ABSTRACT

Title of Document: TWO ESSAYS ON RECENT INNOVATIONS IN FINANCE: MICROFINANCING AND FLOATING RATE CONVERTIBLES

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The first essay provides theory concerning the risk-taking incentives of microfinance borrowers in varying cases: individual liability, group liability without social sanctions, and group liability with social sanctions. The results provide insight into how a community's social capital and a country's credit rights interact to induce recipients of microfinance programs to take risk. Consistent with recent anecdotal evidence that suggests a "dark side" to microfinance, the results show that communal ties among joint liability borrowing groups may not lead to higher repayment rates and may have worse welfare effects on the recipients by making the poorest group members unwilling to take the risks necessary to grow a business.

The second essay considers floating rate convertibles (FRCs). FRCs are a category of PIPE securities that receive negative associations in both the academic and professional literature. This study sheds light on the managerial relationship to the decision to issue FRCs and to the variation in market response to these issues. One main result of the study identifies influence of the CFO relative to the CEO as significant in the decision to issue FRCs and in the market's immediate reaction to the issuance. Another main result is that FRC issuing firms with CFOs without prior public equity issuance experience have significantly negative long run abnormal returns, whereas FRC issuing firms with experienced CFOs do not.

TWO ESSAYS ON RECENT INNOVATIONS IN FINANCE: MICROFINANCING AND FLOATING RATE CONVERTIBLES

By

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Dedication

To my wife, Meghan, who has faithfully loved and supported me. She is truly the helper suited for me. I would not have been able to accomplish this dissertation without her encouragement and sacrifices. Her companionship and prayers sustain me through everything I do.

Acknowledgements

I would like to acknowledge the members of my dissertation committee. My advisor, Gordon Phillips, provided expert guidance in the area of PIPEs research and encouraged me to pursue microfinance. Jerry Hoberg clearly communicated his knowledge concerning the newest and best empirical methods to me. Alexander Triantis persevered in keeping me on track and prevented me from giving up completion of this dissertation. Lemma Senbet reminded me to keep first principles in the forefront and pushed me to put more rigor into the theoretical components. Peter Murrell, as an expert in economic institutions, provided inspiration to pursue research in microfinance.

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Essay 1: A Theory on the Risk-Taking Behavior of Microfinance Borrowers, Creditor Rights, and Social Capital

Abstract:

This paper provides theory concerning the risk-taking incentives of microfinance borrowers in varying cases: individual liability, group liability without social sanctions, and group liability with social sanctions. The results provide insight into how a community's social capital and a country's credit rights interact to induce recipients of microfinance programs to take risk. Consistent with recent anecdotal evidence that suggests a "dark side" to microfinance, the results show that communal ties among joint liability borrowing groups do not lead to higher repayment rates and does have worse welfare effects on the recipients by making the poorest group members unwilling to take the risks necessary to grow a business. This paper contributes to the literature on contract design and on financial development and growth, extending them into the realm of finance for the poorest and least able to access formal financial markets.

I. Introduction

Microfinance is the popular economic development program aimed at the world's poorest entrepreneurs in many developing countries. It normally consists of lending very small amounts, as little as $75, to invest in self-owned enterprises, in order to provide more opportunities beyond wage labor. Microfinance is intriguing because it provides financial services to a very large segment of the world's population, who otherwise would borrow in the informal financial market from friends, family, and moneylenders. Furthermore, prior to its first implementation by economics professor Mohammed Yunus in Bangladesh in the 1970s, very poor borrowers in developing countries were not expected to be willing or at least able to repay unsecured business loans made by lenders from outside their communities.

It is commonly believed that microfinance programs succeed in leading to high repayment rates because of the strong social ties that exist among their clients. "Social capital" is considered an alternative to physical capital in the developmental economics literature. While borrowers may not have physical collateral to secure a loan, they do live in tight knit cultures where the social repercussions from defaulting on a loan could be as costly as losing material possessions. The first microfinance programs were thought to tap into this social capital by giving loans to groups, where each member of the group was liable for all the others' share of the loan (Van Bastalaer, 2000).

Because all members of the borrowing group are liable for each other, they have incentives to punish noncontributing members and to encourage each other to succeed. They also have incentives to screen potential members into the group as well as verify that each group member exerts effort in the projects so that they can repay their shares of the loans. Harnessing social capital is particularly important in countries where lenders have little recourse to deal with borrowers that are able to repay their loans but choose not to do so. This inability is often due to poor institutions like creditor rights. (La Porta, et. al., 1998)

Even if borrowers own land, they may not be able to use it as collateral because of laws that restrict the use of land as collateral or make the ability to seize collateral very costly or impossible. Also, record of title may be unavailable due to poor record keeping.

Despite the theoretical support for the value of social capital in providing financial services to developing nations' poor entrepreneurs, studies of microfinance programs have also yielded some puzzling results. One is the success of microloans made on an individual liability basis.

If individual liability loans have similar repayment rates as joint liability loans, what does this say about either the need for social capital or the necessity of the joint liability contract in harnessing it? The other puzzle deals with the problem of loans not being put to productive use. That is, many of microborrowers seem to hold onto their loans or consume them rather than invest them in a business.

This is one finding that does not have much theoretical explanation. Intuitively, the reasons given is that the members of the group receiving the loan are too afraid of the repercussions from failure from their peers that they prefer to use the loan to smooth their consumption and payoff the loan with income from pre-existing sources such as a wage earning job or even a business that they did not invest the loan in.

In this paper, I develop a theoretical model on the relationship between the repayment strategies of microfinance borrowers and the types of projects they invest their microloans in. Besley and Coate (1995) model how group lending mitigates the moral hazard problem of borrowers being unable to credibly contract with lenders to repay their loans even when they are able. Besley and Coate address the question of how the lending schemes affect the incentives of borrowers to repay their loans, but they assume that the borrowers' projects are exogenously given. This paper extends their model by endogenizing project selection under various lending schemes. By modeling the choice of what project a borrower will choose, I provide a theory to explain the relationship between financial contract design, a country's creditor protections, investment choice, entrepreneurship, and poverty.

I present conditions for microfinance programs resulting in optimal project selection. I show that certain entrepreneurs who are jointly liable for their loans will not take the necessary business risks that microfinance is supposed to induce them to take while not improving the repayment rate over individual liability. This result is driven by strong social ties that exist among borrowing group members, which is usually thought of as a positive effect on social welfare.

The conclusions of this study contribute to the theory of microborrower behavior in two main ways. The first theoretical contribution of this study is an extension of Besley and Coate's (1995) comparison of the repayment behavior of microborrowers under varying assumptions of liability and existence of social sanctions. I show that borrowers under joint liability without the threat of social sanctions are more likely to repay their loans than when under the threat of social sanctions. By introducing project and peer selection into the model, I get this result because the threat of social sanctions stifles risk sharing and encourages free-riding among borrowers with low upside potential to their project options.

The second theoretical contribution is the identification of people who choose particular types of contracts where there is an option between individual and joint liability contracts. If there are no social sanctions, then people with high upside potential to their projects take the joint liability contract because the benefits of risk sharing outweigh the costs of free-riding. People with low upside project potential, however, take the individual liability contracts because they do not share any risk under the joint liability contract by selecting safe projects. The introduction of social sanctions to the model, however, effectively eliminates the use of the joint liability contract by every microborrower.

Ultimately, studying this question is important because microfinance institutions (MFIs), governments, non-governmental organizations (NGOs), and microfinance investors want to know what model of microfinance to follow. Should a MFI offer joint liability contracts to borrowers who are able to sanction each other if one borrower does not contribute to repayment? Should a social planner subsidize MFIs that offer joint liability contracts or those that offer individual liability contracts?

The remainder of the paper is organized as follows. Section two reviews the relevant literature on microfinance and positions this paper in the existing literature. Section three presents a model of individual liability lending. Section four presents a model of joint liability lending without and with social sanctions. Section five discusses the results of the model. Section six concludes with a summary and direction for further research.

II. Literature Review

The literature on group lending argues for social capital to impact the likelihood of repayment through various channels. The most frequently cited categorization of models explaining how social capital impacts group repayment rates is by Ghatak and Guinnane (1999). The first is in a superior screening ability of peers over delegated monitors because most groups select which borrowers can join them (Ghatak and Guinnane 1999). The second is a superior monitoring ability of peers to control ex ante moral hazard (Stiglitz 1990). The third is a superior auditing ability of peers to limit verification costs. The fourth is a superior enforcement mechanism through imposition of social sanctions should a borrower default to control ex post moral hazard (Besley and Coate 1995). As opposed to comparing the effects of each of these four assumptions on what kind of problem social capital addresses in group lending, I compare the impact of various forms of social capital on risk taking and repayment of borrowers.

Besley and Coate (1995) provide a model to predict how the group liability aspect of microfinance affects the repayment behavior of borrowers when repayment of loans is not enforceable. They compare the model's predictions of repayment rates among three lending systems: individual lending, group lending without social sanctions, and group lending with social sanctions. The individual lending system describes the traditional arrangement in which the bank lends to an individual who is solely liable. The group lending system without social sanctions describes an arrangement in which the bank lends to a group of borrowers who divide the loan among themselves and invest their shares in their own enterprises, which are independent from one another. In this system, the group as a whole is liable, each member of the group decides whether or not she contributes her share to the group's repayment, and the group cannot penalize noncontributing members. The group lending system with social sanctions describes the same arrangement, except the group can exert peer pressure on the members to contribute to the repayment of the loan.

Their main conclusions are twofold. First, the impact of group lending on repayment rates over that of individual lending are affected by two countervailing forces: risk-sharing and free-riding. On one hand, if one member of the group cannot contribute her share of the loan because of poor project returns, the other group members can cover her share. Therefore, group lending may improve loan repayment rates through sharing risk. On the other hand, a borrower who would have repaid her loan under individual lending might take advantage of the group's incentives to cover her share of the loan. This free-riding incentive leads to a coordination failure whereby the group as a whole will default even though certain individuals would have repaid their own shares if they were individually liable. Without social sanctions, it is unclear as to which effect dominates. The second conclusion is that the free-rider effect can be lessened if the group is able to use social sanctions to pressure the members if they stand to lose a significant amount of social capital. They show that if social sanctions are great enough, then group lending does dominate individual lending in regard to the repayment rate.

An extension of Besley and Coate's model is Che (2002)'s dynamic model of repayment behavior in a repeated game. Che does not include social sanctions other than exclusion from participation in future borrowing opportunities. He shows that while the static model has ambiguous results concerning group lending's repayment rates due to the free-rider problem, the dynamic model shows that group lending weakly dominates individual lending due to the cost of exclusion from future opportunities.

In addition to extending their model to a dynamic setting, among the recommendations that Besley and Coate make for further research is to model the effect of group lending on the type of project that each member chooses. As this paper will show, Besley and Coate's model can be adapted to find interesting implications for selection of project risk by different lending schemes. In addition, I extend their model to include self selection of borrowers into groups. The outcome of endogenizing project and group member selection is domination of the risk sharing effect without social sanctions and suboptimal risk taking with social sanctions.

In addition to Besley and Coate (1995)'s focus on the enforcement problem, other theories focus on the problem of (i) screening out risky borrowers, (ii) monitoring borrower effort ("ex ante" moral hazard), and (iii) verification of project outcomes. Ghatak (1999) and Ghatak and Guinnane (1999) provide the most cited model of how joint liability microloans induce risky borrowers to select other risky borrowers to form a group and safe borrowers select other safe borrowers. By this assortive matching process, lenders are more able to identify risky borrowers from safe borrowers "by the company they keep". Other theories such as van Tassell (1999) and Laffont and N'Guessan (2000) also conclude that borrowers will match with borrowers of similar riskiness. Guttman (2006, 2007), however, offers a model that predicts the opposite: Borrowers of opposite risk types will match with each other. Guttman makes this prediction because he assumes that borrowers can make side payments to each other to attract group members. While both risky and safe borrowers prefer to have safe peers, the value of a safe peer to a risky borrower is greater than to another safe borrower. Intuitively, this greater value comes from a diversification benefit of matching a risky borrower with a safe one. This later conclusion is also supported by my model as well as experimental evidence (Gine, Jakiela, Karlan, and Morduch, 2010).

Stiglitz (1990) finds group lending's advantage in improving repayment rates come from the peer monitoring effect, thus limiting the ex ante moral hazard of how group members will use their loans and exert effort. He focuses on group members being able to observe the effort each applies to her projects and to write enforceable contracts among themselves.

Ghatak and Guinnane (1999) present a model where verification of states is costly in the spirit of Townsend (1979), demonstrating that joint liability contracts induce truth telling by borrowers concerning their projects' payoffs by delegating the auditing function to group members. Therefore, the lender only has to verify the state when the entire group defaults, thus reducing the number of cases the bank has to incur auditing costs.

While most research deals with comparing available microfinance contracts' impact on welfare, some offers new kinds of contracts that are currently not observed. Bubna and Chowdhry (2009), for example, offer a new institution they call, "microfinance franchising" in which a single MFI offers a lending franchise to local capitalists who compete with a single moneylender. Their model is currently being experimented in Samoa. Ayi (2007) suggests that MFIs offer a "microequity" contract whereby the MFI has an equity stake in the microenterprises, similar to venture capitalists.

A similarly titled contract is also suggested by Pretes (2002). The newest stage in the microfinance movement is that of "microinsurance," which offers insurance contracts to the same people that microloans are intended for (Morduch, 2004; McGuinness and Tounytsky, 2006; Leftley and Mapfumo).

While all the theory on microfinance loan performance assumes that social capital is pivotal, the way in which social capital functions differs among the theories. The empirical research also varies in its conclusions regarding social capital's effect on loan repayment and on borrower welfare.

How aspects of borrowers' relationship to each other and their culture add to or subtract from social capital is complicated. Studies on the type of social ties show that certain aspects of relationships among borrowers in a group differ in their effect on borrower behavior. Hermes and Lensink (2007) survey of empirical studies on social capital's relationship to loan repayment identifies several characteristics of social capital that actually have negative effects on loan repayment: family membership in group, distance between members, strong social ties, group homogeneity, relatedness, sharing within group, and high level of joint liability. They also find that some of these characteristics also have positive effects on loan repayment in other studies, indicating that the relationship between social capital and loan repayment is actually ambiguous. Similarly another survey concludes, "The results of available empirical studies are contradictory with respect to virtually all potential determinants of repayment performance" (Guttman, 2006).

Studies show that the joint liability contract is not the only means of harnessing social capital. De Aghion and Morduch (1998) find that microfinance borrowers in transition economies who borrow on an individual liability basis still have incentives to repay their loans because of social stigma over default. Also, an individual liability loan can be marketed to, purchased by, and collected in groups, thereby lowering transactions costs, having a good information source, fostering education and training, and increasing individuals' comfort with banks. In a randomized controlled field experiment, Karlan and Gine (2010) show that repayment rates of borrowers of a Philippine MFI with branches that are randomly converted from offering offer joint liability to loans to individual liability loans do not differ from unconverted branches. They find that social capital plays an important role in influencing repayment after branches are converted to offering individual liability loans.

Studies on the impact of microfinance programs on repayment and on poverty reduction are not uniformly supportive. However, they find that the impact of microfinance programs is not uniform across borrowers. Hulme and Mosley (1996) and Morduch (1998) find microfinance programs are less effective in increasing income among those below the poverty line. In Hulme and Mosley (1996), the researchers suggest that microfinance programs' impact decreases with falling income because the borrowers below the poverty line take less risks, invest less in technology, and use their loans to protect their subsistence. In some cases, the loans lower income among the poorest of the poor (Khawari 2004). Many microfinance borrowers take loans to reduce variation in consumption and not to increase expected income.

Pretes (2002) criticizes the use of microfinance for certain borrowers. He cites cases where very poor borrowers become worse-off because of business failure. They attempt to repay their portion of the loan by borrowing from moneylenders, selling their household assets or food, or leaving their home to find wage labor. Taking these drastic steps as opposed to just defaulting as would be the case in a country with developed bankruptcy laws may be due to "the darker side of collective peer pressure." Social sanctions may be so strong that the borrower may be in fear of becoming an outcast. Also, since most microfinance borrowers are women in countries where they are under a high degree of male control, the husbands of the borrowers sometimes take the money away, leaving the wife to struggle to find a way to repay the loan. So, the informal institutions of the community and the home may not allow for microfinance to succeed in empowering borrowers to take the appropriate risks as an entrepreneur.

Pretes postulates that the high repayment rates of microfinance programs are misleading as to their effectiveness in reaching the very poor, as "financial benefits disproportionately accrue to the middle poor and do not reach the very poor."

This paper contributes to the literature on microfinance by combining Besley and Coate's model with other models of microfinance to consider how the group lending system affects peer and project choices. Allowing for projects of varying levels of risk is an important assumption due to the empirical evidence that project selection matters. The model's results provide a theoretical explanation for the finding that group lending can have the opposite effect on investment decisions than is intended. I show how the nature of social sanctions that are levied by the group play a role in this result.

III. Individual Lending

Consider an entrepreneur's payoff function when liability is individual. In the first period, $t = 0$, the borrower receives a loan of l at an interest rate, i. At $t = 1$, the borrower chooses whether to invest in a safe or risky project. At $t = 2$, the investment returns are realized and the borrower chooses whether to repay the loan. Assume that without a loan, the entrepreneur would not be able to invest in any project. All loans are for the same amount and require a repayment of r. $r = l(1+i)$. The project returns a random variable, $\tilde{\theta}$. If the risky project is taken, then the outcome has either a high or low payoff (θ^L or θ^H) with equal probability. If the safe project is taken, then the outcome has a payoff of θ^S with probability of 1. $\theta^S = (\theta^L + \theta^H)/2$. After the payoffs are realized, the entrepreneur has the choice of repaying or not repaying the loan. Partial repayment is not a possibility. If she repays the loan, she has a net payoff of $\tilde{\theta} - r$.

The assumption of either full repayment or total default is made by Besley and Coate (1995). It is a realistic assumption because these are very small loans, where the amount to be voluntarily paid can be thought of as discrete. Alternatively, the consequence to defaulting can be thought of as discrete, where any kind of default disqualifies the borrower from borrowing in the future. Therefore, she would not have any motivation to make a partial repayment. Also, the model can be adapted to there being partial repayment in that the borrower faces a potential penalty for strategically defaulting. The penalty may include collection of a portion of her project's payoffs when she defaults.

If she does not repay the loan, then she incurs costs of various forms. First, the lender may penalize her for defaulting through refusing to make future loans or sharing this information with other potential lenders (a credit bureau). Second, the lender may retrieve a portion of what is owed by litigation. Third, the borrower may face loss of reputation in her community. Fourth, the borrower may expend resources to hide her profits from the lender and her community. Fifth, the borrower may inflict guilt on herself for not repaying the loan when she has the means to repay it.

Because I am considering lending in a developing country where institutions that allow for contract enforcement are lacking, the bank is limited in how much it can penalize the borrower. The costs of default may differ from those in a developed country. First, the loan officer may not be able to credibly commit to refusing to make another loan and there may not be a credit bureau if there are other lenders in the market. Second, bringing the case to court may be too costly to the lender for the amount that would be recovered, and the laws governing collection of debts in developing countries often favor the debtors over the creditors. Third, though the borrower is individually liable, she may be concerned with what her community thinks of her if she does not repay a debt. Because the borrowers under consideration typically live in tight knit communities, the knowledge and opinions of others concerning one's own affairs could be quite significant. On the other hand, her community may have greater solidarity with her rather than the bank, thereby causing it to be understanding of a defaulting borrower's non-repayment. Fourth, the borrower may very easily hide the amount of her project's payoffs from observation if she lives in a remote village. Fifth, whether borrowers' average conscience in developing countries differs from other borrowers is unknown.

Assume that the penalty for default is increasing in her project's payoffs. Assume there is a fixed cost and a variable cost that is increasing in project payoffs. For simplicity, I assume that penalty function is an affine function in project payoffs. Let α_f represent the fixed cost and $\alpha \in (0,1)$ represent the variable cost per unit of project payoff. The penalty function is defined as $p(\widetilde{\theta})=\alpha_f + \alpha\widetilde{\theta}$. Assume for now that $\alpha_f=0$ so that all of the penalty is linear in project payoffs. Making this assumption will not change the analysis as long as α_f is not greater than r. I assume that penalties increase in project payoffs for the following reasons. First, limitation on obtaining future financing limits the ability of the successful but defaulting entrepreneur from being able to fully utilize her present project's payoffs. That is, a portion of the value of project payoffs may be in the ability to invest them in future projects. If additional external financing is also necessary for this future investment and there are increasing returns to scale, then the value of these payoffs will be less. Second, the greater the payoff, the greater is the amount that may be retrieved through litigation. Third, the community would probably think worse of a defaulting borrower the more able she is of repayment. Fourth, the more project payoffs there are, the more there is to hide; the more there is to hide, the more costly it is to hide. Fifth, the defaulting borrower would probably think worse of herself the more she is able to repay.

The entrepreneur will repay only when the payoff from doing so is greater than not doing so, which is when $\tilde{\theta} \geq r/\alpha$. See Proof 1.

Therefore, the individual's payoff function is $P^*(\tilde{\theta}) = \max(\tilde{\theta} - r, (1-\alpha)\tilde{\theta})$ from implementing the optimal strategy**.** Figure 1 graphs the individual lending optimal strategy payoff function.

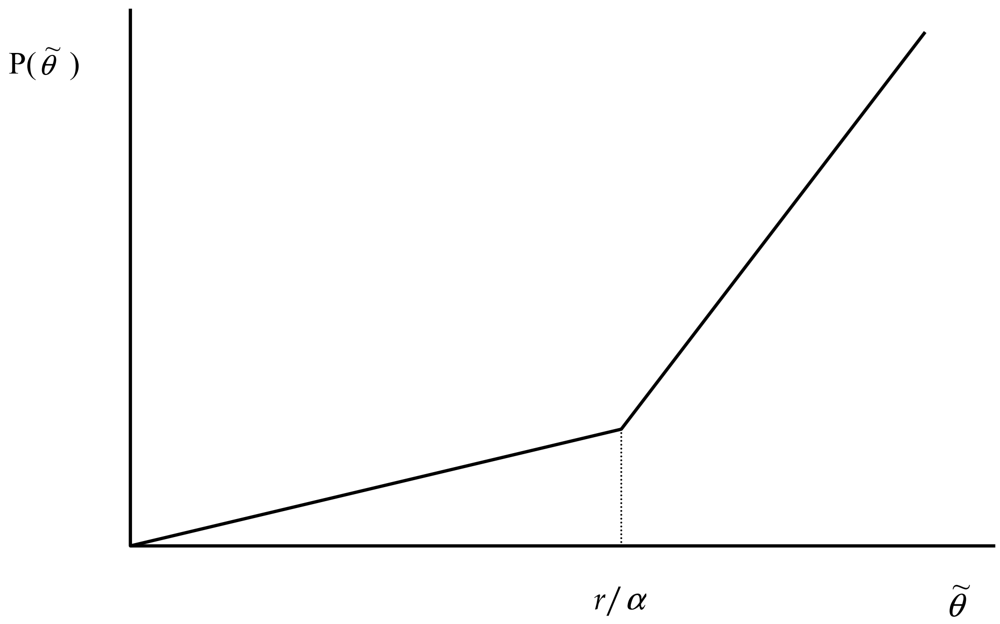

Figure 1. Individual borrower's net payoff as a function of her project's payoffs ($\tilde{\theta}$), assuming penalty parameter (*α*) and amount owed (*r*).

Note that this payoff function is weakly convex in $\tilde{\theta}$:

> **Proposition 1:** An individual liability borrower's optimal repayment strategy (*s**) implies the utility (U^I) of the individual liability loan to be convex in her project's payoffs ($\tilde{\theta}$). See Appendix for proof.

As can be seen in Figure 1, if the entrepreneur were to select between the safe and risky projects, then she would certainly choose the risky project if $\theta^H > r/a > \theta^L$:

> **Proposition 2:** An individual liability borrower's optimal investment decision *(p*)* is to take the risky project (R) rather than the safe project (S). See Appendix for proof.

However, if $\theta^S \geq r/a$, then the lender would prefer that the safe project be chosen, in which case its expected repayment would be r, rather than the risky project, whose expected repayment is $r/2$:

> **Proposition 3:** The expected repayment rate of an individual liability loan is 50 percent. See Appendix for proof.

Typically, in developed countries' markets for loans where there are significant information asymmetries, credit rationing is understood to occur due to the moral hazard at the investment choice stage induced by setting interest rates high enough to compensate for the prior riskiness of the borrower (Stiglitz and Weis 1981). Because this agent's action in this moral hazard problem occurs before the project payoffs are realized, this type of moral hazard is referred to as *ex ante* moral hazard. This is demonstrated in Proof 2, where the borrower would choose to invest in the risky project that has only a 50 percent chance of her repaying the loan instead of the safe project, which the bank would prefer her to take. The bank is limited in raising r to compensate for this problem because the critical point, r/a, for the borrower to choose to repay the loan increases in r. However, if a is higher, then the expectation of repayment is higher because the critical point for the repayment decision, r/a, is lower and the fraction of payoffs recoverable in default is higher. Therefore, the bank will limit its losses through controlling the quantity of credit supplied rather than in price.

In undeveloped economies with weak institutions, another type of moral hazard is introduced: whether or not to default when the borrower is in fact capable of repaying the loan (Besley and Coate 1995). This other type of moral hazard is referred to as either *ex post* moral hazard, strategic default, or unenforceability. If a is higher, then the expectation of repayment is higher because the critical point for the repayment decision, r/a, is lower and the fraction of payoffs recoverable in default is higher. This can be seen in the proof for Proposition 1.

IV. Joint Liability Lending

Next, consider an entrepreneur's payoff function when the loan is made to a group. I model group lending in a two-player (like Besley and Coate), three-period (t = {0,1,2}) game in which both borrowers choose whether or not to contribute to the repayment of their loan. The two borrowers are identified as "Borrower j" where j = 1 or 2. In the first period, t = 0, the two-member group forms and receives a loan. The loan agreement stipulates that the group must pay a total of $2r$ in principal and interest in the last period, t = 2. (Under individual lending, each borrower would have to pay r.) At t = 1, each borrower invests her share of the loan in a project that yields a random variable, $\tilde{\theta}_j$. She chooses between two investments, safe or risky.

At t = 2, each group member decides whether or not to contribute to the repayment of the loan. Following the assumption of Besley and Coate (1995), the group as a whole can either default on the entire loan or repay the entire amount. If each member does contribute, then borrower j has a payoff of $\tilde{\theta}_j$-r. If one contributes nothing, then the other borrower can either decide to also contribute nothing, thereby allowing the group to default, or to cover both members' share and repay the entire loan. If the group defaults, then, the borrowers are penalized by the same amount as under individual liability (p($\tilde{\theta}_j$)). The penalties are increasing in $\tilde{\theta}_j$. Therefore, if the group defaults, then each member gets a payoff of $\tilde{\theta}_j$ (1-α).

IV. A. Joint Liability Lending without Social Sanctions

It has already been recognized that simply making borrowers jointly liable for each other's loan does not have strictly positive net effects on borrower repayment (Besley and Coate 1995). Furthermore, it has been shown empirically in the Philippines that joint liability is not the only method by which social capital can impact the probability of repayment by groups (Karlan, *et. al.*). Therefore, the first kind of group lending that I consider is one where the group members are jointly liable for each other but cannot impose any kind of penalty for non-contribution to the repayment of the loan. I call this type of harnessing of social capital as joint liability lending without social sanctions. By making this distinction, I can separate out the effects of joint liability itself from other factors on the enforcement mechanism.

