Essays on Corporate Finance and Financial Intermediation

Schmeits, A.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: https://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
CHAPTER 3

DISCRETION IN BANK CONTRACTS AND THE FIRM’S FUNDING SOURCE CHOICE BETWEEN BANK AND FINANCIAL MARKET FINANCING

Abstract

In this chapter we provide a rationale for the use of flexibility and discretion in bank loan contracts. Flexibility and discretion allow banks which produce information on borrowers to optimally condition their contracts on a finer partitioning of the state space than financial markets can. This facilitates intermediate adjustments in lending terms that could enhance both ex ante and ex post investment efficiency. The benefits of flexibility and discretion do however critically depend on the reputation of the banking system. We show that better quality borrowers will prefer discretionary contracts offered by higher quality banks. Lower quality borrowers have no option other than to mimic the high quality borrowers’ contract choice in a pooling equilibrium. Our analysis has implications for the firm’s choice of funding source and its choice of investment projects. We also emphasize an important link between the quality of the banking system, the level of information production by banks and the types of contracts offered and - more importantly - the competitive position of banks vis-à-vis the financial market.

Acknowledgements: We would like to thank Patrick Bolton, Arnoud Boot, Mike Burkart, Phil Dybvig, Linda van Goor, Clara Raposo, Ailsa Röell, Jianping Qi, Anjan Thakor and participants of the Annual Meeting of the European Finance Association in Oslo (August 1996) and seminar participants at Tilburg University, the University of Amsterdam, Washington University, the Norwegian School of Management and the Stockholm School of Economics for helpful comments and suggestions.
1 Introduction

Financial contracts are often incomplete in the sense that they fail to legally bind in at least some states, thereby leaving contractual discretion (i.e. flexibility) with the contracting parties. While this incompleteness may result from technical constraints (contracting on all possible states in the economy may either be too complex or too costly), the use of discretion in financial contracts may also be deliberate. That is, even if enforceable contracts could be written on a specific set of states, contracting parties may prefer not to do so and to leave contractual conditions unspecified. This raises questions as to why we observe such discretionary contracts and also why these contracts are mainly offered by banks. Does the use of discretion in bank contracts improve investment efficiency in the economy? And how does it affect the firm’s funding source choice between bank and financial market financing?

In this chapter we try to shed light on these issues and provide a rationale for the use of discretionary bank contracts in bank-firm relationships. We will argue that flexibility and discretion in bank contracts allow banks which produce information on borrowers to optimally condition their contract terms on a finer partitioning of the information state space than financial markets can. This facilitates intermediate adjustments in lending terms that may enhance both ex ante and ex post investment efficiency on the side of the borrower. In this context we explain why the use of discretionary contracts by banks is credible, and analyze the relation between the quality of a banking system, its competitive position vis-à-vis financial markets, and the types of contracts offered to borrowing firms. Furthermore, we make a first attempt to link a firm’s funding source choice to the type of its investment projects.

The insights developed from our analysis are important in light of recent developments in the theory and practice of banking. A large amount of theoretical and empirical work in the corporate finance and financial intermediation literature has sought to identify the comparative advantages of banks in the funding of corporations. Both theory and empirical evidence suggest that bank lending has distinct economic advantages, which arise predominantly from the banks’ informational role in the economy. Banks engage in screening and monitoring activities and, as a consequence, develop proprietary information on their customers. Among other benefits, this supports the development and endurability

---

1 For a comprehensive review of this literature see e.g. Bhattacharya and Thakor (1993) and also Chapter 2 of this dissertation.
of close bank-firm relationships which may mitigate information asymmetries between borrowers and lenders (see e.g. Sharpe (1990) and Petersen and Rajan (1994)). In recent years however banks have been confronted with an increasing competition from non-banking financial institutions and the financial markets. In addition, the informational roles (and merits) of financial markets, which have been neglected in the earlier financial intermediation theories, have become explored and understood in more detail (see e.g. Allen (1993), Holmström and Tirole (1993) and Boot and Thakor (1997)). As a consequence, it has been suggested that banks’ traditional comparative advantages in relationship banking have been diluted by transaction-oriented financing available in the financial markets. Competition from financial markets may therefore destabilize (durable) bank-firm relationships and reduce the value of proprietary information to banks, thereby diminishing the level of information acquisition. As a result banks may lose market share to financial markets.

