**PhD THESIS ABSTRACT**

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# Thesis Title:
# *Facing Loss: Reactions of Microeconomic Agents*

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**Abstract**

The first part of the thesis is the paper “A Bank Competition Model with TBTF Subsidy”, develops a theoretical model which could offer some insights on the effects of a systemic subsidy on the competition dynamics among banks.

In Chapter 1, there is the introduction to the work, with the research objective.

In Chapter 2, there is the literature review on the subject.

In Chapter 3, there is the description of the modelled economy and the agents.

In Chapter 4, the static symmetric game case is developed.

In Chapter 5, the static asymmetric game, with the subsidy, is developed and the Sub-game Perfect Nash Equilibria is found.

In Chapter 6, the effects of the too-big-to-fail are analysed.

In Chapter 7, conclusions are drawn.

The second part of the thesis is the paper “Response Time under Gains and Losses”, which has investigated cognitive effort exercised by subjects in a variety of games - binary and continuous choices, in both the individual context and in the social one - taking response times as a proxy. Its main focus has been the difference in the level of cognitive effort between the loss and the gain domain.

In Chapter 1, there is the introduction to the work and the research objective is stated.

In Chapter 2, there is the literature review on the subject.

In Chapter 3, there is the description of the experiment held in CESARE lab at LUISS Guido Carli university.

In Chapter 4, there is the analysis of response times, with a particular emphasis on the role of the domain.

In Chapter 5, conclusions are drawn.

# Summary

The first paper, “A Bank Competition Model with TBTF Subsidy”, develops a theoretical model which could offer some insights on the effects of a systemic subsidy on the competition dynamics among banks. There are three types of agent interacting with each others: banks, bond holders and entrepreneurs. Each one of them is perfectly informed. The interactions among the agents develops in two periods, $t = 0, 1$, in a static game setting.

There are two banks in this economy, bank $i$ and bank $j$, competing à la Bertrand both in the bond market and in the loan market in $t = 0$. The competition is modelled with a two-stage game. In the first stage they compete in the bond market, choosing strategically the yield to offer for their bonds. Once they acquire a bond supply, in the second stage they use it to sell loans to entrepreneurs, competing on the loan rate. Basically, the decisions taken in the bond market act as a capacity constraint for the choices in the loan market. In $t = 1$ there are no strategical decisions to take. The investment project of the entrepreneurs (who borrowed money from the banks) comes to maturity, leading to two possible scenarios:

- Good scenario: the project succeeds, thus the entrepreneurs repay their loans to the banks, which can repay the bond holders. This happens with probability $1 - \omega$.
- Bad scenario: entrepreneurs default on their loans and cannot repay the banks. This happens with probability $\omega$. At this point, two things may happen: neither institution is systemic, thus they both go bankrupt and fail to repay their bond investors; or one institution is systemic - without loss of generality we assume it is bank $i$ -, leading to the following scenario:
  - The non-systemic bank goes bankrupt. It cannot pay back its bond holders and exits the market;
  - The systemic bank can receive a subsidy, with probability $1 - \sigma$, or not, with probability $\sigma$. If it does receive it, the State or the central bank wipes its balance sheet clean and pays back the bond holders only their initial investment (alternatively, the bank becomes state owned, i.e. Monte dei Paschi di Siena, to mention one). Otherwise, the bank goes bankrupt.

In this economy there is a finite continuum $B$ of bond holders. In order to model their behaviour and derive the bond supply schedule, I use a spatial competition model, as in **?**, and take from

the literature of consumer inertia models with switching costs, with some modifications to suit my needs.

As in the traditional model, the $B$ bond holders are uniformly distributed on a line going from 0 to 1; however, instead of representing a linear city, along which consumers are distributed and the firms are located at a certain distance, the line represent the level of "risk preference" of the bond holders[1], which I call $\gamma$, going from very risk loving individuals ($\gamma = 0$) to highly risk averse ones ($\gamma = 1$). This parameter must not be considered as traditional risk aversion, it is simply a taste for risk, a behavioural characteristic. Bond holders are placed over the line according to their risk taste and they place on it the two banks as well, on the basis of each bank's perceived risk profile. The latter depends from a mix of the bank's own characteristics, exogenous to the model, like the banks' regulatory capital (the banks' loan policies in the second stage game do not change the perception bond holders have on the riskiness of the bank[2]), and the presence of the TBTF subsidy. One might ask, why not simply assume that the position of the banks on the line depends simply on each bond holders' preferences about a bank (i.e.: it's physically closer, or it's the family bank, etc.). It this were the case, than the presence of the subsidy would not influence the place of the banks on the line; therefore, the subsidy would not be important for bond holders at all. If I go to a bank because it has been my family bank for generations, whether it is systemic or not would not particularly concern me: its riskiness is only one of the main factor determining my choice of that specific bank. Instead, assuming that the line is the space of risk taste, and risk taste is what determines the position of the bank on the line, allows to link the bond holders' choice to the presence of the subsidy or not and to isolate the subsidy effect in the competition among banks.

