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# Peer-to-Peer Lending: An Empirical Study

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## ABSTRACT

Online peer-to-peer (P2P) lending, where individual investors provide unsecured loans directly to individual borrowers without the intermediation of banks, has experienced rapid growth in recent years. One of its defining features is the presence of social networks, which could provide important credit information about borrowers. Drawing on the literature in finance and social networks, I study whether and how network metrics affect the outcome of financial transaction in this market, and whether such credit-worthiness is supported ex post through loan performance data. Results show that relational aspects of the online social network help mitigate information asymmetry in the lending process, and that a critical success factor of the industry is to better reveal and utilize the soft credit information embedded in social networks.

## Keywords

Information asymmetry, social networks, decentralization, trust, reputation

## INTRODUCTION

Online social networks such as Facebook, LinkedIn, and MySpace, powered by the growth in digitization and Internet technologies, have dramatically altered the way users interact and connect with each other. Increasingly, these online social networks are serving as the cornerstone for new business models that promise to transform traditional commerce in several industries. One industry where “social commerce”, as this phenomenon is aptly named, is showing a transformative effect is financial lending. Online peer-to-peer (P2P) lending, where individual investors provide unsecured microloans directly to individual borrowers without the intermediation of financial institutions, has experienced rapid growth in recent months, with new loan expected to reach a billion dollars by 2010.

These players have some minor differences in their specific operations, but their similarity is more important. Unlike traditional lending which is coordinated by a centralized institution (e.g. banks), online P2P lending is largely decentralized with individual lenders making lending decisions independently or as part of a network of lenders. Lacking sophisticated risk assessment methodologies available to banks and centralized lending institutions, online P2P lenders are often dependent on social networks, or online community, to manage the risks in their transactions. Significant innovations are taking place in this arena every day and there has been very little research so far, either empirical or theoretical. Given the unique features of online P2P lending, and its potential to disrupt traditional institutional lending models, especially the role of social networks in this marketplace, our paper employs a multi-disciplinary perspective on peer-to-peer lending to examine this new phenomenon and seeks to address the following questions:

1. *Does the network structure and network position of individuals affect transactional outcomes? Can we quantify their effects?*
2. *How does the credit information conveyed through social networks, if any, relate or compare to traditional credit information of borrowers?*
3. *Does network structure and network position of members affect the performance of peer-to-peer loans? If so, how do these effects compare to their effects at the time loans are originated? Do investors overvalue or undervalue such “soft credit information” at the time of loan origination?*

Questions 1 and 3 can be considered as the business or financial value of social networks. As our literature review will show, significant theoretical and empirical research has shown a relationship between the network position of members and their economic outcomes. Our study is focused on a financial market that tries to leverage such social capital; therefore it allows us to study whether and by how much social network positions matter. Moreover, since we observe the life cycle of loans (from its origination to repayment or default), we are able to see whether investors rationally internalize the credit information about borrowers conveyed through the social networks. For instance, if certain network metrics can predict loan interest rates at the time of loan origination, but the same metric is not associated with good loan performance, investors would have overvalued the information through social networks. Question 2 attempts to juxtapose two different types of information about borrowers, and see whether one subsumes the other, or whether they have other interaction effects.

We raise these questions not merely out of curiosity but also because of their academic and practical significance. For researchers, answers to these questions should provide insights into not only the emerging P2P lending industry but also “social commerce” business models in general. While the importance of network has been widely accepted, this research could provide some quantification of its value, as well as some boundary conditions to that claim.

For practitioners, our research would help them better understand the operation of peer-to-peer lending and realize the business values of communities. Our results will also point to potential future developments in this emerging market. More generally, the study will demonstrate the potential of this new channel as opportunities of both investment and for obtaining loans, either for regional development or business growth; and we will also point out some caveats for practitioners when they are ready to participate in this new arena.

## LITERATURE AND HYPOTHESES

To date there has not been much academic work directly related to online peer-to-peer lending. But as can be seen from our characterization of peer-to-peer lending, our study can be grounded in the following streams of literature: the finance literature on information asymmetry and financial intermediation, as well as the production of information; the management and sociology literature on social networks and social capitals; and, last but not least, research on peer-to-peer communities in other industries. In this section we will briefly outline some of the major published work in these areas.