In this chapter we argue that bank contracts may nevertheless continue to be optimal financing instruments, even in a more competitive environment. Our analysis starts from the general observation that the bank-borrower relationship is less rigid than those normally encountered in the financial market. Therefore, bank lending potentially facilitates more informative decisions based on a better exchange of information between borrower and lender. This is in line with the important ongoing discussion in economic theory on rules versus discretion, where discretion allows for decision-making based on more subtle - potentially non-contractible - information. In many ways, the bank-borrower relationship can be characterized as a mutual commitment based on trust and respect. This allows for implicit - non-enforceable - long-term contracting. An optimal information flow is crucial for sustaining such contracts. Information asymmetries in the financial market, and also the non-contractibility of various pieces of information could rule out long-term alternative capital market funding sources as well as explicit long-term commitments by banks in some circumstances. Furthermore, the fact that bank loans are generally easier to renegotiate than bond issues or other capital market funding vehicles allows for a qualitative use of flexibility (see also Berlin and Mester (1992)). Therefore, both banks and borrowers may realize the added value of their relationship, and may seek to foster their relationship, even in a more competitive environment.

An example of an existing bank loan contract which leaves the bank some discretion in the course of lending is a bank loan commitment. Bank loan commitments frequently contain a Materially Adverse Change clause, which gives the bank the option to
repudiate the contract if the borrower's credit quality has deteriorated 'sufficiently' between the time of the issue of the loan commitment and the time of take-down. Material deterioration is typically left undefined, and is therefore non-verifiable in at least certain states (see e.g. Boot, Greenbaum and Thakor (1993)). Even though a borrowing firm may generally be able to replicate a loan commitment contract by buying legally enforceable exchange-based options, these options do typically not allow the firm to capture the benefits of flexibility which arise due to information production by the bank. As a consequence, the borrower may prefer the discretionary bank loan commitment under certain conditions (see also Boot, Thakor and Udell (1991)).

In order to formalize these issues we present a simple model structure in which a borrower seeks long-term debt financing for an investment project by either going to a bank or by obtaining funding in the financial market. Banks invest in information production (i.e. monitoring) and during the course of lending receive non-verifiable (and therefore non-contractible) information with respect to the borrower's investment opportunities. Financial market financing might now be at a disadvantage; not conditioning on this finer information set may give the wrong 'price signal' to the borrower and hence may adversely affect the borrower's real decisions.

In this setting we examine a firm's investment incentives and its choice of contract type and funding source. With financial market financing, the adverse selection premium in the borrower's pooled funding cost may give rise to asset substitution moral hazard (Jensen and Meckling (1976)). Bank contracts may allow a bank to mitigate this ex post investment inefficiency, since a bank could decrease the interest rate for borrowers which end up with good investment opportunities. While interest rate reductions are always feasible, interest rate increases are not, unless the bank reserves the right to do so. The latter would be the case with a discretionary bank contract. Enforceable contracts do not allow for this flexibility, and thus only allow the bank to reduce the interest rates.

