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WORKING PAPER SERIES

Baptiste Massenot

Credit Cycles: Experimental Evidence

SAFE Working Paper No. 104

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Credit Cycles: Experimental Evidence*

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April 7, 2020

Abstract

Credit boom-busts are observed in experimental credit markets with perfect information, no aggregate shocks, and no speculative motive. By contrast, a stable outcome is observed in the island economy, which isolates the borrowers but is otherwise similar to the market economy. The higher willingness to pay for credit following higher market but not island interest rates is consistent with herding, which can create spiraling effects and predict a credit boom-bust.

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1 Introduction

Credit booms and busts can have devastating economic consequences (Schularick and Taylor, 2012; Jordà et al., 2013; Mian et al., 2017), but their origins are still debated and indeed have been attributed to a series of fundamental factors, such as lax regulation, global imbalances, financial innovation, or monetary policy, among others. There is also a more fatalistic view suggesting that human psychology may inherently destabilize financial markets (Keynes, 1936; Minsky, 1977) and implying that credit boom-busts may be difficult to avoid.

I propose a basic laboratory credit market in which the fundamental factors listed above can be held constant. Having observed credit boom-busts even in this basic environment, I proceed to investigate the possible reasons behind the emergence of these boom-busts.

The main features of the laboratory credit market can be summarized as follows. Participants can borrow funds to invest in a risky project. To do so, they state how much they want to borrow and the maximum interest rate they are willing to pay, subject to a collateral constraint. Credit supply is exogenous and the equilibrium interest rate clears the market.

It is unclear how booms and busts could emerge in this environment. First, there are no aggregate shocks and information is perfect. More specifically, the return on the project and the credit supply are perfectly known and stay constant throughout the experiment. Second, there is no speculative motive because both the projects and the loans last for one period, so participants do not have to form expectations about future prices or about the behavior of the other market participants, which could destabilize the economy. With risk-neutral investors, the equilibrium interest rate is predicted to be constant and equal to the expected return of the project.

In spite of the simplicity and stability of this environment, credit boom-busts emerge. The market interest rates increase over time and crash towards the end of the experiment. Furthermore, the interest rates largely exceed the expected return of the project, suggesting that participants are risk-seeking.

These observations yield two puzzles. First, why are participants willing to pay interest rates that are higher than the expected return of the project? This is puzzling because participants lose money on average and also because a separate task that elicits their risk preferences indicates risk aversion. Unlike the bubbles observed in stock market experiments, these high interest rates cannot be explained by a speculative motive because the loans and the projects only last for one period. Neither can they be explained by limited liability, which could increase the value of projects by limiting the downside risk, because participants could not default by design.

Second, what explains the boom-bust dynamics? Why do participants want gradually more credit and then gradually less? The evolution of wealth cannot explain this pattern. Participants lose money on average because they pay interest rates that are higher than the expected return of the project. The resulting downward wealth dynamics can explain the credit bust if lower wealth decreases credit demand, but not the credit boom.

To shed light on these puzzles, I also study an even more basic environment, the island economy, that isolates borrowers but is otherwise similar to the market economy. Credit goes to the investors who want to pay more than a random variable (following the method of Becker et al., 1964). Unlike the market economy, participants do not interact with the other members of the group. The interest rate they pay and whether they get credit is independent of how the other members of the group behaved. Furthermore, there is no market price to reveal something about the behavior of the group.

In stark contrast to the market economy, no credit boom-busts emerge in the island economy. The equilibrium interest rates remain stable and close to the expected return of the project, consistent with the behavior of risk-neutral investors. Another noteworthy difference between the two economies is that the willingness to pay for credit increases with past interest rates in the market economy while it is unrelated to past interest rates in the island economy, consistent with herding in the market economy. These differences in outcomes suggests that the method to allocate credit, whether through the market or through a random device, affects both individual behavior and aggregate outcomes.

Finally, I offer a possible explanation based on herding for the emergence of credit boom-busts in the market economy. A higher market interest rate suggests that the “herd” wants more credit and induces participants, if they have a herd instinct, to want more credit too. This higher demand for credit in turn results in a higher market interest rate. Thus, herding creates a spiral between higher interest rates and higher credit demand in the market economy. The last missing piece of the puzzle is to explain how the credit boom transitions to a credit bust. A possible explanation relies on the declining wealth, which gradually decreases credit demand. Once this negative wealth effect becomes strong enough, it can revert the boom and initiate the bust. This mechanism is shown to arise in a stylized model enriched with a herding motive.

To summarize, this paper shows that credit boom-busts occur in a basic and stable experimental setup, suggesting that credit markets may be inherently unstable. Furthermore, a combination of herding, which creates spiraling effects, and wealth dynamics can explain these findings.

The interest rate boom-busts documented in this paper are remarkably similar

to the asset price bubbles in the experimental asset market literature (Smith et al., 1988), in which asset prices also exceed the fundamental value and display a boom-bust pattern. However, the explanations for these asset price bubbles typically rely on a speculative motive, which cannot account for my findings because the loans and the projects last one period. Instead, I propose that they can be explained by herding, which could also play a role in asset market experiments since it shares several elements with the current setup, such as competitive markets and risky payoffs. The results support Lei et al. (2001), who show in an asset market experiment that bubbles persist when speculation is impossible because participants cannot resell the assets they bought.

This paper also contributes to the literature studying herding in financial markets. Herding may occur in setups with career concerns (Scharfstein and Stein, 1990) or incomplete information (Avery and Zemsky, 1998). Several laboratory experiments specifically test for the role of herding in financial markets with incomplete information (Drehmann et al., 2005; Cipriani and Guarino, 2005, 2009). This paper contributes to this body of work by suggesting that herding may also play a role in setups with complete information and may produce credit boom-busts. A more likely cause of herding in my setup is that investors may be unsure of how to behave and believe that the herd knows better (Shiller, 2015).

The paper also contributes to the literature on credit cycles. An important insight of this literature is to show how agency costs in lender-borrower relationships can amplify the economic consequences of fundamental shocks (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997). I study credit cycles from a different perspective, using experimental methods in a setup without agency costs and without fundamental shocks.