Optimal Strategies at t=2

The two group members have to choose a strategy of either contribute (*C*) or not contribute (*NC*). Let $s_j \in \{C,NC\}$ denote the strategy played by borrower j. Each borrower's net payoff depends on the strategy played by the peer. Denote borrower 1's net payoff as $U^{J1}(\underline{s},\underline{\tilde{\theta}}) \equiv U^{J1}[(s_1,s_2),(\tilde{\theta}_1,\tilde{\theta}_2)]$. Their payoffs from each possible strategy are denoted in Figure 2.

		Borrower 2 Strategy (s_2)	
		C	NC
Borrower 1 Strategy (s_1)	C	$\tilde{\theta}_1 - r$, $\theta_2 - r$	$\tilde{\theta}_1 - 2r$, $\tilde{\theta}_2$
	NC	$\tilde{\theta}_1$, $\tilde{\theta}_2 - 2r$	$\tilde{\theta}_1(1-\alpha)$, $\tilde{\theta}_2(1-\alpha)$

Figure 2. Joint liability without social sanctions net payoffs $U^{J1}(\underline{s},\underline{\tilde{\theta}})$, $U^{J2}(\underline{s},\underline{\tilde{\theta}})$ under the four possible strategy combinations of both borrowers in a group.

Project returns, $\tilde{\theta}_1$ and $\tilde{\theta}_2$, determine the payoffs of each combination of strategies. Therefore, the Nash equilibria vary by the realizations of $\tilde{\theta}_1$ and $\tilde{\theta}_2$. The optimal strategies, then, proven in Lemmas 1.1 – 1.4 in the Appendix. Figure 3 presents these optimal strategies in a table.

		$\tilde{\theta}_2$		
		$\tilde{\theta}_2 < r/\alpha$	$r/\alpha \leq \tilde{\theta}_2 < 2r/\alpha$	$\tilde{\theta}_2 \geq 2r/\alpha$
$\tilde{\theta}_1$	$\tilde{\theta}_1 < r/\alpha$	(NC, NC)	(NC, NC)	(NC, C)
	$r/\alpha \leq \tilde{\theta}_1 < 2r/\alpha$	(NC, NC)	(C, C)	(NC, C)
	$\tilde{\theta}_1 \geq 2r/\alpha$	(C, NC)	(C, NC)	(C, NC), (NC, C)

Figure 3. Nash equilibrium strategies (s_1*, s_2*) for various project under joint liability without social sanctions.

The impact of joint liability without any social sanctions on bank repayment appears ambiguous. On one hand, there is a positive effect of joint liability on borrower repayment. Suppose the bank makes two loans on an individual liability basis to the two members in this group. If one's project payoffs were less than *r*/*a* but the other's were greater than 2*r*/*a*, then only one loan would have been repaid. However, under joint liability, the borrower with the project with the higher payoffs will pay for her peer's loan. The bank then has both loan repaid under joint liability. This positive effect on the probability of repayment of loans is the risk-sharing effect.

Consider now a different scenario: Borrower 1 has payoffs greater than *r*/*a* but less than 2*r*/*a*, and Borrower 2 has payoffs less than *r*/*a*. Under individual liability one loan is repaid. Under joint liability, neither loan is repaid because Borrower 1 will not cover for Borrower 2. This negative effect on the probability of repayment of loans is the free-riding effect.

A borrower's expected payoff function under optimal strategies, then is more complicated than under individual liability because her net payoffs and optimal strategies depend on the payoffs of the other borrower's project and her strategy. The dominance of the risk sharing effect or the free riding effect depends on the project payoff. If her peer contributes to the repayment of the loan, Borrower 1, in contrast to the individual liability case, keeps more of her project's payoffs in low payoff states ($\tilde{\theta}_1 < r/a$) due to the risk-sharing effect, has the same net payoff in intermediate payoffs ($r/a \leq \tilde{\theta}_1 < 2r/a$), and keeps all of her project's payoffs in high payoffs ($\tilde{\theta}_1 \geq 2r/a$) due to the free-riding effect. However, if her peer does not contribute to the repayment of the loan, Borrower 1 keeps the same amount of the loan for low payoffs ($\theta_1 < r/a$), has lower net payoffs under intermediate payoffs ($r/a \leq \tilde{\theta}_1 < 2r/a$) due to the coordination failure induced by free-riding, and also has lower net payoffs under high payoffs states due to being exploited by free-riding. These payoffs are represented in Figure 4.

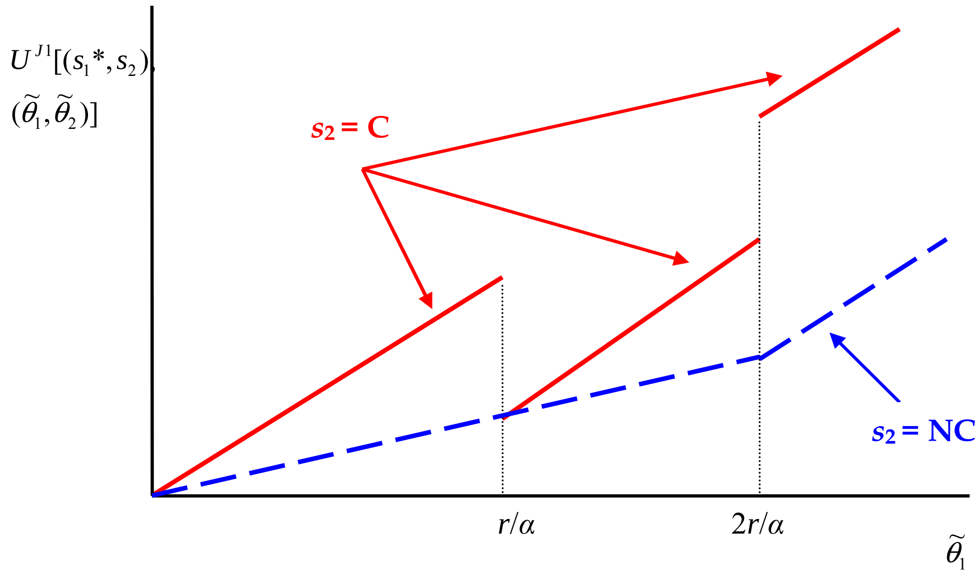

Figure 4. Optimal strategy net payoff functions of Borrower 1. The solid lines represent $P^*_1(\theta_1 | C)$, the optimal strategy net payoff if Borrower 2 contributes to repayment. The dashed line represents $P^*_1(\theta_1 | NC)$, the optimal strategy net payoff if Borrower 2 does not contribute to repayment.

The uncertainty surrounding what a borrower's payoffs does not only stem from the payoffs of her peer's project, but also on which equilibrium strategy they play. When both projects have high levels of payoffs, they play either (*C, NC*) or (*NC, C*). This surprising result that one borrower allows the other to free-ride on her comes from neither borrower credibly being able to commit to the group to default This leaves a question of which equilibrium strategy will be played when project payoffs are in these ranges. If the game were moved from static to dynamic or a convention were applied to it, then the Pareto improving strategy may be played more often. For the purposes of a borrower's prior beliefs about which equilibrium strategy will be played, I will assume that the probability of 0.5 for each strategy when there are two equilibrium strategies.[3]

Optimal Strategies at t=1

Each borrower will uses her expectations of her own project's payoffs and her peers at t=1 when she chooses what kind of project in which to invest. Assume that there are two projects to choose from, as under the individual liability case. For simplicity, add the assumption that the safe investment's payoffs are strictly less than $2r/a$. Does Borrower 1 choose the risky or the safe investment if Borrower 2 invests in the safe investment? What does Borrower 1 choose if Borrower 2 invests in the risky investment.

To address the first question, assume that Borrower 2 invests in the safe investment. This means that Borrower 2's project yields θ^S, where $2r/a > \theta^S \geq r/a$. If Borrower 1 invests in the safe project, then her project's payoff is in the same range, and they would play (C, C). Borrower 1's expected net payoff, then, is $\theta^S - r$. If Borrower 1 were to invest in the risky project, then the group will default if her project pays θ^L, or it will repay the loan with her paying all of it if her project pays θ^H. Her expected payoff is θ^S - $a\ \theta^L/2 - r$, which is less than $\theta^S - r$, the net payoff from taking the safe project. She, therefore, prefers to take the safe project:

> **Proposition 4:** Under a joint liability contract, if one borrower invests in the safe project, then the other borrower will also invest in the safe project (S) rather than the risky project (R). See Appendix for the proof.

Next, consider what Borrower 1's net payoffs would be under the two investment options if Borrower 2 takes the risky project. There are now five possible net payoffs if she takes the risky project shown in Figure 5.

[3] One possible rule of the game is for each borrower to flip a coin when they come together at t=2 to determine who plays her strategy first. If both have payoffs greater than $2r/\alpha$, then the loser of the coin flip goes second and therefore covers the entire loan.

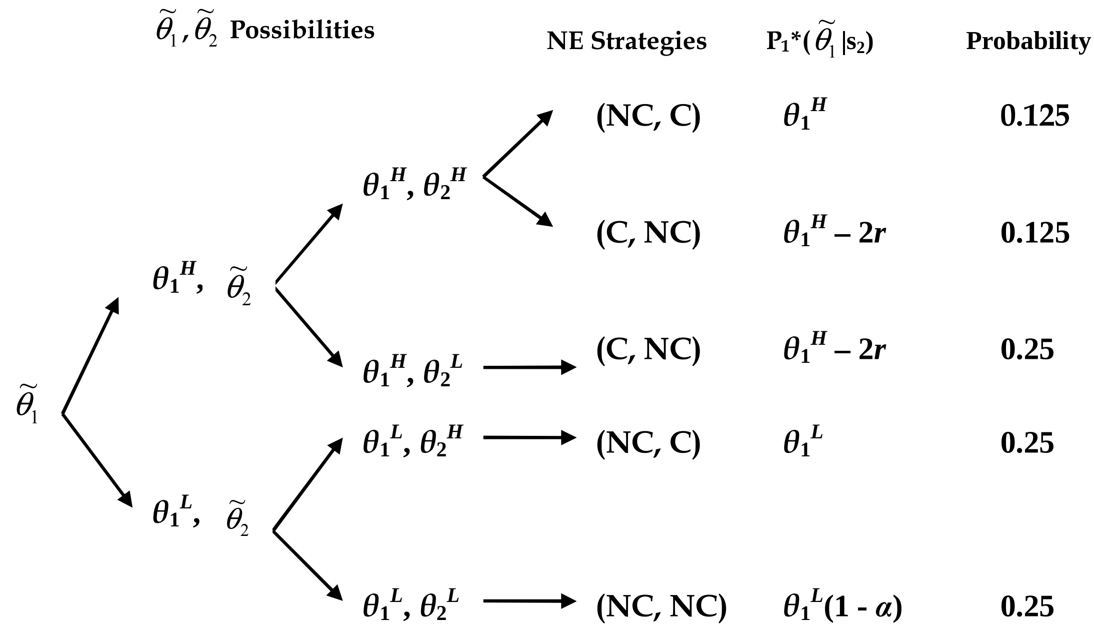

Figure 5. Optimal strategy net payoffs to Borrower 1 when both borrowers take the risky project.

The expected payoff for Borrower 1 in taking the risky project when Borrower 2 does the same is $\theta^S - \alpha\, \theta^L/4 - 3r/4$. If Borrower 1 takes the safe project when Borrower 2 takes the risky, then Borrower 1 has possible payoffs shown in Figure 6 instead. Her expected net payoff from taking the risky project would be $\theta^S - \alpha\, \theta^L/2$.

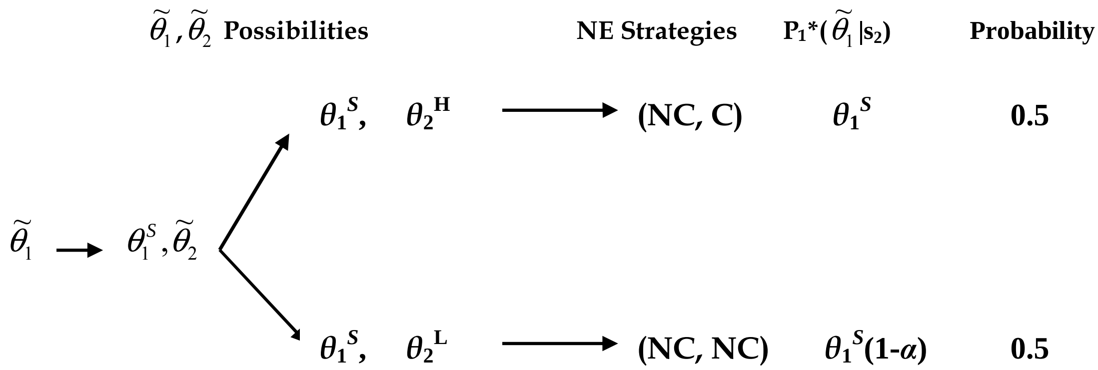

Figure 6. Optimal strategy net payoffs to Borrower 1 when Borrower 2 takes the risky project and Borrower 1 takes the safe project.

Her payoff from choosing the safe project over the risky project is θ^S - a $\theta^S/2$ – [θ^S - $a\theta^L/4$ - $3r/4$] = $3r/4$ - $a\theta^L/4$. Comparison of the expected utilities yields the following result:

Proposition 5: Under a joint liability contract, if one borrower invests in the risky project, then the other borrower will invest in the risky project only if her projects' high state payoff is greater than $\frac{3r}{\alpha}$. Otherwise, she will invest in the safe project. See Appendix for the proof.

Each borrower, therefore, knows that if she takes the safe project, then the other borrower will take the safe project, also. If she takes the risky project, then the other borrower will take the safe project only if $\theta^H \leq 3r/a$ and will take the risky project only if $\theta^H > 3r/a$. The borrowers investing in different projects, however, is not an equilibrium strategy because if Borrower 2 first chooses a risky investment and Borrower 1 responds by choosing a safe investment because $\theta^H \leq 3r/a$, then Borrower 2 would reverse her investment decision to the safe investment as shown in Proof 4. Therefore, if $\theta^H \leq 3r/a$, then both borrowers choose to make the safe investments; and if $\theta^H > 3r/a$, then both borrowers choose to make the risky investments. In other words, if the mean payoffs of the investments are higher, then the borrowers will choose risky strategies.

Optimal strategies at t=0

If the payoffs of the possible projects differ between the group members, then borrowers with $\theta^H \leq 3r/a$, who always prefer the safe project select other borrowers who would prefer the safe project, too. Likewise, the borrowers with $\theta^H > 3r/a$ select other borrowers with the same possible high payoff state. Therefore, when there are no social sanctions on noncontributing group members, there is assortive matching of borrowers, consistent with Ghatak and Guinnane (1999) and Ghatak (1999):

> **Corollary 1:** Borrowers with high possible project payoffs ($\theta^H > \frac{3r}{a}$) select each other to take joint liability loans and invest in risky projects. Other borrowers ($\theta^H < \frac{3r}{a}$) select each other and invest in safe projects. See Appendix for the proof.

Optimal group project selection under joint liability without social sanctions is peer dependent. That is, even if the project opportunity sets between the two borrowers differ, each borrower's strategy is dependent on whether at least one borrower always prefers to take the safe investment.

Does the lender choose to make this joint liability loan rather than two individual liability loans? If $\theta^H \leq 3r/a$, then both borrowers play "safe", which implies a repayment probability of 1. If $\theta^H > 3r/a$, then both borrowers play risky, which implies a repayment rate of $(2r * 0.75 + 0 * 0.25)/(2r) = 0.75$. These repayment rates are improvements over the repayment rate of making two individually liable loans: $(2r * 0.25 + r * 0.5 + 0 * 0.25)/2r = 0.5$ because the individually liable borrower will always choose the risky investment. Since the lender has a higher probability of being repaid under joint liability, borrowers benefit from reduced credit rationing and reduced interest rates. This is shown formally in the proof for the following proposition in the Appendix:

> **Proposition 6:** The expected repayment rate of a joint liability loan is between 75 and 100 percent.

Presuming the same availability and terms of credit, does the borrower choose to accept a joint liability loan over an individual liability loan? If $\theta^H \leq 3r/a$, then Borrower 1 has an expected payoff of $\theta^S - r$ if she has a joint liability loan because both take the safe projects. This is less than the expected payoff from taking an individual liability loan. See Proof 2. If $\theta^H > 3r/a$, then Borrower 1 will have an expected payoff of $\theta^S - a\theta^L/4 - 3r/4$. This net expected payoff is also less than that under individual liability. The difference in net expected payoffs of the individual liability loan over the joint liability loan is $[\theta^S - a\theta^L/2 - r/2] - [\theta^S - a\theta^L/4 - 3r/4] = (r - a\theta^L)/4 > 0$ since $\theta^L < r/a$. Therefore, if equal in terms and accessibility, microentrepreneurs would prefer the individual liability loan. See Proposition 12 in the Appendix with proof.

The insight that the joint liability contract without social sanctions induces the borrowers to take safe investments when the payoff possibilities are lower implies that the risk sharing effect does dominate the free riding effect. This result contradicts Besley and Coate (1995), who argue that the ability of borrowers to level punishments on one another is a necessary element to guarantee superior repayment rates for joint liability loans. I find this different result because I relax their assumption of project choice being exogenous.

IV. B. Joint Lending with Social Sanctions

Now, I allow group members to penalize each other if one does not contribute to the repayment of the loan. Following Besley and Coate (1995), social sanctions are a function of payoffs of the noncontributing borrower, and not on observation of effort or project selection. Social sanctions can be in the form of loss of reputation in the community or inability to participate in future loans. "Social sanctions" can also be seen as the group member's internal sense of obligation or guilt or for not contributing to the repayment of the loan even if the community completely forgives her. With an outside, impersonal institution, she may not have such guilt for defaulting. Social sanctions' sensitivity to realized returns are assumed to be more punitive than the bank penalty functions; this belief is the basis for arguments that the cultural realities of these borrowers can induce them to repay their loans better than what a lender outside the community has at its disposal. The structure of the social sanctions function, $s(\theta_j)$, is similar to that of the bank penalty function: $s(\tilde{\theta}_j) = s_f + \frac{\alpha}{\beta}\tilde{\theta}_j$, where $s_f \geq a_f$ and $\alpha \leq \beta \leq 1$. $1/\beta$ represents the increased degree by which the contributing borrower can penalize the noncontributing borrower over that of the bank. A larger β implies relatively greater leniency by the group.

Optimal Strategies at t=2

A group member's payoffs decrease by $s(\tilde{\theta}_j)$ only when the other group member repays the loan and the member being sanctioned does not contribute. If the loan is not repaid (i.e., neither borrower contributes), then they do not sanction each other, but they are both penalized by the bank. Continue to assume that $a_f = 0$, and also assume for now that $s_f = 0$. The borrowers' payoffs to each pair strategies are given in Figure 7.

		Borrower 2 Strategy (s_2)	
		C	NC
Borrower 1 Strategy (s_1)	C	$\tilde{\theta}_1$-r, $\tilde{\theta}_2$-r	$\tilde{\theta}_1$-2r, $\tilde{\theta}_2$(1-α/β)
	NC	$\tilde{\theta}_1$ (1-α/β), $\tilde{\theta}_2$-2r	$\tilde{\theta}_1$ (1-α), $\tilde{\theta}_2$(1-α)

Figure 7. Joint liability with social sanctions net payoffs ($U^{JS1}(\underline{s},\underline{\tilde{\theta}})$, $P_2(\tilde{\theta}_2 \mid s_1)$) under the four possible strategy combinations of both borrowers in a group.

Project returns, $\tilde{\theta}_1$ and $\tilde{\theta}_2$, determine the payoffs of each combination of strategies as in the previous considered case. Therefore, the Nash equilibria vary by the realizations of $\tilde{\theta}_1$ and $\tilde{\theta}_2$. The optimal strategies are in Lemmas 3.1 – 3.4 in the Appendix with proofs and summarized in a table in Figure 8. The optimal strategies when borrowers can sanction each other are less likely to be dominated by free-riding. When both borrowers have payoffs in excess of $\beta r/\alpha$, then the entire group repays the loan. Furthermore, since $\beta \leq 1$, the lender is more likely to be repaid than in the individual liability case, where the critical point for individual repayment is $r/\alpha \geq \beta r/\alpha$. However, joint liability with social sanctions still suffers from the problem of a borrower with medium level payoffs not contributing her portion when her peer's project has very low payoffs.

		$\tilde{\theta}_2$		
		$\tilde{\theta}_2 < \beta r / \alpha$	$\beta r / \alpha \leq \tilde{\theta}_2 < 2r / \alpha$	$\tilde{\theta}_2 \geq 2r / \alpha$
$\tilde{\theta}_1$	$\tilde{\theta}_1 < \beta r / \alpha$	(NC, NC)	(NC, NC)	(NC, C)
	$\beta r / \alpha \leq \tilde{\theta}_1 < 2r / \alpha$	(NC, NC)	(C, C)	(C, C)
	$\tilde{\theta}_1 \geq 2r / \alpha$	(C, NC)	(C, C)	(C, C)

Figure 8. Nash equilibrium strategies (s_1*, s_2*) for various project payoffs under joint liability with social sanctions.

Figure 9 graphs the payoffs of these optimal strategies. The new payoff functions with social sanctions differ from those without. The joint liability loan without social sanctions does have payoffs that exceed that of the social sanctions case and the individual liability case due to the reduction in the free-riding effect. Borrowers are more likely to both contribute to the repayment of the loan for high realizations of project payoffs. However, there are no net payoffs under joint liability with social sanctions that exceed that of the individual liability case.

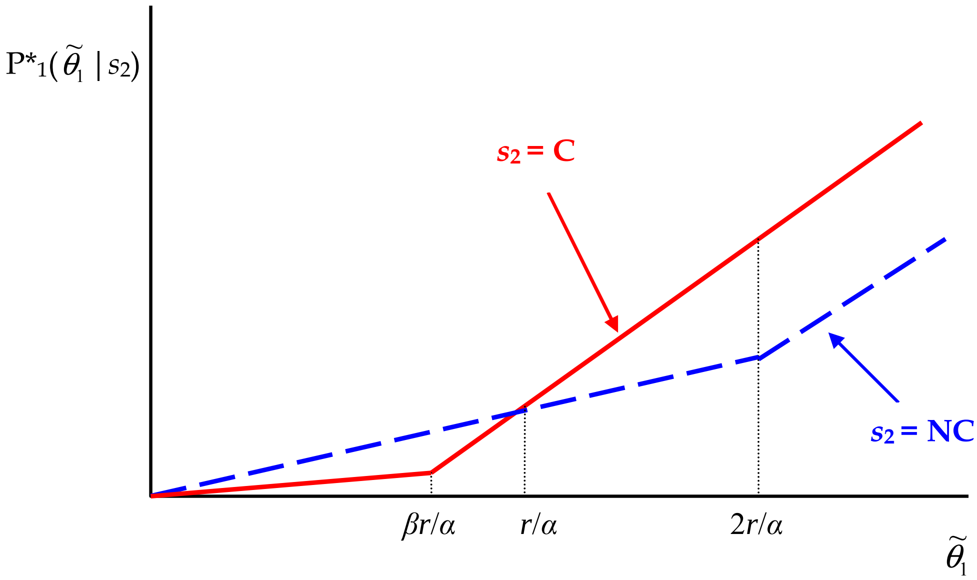

Figure 9. Optimal strategy net payoff functions of Borrower 1 under joint liability with social sanctions. The solid line represents $P^*_1(\tilde{\theta}_1 \mid C)$, the optimal strategy net payoff if Borrower 2 contributes to repayment. The dashed line represents $P^*_1(\tilde{\theta}_1 \mid NC)$, the optimal strategy net payoff if Borrower 2 does not contribute to repayment.

Optimal Strategies at t=1

As in the other joint liability case, each borrower will use her expectations of her own project's payoffs and her peers' at t =1 when choosing what kind of project in which to invest. Assume that there are two projects to choose from as before and that that the safe investment's payoffs are strictly less than $2r/\alpha$. Does Borrower 1 choose the risky or the safe investment if Borrower 2 invests in the safe investment? What does Borrower 1 choose if Borrower 2 invests in the risky investment?

First, consider what possible net payoffs Borrower 1 faces if Borrower 2 chooses the safe investment. If Borrower 1 chooses the safe investment also, then they would play (C, C), and Borrower 1 has a net payoff of $\theta^S - r$ for sure. If Borrower 1 chooses the risky investment, then she has a net payoff of $\theta^H - r$ if the project pays θ^H, and she has a net payoff of either $\theta^L - r$ or $\theta^L(1-\alpha/\beta)$, depending on whether θ^L is greater than or less than $\beta r/\alpha$, respectively. If $\theta^L \geq \beta r/\alpha$, then her expected net payoff is $(\theta^H - r)/2 + (\theta^L - r)/2 = \theta^S - r$, making her indifferent between taking the safe project and the risky project. In either case, both she and her peer contribute to repayment. If $\theta^L < \beta r/\alpha$, then her expected net payoff is $(\theta^H - r)/2 + \theta^L(1-\alpha/\beta)/2 = \theta^S - \alpha\, \theta^L/(2\beta) - r/2$. In this case, she will choose the risky investment:

> **Proposition 7:** If borrower 2 invests in the safe project, then borrower 1 will invest in the risky project. See Appendix for the proof.

Next, consider what possible net payoffs Borrower 1 faces if Borrower 2 chooses the risky investment. If Borrower 1 also chooses the risky investment, she faces four possible net payoffs. Figure 10 shows the net payoffs for that case. In this case, there are possibilities that Borrower 1 will either depend on her peer to cover her portion of the loan or she will cover her peer's portion of the loan. The expected net payoff from taking the risky investment when Borrower 2 also takes the risky investment is $EU_{RR}^{JS1} = \theta_1^S - \dfrac{\alpha(1-\frac{1}{\beta})\theta_1^L + 3r}{4}$. If Borrower 1 takes the safe project, however, then she has possible net payoffs shown in Figure 11. The expected net payoff from taking the safe investment when Borrower 2 takes the risky investment is $EU_{SR}^{JS1} = \theta_1^S - \dfrac{\alpha\theta_1^S + r}{2}$.

The difference in taking the risky project over taking the safe project when Borrower 2 takes the risky project is $EU_{RR}^{JS1} - EU_{SR}^{JS1} = \frac{2\alpha\theta_1^S - (\beta+2)r}{4}$, which is greater than zero only if $\theta_1^S \geq \frac{(\beta+2)r}{2\alpha}$. Therefore, Borrower 1 chooses the risky project when Borrower 2 chooses a risky project if $\theta_1^S \geq \frac{(\beta+2)r}{2\alpha}$ and the safe project otherwise:

> **Proposition 8:** If $\theta_1^L < \frac{\beta r}{\alpha}$ and borrower 2 invests in the risky project, then borrower 1 will take the risky project only if $\theta_1^S \geq \frac{(2+\beta)r}{2\alpha}$. Otherwise, borrower 1 will take the safe project. See Appendix for the proof.

