGE OF REPAYMENT

| | First round | | | Last round | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|
| | UW | TW | Δ | UW | TW | Δ | UW | TW | Δ |
| GE | 90 | 72 | 18 | 90 | 45 | 45* | 91 | 60 | 31* |
| BE | 80 | 48 | 32* | 70 | 22 | 48** | 75 | 32 | 43** |
| Δ | 10 | 24* | | 20 | 23 | | 16* | 28** | |

*Note*: *significant at 5 % level, ** significant at 1% level, Mann-Whitney U test.

the lowest rates of repayment, with the other two treatments in between. In the BE treatments these percentages do not include forced defaults by insolvent borrowers, only strategic defaults.[8] The results show that transparency may be harmful in the current setting. Under purely strategic uncertainty, borrowers are not able to coordinate successfully on the efficient repayment Nash equilibrium. Similarly, economic uncertainty in the form of possible forced defaults by genuinely distressed borrowers increases the likelihood of coordination failure. From the game theoretic perspective, this pattern is consistent with the prediction of risk dominance, but not payoff dominance, because in BE-UW there is more repayment than in GE-TW. Clearly, hypothesis 1 of identical repayments rates is rejected by the data.

To test the overall pattern and the effect of dominance criteria and loss aversion as stated in hypotheses B1, B2 and B3, we run regression analyses on the group level using OLS on average repayment rates.[9] Table 9 shows the results. Regression I confirms the pattern predicted by risk dominance. With GE-TW the excluded category, we find significantly more repayment in GE-UW and BE-UW and less in BE-TW, but GE-UW not significantly larger than BE-UW (p=.177). B1 is clearly rejected.

[8] In all analyses we only study the determinants of strategic defaults. Defaults caused by insolvent borrowers are included as experienced defaults of the other borrower, however. We do not distinguish between borrower type in the analysis, which changes between rounds. Restricting analyses to borrower A types only replicates the results.

[9] Controlling for censoring by using tobit models does not affect any results.

A loss aversion index per group was constructed by splitting the sample of elicited individual loss attitudes at the median number of loss averse choices and categorizing subjects into loss averse and not loss averse.[10] We then counted the number of loss averse subjects in each group and included it as a covariate. Model I shows that each loss averse subject reduces the repayment percentage in the group by 7.4 points, supporting hypothesis B3.

Model III directly includes payoff and risk dominance given in Table 5 in the regression, confirming the observed pattern. Risk dominance and loss aversion significantly affect repayment, while payoff dominance has no influence. Models II and IV test for interactions of loss aversion with the treatment conditions and dominance criteria directly. The results show no significant treatment interactions, but risk dominance seems to be more effective for loss averse borrowers. The direct and interacted effects in model II are jointly significant for each treatment, and in model IV the direct and interacted effects of risk dominance and those of loss aversion are jointly significant, but not for payoff dominance.

Table 8 implies a deterioration of the repayment coordination in groups over time. Across all treatments repayment declines from 68% in the first to 49%in the last round ($p<0.01$, Wilcoxon signed rank test). A fixed effects panel regression with round as the only explanatory variable shows a significant decline of 7.2 and 6.3 percentage points repayment in treatments GE-TW and BE-TW ($p<0.01$), respectively. In the UW treatments there was no significant decline over time (0 and 4 percentage points, not significant).

Further, using the group level data from both part I and part II we can test for dynamic effects on the group level, due to regime shifts as shown in Table 7. We run a regression on repayment rates for the TW treatments including a dummy indicating whether the treatment followed after an UW treatment, controlling for

[10]We call a subject loss averse if she rejects more than 3 prospects. A discussion of the loss aversion results is in the Appendix. There we also show that the loss aversion measure is exogenous in the sense that loss attitudes are not driven by previous experiences in the coordination games.

TABLE 9: COORDINATION BEHAVIOR: DETERMINANTS OF REPAYMENT

(GROUP LEVEL ANALYSIS)

| | I | II | III | IV |
|---|---|---|---|---|
| GE-UW | .306** | .051 | | |
| | (.091) | (.185) | | |
| BE-TW | -.279** | -.497* | | |
| | (.080) | (.182) | | |
| BE-UW | .213* | .146 | | |
| | (.077) | (.177) | | |
| # loss averse subjects | -.074* | -.139* | -.056* | .123 |
| In group (lasg) | (.027) | (.057) | (.027) | (.080) |
| GE-UW×lasg | | -.127 | | |
| | | (.067) | | |
| BE-TW×lasg | | .109 | | |
| | | (.071) | | |
| BE-UW×lasg | | -.043 | | |
| | | (.060) | | |
| Risk dominance | | | .218** | .052 |
| | | | (.058) | (.112) |
| Payoff dominance | | | .103 | 1.788 |
| | | | (.557) | (1.189) |
| Risk dominance×lasg | | | | .082* |
| | | | | (.038) |
| Payoff dominance×lasg | | | | -.833 |
| | | | | (.425) |
| Constant | .747** | .878** | .790** | .425 |
| | (.096) | (.166) | (.124) | (.225) |
| # Obs | 30 | 30 | 30 | 30 |
| $R^2$ | .72 | .76 | .65 | .70 |