Observe that a bank will only lower the interest rate at an intermediate date if it is ex post optimal (i.e. subgame perfect) for the bank to do so. In our analysis, a lower interest rate enhances investment efficiency and therefore is socially optimal. Observe however that an interest rate decrease could also occur due to the existence of a soft budget constraint problem (see Chapter 2). In our basic model we do not explicitly address this issue. An incorporation of the potential negative ex ante incentive effects stemming from soft budget constraint problems would partly offset the benefits of discretion discussed in this chapter. On the other hand, the frequency of occurrence of soft budget constraint problems could be reduced with discretionary contracts, since the lower ex ante interest rates with such contracts may mitigate the need for ex post contract renegotiation. For a more detailed analysis of the soft budget constraint problem and its possible implications, see e.g. Dewatripont and Maskin (1995) and Bolton and Scharfstein (1996).
whenever optimal. Discretionary (or implicit) bank contracts on the other hand give the bank the flexibility to either decrease or increase the interest rate at an intermediate date, based on the non-contractible information obtained from monitoring. The potential for upward interest rate adjustments lowers the borrower’s ex ante interest rate in a competitive market, and as a consequence may improve his ex ante investment incentives. Discretionary contracts therefore may stimulate both ex ante and ex post investment efficiency.

A potential drawback of discretionary bank contracts is that they allow a bank to make ‘unjustified’ interest rate increases, which may be based on incorrect or ‘noisy’ information\(^3\). The bank’s intermediate interest rate (or pricing) strategy depends on the signal that the bank receives from its investment in information production. High quality banks can be expected to receive better (i.e. more precise) information with respect to the borrower’s investment opportunities from their investment in information production than lower quality banks, and thus face a smaller likelihood of type 1 and type 2 errors. The attractiveness of discretionary contracts therefore depends on the bank’s expected quality or reputation.

This intuition has implications for a borrowing firm’s optimal choice of funding source. By choosing a discretionary bank contract a borrower benefits from a lower ex ante interest rate as compared to either enforceable bank financing or financial market financing. However, since with a discretionary bank contract a borrower exposes himself to the possibility of an unjustified interest rate by a lower quality bank, a good borrower will prefer discretionary bank financing only if the bank’s expected quality (or reputation) is sufficiently high. Although a bad borrower may be worse off with a discretionary contract, he has no option other than to mimic the good borrower’s contract and funding.

\(^3\) In general, a drawback of discretionary contracts is that a bank could potentially take actions at the expense of the borrower in the course of lending (for example, by always increasing the interest rate to a maximum level), and therefore may extract rents. In the analysis that follows, however, it will be shown that this would not be beneficial to the bank. The reason for this is twofold. First, the bank may prevent asset substitution moral hazard by not increasing the interest factor too much. This increases the repayment probability of the loan, which is in the bank’s interest. Second, the bank is restricted by the presence of less informed (outside) competitors in determining its intermediate interest rate strategy (see also Sharpe (1990) and Sabani (1993)). Different alternative mechanisms have been discussed in the literature to prevent rent extraction by the bank in the case of unenforceable contracts. Boot, Thakor and Udell (1991) rationalize the existence of banks as an organizational solution to contract enforcement problems, whereas Boot, Greenbaum and Thakor (1993) and Boot and Greenbaum (1993) present a reputational mechanism to prevent the bank from exploiting the borrower. See Section 5 for a discussion of reputational considerations in our model framework.
source choice in a pooling equilibrium, since he would otherwise unambiguously be identified as a bad quality borrower.

Our analysis thus provides a link between borrower quality, bank quality (or reputation) and the types of contracts offered to borrowing firms. Our main insights are as follows. Discretion in bank contracts is most attractive if the quality of the borrower pool is relatively low. In this case good borrowers suffer significantly from the presence of bad borrowers in the economy and the scope for asset substitution moral hazard is high. Discretionary bank contracts then allow for both an increase in investment efficiency and a substantial wealth redistribution between bad and good borrowers. This reduces the ex ante interest rate in a competitive market and as a consequence improves a borrower’s ex ante incentives. We show that this does not only improve the quality of more ‘conservative’ investment projects, but may also stimulate the execution of risky but innovative projects which generally require a significant amount of (ex ante) firm-specific investment. Financing for such projects may not be feasible through the use of either enforceable bank contracts or financial market contracts. The use of discretion in bank contracts can however also be beneficial for borrowers of intermediate and high observable qualities. Since for such borrowers ex post investment efficiency could be realized with financial market financing as well, higher quality borrowers would not benefit from the use of enforceable bank contracts. Discretionary contracts therefore can improve better quality banks’ competitive position vis-à-vis financial markets for higher quality borrowers. A comparison of long-term renegotiable bank contracts with short-term - by definition renegotiable - financial market contracts finally implies that long-term bank contracts dominate short-term financial market contracts. The intuition is that since short-term contracts need to break even on a period by period basis, they exclude possibilities for intertemporal sharing of surplus and wealth redistribution in a competitive credit market.