In the case represented in Figure 1 below, bank $i$ is seen as safer, so it is placed toward the right end of the line, in position $1 - b$, while bank $j$ is perceived as riskier, so it is placed toward the left end of the line, in position $a$. This perception is common among all $B$ bond holders. As far as the positions of the banks are concerned, there are only two assumption:

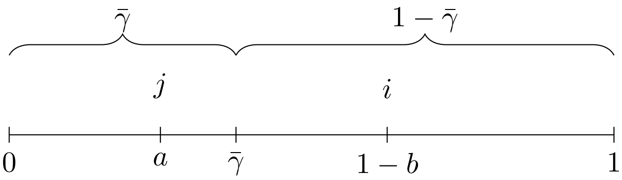
1. $a \leq 1-b \Rightarrow a+b \leq 1$. This is to ensure that in position $a$ there is always the bank perceived as riskier, which cannot be to the right of the "safer" bank, placed in $1 - b$ (remember, the closer we are to 1, the more the individuals are risk averse). From this, we can derive that:
   - $a \in [0, 1)$;
   - $(1 - b) \in (0, 1]$;
2. $a$, $b \leq \frac{1}{2}$. This assumption ensures no bank begins with a turf of clients greater than half the entire supply, making competition for bond holders in the middle more meaningful.

Each bond holder would like to invest in the unit bond of the bank that is closer to its level of risk preference, since moving away (i.e. switching from one position to another) entails a cost,

[1] In inertia models, the line represents the taste for the product of the firm.

[2] The model develops around a static game. Once the game is over and the entrepreneurs pay or not their loan back, the model ends. There is no repetition; therefore, bond holders cannot update their risk perception based on the loan policies previously chosen by the banks. Their perception is the result of the status of each bank at the beginning of the game, in $t = 0$.

Figure 1: The $\gamma$-line




$m > 0$. This cost can be seen as a compromise cost, which the bond holder pays when she has to "compromise" for a bank whose risk profile does not perfectly match her own. The cost is such that the bond holders in the space between one extremum and the bank have no incentive to choose the bank further away, rather than the closest one, even if the former were to offer a better yield.

As we can see from Figure 1, bond holders to the left of $a$ are going to invest in bank $j$, those to the right of $1-b$, are going to invest in bank $i$. As far as the middle segment is concerned, we need to determine which share of bond holders are going to invest in which bank. In order to do so, we need to find the level of risk preference of the indifferent bond holder, $\bar{\gamma}$; in other words we need to find, the position of the bond holder who is indifferent from investing in a unit bond of either banks. In this way, we can determine the bond supply fractions and each bank's bond supply: $b_i = (1-\bar{\gamma})B$ and $b_j = \bar{\gamma}B$.

Finally, there is a finite continuum of moneyless, risk neutral entrepreneurs.

At $t = 0$ , each one of them wishes to borrow a unit loan from one of the banks to fund a risky investment project, which at $t = 1$ will either return a positive profit, or fail and return zero. For simplicity, I assume no screening or monitoring process of the entrepreneurs by the bank.

I assume a linear loan demand specification, $L - cr^l$, as in MMR (2010), where $L$ is the total loan demand (the loan demand at zero interest rate) and $c$ is a linear coefficient representing the sensitivity of the loan demand to changes in the interest rate. The loan demand schedule for bank $i$ is:

$$l_i(r_i^l, r_j^l, b_i) = \begin{cases} min\left\{b_i, L-cr_i^l\right\} & \text{if } r_i^l < r_j^l \\ min\left\{b_i, \frac{L-cr_i^l}{2}\right\} & \text{if } r_i^l = r_j^l \\ min\left\{b_i, RD_i(r_i^l, r_j^l, b_i)\right\} & \text{if } r_i^l > r_j^l \end{cases} \qquad (3.3.1)$$

where $r_i^l$ is the loan rate charged by bank $i$, $r_j^l$ is the one charged by bank $j$ and $RD_i(r_i^l, r_j^l, b_i)$ is the residual demand of bank $i$.

As far as the residual demand (the loan demand remaining to the "looser" after the competition "winner" exhausts its loan supply) is concerned, I follow **?** in not choosing a specific rationing rule, but instead I define three conditions the residual demand must fulfil, in order for equilibria to exists:

1. $RD_i(r_i^l, r_j^l, b_i)$ is jointly continuous in $(r_i^l, r_j^l)$ and decreasing in $r_i^l$;

2. $\lim_{r_i^l \to r_j^l} RD_i(r_i^l, r_j^l, b_i) = max\left\{l_j(r_j^l) - b_j, 0\right\}$;

3. $RD_i(r_i^l, r_j^l, b_i) \leq \dfrac{l_i(r_i^l)}{2}$ for all $r_i^l > r_j^l \geq l_j^{-1}(b_i + b_j)$;

The first conditions is standard for every demand function. The second one ensures that at the limit the residual demand is equal to the entire demand at $r_j^l$ minus the demand satisfied by bank $j$ or it's 0 because bank j has supplied all the demand. The third one guarantees that the residual demand of the high rate bank cannot be grater than half the demand it would face on its own.

