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*Research Article*

# Oligopolistic Banks, Bounded Rationality, and the Credit Cycle

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This paper studies how boundedly rational default expectations affect the credit cycle. I propose a simple model of oligopolistic bank competition which serves to compare situations with just a portion of boundedly rational banks to situations where either all banks are rational or all banks are boundedly rational. When all banks are boundedly rational, the credit cycle is most amplified relative to the situation where all banks are rational. However, the amplifying effect of bounded rationality on the side of banks largely remains even when only a portion of banks are boundedly rational. Hence, the interest rate decisions of a minority of boundedly rational banks induce the more rational competitors to aggravate the credit cycle.

## 1. Introduction

Credit cycles have recently gained new attention in economic research (see, e.g., [1]). In the literature that has emerged, imperfect competition among banks plays a major role (see [2, 3]). Although imperfect competition in the credit market has been extensively documented in empirical research (see [4], for a survey), no theoretical workhorse model has yet emerged. This note proposes a simple model of an oligopolistic banking market that makes the connection from individual bank behavior to aggregate credit booms and credit crunches. I simulate the course of the aggregate credit supply in the following scenarios:

(i) all banks have rational credit default expectations;

(ii) a portion of banks have boundedly rational (i.e., excessive) credit default expectations, and the remaining competitors rationally assess future credit defaults;

(iii) all banks have boundedly rational default expectations.

This analysis details a possible theoretical mechanism for the mostly empirical work on herd behavior among banks (see [5]). The results of our analysis can be summarized as follows: (i) when all banks are boundedly rational, the credit cycle is amplified compared to a situation where all banks are rational; (ii) even when the boundedly rational competitors are in the minority, the credit cycle is close to its course with generalized bounded rationality. This effect emerges because the pricing of credit by the boundedly rational players influences the loan rates of their rational competitors.

## 2. A Model of an Oligopolistic Credit Market

I model an oligopolistic market for credit by drawing on the literature on spatial competition that goes back to the contribution by Hotelling [6]. (See Capozza and Van Order [7] for a concise exposition.) We start with the duopoly setup and then extend the analysis to larger numbers of competitors. Banks compete for borrowers by setting their lending rate in a spatial economy. Bank customers are located (and evenly distributed) on a line of length one between two banks. The cost of credit for the customer, that is, his borrowing rate consists of the lending rate set by the bank plus a charge (travel or information cost) that the borrower must bear. This charge is assumed to be proportional (at rate c) to the distance ($d$) of the customer from the bank. Hence, the borrowing rates, from the two potential credit suppliers $A$ and $B$ for a customer at a distance $d_A$ from bank $A$ are

$$\begin{aligned} r_A &= i_A + cd_A, \\ r_B &= i_B + c(1 - d_A). \end{aligned} \tag{1}$$

Minimizing the borrowing costs determines the segment ($d_A^*$) that is served by bank $A$:

$$d_A^* = \frac{1}{2} + \frac{i_B - i_A}{2c}. \tag{2}$$

The demand for credit of an individual borrower is a linear function of the borrowing rate

$$k = \alpha - \beta r. \tag{3}$$

Hence, the demand for credit of bank $A$, in the market it shares with bank $B$, is

$$k_A = \int_0^{d_A^*} [(\alpha - \beta i_A) - \beta c x] dx. \tag{4}$$

Evaluating this definite integral yields

$$\begin{aligned} k_A &= \left[ (\alpha - \beta i_A) x - \frac{\beta c x^2}{2} \right]_0^{d_A^*} \\ &= (\alpha - \beta i_A)\left(\frac{1}{2} + \frac{i_B - i_A}{2c}\right) - \frac{\beta c}{2}\left(\frac{1}{2} + \frac{i_B - i_A}{2c}\right)^2. \end{aligned} \tag{5}$$