### Financial literature on information asymmetry and intermediation

Since peer-to-peer lending is first and foremost a financial marketplace, informational issues is not less conspicuous than the traditional financial industry. In particular, we focus on how the peer-to-peer lending tries to resolve the information asymmetry that give rise to formal institutions such as banks. What makes peer-to-peer lending fundamentally different is the fact that lenders and borrowers are largely matched on their own, not through a formal intermediary. Therefore, the purpose of this literature review is to identify how the functions of traditional intermediaries are replaced or improved in the peer-to-peer setting. More specifically, we first review the role of intermediaries in the traditional financial industry, or the problem of why they exist. Peer-to-peer lending, as we shall argue, provides an innovative alternative to the “information production” issue that justifies the existence of banks. After discussing the role of social network theory in finance research, particularly those on banking relationships, we summarize some seminal research on the effect of social networks on economic outcomes from sociology and management. Building upon Petersen (2002), we then propose that the peer-to-peer mechanism conveys “soft credit information” through social networks, and such information can be used by borrowers and lenders to reach efficient transactions. The literature review will also lead to our model specification and empirical hypotheses.

Information asymmetry between financial institutions and borrowers is one of the key issues in the financial industry. Such asymmetry presents itself through both ex ante adverse selection and ex post moral hazard. Gorton and Winton (1994) reviewed empirical evidence for why financial intermediaries exist, and suggested several roles that banks fulfill. Two of these roles are directly related to the issue of information asymmetry – banks as information producers, and banks as delegated monitors. If peer-to-peer lending can work, these roles should also be somehow fulfilled.

Banks as delegated monitors: Diamond (1984) argues that banks exist because ex post monitoring of borrowers is costly; hence intermediaries are established to economize on these activities. But this would induce the problem of “monitoring of the monitors”, where lenders need to be assured that the intermediary itself is indeed monitoring the borrowers. Williamson’s (1986) presentation of the Diamond result suggests that this problem can be solved by diversification: if the intermediary has an infinitely large number of borrowers, the lenders do not need to monitor the intermediary, because the market return can be ensured with probability 1 (Gorton and Winton, page 443).

Such monitoring is no less important in the context of online peer to peer lending. Despite the advancement in information and communication technologies, the fundamental issue of monitoring still exists: it will be inefficient for each investor to monitor the borrower, and whoever is delegated to monitor should assure the investors that he or she is indeed monitoring (again, the “monitoring of the monitor” problem). New business models could arise in the future to provide a crowd-production solution to this issue, but currently, most peer to peer lending websites are responsible for the ex post monitoring, with the assistance from credit bureaus and collection agencies.

Banks as information producers: Another important reason that financial intermediaries exist, as argued by Gorton and Winton (1994), is that without intermediaries, lenders are faced with two inherent issues in information production: (1) “reliability problem”: while a small number of agents can produce information about the borrowers and sell it to other lenders (thereby economizing the cost of information production), these producers cannot credibly ensure that the information he produced is valuable (Gorton and Winton 1994, page 444). This issue is first identified by Hirshleifer (1971). (2) “appropriability problem”: even if the information producer can assure other agents that the information is valuable, purchasers of the information can always easily re-sell such information, or share it with others; this would further render the production of information less economic (Grossman and Stiglitz 1980; Gorton and Winton 1994 page 444).

Peer-to-peer lending, by contrast, provides an alternative way to produce information about the borrowers. In fact, the long-term sustainability of this financial innovation critically depends on whether information production in this context can prove to be no less efficient than what is produced by intermediaries. A common feature across peer to peer lending platforms is the role of social networks: if someone who knows the borrower personally can attest to his or her credit-worthiness, or, even better, personally participates in the loan to the borrower, the loan should be relatively less risky. By leveraging the offline social network, peer to peer lending websites can reduce the cost of individually evaluating each borrower, thereby circumventing the “appropriability problem”; moreover, if the social network can prove to carry reliable information about the borrower, the “reliability problem” can also be resolved.

