

Self-selection in risky financial decision-making: An experiment on framing and “perceived loss” aversion

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ABSTRACT

A major characteristic of financial markets is information asymmetry. To combat its problems principals can use screening. That is, they can offer the clients a menu of contracts and infer their risk level from their choices. If the pattern of choices that clients with different risk level make differs, there is self-selection of clients and screening occurs. We conduct an experiment to address an important question for such settings—does the framing of the offered menu of contracts interfere with the self-selection of clients? The answer is yes. In fact, subjects’ choices shift when the same (positive) outcomes of the same menu of contracts are presented in two different frames. Since both frames differ in the “perceived” reference-point, we propose a theoretical approach that initially follows Prospect Theory to explain our results. Subjects exhibit loss aversion in their perception and assessment of the positive outcomes below the reference-point, and self-selection fails to occur.

KEYWORDS: Behavioral finance, Framing, Loss aversion, Reference point, Self-selection, Screening

JEL CLASSIFICATION: C91, D03, D82, G32

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1. INTRODUCTION

Would you offer your apartment (where you are living in with your family) as collateral for an investment project? Consider now a slightly different frame: Would you get a mortgage to buy an apartment? The difference between the first and the second question is the reference point: In the first question you are endowed with the apartment.

A large number of experimental studies, within economics and psychology, support that individuals decision-making differ depending on the reference they are given¹. The reference-dependant approaches [see Thaler (1980)], and most prominently the Prospect Theory [Kahneman & Tversky (1979); Tversky & Kahneman (1992)] have gained widespread success in economics and decision research. In contrast with more conventional economic approaches, in which the possible outcomes of available choice options are valued in absolute terms, as the Expected Utility Theory, reference-dependant theories are based on the idea that outcomes are always evaluated relative to some relevant reference point.

In this paper, we present an experiment designed to study the reference effect on a question of major importance in financial markets: credit screening. A key characteristic of credit—and insurance—markets is information asymmetry. To combat its problems of adverse selection and moral hazard, banks and insurance companies can use screening. That is, they can offer the clients a menu of contracts and infer their characteristics from their choices. If the pattern of choices that individuals with different characteristics, as risk level, make when facing a menu of contracts differs, then there is self-selection of clients and screening occurs. The possibility of screening borrowers by their risk level is of great importance. When lenders offer a menu of contracts inducing the self-selection of firms, there is a separating equilibrium that reveals information and can resolve rationing. Hence, the monetary policies by Central Banks can be improved.

Among the extant screening mechanisms, lenders may employ collateral requirements along with the interest rate². Bester (1985) shows that applicants with lower-risk projects are willing to accept higher collateral at a lower premium, while those with higher-risk projects select unsecured loans at a higher premium.

¹ The empirical/experimental literature on reference-dependant individual decision-making is too large to be cited here. See Camerer (1995) and Sudgen (1999) for insightful surveys.

² See Bester (1985), Chan & Kanatas (1985), Besanko & Thakor (1987), Chan & Thakor (1987), Deshons & Freixas (1987), Igawa & Kanatas (1990), Stiglitz & Weiss (1992).

Our experiment aims to answer an essential question for such settings: Does the framing of the offered menu of contracts interfere with the self-selection of clients? The answer is yes. In fact, subjects' choices shift when the same (positive) outcomes of the same menu of contracts are presented in two different frames. Since both frames differ only in the "perceived" reference point, we propose a theoretical approach that initially follows Prospect Theory to explain our results.

An important feature of Prospect Theory and other reference-dependant approaches is the behavioral assumption that postulates that individuals overvalue what is lost from their reference viewpoint (loss aversion). If individuals perceive the collateral contract terms as a possible loss, it may imply that individuals value the collateral more than Bester's theory predicts. As a result, applicants with lower-risk projects may not be willing to accept higher collateral at a lower premium to self-select, and the screening mechanism may fail.