This chapter is organized as follows. In Section 2 we relate the main argument developed in this chapter to the existing literature and discuss our contribution. In Section 3 we present the basic model. Section 4 contains the analysis and provides the main results of the paper and their intuition. In Section 5 several extensions and possible further implications of the analysis are discussed. Finally, Section 6 concludes. All the proofs are given in the Appendix.

2 Related Literature

Our analysis in this chapter relates to various strands of the corporate finance and
financial intermediation literature. First, there is the literature on incomplete contracts and contractual discretion. A closely related paper which also rationalizes the use of discretionary bank contracts is Boot, Greenbaum and Thakor (1993). In Boot, Greenbaum and Thakor (1993) discretionary contracts allow banks to liquify reputational capital by allowing it to be depreciated in exchange for the preservation of financial capital and information reusability in financially impaired states. In addition, discretionary contracts serve as a reputation formation device. That is, by honoring discretionary contracts high quality banks may distinguish themselves from lower quality banks, which would benefit less from reputation enhancement. Whereas in Boot, Greenbaum and Thakor (1993) discretionary bank contracts may serve to improve investment efficiency, their focus is primarily on the bank’s tradeoff between flexibility and reputation. The rationale for discretion in our model is not necessarily driven by these reputational considerations. Instead, it is more directed towards the analysis of investment incentives on the side of the borrower. The discretion that the bank has with respect to adjusting the interest rate can be interpreted as a 'price mechanism' that the bank can use in order to provide the right investment incentives to the borrower. Even absent reputational considerations a bank will not necessarily exploit the borrower, although it has the discretion to do so. We furthermore argue that discretionary contracts may be optimal even if a bank’s intermediate pricing strategy with discretionary and enforceable contracts would have similar reputational consequences, because discretionary contracts may enhance both ex ante and ex post investment efficiency, and may also increase the level of information production in an economy.

A second strand of related literature addresses the benefits of the renegotiability of bank contracts. The most closely related paper in this respect is Berlin and Mester (1992), which links the value of the option to renegotiate restrictive covenants in bank contracts to the firm’s funding source choice. The paper argues that restrictive covenants in debt contracts may control agency problems, but may also reduce a firm’s flexibility to pursue profitable investments. Renegotiable bank contracts allow the bank to relax initial covenants selectively when the lender believes they impose an ex post inefficient constraint. This reduces agency problems without unduly restricting the borrower’s ability to make valuable investments. Renegotiable bank contracts therefore are beneficial, because they permit stricter covenants to be imposed on bad firms, and because they allow firms with good investment opportunities to negotiate less restrictive covenants when the lender is informed. In either case the covenants are enforceable, since violation can be observed
and verified. The renegotiable bank contracts in Berlin and Mester (1992) thus resemble the enforceable bank contracts in our analysis. As in our analysis, the attractiveness of these contracts depends on the ex ante creditworthiness of the borrowing firm and on the quality of interim information available to lenders. We emphasize the incremental value of discretion (flexibility) which arises from allowing the bank to renegotiate based on non-verifiable information with respect to the borrower’s quality.