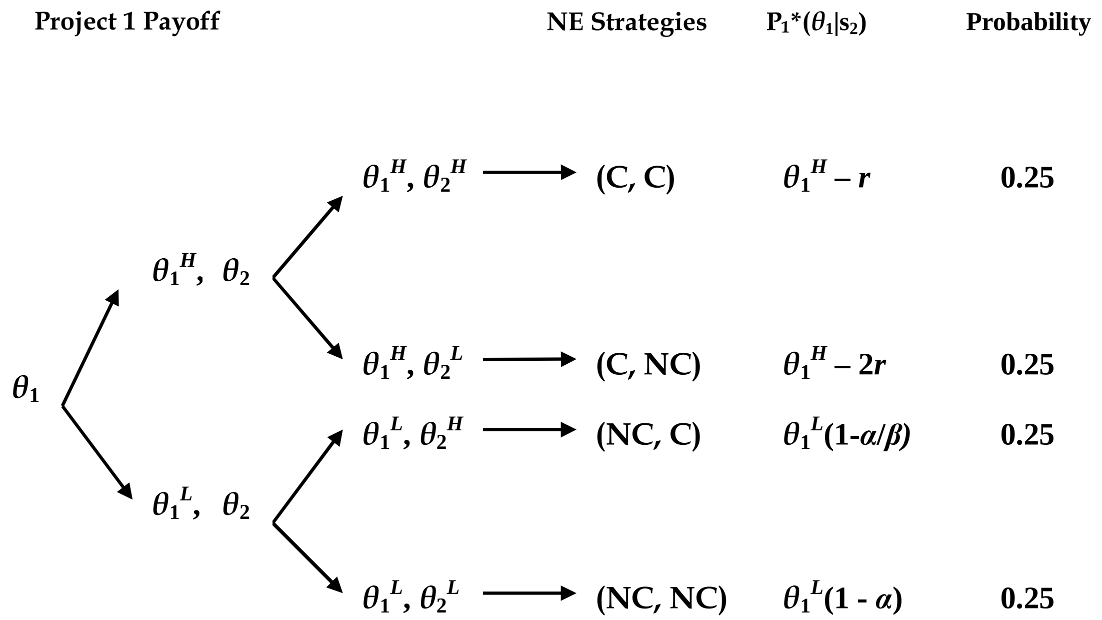

Figure 10. Optimal strategy net payoffs to Borrower 1 when both borrowers take the risky project, there are social sanctions, and $\theta^L \leq \beta r/\alpha$.

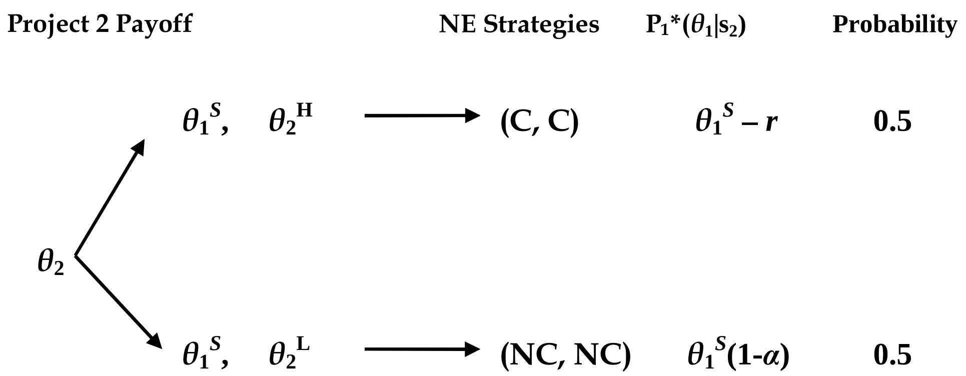

Figure 11. Optimal strategy net payoffs to Borrower 1 when Borrower 2 takes the risky project, Borrower 1 takes the safe project, there are social sanctions, and $\theta^L \leq \beta r/\alpha$.

Optimal Strategies at t=0

The following lemmas identify which peers each type of borrower prefers according to her expected project payoff:

> **Lemma 4.1:** For the borrower who will always choose the risky project, *i.e.* those who have project expected payoffs greater than $\frac{(\beta+2)r}{2\alpha}$, it is preferable for her to find a peer who will choose the safe project. See Appendix for the proof.

> **Lemma 4.2:** For the borrower who will invest in the safe project when her peer invests in the risky project, it is preferable for her to find a peer with low expected payoffs, *i.e.* between $\frac{r}{\alpha}$ and $\frac{(\beta+2)r}{2\alpha}$. See Appendix for the proof.

By consequence of these preferences, borrowers with similar project expected payoffs will match together, as stated in the following proposition:

> **Proposition 9**: Borrowers will match with other borrowers with the same expected project payoffs where there is a possibility of social sanctions. See Appendix for the proof.

As a consequence, there are is separation in investment strategies according to the groups' projects' expected payoffs:

> **Proposition 10:** The only investment strategies that will be played are *P1=P2=R* for groups with high expected project payoffs and *P1≠P2* for groups with low expected project payoffs. See Appendix for the proof.

Would we see groups who play opposite investment strategies? Guttman (2006, 2007) show that if group members can select each other and they can make side payments to each other, then the risky borrowers will match with safe borrowers. My model is consistent with this finding because groups of borrowers with low expected payoffs play opposite investment strategies. However, my model does not identify which borrower would invest in which type of project, though the possibility of side payments could resolve such a question as long as each borrower has an equal probability of offering the side payment and receiving it.

In the above scenario, the repayment rate is 0.5:

> **Proposition 11:** The expected repayment rate of a joint liability loan with the possibility of social sanctions is between 50 percent and 75 percent. See Appendix for the proof.

Therefore, the repayment rate of joint liability contracts with social sanctions is greater than that of the individual liability contract. However, if all borrowers have average project prospects that are sufficiently low, then the repayment rate is no greater than the individual liability's. See the proof for Proposition 11. Therefore, we see a case where a joint liability contract might be inferior to an individual liability contract because both the lender will not be any better off, and the borrower will be worse off.

Note that the conditions for the mixed investment strategy of borrowers, for whom $\theta 1^S \leq (2 + \beta)r/(2\alpha)$, implies that the more stringent the social sanctions (lower β), the less likely it is that the mixed investment strategy will occur because the minimum threshold for taking the (Risky, Risky) strategy is lowered. Therefore, though joint liability with social sanctions leads to lower repayment rates than a joint liability without them, stronger social sanctions do make it less likely that the strategies of (Risky, Safe) will be played.

V. Welfare Comparisons and General Equilibrium Extension

The ultimate question for microfinance institutions, governments, and NGOs is what type of contract maximizes welfare? The microfinance contract that maximizes societal welfare is one that increases the expected net payoff to one borrower without decreasing the expected repayment to the lender.[4] Recent experience with individual liability contracts supports my contention below that the individual liability contract is often superior to the joint liability contract. It has been found in practice as well as in controlled experiments that MFIs that switched from joint liability to individual liability loans did not experience a decrease in loan repayments.

Social capital, therefore, has a "dark side" of inhibiting some borrowers from taking more risk, which does not improve repayment rates because of the enforceability problem that exists in the countries these loans are made in. These results provide some counter predictions to the usual beliefs that group lending programs improve repayment rates because the group is able to penalize its members by taking away some of their social capital. Furthermore, these results give a theoretical explanation for anecdotal evidence of the negative welfare effects of microfinance programs on very poor borrowers (Khawari 2004, Hulme and Mosley 1996, and Pretes 2002). These borrowers in particular seem to pick relatively overly safe projects. The empirical evidence shows it is the very poor for whom microfinance does not work as well as intended. The results presented here show group lending produces the same choice by borrowers facing project opportunity sets with a low expected outcome. If borrowers' incomes are positively correlated with the project opportunity sets available to them, then these results may explain the disparate impact of microfinance programs. Interestingly, social sanctions may work *too* well by making borrowers too scared to take on an optimal amount of risk.

V.A. Only One Contract Is Offered

Inspection of Figures 1, 4, and 9 reveals that for the same loan availability and terms, borrowers' expected net payoffs are higher under individual liability contracts for all projects than under either joint liability cases.

> **Proposition 12:** In terms of borrower expected utility, the individual liability contract weakly dominates the joint liability contracts assuming the same

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[4] An additional criterion for maximum societal welfare is the degree that business activity has a positive externality. If the microentrepreneurs invest loans by purchasing capital and hiring labor within their community and the risky projects require greater investment than the safe project, then this externality effect would also suggest that more risk taking by, *Ceteris Paribus*, would increase welfare. I show later that if such an externality exists, then my conclusions are even stronger.

principal and interest across contracts (*i.e.,* same *r*) and only one contract is offered. See Appendix for the proof.

However, I also show that the repayment rate under joint liability without social sanctions is higher by 25 to 50 percent than the repayment rate under individual liability. This increase in repayment probability is due to the risk sharing benefit when risky projects are taken or to the incentive to take safe projects when the payoffs to the risky investment are not very high. Because the lender can expect to be repaid with a higher probability, it will make loans available to more borrowers by rationing credit less and/or reducing the interest rate.

If borrowers are able to sanction each other, however, there actually may be no effect on the repayment rate over the individual liability contract if the sanctions are not sufficiently strong and average payoffs are not sufficiently high. This surprising conclusion is due to the lack of risk-sharing benefit by groups forming whereby only one borrower takes the risky project. This is worse than if the borrowers both chose to take the risky project because if only one borrower takes the risky project and the project pays θ^L, then there will be no chance of the borrower taking the safe project being able to cover for her. The costs of being punished by one's peer are what drive this result.

The question has been raised in microfinance circles of whether the joint liability feature of group lending is what harnesses the social capital that leads to high repayment rates. I also demonstrate how joint liability contracts can induce greater repayment without peers being able to sanction each other. The mechanism by which joint liability works to increase loan repayment is not through inducing peers to punish each other, but rather through borrowers sharing risk or through cooperatively avoiding risk. If peers can punish each other, however, joint liability does not necessarily work better than individual liability loans.

The dominance of the individual liability contract with the constraint that the lender can only offer one contract is demonstrated in the proof of the following proposition, which is in the Appendix:

V.B. A Choice of Contract Is Offered

The microfinance industry has developed to the point that microborrowers have options of taking an individual liability or joint liability contract. In this section, I allow the amount due, *r*, to vary across contract types, which is dependent on the types of borrowers who may separate into either type of contract. It also influences which borrower will take a particular contract type.

First, I compare the individual liability loan to the joint liability loan without the possibility of social sanctions. The following proposition is obtained:

Proposition 14: If given the choice between an individual liability and joint liability contract with the possibility of social sanctions, borrowers with $\theta_i^H < \frac{3r}{\alpha}$ choose the individual liability contract and those with $\theta_i^H \geq \frac{3r}{\alpha}$ choose the joint liability contract. The total principal and interest due on the individual liability contract is 150% of that of the joint liability contract. See Appendix for the proof.

Proposition 14 implies that borrowers with better prospects ($\theta_i^H \geq \frac{3r}{\alpha}$) prefer the joint liability contract because the interest rate is lower because the lender knows that peers share risk with them. Borrowers with lesser prospects ($\theta_i^H < \frac{3r}{\alpha}$) prefer the individual liability contract because the cost imposed by the lender is less than the cost of taking the safe project.

By offering the individual liability contract in addition to the joint liability contract, the borrowers who otherwise would have invested in the safe projects under joint liability now invest in the individual liability contract. Therefore, everyone invests in the risky project.

Next, I compare the individual liability loan to the joint liability loan where there is a possibility of social sanctions. The following lemma and proposition are obtained:

Lemma 5: If given the choice between an individual and joint liability contract where there will be social sanctions, borrowers for whom $\underline{p}^*=(R,R)$ will choose the individual liability contract. See Appendix for the proof.

Proposition 15: If given the choice between an individual liability and joint liability loan where there is a possibility of social sanctions, no one will take the joint liability contract. See Appendix for the proof.

Therefore, the dominance of the individual liability contract is maintained where there would be social sanctions under a joint liability contract under the general equilibrium assumptions and assumption A8 that expected project payoffs are always greater than r/α. If this assumption is relaxed, however, then the lower interest rate induced by the possibility of higher repayment under joint liability would cause more people to take these loans who otherwise would not borrow at all.

VI. Empirical Hypotheses

The conclusions of this study imply some empirical hypotheses using data on the MFI level. Using this level of data is newer in microfinance research because these data have only become available within the last decade. One seminal paper is Cull, Demirguc-Kunt, and Morduch (2009), which studies the financial and customer demographic ratios of MFIs as reported by www.mixmarket.org. They study such key questions in microfinance as what is the potential tradeoff between MFI sustainability and reach to the poorest borrowers. Cull, et. al. (2009) find that contract design substantially impacts MFI profitability, loan repayment, and costs. They find that MFIs that make individual liability loans experience increases in portfolio quality and profitability when they raise interest rates. Whereas they compare contract types of individual versus group based lending, the theory presented here predicts different results among group based lenders based on the social ties of their customers. The difference arises from varying strengths and types of informal institutions that impact how group members respond to non-paying peers.

The data used by Cull, et. al. (2009) could be augmented with measures of formal and informal institutions within in each of the MFIs' markets. If these measures can be obtained and MFIs are identified by their mix of making individual and joint liability contracts, then repayment rates across the three kinds of lending discussed here could be compared.

This study also has implications for testing using micro level data, which is what the majority of studies have used. If a measure of the project opportunities available to microborrowers can be collected, then there are several more testable hypotheses. Microfinance borrowers with higher (lower) possible project payoffs are expected to be more like likely to find peers with similarly higher (lower) possible project payoffs. Microfinance borrowers with higher and more varied possible project payoffs are expected to be more likely to match with peers with lower and less varied possible project payoffs. Joint liability borrowers are expected to switch to riskier projects if they switch to receiving individual liability loans, especially if they have project opportunities with low upside payoffs.

The empirical testing of this model entails data collection challenges. First, measures of forbearance by culture would require conducting surveys among every identifiable culture served by the MFIs being studied. Second, measuring project possibilities directly also would require reliance on surveying microborrowers.

VII. Conclusion

Microfinance has popularly been touted as a program that succeeds in improving its borrowers' incomes by overcoming the moral hazard problem inherent in individual liability loans in countries with poor institutions. This paper contributes to theory as to why microfinance does not always work as intended. Furthermore, it shows that both formal and informal institutions matter, which could lead to certain policy prescriptions according to a country's institutions.

Given that the whole purpose of microfinance is to promote entrepreneurship, which is inherently a risky project, and if the borrower's prospects are low, then she will not use the funds to make a business grow. Rather, she will use it for some other purpose, such as income smoothing. She may even forgo her entrepreneurial pursuits in order to be certain to pay back the loan: There have been stories of borrowers taking on jobs in cities just to repay their portions of loans rather than working on their own businesses. If the real need of these individuals is insurance, then they may benefit more by microinsurance programs instead of microlending ones.

On the one hand, the presence of social sanctions in joint liability contracts may inhibit entrepreneurial activity among people who would otherwise take business loans as individuals. On the other hand, joint liability contracts can be made to groups with social capital but low payoff project opportunities would otherwise not borrow money at all.

There are several testable empirical hypotheses implied by this model that may be tested. First, MFIs that make individual liability loans should have lower repayment rates than those that make joint liability loans if the group members are unlikely to punish one another for non-contribution. Second, MFIs that make individual liability loans should have the same repayment rates as those that make joint liability loans where group members are likely to punish one another for non- contribution and project payoffs are sufficiently high. To test these first two predictions, one would regress repayment rate at the MFI level on the composition of individual liability contracts to total contracts, the average measure of social ties among borrowers' communities, and the average measure of potential project payoffs to the borrowers. Tests using this regression would be most powerful with a sample of MFIs that serve identifiably specific types of borrowers by culture and economic status. Third, microfinance borrowers with higher (lower) possible project payoffs will be more likely to find peers with similarly higher (lower) possible project payoffs. Fourth, microfinance borrowers with higher and more varied possible project payoffs will be more likely to match with peers with lower and less varied possible project payoffs. Fifth, joint liability loan borrowers will be more likely to switch to riskier projects if they switch to receiving individual liability loans. These third, fourth, and fifth predictions would be tested using individual borrower data, which would depend more heavily on specialized surveys than the methodology for testing the first two predictions.

Appendix

Assumptions:

1. Ordering of Payoff Possibilities for Borrower *i*:

$$0 \leq \theta_i^L < \theta_i^S < \theta_i^H \tag{A1}$$

2. Payoff Probabilities Conditional on Investing in the Risky Project:

$$pr(\tilde{\theta}_i = \theta_i^L \mid p_i = R) = pr(\tilde{\theta}_i = \theta_i^L \mid p_i = R) = \frac{1}{2} \tag{A2}$$

3. Payoff Probability Conditional on Investing in the Safe Project:

$$pr(\tilde{\theta}_i = \theta_i^S \mid p_i = S) = 1 \tag{A3}$$

4. Equivalence of Expected Payoffs of Both Projects:

$$E(\tilde{\theta}_i \mid p_i = R) = \frac{\theta_i^L + \theta_i^H}{2} = \theta_i^S \tag{A4}$$

5. Bank Penalty Parameter Bounds:

$$0 < \alpha \leq 1 \tag{A5}$$

6. Social Sanctions Parameter Bounds:

$$\alpha \leq \beta \leq 1 \tag{A6}$$

7. Low State Payoff Bounds:

$$0 \leq \theta_i^L < \frac{\beta r}{\alpha} < \frac{r}{\alpha} \tag{A7}$$

8. Expected Payoff Bounds for Both Projects:

$$\frac{r}{\alpha} < \theta_i^S < \frac{2r}{\alpha} \tag{A8}$$

9. High State Payoff Bounds:

$$\frac{2r}{\alpha} < \theta_i^H \qquad \text{(A9)}$$

Proposition 1: An individual liability borrower's optimal repayment strategy (*s**) implies the utility (U^I) of the individual liability loan to be convex in her project's payoffs ($\tilde{\theta}$).

<u>Proof</u>:

$U^I[s(\tilde{\theta}), \tilde{\theta}]$ is the utility of individual liability borrower from playing s ∈ (C, NC) and realizing outcome $\tilde{\theta}$.

$$U^I(C, \tilde{\theta}) = \tilde{\theta} - r \qquad (1)$$

$$U^I(NC, \tilde{\theta}) = \tilde{\theta}(1-\alpha) \qquad (2)$$

If $\tilde{\theta} \geq \frac{r}{\alpha}$, then $U^I(C, \tilde{\theta}) - U^I(NC, \tilde{\theta}) \geq 0$. Therefore, $s^*(\tilde{\theta} \geq \frac{r}{\alpha}) = C$. (3)

If $\tilde{\theta} < \frac{r}{\alpha}$, then $U^I(C, \tilde{\theta}) - U^I(NC, \tilde{\theta}) < 0$. Therefore, $s^*(\tilde{\theta} < \frac{r}{\alpha}) = NC$. (4)

Therefore, individual liability borrower's utility under her optimal repayment strategy is as follows (combining (1) – (4)):

$$U^I[s^*(\tilde{\theta}), \tilde{\theta}] = \begin{cases} \tilde{\theta}(1-\alpha) & if \quad \tilde{\theta} < \frac{r}{\alpha} \\ \tilde{\theta} - r & if \quad \tilde{\theta} \geq \frac{r}{\alpha} \end{cases} \qquad (5)$$

Since $0 < \alpha < 1$, (5) is a convex function.

Proposition 2: An individual liability borrower's optimal investment decision *(p*)* is to take the risky project (R) rather than the safe project (S).

Proof:

$\mathrm{E}[\mathrm{U}_{\mathrm{p}}^{\mathrm{I}}(s^*,\widetilde{\theta})]$ is the expected utility of individual liability borrower from take project $p\in$ *(R, S)* according to playing her optimal repayment strategy *(s*)*.

The expected utilities from investing in the risky *(R)* and safe *(S)* project *(p)*:

If $p = R$:

$$\mathrm{E}[U_R^I(s^*,\widetilde{\theta})] = \frac{1}{2}U^I(s^*,\theta^L) + \frac{1}{2}U^I(s^*,\theta^H)$$

$$= \frac{1}{2}\theta^L(1-\alpha) + \frac{1}{2}(\theta^H - r) \qquad (6)$$

Recognizing that $\frac{1}{2}\theta^L + \frac{1}{2}\theta^H = \theta^S$ and suppressing the arguments of U_R^I, (6) reduces to:

$$EU_R^I = \theta^S - \frac{\alpha\theta^L + r}{2} \qquad (7)$$

If $p = S$:

$$\mathrm{E}[U_S^I(s^*,\widetilde{\theta})] = U^I(s^*,\theta^S) \qquad (8)$$

$$EU_S^I = \theta^S - r \qquad (9)$$

Subtracting (9) from (7) yields the difference in expected utility between the two investment strategies:

$$EU_R^I - EU_S^I = \frac{r - \alpha\theta^L}{2} \qquad (10)$$

Since, by assumption, $\theta^L < \frac{r}{\alpha}$:

$$EU_R^I - EU_S^I > \frac{r - \alpha(\frac{r}{\alpha})}{2} = 0 \qquad (11)$$

Therefore, the expected utility to the individual liability borrower of investing in the risky project exceeds that of investing in the safe project, *i.e.,* $p^* = R$.

Proposition 3: The expected repayment rate of an individual liability loan is 50 percent.

Proof:

$V^I(s^*,\widetilde{\theta})$ is the ex post value to the lender from making an individual liability loan conditional on the project payoffs and the borrower's optimal repayment strategy.

From Proposition 1:

$$V^I(s^*,\widetilde{\theta}) = \begin{cases} 0 \quad if\ \widetilde{\theta} < \dfrac{r}{\alpha} \\ r \quad if\ \widetilde{\theta} \geq \dfrac{r}{\alpha} \end{cases} \qquad (i)$$

$EV_P^I(s^*,\widetilde{\theta})$ is the expected value to the lender of making an individual liability loan conditional on the borrower taking investment *P*.

$EV_{P*}^I(s^*,\widetilde{\theta}) = EV_R^I(s^*,\widetilde{\theta})$ by Proposition 2.

$$EV_{P*}^I(s^*,\widetilde{\theta}) = \frac{1}{2}\cdot 0 + \frac{1}{2}\cdot r = \frac{r}{2} \qquad (ii)$$

Therefore, the expected repayment rate is $\dfrac{EV_{P*}^I(s^*,\widetilde{\theta})}{r} = \dfrac{1}{2}$ = 50%.

Lemma 1.1: The unique Nash Equilibrium strategy (s*) for both borrowers under a joint liability contract is to not contribute (*NC*) to the loan repayment when both projects' payoffs are less than $\dfrac{2r}{a}$.

Proof:

$U^{J1}(\underline{s},\widetilde{\theta})$ is the value to borrower 1 under a joint liability contract from playing $\underline{s} = (s_1, s_2)$, where $s_1 \in (C_1, NC_1)$, $s_2 \in (C_2, NC_2)$, and $\underline{\widetilde{\theta}} = (\widetilde{\theta}_1, \widetilde{\theta}_2)$.

$$U^{J1}[(NC,NC),\widetilde{\theta}] = \widetilde{\theta}_1(1-\alpha) \tag{12}$$

$$U^{J1}[(C,NC),\widetilde{\theta}] = \widetilde{\theta}_1 - 2r \tag{13}$$

Subtracting (13) from (12): $U^{J1}[(NC,NC),\widetilde{\theta}] - U^{J1}[(C,NC),\widetilde{\theta}] > 0$ since $\widetilde{\theta}_1 < \frac{2r}{\alpha}$. The same applies to $U^{J2}(\underline{s},\widetilde{\theta})$. Therefore, $\underline{s}^*$ = (*NC, NC)* when $\widetilde{\theta}_1 < \frac{2r}{\alpha}$ and $\widetilde{\theta}_2 < \frac{2r}{\alpha}$.

Lemma 1.2: The unique Nash Equilibrium strategy ($\underline{s}^*$) under joint liability contract is for the borrower with the project payoffs greater than or equal to $\frac{2r}{a}$ to pay for both loans and the borrower with project payoff less than $\frac{2r}{a}$ to not contribute.

Proof:

Let $\widetilde{\theta}_1 \geq \frac{2r}{\alpha}$ and $\theta_2 < \frac{2r}{\alpha}$.

From (12) and (13):

$$U^{J1}[(C,NC),\widetilde{\theta}] - U^{J1}[(NC,NC),\widetilde{\theta}] = \alpha\widetilde{\theta}_1 - 2r \tag{14}$$

(14) is greater than zero since $\widetilde{\theta}_1 \geq \frac{2r}{\alpha}$. Therefore, borrower would not deviate from playing *C*.

Applying (12) and (13) to borrower 2

$$U^{J2}[(C,NC),\widetilde{\theta}] - U^{J1}[(C,C),\widetilde{\theta}] = r \tag{15}$$

(15) is greater than zero. Therefore, borrower 2 will not deviate from playing *NC*.

Therefore, $\underline{s}$*=(*C, NC*) when $\tilde{\theta}_1 \geq \frac{2r}{\alpha}$ and $\tilde{\theta}_2 < \frac{2r}{\alpha}$, and by the same reasoning, $\underline{s}$*=(*NC, C*) when $\tilde{\theta}_1 < \frac{2r}{\alpha}$ and $\tilde{\theta}_2 \geq \frac{2r}{\alpha}$.

Lemma 1.3: The unique Nash Equilibrium strategy ($\underline{s}$*) under a joint liability contract is for both borrowers to contribute (C,C) to repayment of the loan if both projects' payoffs are greater than $\frac{r}{a}$ and less than $\frac{2r}{a}$.

Proof:

Let $\frac{r}{\alpha} \leq \tilde{\theta}_1 < \frac{2r}{\alpha}$ and $\frac{r}{\alpha} \leq \tilde{\theta}_2 < \frac{2r}{\alpha}$.

$$U^{J1}[(C,C),\tilde{\theta}] = \tilde{\theta}_1 - r \quad (16)$$

$$U^{J1}[(NC,C),\tilde{\theta}] = \tilde{\theta}_1 \quad (17)$$

Subtracting (17) from (16):

$$U^{J1}[(NC,NC),\tilde{\theta}] - U^{J1}[(C,NC),\tilde{\theta}] = -r \quad (18)$$

Since (18) is less than zero, borrower 1 would like to deviate from playing *C* to *NC* if borrower 2 does not respond by deviating. Borrower 1 anticipates how borrower 2 will respond by evaluating the following:

$$U^{J2}[(NC,NC),\tilde{\theta}] - U^{J2}[(NC,C),\tilde{\theta}] = 2r - \alpha\tilde{\theta}_2 \quad (19)$$

Because $\frac{r}{\alpha} \leq \tilde{\theta}_2 < \frac{2r}{\alpha}$, the right hand side of (19) is strictly greater than zero: $r \geq 2r - \alpha\tilde{\theta}_2 > 0$. Therefore, borrower 2 would respond to borrower 1 deviating by also deviating. Because both borrowers know that deviating from *C* to *NC* induces the peer to doing likewise, neither borrower will deviate from playing *C* if the marginal value to each borrower from the group playing (*C,C*) over (*NC,NC*) is positive:

From (12) and (16):

$$U^{J1}[(C,C),\tilde{\theta}]-U^{J1}[(NC,NC),\tilde{\theta}]=\alpha\tilde{\theta}-r \qquad (20)$$

(20) is weakly greater than zero since $\frac{r}{\alpha}\le\tilde{\theta}_1<\frac{2r}{\alpha}$. Therefore, neither borrower will deviate from *C*, and $\underline{s}$*=(C,C) when $\frac{r}{\alpha}\le\tilde{\theta}_1<\frac{2r}{\alpha}$ and $\frac{r}{\alpha}\le\tilde{\theta}_2<\frac{2r}{\alpha}$.