Our results show that subjects exhibit loss aversion in their perception and assessment of the positive outcomes under the reference point, and self-selection fails to occur. To the best of our knowledge, this is the first paper that applies a reference-dependant approach to screening mechanisms.

A few experimental papers have examined screening. Shapira & Venezia (1999), Posey & Yavas (2007), and Kübler *et al.* (2008) have studied screening in the labor market and have focused on the principal's behavior, not in the self-selection mechanism. Only Capra *et al.* (2009) have focused on the self-selection mechanism. Our experiment starts with the scenario proposed by Capra *et al.* (2009) and studies framing effects in the classic problem of credit screening.

In the next section, the experiment is presented: the game theoretic prediction and hypotheses first and the experimental design and procedures afterwards. In section 3, the results from the experiment are described. Section 4 presents the theoretical approach that explains the results, and the final section summarizes the main conclusions.

2. THE EXPERIMENT

2.1. GAME-THEORETIC PREDICTION AND HYPOTHESES

Our experimental design revolves around a principal-agent game that initially follows Bester's (1985) model. It considers a market with N_i agents, who can either be type $i = a$ or b , according to their project risk level. Each agent has the possibility of starting a project that requires an initial fixed investment I .³

³ Given that the required investment is fixed, it is not used as a way to signal information about the agent's risk. See Milde & Riley (1988) for models in which the investment is used as a signal.

The return on the project for agent i is given by the random variable \tilde{R}_i , with $0 \leq \tilde{R}_i \leq \bar{R}_i$ and a distribution function $F_i(R) > 0$ for all $R > 0$.⁴ The agents (firms) have an initial wealth $W < I$, which together with a loan $B = I - W$ finance the project. Given the size of the loan, B , a credit contract $\gamma = (r, C)$ is specified by the interest rate r and the collateral C . Firms may face collateralization costs assumed to be proportional to the amount of collateral. When $C > (1+r)B$, the firm would not admit project failure. Therefore, only contracts with $C \leq (1+r)B$ are considered. It is assumed that firm i 's project fails if $C + R_i < (1+r)B$, and this becomes observable only after a firm declares project failure. If this happens, the bank becomes the owner of both the investment project and its return. Thus, the expected profit of the project for firm i and a credit contract γ is given by:

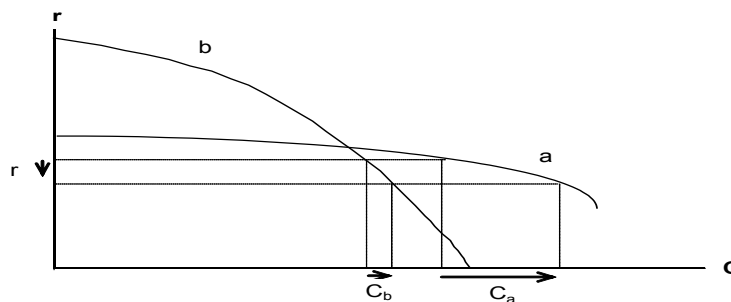
$$\Pi_i(\gamma) = E\{\max[\tilde{R}_i - (1+r)B - kC, -(1+k)C]\} \quad [1]$$

Banks cannot distinguish borrowers by risk; however, they can separate them by offering a pair of contracts $(\gamma_\alpha, \gamma_\beta)$ that are incentive compatible and act as self-selecting mechanisms. The pair $(\gamma_\alpha, \gamma_\beta)$ is incentive compatible if:

$$\Pi_a(\gamma_\alpha) \geq \Pi_a(\gamma_\beta); \quad \Pi_b(\gamma_\beta) \geq \Pi_b(\gamma_\alpha) \quad [2]$$

As long as a pair of contracts $(\gamma_\alpha, \gamma_\beta)$ is offered, the firm prefers the contract that maximizes its expected profits. Thus, if preferences of investors depend systematically on their types, banks can utilize a menu of contracts with different collateral requirements as self-selection mechanisms. Bester (1985) concludes that the low risk loan applicants try to differentiate themselves from high risk applicants by accepting higher collateral for a given reduction in interest rates, as collateral is costly.