*Note:* Dependent variable: average repayment percentage in group; robust standard errors in parenthesis; in model I and II the excluded category is the GE-TW treatment with pure strategic uncertainty; *significant at 5 % level, ** significant at 1% level the state of the economy and loss aversion. Similarly, we run a regression for the UW treatment including a dummy indicating whether the treatment followed after an TW treatment, including the state of the economy and loss aversion. The results show that repayment rates are 27 percentage points higher in TW conditions if they follow after a UW condition ($p<0.01$). Repayment rates are 21 percentage points lower in UW if they follow after a TW condition ($p<0.01$). In both regressions loss aversion leads to significant reduction in repayment rates of about 7 percentage points per loss averse subject. These results suggest that past experiences influence repayment behavior, leading to effects of previous regimes after a regime shift. It is not clear from these results, however, whether negative or positive experiences cause the effect. The individual level data analysis below suggest that negative experiences (observed defaults) have stronger effects. However, these effects may be mitigated by positive experiences of strong banks.

### 3.5.2 Individual Level Analysis

Individual level analysis allows us to study in more detail the effects of loss aversion and experiences. Splitting the sample at the median of loss aversion, we obtain a repayment rate of 58% for the high loss aversion group and 69% for low loss aversion group ($p<0.05$, Mann-Whitney U test), corroborating the results from the group level analysis. To test for loss aversion and experience effects we run a set of regressions on individual choices, controlling for clustering of errors within groups. We include a dummy for high loss aversion showing group differences due to loss aversion. The results are similar if we use the absolute number of loss averse choices.

Regressions I and II replicate the results for groups at the individual level. Clearly, individual level loss aversion is affecting repayment decisions, with loss averse subjects repaying 12 percentage points less often. Treatment differences can be explained by the risk dominance properties, but not by the payoff dominance properties of the repayment equilibria. Regression III studies behavior in part II, controlling for ex-

TABLE 10: REPAYMENT BEHAVIOR (INDIVIDUAL LEVEL ANALYSIS)

| | I | II | III | IV |
|---|---|---|---|---|
| | Random effects panel, part I and II | | OLS, part II | Probit, part II |
| GE-UW | .219** | | | |
| | (.062) | | | |
| BE-TW | -.298** | | | |
| | (.063) | | | |
| BE-UW | .019 | | | |
| | (.080) | | | |
| High loss aversion | -.122** | -.119** | -.145** | -.228** |
| | (.041) | (.040) | (.044) | (.080) |
| Risk dominance | | .142** | .111 | .139 |
| | | (.040) | (.064) | (.227) |
| Payoff dominance | | .601 | .913 | -.186 |
| | | (.415) | (.587) | (.813) |
| Part I defaults experienced | | | -.078** | -.082** |
| | | | (.020) | (.029) |
| Round 1-4 defaults experienced | | | | -.197** |
| | | | | (.043) |
| Part1 | .063 | .063 | | |
| | (.041) | (.041) | | |
| Constant | .623** | .526** | .638** | |
| | (.068) | (.077) | (.112) | |
| # Obs | 360 | 360 | 180 | 180 |
| $R^2$ | .29 | .29 | .32 | .32 |

*Note*: Dependent variable: in model I to III repayment percentage over five rounds and in model IV last round repayment decision; robust standard errors in parentheses, corrected for clustering on group level; marginal effects reported for probit regression; *significant at 5 % level, ** significant at 1% level periences in part I. While loss aversion remains a strong predictor, risk dominance becomes marginally insignificant. Part I experienced defaults by coordination partners negatively affect repayment. Each default reduces the average repayment of the individual by about 8 percentage points. Finally, regression IV considers only the last round of part II, including as an additional covariate the number of defaults experienced in part II before the last round. As before, loss aversion and negative part I experiences reduce repayment. The more recent part II negative experiences also reduce repayment, and their effect is stronger than the effect of part I experience ($p<0.05$). At this point risk dominance does not add significantly the explain repayment probability beyond its possible effects through experiences. Note that these results remain the same if we include subjects' own first round decision as a covariate in the probit regression (not shown in the table), although the own first round repayment is clearly predictive of last round repayment.

Table 10 suggests that the effect of loss aversion increases over time, as predicted by psychological research showing that negative experiences increase the impact of loss aversion (Baumeister et al. 2001, p.326). Including separate loss aversion effects for each part in regression II as covariates, we find indeed a larger effect of loss aversion in part II, but the difference is not statistically significant ($-.09$ vs. $-.14$ in part I and II, $p=0.384$).