Lemma 1.4: The only Nash Equilibrium strategies ($\underline{s}$*) under a joint liability contract is for only one borrower to contribute to repayment of the loan for both [(*C,NC*) or (*NC,C*)] if both projects' payoffs are greater than or equal to $\frac{2r}{a}$.

<u>Proof</u>:

From (12) and (13):

$$U^{J1}[(C,NC),\tilde{\theta}]-U^{J1}[(NC,NC),\tilde{\theta}]=\alpha\tilde{\theta}_2-2r \qquad (21)$$

Since $\tilde{\theta}_1\ge\frac{2r}{\alpha}$, the right hand side of (21) is greater than or equal to zero. Therefore, borrower 1 will not deviate from playing *C*.

From (13) and (16):

$$U^{J2}[(C,NC),\tilde{\theta}]-U^{J2}[(C,C),\tilde{\theta}]=r \qquad (22)$$

Since the right hand side of (22) is positive, borrower 2 will not deviate from playing *NC*.

However, the same logic applies to show that it is also a Nash Equilibrium for borrower 1 to not contribute and borrower 2 to contribute. Therefore, $\underline{s}^*=[(C,NC),(NC,C)]$.

Proposition 4: Under a joint liability contract, if one borrower invests in the safe project, then the other borrower will also invest in the safe project (*S*) rather than the risky project (*R*).

Proof:

$E[U^{J1}_{P_1P_2}(\underline{s}^*, \underline{\widetilde{\theta}})]$ is the expected value to borrower 1 from borrower 1 taking project P_1 and borrower 2 taking project P_2 according to both players' optimal contribution strategies ($\underline{s}$*) and payoff possibilities ($\underline{\widetilde{\theta}}$).

If $P_1 = R$ and $P_2 = S$, then by Lemma 1.1 and Lemma 1.2:

$$\underline{s}^*(\theta_1^L, \theta_2^S) = (NC, NC) \tag{23}$$

$$\underline{s}^*(\theta_1^H, \theta_2^S) = (C, NC) \tag{24}$$

Therefore,

$$\begin{aligned} EU^{J1}_{RS} &= \frac{1}{2}U^{J1}[\underline{s}^*, (\theta_1^L, \theta_2^S)] + \frac{1}{2}U^{J1}[\underline{s}^*, (\theta_1^H, \theta_2^S)] \\ &= \frac{1}{2}\theta_1^L(1-\alpha) + \frac{1}{2}(\theta_1^H - 2r) \\ &= \theta_1^S - \frac{\alpha\theta_1^L}{2} - r \end{aligned} \tag{25}$$

If $P_1 = R$ and $P_2 = S$, then by Lemma 1.3:

$$\underline{s}^*(\theta_1^S, \theta_2^S) = (C, C) \tag{26}$$

Therefore,

$$EU^{J1}_{SS} = U^{J1}[\underline{s}^*, (\theta_1^S, \theta_2^S)] = \theta_1^S - r \tag{27}$$

To compare the marginal value to borrower 1 from taking the safe project over the risky project when borrower 2 takes the safe project, subtract (25) from (27):

$$EU_{SS}^{J1} - EU_{RS}^{J1} = \theta_1^S - r - (\theta_1^S - \frac{\alpha\theta_1^L}{2} - r) = \frac{\alpha\theta_1^L}{2} \tag{28}$$

Because the right hand side of (28) is greater than or equal to zero, borrower 1 will invest in the safe project if borrower 2 invests in the safe project. I.e., $P_1^* = S$ if $P_2 = S$.

Proposition 5: Under a joint liability contract, if one borrower invests in the risky project, then the other borrower will invest in the risky project only if her projects' high state payoff is greater than $\frac{3r}{\alpha}$. Otherwise, she will invest in the safe project.

Proof:
If P_1=P_2=R, by Lemmas 1.1, 1.2, and 1.4:

$$\underline{s}*(\theta_1^L, \theta_2^L) = (NC, NC) \tag{29}$$

$$\underline{s}*(\theta_1^L, \theta_2^H) = (NC, C) \tag{30}$$

$$\underline{s}*(\theta_1^H, \theta_2^L) = (C, NC) \tag{31}$$

$$\underline{s}*(\theta_1^H, \theta_2^H) = [(C, NC), (NC, C)] \tag{32}$$

Therefore, the expected value to borrower 1 from taking the risky project when borrower 2 does likewise is

$$\begin{aligned} EU_{RR}^{J1} &= \frac{1}{4}U^{J1}[\underline{s}*, (\theta_1^L, \theta_2^L)] + \frac{1}{4}U^{J1}[\underline{s}*, (\theta_1^L, \theta_2^H)] + \frac{1}{4}U^{J1}[\underline{s}*, (\theta_1^H, \theta_2^L)] \\ &+ \frac{1}{4}\{\frac{1}{2}U^{J1}[(C, NC), (\theta_1^H, \theta_2^H)] + \frac{1}{2}U^{J1}[(NC, C), (\theta_1^H, \theta_2^H)]\} \\ &= \frac{1}{4}\theta_1^L(1-\alpha) + \frac{1}{4}\theta_1^L + \frac{1}{4}(\theta_1^H - 2r) + \frac{1}{4}[\frac{1}{2}(\theta_1^H - 2r) + \frac{1}{2}\theta_1^H] \end{aligned}$$

$$= \theta_1^S - \frac{\alpha\theta_1^L + 3r}{4} \tag{32}$$

If P_1=S and P_2=R, by Lemmas 1.1 and 1.2:

$$\underline{s}^*(\theta_1^S, \theta_2^L) = (NC, NC) \tag{33}$$

$$\underline{s}^*(\theta_1^S, \theta_2^H) = (NC, C) \tag{34}$$

Therefore, the expected value to borrower 1 from taking the safe project when borrower 2 takes the risky project is

$$EU_{SR}^{J1} = \frac{1}{2}U^{J1}[\underline{s}^*, (\theta_1^S, \theta_2^L)] + \frac{1}{2}U^{J1}[\underline{s}^*, (\theta_1^S, \theta_2^H)]$$

$$= \frac{1}{2}\theta_1^S(1-\alpha) + \frac{1}{2}\theta_1^S$$

$$= \theta_1^S - \frac{\alpha\theta_1^S}{2} \tag{35}$$

To compare the marginal value to borrower 1 from taking the risky project over the safe project when borrower 2 takes the risky project, subtract (35) from (32):

$$EU_{RR}^{J1} - EU_{SR}^{J1} = \theta_1^S - \frac{\alpha\theta_1^L + 3r}{4} - (\theta_1^S - \frac{\alpha\theta_1^S}{2}) = \frac{a(2\theta_1^S - \theta_1^L) - 3r}{4} \tag{36}$$

Using $\theta_1^S = \dfrac{\theta_1^L + \theta_1^H}{2}$ in (36):

$$EU_{RR}^{J1} - EU_{SR}^{J1} = \frac{\alpha\theta_1^H - 3r}{4} \tag{37}$$

The right hand side of equation (37) is greater than zero if $\theta_1^H > \frac{3r}{4}$ and less than zero if $\theta_1^H < \frac{3r}{4}$.

Therefore, $P_1^* = R$ if $P_2 = R$ and $\theta_1^H > \frac{3r}{4}$, and $P_1^* = S$ if $P_2 = R$ and $\theta_1^H < \frac{3r}{4}$.

Lemma 2: The expected value to one borrower of a joint liability contract when both borrowers invest in the risky project exceeds the expected value when they both invest in the safe project.

Proof:

Subtract (27) from (32):

$$EU_{RR}^{J1} - EU_{SS}^{J1} = \frac{r - \alpha\theta_1^L}{4} \qquad (38)$$

Because $\theta_1^L < \frac{r}{a}$, the right hand side of (38) is greater than zero. Therefore, both borrowers prefer to choose the same investment strategies of P_1=P_2=S or P_1=P_2=R.

Corollary 1: Borrowers with high possible project payoffs ($\theta^H > \frac{3r}{a}$) select each other to take joint liability loans and invest in risky projects. Other borrowers ($\theta^H < \frac{3r}{a}$) select each other and invest in safe projects.

Proof:

Following Proposition 4 there is only a possibility of P_1=P_2=S or P_1=P_2=R because it is not possible for one borrower to invest in the safe project and the other to invest in the risky project. Lemma 2 shows that both borrowers would prefer that they both invest in the risky project. From Proposition 5, it is only the borrowers who have high state payoffs under the risky investment who can commit to investing in the risky project when her peer does the same. Therefore, borrowers who can commit to not deviating from investing in the risky project when they both agree to do so would prefer to match with each other. The borrowers who cannot make such a commitment will be forced to match with other such borrowers. Therefore, the borrowers with the very high state payoff possibilities will match with each other and invest in risky projects; the borrowers with the moderately high state payoff possibilities will match with each other and invest in safe projects.

Proposition 6: The expected repayment rate of a joint liability loan is between 75 and 100 percent.

Proof:

Let $\psi \in [0,1]$ be the fraction of borrowers with $\theta^H > \frac{3r}{a}$.

$EV^J_{P_1P_3}(\underline{s}^*, \underline{\tilde{\theta}})$ is the expected value per borrower to the lender from making a joint liability loan to a group conditional on borrowers' investment choices (P_1 and P_2).

By equation (26):

$$EV^J_{SS}(\underline{s}^*, \underline{\tilde{\theta}}) = 2r/2 = r \tag{39}$$

By equations (29) - (32):

$$EV^J_{RR}(\underline{s}^*, \underline{\tilde{\theta}}) = \frac{1}{4}\cdot 0 + \frac{3}{4}\cdot 2r = \frac{3r}{2}/2 = \frac{3r}{4} \tag{40}$$

EV^J is the expected value to the lender per borrower from making a joint liability loan to a group without knowing what projects are available to them.

$$EV^J = \psi EV^J_{SS} + (1-\psi)EV^J_{RR} = \psi r + \frac{3}{4}(1-\psi)r$$

$$= \frac{(3+\psi)r}{4} \tag{41}$$

Therefore, the expected repayment rate is $= \frac{(3+\psi)r}{4}/r = \frac{3+\psi}{4}$, which is bounded between ¾ and 1 (75% and 100%) because $0 \le \psi \le 1$.

Lemma 3.1: The unique Nash Equilibrium strategy ($\underline{s}$*) for both borrowers under a joint liability contract with a possibility of social sanctions is to not contribute to the loan repayment when both projects' payoffs are less than $\frac{\beta r}{\alpha}$.

Proof:
JS ≡ joint liability contract with a possibility of social sanctions

$$U^{JS1}[(NC,NC)],\underline{\tilde{\theta}}] = \tilde{\theta}_1(1-\alpha) \tag{42}$$

$$U^{JS1}[(C,NC)],\underline{\tilde{\theta}}] = \tilde{\theta}_1 - 2r \tag{43}$$

To compare the value of not contributing over contributing, subtract (43) from (42):

$$U^{JS1}[(NC,NC)],\underline{\tilde{\theta}}] - U^{JS1}[(C,NC)],\underline{\tilde{\theta}}] = 2r - \alpha\tilde{\theta}_1 \tag{44}$$

Applying this case, *i.e.,* $\tilde{\theta}_1 < \frac{\beta r}{\alpha}$, to equation (44):

$$U^{JS1}[(NC,NC)],\underline{\tilde{\theta}}] - U^{JS1}[(C,NC)],\underline{\tilde{\theta}}] > 2r - \beta r > 0$$

The same logic applies to the borrower 2. Therefore, $\underline{s}$*=*(NC,NC)* when $\theta_1 < \frac{\beta r}{\alpha}$ and $\theta_2 < \frac{\beta r}{\alpha}$.

Lemma 3.2: The unique Nash Equilibrium strategy ($\underline{s}$*) under a joint liability contract and possibility of social sanctions is for the borrower with project payoffs greater than $\frac{2r}{\alpha}$ to contribute to the repayment of the loan for both borrowers and for the borrower with project payoffs less than $\frac{\beta r}{\alpha}$ to not contribute.

Proof:
Assume that $\tilde{\theta}_1 \geq \frac{2r}{\alpha}$ and $\tilde{\theta}_2 < \frac{\beta r}{\alpha}$.

To compare the value of contributing over not contributing for borrower 1, subtract (42) from (43):

$$U^{JS1}[(C,NC)],\underline{\tilde{\theta}}] - U^{JS1}[(NC,NC)],\underline{\tilde{\theta}}] = \alpha\tilde{\theta}_1 - 2r \quad (45)$$

Applying this case, *i.e.,* $\tilde{\theta}_1 \geq \frac{2r}{\alpha}$, to equation (45): $U^{JS1}[(C,NC)],\underline{\tilde{\theta}}] - U^{JS1}[(NC,NC)],\underline{\tilde{\theta}} \geq 0$. Therefore, borrower 1 will not deviate from contributing for both.

$$U^{JS2}[(C,NC)],\underline{\tilde{\theta}}] = \tilde{\theta}_2(1-\frac{\alpha}{\beta}) \quad (46)$$

$$U^{JS2}[(C,C)],\underline{\tilde{\theta}}] = \tilde{\theta}_2 - r \quad (47)$$

To compare the value of not contributing over contributing for borrower 2, subtract (47) from (46:

$$U^{JS2}[(C,NC)],\underline{\tilde{\theta}}] - U^{JS2}[(C,C)],\underline{\tilde{\theta}}] = r - \frac{\alpha\tilde{\theta}_2}{\beta} \quad (48)$$

Apply this case, *i.e.* $\tilde{\theta}_2 < \frac{\beta r}{\alpha}$, to (48): $U^{JS2}[(C,NC)],\underline{\tilde{\theta}}] - U^{JS2}[(C,C)],\underline{\tilde{\theta}}] > 0$. Therefore, borrower 2 will not deviate from not contributing.

So, when $\tilde{\theta}_1 \geq \frac{2r}{\alpha}$ and $\tilde{\theta}_2 < \frac{\beta r}{\alpha}$, $\underline{s}^* = (C,NC)$, and vice versa.

Lemma 3.3: The unique Nash Equilibrium strategy ($\underline{s}$*) under a joint liability contract with possibility of social sanctions is for both borrowers to contribute to the repayment of the loan if one's project pays off $\frac{2r}{\alpha}$ or more and the other pays off $\frac{\beta r}{\alpha}$ or more.

Proof:

Let $\tilde{\theta}_1 \geq \frac{2r}{\alpha}$ and $\tilde{\theta}_2 \geq \frac{\beta r}{\alpha}$.

Apply (43) and (47) to borrower 1:

$$U^{JS1}[(C,C),\underline{\tilde{\theta}}]-U^{JS1}[(NC,C),\underline{\tilde{\theta}}]=\tilde{\theta}_1-r-(\tilde{\theta}_1-\frac{\alpha}{\beta})=\frac{\alpha\tilde{\theta}_1}{\beta}-r \quad (49)$$

Applying this case, *i.e.* $\tilde{\theta}_1 \geq \frac{2r}{\alpha}$ to (49): $U^{JS1}[(C,C),\underline{\tilde{\theta}}]-U^{JS1}[(NC,C),\underline{\tilde{\theta}}]\geq 0$. Therefore, borrower 1 will not deviate from contributing to repayment.

Apply (49) to borrower 2:

$$U^{JS2}[(C,C),\underline{\tilde{\theta}}]-U^{JS2}[(C,NC),\underline{\tilde{\theta}}]=\tilde{\theta}_2-r-(\tilde{\theta}_2-\frac{\alpha}{\beta})=\frac{\alpha\tilde{\theta}_2}{\beta}-r \quad (50)$$

Applying this case, *i.e.*, $\tilde{\theta}_2 \geq \frac{\beta r}{\alpha}$ to (50): $U^{JS2}[(C,C),\underline{\tilde{\theta}}]-U^{JS2}[(C,NC),\underline{\tilde{\theta}}]\geq 0$. Therefore, borrower 2 will not deviate from contributing to repayment.

So, when one project pays $\frac{2r}{\alpha}$ or more and the other project pays $\frac{\beta r}{\alpha}$ or more, $\underline{s}^*=(C,C)$.

Lemma 3.4: The unique Nash Equilibrium strategy ($\underline{s}$*) under a joint liability contract with the possibility of social sanctions is for neither borrower to contribute to the repayment of the loan if one project payoffs less than $\frac{\beta r}{\alpha}$ and the other pays off less than $\frac{2r}{\alpha}$.

Proof:

Let $\frac{\beta r}{\alpha}<\tilde{\theta}_1 \leq \frac{2r}{\alpha}$ and $\tilde{\theta}_2 < \frac{\beta r}{\alpha}$.

Recall (44):

$$U^{JS1}[(NC,NC)],\underline{\tilde{\theta}}]-U^{JS1}[(C,NC)],\underline{\tilde{\theta}}]=2r-\alpha\tilde{\theta}_1$$

Applying this case, *i.e.,* $\frac{\beta r}{\alpha} < \tilde{\theta}_1 \leq \frac{2r}{\alpha}$ to the above: $(2-\beta)r \geq U^{JS1}[(NC,NC)],\underline{\tilde{\theta}}] - U^{JS1}[(C,NC)],\underline{\tilde{\theta}}] > 0$.

Apply the above to borrower 2 and this case, *i.e.* $\tilde{\theta}_2 < \frac{\beta r}{\alpha}$: $U^{JS2}[(NC,NC)],\underline{\tilde{\theta}}] - U^{JS2}[(C,NC)],\underline{\tilde{\theta}}] > 0$.

Therefore, neither borrower deviates from this strategy. So, $\underline{s}^* = (NC,NC)$.

Proposition 7: If $\theta_1^L < \frac{\beta r}{\alpha}$ and borrower 2 invests in the safe project, then borrower 1 will invest in the risky project.

Proof:

If $P_1=R$ and $P_2=S$, then by Lemmas 3.4 and 3.3:

$$\underline{s}^*(\theta_1^L, \theta_2^S) = (NC, NC) \tag{51}$$

$$\underline{s}^*(\theta_1^H, \theta_2^S) = (C, C) \tag{52}$$

Therefore, the expected value to borrower 1 from taking the risky project when her peer takes the safe project is:

$$EU_{RS}^{JS1} = \frac{1}{2}[\theta_1^L(1-\alpha)] + \frac{1}{2}(\theta_1^H - r) \tag{53}$$

Use $\theta_1^S = \frac{\theta_1^L + \theta_1^H}{2}$ in (53):

$$EU_{RS}^{JS1} = \theta_1^S - \frac{\alpha\theta_1^L + r}{2} \tag{54}$$

If $P_1 = P_2$=S, then by Lemma 3.3:

$$\underline{s}^*(\theta_1^S, \theta_2^S) = (C, C) \tag{55}$$

Therefore, the expected value to borrower 1 from taking the safe project when her peer does likewise is:

$$EU_{SS}^{JS1} = \theta_1^S - r \tag{56}$$

To compare the marginal value to borrower 1 from taking the risky project over the safe project when borrower 2 takes the safe project, subtract (56) from (54):

$$EU_{RS}^{JS1} - EU_{SS}^{JS1} = \theta_1^S - \frac{\alpha\theta_1^L + r}{2} - (\theta_1^S - r) = \frac{r - \theta_1^L}{2} \tag{57}$$

Apply this case, *i.e.*, $\theta_1^L < \frac{\beta r}{\alpha}$, to (57): $EU_{RS}^{JS1} - EU_{SS}^{JS1} > \frac{r(1-\beta)}{2} > 0$. Therefore, borrower 1 will invest in the risky project when her peer invests in the safe project and her risky project's low state payoff is less than $\frac{\beta r}{\alpha}$.

Proposition 8: If $\theta_1^L < \frac{\beta r}{\alpha}$ and borrower 2 invests in the risky project, then borrower 1 will take the risky project only if $\theta_1^S \geq \frac{(2+\beta)r}{2\alpha}$. Otherwise, borrower 1 will take the safe project.

Proof:
If $P_1 = P_2$=R, then by Lemmas 3.1, 3.2, and 3.3:

$$\underline{s}^*(\theta_1^L, \theta_2^L) = (NC, NC) \tag{58}$$

$$\underline{s}^*(\theta_1^L, \theta_2^H) = (NC, C) \tag{59}$$

$$\underline{s}^*(\theta_1^H, \theta_2^L) = (C, NC) \tag{60}$$

$$\underline{s}^*(\theta_1^H, \theta_2^H) = (C, C) \tag{61}$$

Therefore, the expected value to borrower 1 from taking the risky project when her peer does the same is:

$$EU_{RR}^{JS1} = \frac{1}{4}U^{JS1}[\underline{s}^*, (\theta_1^L, \theta_2^L)] + \frac{1}{4}U^{JS1}[\underline{s}^*, (\theta_1^L, \theta_2^H)] + \frac{1}{4}U^{JS1}[\underline{s}^*, (\theta_1^H, \theta_2^L)]$$
$$+ \frac{1}{4}U^{JS1}[\underline{s}^*, (\theta_1^H, \theta_2^H)]$$
$$= \frac{1}{4}\theta_1^L(1-\alpha) + \frac{1}{4}\theta_1^L(1-\frac{\alpha}{\beta}) + \frac{1}{4}(\theta_1^H - 2r) + \frac{1}{4}(\theta_1^H - r) \tag{62}$$

Use $\theta_1^S = \dfrac{\theta_1^L + \theta_1^H}{2}$ in (62) and reduce:

$$EU_{RR}^{JS1} = \theta_1^S - \frac{\alpha(1-\frac{1}{\beta})\theta_1^L + 3r}{4} \tag{63}$$

If $P_1=S$ and $P_2=R$, then by Lemmas 3.4 and 3.3:

$$\underline{s}^*(\theta_1^S, \theta_2^L) = (NC, NC) \tag{64}$$

$$\underline{s}^*(\theta_1^S, \theta_2^H) = (C, C) \tag{65}$$

Therefore, the expected value to borrower 1 from taking the safe project when her peer takes the risky project is:

$$EU_{SR}^{JS1} = \frac{1}{2}U^{JS1}[\underline{s}^*, (\theta_1^S, \theta_2^L)] + \frac{1}{2}U^{JS1}[\underline{s}^*, (\theta_1^S, \theta_2^H)]$$

$$= \frac{1}{2}\theta_1^S(1-\alpha) + \frac{1}{2}(\theta_1^S - r)$$

$$= \theta_1^S - \frac{\alpha\theta_1^S + r}{2} \tag{66}$$

To compare the marginal value of borrower 1 taking the risky project over the safe project when her peer takes the risky project, subtract (66) from (62):

$$EU_{RR}^{JS1} - EU_{SR}^{JS1} = \frac{2\alpha\theta_1^S - (\beta+2)r}{4} \tag{67}$$

A necessary and sufficient condition for the right hand side of (67) to be greater than or equal to zero is determined by setting (67) greater than or equal to zero, which yields:

$$\theta_1^S \geq \frac{(\beta+2)r}{2\alpha} \tag{68}$$

Therefore, if borrower 1's projects' mean expected payoff exceeds $\frac{(\beta+2)r}{2\alpha}$, then she invests in the risky project when her peer does also. If her mean expected payoff is between $\frac{r}{\alpha}$ and $\frac{(\beta+2)r}{2\alpha}$, then she invests in the safe project.

Lemma 4.1: For the borrower who will always choose the risky project, it is preferable for her to find a peer who will choose the safe project.

Proof:

If $\theta_1^S \geq \frac{(\beta+2)r}{2\alpha}$, then borrower 1 will invest in the risky project when her peer invests in the risky project (Proposition 8) or if her peer invests in the safe project (Proposition 7). The relative value of finding a peer who will invest in the safe risky project when she invests in the risky project over one who will invest in the safe project is determined by subtracting (54) from (62):

$$EU_{RR}^{JS1} - EU_{RS}^{JS1} = \theta_1^S - \frac{\alpha(1-\frac{1}{\beta})\theta_1^L + 3r}{4} - \left(\theta_1^S - \frac{\alpha\theta_1^S + r}{2}\right) = \frac{\alpha\left(\frac{\beta-1}{\beta}\right)\theta_1^L - r}{4} < 0 \quad (69)$$

Since (69) is negative, a borrower with an expected payoff on her projects greater than $\frac{(\beta+2)r}{2\alpha}$ values having a peer who will invest in the safe project.

Lemma 4.2: For the borrower who will invest in the safe project when her peer invests in the risky project, it is preferable for her to find a peer with low expected payoffs, *i.e.* between $\frac{r}{\alpha}$ and $\frac{(\beta+2)r}{2\alpha}$.

Proof:

Proposition 7 states that if one borrower invests in the safe project, then the other will invest in the risky project. Proposition 8 states that if the expected project payoffs are low, then a borrower will maintain investment in the safe project when her peer invests in the risky project. If both borrowers have low expected project payoffs, then their optimal investment strategy, $\underline{P}^* = (R,S)$ or $\underline{P}^* = (S,R)$. There is no *a priori* reason for either borrower to expect that she will be the one to play the risky investment strategy. Therefore, both will expect to play either strategy equally.

The expected value for a borrower with low expected payoffs (borrower 1) from having a peer with similarly low expected payoffs is derived from (54) and (66):

$$\frac{1}{2}EU_{RS}^{JS1} + \frac{1}{2}EU_{SR}^{JS1} = \theta_1^S - \frac{2r + \alpha(\theta_1^L + \theta_1^S)}{4} \quad (70)$$

If the peer has high expected payoffs, however, the borrower with low expected payoffs is assured to always invest in the safe project because she cannot credibly commit to the risky strategy and the high expected payoff borrower will always invest in the risky project (Proposition 8).

The expected value for a borrower with low expected payoffs (borrower 1) from having a peer with high expected payoffs is given in (64).

The marginal value to the low expected payoff borrower from having a peer with similarly a low expected payoff project is the difference between (64) and (71):

$$(\frac{1}{2}EU_{RS}^{JS1}+\frac{1}{2}EU_{SR}^{JS1})-EU_{SR}^{JS1}=\frac{\alpha(\theta_1^S-\theta_1^L)}{4}>0 \tag{71}$$

Proposition 9: Borrowers will match with other borrowers with the same expected project payoffs where there is a possibility of social sanctions.

Proof:
Borrowers with low expected project payoffs prefer to invest in the risky project (Lemma 4.2).

These borrowers cannot credibly commit to invest in the risky project with a peer with high project payoffs because the peer would always invest in the risky project (Proposition 8).

Therefore, the only chance the low expected project payoffs borrower has to play the risky strategy is to match with a borrower with low expected project payoffs, too (Proposition 7).

Proposition 10: The only investment strategies that will be played are $P_1=P_2=R$ for groups with high expected project payoffs and $P_1\neq P_2$ for groups with low expected project payoffs.

Proof:
This follows from Propositions 7, 8, and 9.

Proposition 11: The expected repayment rate of a joint liability loan with the possibility of social sanctions is between 50 percent and 75 percent.

Proof:
Let $\phi\in[0,1]$ be the fraction of borrowers with $\frac{r}{\alpha}<\theta^S<\frac{(\beta+2)r}{2\alpha}$.

