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Credit rationing by loan size: A synthesized model☆

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ABSTRACT

We construct a synthesized model to study credit rationing by loan size. In our model, the borrower faces a trade-off between raising debt and exerting costly effort to undertake an investment project. In the absence of agency costs, increasing the loan size at the equilibrium interest rate raises the default risk and hence reduces the average cost of the loan for the borrower, so the borrower always demands a larger loan than what the lender can offer. Furthermore, agency cost raises this excess demand for a given interest rate. If the agency cost is sufficiently high, the borrower is unable to obtain the loan she needs at any interest rate, requiring the use of non-price instruments in the loan contract. In sum, we generalize the two types of credit rationing in a unified framework that facilitates our understanding of credit rationing due to various ex-post agency issues.

1. Introduction

In classical demand-supply economic theory, market clears through price. A buyer can get as many of the goods as she demands by offering the competitive market price. This is the case for any traditional goods such as apples or desks. In credit markets, where the interest rate is referred to as the loan price, the situation is different. Instead of adjusting the loan price or the interest rate to reach market clearing, lenders often set limits on the loan size for certain borrowers, especially small- and medium-sized enterprises (SMEs). This phenomenon is called credit rationing by loan size or quantity credit rationing.

Given the importance of SMEs for innovation, economic growth and employment (e.g. Beck, Demirguc-Kunt, & Levine, 2005), credit rationing have attracted much attention among researchers in the past four decades. The main focus has been to understand what credit rationing is and how to mitigate its effects on the real economy. It has been understood that there are two main cases of credit rationing. In the first case, some borrowers demand larger loans than their lenders can offer at the market interest rate. In the second, some borrowers may not get the loans that they need at any interest rate, i.e., they are denied by lenders.[1] The two cases are both widely observed in practice (see e.g. Becchetti, Castelli, & Hasan, 2010; Cowling, 2010; Gaiotti, 2013). Although both cases are called credit rationing, they are different in nature. In the former case, raising the interest rate is sufficient for the borrower to get financed, although the borrower prefers a larger loan size at the ruling market interest rate. This is well explained by Jaffee and Russell (1976) and is henceforth referred to as the *JR-type* rationing. In the latter case, modeled by Tirole (2010) and so called the *Tirole-type* rationing in the following, the borrower cannot get financed at any interest rate. Although well developed, the theories of the two types of credit rationing are isolated. This leaves unanswered questions. What is the intrinsic link between the two types of rationing? And

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[1] In the literature, there is no strict consensus concerning the definition and classification of credit rationing (Jaffee & Stiglitz, 1990). For example, De Meza and Webb (2006) classify credit rationing into two types. One is the *JR-type* rationing. The other is called random rationing proposed by Stiglitz and Weiss (1981). Random rationing is defined as the situation in which the lender randomly chooses borrowers to be granted credit or be rationed. In this case, none of the contract instruments is used to ration credit. The significance of random rationing has been questioned both theoretically (e.g. Arnold & Riley, 2009; Su, 2012) and empirically (e.g. Berger & Udell, 1992).

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in which state of the economy are we likely to observe one type of credit rationing over the other?

To answer these questions, the current paper constructs a unified framework to incorporate the two strands of theories. We start with a perfect credit market and illustrate that limited liability and uncertainty can induce the *JR-type* credit rationing with no efficiency loss. We then introduce agency problems to our analysis. When the agency problem is not severe, the borrower can still obtain financing at equilibrium, albeit with a smaller loan size. This is still the *JR-type* credit rationing but with a deadweight loss. For high enough agency costs, the borrower cannot be financed at any interest rate, i.e. in the sense of the *Tirole-type* rationing. Our results may imply that, in good times of an economy or a credit boom, firms could be mainly experiencing the *JR-type* credit rationing. In bad times or economic recessions when agency problems are arguably more severe, all else equal, more firms are denied credit experiencing the *Tirole-type* rationing.

Our baseline model considers the relationship between a borrower or entrepreneur, who has an investment project under finance, and a bank in a competitive credit market. The borrower undertakes the project through debt from the bank as well as personal effort that reduces the initial cash investment with a convex cost. Without any agency problem, the borrower balances the cost between personal effort and debt, and chooses the optimal contract along the loan offer curve, which is the zero-profit curve of the lender in the *loan size–interest rate* space. At equilibrium, the marginal cost of effort is equal to the marginal cost of debt. Due to default risk, the interest rate is not the *effective* price of the loan. A larger loan size requires a higher interest rate to compensate the lender for higher default risk, so the loan offer curve is positive-sloping. Although the marginal cost of debt is constant along the loan offer curve, increasing the loan size for any given interest rate reduces the cost of the loan, so the borrower would prefer a larger and hence cheaper loan than the lender can offer. This is analogous to the *JR-type* credit rationing. As there is no agency cost, such kind of rationing is not a proof of efficiency loss.