Information asymmetry in the financial industry extends beyond the problem of information production and delegated monitoring. Even with the presence of banks, the financial market still demonstrates a variety of problems. One of the most conspicuous issues under the intermediated finance is the credit rationing problem (Williamson 1987; Stiglitz and Weiss 2000), where some worthy borrowers will not be able to obtain loans no matter how high the interest rate they are willing to pay, because banks cannot efficiently distinguish between risky versus less risky borrowers, and the interest rate becomes too high (de Aghion and Gollier 2000). With data from peer-to-peer lending, we will be able to present some preliminary evidence as to whether such social network-based decentralized finance mechanism can help alleviate this issue, hence allowing wider access to financial capital.

Given the role of social networks in the peer-to-peer lending market, we now turn to studies in finance related to networks and banks, as well as the broader literature in economics and sociology regarding social networks and economic outcomes.

There have not been many published studies that explicitly deal with the relationship between social networks and financial intermediaries. Most of these focus on the dyadic relationship between banks and the borrowing firms, instead of the relationship among the borrowers or third parties. For instance, Blackwell and Winters (1997) found in their sample a positive correlation between bank’s monitoring effort and the loan’s interest rate, as well as an inverse relationship between the interest rate and the closeness of the relationship with banks. They argue that borrowing firms could reduce their interest rate burden by completing loan transactions with banks. Another similar example is Berlin and Mester (1997), who studied the cost and profitability of relationship lending. While these papers touch on the “relationship” dimension, they are not concerned with information about borrowers generated through the interaction among borrowers, or between borrowers and third parties.

Some organizational researchers, on the other hand, have applied social network theories to the banking sector. Uzzi (1999) applied a social embeddedness approach (Granovetter 1985) and studied how bank-borrower relationships and networks affect a firm’s acquisition and cost of capital, where the idea of “network” is formally introduced.

One notable paper related to social networks among borrowers is de Aghion and Gollier (2000). This paper presents a model similar to the Grameen bank as well as group lending in several US urban areas (de Aghion and Gollier 2000), where the borrowers form “peer groups” and then borrow from the bank. Members of a peer group take joint responsibility toward the loan: if one member defaults, other members should bear the obligation to repay; otherwise, the whole group will be denied credit in the future. The authors’ model shows that by establishing such peer groups, the adverse selection problem can be alleviated and the credit rationing problem can be resolved. While such mechanism is not yet fully implemented in P2P lending (the groups on P2P sites do not have such “joint responsibility” setup), it could very well be the next step for this market.

## Social networks and social capital literature

More broadly, many studies in sociology and management have shown that on a given network, the position of an agent can often reflect his or her resources. Those with certain positions in a network can potentially control the flow of information and other resources through the network; i.e. those in a “hub” position, those with “weak ties” (Granovetter 1973), or those occupying “structural holes” (Burt 1992). Such possession of resources associated with positions on a network is broadly defined as “social capital” (e.g. Coleman 1988). Members on these positions should usually have better economic outcomes. Moreover, in terms of financial borrowing, members in a more central or visible position on the network would be exposed to a higher level of peer pressure to comply with his or her obligations; otherwise, their default can be easily observed by other members of the network. Accordingly, in the context of peer-to-peer lending, we should expect to see members with more central positions in the network should not only have access to cheaper capital (or lower interest rates on loans), but also more likely to fulfill their financial obligations by repaying on time.

Petersen (2002) argues that in financial markets there are two types of information: hard and soft. Hard information is “quantitative, easy to store and transmit in impersonal ways”, while soft information is “difficult to completely summarize in a numeric score”. In our current paper, we define “hard credit information” as the credit profile information of borrowers, including many of the indicators adopted by banks in loan decisions: credit grade, debt-to-income ratio, number of credit inquiries, number of outstanding loans, number of public records, and so on. This is very similar to Petersen’s (2002) definition of “hard information”. On the other hand, we define “soft credit information” as the information about borrowers’ riskiness generated by his or her social network in the peer-to-peer lending community. This is related to but somewhat different from Petersen’s definition: it is absent from traditional bank’s credit information; but still quantifiable now that it has been largely digitalized. In what follows, we will study the relationship between these two categories of information at different stages of a loan lifecycle: (1) whether a loan is funded; (2) the level of the interest rate attached to the loan; and (3) whether the loan is healthy (not defaulted).

