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Two-sided matching in the loan market ☆

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ABSTRACT

This paper investigates the matching between banks and firms in the loan market. We estimate a many-to-one two-sided matching model using the Fox (2010) matching maximum score estimator. Using data on the U.S. loan market from 2000 to 2003, we find evidence of positive assortative matching of sizes. Moreover, we show that banks and firms prefer partners that are geographically closer, giving support to the importance of physical proximity for information gathering and expertise sharing. We also show that banks and firms prefer partners with whom they had prior loans, indicating that prior loan relationship plays an important role in the selection of current partners.

1. Introduction

Bank loans play a unique role in corporate financing. They are important not only for small businesses, which often lack access to public debt markets, but also for large corporations, which depend on them as a reliable source of liquidity helping to insulate them from market shocks (James and Smith, 2000; Saidenberg and Strahan, 1999). Furthermore, bank lending is an important conduit for monetary policy and is closely linked to investment and macroeconomic activity (Kashyap and Stein, 1994).

Given the importance of the loan market in the economy, it is critical for policymakers and researchers to understand the workings of the loan market. In particular, knowledge of how banks and firms choose each other (the matching between banks and firms) is important for effective policy making in the loan market and more generally for economic development.

For example, if we find that in the loan market small (large) firms generally match with small (large) banks (positive assortative matching of sizes), and assuming that this pattern cannot be easily changed in the short run, then a policymaker with the objective to increase the availability of credit to small businesses should focus on improving the economic environment for small banks and strengthening their incentive to lend. Restrictions on bank mergers and acquisitions can also help, as consolidation in the banking sector leads to the dominance by large banks who do not lend much to small businesses.

Similarly, an assessment of the role of physical proximity in banks and firms' selection of partners will prove useful for state and local officials who aim at spurring industrial investment in the local economy, and for federal regulators who contemplate restrictions on interstate banking activities.

While the loan market has attracted a considerable amount of scholarly attention, most of the existing research has been on issues such as the determination of loan interest rates and the analysis and prediction of loan performance, and little has been done to formally investigate the matching between banks and firms. This paper fills the gap by estimating a two-sided matching model of banks and firms in the loan market. In the model, banks choose firms, firms choose banks, and they all face a tradeoff between the match quality and the transfer, as explained below.

First, from the perspective of each agent (bank or firm), matching with different partners generates different match values, giving rise to agent-specific rankings of potential partners. For example, according to Cole et al. (2004), large banks rely on standardized quantitative criteria to assess loan applications (a "cookie-cutter" approach), while small banks favor qualitative criteria based on loan officers' interactions with loan applicants (a "character" approach). At the same time, large firms are more likely to have well-documented track records and financial information, while small firms tend to focus more on relationship-building. Therefore, a large firm is a better match for a large bank's cookie-cutter approach, whereas a small firm is a better match for a small bank's character approach. In addition, large firms tend to need large loans, and small firms tend to need small loans, which also

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makes them attracted to large banks and small banks, respectively. Similarly, agents' preferences for other attributes in their partners, such as physical proximity and prior loan relationship, also give rise to agent-specific rankings of potential partners.

Second, when a bank and a firm enter into a loan ("form a match"), the price and non-price characteristics of the loan determine the transfer of utility between the partners. The loan interest rate is clearly an important factor in the transfer, but other characteristics of the loan matter, too. For example, everything else equal, a borrower gives up more utility to the lender if collateral is pledged (secured loan); similarly, other characteristics such as maturity (i.e., the length of the loan, which, together with the interest rate and the discount rate, determines the net present value of all interest payments), loan size and upfront fees also influence the division of utility between the bank and the firm.[1] In this paper we model the matching between banks and firms using a transferable utility matching framework: the transfer is endogenously determined at the time of the matching, and an agent is willing to trade away match quality in order to obtain a better transfer.[2]

Estimation of the model uses the Fox (2010) matching maximum score estimator. The estimator makes use of the inequalities regarding the match values implied by the matching equilibrium. Take any two pairs that are matched in the equilibrium and swap the partners. The equilibrium condition requires that the original sum of match values be greater than or equal to the new sum of match values after the swap. The estimator maximizes the number of such inequalities that are satisfied.

Using data on the U.S. loan market from 2000 to 2003, we find evidence of positive assortative matching of sizes, that is, large banks tend to match with large firms and small banks tend to match with small firms. Moreover, we show that banks and firms prefer partners that are geographically closer, giving support to the importance of physical proximity for information gathering. We also show that banks and firms prefer partners with whom they had prior loans, indicating that prior loan relationship plays an important role in the selection of current partners. We also test a couple of other hypotheses regarding the matching and do not find support for them.

2. Model

We consider a two-sided matching model of the loan market, in which banks choose firms, firms choose banks, and the market outcome is an equilibrium matching which depends on the match values of all the bank–firm pairs (match values and the equilibrium concept are defined later).