Similarly, a demand for credit for bank $B$ ($k_B$) can be written. So far our model is static. For the description of bank behavior over time, we assume that each bank maximizes expected profit in any given period. Expected profit of bank $A$ is written as

$$\begin{aligned} \pi_A^e = &\left[ (\alpha - \beta i_A)\left(\frac{1}{2} + \frac{i_B^e - i_A}{2c}\right) - \frac{\beta c}{2}\left(\frac{1}{2} + \frac{i_B^e - i_A}{2c}\right)^2 \right] \\ &\times (i_A - \phi_A^e), \end{aligned} \tag{6}$$

where $i_B^e$ is the interest rate expected to be set by the competing bank $B$, and $\phi_A^e$ is the expected cost of the loan as assessed by bank $A$. If, for simplicity, we assume refinancing costs to be zero, then $\phi^e$ denotes the expected loan losses due to default. The term $\phi^e$ is a key variable in the analysis and will be further discussed below. Moreover, we assume that banks form static expectations regarding the interest rate set by their competitor. Hence, $i_B^e = i_{B,t-1}$. Maximizing expected profit (i.e., fulfilling the first- and second-order conditions for a maximum) with respect to the lending rate yields the following interest rate rule for bank $A$:

$$\begin{aligned} i_A = \frac{2}{9}\Bigg[ &\left(c + i_{B,t-1} + \frac{2\alpha}{\beta} + \frac{3}{2}\phi_A^e\right) \\ &- \Bigg[ \left(c + i_{B,t-1} + \frac{2\alpha}{\beta} + \frac{3}{2}\phi_A^e\right)^2 \\ &- 9\left(\frac{c\alpha}{\beta} - \frac{1}{4}c^2 - \frac{1}{2}c i_{B,t-1} + \frac{1}{2}c\phi_A^e \right. \\ &\left. + \frac{1}{2}\phi_A^e i_{B,t-1} + \frac{\alpha i_{B,t-1}}{\beta} - \frac{1}{4}{i_{B,t-1}}^2 + \frac{\alpha\phi_A^e}{\beta}\right)\Bigg]^{1/2}\Bigg]. \end{aligned} \tag{7}$$

A similar equation (with $i_B$ exchanged for $i_A$ and $\phi_A^e$ replaced by $\phi_B^e$) determines the interest rate set by bank $B$. The total credit supply for the duopoly case is found by inserting the two interest rates into the credit demand functions and adding $k_A$ and $k_B$. Consider next how the analysis changes when we add more competitors to the market. We can add a third (a fourth) competitor to our market by changing our spatial setup to a regular triangle (tetrahedron). (A close spatial analogue to the tetrahedron case—i.e., four banks with equal distances between them—could be imagined with four banks located at equal and maximum distance from each other on the terrestrial globe. While this interpretation may open up interesting perspectives for international issues, it also makes clear that the spatial representation of bank competition has its limitations. Hence, information costs with differences in a priori "distance" relative to various banks on the side of the borrower are the more realistic interpretation of our setup particularly when attempting to explain the credit cycle in an individual economy and not in the world economy.) This setup makes it possible to investigate how one single boundedly rational player can affect the total supply of credit under a triopoly and a tetrapoly. Before turning to simulations, we have to model banks' setting of their default risk premium.

## 3. Boundedly Rational Loan-Loss Expectations

The dynamics of credit risk are closely tied to business conditions. We can think of business conditions following a Markov process. In the USA, credit defaults in recession times are about three times higher than during upswings. A model of boundedly rational credit risk assessment (the $\phi^e$ of the model) can be built based on the assumption that bankers have a limited experience span and thus, in their Bayesian learning, overestimate the risk of default in recessions and underestimate this risk as the upswing continues for several years. This process of boundedly rational learning of expected credit defaults is detailed in Rötheli [8]. Here, I summarize the stylized dynamics derived from that analysis in a graphical display. Figure 1 shows the course of the credit default risk over the course of a typical U.S. business cycle. According to the NBER data, and looking back over 11 complete cycles from 1945 until 2009, the average duration of a cycle is approximately 24 quarters (70 months) with the average recession lasting 4 quarters (11 months) and the average expansion lasting 20 quarters (59 months). Rationally assessed credit default risk rises during the recession and falls during the upswing. During the recession and during the early stages of the upswing, the boundedly rational risk assessment is overly pessimistic. However, in the course of the later stages of the upswing, boundedly rational banks form an overly optimistic assessment of credit risks and set an overly low default premium. Quantitatively, the two paths displayed are designed to capture the magnitudes derived from the simulations with Bayesian learning. (Based on the empirical magnitudes for the U.S. economy, the boundedly rational