While the individual data analyses show clear effects of negative experiences, the effect may also in principle be due to more repayment driven by positive experiences. We take a closer look at negative versus positive experiences by studying behavioral changes after unexpected outcomes between the first and second rounds after out-of-equilibrium play. The first round is not affected by any experiences and the second round only by one single past experience, allowing us to separate the effects of negative from positive experience. We define a *negative surprise* as a situation where the subject repaid but the coordination partner defaulted. Similarly, a *positive surprise* occurs if the subject defaulted but observed the other player repaying. Equilibrium

TABLE 11: COORDINATION BEHAVIOR: THE ROLE OF NEGATIVE VERSUS POSITIVE EXPERIENCES

| | I<br>Probit, part I | II<br>Probit, part II |
|---|---|---|
| Neg. surprise round 1 | -.570** | -.510** |
| | (.102) | (.105) |
| Pos. surprise round 1 | .132 | .183 |
| | (.084) | (.127) |
| Neg. surprise × bank survives | .252 | .347** |
| | (.106) | (.060) |
| Pos. surprise × bank survives | .247 | -.090 |
| | (.114) | (.174) |
| Own repayment decision round 1 | .709** | .764** |
| | (.076) | (.076) |
| Part1 defaults experienced | | -.060 |
| | | (.031) |
| # Obs | 180 | 180 |
| $R^2$ | .29 | .36 |

*Note*: Dependent variable: round 2 repayment. Excluded category is neutral experience. robust standard errors in parentheses, corrected for clustering on group level; marginal effects reported; *significant at 5 % level, ** significant at 1% level

play we count as neutral experience. We also include a variable that measures if the bank survived in treatments UW after a borrowers' default because of strong fundamentals. That is, the negative surprise may be mitigated because the bank did survive although there was observable coordination failure. Table 11 shows probit regressions of round 2 repayment in part I and part II. While in part I the subjects are completely inexperienced, part II is affected by part I play, for which we control.

As shown in the table, negative surprises have a strongly negative effect on subsequent behavior, reducing the probability of repayment by more than 50 percentage points. Positive surprises have no influence, however. We also find that the effect of a negative surprise can be mitigated if the bank survives after a coordination failure because of strong fundamental. This effect is significant only for the part II data. The total effect of a negative surprise with bank survival is still negative in both regressions, but this total effect is not significantly different from zero in either regression. This suggests that bank survival can effectively eliminate the negative effect of coordination failure on future repayment behavior. The lack of a positive surprise effect explains why in the treatments with high initial repayment coordination (that is, larger than 50%), behavior does not convergence towards full repayment. The minority initial negative surprises have much stronger impact than the majority positive surprises, leading to an overall demise of repayment coordination.

## 3.6 Discussion

Bank runs are difficult to study empirically. For depositors, a few studies have identified runs from real world micro data (Kelly and O'Grada 2000, Iyer and Puri 2009 and Saunders and Wilson 1996). Observing runs from the asset side of the bank's balance sheet is even more difficult because of the problem of distinguishing genuine insolvency from strategic default. We therefore studied an experimental credit market that allows us to observe strategic default, varying the degree of uncertainty regarding bank and borrower fundamentals. Multiple equilibria exist in our market which are not affected by the uncertainty, but uncertainty does affect the risk and payoff dominance of the repayment equilibrium. Consistent with previous literature on coordination, we find strong effects of risk dominance but no effects of payoff dominance. Our results extend the current literature by showing how uncertainty endogenously affects these dominance criteria and thereby the coordination outcomes. We also find that in situations of strategic uncertainty, individual loss attitudes and negative experiences become relevant in repayment decisions.

We find clear evidence for strategic default. The experiment shows that disclosure of weak banks can have harmful effects on repayment in both a strong economy and in a weak economy with a significant portion of borrowers potentially insolvent. Similarly, a weak economy always increases the incidence of strategic default. In times of financial and real crises our results suggest that only strong legal institution may overcome coordination failure. The borrower behavior observed in the U.S. mortgage market during the current financial turmoil suggest that moral constraints on defaulting, which may not be as pronounced in the laboratory, will not be strong enough to prevent strategic default (The Economist 2010, p.5, Guiso et al. 2009).

The current study complements the recent experimental literature on depositor runs. Garratt and Keiser (2009) and Madies (2006) explore the occurrence of depositor runs, while Schotter and Yorulmazer (2009) study the dynamics and severity of such events. Garratt and Keiser (2009) argue that bank runs occur mainly when fundamental withdrawal demand is stochastic. Madies (2006) finds that in the presence of healthier banks, depositor runs are less frequent, while Schotter and Yorulmazer (2009) show that withdrawal incidence is lower when bank has strong fundamentals and depositors have multiple opportunities to withdraw. These papers also suggest that in the basic pure multiple equilibria model with strategic uncertainty bank runs may be rather rare. Our results show that successful coordination is very sensitive to the risk dominance properties of the game structure. Any perturbation that affects risk dominance, such as liquidity shocks for depositors, the strength of the bank, or in our case the borrower fundamentals, is therefore likely to affect the likelihood of bank failures.

Our findings on individual level loss attitudes and negative experience effects suggest that coordination failure may be most relevant in markets with small individual borrowers such as mortgage markets and retail loans. On the other hand, the events surrounding recent large scale bank failures show that repayment to a falling bank can also permanently destroy the reputation of an institution and its management. As such, incentive structures for management may induce loss aversion in the sense of an increased weight on the available cash than on the more distant and uncertain outcomes if the relation with their bank is maintained. Negative experiences are important in financial decisions as shown by Malmendier and Nagel (2010). In their study, people who have experienced inflationary periods are less likely to hold assets sensitive to inflation such as bonds. Similarly, Guiso et al. (2009) find that people who know or hear about other people defaulting strategically are more likely to do so as well. They identify these social experiences as one of the main factors in predicting the incidence of strategic default. Interestingly, we find that bank survival can mitigate the effect of negative experiences. Model II in Table 11 suggests that borrowers are more likely to repay their loans after experiencing a defaulting borrower if the bank does not fall. In a larger context, government support may prevent bank collapse from materializing.