Figure 1. Agents' Isoprofit Curves



The isoprofit curves for the two types of loan applicants are depicted in Figure 1. Applicant b 's isoprofit curve has a steeper slope than applicant a 's, because the first's project is riskier and, by stochastic dominance of second degree, profits are a convex function of the realized returns (R). This means that type a firms are inclined to accept a higher increment in collateral for a given reduction in

⁴ This condition ensures that there is a positive probability of failure as long as the interest payments exceed the collateral.

interest rates than type b firms. This fact allows self-selection of agent's types when the principal (bank) offers different pairs of incentive-compatible contracts.⁵

However, under Prospect Theory and other reference-dependant approaches, individuals overvalue what is lost from their reference viewpoint. These behavioral approaches are strongly at odds with traditional economic approaches, as Bester's, according to which framing should not affect valuations of the collateral.

We use experimental methods to analyze agents' self-selection under two different frames (both positive). The aim of the paper is to test the screening power of co-payment devices. As in the theoretical models of credit screening, we design ad hoc incentive compatible contracts to test the following hypotheses.

H1: Contracts combining pairs of collateral and price screen agents with different risk levels.

H2: Framing affects the valuation of collateral and interferes with the screening mechanism.

2.2. EXPERIMENTAL DESIGN AND PROCEDURES

An environment was designed in which there were N subjects that needed money to develop a project with some expected future return. Each subject had the two types of projects $i = s$ (safer: 90% prob. success), r (riskier: 50% prob. success). They played 10 rounds with the safer project and 10 rounds with the riskier project in each treatment. We offered a menu of two contracts each round. Each contract included two features: the price to be paid and a deposit, representing the collateral.

We run two treatments, A and B, one with broken down payments. In order to control for individual differences in personality or risk attitude, all subjects play the two treatments (within subject treatments). Half of the subjects played Treatment B first, to control for order effects. Both treatments had the same instructions⁶.

There is only one difference between the two Treatments: The payoffs' framing (See Figures 2 and 3). Treatment A (Figure 2) shows, in this example, a payoff of 725 units for contract A when the project succeeds, whereas Treatment B (Figure 3) shows a payoff of 300+425 (that equals 725). Similarly, Treatment A (Figure 2) shows a payoff of 75 units for contract A when the project fails, whereas Treatment B (Figure 3) shows a payoff of 300-225 (that equals 75).

⁵ In Bester (1985), self-selection resulted from stronger assumptions than in Stiglitz & Weiss (1981). To produce a separating equilibrium the additional assumption that $F_i(R) > 0$ for all $R > 0$ is needed. With this assumption, it is possible to have a monotonous relationship between risk and applicants' preferences.

⁶ The instructions and other documents used in this experiment are available upon request.