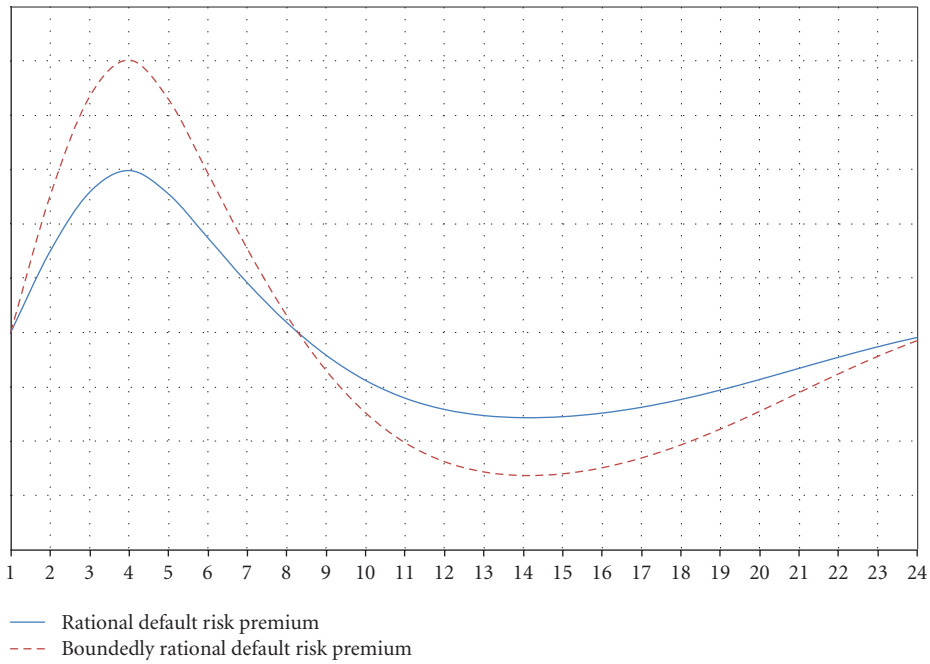


Figure 1: The rational and the boundedly rational default risk premium over the business cycle.