Runs on individual banks from either the borrower or depositors side are economically harmful, but of the real concern are systemic crises. Uncertainty about the nature of a run may lead to contagion of otherwise stable banks which may trigger a system-wide collapse or panic. If one bank goes bankrupt, borrowers and deposit holders may interpret this event as a signal for the existence of solvency problems in the entire financial sector and react by delaying the repayments of their loans or massive withdrawal of funds, respectively. Our findings suggest that in the credit market, similarly to the depositors market, there is the risk of contagion. Past experience is relevant in reality because it can be one of those factors driving the systemic risk. People who have experienced directly bank failures or who have learned about strategic default of others are more likely to stop repaying if they hear bad news about their bank. Kelly and O'Grada (2000) and Iyer and Puri (2009) documented the occurrence of pure-panic contagion for depositor market.

The recent financial crisis of 2007-2010 has shown the limits of market discipline, and consequently, there are many initiatives that promote more disclosure and transparency by banks. Proponents of such initiatives argue that more information about bank fundamentals enhances investors' assessment of bank activities and improves market discipline (Baumann and Nier 2003, Bliss and Flannery 2000). On the other hand, the opposing view suggests that too much disclosure of information about bank's fundamentals may increase the probability of failure. Public confidence is crucial for the banking sector. Once the trust in the financial sector is lost banks can be subject to runs or panics which affect the entire banking sector. Our study helps to evaluate the effects of such regulatory policies on bank stability. The results support the latter view, by showing that borrowers may not be able to overcome coordination problems if banks are transparently weak. Moreover, if disclosure rules are strengthened during time of widespread banking weakness, more bad information may be revealed to market participants. Non-repayment rates will increase because borrowers have already accumulated negative experiences regarding bank failures, so they are more likely to default, exacerbating the problems in the banking system. Thus, we may argue that disclosure requirements should not become stricter during ongoing banking crises or immediately after. Similarly, experiences accumulated during a banking crisis may reduce any positive effect following the softening of disclosure rules, and such regulatory changes may therefore not lead to fast improvements in bank stability. These effects should be considered in the evaluation of the two opposing policies, particularly in time of distress. The current findings provide a rationale for central banks' interventions as lender of last resort. The large scale intervention of financial authorities during the recent financial turmoil led to immense liquidity support for banks and this support has helped most of them to avoid failure, and thus helped to regain the stability of the banking system. Beside other potential positive effects not discussed here, it has allowed banks to maintain the relation with their customers and to perform normal lending activities. Keeping banks afloat, such interventions have also mitigated the impact of negative experiences market participants had, reducing the problems of strategic delay or default of borrowers.

## 3.7 Concluding Remarks

We identify strategic defaults in credit markets experimentally and study the effect of uncertain bank and borrower fundamentals. Borrowing from the behavioral literature on coordination games we identify concepts that explain the observed variation in repayment. In our study the bank's fundamentals were defined exogenously to maximize control and obtain unambiguous effects on borrower behavior. Future research may take a closer look at the supply side of the market, studying how disclosure rules and business cycle affect banks' lending behavior.

The current results confirmed a role for contagion in coordination problems as suggested in real world data. For regulatory policy it is crucial to identify the conditions under which contagion occurs and how it can be avoided. Experimental control along the lines applied in the current paper may be used to implement various market conditions and lay bare its effects on behavioral contagion in credit or depositor markets.

## 3.A Derivation of Equilibria

### 3.A.1 Pure Strategy Equilibria

**GE-TW** (Repay, repay) and (default, default) are obvious equilibria. (Default, repay) and (repay, default) cannot form equilibria because the repaying borrower strictly prefers to deviate to default.

**GE-UW** (Repay, repay) is an obvious equilibrium. (Default, default) forms an equilibrium if and only if the probability of strong bank fundamentals is not too high. A borrower's expected payoff from deviating to repayment is $pV$, thus implying the condition $pV < R$. If $pV < R$, (default, repay) and (repay, default) cannot form equilibria because the repaying borrower strictly prefers to deviate to default.

**BE-TW** (Default, default) is an obvious equilibrium. (Repay, repay) forms an equilibrium if and only if the probability of a solvent borrower B is not too low. A borrower's expected payoff from repayment is $qV$, thus implying the condition $qV > R$. (Default, repay) and (repay, default) cannot form equilibria because the repaying borrower strictly prefers to deviate to default.