Figure 2. Experimental design: Treatment A

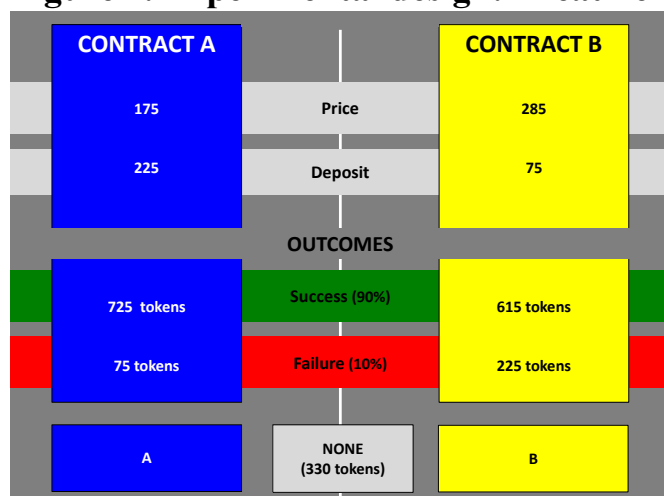
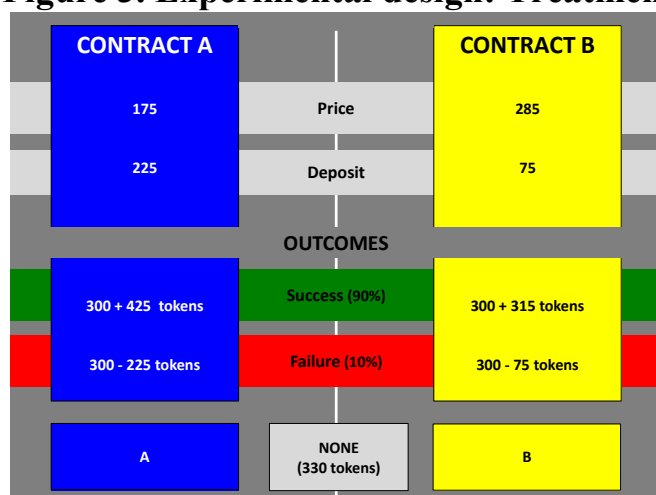


Figure 3. Experimental design: Treatment B



In this experimental market, each individual started each round with an initial wealth of 300 units. Each subject had to choose one or none of the two offered contracts in each round. The subjects who do not choose any contract in the round receive a return of 30 monetary units. The individuals expected returns for investing in the project were:

$$ERs = 0.9 (300 + 600 - \text{Price}) + 0.1 (300 + 0 - \text{Deposit}) \quad [3]$$

$$ERr = 0.5 (300 + 1080 - \text{Price}) + 0.5 (300 + 0 - \text{Deposit}) \quad [4]$$

In each of the rounds, we offered a pair of theoretically incentive compatible contracts (C1, C2) with: $ERs (C2) \geq ERs (C1)$ and $ERr (C1) \geq ERr (C2)$

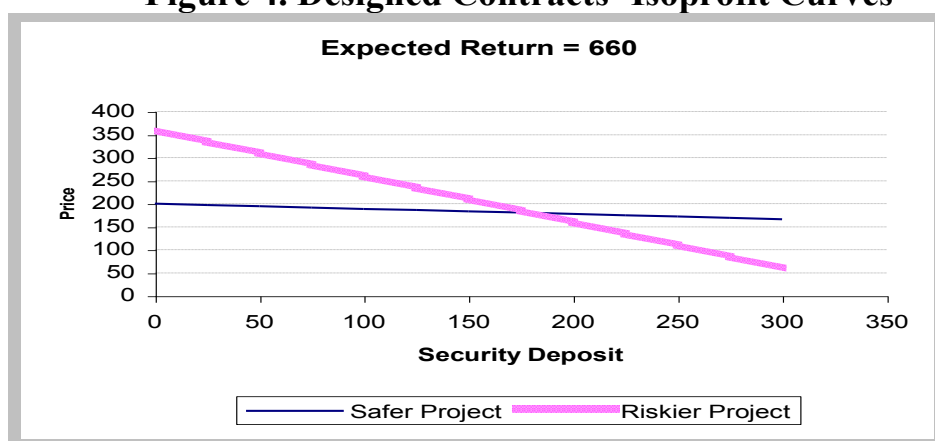
Table 1 shows the 5 pairs of contracts offered to the subjects and Figure 4 illustrates the iso-profit curves designed with the 5 pairs of offered contracts. The pairs of theoretically incentive-compatible contracts applied here are the ones used originally by Capra *et al.* (2009). In the Capra *et al.* (2009)'s paper these pairs of contracts (though with a different success probability) screen

borrowers characterized by different risk-levels. In our experiment, each pair of contracts was shown in two different rounds, in order to counterbalance the side (left, right) and colors (blue and yellow) of the contracts in each pair. The experiment was programmed and run in E-prime for these graphical reasons.