Bank $j$'s loan demand schedule and residual demand conditions are perfectly symmetrical.

Using backward induction, I find the Sub-game Perfect Nash equilibrium for the static asymmetric game, where only one bank has the subsidy:

- First stage game:

$$r_i^{b,S*} = (1-\omega)(1+\bar{r}^l)\frac{(2+t_i)}{3t_i} - 1 - \frac{(2h_b + h_a + sub)}{3s}$$

$$r_j^{b,S*} = (1-\omega)(1+\bar{r}^l)\frac{(1+2t_i)}{3t_i} - 1 - \frac{(2h_a + h_b - sub)}{3s}$$

- Second stage game:

$$r_i^l = r_j^l = \bar{r}^l : \begin{cases} l_i = \left(1 - \bar{\gamma}^{S*}\right) B \\ \\ l_j = \bar{\gamma}^{S*} B \end{cases}$$

The red parts are the ones characterising the asymmetric game with the subsidy, compared to the asymmetric game without the subsidy and represent the subsidy effect. Its intensity (evidence 4) depends on the bonds holders' risk perception of the banks (where they place them on the $\gamma$-line). The TBTF subsidy affects banking competition in the following ways:

1. Both banks are more sensitive to changes in the loan market rate. For any given level of $\bar{r}^l$, not only the systemic bank, but also the non-systemic one, seeks profit more aggressively, by offering a higher bond yields than they would if no State aid were allowed.

2. The subsidy increases the offered bond yield for the non-systemic bank, compared to the one it would charge without the subsidy in place. The systemic bank, instead, has the option to set the yield according to the level of risk in the economy and the likelihood of actually being bailed-out.

3. The optimal bond yield charged by the bank with the subsidy is always smaller than the one charged by the bank without it.

4. Since the two banks are sufficiently differentiated in terms of risk profiles for the bond holders (i.e. $a,b < \frac{1}{2}$), bank $i$'s bond supply is higher than bank $j$'s one, $b_i^{*S} > b_j^{*S}$, even though it offers a lower bond yield. The State subsidy gives the systemic bank an advantage in its competition with the non-systemic one.

The first evidence highlights the distortion in the risk-taking behaviour of both banks, in particular, if for the TBTF bank there might be a situation of moral hazard, for the non systemic institution risk incentives are distorted for the simple reason of remaining in the market. The other results, instead, confirm the competitive advantage given by the subsidy to the systemic bank, which has control over the level of its costs (evidence 2), keeping them lower than the other bank's ones (evidence 3). Moreover, since bond holders perceive the two banks as different in terms of risk profile, giving a value to being systemic (the bank is seen as safer), the TBTF bank can have a higher bond supply than its competitor, despite offering a lower yield (evidence 4).

The second paper, "Response Time under Gains and Losses", has investigated cognitive effort exercised by subjects in a variety of games - binary and continuous choices, in both the individual context and in the social one - taking response times as a proxy. Its main focus has been the difference in the level of cognitive effort between the loss and the gain domain. Response time is a cheap proxy for the cognitive effort exerted by individuals in order to reach a decision (Rubinstein, 2007). It contains information the mere choice - e.g. how much to contribute in a dictator game, which of two alternatives is selected, etc – does not.

We reanalyse data from the experiment described in Angino (2017), which presents the "loss after earned endowment" methodology as a way to effectively implement losses in a laboratory environment: subjects assigned to the loss treatment earn their endowment after the completion of a simple task that is meant to be perceived as useful for the experimenter. In this way, subjects feel rightfully endowed to their compensation and will not consider it as manna from heaven during the main phase of the experiment.

We have shown that individuals consistently exercise a higher cognitive effort when they face alternatives framed in terms of losses. Also, such increase is sizeable and rather stable across games. It goes from 20% in the dictator games to 30% in the binary choices. According to prospect theory, losses loom larger than gains. Previous research shows that the higher the incentives, the higher is cognitive effort. Hence, when playing with the same absolute values, decisions under losses require more time. For every minute spent on the experiment's scenarios in the gain treatment, around fifteen additional seconds are necessary under losses.

We have also confirmed the importance of experience. Every period decreases response time from 4 to 8%; whether this depends on the subjects acting in the social context or on the order of the games requires further investigation, as well as the higher level of cognitive effort we find when subjects face binary choices in the social context. Similarly, in line with previous literature, we found that closeness to indifference is linked with higher response times.