**BE-UW** (Repay, repay) forms an equilibrium if and only if the probability of a solvent borrower B is not too low or the probability of the bank being strong is high. A borrower's expected payoff from repayment is $(qp + q(1-p) + (1-q)p)V$, thus implying the condition $(q + p - pq)V > R$. In particular, if $p$ is small $qV > R$ is sufficient, and if $q$ is small, $pV > R$ is sufficient for repayment being an equilibrium. A necessary and sufficient condition for the (default, default) equilibrium is that $pV < R$. If these conditions hold, (default, repay) and (repay, default) cannot form equilibria because the repaying borrower strictly prefers to deviate to default.

### 3.A.2 Mixed Strategy Equilibria

We first derive the mixed equilibria and then show that it is unlikely that subjects in the experiment played these equilibria.

**GE-TW** A mixed strategy for borrower B is the probability distribution $(s, 1 - s)$, where $s$ is the probability of playing repay, $1 - s$ is the probability of playing default, and $0 \leq s \leq 1$. Suppose that borrower A plays repay with probability $t$ and default with probability $1 - t$, where $0 \leq t \leq 1$.Then borrower B's expected payoff from playing repay is $tV$ and her expected payoff from playing default is $R$ (the coordination game is depicted in Table 3). Expected payoffs are equal for $t = R/V$. By a similar argument, we find that borrower's B probability of playing repay must be $s = R/V$, such that borrower A is indifferent between repay and default. Each borrower repaying with probability $R/V$ is a mixed Nash equilibrium. For our parametrization this implies a probability of repay of 0.73.

**GE-UW** The type of bank is drawn randomly in this treatment, and can be either strong (with probability $p$) or weak (with probability $1 - p$). The coordination games are depicted in Tables 2 and 3. A mixed strategy for borrower B is the probability distribution $(s, 1 - s)$, where $s$ is the probability of repaying, $1 - s$ is the probability of defaulting, and $0 \leq s \leq 1$. Suppose that borrower A plays repay with probability $t$ and default with probability $1 - t$, where $0 \leq t \leq 1$. Then borrower B's expected payoff from playing repay is $tV + (1 - t)pV$ and her expected payoff from playing default is $R$. Expected payoffs are equal for $t = \frac{\frac{R}{V} - p}{1 - p}$. By symmetry, we find that borrower B's probability of playing repay must be $s = \frac{\frac{R}{V} - p}{1 - p}$ , such that A is indifferent. If the probability of strong bank fundamentals is too high (i.e., $p > R/V$), then $t = s = 1$ and (repay, repay) is the dominant strategy. Otherwise, each borrower repaying with probability $\frac{\frac{R}{V} - p}{1 - p}$ is a mixed Nash equilibrium. For our parametrization this implies a probability of repay of 0.46.

**BE-TW** The type of borrower B is drawn randomly in this treatment. She can have either good fundamentals (with probability $q$), or bad fundamentals (with probability $1-q$). The coordination game for the case of solvent borrower B is depicted in Table 3. If borrower B turns out to be insolvent, borrower A will get either 0 or $R$, depending if she repays or not. A mixed strategy for a solvent borrower B is the probability distribution $(s, 1-s)$ as above. Borrower A repays with probability $t$ and defaults with probability $1-t$. Borrower B expected payoff from repaying is $tV$ and her expected payoff from playing default is $R$. Expected payoffs are equal for $t = R/V$. By a similar argument, borrower A's expected payoff from playing repay is $qsV$ and her expected payoff from playing default is $R$. Hence, the probability of repay must be $s = R/qV$, implying indifference between repay and default. If the probability of a solvent borrower B is too low (i.e., $q < R/V$), then $t = s = 0$ and (default, default) is the dominant strategy. Otherwise, borrower B repaying with probability $R/qV$ and a solvent borrower A repaying with probability $R/V$ is a mixed Nash equilibrium. For our parametrization this implies borrower B repaying with probability 0.97, and borrower A repaying with probability 0.73.

**BE-UW** For this treatment the type of bank is drawn randomly and can be either strong (with probability $p$) or weak (with probability $1-p$), and also borrower B's type is drawn randomly such that she can have either good fundamentals (with probability $q$), or bad fundamentals (with probability $1-q$). The coordination games for the case of solvent borrower B are depicted in Tables 2 and 3. If borrower B turns out to be insolvent, borrower A will get an expected payoff of either $pV$ or $R$, depending on whether she repays or not. A mixed strategy for a solvent borrower B is the probability distribution $(s, 1-s)$ as above. Borrower A repays with probability $t$ and defaults with probability $1-t$. Borrower B' expected payoff from repaying is $tV + (1-t)pV$ and her expected payoff from playing default is $R$. Expected payoffs are equal for $t = \frac{\frac{R}{V}-p}{1-p}$ . By a similar argument, borrower A's