Table 1: Pairs of Offered Contracts

Pair	Contract 1		Contract 2	
	Price	Dep.	Price	Dep.
1	360	0	166	300
2	335	25	169	275
3	310	50	172	250
4	285	75	175	225
5	260	100	177	200

Figure 4. Designed Contracts' Isoprofit Curves



The design of the experiment controls for the order of treatments, the presentation (right/left; blue/yellow colors), and allows for indifference: We ask two times the same choice (an indifferent participant may choose contract 1 once, and contract 2 once).

The 47 subjects of the experiment were students from the University of Geneva (Switzerland) recruited from various courses and grades using flyers (23 males, 24 females). During the experiment, they were not allowed to communicate with the rest of the participants. The individuals read the instructions and we answered their questions. During the experiment the subjects received no feedback. At the end of the game, they received their gains (around 17 CHF each⁷). Each session lasted for one hour and 15 minutes and was run either at the laboratory of the Swiss Center for Affective Sciences or at the laboratory of the Faculty of Psychology, both at the University of Geneva.

⁷ Subjects were paid on the basis of their decisions. Four trials drawn at random were paid, one from the low risk and one from the high risk project, both in treatment A and in treatment B.

3. RESULTS

The results of the experiment are summarized in Table 2 and Figure 5. There are a total of 470 observations per Treatment. Treatment A (hereby Framing 1) differs from Treatment B (hereby Framing 2) only in the outcomes' presentation.

In Framing 1, as predicted by Bester's model, subjects with riskier project mostly choose the low collateral contract (58.94%). The Wilcoxon test shows that the difference between low collateral and high collateral contract choices is significant at 1% level ($p=0.01$). By contrast, when the same subjects have the safer project, they prefer (55.32%) the contract with the higher collateral ($p=0.08$). Our results confirm that Framing 1 allows the subjects to self-select and, therefore, screening occurs⁸. **H1** is confirmed in Framing 1.

Table 2. Descriptive and Test Statistics by Framing and Project

	Framing 1				Framing 2			
	Riskier Project		Safer Project		Riskier Project		Safer Project	
	Obs	%	Obs.	%	Obs	%	Obs	%
Lowcoll (LC)	277	58.94%	183	38.94%	338	71.91%	211	44.89%
Highcoll (HC)	151	32.13%	260	55.32%	96	20.43%	232	49.36%
None (NC)	42	8.94%	27	5.74%	36	7.66%	27	5.74%

<i>Wilcoxon Test</i>	Riskier Project		Safer Project	
	Framing 1	Framing 2	Framing 1	Framing 2
Lowcoll-Highcoll	$p = 0.01$	$p = 0.00$	$p = 0.08$	$p = 0.71$
Lowcoll-None	$p = 0.00$	$p = 0.00$	$p = 0.00$	$p = 0.00$
Highcoll-None	$p = 0.00$	$p = 0.03$	$p = 0.00$	$p = 0.00$
Lowcoll		$p = 0.01$		$p = 0.20$
Highcoll		$p = 0.01$		$p = 0.32$
None		$P = 0.43$		$P = 0.62$