## DATA

Our data is collected from a major online peer-to-peer lending website, Prosper.com. Members who wants to borrow or lend on the website has to formally prove their true identity by providing verifications including social security number, driver’s license, and bank information. Credit report of borrowers will also be extracted from a credit bureau, and some key credit information (which we will specify below) will be presented to lenders. Lenders do not know the true identity of the borrowers, however.

Borrowers specify the amount that they would like to borrow, and the maximum interest rate they are willing to pay for the loan, as well as other information such as the duration of loans and the format of auction (close versus open). A close-format auction is one in which the auction closes as soon as the amount requested has been fulfilled, whereas an open-format auction allows the bidding process to go on so that the borrower can receive a lower rate.

Bidders, on the other hand, choose and bid on the loans through a proxy bidding process. The key design is that each individual lender need not fund the entire loan request, but rather, he or she can invest as little as \$50 on a loan. Such diversification is designed to lower the risk to lenders, but also serves to make loans more accessible to borrowers.

When the auction process ends, the listing will be processed by website staff for further verifications; during this process, the borrower could be asked to provide further documentation. Once the loan is approved, the loan originates, and the funds will be transferred from the lenders to the borrower. There will be 1-2% service fee to maintain the website, depending on the credit grade of borrowers. After that, the loan will be managed by the firm, and lenders are paid each month automatically. Borrowers who defaulted will be reported to credit bureaus and collection agencies, and will not be allowed to borrow from the site again.

We obtained information regarding borrower’s credit history, their unique identifiers (not their social security numbers), their position in the online community, features of their auctions, outcome of their loan listings, and the current status of their loans. In particular, we obtained detailed credit profile information of the borrowers at the time of listing. Our dataset contains information about loans originated between Jan 1st, 2007 and May 20th, 2008. In the next section, we will first describe the “hard credit information” and “soft credit information” used in our models, followed by summary statistics of the major variables. After that, we will present the models that we estimated to answer the research questions mentioned at the beginning of the paper.

- **Hard credit information:** including credit grades, debt-to-income ratio, bank card utilization, number of credit inquiries in the past 6 months, number of public records, record of bankruptcy, and so on. When borrowers apply for loans at banks, these are typically requested by banks to evaluate their riskiness and probability of repayment.

- **Soft credit information:** as mentioned earlier, we define soft credit information as information regarding a borrower's credit-worthiness conveyed through their role and position on the social network of members. These include the position of a borrower in the friendship network, whether they are affiliated with certain groups, the rating of that group, the size of that group (total membership size), number of endorsements (from friends) the borrower has received from friends, and the role that the member takes on in the community.
  - Friendship network: Members can be friends with each other, or can invite their offline friends online to endorse them so that they can obtain better loans terms. One of our key hypotheses is that having more friends should create the peer and social pressure on the borrower to repay the loan on time, and, therefore, this should be reflected on the condition of loans.
  - Roles: a member can take on one or more of the following roles in the community: borrower, lender, group leader (by creating groups), endorser, and so on. It should be noted that being a borrower requires the disclosure of the largest amount of personal information; while to be a lender, one only needs to provide the bank account and transfer any amount to their account. In other words, information needed to have a "lender" role is very low for borrowers. We will be able to see in our models whether investors would value such "cheap signal" in their investment decisions. By comparison, being a group leader or endorser requires no information at all.
  - Groups: Members can choose to create or join groups on any basis: geographic proximity, common interest, alumni, or any other possible commonality. However, once they create a loan while a member of a group, they are not allowed to change their affiliation until the loan is repaid in full.
- **Auction Characteristics:** These include the duration of listing, the format of auction, the maximum interest rate (similar to the starting bid in auctions), and the amount requested. We mainly incorporate these variables in the model as controls.

## MODELS AND RESULTS

To answer the research questions raised at the beginning of the paper, we specify three models for the lifecycle of the loan: (1) what factors determine whether a loan can be funded or not? (2) Given that a loan has been funded, what factors determine the interest rate at which the loan is made? And (3) what factors predict the performance of the loan once it has originated? In other words, what characteristics of borrowers can we use to predict the final outcome of loans? To ensure comparison, we use similar sets of explanatory variables in all three models, with minor differences.