TABLE A1: MIXED EQUILIBRIUM VERSUS OBSERVED PERCENTAGE OF REPAYMENT

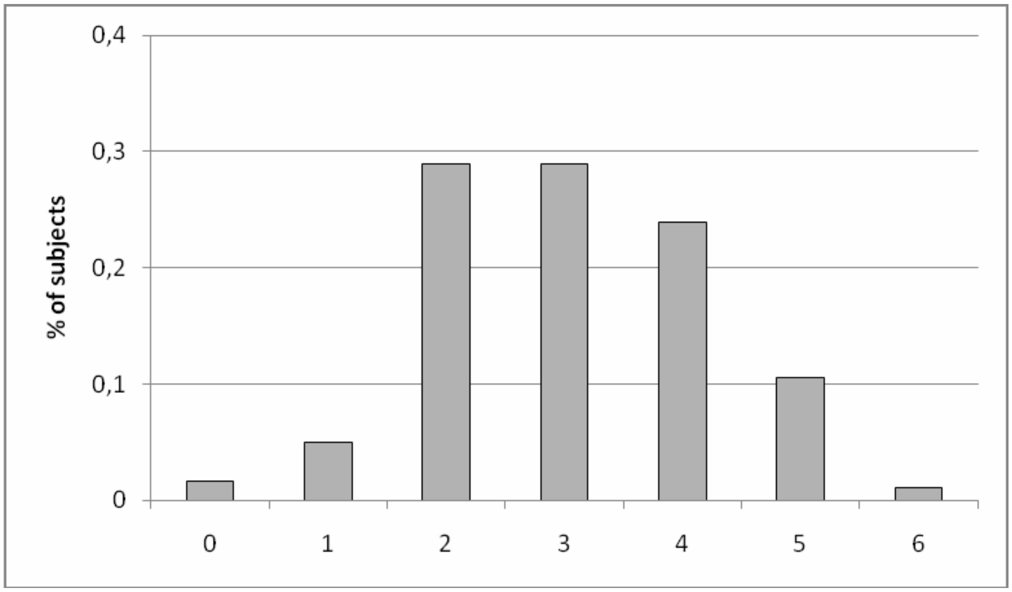
| | Mixed equilibrium | | | Observed average | | |
|---|---|---|---|---|---|---|
| | UW | TW | Δ | UW | TW | Δ |
| GE | 46 | 73 | -27 | 91 | 60 | 31* |
| BE | 53.5 | 85 | -31.5 | 75 | 32 | 43** |
| Δ | -7.5 | -12 | | 16* | 28** | |

*Note*: average of player A and B used in left panel; *significant at 5 % level, ** significant at 1% level, Mann-Whitney U test.

expected payoff from repaying is $qsV + q(1-s)pV + (1-q)pV$ and her expected payoff from defaulting is $R$. Hence, the probability of B repaying must be $s = \frac{\frac{R}{V}-p}{q-pq}$ such that A is indifferent. If the probability of strong bank fundamentals is too high (i.e., $p > R/V$), then $t = s = 1$ and (repay, repay) is always the dominant strategy if B is solvent. If the probability of a solvent borrower B is too low (i.e., $q < R/V$), then $t = s = 0$ and (default, default) is the dominant strategy if $p < R/V$. Otherwise, when conditions $p < R/V$ and $q > R/V$ are jointly satisfied, borrower A repaying with probability $\frac{\frac{R}{V}-p}{1-p}$ and a solvent borrower B repaying with probability $\frac{\frac{R}{V}-p}{q-pq}$ is a mixed Nash equilibrium. For our parametrization this implies borrower A repaying with 0.46 probability, and borrower B playing repay with 0.61 probability.

**Mixed equilibrium versus observed behavior** Table A1 summarizes the mixed equilibrium predictions for repayment across treatments and also replicates the observed average percentages of repayment. Observed repayment percentages are not well described by the predicted mixing. Our statistical tests (see Section 3.5) between treatments clearly reject mixed equilibrium, with all differences pointing in the wrong direction. This result is consistent with findings in Heinemann et al. (2009) on the poor predictive power of mixed equilibrium in coordination games.

FIGURE B1: DISTRIBUTION OF LOSS AVERSE CHOICES




Note: six choices made by subjects between safe option and risky option involving gains and losses.

## 3.B Loss Aversion Results

The loss aversion task resulted in an index of loss averse (safe) choices between 0 and 6. The median loss aversion was 3 and the mean was 3.04. The distribution is shown in Table B1.

In the regression analysis of repayment behavior we include loss aversion as an explanatory variable. To test if loss aversion is not affected by previous game play, we use the exogenous variation in treatment to test for the endogeneity of loss attitude. In particular, treatments with bad economy involve more defaults beyond the influence of the subjects. Comparing loss attitude of subjects participating in BE only with those participating in GE only, we find no differences (mean 3 vs. mean 3.18, $p = .389$, Mann-Whitney-U test). Similarly, comparison between the BE-TW condition with least coordination and the GE-UW treatment with most repayment yields no significant differences (mean 3 vs. mean 3.22, $p = .479$, Mann-Whitney-U test). These finding support the assumption that our loss aversion task measures an individual preference parameter that is not affected by the preceding coordination game.

## 3.C Sample Instructions

**General Instructions**

This is an experiment about decision-making. If you follow these instructions carefully and make good decisions you can earn a considerable amount of money, which will be paid to you at the end of this experiment in cash. The duration of the experiment will be maximum 80 minutes. During the entire experiment, communication of any kind is strictly prohibited. Communication with other participants will lead to your exclusion from the experiment and the forfeit of all your monetary earnings. Please put your mobile phone away.

All your decisions and answers to questions remain anonymous. At the end of the experiment we will pay you in private.