$EV^{JS}_{P_1P_2}(\underline{s}^*,\underline{\tilde{\theta}})$ is the expected value per borrower to the lender from making a joint liability loan to a group conditional on borrowers' investment choices (P_1 and P_2).

$$EV^{JS}_{RR}(\underline{s}^*,\underline{\tilde{\theta}}) = (\frac{1}{4}\cdot 0 + \frac{3}{4}\cdot 2r)/2 = \frac{3r}{4} \qquad (72)$$

$$EV^{JS}_{RS}(\underline{s}^*,\underline{\tilde{\theta}}) = EV^{JS}_{SR}(\underline{s}^*,\underline{\tilde{\theta}}) = (\frac{1}{2}\cdot 0 + \frac{1}{2}\cdot 2r)/2 = \frac{r}{2} \qquad (73)$$

The expected value to the lender is the weighted average of (72) and (73) by the distribution of all borrowers' expected project payoffs:

$$EV^{JS} = (1-\phi)EV^{JS}_{RR} + \phi EV^{JS}_{RS} = \frac{(3-\phi)r}{4} \qquad (74)$$

The expected repayment rate is (74) divided by r and is bounded according to the value of ϕ:

$$\frac{1}{2} \le \frac{3-\phi}{4} \le \frac{3}{4} \qquad (75)$$

Proposition 12: In terms of borrower expected utility, the individual liability contract weakly dominates the joint liability contracts assuming the same principal and interest across contracts (*i.e.,* same r).

<u>Proof</u>:

Case 1: Borrowers with low expected payoffs

From Proposition 2, Corollary 1, and Proposition 10 for borrower 1 with $\theta_1^H < \frac{3r}{\alpha}$: $EU^I_{p^*} = EU^I_R$, $EU^{J1}_{\underline{p^*}} = EU^{J1}_{SS}$, and $EU^{JS1}_{\underline{p^*}} \in \{EU^{JS1}_{RS}, EU^{JS1}_{SR}\}$.

The value of the individual liability contract over the joint liability contract without the possibility of social sanctions is given by subtracting (27) from (7):

$$EU_{p^*}^{I} - EU_{\underline{p}^*}^{J1} = \frac{r - \alpha\theta_1^L}{2} > 0 \qquad (76)$$

The value of the individual liability contract over the joint liability contract with the possibility of social sanctions is given by subtracting (64) from (7) or (71) from (7):

$$EU_{p^*}^{I} - EU_{RS}^{JS1} = 0 \qquad (77)$$

$$EU_{p^*}^{I} - EU_{SR}^{JS1} = \alpha(\theta_1^S - \theta_1^L) > 0 \qquad (78)$$

Case 2: Borrowers with high expected payoffs

From Proposition 2, Corollary 1, and Proposition 10 for borrower 1 with $\theta_1^H \geq \frac{3r}{\alpha}$: $EU_{p^*}^{I} = EU_{R}^{I}$, $EU_{\underline{p}^*}^{J1} = EU_{RR}^{J1}$, and $EU_{\underline{p}^*}^{JS1} = EU_{RR}^{JS1}$.

The value of the individual liability contract over the joint liability contract without the possibility of social sanctions is given by subtracting (32) from (7):

$$EU_{p^*}^{I} - EU_{\underline{p}^*}^{J1} = \frac{r - \alpha\theta_1^L}{4} > 0 \qquad (79)$$

The value of the individual liability contract over the joint liability contract with the possibility of social sanctions is given by subtracting (63) from (7):

$$EU_{p^*}^{I} - EU_{\underline{p}^*}^{JS1} = \frac{r - \frac{\alpha\theta_1^L}{\beta}}{4} > 0 \qquad (80)$$

Proposition 14: If given the choice between an individual liability and joint liability contract without the possibility of social sanctions, borrowers with $\theta_i^H < \frac{3r}{\alpha}$ choose the individual liability contract and those with $\theta_i^H \geq \frac{3r}{\alpha}$ choose the joint liability contract. The total principal and interest due on the individual liability contract is 150% of that of the joint liability contract.

Proof:

Let r_I be the amount due for the individual contract and r_J be the amount due for the joint liability contract without the possibility of social sanctions.

From Propositions 3 and 6:

$$EV^I_{p*} = \frac{r_I}{2} \tag{81}$$

$$EV^J_{\underline{p}*} = \frac{(3+\psi)r_J}{4} \tag{82}$$

If the lender were to choose r_I relative to r_J such that the expected values to the lender is equal, then set (81) equal to (82), which yields:

$$r_I = \frac{(3+\psi)r_J}{2} \tag{83}$$

The borrower will choose the individual liability loan over the joint liability loan if $(EU^I_{p*} \mid r_I) - (EU^{J1}_{\underline{p}*} \mid r_J) > 0$. Otherwise, she will choose the joint liability loan.

Case 1: $\underline{p}$=(R,R)*

From Propositions 2 and 5:

$$(EU^I_{p*} \mid r_I) - (EU^{J1}_{\underline{p}*} \mid r_J) = \left(\theta_1^S - \frac{\alpha\theta_1^L + r_I}{2}\right) - \left(\theta_1^S - \frac{\alpha\theta_1^L + 3r_J}{4}\right) \tag{84}$$

Substitute r_I with expression (83) in (84):

$$(EU^I_{p*} \mid r_I) - (EU^{J1}_{\underline{p}*} \mid r_J) = -\frac{\alpha\theta_1^L + (3+2\psi)r_J}{4} < 0 \tag{85}$$

Therefore, borrowers for whom $\underline{p}^* = (R, R)$ (those with $\theta_i^H \geq \frac{3r}{\alpha}$) will always select the joint liability contract.

Case 2: $\underline{p}$=(S,S)*

From Propositions 2 and 4:

$$(EU_{p^*}^I \mid r_I) - (EU_{\underline{p}^*}^{J1} \mid r_J) = \left(\theta_1^S - \frac{\alpha\theta_1^L + r_I}{2}\right) - \left(\theta_1^S - r_J\right) \tag{86}$$

Substitute r_I with expression (83) in (86):

$$(EU_{p^*}^I \mid r_I) - (EU_{\underline{p}^*}^{J1} \mid r_J) = \frac{(7+\psi)r_J - 2\alpha\theta_1^L}{4} \tag{87}$$

Use the assumption that $\theta_1^L < \frac{r_J}{\alpha}$ to show that the right hand side of (87) is greater than zero:

$$\frac{(7+\psi)r_J - 2\alpha\theta_1^L}{4} > \frac{(7+\psi)r_J - 2r_J}{4} = \frac{(5+\psi)r_J}{4} > 0 \tag{88}$$

Therefore, borrowers for whom $\underline{p}^*=(S, S)$ (those with $\theta_i^H < \frac{3r}{\alpha}$), will always choose the individual liability contract.

Since the borrowers will separate in this way, the lender believes that $\psi = 0$. Therefore, substituting in (83): $r_I^* = \frac{3r_J^*}{2}$, where r_I* and r_J* are the equilibrium amounts due for both the individual and joint liability contracts.

The lender values the joint liability contract at the general equilibrium amount due, r_J*, at (82) evaluated with $\psi = 0$: $EV^J_{\underline{p}*} = \frac{3r_J*}{4}$. The repayment rate in general equilibrium, therefore, is $EV^J_{\underline{p}*} = \frac{3r_J*}{4} \Big/ r = \frac{3}{4} = 75\%$.

Comment 1: Borrowers with better prospects ($\theta^H_i \geq \frac{3r}{\alpha}$) prefer the joint liability contract because the interest rate is lower because the lender knows that their peers share risk with them. Borrowers with lesser prospects ($\theta^H_i < \frac{3r}{\alpha}$) prefer the individual liability contract because the cost imposed by the lender is less than the cost of taking the safe project.

Comment 2: Everyone invests in the risky project.

Lemma 5: If given the choice between an individual and joint liability contract where there will be social sanctions, a borrowers for whom $\underline{p}*=(R,R)$ will choose the individual liability contract.

Proof:
Let r_{JS} be the amount due under a joint liability contract with the possibility of social sanctions.

From Propositions 3 and 11:

$$EV^I_{p*} = \frac{r_I}{2} \tag{89}$$

$$EV^{JS}_{\underline{p}*} = \frac{(3-\phi)r_{JS}}{4} \tag{90}$$

If the lender were to choose r_I relative to r_{JS} such that the expected values to the lender is equal, then set (89) equal to (90), which yields:

$$r_I = \frac{(3-\phi)r_{JS}}{2} \tag{91}$$

The borrower will choose the individual liability loan over the joint liability loan if $(EU^{I}_{p*}) - (EU^{JS1}_{\underline{p}*}) > 0$. Otherwise, she will choose the joint liability loan.

If $\underline{p}$*=*(R,R)*, then:

$$(EU^{I}_{p*}) - (EU^{JS1}_{\underline{p}*}) = \left(\theta_1^S - \frac{\alpha\theta_1^L + r_I}{2} \right) - \left(\theta_1^S - \frac{\alpha(1+\frac{1}{\beta})\theta_1^L + 3r_{JS}}{2} \right) \tag{92}$$

Substitute r_I with expression (91) in (92):

$$(EU^{I}_{p*} \mid r_I) - (EU^{JS1}_{RS} \mid r_{\underline{p}*}) = \frac{\alpha\theta_1^L(1-\beta) + 4\beta\phi r_{JS}}{4\beta} > 0 \tag{93}$$

Therefore, if $\underline{p}$*=*(R,R)*, then the borrowers prefer the individual liability contract.

Proposition 15: If given the choice between an individual liability and joint liability loan where there is a possibility of social sanctions, no one will take the joint liability contract.

<u>Proof</u>:

If anyone does take the joint liability contract, it would be the borrowers with lower expected project payoffs because Lemma 5 shows that the high expected project payoff borrowers will definitely choose the individual liability contract. These lower expected project payoff borrowers are those who would play *(R,S)* or *(S,R)* investment strategies. Therefore, if the joint liability contract is taken by at least one group, $\phi = 1$.

Compare the expected values from taking the individual liability loan to the joint liability loan with the possibility of social sanctions by subtracting (70) from (10) and substituting r_I with expression (91):

$$EU^{I}_{p*} - \left(\frac{1}{2} EU^{JS1}_{RS} + \frac{1}{2} EU^{JS1}_{SR} \right) = \frac{\alpha(\theta_1^S - \theta_1^L) - (1-\phi) r_{JS}}{4} \tag{94}$$

As explained above, if this contract is accepted by anyone, it is by the lower expected payoff borrowers. Therefore, evaluate (94) with $\phi = 1$:

$$EU_{p^*}^{I} - \left(\frac{1}{2} EU_{RS}^{JS1} + \frac{1}{2} EU_{SR}^{JS1} \right) = \frac{\alpha(\theta_1^S - \theta_1^L)}{4} > 0 \tag{95}$$

Therefore, the borrowers with lower expected project payoffs would choose the individual liability loan.

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Essay 2: Issuances of Floating Rate Convertible Securities and Financial Manager Characteristics

Abstract

Floating rate convertibles (FRCs) are a category of PIPE securities that receive negative associations in both the academic and professional literature, earning monikers such as "death spirals" because of significant negative returns to equity of firms subsequent to issuing them. This study sheds light on the managerial relationship to the decision to issue FRCs and to the variation in market response to these issues. One main result of the study identifies influence of the CFO relative to the CEO as significant in the decision to issue FRCs and in the market's immediate reaction to the issuance. Another main result is that FRC issuing firms with CFOs without prior public equity issuance experience have significantly negative long run abnormal returns, whereas FRC issuing firms with experienced CFOs do not. Overall, I find support for the faulty contract design hypothesis for the firms with less experienced CFOs and a new hypothesis consistent with optimal security design (OSD) for the firms with more experienced CFOs.

I. Introduction

Since 1995, a growing number of public firms have raised funds through issues of private investment in public equity (PIPEs). PIPEs are common stock, preferred stock, convertible debt, convertible preferred stock, stock warrants, and equity lines, which are sold to investors privately by public firms. While private issuances of stock took place prior to 1995, that was the year in which the term, PIPE, came into use. PIPEs are typically more than solely straight equity deals, but those that include asymmetric payoff features such as that of a warrant.

PIPEs typically have been seen as solutions to an information asymmetry problem that firms, particularly small growth ones, face when needing to raise external funds publicly. Through the private negotiations preceding a private issue, information can be conveyed to the investor at less cost than in a public issue. Nevertheless, some private placement advisors are critical of a significant number of PIPE deals, contending that these deals' terms are harmful to the issuing firms.

Given the theoretical benefit of PIPE issues in solving the information asymmetry problem and the fact that firms choose to enter into deals that have been deemed harmful, why question the net benefit of any PIPE to the firm? Investors in PIPEs that contain the arguably adverse terms for the firm are primarily hedge funds, which make their profit on arbitrage opportunities and not on the long run performance of the firms. According to these funds' detractors, they trick PIPE issuers to accept "bad" deals because issuing firm managers are unsophisticated or have personal connections to the funds. The criticism says that the principal-agency conflict between shareholders and management cause firms to issue PIPEs with "bad" terms.

A type of PIPE that has come under particular scrutiny is the floating rate convertible (FRC), which is either a preferred stock or a bond that is convertible into common stock at a price determined by the future stock price at the time of conversion. Chaplinsky and Haushalter (2003), Hillion and Vermaelen (2004), and others have studied the firms issuing FRCs. They and finance practitioners have found a negative relationship between the issuance of a floating rate convertible (FRC) and firm performance.

Existing evidence supports two theories for this relationship. The first, the faulty contract design (FCD) hypothesis, states that firms mistakenly issue FRCs because they do not understand how they will impact long term performance. The second theory, the financing of last resort (FLR) hypothesis, states that firms rationally issue FRCs because they face severe information asymmetry problems and are unable to find financing elsewhere. This second theory states that these firms' poor performances are simply anticipated by the FRCs themselves. Hindsight indicates that certain FRCs are not good financing options. Why then are they issued in the first place? How could have one predicted a poor financing decision? And by implication, how can one predict poor financing decisions by firms now? I model the FRC issue choice as a function of CFO characteristics. This approach yields interesting answers to the question of whether FRC issues precipitate or simply anticipate poor future performance. It also addresses an interesting question of whether the degree and type of sophistication of financial managers add value to the firm.

I show that the financial sophistication does indeed affect the FRC issuance decision and affects how the market reacts to the issue. Firms where the CFOs are more highly compensated relative to their CEOs are more likely to issue FRCs. Among FRC issuing firms, those with higher CFO-to-CEO compensation have lower abnormal returns around the issuance announcements. In the long-term, FRC issuing firms whose CFOs do not have experience accessing the public equity market have significantly negative stock returns. These findings support the FCD hypothesis where the CFO has less experience. In addition, they support an alternative hypothesis of optimal security design (OSD) where the CFO does have experience.

This paper is organized as follows. Section 2 reviews the literature on PIPEs and impact of financial management on firm actions and performance. Section 3 discusses the sources of the data, methodology for identifying control firms, and summary statistics. Section 4 presents hypotheses, including an introduction of the optimal security design (OSD) hypothesis to the FRC literature. Section 5 analyzes the results of testing the hypothesis. Section 6 concludes.

2. Literature

This study brings together two strands of financial research. The first is on the motivation and impact of PIPE issues, particularly structured PIPE issues. The existing literature has come to support two major hypotheses for why a firm would issue a floating rate convertible security (FRC): the faulty contract design hypothesis and financing of last resort hypothesis. I join this research area to another strand, which is how CFOs' incentives and abilities along with directors' financial ties affect financing actions of firms.

A. Private Investment in Public Equity (PIPEs)

How does a firm benefit from privately placing equity when it is already a registered public firm? In a Myers and Majluf (1984) framework, a private issue could be a less costly way of conveying information to the market while raising new equity. At the heart of Myers and Majluf's model is information asymmetry between a firm and potential outside investors. In bad states, the firm knows that its stock is overvalued. In this case, the firm has the reason to issue new equity because it is overvalued. The market, then, would know whether the bad state of the world has been realized, and firm's stock price would decline. If outside financing is necessary to invest in a positive net present value project, then some such projects would not be taken. How, then, can this suboptimal investment policy be avoided? If information on the true value of the assets and growth opportunities can be conveyed, then an issue of equity would not be a negative signal. However, transmission of this information to the public is costly. For example, it may entail giving away trade secrets.

Theoretically, the certification benefit of PIPE issues is found in Hertzel and Smith (1993), which is an extension of Myers and Majluf (1984)'s model of information asymmetry and security selection. Hertzel and Smith (1993) suggest that private placements of equity can serve as a less costly way to convey information to the market and thus allow for a more optimal investment decision rule in the Myers and Majluf framework. By issuing stock privately, a firm can convey information through the negotiations with the investors, raise the capital it needs, and signal to the market that it is issuing stock because of good growth prospects. Hertzel and Smith postulate and test that firms sell their privately placed stock at a discount to pay for the due diligence costs.

The certification benefit of PIPEs is supported by the observation that the market reacts positively to the announcement of PIPE issues even though they are typically issued at a discount to market price. Hertzel and Smith (1993) strictly consider placements of common stock, and Chaplinsky and Haushalter (2003) consider all PIPEs issued between 1995 and 2000. Consistent with Hertzel and Smith, Chaplinksy and Haushalter find positive announcement returns for PIPEs. They also find that PIPEs with features that protect investors against declines in stock prices have lower announcement returns than those with such protections. Examples of securities with downside price protections are floating rate convertible debt and floating rate convertible preferred stock (FRCs). They infer that the market interprets the terms as signals of the quality of the firms' prospects, because they indicate that the issuing firms agree to the investors' concern that the firms' stock prices will decline in the future. The convertible security holder may convert at a low stock price, forcing the firm to give more shares of stock than it would at the time of the security's issuance. Terms with less downside protection indicates that private investors have greater confidence in the firm's future performance. In other words, the structured nature of the PIPE signals that the investor is unable to certify the value of the firm.

Studies on PIPE issuing firm performance that control for identity of the investor supports the notion that there is a certification effect. Dai (2007) directly examines how VC's and hedge funds differ in their relationship to PIPE issuing firms, finding that VCs tend to have seats on the issuing firms' boards of directors and to have longer investment horizons than hedge funds. She finds support for the argument that VCs provide certification to the PIPE issuers in which they invest. Similarly, Krishnamurthy, Spindt, Subramaniam, and Woidtke (2004) find that the negative long run abnormal returns of firms after issuing PIPEs are confined to the sample of nondistressed firms that issue to nonaffiliated investors. Distressed firms, on the other hand, show a positive announcement effect and no long-run underperformance regardless of whether the investors are affiliated or unaffiliated. This provides support to the hypothesis that the identity of the investor provides a certification benefit.

Consistent with other studies (Hertzel and Smith, 1993; Dai, 2007; Krishnamurthy, et. al., 2004; and Barclay, et. al. 2003), Brophy, et. al. (2006)¸ do not find support for a monitoring benefit in PIPE issues. The monitoring hypothesis states that since PIPEs are issued to a block holder, the free-riding problem of equity issuance to disperse shareholders is circumvented. The argument for a monitoring benefit is set forth by Wruck (1989), who postulates that private placements enhance value by targeting a small number of investors rather than a large number typical in a public issue. By concentrating ownership, investors are capable of monitoring the firm more carefully. The discount that private investors usually receive, therefore, compensates for monitoring costs according to Wruck's ownership concentration hypothesis. Hertzel and Smith, however, find that the ownership concentration variable does not have statistical significance in a regression of abnormal returns in the presence of certification variables. Barclay, Holderness, and Sheehan (2003) find that investors in PIPEs typically are passive, and therefore they actually serve to entrench management, which they argue is why PIPE issues are typically followed by long run negative abnormal returns.

Despite the support for a certification effect motivating the issuance of PIPEs at discounts, PIPE issuers also tend to experience negative long run abnormal returns following the issue. This is documented by Hertzel, et. al. (2002) and Chaplinsky and Haushalter (2003). Why then are PIPEs issued?

One explanation is faulty contract design (FCD) hypothesis, which states that firms issue FRCs because their managements do not recognize that the securities induce short selling in their firms' stock; the investors of these FRC buy the shares in order to profit from anticipated manipulation of the stock price to the detriment of the existing share holders. Even among nonstructured PIPE issues, Hertzel, et. al. (2002) find a negative post-event performance, despite a positive announcement effect for private placements of equity. They interpret this result as indicating that the issuing firm management is overly optimistic concerning growth opportunities. They speculate that, rather than covering due diligence or monitoring costs, the discounts on privately placed stock indicate that the investors in these issues are better informed concerning the firms' true lower value.

They do recognize such a story is inconsistent with an efficient market because, while privately issued stock are sold at a discount, the market prices of existing stock are higher when the deals are announced.

Another explanation is the financing of last resort (FLR) hypothesis, which states that the issuing firm needs external financing, and despite the costliness of the issuance, it will do so out of desperation. Indeed, Chaplinsky and Haushalter (2003) find that over 80 percent of PIPE issuing firms have negative operating income prior to an issue. They say that companies using PIPEs "appear to be highly distressed and have a high probability of failure regardless of the actions taken by management. Therefore, it is difficult to judge the success of these contracts based solely on the issuer's post issue performance." (Chaplinsky and Haushalter's study of PIPEs is restricted to the 1990s. Since 2000, however, PIPE financing has become more common among healthier firms.)

B. Structured PIPEs

If a non-structured PIPE provides a certification benefit, and the market reacts negatively to the issue of a structured PIPE, then why would a firm opt to issue a structured PIPE? The development of hypotheses concerning relationship between FRCs and their long run return and operating performance of their issuers is most comprehensively set forth in Hillion and Vermalaen (2004). They test the faulty contract design (FCD) hypothesis, and financing of last resort (FLR) hypothesis, as well as a third, the undervaluation hypothesis.

The undervaluation hypothesis states that firms issue FRCs because their price is undervalued. Therefore, they issue a convertible security that converts at a future market price that the firm believes will match its true value.

Using a dataset of all FRC issues from December 1994 – July 1998, Hillion and Vermaelen reject the undervaluation hypothesis and find support for both the faulty contract design (FCD) and financing of last resort (FLR) hypotheses. They reject the undervaluation hypothesis because firms that issue FRCs typically experience significant negative abnormal returns in the years following issuance. Their support for the FCD hypothesis follows from supporting several empirical predictions of this hypothesis. While negative abnormal returns would be expected under both the FCD hypothesis and the FLR hypothesis, the reasons are different. One unique prediction of the FCD hypothesis, for which the authors finds support, is that the conversion discount is negatively correlated with the abnormal returns of the issuing firm and with the size of the issue. A unique prediction of the FLR hypothesis is that the negative abnormal returns of an FRC issuing firm is accompanied by negative abnormal operating performance because the issuance of the FRC is interpreted as a signal of future problems for the firm. The authors find that this prediction holds also.

Chaplinsky and Haushalter (2003) consider all PIPE issues from 1995 – 2000. This study not only considers more deals than Hillion and Vermaelen, but also provides further evidence of long run abnormal performance of FRC issuers by comparing them to firms that issue PIPEs that do not provide the downside price protection to the holders of the securities, such as straight equity and fixed rate convertible securities.

Brophy, Ouimet, and Sialm (2006) support the FLR hypothesis despite finding a relationship between negative abnormal returns and the PIPE investor being more likely to be involved in short selling. Specifically, they argue that firms issue FRCs as a last resort when they issue to hedge funds. They find that the long run underperformance of traditional PIPEs is confined to the sample of firms issuing structured PIPEs to hedge funds. This finding is consistent with the FCD hypothesis because hedge funds are not long term investors, but often engage in significant amounts of short selling and operate by taking advantage of arbitrages (Dai, 2007). Nevertheless, the authors do not accept the FCD hypothesis because the amount of short positions on firms issuing structured PIPEs to hedge funds does not vary significantly from the short positions of other deals. Therefore, they argue that these negative abnormal returns are due to these firms having the severest asymmetric information and agency problems, risks that only hedge funds are able to hedge against. They also find that PIPE issuing firms that were backed by a venture capitalist before IPOing do not experience the long run underperformance of other PIPE issuers. Their interpretation of this finding is that VCs provide certification of these firms and therefore do not have the adverse selection problems of firms without VC backing.

In summary of the literature on PIPEs, the motivation for the issuance is concluded to be despair (FLR hypothesis) and/or ignorance (FCD hypothesis). A puzzling finding in the empirical literature, however, is that there are long run negative abnormal returns to firms making private placements. Explanations for the puzzle have been based on a lack firm management sophistication (ignorance; faulty contract design) or the market's slowness to recognize that the underlying conditions of the issuer (despair; financing of last resort). Support has been provided for both explanations. Observation of the level of sophistication and incentives of the issuing firm's financial management would serve to disentangle the faulty contract design hypothesis from the financing of last resort hypothesis. The literature has yet to incorporate such a control and therefore has not fully answered the question of how much the security choice affects the value of the firm rather than merely signaling its existing value.

C. Financial Managers

Despite Hillion and Vermaelen (2004)'s observation that the amount of FRC's issuance has declined at the time of its writing, Singh (2005) notes that there is still a significant amount of FRCs being issued. This observation either can be indicative of the financing of last resort motivation functioning or a continued slowness of financial managers to recognize the faulty design features of FRCs. According to Placement Tracker, there were 121 FRC deals in 2004. While less than a third of issues made in 2000, this is still a significant amount of deals, amounting to $628 million ($3.2 billion in 2000). Though, Singh does find that more recently issued FRCs have terms that reduce the problems that these FRCs have had in the past. Examples of terms that can control the price manipulation of the stock of FRC issuers are (1) direct restriction on the investor from short selling, (2) floors on the conversion price, (3) restriction on the number of shares convertible at one time, (4) reduced discounts relative to the reference price, and (5) investigating whether the investor has engaged in price manipulation in the past. The change in these terms, therefore, would support the view that these contracts were faulty and have merited being altered. However, not all issues involve these controls. Singh concludes,

> "toxic convertibles represent a financial innovation that, through an iterative and – unfortunately, for any investors – costly process, has improved its design but is still used by the same types of firms as in the past.…The rationale for use of toxics appears to be driven by despair, ignorance, or both. However, with improvements in contract design, as outlined earlier, smaller firms in need of capital that cannot access the market for traditional securities are better positioned to consider these securities"

The existence of research that cautions against the use of FRCs raises the question of why some firms issue them and why others avoid them. The implication of the FCD hypothesis is that the financial management of the issuers do not understand them. While there is a large literature on the impact of the chief executive officer on the decisions and performance of the firm, there is an emerging literature on the impact of the chief financial officer. CFOs do influence the performance of firms as evidenced by their removal following poor performance in Mian (2001). The disciplinary removal of CFOs is robust to decision to retain or remove the CEO. Chava and Purnanandam (2007) show that the incentives of the CFO, not the CEO, affect the firm's choice of floating rate versus fixed rate straight debt. Brettel et. al. (2008) test Hackbarth (2004)'s model of firm leverage and CFO. They find that firms with "overconfident" CFOs tend to have higher leverage.

While the above papers consider the interaction among firm performance, CFO actions, and CFO incentives, the only area of research regarding direct measures of financial manager skill that the author is aware of is in the mutual fund literature. Numerous studies document that mutual fund managers differ in their stock picking skills (Wermers, 2000; Chen, et. al., 2001; Baker, et. al., 2005; and Harlow and Brown, 2007).

In a study of active fund managers, MBA school quality is positively and significantly related to fund performance over 2000-2003 (Gottesman and Morey, 2006). This effect is particularly strong among the top business schools, as ranked by *Business Week*. Other studies find a significance of the undergraduate program from which the manager graduated (Chevalier and Ellison, 1999). Furthermore, other certifications or degrees such as a CFA, other masters degrees, or Ph.Ds does not appear to correlate with fund performance.

There also has been recent research regarding the financial connection and expertise of the board of directors. Mitchell and Walker (2008) find that firms that are large and less likely to be in financial distress are more likely to have commercial bankers on their boards. Also, firms that have higher leverage, less market value of equity, and high investment / low Tobin's q or low investment / high Tobin's q are more likely to have bankers as directors. Becker-Blease and Grein (2008) argue that the advisory role of the board of directors needs to be considered in addition to the monitoring role.