The experimental setup studied in this paper is highly stylized. Among other simplifications, there is no default risk, loans only last one period, there are no strategic interactions, the payoffs are perfectly known, and credit supply is exogenous. Earlier experimental work has studied credit markets in richer environments, with a focus on bank runs (Madies, 2006; Schotter and Yorulmazer, 2009; Garratt and Keister, 2009; Arifovic et al., 2013), adverse selection (Asparouhova, 2006), credit market bubbles (Asparouhova et al., 2016), contagion (Brown et al., 2017), rollover risk (Bosch-Rosa, 2018), and interbank markets (Davis et al., 2019a,b).

The simplicity of this experimental environment makes it difficult to draw strong conclusions on the implications of these findings for real-world credit boom-busts. However, one important benefit of this simplicity is to shed light on mechanisms that would have been obscured in richer experimental setups. Since many real-world credit markets share some the basic features of this experimental setup, such as competitive

markets or risky payoffs, the mechanisms that emerge from this basic setup may also be at work in real-world credit markets and contribute to their instability.

The paper is organized as follows. Section 2 presents the experimental setup. Section 3 shows the experimental results. Section 4 presents a model with a herd instinct to rationalize the experimental findings. Section 5 concludes.

2 Experimental Credit Market

Environment. The economy consists of ten subjects who can invest in a one-period risky project in every period $t = 1, 2, \dots, 20$. Payoffs are denoted in Taler. For each Taler invested, the project returns either 2 Taler (100% return) with probability 42% or .5 Taler (-50% return) with probability 58%. Return realizations are independent across subjects and periods. The credit supply is constant and equal to S in every period. Subjects are fully informed about all these parameters.

Demand for credit. Each subject i is cashless and thus has to borrow money on the credit market against his collateral C_t^i if he wants to invest in the project. Every period, subjects report how much they want to borrow I_t^i and the maximum interest rate r_t^i they are willing to pay. Subjects make their demand decisions simultaneously and without observing the decisions of other participants. Their total credit repayment has to be lower than their collateral in every period, that is, they cannot default:

$$I_t^i(1 + r_t^i) \leq C_t^i.$$

Market interest rate. In the market economy, the equilibrium interest rate r_t is determined each period by equalizing the aggregate demand for credit and the aggregate credit supply S via a centralized call market. The aggregate demand for credit represents the total quantity of credit requested in the economy for each interest rate. Subjects who bid $r_t^i < r_t$ obtain the quantity of credit they requested, subjects who bid $r_t^i = r_t$ may obtain only a fraction of the credit they requested to ensure market clearing, while subjects who bid $r_t^i > r_t$ do not get the credit they requested.

Island interest rate. In the island economy, subjects receive the quantity of credit requested I_t^i if their willingness to pay for credit r_t^i is higher than a randomly drawn interest rate u_t^i , following the Becker-DeGroot-Marschak method (Becker et al., 1964). If $u_t^i \leq r_t^i$, the subject can borrow and has to pay the interest rate u_t^i . Otherwise, the subject cannot borrow. Unlike the market economy, the decisions of a participant do not affect the other participants. Based on the first set of market economy sessions

in which we rarely observed interest rate bids above 50%, we limit the support of u_t^i to be less than or equal to 50%. Subjects are fully informed about the support of u_t^i . The quantity each subject can obtain is bounded above by the credit supply S .

Collateral. Each subject i is initially endowed with collateral $C_0^i = 100$. At the end of each period, the subjects who obtain credit make a profit $\Pi_t^i = (\tilde{A}_t^i - r_t)I_t^i$, where \tilde{A}^i refers to the idiosyncratic return realization of each subject (either -50% or 200%). The subjects who do not obtain credit make zero profit ($\Pi_t^i = 0$). At the end of each period, these profits are added to or subtracted from their collateral:

$$C_{t+1}^i = C_t^i + \Pi_t^i.$$

Their final collateral C_{20}^i determines the payment they receive from the experimenter.

Beliefs At the beginning of every period, subjects report what they believe the equilibrium interest rate is going to be this period and whether they believe that their idiosyncratic return realization is going to be 100% or -50% this period. At the end of the experiment, three interest rate forecasts and three return realization forecasts are randomly picked for each subject for payment purposes. Every correct return realization forecast and every interest rate forecast that is within a $\pm 3\%$ bandwidth around the actual interest rate results in an additional payment of 15 Taler.¹

Additional questions. Information about subjects' risk aversion, skills, and demographics are collected at the end of the experiment.

Risk preferences are elicited using the bomb task developed by Crosetto and Filipin (2013). Subjects decide how many boxes to collect from a pile of 36 boxes, one of which contains a bomb. If they do not collect the bomb, they earn 10 Taler for each box collected. If they collect the bomb, they earn nothing.

Finally, subjects also report their gender, age, and self-assessed mathematical skills on a Lickert scale of 1 to 10.

Procedures. All sessions were conducted at the Frankfurt Laboratory of Experimental Economic Research at Goethe University Frankfurt in the winter of 2014. Subjects were recruited via ORSEE (Greiner, 2015). Each participant took part in one session and played two treatments of 20 periods each. Participants either experienced both the market and island economies or different levels of credit supply (in varying orders).

¹The incentives to hedge are minimal given the relatively low potential payoffs from the forecasting exercise in comparison to the payoffs from the credit market.

Table 3 summarizes the different sessions and treatments. The main analysis focuses on a credit supply level of $S = 100$. Higher credit supply levels $S = \{200, 300, 400\}$ were also implemented but are less interesting because they made credit so abundant that participants did not have to compete anymore to obtain credit in the market economy. Participants who play the first treatment are called inexperienced and those who play the second treatment experienced.

Session	Price mechanism		Credit supply	
	Periods 1-20	Periods 21-40	Periods 1-20	Periods 21-40
1	ME	ME	100	200
2	ME	ME	200	100
3	ME	ME	100	200
4	ME	ME	200	100
5	ME	ME	200	400
6	ME	ME	400	200
7	ME	ME	200	300
8	ME	IE	100	100
9	ME	IE	100	100
10	ME	IE	200	200
11	ME	IE	200	200
12	IE	ME	100	100
13	IE	ME	100	100
14	IE	ME	200	200
15	IE	ME	200	200

Table 1: Summary of sessions and treatments. IE refers to island economy, ME refers to market economy.