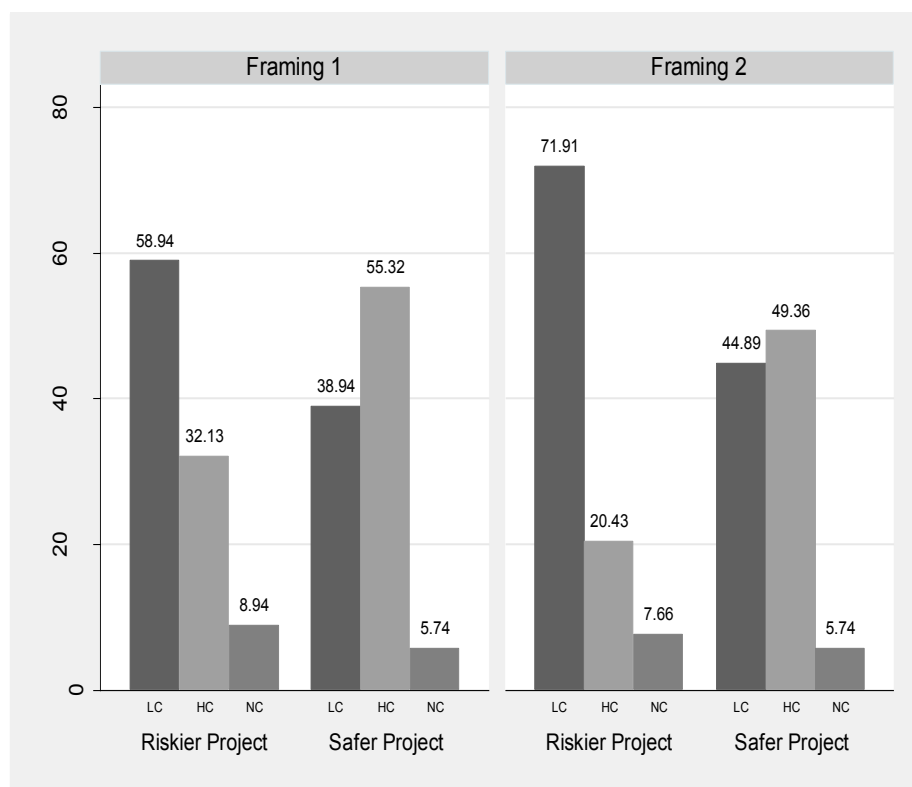
In Framing 2, the percentage of choices of the low collateral contract rises in both projects, and screening fails to occur (71.91% choices for riskier projects, and 44.89% choices for safer projects —although the increase in choices for safer projects is not statistically significant, $p=0.20$). This result supports **H2**. Subjects perceiving they may “lose” the initial wealth (remember Figure 3; subjects see, for example: 300+425, 300-225), avoid high collateral contract choices. Table 2 shows that, in framing 2, there is no self-selection. When subjects have the safer project, the difference between low collateral contract choices (44.89%) and high collateral contract choices (49.36%) is not significant ($p=0.71$).

Figure 5 shows the histograms of these results by framing and project type.

⁸ Capra *et al.* (2009) present the outcomes in absolute values and find screening, too.

Most of the subjects with the safer project choose, in the Framing 1, the high collateral contract, whereas in Framing 2, the same subjects modify their choices and reduce their choices of high collateral contract. Therefore, Framing 2 interferes with self-selection and screening fails to occur.

Figure 5. Histogram by Framing and Project



We run a (panel) logistic model to confirm that self-selection is influenced by framing, as descriptive statistics show. Table 3 displays the results of the logistic analysis.

Table 3. Logit model

Prob. of Low Collateral	dy/dx	Std. Errors
F1*Safer	-0.09	0.05*
F2*Safer	-0.01	0.04
F1*Riskier	0.18	0.03***
F2*Riskier	0.32	0.02***
Number of obs.	= 1748	Wald χ^2 = 166.82
Number of groups	= 47	Prob. > χ^2 = 0.00
Obs per group:	min	= 22

Marginal effects after Random-effects logit regression. *, ** and *** significant at 10%, 5% and 1% confidence level respectively.

As expected, in both frames, the probability of choosing the low collateral contract increases when subjects have a riskier project (F1*Riskier and F2*Riskier variables). On the other hand, when subjects have the safer project, they prefer the high collateral contract in Framing 1 (see the negative sign in F1*Safer). However, having the safer project in Framing 2 does not play any significant role in subjects' choices (F2*Safer).

The results clearly support **H1** (*Contracts combining pairs of collateral and price screen agents with different risk levels*) for Framing 1. Nevertheless, by presenting the outcomes in a slightly different way in Framing 2, the results confirm **H2** (*Framing affects the valuation of collateral and interfere the screening mechanism*).