III. Data Sample

A. Sources

All FRC deals made in 2001 and 2002 are considered. Deal data come from PrivateRaise. Stock return and delisting information for each issuer come from CRSP, and financial statement data from Compustat. Analyst coverage data come from I/B/E/S. CFO, CEO, and director data are hand collected primarily from Edgar filings (10K's, 10Q's, and proxy statements mostly). Lexis Nexis and online business press articles are used where Edgar and the companies web sites do not provide the information.

B. Pre-Issue Firm Characteristics

1. FRC Issuers

I identify the CFO characteristics of 61 firms issuing FRCs in 2001 and 2002. I am able to identify the CFO characteristics of 43 firms that issued FRCs over the same period. Issuing firms tend have small size, high growth opportunities, low leverage, high investment, operating losses, and high propensity to be in bankruptcy (median Ohlson score of 0.88). See Table 1.

Table 1
Pre-Issue Firm Financial Characteristics

This table displays summary statistics of characteristics of FRC issuers and three groups of control firms, fixed price PIPE issuers, SEO issuers, and match non-equity issuers measured in the year prior to the firms making these issues. (In the case of match non-issuers, FRC issuance dates are imputed to them.) *COVERED* is an indicator that equals 1 if at least one stock analyst made a forecast for the firm. *CFVOL* is the cash flow volatility, defined as the standard deviation of operating income up to twenty fiscal quarters before the announcement date. *OSCORE* is the probability of becoming financially distressed defined by Ohlson (1980). *FIRMVALUE* is log of the market value of equity plus book values of preferred and total debt. *TOBINQ* is the market value of the firm divided by the book value of the assets. *LEVERAGE* is the the long term debt divided by the book value of assets. INVESTMENT is the total of R&D and advertising divided by the lagged property, plant, and equipment. *PROFITABILITY* is the operating cash flow before depreciation divided by lagged assets. FRC issuers' variables' means are significantly different from the fixed price PIPE issuers, SEO issuers, non-equity-issuers if denoted by an *a, b,* or *c*, respectively, at the 5% level.

Panel A: FRC Issuers

	Variable							
Statistic	**COVERED**	**CFVOL**	**OSCORE**	**FIRMVALUE**	**TOBINQ**	**LEVERAGE**	**INVESTMENT**	**PROFITABILITY**
N	43	43	43	43	43	43	43	43
Median	1.000	5.793	0.879	4.410	0.054	0.087	0.780	-0.192
Mean	0.581[b]	20.193	0.753[b]	4.726[b]	0.180[ab]	0.470	2.563	-0.346[bc]
Standard Error	0.076	7.507	0.042	0.225	0.051	0.212	0.656	0.093

Panel B: Fixed Price PIPE Issuers

	Variable							
Statistic	**COVERED**	**CFVOL**	**OSCORE**	**FIRMVALUE**	**TOBINQ**	**LEVERAGE**	**INVESTMENT**	**PROFITABILITY**
N	40	40	40	40	40	40	40	40
Median	1.000	4.431	0.794	4.440	0.100	0.002	0.905	-0.139
Mean	0.600	10.784	0.715	4.245	0.135	0.100	2.942	-0.620
Standard Error	0.078	3.385	0.047	0.209	0.023	0.037	0.845	0.320

Panel C: SEO Issuers

	Variable							
Statistic	**COVERED**	**CFVOL**	**OSCORE**	**FIRMVALUE**	**TOBINQ**	**LEVERAGE**	**INVESTMENT**	**PROFITABILITY**
N	46	46	46	46	46	46	46	46
Median	1.000	18.352	0.530	6.792	0.015	0.555	0.076	0.150
Mean	0.934	25.127	0.529	6.693	0.030	0.562	1.787	-0.060
Standard Error	0.036	3.747	0.039	0.150	0.006	0.084	0.618	0.097

Panel D: Non-Issuers

	Variable							
Statistic	**COVERED**	**CFVOL**	**OSCORE**	**FIRMVALUE**	**TOBINQ**	**LEVERAGE**	**INVESTMENT**	**PROFITABILITY**
N	38	38	38	38	38	38	38	38
Median	1.000	14.222	0.870	5.047	0.035	0.022	0.183	-0.043
Mean	0.736	23.562	0.696	5.108	0.072	0.202	1.730	-0.057
Standard Error	0.072	4.221	0.053	0.308	0.018	0.043	0.624	0.043

The sample of FRC issuers tend to be in the information technology or pharmaceutical industries. Using the 48 industry Fama-French industry definitions, the most represented industries among the 43 FRC issuing firms are "Business Services" (ten), "Drugs" (five), "Medical Equipment" (four), and "Telecommunications" (four).

Only half of the firms have at least one analyst covering them in the year prior to issue. Therefore, I mostly measure the degree of information asymmetry by using a dummy variable that equals one if the firm has at least one analyst covering it in the prior year and zero otherwise. Among the 19 issuers that do have analyst coverage, the median earnings surprise is 30.80 percent. Among analysts covering the same firm, the median standard deviation in estimates of earnings is 16.76 percent. See Table 2.

Table 2
Pre-Issue Analyst Coverage Characteristics

This table displays summary statistics of analyst forecasts of FRC issuers and the three control group firms (fixed price PIPE issuers, SEO issuers, and match non-equity-issuing firms). The mean surprise is the absolute percent difference in actual earnings from forecasted earnings over the year. Dispersion is the standard deviation of forecasts among analysts. Maximum # of Analyst Coverage is the maximum number of analysts covering the firm at the same quarter. FRC issuers' variables' means are significantly different from the fixed price PIPE issuers, SEO issuers, non-equity-issuers if denoted by an *a, b,* or *c*, respectively, at the 5% level.

Panel A: FRC Issuers

	Variables		
Statistics	**Mean Surprise**	**Dispersion**	**Maximum # Analyst Coverage**
N	19	19	22
Median	0.308	0.005	4.500
Mean	0.396	10.103	5.727[b]
Standard Error	0.065	9.472	0.947

Panel B: Fixed Price PIPE Issuers

	Variables		
Statistics	**Mean Surprise**	**Dispersion**	**Maximum # Analyst Coverage**
N	21	20	21
Median	0.302	0.059	4.000
Mean	0.709	1.041	6.761
Standard Error	0.234	0.895	1.305

Panel C: SEO Issuers

	Variables		
Statistics	**Mean Surprise**	**Dispersion**	**Maximum # Analyst Coverage**
N	45	45	45
Median	0.082	0.049	9.000
Mean	0.291	0.109	10.933
Standard Error	0.107	0.032	1.328

Panel D: Matched Non-Equity-Issuers

	Variables		
Statistics	**Mean Surprise**	**Dispersion**	**Maximum # Analyst Coverage**
N	21	18	21
Median	0.230	0.047	5.000
Mean	0.353	0.090	10.761
Standard Error	0.073	0.030	3.110

These firm characteristics are consistent with prior studies of FRC issues and with the theory that firms with severe information asymmetries and risk can use privately placed equity to find financing at a low enough cost. Furthermore, the structured nature of FRCs indicates that investors have concerns that the values of the firms' stock will drop. The apparent decline in number of FRC deals from 2001 to 2002 may also reflect the disproportionate reluctance of investing in such firms as the stock market continued to cool.

2. Control Firm Identification

Finding the benchmark for these firms is a challenging task that some previous studies deal with. Hillion and Vermaelen (2004) compare issuing firms to matched nonissuing firms using a propensity to issue matching algorithm wherein they create a probit model for propensity to issue a FRC (Dehejia and Wahba, 1998). They match every issuer with a nonissuer that has the closest propensity of issuing a FRC.

Their probit model uses operating return on assets, profit margin, ROA, operating income / sales, (capitalization expenditures + R&D) / assets, and market to book value of equity. I use the same or similar predictors plus a measure for financial distress. I include the Ohlson financial distress variable ("O-score", or OSCORE) (Ohlson, 1980) because I am considering a very special segment of stocks that are characterized by being in extreme financial distress (Chaplinsky and Haushalter, 2003). These firms are likely to "go dark," i.e. cease trading on NYSE or Nasdaq, which may occur because their stock price falls below the minimum levels allowed by the exchanges (Leuz, Triantis, and Wang, 2006). Furthermore, the financing of last resort hypothesis states that it is precisely the firms that are in financial distress that would issue a FRC.

In addition to OSCORE, I borrow variables used by Gomes and Phillips (2005) in their study of public versus private security issuance choice. To measure risk, they use cash flow volatility (CFVOL), defined as the standard deviation of operating income before depreciation (Compustat item data13) up to twenty fiscal quarters before the announcement date. To measure information asymmetry, they use the mean earnings surprise and dispersion of analyst earnings estimates discussed previously. Because half the sample of firms issuing FRCs do not having any analyst coverage, I cannot use these variables without losing half the sample of firms, leaving only 19. Therefore, I use a dummy variable, COVERED, that equals one if the firm is covered by at least one analyst in at least one quarter prior to the issue, and zero otherwise. In addition to measures for risk and information asymmetry, Gomes and Phillips (2005) use log of firm value, Tobin's q, leverage, investment in R&D, and profitability as controls. The log of firm value (FIRMVALUE) is defined by the market value of equity plus book values of preferred and total debt (in Compustat: data24*data25 + data9 + data34 + data39). Tobin's q (TOBINQ) is defined by the market value of the firm divided by the book value of the assets (exp(FIRMVALUE) / data6). The debt to asset ratio (LEVERAGE) is defined by the long term debt divided by the book value of assets ($data9_t$ / $data6_{t-1}$). Research and development (INVESTMENT) is defined by the total of R&D and advertising divided by the lagged property, plant, and equipment $(data45_t+data46_t)/data8_{t-1}$. PROFITABILITY is defined by the operating cash flow before depreciation divided lagged assets $(data13_t/data6_{t-1})$. [1]

I regress the qualitative variable that equals one if a firm issues a PIPE of any kind and zero if it does not on these variables with clustered standard errors by Fama-French 48 industry classification. The regression model has an explanatory power of 9.86 percent. Consistent with previous research, firms that issue PIPEs are more likely to be in financial distress and high R&D expenditure (all significant at the 5% or greater levels.) See Table 3.

Table 3

Propensity to Issue a PIPE Logit Regression

Below are logit model estimates of the likelihood that a firm issues a PIPE. The standard errors are clustered by the Fama-French 48 industry classification. *COVERED* is an indicator that equals 1 if at least one stock analyst made a forecast for the firm. *CFVOL* is the cash flow volatility, defined as the standard deviation of operating income up to twenty fiscal quarters before the announcement date. *OSCORE* is the probability of becoming financially distressed defined by Ohlson (1980). *FIRMVALUE* is log of the market value of equity plus book values of preferred and total debt. *TOBINQ* is the market value of the firm divided by the book value of the assets. *LEVERAGE* is the the long term debt divided by the book value of assets. INVESTMENT is the total of R&D and advertising divided by the lagged property, plant, and equipment. *PROFITABILITY* is the operating cash flow before depreciation divided lagged assets. Estimates are significant at the 10%, 5%, and 1% levels if denoted with *, **, or *** respectively.

Variable	Coefficient Estimate	Robust Standard Error
COVERED	0.697***	0.132
CFVOL	-0.004	0.002
OSCORE	2.544***	0.206
FIRMVALUE	0.094*	0.051
TOBINQ	-0.017**	0.008
LEVERAGE	-0.106*	0.061
INVESTMENT	0.006***	0.002
PROFITABILITY	-0.027*	0.014
CONSTANT	-5.056***	0.302
N	10509	
PSEUDO R-SQUARED	0.098	

Firms that are covered by at least one stock analyst are actually more likely to issue PIPEs. If COVERED represents information asymmetry, then such a result is not expected if the regression were conditional on issuing some type of equity security. However, the regression is based on all firms in the Compustat universe in 2001 and 2002. Therefore, firms that are not covered by an analyst at all, ceteris paribus, are less likely to issue a PIPE (and in all probability, a SEO as well). If COVERED represents the costs to issuing equity publicly, then the fact that PIPE issuers are likely to be covered by an analyst already may indicate that private costs borne by the managers of the firm may be taken into consideration when making the issuance decision. Variables that are weakly significant in the propensity equation are FIRMVALUE (positive sign), LEVERAGE (negative sign), and PROFITABILITY (negative sign).

[1] Gomes and Phillips (2005) use an alternative measure for financial distress, *ALTMAN*, a dummy variable that equals one if the firm's Altman z-score is less than 1.81 (Altman, 2000). I also compute a propensity model using *ALTMAN*, and do not find qualitatively different results. I choose the OSCORE because it produces a 1% higher pseudo-R2 in the logit regression.

Using the propensity scores computed on the universe of non-structured PIPE issuers, defined by PIPEs that do not have downward price protections ("Fixed PIPEs"), SEO issuers ("SEOs"), and non-equity matched issuers ("Non-Issuers"), I match the firms from each control group that have the closest propensity score (PROPENSITY) to each FRC issuer.

Because the Non-Issuer control group has no issue date, for the purpose of the event study, I impute an event date to each Non-Issuer equivalent to the announcement date of a FRC issue of the firm with the closest propensity score.

C. Deal Characteristics

1. FRC Deals

The median FRC deal is for $4.0 million and 12.1 percent of the issuing firm's market capitalization.

Table 4
PIPE Deal Characteristics

This table enumerates the characteristics of FRC deals and control set of fixed price PIPE deals.

	FRC	Fixed PIPE		FRC	Fixed PIPE
Security Type			**Conversion Restriction**		
Common Stock	6	25	No	19	11
Convertible Debt	22	9	Unknown	14	25
Convertible Preferred Stock	15	6	Yes	10	4
Conversion Type			**Selling Restriction**		
Fixed	0	40	No	27	26
Reset	22	0	Unknown	14	12
Variable	23	0	Yes	2	2
Warrants Included			**Hedge Restriction**		
No	15	23	No	23	25
Yes	28	17	Unknown	13	13
			Yes	7	2
Antidilution Clause			**Forced Conversion**		
No	15	19	No	14	7
Unknown	12	11	Unknown	15	27
Yes	16	10	Yes	14	6
Hard Floor Price			**Investor Purchase Rights**		
No	21	40	No	20	22
Unknown	7	0	Unknown	14	12

Yes	15	0	Yes	9	6
Soft Floor Price			**Mandatory Registration**		
No	33	40	No	6	8
Unknown	7	0	Unknown	4	10
Yes	3	0	Yes	33	22

There is a wide range of deal sizes from $1.0 million to $1.5 billion, and percentages of market capitalization from 1.7 percent to 108.8 percent. The median conversion price is calculated at 100.0 percent of the reference stock price, with the lowest conversion price being 50 percent and the highest being 242 percent. These deal characteristics are consistent with previous research finding that these deals are made at discounts and of significant sizes. See Table 5.

Of the 43 deals, a significant number have at least one term that provides some type of limit on how much investors can profit from stock price declines. See Table 4. Eighteen deals impose floors on the conversion prices, and 10 deals restrict the amount of converting at one time. Two deals restrict short selling, and seven restrict hedging by the investors, thus limiting their ability and incentive to exert selling pressure on the issuers' stocks. Ten of the deals have forced conversion provisions, which would force the investors to convert their securities under certain circumstances; this provision enables the firm to take advantage of a rising stock price by selling shares at the future high market price.

Sixteen deals have anti-dilution clauses, which provide more shares to the investor if the firm issues more shares in the future, so as to protect the investor from diluted value of shares. Thirty-three of the deals include mandatory registration rights of the stock underlying the FRCs, making the investors able to sell the shares that they convert. Nine of the deals have investor purchase rights, which gives the investor in the FRC the right of first refusal when the firm attempts to issue future securities; thus, firms that issue these rights would be limited in its future financing options.

Twenty-eight deals include warrants, which tend to have high exercise prices; median exercise price is at a premium of 16 percent over the market price at issuance (See Table 5). Inclusion of warrants at premiums may offset the interest the investors have in stock price declines. These warrants represent sizable stakes in the warrant issuers, ranging from 4.4 percent to 150.0 percent of outstanding shares with a median of 33.3 percent.

2. Fixed-Price PIPE Deals

The deal sizes of the fixed PIPE issues of the control group are similar to those of the FRC issues. The median deal size is $6.5 million and 16.0 percent of market capitalization. The median PIPE price is 97.0 percent of the market stock price.

Fixed price PIPEs do not have the features that pressure the stock prices down as do FRCs. Therefore, the net benefits of including specific terms differ between the two types of issuances. Fixed price PIPE issuers are less likely to include conversion restrictions (4 out of 40 deals) and less likely to include hedge restrictions (2 out of 40), indicating that some issuers who choose to issue FRCs over fixed price PIPEs negotiate terms that are particularly important to moderating the impact of the FRC. However, other terms are equally present in the two types of deals: short-selling restrictions and forced conversion clauses.

The fraction of deals with pro-investor terms is higher among FRC issues than fixed price PIPE issues. Fixed price PIPE deals are less likely to have anti-dilution clauses (10 out of 40 deals) and less likely to have registration rights (22 out of 40 deals). This pattern is contrary to that of the greater prevalence of pro-issuer rights among FRC deals than fixed PIPE deals. Perhaps the investors in FRCs demand that they be protected from the higher likelihood that the firm will need to raise more capital in the future via anti-dilution clauses and from the likelihood that the investor will be unable to sell its shares if it waits too long to seek to have them registered.

Fixed PIPE issuers are also less likely to include warrants. Only 17 out of the 40 fixed price PIPE deals include warrants. The lower rate of inclusion of warrants among fixed price PIPE issuers may indicate the lesser need to provide rewards to the investor for upward movements in the stock price. The fixed price PIPE deals' median warrant premium, 6.0 percent, and median warrant coverage amount, 50.0 percent, are comparable to the FRC issues.

3. SEO Deals

The size of SEO deals in comparison to the FRC deals is greater in absolute dollars but similar in percent or market capitalization. The median SEO amount is $114.5 million, and the median deal amount as percent of market capitalization is 16.8 percent. The median SEO price is 95.9 percent of the market stock price.

Table 5
Deal Characteristics

The pricing and quantity of deals among the FRC, fixed price PIPE, and SEO issuers are given below. The deal amount / market cap is the amount raised divided by the market value of the stock at the time of issuance. The premium is the percentage of the reference stock price. The warrant premium is in term of the stock price at the time of issuance. The warrant coverage is the number of shares underlying the warrants as a percent of outstanding shares. FRC issuers' variables' means are significantly different from the fixed price PIPE issuers, SEO issuers, non-equity-issuers if denoted by an *a, b,* or *c*, respectively, at the 5% level.

Panel A: FRCs

Statistics	Deal Amount ($000)	Deal Amount / Market Cap (%)	Premium (%)	Warrant Premium (%)	Warrant Coverage (%)
N	43	43	43	28	27
Median	4.000	12.100	100.000	115.500	33.300
Mean	45.518^{b}	21.041	103.504	117.642	49.644
Standard Error	34.694	4.035	5.554	8.740	7.447

Panel B: Fixed Price PIPEs

Statistics	Deal Amount ($000)	Deal Amount / Market Cap (%)	Premium (%)	Warrant Premium (%)	Warrant Coverage (%)
N	40	40	40	17	17
Median	6.500	16.000	97.000	106.000	50.000
Mean	10.047	21.707	99.017	112.970	64.635
Standard Error	1.611	4.136	5.610	5.603	11.384

Panel C: SEOs

Statistics	Deal Amount ($000)	Deal Amount / Market Cap (%)	Premium (%)
N	46	44	44
Median	114.550	16.760	95.893
Mean	171.258	36.238	101.490
Standard Error	33.836	11.037	4.294

D. CFO and Other Management Characteristics

CFO Characteristics. The median age of the CFOs of FRC issuers is 43.5 years. The median amount that CFOs own of the firm is 1.0 percent. Fifty-one percent of CFOs have experience as a CFO, treasurer, or comptroller of another public firm. However, only 27 percent were financial officers at public firms when those firms issued either IPOs or SEOs. Among the more limited number of FRC issuers for which I could find educational data, 42 percent have CFOs who have MBAs. CFOs of FRC issuers are less likely to have been at the firm when it went public than the control firms. See Table 6.

In addition to the CFO variables in Table 6, the tenure of the CFO at her firm is collected. Only two of the CFOs of FRC issuers were at their firms when they made their initial public offerings. However eight fixed price PIPE issuers, seven SEO issuers, and four non-equity issuers have CFOs at the time of issue who also were CFOs at the time of IPO. See the Appendix for the biographical information provided by firms on their CFOs, organized by CFO public equity experience.

Boards of Directors. The median board size of FRC issuers is six. The median percent of board members who are also employees of the firm ("insiders") is 33.33. The median percent of board members who are financial professionals is 16.67. Financial professional is defined as being an employee of a financial institution, such as an investment bank or hedge fund, or being a financial officer, such as a CFO, of another firm. The median of the mean age of the firms' directors is 54.8 years. The median ownership of the firm by all directors and managers is 18.1 percent. See Table 6 for summary statistics on all four groups of firms' managerial characteristics.

Table 6
Management Characteristics

The descriptive statistics of the CEOs, CFOs, and boards of directors of the FRC issuers and control firms are shown the following panels. These values are collected in the period prior to the security issuances, or imputed issuances in the case of the matched non-equity-issuers. CFO / CEO Comp is the fraction of CFO cash compensation to CEO cash compensation. % Board Insiders is the percent of board members who are also managers of the same firms. % Board Financial Experts is the percent of board members who are either employed by a financial institution or is a CFO. FRC issuers' variables' means are significantly different from the fixed price PIPE issuers, SEO issuers, non-equity-issuers if denoted by an *a, b,* or *c*, respectively, at the 5% level.

Panel A: FRC Issuers

Variable	**N**	**Median**	**Mean**	**Standard Error**
CFO with Prior Public Firm Experience	53	1	0.547[b]	0.069
CFO with Public Equity Offering Experience	54	0	0.203[b]	0.055
Total Director and Management Ownership	51	18.100	24.306[b]	2.571
CFO/CEO Comp	44	0.622	0.692[b]	0.051
% Board Insiders	51	0.333	0.390[ab]	0.041
% Board Financial Experts	51	0.166	0.217	0.032
Avg. Board Age	51	54.80000	53.649	0.891
CFO with MBA	57	0.000	0.421[a]	0.065
CFO with Unknown Education	57	0.000	0.175[abc]	0.050
CFO Ownership	47	0.010	0.020[b]	0.005
CEO Ownership	51	4.4000	9.447[ac]	1.939
CEO Compensation	50	325072	611264	236765
CFO Compensation	45	199615	229416[b]	19358
CFO Age	36	43.500	42.250[b]	1.257
Board Size	38	6.000	6.289	0.330

Panel B: Fixed Price PIPE Issuers

Variable	**N**	**Median**	**Mean**	**Standard Error**
CFO with Prior Public Firm Experience	40	0.000	0.425	0.079
CFO with Public Equity Offering Experience	40	0.000	0.325	0.075
Total Director and Management Ownership	42	13.910	21.130	2.906
CFO/CEO Comp	41	0.606	1.978	1.323
% Board Insiders	43	0.250	0.294	0.024
% Board Financial Experts	43	0.222	0.271	0.030
Avg. Board Age	43	54.500	53.820	0.732
CFO with MBA	47	0.000	0.234	0.062
CFO with Unknown Education	47	0.000	0.489	0.073
CFO Ownership	42	0.010	0.012	0.003
CEO Ownership	42	0.0272	0.0626	0.016
CEO Compensation	43	310000	365279	49104
CFO Compensation	42	200053	210114	17327
CFO Age	34	42.500	43.882	1.452
Board Size	36	6.000	6.222	0.314

Panel C: SEO Issuers

Variable	N	Median	Mean	Standard Error
CFO with Prior Public Firm Experience	41	1.000	0.804	0.062
CFO with Public Equity Offering Experience	41	1.000	0.951	0.034
Total Director and Management Ownership	40	7.850	16.052	3.024
CFO/CEO Comp	41	0.409	0.502	0.041
% Board Insiders	39	0.285	0.290	0.024
% Board Financial Experts	39	0.200	0.215	0.025
Avg. Board Age	38	55.160	55.832	0.949
CFO with MBA	47	0.000	0.361	0.070
CFO with Unknown Education	47	0.000	0.468	0.073
CFO Ownership	40	1.000	0.985	0.027
CEO Ownership	40	2.045	5.352	1.617
CEO Compensation	41	806077	1033665	120987
CFO Compensation	41	357180	389269	27236
CFO Age	44	45.000	45.750	1.112
Board Size	36	7.000	7.194	0.313

Panel D: Non-Issuers

Variable	N	Median	Mean	Standard Error
CFO with Prior Public Firm Experience	39	0.000	0.435	0.080
CFO with Public Equity Offering Experience	39	0.000	0.282	0.073
Total Director and Management Ownership	39	21.400	25.801	3.421
CFO/CEO Comp	38	0.586	0.660	0.074
% Board Insiders	39	0.333	0.366	0.039
% Board Financial Experts	39	0.250	0.270	0.031
Avg. Board Age	39	53.571	52.761	0.992
CFO with MBA	47	0.000	0.319	0.068
CFO with Unknown Education	47	1.000	0.510	0.073
CFO Ownership	39	0.010	0.013	0.001
CEO Ownership	40	0.023	0.071	0.014
CEO Compensation	39	399250	547564	69821
CFO Compensation	39	206153	296634	52068
CFO Age	32	45.000	44.750	1.448
Board Size	31	7.000	7.129	0.421

PIPE Investor Identity. Investors in FRCs are unlikely to be firm managers. Only two FRC issues are purchased by management, whereas eight fixed price PIPE issues were purchased by management. FRC and fixed price PIPE issues are made to investors who hold seats on the issuers' boards at a rate less than ten percent. Four FRC issuers and six fixed price PIPE issuers sold PIPEs to institutions with board seats.

E. Announcement Cumulative Abnormal Returns

A Fama-French three-factor plus momentum model was built to calculate abnormal returns. The CARs are also robust to alternative market models: the capital asset pricing model and the Fama-French three factor model. The coefficients for each model are determined using a 250 market day window prior to three months prior before the announcement dates. Table 7 presents the cumulative abnormal returns (CARs) over an event windows covering five days prior through five days after the announcement ([-5,+5]).

Table 7
Cumulative Abnormal Returns by Firm Group

Cumulative abnormal returns are calculated five days prior through five days after the issuance announcement (imputed announcement in the case of the matched non-equity-issuers). The abnormal return is computed by using a four factor market model: the excess market, small minus big portfolio, high minus low market to book portfolio, and the winners minus losers momentum portfolio. The coefficients on each of these are calculated over the 250 market day period a month prior to the events for each firm. Estimates are significant at the 10%, 5%, and 1% levels if denoted with *, **, or *** respectively.