### Model 1: What determines whether a loan can be fully funded?

The dependent variable of the first model is the probability of a loan getting 100% funding. This is estimated using a Probit model. The independent variable consists of three sets of information about the borrowers that we discussed in the previous section. Robustness checks have been conducted so as to ensure that results are not merely an artifact of the model setup, including the removal of variables such as duration of auctions, or changing credit grades into a continuous measure.

### Model 2: What determines the interest rate of funded loans?

After the funding has reached 100%, the final interest of the loan will depend on the format of auction that the borrower specified. For close-format auctions, the interest rate is equal to the "borrower maximum rate", or the asking interest rate. Otherwise, the listing will remain open, allowing potential lenders to bid down the interest rate. Since the interest rate of loan is meaningful only if a loan is funded, there is a selection bias if we use a simple ordinary least squares estimation. I therefore use a Heckman model to simultaneously estimate the probability of selection (having loans funded) and the interest rate of loans conditioning on the fact that it has been funded. This system of equations is estimated using a 2-stage estimation method.

### Model 3: Ex post loan performance

We propose two models to study the performance of loans: (1) a cross-sectional probit/logit model to study whether the outcome of a loan at the time of study is defaulted, and how this outcome is related to the characteristics of the borrowers at the time of the listings; (2) a survival model of the loans performance, taking into account the unique nature of loan performance data – truncation and censoring.

**Model 3a: Probit model of loan performance**

In this simple version of loan performance, we model the dependent variable as the probability of a loan to become defaulted. Here we define default as being late for 2 months or more. This is enhanced by marginal effects analysis after the Probit model.

**Model 3b: Survival model of loan performance**

We constructed a survival time dataset using status of loans in each billing cycle. A loan is considered not to be “surviving” if it is 2 months late, or more. The dependent variable, as is typical in duration studies, is “time to default”. I use a Cox Proportional Hazards Model, which is a semiparametric estimation method and typically considered more robust than its parametric counterparts.

**PRELIMINARY FINDINGS**

In this paper we empirically investigate the role of “hard credit information” and “soft credit information” in the emerging peer-to-peer lending market, which is one of the new “social commerce” business models leveraging online and offline social networks for valuable information. This market also provides a rich context for us to understand the “financial value of social capital”, or whether there are certain boundary conditions to its benefits. Drawing on theories of financial intermediation, information production and social networks, we argue that the social network of the borrower conveys important information regarding his or her credit worthiness, which we call “soft credit information”. Using data from a popular peer-to-peer lending website, we estimated three models on different stages of a loan’s lifecycle, using both hard and soft credit information as explanatory variables: (1) what determines the probability of a loan request being funded? (2) if the loan is funded, what conditionally determines the interest rate of the loan? And (3) whether and how much can we use soft credit information to predict whether a loan will be in default.

Our analysis uncovers some interesting results. In examining the value of a borrower’s social network, we find that the structural aspects of the network – for example, the degree centrality of the borrower’s friendship network – do not affect the risk of default and therefore do not help alleviate information asymmetry. The relational aspects of these online social networks are indeed valuable; however, the value of the relational aspects of these online social networks depends crucially on the verifiability of these social ties. Distinguishing a borrower’s friends on the basis of their roles, identities, and actions of friends, we find that the more verifiable the tie, the stronger the impact on the transactional outcomes. The group network also show a similar pattern: only groups that contain verifiable information, such as alumni groups and geography-based groups have an identifiable impact on the transactional outcomes.

These findings are important not only for researchers but also for practitioners. For practitioners who are trying to improve peer-to-peer lending websites, our results suggest that the social network of borrowers is an important piece of information, providing additional signals regarding the borrower’s creditworthiness. On the other hand for researchers, our findings support the emphasis on relational instead of structural aspects of the network. Even for regulators who are creation and implementing rules of this marketplace, understanding the unique features, especially the social networks on these sites can be beneficial for sensible policymaking.

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