Ten subjects participated in each session for a duration of approximately 90 minutes. The exchange rate was 30 Taler = 1 Euro. Average earnings per subject were 15.6 Euros including a 5 Euro show-up fee.

After the experimenter read the instructions out loud at the beginning of the experiment, subjects answered a number of control questions to test their understanding and played one practice round to familiarize themselves with the environment. Instructions for the elicitation of risk preferences were provided on screen.

Programming was done in z-Tree (Fischbacher, 2007). At the end of the experiment, subjects were called forward one by one and paid privately.

3 Results

Equilibrium interest rate Figure 1 depicts the evolution of the mean equilibrium interest rates in the market and island economies, for a credit supply of 100. In

the market economy, the interest rates display a boom-bust pattern and exceed the expected return of the project. Starting from about 20%, they gradually increase to about 35 % over the first half of the experiment and then gradually revert to their starting point over the second half of the experiment. In the island economy, by contrast, the interest rates are more stable and stay around 13%, the expected return of the project.

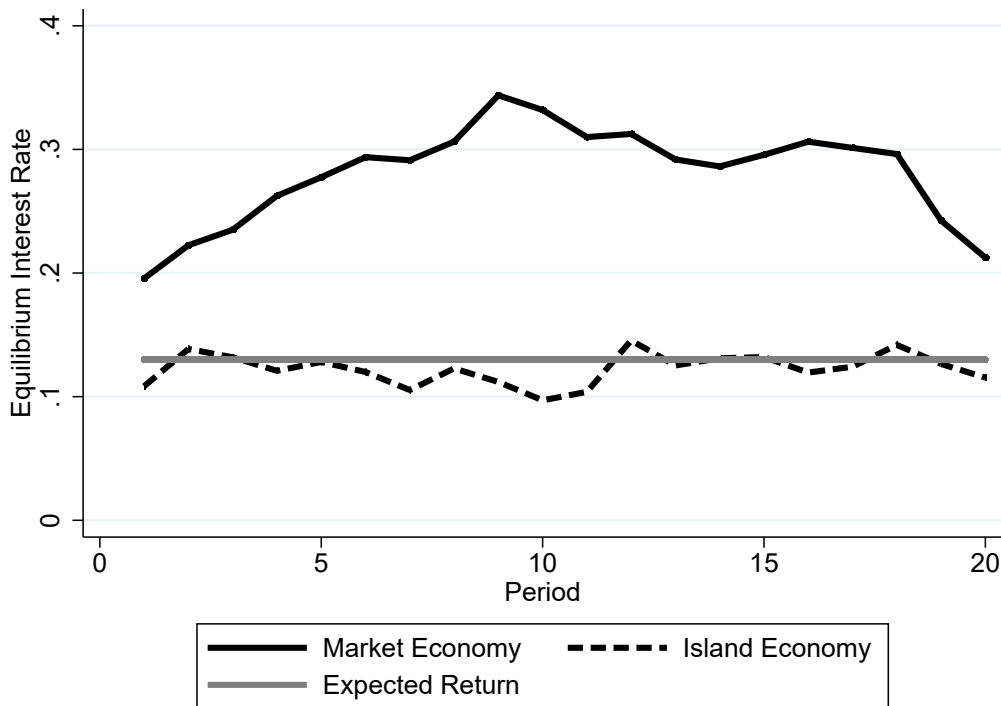


Figure 1: Evolution of mean market and island equilibrium interest rates. Expected return of the project is 13%.

With risk-neutral investors, interest rates were expected to be equal to the expected return of the project (13%) in both economies. This prediction is confirmed in the island economy but not in the market economy. The method to determine the equilibrium interest rate, the only difference between the two economies, likely explains why the equilibrium interest rates follow different paths.

These observations are puzzling. First, why are subjects willing to pay more than the expected return of the project in the market economy and make losses as a result? Second, why do interest rates follow a boom-bust pattern in the market economy? This suggests that subjects become gradually more risk-seeking and then gradually less risk-seeking.

Before further exploring the experimental data to understand these results, several standard explanations can be ruled out. First, these results cannot be explained by fixed risk preferences. The island interest rates are close to the expected return of

the project, which would be consistent with risk neutrality. However, risk-neutral preferences would imply the same interest rate in the market economy, not a higher one. Furthermore, the subjects appear risk averse in a separate risk elicitation task, which would imply interest rates that are lower than the expected return of the project. In the bomb task, they collected about 14 boxes out of 36 (with a standard deviation of 5 boxes). They would have had to collect 18 boxes to be risk neutral and more than 18 to be risk-seeking.

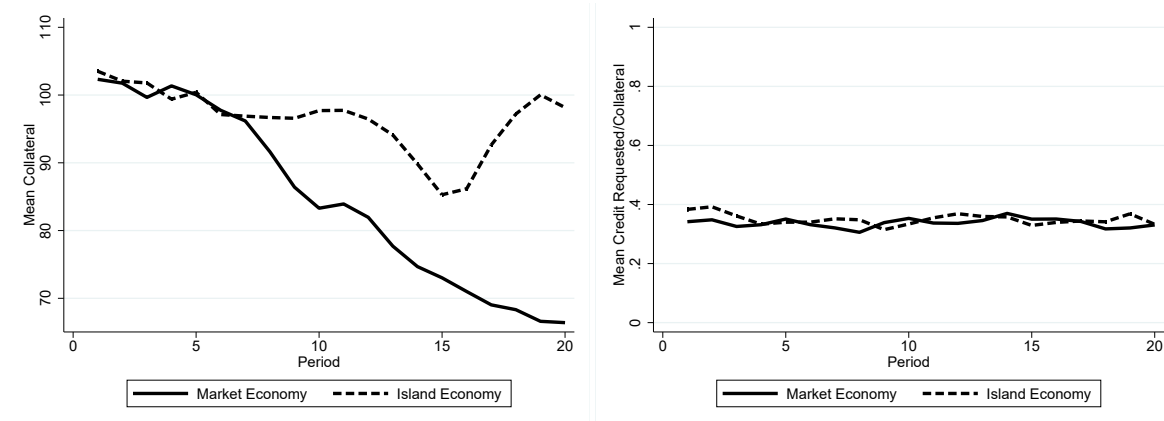
Second, unlike most asset market experiments, there is no speculative motive. Subjects are not willing to pay more than the expected return of the project because they expect to resell their asset to a greater fool. Indeed, the loans and the projects cannot be resold because they last for one period only. Once subjects have borrowed and invested, they learn about the outcomes of the project and repay their loan immediately, before they have to make any other decision.