Firm Type	Frequency	Minimum	Median	Maximum	Mean	Standard Error
FRC Issuer	41	-0.387	-0.040	0.682	-0.011	0.035
Fixed Price PIPE Issuer	34	-0.421	0.004	2.339	0.152*	0.083
SEO Issuer	35	-0.188	0.024	0.889	0.063	0.030
Non-Equity Issuer	31	-0.301	0.016	0.473	0.028	0.030
Total	141	-0.421	0.013	2.339	0.055**	0.024

F. Post-Issue Firm Characteristics

In the year of the FRC issuance, the only financial ratios presented in Table I that significantly change is financial distress (OSCORE) and the value of the firm (FIRMVALUE). The mean probability of financial distress increases 13.01 percent and the mean firms' value decreases by $0.50 million, both with significances greater than the one percent level. From the year of issue to the following year, neither the level of financial distress nor firm value change. However, from the year of the issue to the following year, Tobin's q increases by eight percent and R&D drops by 64 percent, both at the five percent level of significance. These patterns are also robust to industry adjustments. These changes in operating performance over the period of a year prior to the year of issue are only found in the group of FRC issuers. SEO issuers and non-equity issuers experience significant drops in the probability of financial distress (SEO: -10.1 percent; Non-Issuers: -12.2 percent). SEO issuers' value significantly increases by 23.2 percent, and their leverage significantly decreases by 16.4 percent. Fixed price PIPE issuers and non-equity-issuers decrease their levels of R&D investment (Fixed PIPE: -127.6 percent; Non-Issuers: -51.2 percent). Among the control groups, there is little change from the year of issue to the following year. Fixed price PIPE issuers are more likely to be in financial distress by a mean of 10.5 percent. Non-equity issuers' profits increase by a mean of 6.7 percent.

While the level of R&D investment does not decrease significantly from the year prior to and year of issue among FRC issuers, the fixed PIPE issuers and non-equity-issuers have significant decreases in R&D. However, in the year following issue, only FRC issuers significantly reduce R&D investment. This finding is consistent with Hillion and Vermaelen (2004)'s, who interpret the relative initial run up in R&D and subsequent decline in R&D as a pre-issue confidence by issuing management in future returns to their investment.

Of the 43 FRC issuers, ten are delisted and one is acquired within one year following the issuance. However, only two of the 40 fixed-price-PIPE issuers are delisted and three are acquired in one year following the announcement. None of the 46 SEO issuers are delisted and one is acquired. The only control group that has a similar number of delistings to the FRC issuer group is 38 non-equity issuers, of which seven are delisted.

The similarity between FRCs and non-issuers in terms of delisting rates indicates that the issuance of a FRC does not increase its chances of remaining in business (or, is predictive of being able to stay in business). On the other hand, fixed PIPE issuers and SEO issuers have a greater chance of remaining in business and being acquired than FRC issuers and non-equity issuers. This pattern does not support the FLR hypothesis.

IV. Hypotheses

Hypotheses concerning the rationale for the existence of FRCs are presented in Hillion and Vermaelen (2004): the undervaluation, faulty contract design, and financing of last resort hypotheses. Two of these, the FCD and FLR hypotheses are not rejected by the authors, and they are two explanations that are commonly accepted today for the existence of FRCs. Either of the two hypotheses place FRCs in a negative light. In the case of the FCD hypothesis, the FRC is an instrument of predation by unscrupulous investors who take advantage of firms whose management is either ignorant or in collusion with the investors. In the case of the FLR hypothesis, the FRC is the only source of continued financing for firms that would otherwise have to cease operations.

While the latter hypothesis offers a rational explanation for the existence of FRCs, it does not offer a more positive explanation than that they are cheap enough for investors so that they will be willing to purchase them. Why, however, is the floating conversion feature included rather than a more deeply discounted fixed conversion price? The FLR hypothesis does not provide an answer.

Additional explanations appeal to fundamental concepts in corporate finance. FRCs may exist to resolve problems that reduce firm value, which may be explained by an "optimal security design" (OSD) hypothesis. Two possible examples of the OSD hypothesis are (i) the tradeoff between the debt tax shield and financial distress and (ii) the problem of debt overhang:

(i) Trade-Off: A firm determines an optimal leverage by maximizing the net benefit of the debt tax shield minus bankruptcy costs. The costs of bankruptcy are higher with the likelihood of default. If the market value of the stock falls after the issuance of debt and equity securities, the tax shield benefits decrease due to lower likelihood of having any positive pre-tax income before interest payments for the coming years and the bankruptcy costs increase due to higher likelihood of bankruptcy. The FRC causes the investors to change the debt-equity ratio in this scenario without the firm having to negotiate with bondholders.

(ii) Debt Overhang: A firm issues preferred stock or debt. After issuance, the real option value of its growth prospects decrease. This is reflected in a declining stock price. If the capital structure remains the same, the management, acting in the interest of the common equity holders, does not take positive NPV projects because of the overhang from debt or required dividends (Myers 1977). To avoid the renegotiation costs of exchanging the preferred stock or debt for common stock, the firm issues a FRC so that when the real option value goes down, the FRC is automatically converted into common shares because it is in the interest of the FRC investors.

The hypotheses that this study tests are the FCD, FLR, and OSD hypotheses. The FLR hypothesis and OSD hypotheses are similar in that they provide a rationale for FRCs that does not depend on behavioral arguments. They differ in that the FLR hypothesis basically says that FRCs are issued because they are cheap for the investor, but the OSD hypothesis provides rationales specifically for the floating conversion price feature. Because this study's purview is empirical and the OSD hypothesis is only introduced here, I only test the OSD hypothesis in the broad sense. Testing the specific manifestations of the OSD hypothesis is reserved for future research.

All firms do not necessarily issue FRCs for the same cause. Some firms may be unwitting victims of exploitive investors who intend to manipulate the stock price downward in order to expropriate a larger portion of the firm's equity. Many firms could be fully aware of the costs of FRC issuance and make the decision to issue the FRC wisely. Therefore, the empirical tests of this study do not seek to accept one hypothesis as true for all firms and reject other hypotheses. Rather, the tests are designed to test whether certain characteristics of firms' management can be linked to the various explanations for FRC issuances.

The group of FRC issuing firms is compared to the three control groups: fixed price PIPE issuers, SEO issuers, and no- equity issuing matched firms. Abnormal announcement returns are based on the Fama French three-factor plus momentum model and are computed using the 250 market day window prior to the month of issuance. The control groups are determined by using a score measuring the propensity to issue a PIPE. The non-equity-issuing matched firms are imputed with event dates the same as the FRC issuing firm with the closest propensity scores. Managerial characteristics of FRC issuers relative to the control firms are related to the following three areas: propensity to issue FRCs, stock market FRC announcement reaction, and long-term stock performance of FRC issuers.

In the first area, multinomial logit regression of the issuance type among the control groups is run on managerial characteristics. Significant coefficients on sophistication and/or incentives provide support to the FCD hypothesis and lack of support to the FLR and OSD hypotheses. If less sophistication, greater conflicts of interest, and less monitoring of financial managers correlate with greater likelihood of issuing a FRC, then the FCD hypothesis is supported. The FLR and OSD hypotheses would not necessarily be refuted because it would be possible for certain FRC issuers to issue FRCs that benefit their firms if they have CFOs who have above average sophistication than the entire sample of FRC issuers.

In the second area, the stock market cumulative abnormal return is regressed on the managerial characteristics. If the market reacts negatively to firms issuing FRCs with unsophisticated or conflicted management, then the FCD hypothesis may be true for those firms. In addition, I would interpret such a relationship to support the OSD hypothesis because the market only would be reacting negatively when the FRC is issued to the determinant of existing shareholders. I would not interpret such a finding to support the FLR hypothesis, however, because if the market differentiates FRC issues by managerial characteristics, then it should also be able to interpret the issuance as a negative signal immediately upon announcement rather than over a long period of time after issuance.

In the third area, calendar time alphas of a portfolio long on experienced and short on inexperienced FRC issuers is computed. If this portfolio is positive, then this supports the FCD and OSD hypotheses. I would conclude that a non-equity-value maximizing choice was made where the firm management is less experienced. On the other hand, among the firms where the firm management is experienced, I would conclude that the FRC was issued to maximize existing shareholder value if no long run abnormal returns are detected among these same firms. I would reject the FLR hypothesis if only the FRC issuers with inexperienced CFOs have negative long run returns because the FLR hypothesis predicts that all FRC issuers experience negative long run returns.

V. Results

A. Relationship of Managerial Characteristics on Issuance Choice

Unconditional Mean Comparison of Firm Managements. If FRCs are issued because they are faulty contracts rather than financings of last resort, then the firms that issue FRCs are less financially savvy than similar firms. Or, their management has conflicts of interest whereby they have interests with the FRC investors. I show that firms with CFOs who have had experience placing equity publicly and those with boards that are less composed of insiders are less likely to issue FRCs.

The unconditional means between the two groups show that 85.85 percent of the non-FRC issuing firms have CFOs who are the CFO, treasurer, or comptroller over a firm when it makes either an IPO or SEO. On the other hand, only 27.91 percent of the FRC issuing firms had CFOs with such experience. This is statistically significant at the five percent level. (Compare Panel A with the other panels of Table 6.) This difference in groups that are otherwise just as likely to issue a PIPE suggests that the CFOs' experience issuing public equity predicts which kind of security is issued. This result supports the argument underlying the FCD hypothesis that firms issue FRCs because their management is not comfortable with alternative ways to issue equity.

The unconditional means of the two groups show that the average percent of insiders on the board of directors is 29.84 percent among non-FRC issuing firms. (See Table 8.) On the other hand, the average insider percentage is 40.33 percent among FRC issuers. The difference is statistically significant at the five percent level. This difference in groups suggests that the quality of board monitoring affects the decision to issue FRCs. This result also supports the belief that faulty contract design is an influential reason for firms to issue FRCs because if FRC issuance were to maximize the value of existing equity in the firm, then firms whose boards are more independent from management would permit the issuances of FRCs.

Other variables do not display statistically significant differences between the two groups. Whether the CFO was previously a financial officer of a different public firm or a non-public firm does not make any difference between the FRC issuers and the control firms. Officer and director ownership of the firm is not different between the two groups. The percent of directors who are financial experts, i.e. those who are officers in a financial institution or are CFOs themselves, is not different between the two groups either.

The data of one variable, MBA, is frequently less available than the others in the firms' filings. Among the control group, 60.32 percent of firms' CFOs did have MBAs, and among FRC issuers, 44.44% had MBAs. However, this difference is not statistically significant. Because this field has more missing values, the regressions in the next section use a dummy variable that equals one when the education of the CFO is unknown and zero otherwise, and the MBA variable equals one if the CFO is known to have an MBA and equal to zero if otherwise.

Regression. A multinomial regression is run on the managerial characteristics and the PIPE issuance propensity score. The dependent variable takes four values: 0 if the firm is a matched non-equity issuer, 1 if a FRC issuer, 2 if a fixed price PIPE issuer, and 3 if a SEO issuer. The propensity score is included as a regressor as an additional control beyond the fact that the firms are already similarly matched. The results of the regression are robust to excluding the propensity score. I find that firms with CFOs with prior public equity experience are less likely to issue FRCs at the ten percent level. The regression does not support the unconditional means finding that more board insiders are positively correlated with FRC issuance in the presence of other management variables. I do find that the ratio of CFO to CEO pay is positively correlated with PIPE issuance over SEO or no equity issuance at the five percent significance level. This relationship may be saying that, all else equal, a firm where the CFO is more on par with the CEO in influence is more likely to issue PIPEs.

Table 8
Issuance Choice: Multinomial Logit Regression

A multinomial regression model is presented. The left hand side takes four possible: FRC issuer, fixed price PIPE issuer, SEO issuer, and match non-equity issuer. The non-issuer is the excluded class. The coefficients with standard errors in parentheses are given below. Statistical significance at varying levels is denoted with a * (10%), ** (5%), and *** (1%).

Variable	Issuer Type		
	FRC Issuer	Fixed Price PIPE Issuer	SEO Issuer
CFO with Prior Public Firm Experience	1.253*	-0.634	-0.138
	(0.745)	(0.704)	(1.270)
CFO with Public Equity Offering Experience	-1.451*	0.156	5.249***
	(0.864)	(0.758)	(1.550)
Total Director and Management Ownership	4.23E-05	-0.016	-0.188**
	(0.022)	(0.020)	(0.075)
CFO/CEO Comp	3.707**	3.420**	-3.253*
	(1.599)	(1.555)	(1.807)
% Board Insiders	1.183	-2.984	0.0662
	(1.597)	(2.173)	(2.056)
% Board Financial Experts	-1.768	0.881	2.562
	(1.752)	(1.636)	(3.245)
Avg. Board Age	0.032	0.077	-0.023
	(0.059)	(0.060)	(0.089)
CFO with MBA	-0.273	-0.893	-0.143
	(0.817)	(0.879)	(1.471)
CFO with Unknown Education	-2.117	-0.687	-1.170
	(0.919)	(0.798)	(1.615)
CFO Ownership		-0.161	-0.942

	-0.071	(0.224)	(1.756)
	(0.198)		
CEO Ownership	0.040	0.022	0.188**
	(0.037)	(0.040)	(1.756)
CFO Compensation	-4.49E-06*	-8.07E-06***	2.66E-06
	(2.41E-06)	(3.08E-06)	(2.10E-06)
Propensity to Issue PIPE	-4.335	-4.826	-8.718
	(8.496)	(8.173)	(10.950)
Intercept	-2.125	-1.935	1.521
	(3.478)	(3.604)	(5.463)
Number of Observations	112		
Pseudo R-squared	0.419		

B. Stock Market Reaction to FRC Announcement by Managerial Characteristics

The variation in the stock market reactions to FRC issuances is explained partly by management characteristics. Four separate regressions are run, one for each group of firms. See Table 9. Among FRC issuers, the only characteristic at the five percent level of significance in CARs around the announcement is the ratio of CFO compensation to CEO compensation. The relationship between abnormal returns and this variable is negative, suggesting that the market reacts negatively to FRC issuers by firms in which the CFO has more clout relative to the CEO.

The only other variable displaying significance in the FRC announcement reaction regression is the unknown education dummy variable, having a positive sign. The interpretation for this result is unclear. Unavailable educational data may be a proxy for either less reporting quality, which would not support the argument that managerial quality impacts firm value. Alternatively, citing educational background may be a substitute for citing experience, in which case the significantly positive sign on unknown education would support the argument that managerial quality does impact firm value.

Number of board insiders appears as a significant variable in the SEO and Non-Issuer regressions, but not the FRC issuer regression. This may indicate that corporate governance is a concern when SEOs are issued or no issuance is made by firms similar to the issuing firms.

Apart from the CFO to CEO compensation ratio, I do not see market reaction being sensitive to managerial characteristics in a clearly interpretable way. The market may be concerned in particular by a FRC issuance announcement when the CFO is more highly compensated. This relationship supports the FCD hypothesis where the CFO has less oversight because she holds a higher rank in the firm.

Table 9
Regressions: 11 day CAR on Management Characteristics by Firm Type

Each column represents a separate regression of the CAR [-5,+5] around issuance announcements (or imputed announcements) on the managerial variables. Cumulative abnormal returns are calculated five days prior through five days after the issuance announcement (imputed announcement in the case of the matched non-equity-issuers). The abnormal return is computed by using a four factor market model: the excess market, small minus big portfolio, high minus low market to book portfolio, and the winners minus losers momentum portfolio. The coefficients on each of these are calculated over the 250 market day period a month prior to the events for each firm. The managerial values are collected in the period prior to the security issuances, or imputed issuances in the case of the matched non-equity-issuers. CFO / CEO Comp is the fraction of CFO cash compensation to CEO cash compensation. % Board Insiders is the percent of board members who are also managers of the same firms. % Board Financial Experts is the percent of board members who are either employed by a financial institution or is a CFO. The coefficients with standard errors in parentheses are given below. Statistical significance at varying levels is denoted with a * (10%), ** (5%), and *** (1%). FRC issuers' variables' means are significantly different from the fixed price PIPE issuers, SEO issuers, non-equity-issuers if denoted by an *a, b,* or *c*, respectively, at the 5% level.

Variable	FRC Issuer	Fixed Price PIPE Issuer	SEO Issuer	Non-Issuers
CFO with Prior Public Firm Experience	-0.048	0.027	0.0839487	-0.1047058
	0.105	0.416	0.0526844	0.0829212
CFO with Public Equity Offering Experience	0.019	-0.066	-0.1092252	-0.0378850
	0.156	0.408	0.1125912	0.0892258
Total Director and Management Ownership	0.005	-4.69E-4	0.0079937	-0.0040279
	0.003	0.009	0.0041605	0.0031122
CFO/CEO Comp	-0.396**c	-0.611	-0.0588477	0.0409362
	0.179	0.857	0.1246221	0.1454364
% Board Insiders	-0.104 c	0.100	-0.3762595**	-0.7817884**
	0.146	0.975	0.1701241	0.2892039
% Board Financial Experts	0.271	0.120	-0.0543524	-0.0922416
	0.221	0.848	0.1641585	0.2475943
Avg. Board Age	0.014	0.001	-0.0050111	-0.0143507**
	0.016	0.028	0.0053303	0.0068937
CFO with MBA	-0.008	-0.194	0.0768565	0.1083244
	0.132	0.353	0.0938519	0.1307238
CFO with Unknown Education	0.364** ac	-0.256	0.011357	0.1142139
	0.139	0.273	0.1030467	0.1187252
CFO Ownership	-0.090	-0.106	0.3157607	0.0272749
	0.057	0.290	0.2763186	0.0456118
CEO Ownership	0.005	-0.001	-0.0056735	0.0154634**
	0.005	0.015	0.0045315	0.0064923
CFO Compensation	3.44E-7	2.53E-7	-1.18E-7	1.73E-7
	3.79E-7	1.80E-7	1.19E-7	1.46E-7
Propensity to Issue PIPE	2.159	4.299	1.204**	2.255**
	2.162	3.540	0.580	0.919
Intercept	-0.926 c	-0.283	0.074	0.719
	0.999	1.628	0.354	0.473

C. Long-Run Stock Performance

Four portfolios are created of firms that either issued each for each group of firms. The monthly return of these firms is regressed on the Fama French plus momentum factors over 2001-2003. Each group's monthly portfolio is composed of firms who issue (or are imputed with an issue) in the twelve months prior to the particular month. The non-issuers have an issuance date imputed to them according to the issuance dates of the FRCs to which the non-issuer have the closest propensity scores. The significances of the estimates of alpha are evaluated by the mean return of 1,000 regressions using random samples of firms in the same size and book-to-market deciles as the FRC issuers (Mitchell and Stafford, 2001). The portfolio returns of firm group *p* in month *t* are regressed on a constant, the Fama French factors, and the momentum portfolio:

$$r_{p,t} = \alpha_p + \beta_{p,MKT} r_{MKT} + \beta_{p,SMB} r_{SMB} + \beta_{p,HML} r_{HML} + \beta_{p,MKT} r_{MKT} + \beta_{p,UMD} r_{UMD} + \varepsilon_{p,t}$$

Table 10
Calendar Time Portfolio Alphas

Each row corresponds to a separate regression that predicts the return of the row's portfolio description. The monthly returns are regressed on the Fama French plus momentum factors over 2001-2003. Each group's monthly portfolio is composed of firms who issue (or are imputed with an issue) in the twelve months prior to the particular month. The non-issuers have an issuance date imputed to them according to the issuance dates of the FRCs to which the non-issuer have the closest propensity scores. The significances of the estimates of alpha are evaluated by the mean return of 1,000 regressions using random samples of firms in the same size and book-to-market deciles as the FRC issuers (Mitchell and Stafford, 2001).

Portfolio	Alpha	MKTRF	SMB	HML	UMD	R^2
FRC Issuers	-0.024	1.763***	0.295	0.730	-0.267	0.54
	(0.018)	(0.495)	(0.533)	(0.570)	(-0.400)	
FRC Issuers – Fixed PIPE Issuers	-0.013	-0.732	-1.135	0.763	-0.621	0.13
	(0.025)	(0.679)	(0.731)	(0.781)	(0.548)	
FRC Issuers – SEO Issuers	-0.017	1.012	-0.658	0.919	-0.312	0.22
	(0.022)	(0.613)	(0.660)	(0.705)	(0.495)	
FRC Issuers – Nonissuers	-0.050*	0.788	-0.651	0.624	-0.109	0.10
	(0.025)	(0.688)	(0.741)	(0.792)	(0.555)	
Inexperienced FRC Issuers	-0.045**	1.441**	0.222	0.760	-0.291	0.42
	(0.020)	(0.538)	(0.580)	(0.620)	(0.435)	
Experienced FRC Issuers – Inexperienced FRC Issuers	0.097**	1.452	0.484	-0.824	0.480	0.12
	(0.040)	(1.086)	(1.169)	(1.250)	(0.876)	
Experienced Fixed PIPE Issuers – Inexperienced Fixed PIPE Issuers	0.008	-0.881	-0.265	0.467	-0.055	0.08
	(0.038)	(1.016)	(1.094)	(1.169)	(0.820)	
Experienced SEO Issuers – Inexperienced SEO Issuers	0.016	0.258	0.061	-0.675*	0.130	0.16
	(0.126)	(0.339)	(0.365)	(0.390)	(0.573)	
Experienced Nonissuers – Inexperienced Nonissuers	-0.030	-0.765	1.207	-1.553	0.996	0.15
	(0.041)	(1.106)	(1.191)	(1.273)	(0.893)	

The regression of all FRC issuers shows a negative monthly alpha of -2.48 percent, which is economically a large amount, but weak statistically at only the ten percent level. The weaker significance contrasts with Hillion and Vermaelen (2004)'s stronger statistical finding of negative future abnormal returns. Two differences between this study and theirs are the sample periods and the methodologies. First, Hillion and Veramaelen (2004) use FRCs issued during the 1990s, and I use FRCs issued over 2001-2002. As the market had more experience with FRCs, the firms may have become more careful with the terms to which they agreed, thus reducing the likelihood that their stocks would enter "death spirals." Second, Hillion and Vermaelen (2004) use buy and hold abnormal returns instead of computing calendar time alphas. This difference may be symptomatic of the problems with the buy and hold return approach cited by Barber and Lyon (1997, 1999).

A portfolio with a long position in FRC issuers with CFOs who have prior experience issuing stock publically and a short position in FRC issuers without CFOs with this experience show a more significant statistical result. This "experienced minus inexperienced" FRC portfolio has a positive monthly alpha of 9.79 percent at the five percent level of significance (Mitchell and Stafford t-statistic of 2.53). This striking difference among FRC issuing firms provides support to the FCD hypothesis. The significantly greater returns FRC issuers with experienced CFOs does not indicate these firms are struggling as the FLR hypothesis predicts. Rather, the non-negative returns to these firms support the OSD hypothesis, that the FRC terms are appropriate for the firm and are optimal for existing shareholders.

The same analysis performed on the three groups of control firms provides robust support to the above findings. The portfolios long in FRC issues and short in either the fixed PIPE or SEO issuers both show insignificant alphas, which does not support the FCD and FLR hypotheses, and does support the OSD hypothesis. The portfolio long in FRC issuers and short in matched non-issuers, however, does show a negative alpha close to the five percent significance level, which does not support the FLR hypothesis because the firms that do not obtain additional equity financing perform better overall.

Portfolios long in experienced and short in inexperienced CFOs per control group display no significant alphas. Therefore, the significant alpha of the FRC experienced minus inexperienced portfolio is all the more compelling.

VI. Conclusion

This research adds to the body of knowledge on the motives for FRC issues by characterizing the types of issuers at the managerial level. FRC issuing firms that have CFOs without prior experience in making a public offering of equity have significantly poorer stock returns than FRC issuing firms with CFOs who have prior experience making public offerings. The difference in stock returns suggests that the experience of the CFO indicates which FRC deals will not maximize shareholder value. While some firms may be taken advantage of when issuing FRCs, the FRC contract may be a rational security that is appropriate for some firms by resolving the problems posed by classical corporate finance such as the trade-off between the debt tax shield and bankruptcy costs and the overhang of debt on investment decisions.

I also find an interesting relationship between CFO compensation relative to the CEO and both the decision to issue a FRC and the market's reaction to issuance announcements. Firms with higher CFO to CEO compensation ratios are more likely to issue FRCs. Among FRC issue announcements, the market reacts negatively when CFOs are more highly compensated. This finding merits further study on the relationship between CEO and CFO with regard to financing decisions.

The OSD hypothesis is introduced to explain FRCs. Further research could formalize it and allow for testing of how FRCs resolve issues that reduce firm value.

Appendix

FRC Issuers with CFOs with prior public issue experience

COMPUTER MOTION INC – GORDON L. ROGERS

GORDON L. ROGERS joined the Company as Vice President / Chief Financial Officer in March 2000. From 1999 to 2000, Mr. Rogers served as Vice President of Finance at ViroLogic, Inc. a medical biotechnology company. Previously, he spent five years at Nellcor Puritan Bennett, Inc., one of the world's largest medical device manufacturers, most recently as Controller for Worldwide Field Operations.

CRAY INC – KENNETH L. JOHNSON

Kenneth W. Johnson serves as Vice President - Legal, General Counsel and Secretary and has held those positions since joining us in September 1997. From September 1997 to December 2001 he also served as our Vice President – Finance and Chief Financial Officer. Prior to joining us, Mr. Johnson practiced law in Seattle for twenty years with Stoel Rives LLP and predecessor firms, where his practice emphasized corporate finance. Mr. Johnson received an A.B. degree from Stanford University and a J.D. degree from Columbia University Law School.

EXELIXIS – JOHN Y. S.ATO

Glen Y. Sato has served as the Company's Chief Financial Officer, Vice President of Legal Affairs and Secretary since November 1999. From April 1999 to November 1999, Mr. Sato served as Vice President, Legal and General Counsel for Protein Design Labs, Inc., a biotechnology company, where he previously served as the Associate General Counsel and Director of Corporate Planning from July 1993 to April 1999. Mr. Sato holds a B.A. from Wesleyan University and a J.D. and M.B.A. from the University of California, Los Angeles.

KEY3MEDIA GROUP INC – PETER B. KNEPPER

Peter B. Knepper was hired by Ziff-Davis in March 2000 to be our Executive Vice President and Chief Financial Officer. From 1998 to March 2000, he was a private investor and consultant providing strategic planning and financial management services. Mr. Knepper was previously Senior Vice President and Chief Financial Officer of Ticketmaster Group, Inc., a position he held for more than ten years, from 1988 to 1998.

NEKTAR THERAPEUTICS – BRIGID A. MAKES

Brigid A. Makes has served as Vice President of Finance and Administration and Chief Financial Officer since June 1999. Ms. Makes has also served as Assistant Secretary since January 2001. From 1998 until joining Inhale, Ms. Makes served as Vice President, Chief Financial Officer and Treasurer for Oravax, Inc., a life sciences company. From 1992 to 1998, Ms. Makes served in various management positions for Haemonetics Corporation, a developer of automated blood processing systems, including, from 1995 to 1998, Vice President Finance, Chief Financial Officer and Treasurer. Prior to Haemonetics Corporation, Ms. Makes held a number of financial management positions at Lotus Development Corp. (now International Business Machines) and General Electric Co. Ms. Makes holds a Bachelor of Commerce degree from McGill University in Finance and International Business and an MBA from Bentley College.