4. THEORETICAL ACCOUNTS

Given that Framing 1 and Framing 2 differ only in terms of the “perceived” initial position, it seems natural to use a reference-dependant approach to explain our results.

In this section we use our experimental data to estimate the reference-dependant parameters. We propose, following Barreda-Tarazona *et al.* (2010), the specification typically used for cumulative Prospect Theory (Tversky and Kahneman (1992) without its characteristic probability weighting functions, removed for simplicity. This specification could also be viewed as a reference-dependant Expected Utility representation.

We estimate maximum likelihood models of value function using a structural model of binary choice, following Harrison and Rutström (2008). We assume that the value function $V(W, X)$ is defined by:

$$V(W, X_i) = \begin{cases} (X_i - W)^\alpha & \text{if } X_i \geq W \\ -\lambda (W - X_i)^\alpha & \text{if } X_i < W \end{cases} \quad [5]$$

Where W is the reference point, X_i is the specific outcome, α is the parameter indicating the curvature of the value function, and λ is the loss aversion parameter (normally above 1).

In particular, our model is defined by:

$W = 300$; the initial wealth.

$$X_i = \begin{cases} 600 - Price & \text{if } X_i \geq W \text{ and Safer Projectt} \\ 0 - Deposit & \text{if } X_i < W \text{ and Safer Project} \\ 1080 - Price & \text{if } X_i \geq W \text{ and Riskier Project} \\ 0 - Deposit & \text{if } X_i < W \text{ and Riskier Project} \end{cases}$$

Under the reference-dependant value (RDV), the value associated with a lottery p satisfies:

$$RDV(p) = \sum_{i=1}^n p_i V(W, X_i) \quad [6]$$

We estimate the models using the clustering method that allows for within-subjects choices' correlation. Table 4 shows the estimated parameters and Figure 6 depicts the resulted functions.

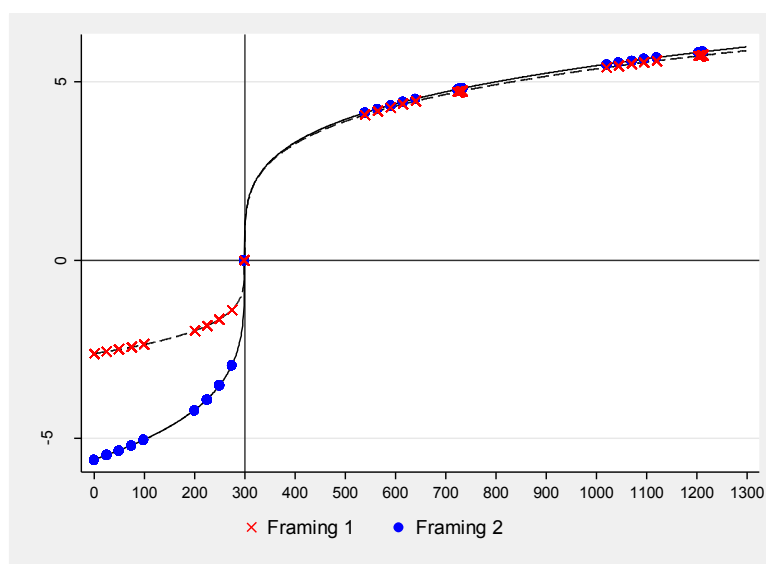
The estimated α parameter, $\alpha=0.26$, shows risk aversion. Interestingly, the estimated α do not differ significantly between Framing 1 and Framing 2 (p -value= 0.95). As expected, above the initial wealth (300), subjects' choices are similar for Framing 1 and 2 (see Figure 6).

Table 4. Estimated Reference-Dependant Parameters

	Framing 1		Framing 2	
	Coefficient	Std. Errors	Coefficient	Std. Errors
α	0.26	0.04***	0.26	0.03***
λ	0.61	0.22***	1.28	0.29***
	Number of obs. = 871		Number of obs. = 877	
$H_0: \alpha_{F1} = \alpha_{F2}$ p -value= 0.95				
$H_0: \lambda_{F1} = \lambda_{F2}$ p -value= 0.03				

Standard Errors adjusted for 47 clusters in subject. *** significant at 1% confidence level.