Third, limited liability cannot explain why subjects pay more than the expected return of the project. In environments where agents can default and end up with a negative payoff, limited liability may lead investors to pay more because it reduces the downside risk by ensuring that they get a zero payoff instead of a negative one. However, subjects cannot benefit from limited liability in this experimental setup because they cannot borrow more than the value of their collateral and, hence, cannot default.

Collateral A first factor that could explain some of the results is the evolution of collateral. Figure 2a shows that the mean collateral in the market economy gradually decreases throughout the experiment, which is not surprising since subjects pay interest rates that are higher than the expected return of the project and makes losses on average. By contrast, the collateral is preserved in the island economy, which is also expected since subjects pay interest rates that are close to the expected return of the project.

Lower collateral may induce subjects to lower their credit demand. First, since subjects are paid the value of their collateral at the end of the experiment, a higher collateral value may increase their credit demand because of a wealth effect. Second, subjects cannot borrow more than the value of their collateral, which may also contribute to a positive relationship between collateral and credit demand.

To assess the role of collateral on credit demand, I compute the ratio between the quantity of credit requested by subjects and their collateral. Figure 2b shows the evolution of this ratio over time in the market and island economies. This ratio is very stable and similar in both economies. Subjects want to borrow about one third of their collateral value. Since their collateral tends to decrease in the market economy, this means that the amount they are willing to borrow gradually decreases over time,



(a) Collateral

(b) Credit requested/collateral ratio

Figure 2: Evolution of collateral and credit demand

which would contribute to the credit bust but would work against the emergence of a credit boom.

To further investigate the significance of these results, I run regressions of individual credit demand on collateral, separately for the island and the market economy, and separately for the quantity and price desired. All the regressions include individual fixed effects to control for unobserved individual characteristics. Hence, the results show how a given subject changes his credit demand when his collateral changes.

Table 3 shows the results. The quantity of credit desired significantly increases with collateral in both the market and island economies. An additional Taler of collateral increases the quantity of credit requested by 0.28 Taler in the market economy and by 0.13 Taler in the island economy. The effect of collateral on the interest rate bid is insignificant in the market economy and slightly positive and significant in the island economy.

These regression results support the hypothesis that lower collateral decreases credit demand. Since collateral tends to gradually decline in the market economy, this tendency could contribute to the credit bust. However, this effect would work against the emergence of a credit boom, which must then be the result of other forces.

Past interest rate I now explore the relationship between past interest rates and the willingness to pay for credit. I explore two hypotheses. First, herding would imply that subjects increase their willingness to pay for credit following a higher interest rate in the market economy but not in the island economy. Second, anchoring or extrapolation would imply that subjects increase their willingness to pay for credit following a higher interest rate in both the market and island economies. Indeed, the market interest rate reveals information about the behavior of other subjects in the market economy (the herd) while the interest rate in the island economy only reflects

	Market economy		Island economy	
	Interest rate bid	Quantity bid	Interest rate bid	Quantity bid
Collateral	-0.0000283 (0.000291)	0.283*** (0.0411)	0.000154** (0.0000600)	0.133** (0.0590)
Constant	0.237*** (0.0249)	1.543 (3.523)	0.0878*** (0.00579)	14.76** (5.690)
Observations	1520	1520	760	760
R^2	0.000	0.222	0.009	0.073

Table 2: Collateral and individual credit demand. *Interest rate bid* is the individual interest rate requested in a period. *Quantity bid* is the individual quantity of credit requested in a period. *Collateral* is the collateral value of the individual at the beginning of the period. *Past equilibrium interest rate* is the equilibrium interest rate of the previous period. Standard errors in parentheses clustered at the individual level. ***, **, * Coefficient estimate statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

the realization of a random variable.

Consistent with herding, figure 3 shows that the interest rate that subjects are willing to pay is positively correlated with past equilibrium interest rates in the market economy (with a correlation of 0.54) while it appears unrelated in the island economy (with a correlation of 0.08). This result suggests that subjects have a herd instinct, since they follow the market interest rate, which reflects the behavior of other market participants, while they do not follow the island interest rate, which is determined by a random variable.

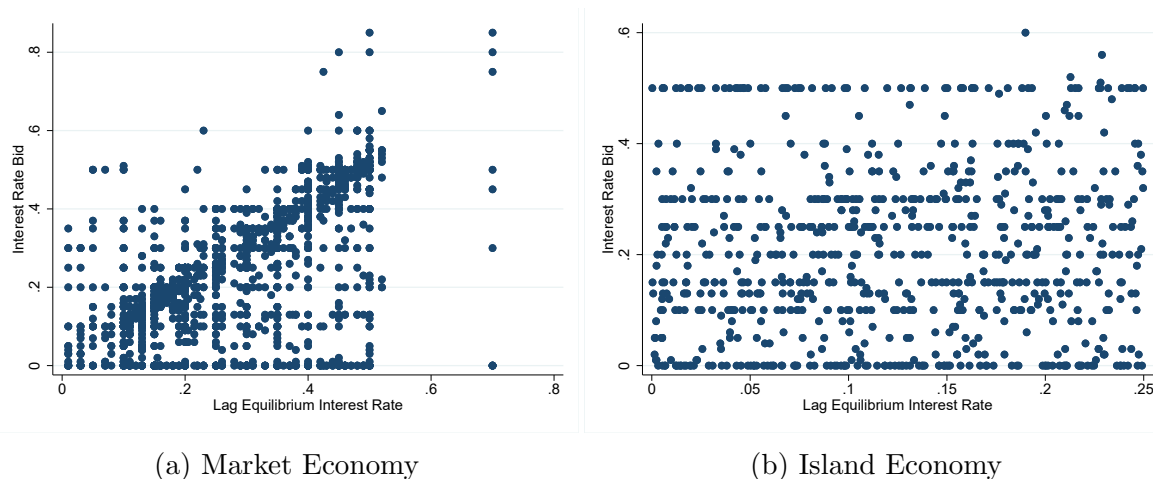


Figure 3: Interest Rate Bids and Past Interest Rates

To further investigate the significance of these results, I run regressions of individual credit demand on past interest rates, separately for the island and the market

economy, and separately for the quantity and price desired. All the regressions include individual fixed effects to control for unobserved individual characteristics and control for collateral, which was shown above to play a role.