Several other papers have studied the firm’s funding source choice between bank and financial market financing. Some of the determinants of the funding source choice that have been identified are the firm’s credit quality (Diamond (1991), Rajan (1992), Boot and Thakor (1997)), the firm’s size (Wilson (1994)), and the stage in the firm’s lifecycle (Diamond (1991)). Diamond (1991) argues that borrowers with nascent credit reputations approach banks, whereas borrowers with established credit reputations borrow directly in capital markets. Boot and Thakor (1997) show that firms with lower observable credit qualities choose bank financing whereas higher quality firms choose capital market funding. In both papers the benefits from bank financing stem from the elimination of asset substitution moral hazard. Rajan (1992) trades off benefits and costs of bank financing and argues that borrowers with good future investment opportunities choose capital market financing in order to prevent future rent extraction by the inside bank. This rent extraction, which arises from the accumulation of proprietary borrower-specific information by the bank in the course of lending, distorts ex ante effort incentives, and thus makes bank financing less attractive. In all these papers the contracts offered by the bank are legally enforceable. In this chapter we focus on the impact of discretion in bank contracts on the firm’s funding source choice. Contrary to Rajan (1992), our analysis implies that the possibility for future rent extraction by the bank may mitigate ex ante effort distortions. The reason is that although the bank can extract future rents from good borrowers in equilibrium, it has the ability to extract even higher rents from bad borrowers. This potential for wealth redistribution between bad and good borrowers lowers the borrower’s ex ante interest rate in competitive credit markets and therefore improves ex ante investment incentives. Borrowers with good projects therefore may still prefer bank financing if the bank’s quality is sufficiently high. Furthermore, this paper makes a first modest attempt to relate the firm’s choice of contract type and funding source to the type of its investment projects by trading off the relative importance of ex ante and ex post investment incentives for firms with different types of projects (and asset specificity), and by linking them to the implied interest structure over time with the different types of
Finally, our paper relates to the financial literature on competition and commitments. As in Sharpe (1990) and Sabani (1993), our model is a model of customer relationships based on the asymmetric evolution of information between inside lenders and outside competitors. Banks and borrowers therefore are capable of intertemporally sharing surplus, even in ex ante competitive capital markets. This makes long-term implicit contracts (commitments) offered by banks credible. Conflicts between competition and commitments as suggested in e.g. Mayer (1988) and Hellwig (1991) are therefore precluded. The link with the loan commitment literature finally will be discussed in Section 5 of this chapter.

3 The Basic Model

3.1 Production Possibilities for Firms

We present a two-period model with universal risk neutrality. The economy consists of firms which need $1 of external debt financing in order to invest in a project. The riskfree interest rate is assumed to be zero. The quality of the projects available to the firms is random. With a probability $\theta \in [0, 0.5] \subseteq (0, 1)$ the firm has both a good and a bad project available, with a probability $(1-\theta)$ the firm can only invest in a bad project. Both projects have positive expected NPVs, however the good project is less risky and has a higher expected NPV (see later). Investment in either project is assumed to generate a cash flow $0_0 > 0$ at the end of the first period which is sufficiently high to enable the borrower to make the first period’s interest payments. The ultimate project choice by a