The experiment consists of **three parts**. Each part will consist of several choices between two or more options. Detailed instructions for Part I follow. After Part I has been completed you will receive instructions for the second part. After Part II is completed you will receive instructions for the third part.

You will first make all choices in all three parts. The first two parts consist of 5 rounds each, while the third part consists of only one round. There are 11 rounds in total. During the first two parts, your choices and the choices of other participants will determine how much your earnings are for each round. For the third part of the experiment, your earnings are based on your own choices only.

After you made all choices in all rounds, your payoff for the experiment is computed as follows:

**One round from Part I** and **one round from Part II** will be selected randomly with equal probability out of the five rounds in each part to be payoff relevant. Your earnings from these part completely depend on the results of these selected rounds therefore.

Note: each **of your choices can be the one that is determining the total payoff for each part**: you should therefore make sure that in each choice during the experiment you make a decision that is in your best interest. For every participant the payoff relevant rounds are determined randomly by the computer independently of the other participants.

In Part III, **all the choices** you make are payoff relevant.

Your payoff for the entire experiment will be equal to the sum of show-up fee, your earnings in the randomly chosen rounds from Part I and Part II, and your earnings from Part III.

In each round, your earnings will be denoted in experimental units. At the end of the experiment, all experimental units that you have gained will be transferred into Euro. The exchange rate will be:

$$1 \text{ Experimental unit} = 0.05 \text{ Euro}$$

For each choice you have a certain amount of time only. Make sure you always choose one of the available Options before time runs out.

After each decision that you make in the experiment you will receive information about the result, and you may take notes of the results during the experiment.

If you have any questions during the experiment or any difficulties in understanding these instructions, please raise your hand and wait for an experimenter to come to your cubicle and answer your question privately.

After reading the instructions for Part I we will start with 2 unpaid warm up rounds that test your understanding of the decision situation. Similarly, before Part II we will have two unpaid warm up and test rounds. *No experimental units can be earned during these rounds.*

**Instructions Part I**

In this part of the experiment you are randomly assigned to a group of 6 people who will be in your group for the entire 5 rounds of this part. In each of the 5 rounds participants in a group are matched in pairs of 2. Hence there are 3 pairs in each group, for each round. Each pair will play a game which is described below. New pairs of 2 players are formed every round from the 6 people forming a group. You are matched with a **different person** from your group in each round, and you will meet each other member of your group **only exactly once**. You will not learn with whom you are matched.

You will make 1 decision in each of the 5 rounds. You have to choose between two options A and B which pay some amount of experimental units depending on your own choice and the choice of the other player you were matched with. Each round is independent of the other rounds, and the choice you make in a particular round has no influence on other rounds.

At the beginning of each round, a screen similar to the one depicted below will appear.

<screenshot shown here>

On the screen there will be two **payoff matrices**:

The **left matrix shows your payoffs**, and the **right matrix shows the other persons'** payoff.

As you see in the screen shot, your choice between A and B influences the potential payoffs that you and the other person can obtain. The payoffs do also depend on the choice of the other person. Both of you choose **simultaneously** between the two options A and B, that is, none of the players in a matched pair knows the choice of the other player before he makes his own choice. The combination of your choices determines your payoffs as shown in the matrices.

In the example provided, if you choose A and the other player chooses B, you will earn 80 experimental units and the other player will earn 90 units. The other outcomes are determined accordingly.

To make a choice between option A and B you have to click the option you want to choose in the lower middle of the screen and then click the SUBMIT button to confirm. Only after the "Submit" button is clicked your choice is registered by the computer!

The screen also shows the round number and the time left for the decision.

After all players have made a decision the payoffs are calculated according to the choices made and the results are shown on the screen. In particular, you will be informed about the other player's decision and your payoff from this round.

Remember that only one round from each part is paid for real. That is, **the payoff from any round may be the one that completely determines your total profit from this part, whether high or low, conditional on this round being selected for real pay later on.** That also means that you do not accumulate earnings: having made some profit in one round does not mean you necessarily can take this profit home. Another round may be selected for pay.

After you have read the results, please click the READY button to continue to the next round. Only after the "Ready" button is clicked the next round will start!

All the participants in this experiment will see the same screens and share the same information.

You will be informed when this part of the experiment ends but you will not be informed about how many experimental units you have earned in this part. The earnings will be determined after all three parts have been played.

Please remember that any communication between participants is strictly prohibited during the experiment.

**Instructions Part II [distributed after part I was finished]**

In this part you are randomly assigned to a **new** group of 6 people as described in Part I. You will play again 5 rounds, each round with a different person from your group, and meet each person only exactly once. The people in your group will be different from the people in Part I.

The game you play in each of these rounds is similar to the one in Part I: your decision and the decision of the other player between two options A and B jointly determine the outcomes for both of you. Again, you have to make your decisions simultaneously. Your payoffs will be shown in matrices on the left side of the screen, and the other player's payoff will be shown in the matrix on the right side of the screen.

In this part, however, you **will not know for sure the game you will play**. In particular, you will be presented with **two games, each of which has a 50% chance to be the one you actually play**. Only after both players made their choice will you learn which game was the one that was played.