Table 3 shows the results. The willingness to pay for credit significantly increases with past interest rates in the market economy but not in the island economy, confirming the lessons drawn from figure 3. The role of collateral remains the same.

	Market economy		Island economy	
	Interest rate bid	Quantity bid	Interest rate bid	Quantity bid
Collateral	0.000195 (0.000204)	0.281*** (0.0403)	0.000299** (0.000121)	0.132** (0.0584)
Past equilibrium interest rate	0.585*** (0.0624)	-3.745 (7.174)	0.103 (0.0640)	12.90* (6.465)
Constant	0.0514** (0.0245)	2.730 (3.435)	0.164*** (0.0136)	13.28** (6.026)
Ind. fixed effects	Yes	Yes	Yes	Yes
Observations	1520	1520	760	760
R^2	0.179	0.223	0.013	0.076

Table 3: Past interest rate and individual credit demand. *Interest rate bid* is the individual interest rate requested in a period. *Quantity bid* is the individual quantity of credit requested in a period. *Collateral* is the collateral value of the individual at the beginning of the period. *Past equilibrium interest rate* is the equilibrium interest rate of the previous period. Standard errors in parentheses clustered at the individual level. ***, **, * Coefficient estimate statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

These results suggest that past interest rates influence the willingness to pay for credit in the market economy but not in the island economy. A possible explanation is that subjects are unsure about what would be a reasonable rate to pay and believe that the herd may know better (chapter 10, Shiller, 2015). Another mechanism through which past interest rates affect credit demand is through anchoring or extrapolation. However, the absence of a strong relationship between past interest rates and interest rate bid in the island economy does not support this channel.

Herding may contribute to the credit boom by creating a spiraling effect. A higher interest rate indeed increases credit demand, which itself increases the subsequent interest rate and so on. To explain the whole credit boom-bust pattern, it must be that this positive spiral initially dominates the negative wealth effect documented above but is eventually dominated by it. These mechanics are developed more formally in the next section.

Beliefs Participants reported their forecast about the upcoming equilibrium interest rate. These forecasts were accurate on average in the market economy. The mean forecast error, computed as the difference between the expected interest rate and the realized interest rate, was close to zero (-0.65%). However, participants still made a lot of forecast errors with a standard deviation of forecast errors of 9% .

Furthermore, participants seem to have understood the role of herding in the market economy. They indeed expect a higher interest rate if the market interest rate was higher in the previous period, with a correlation 0.88 . By contrast, this relationship is much weaker in the island economy, with a correlation of 0.08 .

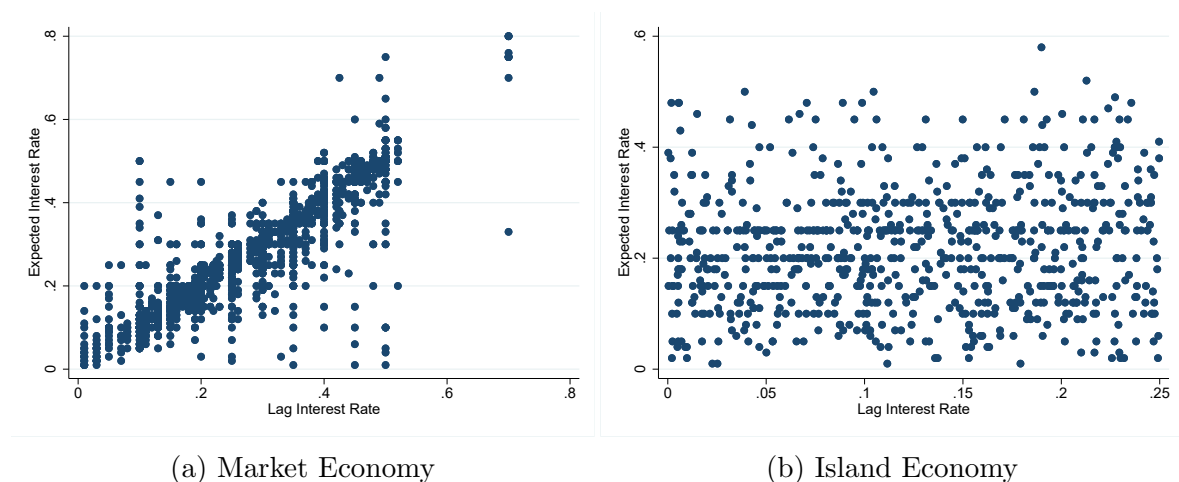


Figure 4: Interest Rate Beliefs and Past Interest Rates

Every period, participants also reported their expectation about the realization of the project (-50% or 100% return). Since the low return was more likely, rational subjects should have always reported to expect the low return to maximize their monetary gains. However, participants expected the low return to realize only 40% of the time and only 3% of the participants always expected the low return. Furthermore, the realization of the project return in the past period is negatively associated with their current belief, consistent with the gambler's fallacy (Kahneman and Tversky, 1974). It is unclear, however, how this bias could contribute to the credit boom-busts.

Past profits Another possible determinant of credit demand is past profits. Based on Thaler and Johnson (1990), both larger past losses and larger past gains are expected to increase credit demand through, respectively, the break-even and the house money effects.