RENTECH INC – JAMES P. SAMUELS

Mr. James P. Samuels, age 55, has served as Vice President-Finance, Treasurer and Chief Financial Officer of Rentech since May 1, 1996. He has executive experience in general corporate management, finance, sales and marketing, information technologies, and consulting for both large companies and development stage businesses. From December 1995 through April 1998, he provided consulting services in finance and securities law compliance to Telepad Corporation, Herndon, Virginia, a company engaged in systems solutions for field force computing. From 1991 through August 1995, Mr. Samuels served as chief financial officer, vice president-finance, treasurer and director of Top Source, Inc., Palm Beach Gardens, Florida, a development stage company engaged in developing and commercializing state-of-the-art technologies for the transportation, industrial and petrochemical markets. During that employment, he also served during 1994 and 1995 as president of a subsidiary of Top Source, Inc. From 1989 to 1991, he was vice president and general manager of the Automotive group of BML Corporation, Mississauga, Ontario, a privately-held company engaged in auto rentals, car leasing, and automotive insurance. From 1983 through 1989, Mr. Samuels was employed by Purolator Products Corporation, a large manufacturer and distributor of automotive parts. He was president of the Mississauga, Ontario branch from 1985 to 1989; a director of marketing from 1984 to 1985; and director of business development and planning during 1983 for the Rahway, New Jersey filter division headquarters of Purolator Products Corporation. From 1975 to 1983, he was employed by Bendix Automotive Group, Southfield, Michigan, a manufacturer of automotive filters, electronics and brakes. He served in various capacities, including group director for management consulting services on the corporate staff, director of market research and planning, manager of financial analysis and planning, and plant controller at its Fram Autolite division. From 1973 to 1974, he was employed by Bowmar Ali, Inc., Acton, Massachusetts, in various marketing and financial positions, and in 1974 he was managing director of its division in Wiesbaden, Germany. He received a Bachelor's degree in Business Administration from Lowell Technological Institute in 1970, and a Master of Business Administration degree in 1972 from Suffolk University, Boston, Massachusetts. He completed an executive program in strategic market management through Harvard University in Switzerland in 1984.

STAR TELECOMMUNICATIONS INC – KELLY D. ENOS

KELLY D. ENOS has served as our Chief Financial Officer since December 1996 and as Treasurer and Assistant Secretary since April 1997. Prior to that time, Ms. Enos was an independent consultant in the merchant banking field from February 1996 to November 1996 and a Vice President of Fortune Financial, a merchant banking firm, from April 1995 to January 1996. Ms. Enos served as a Vice President of Oppenheimer & Co., Inc., an investment bank, from July 1994 to March 1995 and a Vice President of Sutro & Co., an investment bank, from January 1991 to June 1994.

TARGETTED GENETICS CORP – TODD E. SIMPSON

Todd E. Simpson has served as vice president, finance and administration, chief financial officer, treasurer and secretary of Targeted Genetics since October 2001. From January 1996 to October 2001, Mr. Simpson served as vice president, finance and administration and chief financial officer of Aastrom Biosciences, Inc., a public life science company focused on the development of cell-based therapeutics. From August 1995 to December 1995, he served as treasurer of Integra LifeSciences Corporation, a public biotechnology company, which acquired Telios Pharmaceuticals, Inc. in August 1995. From 1992 until its acquisition by Integra, he served as vice president of finance and chief financial officer of Telios and in various other finance-related positions. From 1983 to 1992, Mr. Simpson practiced public accounting with the firm of Ernst & Young LLP. Mr. Simpson is a certified public accountant. He received his B.S. in accounting and computer science from Oregon State University.

TIVO INC – DAVID COURTNEY

David Courtney was appointed by our Board to serve as a director in May 2002. Mr. Courtney joined TiVo in March 1999 as Vice President and Chief Financial Officer and in March 2000 was named Senior Vice President for Finance and Administration. Mr. Courtney is currently Chief Financial Officer and Executive Vice President, Worldwide Operations and Administration, serving in this capacity since October 2001. From May 1995 to July 1998, Mr. Courtney served as a Managing

Director at J.P. Morgan, an investment banking firm, where he was responsible for building and expanding the firm's high technology investment banking business in the United States. From 1986 to 1995, Mr. Courtney was a member of the high technology investment banking group at Goldman, Sachs & Co., most recently serving as Vice President. Mr. Courtney currently serves as a director of KQED Television, a non-profit affiliate of the Public Broadcasting System in San Francisco, California. Mr. Courtney holds a B.A. degree in Economics from Dartmouth College and an M.B.A. degree from Stanford University.

VIASOURCE COMMUNICATIONS INC. DOUGLAS J. BETLACH

DOUGLAS J. BETLACH has been our Executive Vice President, Chief Financial Officer, Treasurer and Secretary since June 1999. Prior to joining Viasource, Mr. Betlach was Vice President, Chief Financial Officer and Treasurer of Dycom Industries, Inc., a nationwide provider of engineering, construction and maintenance services to telecommunications operators.

V-ONE CORP – MARGARET E. GRAYSON

MARGARET E. GRAYSON (54) was elected President and CEO in November 2000. She had served as the Company's Senior Vice President and Chief Financial Officer since May 1999. Ms. Grayson was elected to the Board of Directors in August 1999. Prior to joining V-ONE Corporation, Ms. Grayson served as Vice President of Finance and Administration and Chief Financial Officer for SPACEHAB, Inc. (Nasdaq: SPAB) from September 1994 to October 1998. Immediately prior to joining SPAB, Ms. Grayson served as Chief Financial Officer for CD Radio, Inc. in Washington, D.C., an early entrant in the satellite radio mobile communications market. Previously, Ms. Grayson served as a senior executive and consultant to high technology start-up companies. Ms. Grayson is on the Board of Directors of Ronbotics Corporation and the Advisory Board of Celsion Corporation. Ms. Grayson holds an M.B.A. from the University of South Florida and a B.S. in Accounting from the State University of New York at Buffalo.

<u>FRC Issuers with CFOs without public issue experience</u>

ADEPT TECHNOLOGY – MICHAEL W. OVERBY

Michael W. Overby has served as Adept's Vice President of Finance and Chief Financial Officer since March 2000. From December 1999 to March 2000, Mr. Overby held the position of Corporate Controller at Adept. Prior to joining Adept, Mr. Overby was the financial executive for DG Systems, a leading provider of digital distribution services to the broadcast advertising industry. From 1996 to 1998 he was Corporate Controller and Director of Information Systems at Inprise Corporation, formerly Borland, a public software company. Mr. Overby holds a B.S. in Business Administration from California Polytechnic State University.

ALKERMES INC. – JAMES M. FRATES

Mr. Frates has been Vice President, Chief Financial Officer and Treasurer of Alkermes since July 1998. From June 1996 to July 1998, he was employed at Robertson, Stephens & Company, most recently as a Vice President in Investment Banking. Prior to that time he was employed at Robertson, Stephens & Company and at Morgan Stanley & Co. In June 1996, he obtained his M.B.A. from Harvard University.

ALLIANCE PHARMACEUTICALS – TIM T. HART

TIM T. HART, C.P.A. Mr. Hart, who is 44, was appointed Vice President in May 1999 and Chief Financial Officer in August 1998. He joined the Company in 1991 as Controller and has also served as Treasurer since 1994. Prior to joining Alliance in 1991, he was employed in various financial management positions at Cubic Corporation for over eight years. He was also employed by Ernst & Whinney in San Diego, California as a C.P.A.

ANTEX BIOLOGICS – GREGORY C. ZAKARIAN

GREGORY C. ZAKARIAN, CPA, age 52, has served as Vice President, Finance and Administration, Chief Financial Officer and Treasurer of the Company since September 1992. He has served as Secretary of the Company since November 1993, and as Assistant Secretary of the Company from September 1992 until October 1993. Prior to September 1992, Mr. Zakarian was a partner with an international CPA firm.

APPIANT TECHNOLOGIES – DOUGLAS S. ZORN

DOUGLAS S. ZORN. Mr. Zorn has been our Chairman of the Board, Chief Executive Officer and President since May 2000. Mr. Zorn served as Executive Vice President, Chief Financial Officer, Secretary and a Director of the Company since our incorporation in October 1996 until May 2000. Mr. Zorn served as Executive Vice President, Secretary and Treasurer, and Chief Financial and Operating Officer of BioFactors, Inc. from December 1993 until February 1997 and as a Director from June 1994 until February 1997.

CECO ENVIRONMENTAL CORP – MARSHALL J. MORRIS

Marshall J. Morris became the Chief Financial Officer of the Company on January 26, 2000. From 1996 to 1999 Mr. Morris was Treasurer of Calgon Carbon Corporation which stock trades on the New York Stock Exchange and which is a worldwide producer of specialty chemicals and supplier of pollution control technologies and services with annual sales of approximately $300 million. From 1995 to 1996 he served as a consultant with respect to business management and strategic planning. From 1989 through 1995 Mr. Morris also served as the Treasurer of Trico Products Corporation, an international manufacturer and distributor of original equipment automative parts with annual sales of approximately $350 million.

CEL-SCI CORP – GEERT KERSTEN

Geert R. Kersten, Esq. Mr. Kersten was Director of Corporate and Investment Relations for the Company between February 1987 and October 1987. In October of 1987, he was appointed Vice President of Operations. In December 1988, Mr. Kersten was appointed Director of the Company. Mr. Kersten also became the Company's Treasurer in 1989. In May 1992, Mr. Kersten was appointed Chief Operating Officer and in February 1995, Mr. Kersten became the Company's Chief Executive Officer. In previous years, Mr. Kersten worked as a financial analyst with Source Capital, Ltd., an investment advising firm in McLean, Virginia. Mr. Kersten is a stepson of Maximilian de Clara, who is the President and a Director of the Company. Mr. Kersten attended George Washington University in Washington, D.C. where he earned a B.A. in Accounting and an M.B.A. with emphasis on International Finance. He also attended law school at American University in Washington, D.C. where he received a Juris Doctor degree.

CHAMPION ENTERPRISES – ANTHONY C. CLEBURG

In 2000 Mr. Cleberg joined Champion from Washington Group International ("Washington Group"), a publicly-held engineering and construction firm, where for the previous three years he was the Executive Vice President and Chief Financial Officer. On May 14, 2001, subsequent to Mr. Cleberg's departure from Washington Group, it filed a voluntary petition for bankruptcy under Chapter 11 of the U.S. Bankruptcy Code. On January 25, 2002, Washington Group completed its Plan of Reorganization and emerged from Chapter 11 bankruptcy protection. Previous to Washington Group, Mr. Cleberg worked for Honeywell Inc. for 15 years in various senior financial positions, leaving as Corporate Vice President, Business Development.

CHELL GROUP – DON PAGNUTTI

Don Pagnutti was appointed our Vice President, Finance on September 19, 2000. Mr. Pagnutti has been our Chief Financial Officer since September 1998, and was our Executive Vice President and Chief Operating Officer from September 1997 to September 2000. From 1996 to 1997, he worked for Sullivan Entertainment Inc., as Executive Vice President and Chief Financial Officer. From 1980 to

1996, he worked for Telemedia Communications Ltd., a large Canadian media company as Vice President, Radio. Mr. Pagnutti is a Chartered Accountant and has a Masters Degree in Business Administration and a Bachelor of Commerce Degree from the University of Toronto.

CLEAN HARBORS INC - ROGER A. KOENECKE

Roger A. Koenecke joined the Company as Senior Vice President and Chief Financial Officer in 1998. From 1982 through 1997, Mr. Koenecke held a variety of management positions, including Senior Vice President and Chief Financial Officer, with Millbrook Distribution Services, Inc. and its predecessor corporations, which are engaged in the distribution of health and beauty care, general merchandise, and specialty food products. Prior to that, he was an Audit Manager with Price Waterhouse & Co., an international accounting firm. Mr. Koenecke holds a BS in Chemistry and MBA from the University of Wisconsin.

CYBERCARE – PAUL PERSHES

PAUL C. PERSHES (age 57) Class II, has served as a director since August 1996 and as our president since May 1997. In March 2001, Mr. Pershes assumed responsibilities as acting chief financial officer. Before joining us, Mr. Pershes founded and served as an officer of Weinberg, Pershes & Company, P.A., an accounting firm, from July 1994 to May 1997. Before founding Weinberg, Pershes & Company, Mr. Pershes was a senior partner of the international accounting firm Laventhol and Horvath for 18 years.

DALEEN TECHNOLOGIES – STEVEN M. WAGMAN

STEPHEN M. WAGMAN, 40, has served as chief financial officer of Daleen since June 2000 and has served as an executive vice president of corporate development and secretary since June 1999. Mr. Wagman has over 12 years of finance, business and legal experience with high-growth software companies. Before joining Daleen, Mr. Wagman served in various capacities with PowerCerv Corporation, an enterprise resource planning software company, including Chief financial officer, treasurer, senior vice president of administration, general counsel and secretary.

DATATEC SYSTEMS INC – ISAAC J. GAON

Isaac J. Gaon, Chairman of the Board since December 1997 and Director since 1992, has served as the Chief Executive Officer since October 1994. He served as Chief Financial Officer from April 1992 until October 1994. From September 1987 to December 1991, Mr. Gaon, a chartered accountant, served as President and Chief Executive Officer of Toronto-based NRG, Inc., (a subsidiary of Gestetner International) an office equipment supplier, and in several senior management roles within Gestetner Canada and Gestetner USA.

DIGITAL RECORDERS – LAWRENCE A. TAYLOR

Lawrence A. Taylor, age 55, has 12 years' experience in the transit industry, as well as extensive knowledge and experience in auditing, merger and acquisition reporting, analysis and financial information-technology systems. He has been the Company's secretary, chief financial officer and vice president since May 1998. From March 1997 to June 1999, Mr. Taylor was a partner in the Dallas office of Tatum CFO, LLP, a professional partnership of career CFOs. From March 1995 to August 1996, he was senior vice president of Precept Business Products, Inc., a privately held holding company in Dallas that distributed business forms, construction and on-demand courier services. From May 1991 to December 1994, he was vice president and group controller of Dallas-based Mark IV Industries' Transportation Products Group, which included nine companies, subsidiaries and operating units serving transit and transportation markets worldwide. Prior to 1991, he served in various financial managerial capacities in the food processing, commercial construction and oil field supply industries, as well as other manufacturing environments. A 1970 graduate of Wayne State University in Detroit, Mich., Mr. Taylor earned a B.S. degree in Accounting. A Certified Public Accountant, he is a member of the Texas Society of CPAs and its Dallas Chapter, the American Institute of CPAs, and Financial Executive International.

DYNTECK INC – JAMES A LINESCH

Since August 14, 2000, Mr. Linesch has served as the Chief Financial and Chief Accounting Officer, Executive Vice President and Secretary, and since February 1997 Director, of TekInsight. Previously, Mr. Linesch was the President, Chief Executive Officer and Chief Financial Officer of CompuMed, a public computer company involved with computer assisted diagnosis of medical conditions, which he joined in April 1996 as Vice President and Chief Financial Officer. Mr. Linesch served as a Vice President, Chief Financial Officer of the Company from August 1991 to April 1996. From May 1998 to August 1991, Mr. Linesch served as the Chief Financial Officer of Science Dynamics Corp., a corporation involved in the development of computer Software. Mr. Linesch holds a CPA certification in the State of California, where he practiced with Price Waterhouse from 1981 to 1984.

ECHOSTAR COMMUNICATIONS CORP – MICHAEL R. MCDONNEL

Mr. McDonnell joined EchoStar in August 2000 as Chief Financial Officer. Mr. McDonnell is responsible for all accounting and finance functions of the Company. Prior to joining EchoStar, Mr. McDonnell was a Partner with PricewaterhouseCoopers LLP, serving on engagements for companies in the technology and information communications industries.

ELECTRIC CITY CORP – JEFFERY R. MISTARZ

Jeffrey R. Mistarz has been our chief financial officer since January 2000 and our treasurer since October 2000. From January 1994 until joining us, Mr. Mistarz served as chief financial officer for Nucon Corporation, a privately held manufacturer of material handling products and systems, responsible for all areas of finance and accounting, managing capital and shareholder relations. Prior to joining Nucon, Mr. Mistarz was with First Chicago Corporation (now Bank One Corporation) for 12 years where he held several positions in corporate lending, investment banking and credit strategy.

ELECTROGLAS INC – THOMAS E. BRUNTON

Thomas E. Brunton was appointed Vice President — Finance, Chief Financial Officer, Treasurer and Secretary of the Company in November 2000. Prior to joining the Company, Mr. Brunton was Chief Financial Officer of Centigram Communications from March 1998 to July 2000. He joined Centigram in March 1991 as Controller and also served as Treasurer. Prior to his service at Centigram, he had financial management responsibilities at 3Com, Sun Microsystems, and IBM/ Rolm.

EUROTECH LTD – JOHN W. DOWIE

JON W. DOWIE, 54, IS OUR VICE PRESIDENT, TREASURER AND CHIEF FINANCIAL OFFICER under an employment agreement that expired February 6, 2001. He joined the Company in February 2000 after serving as Vice President, Finance, and CFO for Research Planning, Inc., from September 1997. Prior to that, he served as Controller for Automation Research Systems Ltd. from August 1992. He is a Certified Public Accountant and a Certified Government Financial Manager. He holds a B.S. in Accounting and an MBA from Murray State University, and is a Doctor of Business Administration candidate in Information Systems, Finance, and Marketing at Mississippi State University.

GLOBAL TECHNOVATIONS – DAVID NATAN

David Natan - was appointed a director of the Company on April 16, 1998 in order to fill a vacancy. Currently, Mr. Natan, a CPA, has been Vice President and Chief Financial Officer of the Company since June 1995 and Secretary from August 1997. Mr. Natan previously served on the Company's Board from June 1995 to January 1997. Mr. Natan brings nearly 20 years of management and analytical experience to his responsibilities. Prior to joining the Company, from November 1992 through June 1995, Mr. Natan was Chief Financial Officer of MBf USA, Inc., which is a Nasdaq listed subsidiary of MBf Holdings Berhad, a multi-national conglomerate. From August 1987 through October 1992, Mr. Natan was Treasurer and Controller for Jewelmasters, Inc., an AMEX listed company.

HORIZON MEDICAL PRODUCTS INC – JULIE F. LANCASTER

Julie F. Lancaster has served as the Vice President — Finance since January 2001. Ms. Lancaster joined the Company in 1994 as Assistant Controller and served in that capacity until 1996. From August 1996 through August 2000, Ms. Lancaster served as Controller of the Company. From August 2000 to January 2001, Ms. Lancaster served as Director of Financial Reporting and Planning for the Company.

HYPERTENSION DIAGNOSTICS – JAMES S. MURPHY

James S. Murphy Mr. Murphy joined us as Vice President of Finance and Chief Financial Officer during May 1996. In March 2000, his title was changed to Senior Vice President, Finance and Administration and Chief Financial Officer. Mr. Murphy was Controller of Gaming Corporation of America from December 1992 through November 1995. From 1978 to 1988, he was a tax partner with Fox, McCue and Murphy, a certified public accounting firm located in Eden Prairie, Minnesota. From 1970 to 1978, Mr. Murphy was employed by Ernst & Ernst (currently named Ernst & Young LLP) with both audit (six years) and tax (two years) experience. Mr. Murphy is a member of the American Institute of Certified Public Accountants as well as the Minnesota Society of CPAs. He holds a Bachelor of Science degree from Saint John's University in Collegeville, Minnesota (1966) and a Master of Business Administration degree (M.B.A.) from the University of Minnesota (1968).

INTERNATIONAL FIBERCOM INC – GREGORY B. HILL

Mr. Hill served as our Controller from September 1999 to March 2000 and became our Vice President-Finance in April 2000. From June 1998 until June 1999 he was employed by All Star Telecom, an infrastructure development subsidiary that we acquired in April 1999, where he served as chief financial officer and controller. From June to September 1999, he served as Regional Controller of our Infrastructure Development Group. Mr. Hill is a certified public accountant and served in the Technology Industry Group of Price Waterhouse providing audit, transaction support, and business advisory services to technology companies from January 1992 through June 1998. He received his bachelor of science in business administration from California State University Sacramento.

MEDWAVE INC – MARK T. BAKKO

MARK T. BAKKO is the Chief Financial Officer of the Company. He has served in this position since February 1996. From 1984 to 1996, Mr. Bakko was with Deloitte & Touche LLP with his most recent position being a senior manager. Mr. Bakko has been a Certified Public Accountant since 1985 in the State of Minnesota. Mr. Bakko holds a Masters of Business Taxation and B.S.B.A. degree in Accounting from the University of Minnesota.

ONE VOICE TECHNOGOLOGIES – RAHOUL SHARAN

Rahoul Sharan holds a Bachelor of Commerce degree from the University of British Columbia and is a member of the Institute of Chartered Accountants of British Columbia. Mr. Sharan was employed by Coopers & Lybrand (now Pricewaterhouse Coopers) from 1984 to 1989. Since 1989, Mr. Sharan has been the President and a Director of KJN Management Ltd., a private company that provides a broad range of administrative, management and financial services to both private and public companies. Mr. Sharan has been a partner in S & P Group, a company that specializes in investment financing for venture capital projects and real estate development and construction, since 1988. Mr. Sharan was also a Treasurer and Director.

ONSTREAM MEDIAN CORP – GAIL L. BABITT

GAIL BABITT, CPA. Ms. Babitt joined VDC as Chief Financial Officer in November 2000. From 1999 through October 2000 Ms. Babitt served as Vice President of Finance, North America and Corporate Controller for TeleComputing ASA. TeleComputing ASA is a leading application service provider. From 1997 to 1999 Ms. Babitt served as Manager-Transaction Services for Price Waterhouse Coopers LLP. During 1997 Ms. Babitt served as Director of Finance for ToppTelecom, Inc. Topp Telecom is a prepaid cellular company based in Miami. From 1994 to 1997 Ms. Babitt worked in the audit group with Price Waterhouse Coopers LLP (formerly Price Waterhouse LLP) and with Ernst & Young LLP from 1992 to 1994. Ms. Babitt has received a MBA from Boston University and a B.S. from Nova Southeastern University.

P-COM INC – LEIGHTON J. STEPHENSON

Mr. Stephenson has served as Vice President and Chief Financial Officer since September 2000. From 1993 to 2000 he served as Chief Financial Officer, Treasurer, and Secretary of Vallen Corporation, a Texas company engaged in manufacturing and distribution of industrial safety products and services.

PENTON MEDIA INC. – JOSEPH A. NECASTRO

Joseph G. NeCastro, 44, Chief Financial Officer and Treasurer of Penton since June 1998. Before joining Penton, Mr. NeCastro spent five years with Reader's Digest Association, Inc. Mr. NeCastro was Vice President, Finance for Reader's Digest USA from 1995 until 1998 and Corporate Controller in 1994 and 1995.

RAMP CORP – GARY L. SMITH

Mr. Smith joined the Company as Executive Vice President and Chief Financial Officer in December of 2000. From 1995 to 2000, Mr. Smith was with Provident Group, a financial advisory firm serving companies operating in emerging market countries, where he was a principal. Previously, Mr. Smith was an executive of American Express Bank, the international banking arm of the financial services conglomerate American Express Corporation (NYSE: AXP), where he held various senior financial positions, most recently as Senior Director and Commercial Banking Head, London Branch. He holds a BSc degree in Economics from the Wharton School and an MSc in Accounting and Finance from the London School of Economics.

SCIENCE DYNAMICS CORP – ROBERT O'CONNOR

Robert O'Connor came to SciDyn from PricewaterhouseCoopers, L.L.P in Philadelphia, PA, where he served as a manager of middle market advisory services. Mr. O'Connor brings with him a strong background in corporate finance, including prior positions as Corporate Controller and Chief Financial Officer at three technology companies. Mr. O'Connor received his MBA from Rutgers-Graduate School of Management, BS from Kean University in Union, NJ, and he is a Certified Public Accountant.

STARBASE CORP – DOUGLAS S. NORMAN

Douglas S. Norman founded Starbase in September 1991. In February 2000, Mr. Norman was appointed to serve as our Chief Financial Officer. From September 1997 to February 2000, Mr. Norman served as our Chief Accounting Officer. In February 2002, Mr. Norman was elected Secretary. Mr. Norman has served as our Assistant Secretary since February 1997 and Director of Finance from June 1996 to February 2000. Douglas S. Norman is the son-in-law of William R. Stow III, a member of the Board or Directors. Mr. Norman holds a B.S. in Business Administration from California State University and an M.B.A. from Loyola Marymount.

STORAGE COMPUTER CORP – PETER N. HOOD

Peter N. Hood, 60, has been the Company's Chief Financial Officer since May 16, 2000. Mr. Hood was previously owner and Chief Executive Officer of Phoenix Custom Molders, Inc., a custom manufacturer of plastic parts from 1993 to 2000. Phoenix Custom Molders, Inc. filed Chapter 11 bankruptcy on September 4, 1996 in the U.S. Bankruptcy Court for the District of New Hampshire. The Chapter 11 bankruptcy was entitled "In re Phoenix Custom Molders, Inc." and docketed as Bk. 96-12443-MWV. Phoenix Custom Molders, Inc. emerged from Chapter 11 bankruptcy on August 17, 1997. He was also co-founder and Vice President of Phoenix Distributors, Inc., a business involved in consolidating independent distributors of industrial gas and welding supplies from 1985 to 1993. From 1965 to 1985, he was with the accounting firm of Ernst & Young, becoming a partner in 1976. He received his business degree from Northeastern University and is a certified public accountant.

TEAM COMMUNICATIONS GROUP – JAY J. SHAPIRO

Jay J. Shapiro became our President, Chief Operating Officer and acting Chief Financial Officer on March 16, 2001. Mr. Shapiro will assist us in overseeing our corporate, financial and fiduciary activities worldwide. From 1993 to 2000, Mr. Shapiro, a certified public accountant, operated a private accounting and consulting practice specializing in servicing the television industry. During such period, he served as a temporary corporate officer for several publicly traded entertainment companies. Mr. Shapiro received his B.B.A. from the University of Wisconsin and a MBA (with Distinction) in Accounting and Finance from Arizona State University Graduate School of Business Administration.

THINKPATH INC – KELLY HANKINSON

Kelly Hankinson has served as our Chief Financial Officer since May 1999 and as a Director since June 2000. Ms. Hankinson served as our Controller from February 1994 to May 1999. Ms. Hankinson has a Masters Degree and a Bachelors Degree from York University.

US PLASTIC LUMBER CORP – MICHAEL D. SCHMIDT

MICHAEL SCHMIDT is Treasurer and Vice President of Finance. Mr. Schmidt joined us in December 1997. Mr. Schmidt has over 20 years of public and private accounting experience including ten years in the environmental industry. Prior to joining us, Mr. Schmidt served as Chief Financial Officer of Republic Environmental Systems, Inc., a publicly traded company and a leading environmental service provider, headquartered in Blue Bell, Pennsylvania, a position he held for approximately ten years. Mr. Schmidt has a B.S. degree in Business Administration from Rowan University and is a Certified Public Accountant in the State of New Jersey.

VELOCITY EXPRESS CORP – MARK E. TIES

Mark E. Ties. Mr. Ties joined the Company in April 2000 as its Vice President of Finance. Mr. Ties is also the Vice President of Finance for Velocity Express. Mr. Ties has more than 13 years of financial experience, of which eight years have been at the executive level in a number of companies in varied industries. Since 1998 and prior to joining the Company, Mr. Ties was a Manager and Senior Manager for Ernst & Young LLP in its entrepreneurial services and mergers and acquisitions departments. From 1994 to 1998 Mr. Ties was the Chief Financial Officer of Progressive Beauty Enterprises, Inc., a regional distribution company. Prior to 1994 Mr. Ties was the corporate controller of MEI Salons, Inc. and prior to that he was a senior auditor for Coopers & Libran LLP. Mr. Ties is a Certified Public Accountant.

WAVERIDER COMMUNICATIONS INC. – T. SCOTT WORTHINGTON

T. Scott Worthington has been a Vice President and the Company's chief financial officer since January 1998. From 1988 to 1996, he worked at Dell Computer Corporation, in Canada, where he held numerous positions including CFO of the Canadian subsidiary. From October 1996 to January 1998, he was a financial and business consultant. Mr. Worthington is a Chartered Accountant.

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