When a bank and a firm enter into a loan ("form a match"), they also decide on the price and non-price characteristics of the loan, which determine the transfer of utility between the partners. The transfer is endogenously determined at the time of the matching, and an agent is willing to trade away match quality in order to obtain a better transfer. We therefore model the matching between banks and firms using a transferable utility framework.

2.1. Agents and quotas

Let I_t and J_t denote, respectively, the sets of banks and firms in market t, where $t=1,2,\ldots,T$. I_t and J_t are finite and disjoint. Below the market subscript t is dropped to simplify the notation.

In the empirical implementation of our model, markets are defined by time: a market contains the firms that borrow during a half-year and the banks that lend to them. In the data the vast majority of firms borrow only once during a half-year.[3] In such a short period of time, it is likely that a firm's financial needs can be satisfied by a single loan, whereas borrowing multiple loans would increase the administrative costs, such as the costs associated with the negotiation process. Therefore it is a reasonable approximation to model that a firm matches with only one bank in a given market.

On the other hand, a bank often lends to multiple firms during a half-year. A bank's lending activity is restricted in two ways. First, loan assessment, approval, monitoring, and review processes are relatively labor-intensive, and a bank's lending activity is restricted by the amount of resources that is available for these processes, e.g., the number of its loan officers. Consequently, the number of loans that a bank can make during a given half-year is limited.[4] Second, the total amount of loans a bank can make may be constrained by the availability of deposits, the primary source of funds for bank lending (Jayaratne and Morgan, 2000). Jayaratne and Morgan (2000) find evidence that the deposits constraint on bank lending operates only on small banks whose assets are less than $100 million, and that larger banks are unconstrained because they have better access to capital markets. In our sample less than 1% of the banks have assets lower than $100 million, so the lending constraint posed by inadequate deposits is less of a concern. In our study we take the limit on the total amount of loans as non-binding and take the limit on the number of loans as binding to simplify the empirical implementation and make the model tractable.

In a market, bank i can lend to q_i firms and firm j can borrow from only one bank. The model is a many-to-one two-sided matching model with endogenous transfers (Roth and Sotomayor, 1990; Shapley and Shubik, 1971). q_i is known as the *quota* of bank i in the matching literature, and every firm has a quota of one. We assume that each agent uses up its quota in equilibrium.

2.2. Matches and match values

The set of all potential loans, or *matches*, is given by $I\times J$. A *matching*, μ, is a set of matches such that $(i,j)\in\mu$ if and only if bank i and firm j are matched. We use $\mu(i)$ to denote the set of firms that borrow from bank i, and use $\mu(j)$ to denote the set of banks that lend to firm j, which is a singleton.

For a match between bank i and firm j, let $V_b(i,j)$ and $V_f(i,j)$ denote the bank's and the firm's pre-transfer payoffs, respectively. Let $u_{ij}\in\mathbb{R}$ denote the transfer from firm j to bank i, so that the bank's payoff is $V_b(i,j)+u_{ij}$ and the firm's payoff is $V_f(i,j)-u_{ij}$. The match value is $V(i,j)=V_b(i,j)+V_f(i,j)$.

A bank can match with multiple firms. Let $V_b(i,\mu(i))$ denote bank i's pre-transfer payoff from matching with the set of firms in $\mu(i)$. We assume that $V_b(i,\mu(i))$ is *additively separable* across the firms in $\mu(i)$: $V_b(i,\mu(i))=\sum_{j\in\mu(i)}V_b(i,j)$.

2.3. Equilibrium

An *outcome* of the market consists of a matching μ and a vector of transfers u, one for each of the matches. The equilibrium concept is pairwise stability. An outcome (μ,u) is *pairwise stable* if for each pair $(i,j)\in\mu$,

$$V_b(i,j)+u_{ij}\geq V_b\left(i,j'\right)+\tilde{u}_{ij'}, \tag{1}$$

[1] Therefore neither the interest rate nor the net present value (NPV) of interest payments is the entire transfer in the loan matching. In this paper we do not study the interest rates or the transfers (the empirical method that we use to estimate the matching model does not require knowing the transfers).

[2] Chen (2013) considers a setting in which interest rates are determined by the characteristics of banks, firms, and loans, for example when banks rely on loan pricing formulas instead of negotiations to set interest rates. In this setting, he estimates the loan spread equation (how the markups of interest rates over a benchmark rate depend on the characteristics of banks, firms, and loans) while using a non-transferable utility matching model to control for the endogenous matching between banks and firms.

[3] In the data only 4.1% of the firms borrow more than once during a half-year; they are dropped from our sample.

[4] In the long run, the limit on the number of loans that a bank can make during a half-year can change, since the bank can hire or lay off loan officers if needed.