Figure 6. Estimated Reference-Dependant Parameters



However, below the “perceived” reference point of 300, the same subjects facing the same menus of contracts make different decisions in Framing 1 and Framing 2. Remember that Framing 1 differs from Framing 2 only in the

presentation of outcomes⁹ (see Figures 2 and 3). The estimated λ parameter is significantly different in Framing 1 and 2, p -value= 0.03. In Framing 2, the $\lambda > 1$ shows loss aversion. Subjects perceive the outcomes below 300 (for example, 300-225 in Figure 3) as a loss, and loss aversion is elicited. No loss aversion is elicited by Framing 1, $\lambda < 1$, were the outcomes are shown in absolute values (for example, 75 in Figure 2).

An essential feature of Prospect Theory is that the carriers of value are gains and losses rather than the final outcome (i.e. gains and perceived losses, in our experiment). Loss aversion is the behavioral assumption that postulates that individuals, from their reference viewpoint, value losses more than gains. This implies, as shown in Figure 6, that the perception of a potential loss generated by the collateral contract terms makes subjects overweight this contract component. In Framing 2 subjects perceive that they are already enjoying a good (the initial wealth), and realize that with some probability they can lose this existing good (collateral)¹⁰. Loss aversion interferes with the self-selection of subjects in Framing 2, and the screening mechanism fails.

5. CONCLUDING REMARKS

Inspired by the reference-dependant approaches, and most prominently by the seminal works of Kahnemann and Tversky and their Prospect Theory, we have conducted an experiment to study framing effects in the classic problem of credit screening, a problem with important economic and policy implications.

Extant theories on credit screening assume that borrower' preferences among different combinations of interest and collateral systematically depend on their risk levels. However, these models so far, have not addressed an important question for such settings: Does the framing of the offered menu of contracts interfere with the self-selection of clients? We have found that framing affects the valuation of collateral and interferes with the screening mechanism. In fact, subjects' choices shift when the same (positive) outcomes of the same menu of contracts are presented in two different frames.

Since both frames differ only in the perceived reference point, we use a reference-dependant approach that initially follows Prospect Theory to explain our results. This approach takes explicitly into account that individuals, from their reference viewpoint, value losses more than gains. In fact, our results show that the "loss perception" generated by the collateral contract terms makes subjects overvalue this contract component. Subjects exhibit loss aversion in their perception and assessment of the collateral —although framed as a positive outcome under the reference point—, and self-selection fails to occur.

⁹ Both Framings even share exactly the same instructions.

¹⁰ In the same line, Georgantzis & Navarro-Martínez (2010), in their paper on psychological processes behind the endowment effect, find that two different phases contribute to the endowment effect: (1) a first phase of enhancement of subject's positive feelings produced by ownership and (2) a second phase of aversion to possible loss.

Our result emphasizes the need to account for the frames of reference under which evaluations of probabilistic information take place. In general, principal-agent games and the theoretical models on financial markets should take into account the reference points (and the related concept of endowment effect).

This finding can be used to explain the mixed empirical results reported in the literature on the relationship between collateral and borrower risk¹¹. Banks — and more generally principals— should consider framing and the agents’ reference point when offering a menu of alternatives.

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¹¹ Berger & Udell (1998) offer a comprehensive review of this literature. Some papers show that secured lending is associated with risky borrowers [i.e. Orgler (1970), Hester (1979), Scott & Smith (1986), Leeth & Scott (1989), Berger & Udell (1990), Berger & Udell (1992), Booth (1992), Jimenez & Saurina (2004)], and others find the opposite relationship [Cressy (1996), Machauer & Weber (1998), Burke & Hanley (2006), Comeig *et al.* (2010)].

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