Figure 5 shows the relationship between credit demand, equal to the quantity of credit requested times one plus the interest rate requested, and past profits. Both in the market and in the island economy, the relationship is v-shaped. Furthermore,

participants also increase their credit demand if they made zero profit in the previous period. These results are not driven by selection effects because they remain statistically significant in a regression analysis that controls for individual fixed effects (results not reported). Hence, credit demand is increasing with both past losses and past gains, consistent with, respectively, the break-even and house money effects. Subjects who made zero profit in the previous period are those who were unable to obtain credit, because the interest rate they were willing to pay was too low, either below the market-clearing rate in the market economy or below the random number in the island economy. These subjects subsequently increased their credit demand, creating a winner's curse, because participants who increase their credit demand after being excluded from the credit market are bound to make larger losses in a setup with interest rates that are higher than the expected return.

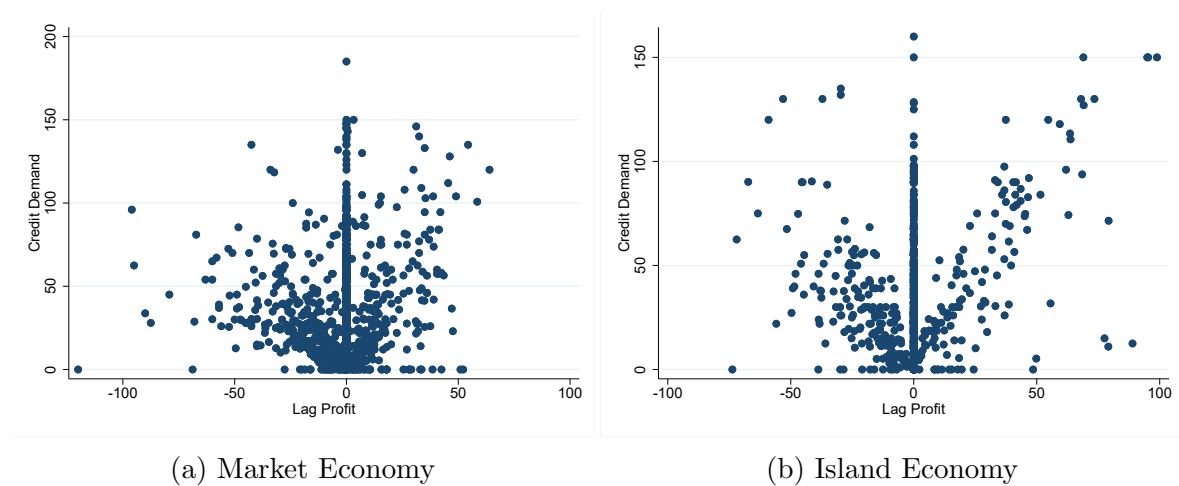


Figure 5: Past profits and individual credit demand, equal to the quantity of credit requested times one plus the interest rate requested.

These effects could add instability to the credit market. Like herding, the break-even effect can produce a spiraling effect because a higher interest rate increases losses, which increases credit demand and the subsequent interest rate, and so on. By contrast, the house money effect predicts oscillations in the interest rate, because a higher interest rate decreases potential gains, which decreases credit demand and the subsequent interest rate. While these effects may contribute to volatile equilibrium interest rates, they hold in both the market and island economies and, hence, are unlikely to explain why interest rates follow different paths in the two economies.

Individual Characteristics I now explore whether individual credit demand depends on the following individual characteristics: risk tolerance, gender, whether the participant plays the second treatment, age, and self-assessed mathematical skills. I estimate random effects models controlling for these variables as well as collateral and

past interest rate, separately for the island and the market economy, and separately for the quantity and price desired.

Table 4 shows the results. Participants who play the second treatment, referred to as experienced, significantly reduce their credit demand, especially the quantity of credit they request in the market economy. Female participants bid a 3 percent point higher interest rate in the market economy, but the effect is only significant at the 10% level. Older participants request more credit in the island economy, but the effect is only significant at the 10% level. The remaining individual characteristics do not have a significant effect on credit demand. The effects of collateral and past interest rate remain similar.

Credit supply All the results so far are for a credit supply of 100. Higher levels of credit supply were also implemented, but were omitted from the main analysis because they were so high that participants did not have to compete anymore to obtain credit. Figure 6 shows that in the market economy with credit supply levels of 200, 300, or 400, interest rates slowly decline over time and are lower than the expected return of the project. While these low interest rates imply that the wealth of participants increases over time, the declining interest rates imply that participants gradually decreased their demand for credit, suggesting that they are bidding less than their willingness to pay. In the island economy, by contrast, the equilibrium interest rates with a credit supply of 200 are very similar to the results shown above, suggesting that the higher supply did not affect their willingness to pay.

4 Model

The results suggest that credit boom-busts may emerge as the result of two competing forces. First, the declining collateral gradually decreases credit demand. Second, the willingness to pay for credit increases with past equilibrium interest rates in the market economy, consistent with herding and creating a spiraling effect. This section develops a stylized model to show how these two forces can combine to produce a credit boom-bust.

First, a baseline model with risk-neutral investors is developed. No credit boom-busts arise in this benchmark.

Then, a herd instinct is introduced in this baseline model. The willingness to pay of investors is assumed to depend on past interest rates. A credit boom-bust can emerge in this environment. A high market interest rate increases credit demand which itself increases the market interest rate and so on. The market interest rate initially follows an explosive path. Because the interest rate is higher than the expected

	Market economy		Island economy	
	Interest rate bid	Quantity bid	Interest rate bid	Quantity bid
Collateral	0.0000657 (0.000186)	0.277*** (0.0387)	0.000322*** (0.000112)	0.146*** (0.0443)
Past equilibrium interest rate	0.578*** (0.0633)	-3.373 (7.208)	0.106 (0.0645)	12.16* (6.472)
Risk tolerance	0.00135 (0.00116)	0.143 (0.314)	0.000837 (0.00225)	0.388 (0.381)
Female	0.0335* (0.0174)	0.285 (3.448)	0.00268 (0.0297)	0.520 (3.975)
Experienced	-0.0328* (0.0177)	-14.36*** (3.601)	-0.0528* (0.0318)	-2.072 (4.041)
Age	-0.00436 (0.00280)	-0.418 (0.485)	0.000810 (0.00427)	0.646* (0.366)
Skill	0.00409 (0.00475)	-0.778 (0.904)	0.00170 (0.00756)	0.459 (1.043)
Constant	0.116 (0.0815)	22.15 (13.81)	0.145 (0.123)	-10.27 (11.95)
Observations	1520	1520	760	760
R^2	0.3118	0.2430	0.0706	0.2919