The following screen shot shows a typical decision situation:

<screenshot shown here>

The basic structure is identical to that in Part I. Now, however, you see one game, Game 1, in the **upper part** of the screen, and the other game, Game 2, in the **lower part** of the screen.

Each of these two games has an equal chance to be the payoff relevant game, **but only after your decision** between options A and B **will you learn which game was played**.

**Note that in each of the 5 rounds the payoff relevant game is randomly determined anew.**

Note that while the upper game matrices show game 1 and the lower matrices show game 2, left matrices always represent your earnings, and right matrices represent the other player's earnings, as in Part I.

In the example provided, imagine you choose A and the other player chooses B.

If Game 1 is randomly selected to be played, then you win 110 and the other player wins 80.

If Game 2 is randomly selected to be played, then you win 80 and the other player wins 90.

For other combinations of choices the payoffs are determined accordingly.

Note again: you make your decision simultaneously with the other person, and before learning which game will actually be played.

After all players made their decisions, you will learn the results of the round. In particular, you receive information about the other player's choice, the game that was relevant, and your earnings (conditional on this round being selected for real pay later on).

**Again, only one round will be selected to completely determine your payoff for this part.**

**Instructions Part III. Risky Decisions**

In this part of the experiment we offer you to participate in any number out of six risky lotteries. Each lottery gives a 50-50 chance to either **win** a certain amount of experimental units or **lose** a certain amount of experiment units.

For each lottery you must decide **if you want to play it or not**.

- For each lottery that you decide to play, your current level will be increased or decreased according to the random outcome of the lottery.
- If you do not play in any lottery, your current level of experimental units earned in the first two parts of the experiment, will not be affected.

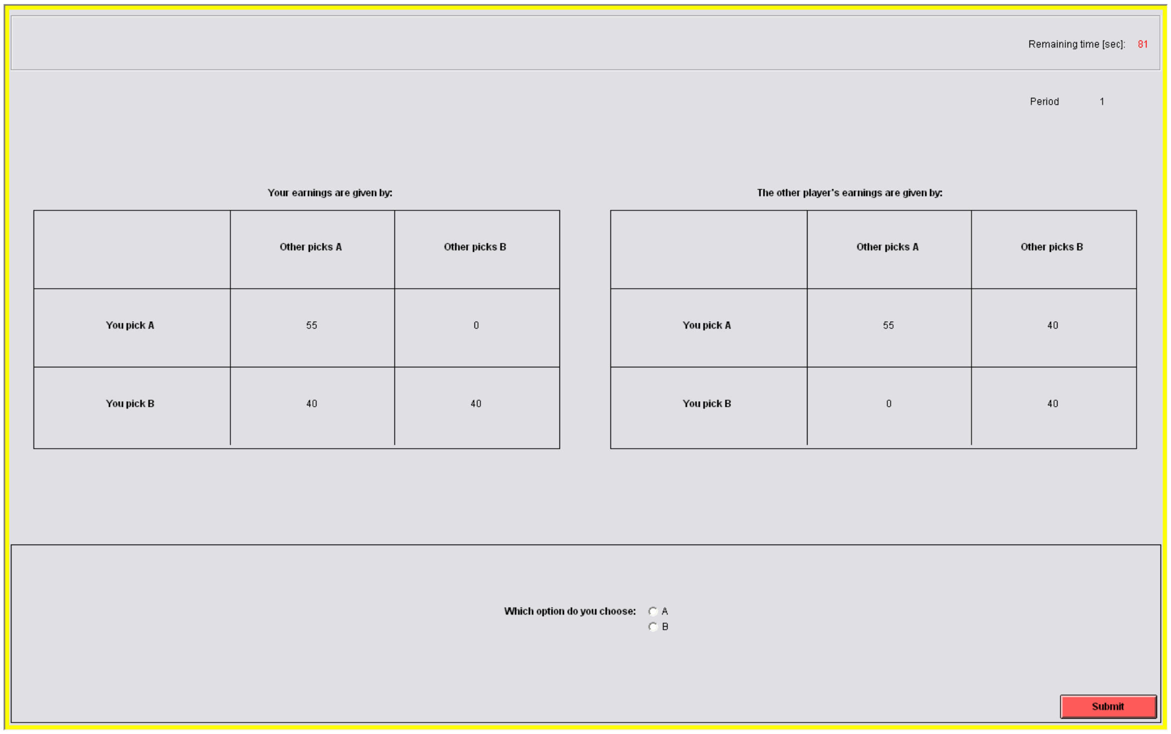
The random outcomes of all six lotteries are drawn by the computer, for each lottery an independent draw is made.

Note that **all** lotteries that you decide to play will be payoff relevant: for each lottery your gain or loss will be determined, and the total sum of these outcomes will be subtracted or added to your experimental units.

Note also that if you choose to play very risky lotteries **you may lose all of your experimental units and even your show-up fee (partially or totally)**. You do not have to play any lotteries if you do not want to.

## 3.D Screenshots

Screenshot for the GE-TW treatment.



Screenshot for the BE-UW treatment (Borrower B).