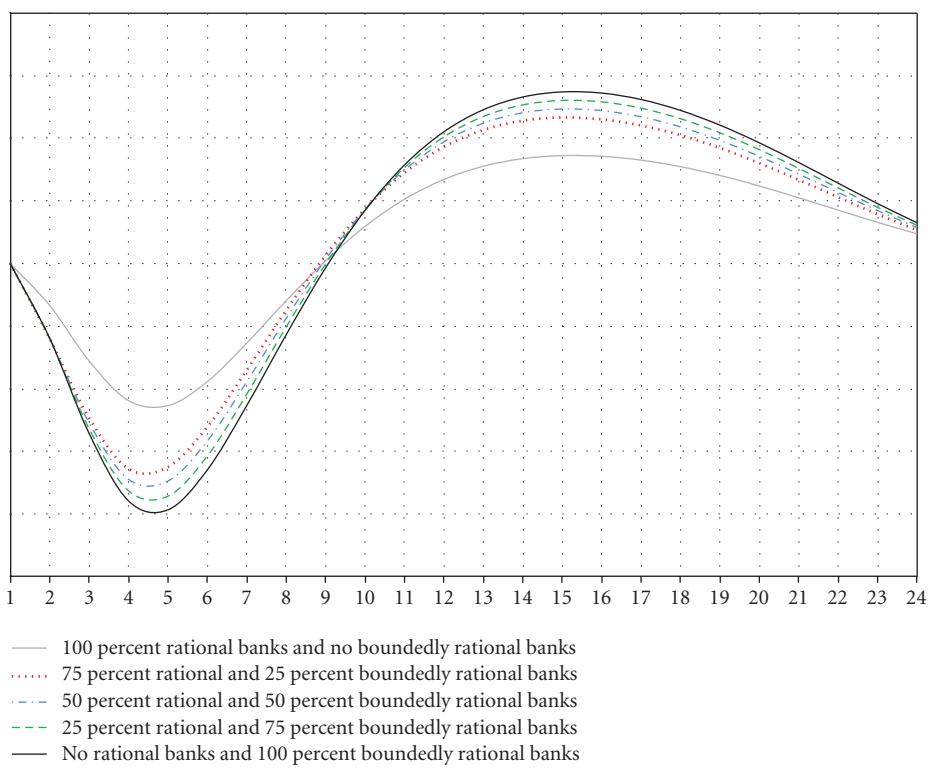


Figure 2: The aggregate credit cycle with various portions of rational and boundedly rational banks.

default expectations ($d_t^{\mathrm{BRE}}$) are described as $d_t^{\mathrm{BRE}} = d_t^{\mathrm{RE}} + 0.677(d_t^{\mathrm{RE}} - \overline{d})$, where $d_t^{\mathrm{RE}}$ and $\overline{d}$ stand for rational default expectations and the average of defaults over the cycle, respectively. The stylized course of $d_t^{\mathrm{RE}}$ is $d_t^{\mathrm{RE}} = d_{t-1}^{\mathrm{RE}} + 0.81(d_{t-1}^{\mathrm{RE}} - d_{t-2}^{\mathrm{RE}}) - 0.06\,(d_{t-1}^{\mathrm{RE}} - \overline{d}) - 900000000\,(d_{t-1}^{\mathrm{RE}} - \overline{d})^4$. The coefficients used here are chosen so that the implied paths replicate the stylized features of the paths derived in Rötheli [8].)

## 4. The Influence of Boundedly Rational Banks on the Aggregate Credit Cycle

In the following, we are interested in the total supply of credit in the following scenarios describing the composition of the population of banks:

(i) all banks have rational credit default expectations;

(ii) a portion of banks has boundedly rational (i.e., excessive) credit default expectations, and the remaining competitors rationally assess future credit defaults. Here, we distinguish situations with 75 percent, 50 percent, and 25 percent of rational banks;

(iii) all banks has boundedly rational default expectations.

Comparing these scenarios leads to an assessment of the pulling power of just a fraction of boundedly rational players on total credit supply. Here, we use the tetrapoly version of the model, that is, we have a total of four competitors. Figure 2 shows the results of our simulations. (For the calculations, we use the parameter values $\alpha = 1$, $\beta = 1$, $c = 0.05$, $\gamma = 0.01$, and $\delta = 0.03$.) The grey line indicates the course of the credit cycle if all competitors hold rational views about credit risks. The solid black line shows the swing of aggregate credit if all banks are boundedly rational. Clearly, the cycle is amplified by boundedly rational behavior. But here are the surprising insights: going from zero percent to just 25 percent of boundedly rational players (i.e., the dotted red line) brings the credit cycle markedly closer to where it is with all banks being boundedly rational than to where it is with all banks being rational. Conversely, when going from 100 percent bounded rationality in the market to just 75 percent (i.e., introducing 25 percent of rational players) has only a marginally attenuating effect on the cycle (see the dashed green line).

## 5. Conclusions

Boundedly rational banks amplify the credit cycle compared to the course of aggregate credit when banks assess credit risk rationally. This amplifying effect of bounded rationality largely persists when only a fraction of banks are boundedly rational. This results because the boundedly rational players' pricing of credit induces a rational herding effect on their rational competitors. The welfare effects of the described changes in lending rates induced by bounded rationality differ between booms and recessions. With oligopolistic competition, the lowering of interest rates and the ensuing lending boom during good times increase welfare. This result is similar to the welfare increasing effect of a positive monetary shock with monopolistically competitive firms documented by Mankiw [9]. In contrast, the credit crunch in bad times aggravated by bounded rationality is clearly welfare reducing.

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