Table 4: Individual characteristics and credit demand. Random effects estimates. *Interest rate bid* is the individual interest rate requested in a period. *Quantity bid* is the individual quantity of credit requested in a period. *Collateral* is the collateral value of the individual at the beginning of the period. *Past equilibrium interest rate* is the equilibrium interest rate of the previous period. *Risk tolerance* refers to the number of boxes collected in the risk preference elicitation task. *Female* is a dummy indicating whether the participant is female. *Experienced* is a dummy variable indicating whether the subject plays the second treatment. *Age* is the age of the participant. *Skill* is the self-assessed level of mathematical skills on a scale of 1 to 10. Standard errors in parentheses clustered at the individual level. ***, **, * Coefficient estimate statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

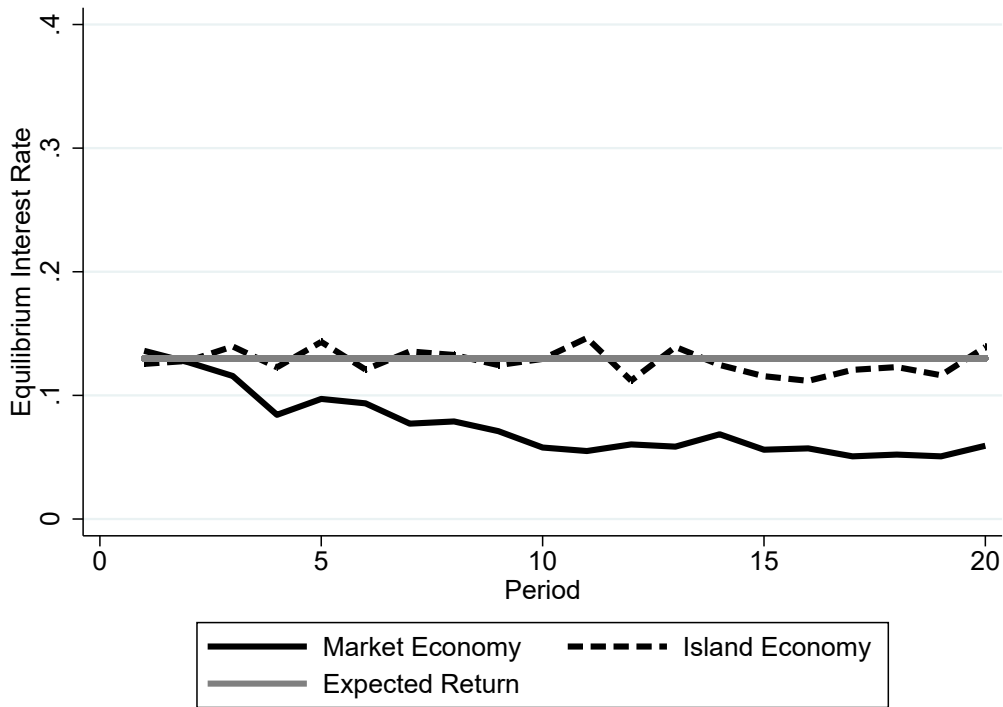


Figure 6: Evolution of equilibrium interest rates in the market and island economies with a credit supply greater than or equal to 200. The gray line shows the expected return of the project (13%).

return, however, the collateral of investors gradually declines, which discourages credit demand. This effect is initially small but gradually increases, eventually overturning the spiraling effect and initiating the credit bust.

4.1 Baseline

Each period $t = 1, 2, \dots$, the representative illiquid risk-neutral investor with initial collateral C_0 borrows I_t at the interest rate r_t to invest in a risky project, that yields a positive return $A_1 > 0$ with probability π and a negative return $A_2 < 0$ with probability $1 - \pi$. To simplify the analysis, the investor is assumed to invest in a continuum 1 of projects and hence make an overall return equal to the expected return of the project $\bar{A} = \pi A_1 + (1 - \pi)A_2 > 0$. The total loan repayment cannot exceed the collateral $(1 + r_t)I_t \leq C_t$. Finally, the collateral is adjusted each period depending on the profit of the investor $C_{t+1} = C_t + (\bar{A} - r_t)I_t$.

The investor chooses I_t to maximize the profit $(\bar{A} - r_t)I_t$, taking r_t as given. The solution is:

$$I_t = \begin{cases} 0 & \text{if } r_t < \bar{A} \\ \in [0, C_t/(1 + r_t)] & \text{if } r_t = \bar{A} \\ C_t/(1 + r_t) & \text{if } r_t > \bar{A} \end{cases}$$

If $r_t < \bar{A}$, the investor does not want to borrow because the profit is decreasing in I_t . If $r_t = \bar{A}$, the investor is willing to borrow any amount between 0 and the maximum quantity $C_t/(1 + r_t)$ because the profit is zero and independent of I_t . If $r_t > \bar{A}$, the investor wants to borrow the maximum quantity because the profit is increasing in I_t .

The exogenous supply of credit is S in every period and market clearing implies $I_t = S$. The equilibrium interest rate is

$$r_t = \begin{cases} \bar{A} & \text{if } C_t \geq (1 + \bar{A})S \\ C_t/S - 1 & \text{if } C_t < (1 + \bar{A})S \end{cases}$$

If $C_t \geq (1 + \bar{A})S$, the collateral is sufficient to absorb the whole credit supply at the equilibrium interest rate $r_t = \bar{A}$. Investors make zero profit and the collateral remains constant.

If $C_t < (1 + \bar{A})S$, collateral is not sufficient to absorb the whole credit supply at the equilibrium interest rate $r_t = \bar{A}$, so the equilibrium interest rate has to decrease to $r_t = C_t/S - 1$. Since the interest rate is lower than \bar{A} , the investor makes a positive profit and the collateral increases over time. This makes it possible for the investor to pay an increasingly higher interest rate until it reaches $r_t = \bar{A}$, at which point the equilibrium interest rate stays at this value and the collateral remains constant and equal to $(1 + \bar{A})S$.