---

4 This assumption allows us to abstract from possible signalling effects associated with the borrower’s first period repayment behavior (see e.g. Diamond (1993)). Observe however that the results of our analysis would still hold if we would allow for some signalling (i.e. posterior updating) with respect to the borrower’s type, as long as there is no full separation at that date. Observe also that, since we assume that a borrower will not default at the end of the first period, we rule out the possibility that, due to a winner’s curse problem, only better quality borrowers would be subject to second period rent extraction with bank financing, whereas the ex ante benefits of bank financing are shared with lower quality borrowers (see Section 4.1). Under specific assumptions such a winner’s curse problem could drive good borrowers to the financial market (see Sabani (1993)). The assumption that $C$ is sufficiently high may seem to be somewhat strict. A possible alternative interpretation of this assumption would be that the cash flow generated by the firm’s current assets after the investment in the new project strategy has been made is sufficiently high to repay on any existing and new debt, irrespective of the level of $C > 0$. Excess cash is assumed to be consumed by the borrower. This excludes the possibility of full repayment on the two-period loan by the borrower at the intermediate date. The assumption that both projects generate the same first period cash flow finally is made for simplicity reasons. Relaxation of this assumption adds complexity without qualitatively changing the results of our analysis.
borrower has to be made by the end of the first period\(^5\). In the second period the partially contractible return for the good project equals \(Y\) with a probability \(\eta \in (0,1)\), and 0 with a probability \((1-\eta)\). The partially contractible end-of-period return for the bad project equals \(X > Y\) with a probability \(\alpha \in (0,1)\), and 0 with a probability \((1-\alpha)\). It is assumed that \(0 < \alpha < \eta < 1\), and that \(\eta Y > \alpha X > 1-C\). For borrowers with a project choice investing in the good project then is first best efficient\(^7\). The realization of whether the firm has a choice of projects or is locked into the bad project is observable only to the firm. Each potential borrower is characterized by an observable \(\theta\), which represents the commonly known prior probability assigned by the market to the event that a randomly selected borrower will have access to both a good and a bad project. Denote the borrower with the project risk choice as type \(G\), and the borrower with only the bad project available as type \(B\). Later on the parametric conditions used in the model will be set such that the type \(G\) borrower would prefer to invest in the good project with external financing at the risk free rate and the full information rate for the good project respectively. With outside financing at a pooled fixed rate however (which contains an adverse selection premium), the type \(G\) borrower might choose to invest in the bad project. This is how asset substitution moral hazard will arise in the model.

### 3.2 Information Structure, Types of Contracts and Funding Sources

Each firm in the economy needs to finance its project externally by either going to a bank or by seeking funding in the financial market. We will focus on long-term (two-period) debt contracts\(^8\). Banks invest in information production (i.e. monitor the borrower) at a cost \(M \geq 0\), and as a consequence receive a signal with respect to the borrower’s

\(^5\) This ultimate project choice can also be interpreted as a 'switch' in project strategy by the borrower with a project choice at the intermediate date.

\(^6\) Furthermore, we assume that the cash flows \(X\) and \(Y\) are sufficiently high, such that the borrower would want to invest in case of outside financing. We therefore abstract from the possibility of underinvestment moral hazard (see Myers (1977)). This assumption is crucial for the results in our model.

\(^7\) Observe that for expositional reasons we now abstract from any ex ante investment decision on the side of the borrower, and focus solely on the borrower’s project choice. We will however explicitly incorporate the borrower’s ex ante investment incentives in Section 5.

\(^8\) In Section 5 we will also consider short-term financial contracts in order to analyze the relation between the borrowing firm’s maturity, contract and funding source choices and its ex ante and ex post investment incentives.
investment opportunity set at the end of the first period\textsuperscript{9}. The noisiness of this signal depends on the bank's quality. Banks can be of two types, high quality (H) with a probability $\gamma \in [0, 1]$ and low quality (L) with a probability $(1-\gamma)$. High quality banks receive a perfectly informative signal with respect to the borrower's type, whereas low quality banks receive an uninformative signal\textsuperscript{10}. In the case of an uninformative signal, a bank learns nothing about the borrower and therefore can only charge a pooling interest rate. The signal that the bank receives is not verifiable by third parties and is therefore non-contractible. This means that no enforceable contracts can be written based on this information, and that a bank may have a finer partitioning of the information state space at $t=1$ in comparison with other lenders (either outside banks which have not invested in information production at $t=0$, or the financial market). We assume that neither the borrower nor the bank know the bank's quality at the beginning of the game. They only know the prior probability distribution with respect to the bank's type. The parameter $\gamma$ can be interpreted as an indicator of the bank's (expected) quality or reputation.