Our baseline model, like the Jaffee and Russell (1976) model, relies on the positive-sloping loan offer curve to derive credit rationing, but the two models differ in the key drivers of the positive slope of the offer curve. Jaffee and Russell (1976) focus on the consumer credit market with unlimited liability and information imperfection. The loan supply curve is positive-sloping because, with a larger loan size, the proportion of *dishonest* borrowers is higher and so is the default rate. We instead focus on the commercial loan market, where borrowers have limited liability and the project's future payoff is uncertain. The positive slope of the loan offer curve is due to the higher default risk following a larger loan size, even if information is perfect. De Meza and Webb (1992) develop a divisible-investment model to illustrate a similar form of rationing. Our model differs from the De Meza and Webb (1992) model mainly in that we assume a fixed initial investment, which simplifies the analysis and makes it possible to extend our model to allow for agency problems.

We then introduce ex-post agency problems to extend our baseline model. Agency costs shift the loan offer curve upward, reducing the loan size for any given interest rate. Again, the positive slope of the loan offer curve induces the *JR-type* rationing at equilibrium, provided that the borrower is able to get financed when the agency cost is low. In this case, the marginal cost of debt is no longer constant along the offer curve due to agency costs, and the equilibrium is associated with an efficiency loss. For sufficiently high agency costs, the borrower cannot get financed at any interest rate, i.e., the *Tirole-type* rationing occurs. We further illustrate the above idea in examples with various agency problems, including costly state versification (e.g. Gale & Hellwig, 1985; Williamson, 1987), money diversion (e.g. Hart & Moore, 1994), risk-shifting (e.g. Jensen & Meckling, 1976; Stiglitz & Weiss, 1981) and hidden shirking (e.g. Tirole, 2010). The paper hence constructs a unified framework that incorporates the two different rationing forms and shows the intrinsic link between the two isolated theories of credit rationing. This makes it easier for people to understand the underlying reasons for credit rationing by the loan size.

To mitigate credit rationing, non-price instruments are necessary in the loan contract. We use collateral as an example to illustrate how non-price instruments can mitigate agency problems and hence ease debt finance. Pledging collateral shifts the loan offer curve downward and hence expands the borrowing capacity. This gives an explanation for the wide use of non-price instruments in bank loans (e.g., Berger, Espinosa-Vega, Frame, & Miller, 2011; Berger, Frame, & Ioannidou, 2011).

Our model is built on the assumption of competitive credit markets. This is a common assumption in the theoretical literature of credit rationing (e.g. Jaffee & Russell, 1976; Stiglitz & Weiss, 1981; Tirole, 2010; Williamson, 1987, etc.). In a different setting where the lender is a monopolist, Schreft and Villamil (1992) illustrate that credit rationing by the loan size may occur due to imperfect information.

The rest of the paper is organized as follows. Section 2 constructs the baseline model with perfect information and derives the *JR-type* rationing without efficiency loss. Section 3 extends the baseline model and shows how various agency problems induce both the *JR-type* and *Tirole-type* credit rationing with efficiency loss. Section 4 discusses how the use of collateral expands the borrowing capacity. Section 5 concludes.

2. The baseline model

2.1. Setup

Consider the borrowing-lending relationship between a borrower and her lender. The borrower is a firm with limited liability. The lender is a bank or some other financial intermediary. Both parties are risk neutral. The credit market is competitive in the sense that in expectation, the lender obtains zero-profit from any individual borrower. It follows that the loan offer curve is the zero-profit curve of the lender and that the borrower is free to choose any contract along this loan offer curve. Denote the cost of bank loanable funds as γ, which can be thought of as the deposit rate plus an intermediary fee.

There are two dates, date 0 and date 1. At date 0, the borrower undertakes her investment project that requires a fixed investment I and has stochastic total return x at date 1. The borrower cannot quit before the return is realized, so she only cares about her expected payoff at the end of the period. The distribution of x is exogenously given by the cumulative distribution function, $F(\cdot)$, or equivalently by the density function, $f(\cdot)$, with support $[m, M]$ where $M > m \geq 0$. The project is profitable if fully financed by debt, i.e., $\int_m^M x\,dF(x) > \gamma I$.

For simplicity, we normalize the initial net worth of the borrower to zero. To start the project, the borrower exerts cash-equivalent effort E as well as raising debt D, where $D + E = I$. What we have in mind here is the case in which, although the initial investment of the project is fixed, the borrower is able to reduce debt borrowing by exerting more effort, for example, by more effectively organizing the project. This is a plausible case for SMEs. For example, the owner of a small firm may use public transportation, instead of a fancy car, to do business. This reduces the initial investment, but costs more effort. In another case, the entrepreneur may work harder to reduce the number of employees and hence reduce