To summarize, this model predicts an equilibrium interest rate that is either equal or below the expected return of the project. It does not predict credit boom-busts.

4.2 Model with Herding

The baseline model is extended with a herd instinct. The willingness to pay for credit now depends not only the expected return of the project but also on the past interest rate. The following credit demand formalizes this idea:

$$I_t = \begin{cases} 0 & \text{if } r_t < \bar{A} + \alpha(r_{t-1} - \bar{A}) \\ \in [0, C_t/(1 + r_t)] & \text{if } r_t = \bar{A} + \alpha(r_{t-1} - \bar{A}) \\ C_t/(1 + r_t) & \text{if } r_t > \bar{A} + \alpha(r_{t-1} - \bar{A}) \end{cases}$$

If $\alpha = 0$, the model is equivalent to the baseline version presented in the previous section. If $\alpha > 0$, the model assumes a herd instinct. If the past interest rate is higher (lower) than the expected return of the project, the investor is now willing to pay more (less) than the expected return of the project.

The exogenous supply of credit is S in every period and market clearing implies

$I_t = S$. The equilibrium interest rate is

$$r_t = \begin{cases} \bar{A} + \alpha(r_{t-1} - \bar{A}) & \text{if } C_t \geq (1 + \bar{A} + \alpha(r_{t-1} - \bar{A}))S \\ C_t/S - 1 & \text{if } C_t < (1 + \bar{A} + \alpha(r_{t-1} - \bar{A}))S \end{cases}$$

If $C_t < (1 + \bar{A} + \alpha(r_{t-1} - \bar{A}))S$, the collateral is sufficient to absorb the whole credit supply at the equilibrium interest rate $r_t = \bar{A} + \alpha(r_{t-1} - \bar{A})$. The dynamics of the equilibrium interest rate depend on the value of α :

- If $\alpha < 1$, the interest rate is stable and converges to \bar{A} . This case is displayed in figure 7a.
- If $\alpha = 1$, the interest rate is also stable but stays constant at r_{t-1} .
- If $\alpha > 1$ and $r_{t-1} \neq \bar{A}$, the interest rate is unstable. It converges to 0 if $r_{t-1} < \bar{A}$ (assuming a zero lower bound) while it explodes if $r_{t-1} > \bar{A}$. This case is displayed in figure 7b. If $r_{t-1} = \bar{A}$, the interest rate is stable and stays equal to \bar{A} .

If $C_t < (1 + \bar{A} + \alpha(r_{t-1} - \bar{A}))S$, collateral is not sufficient to absorb the whole credit supply at the interest rate $r_t = \bar{A} + \alpha(r_{t-1} - \bar{A})$, so the equilibrium interest rate has to decrease to $r_t = C_t/S - 1$. If the interest rate is higher (lower) than the expected return, collateral decreases (increases), which decreases (increases) the equilibrium interest rate. This continues until the equilibrium interest rate reaches \bar{A} (either from below or from above), at which point it stays constant.

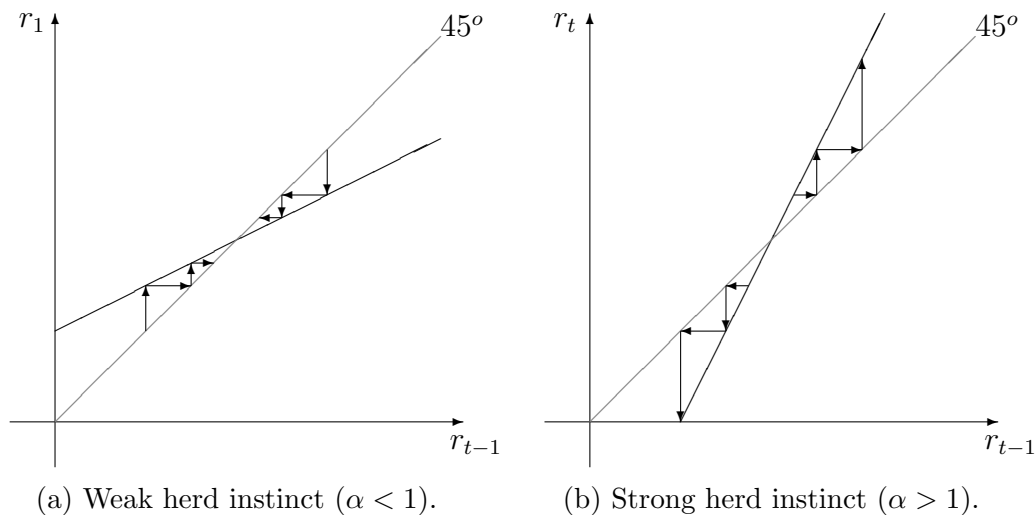


Figure 7: Interest rate dynamics

Introducing a herd instinct in a stylized model of investment can thus predict a credit boom-bust. Starting from an interest rate higher than the expected return, a

strong enough herd instinct ($\alpha > 1$) induces investors to increase their willingness to pay for credit, which increases the equilibrium interest rate. This upward spiral between higher interest rates and higher credit demand produces the credit boom. This latter ends when the collateral constraint starts binding. Investors cannot increase their demand anymore and the interest rate thus starts to decline. This initiates the credit bust.

5 Conclusion

Credit boom-busts have been attributed to many factors, such as lax regulation, global imbalances, financial innovation, or monetary policy, among others. This paper shows that credit boom-busts can still emerge in a laboratory experiment that makes it possible to keep all these factors constant, suggesting that credit markets may be inherently unstable.

The paper proposes an explanation for the emergence of credit boom-busts in this basic environment that relies on herding. If investors have a herd instinct, a higher interest rate increases their subsequent willingness to pay for credit, which itself increases the equilibrium interest rate and so on. This spiral produces the credit boom. At some point, however, investors cannot increase their credit demand anymore, which initiates the credit bust.

These findings were derived in a highly stylized environment that abstracts from many dimensions relevant to credit markets, such as asymmetric information or speculative motives. This simplicity, however, made it possible to uncover factors that would have been obscured in richer environments. Since the basic characteristics of the environment studied, competitive markets and risky payoffs, are present in many financial markets, these factors may be at play in these markets too and may contribute to their instability.

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