Based on the signal received and the contract type used, a bank may adjust the interest rate of the loan at the intermediate date in order to induce the right investment incentives on the side of the borrower. Two types of bank contracts can be distinguished, enforceable (or explicit) contracts and discretionary contracts. These contract types differ with respect to their legal enforceability. The contractual conditions of the first type of contracts can be enforced by court. A bank is therefore not allowed to increase the interest rate in an enforceable contract at the end of the first period. Note however that a bank may decide to decrease the interest rate at the intermediate date if it is in the bank's interest to do so, i.e. if this mitigates asset substitution moral hazard on the side of the type $G$ borrower. Discretionary contracts on the other hand do not explicitly prespecify the contractual conditions for the second period, and therefore do not legally bind. These contracts can be viewed as implicit commitments which leave residual discretion with the contracting parties. With discretionary contracts the bank has the flexibility to either

\textsuperscript{9} For now the bank's investment in information production is assumed to be exogenous. Note that it is only in the bank's interest to invest in information production if bank contracts are renegotiable, i.e. if the bank can act upon this information (see e.g. Sharpe (1990) and Berlin and Mester (1992)). In Section 5 we will discuss the implications of endogenizing the bank's incentives for information production.

\textsuperscript{10} Alternatively, $\gamma$ can be interpreted as the noisiness of the signal that an individual bank receives. High quality banks receive more precise signals, and therefore can be characterized by a higher $\gamma$. 

69
decrease or increase the interest rate at the end of the first period.

In the case of financial market financing no information production takes place, and therefore no intermediate interest rate adjustments will occur\textsuperscript{11}. Financial market contracts therefore are characterized by equal (enforceable) coupon payments in each period of the game. We assume that credit markets are competitive. Table 1 summarizes the different types of contracts that will be compared in the analysis below.

<table>
<thead>
<tr>
<th>Contract Type</th>
<th>Information Production</th>
<th>Possibility for Intermediate Interest Rate Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enforceable Financial Market Contract (Long-Term)</td>
<td>No</td>
<td>No intermediate interest rate adjustments possible</td>
</tr>
<tr>
<td>Enforceable Bank Contract</td>
<td>Yes</td>
<td>Interest rate decrease possible</td>
</tr>
<tr>
<td>Discretionary Bank Contract</td>
<td>Yes</td>
<td>Both interest rate decrease and interest rate increase possible</td>
</tr>
</tbody>
</table>

Table 1: Overview of Types of Contracts and Funding Sources

3.3 Sequence of Events in Lender-Borrower Interaction

The sequence of events in the model is as follows. At $t=0$ lenders (either banks or financial markets) offer contracts to the borrower and set their lending terms. The borrower then chooses both the contract type and the funding source and invests. At $t=1$ the first period's cash flow $C$ is realized and first period interest payments are made. Banks which lent to the borrower in the first period receive a signal with respect to the borrower's investment opportunity set and decide whether or not to adjust the second period interest rate. The borrower then makes his ultimate project choice. At the end of the second period ($t=2$) project cash flows are realized, and repayments are made if possible. Then the game ends.

\textsuperscript{11} For an exposition of the difference in the informational role of banks and financial markets see e.g. Diamond (1984), Allen and Gale (1997), Boot and Thakor (1997) and also Chapter 2.
4 Model Analysis

We solve the model backwards and first analyze the borrower’s project choice with financial market financing and bank financing respectively, and the bank’s intermediate interest rate decision (at t=1). Subsequently, we analyze the borrower’s contract and funding source choice at t=0.

4.1 Determination of Interest Rates

With external financing the interest factor (i.e. $1 + \text{loan interest rate}$) $r^*$ for which a type $G$ borrower would be indifferent between choosing the good and the bad project follows from equation (1)\textsuperscript{12}:

$$C - (r^*-1) + \eta(Y-r^*) = C - (r^*-1) + \alpha(X-r^*) \quad \Leftrightarrow \quad r^* = \frac{\eta Y - \alpha X}{\eta - \alpha}$$

(1)

Observe that the interest rate structure in equation (1) implies that the borrower pays coupon interest in every period and repays the debt at the end of the game\textsuperscript{13}. The competitive interest factor is set to yield the lender an expected profit of zero. With equal coupon payments in each period, the full information interest factors set at t=0 would be $2/(1+\eta)$ for a type $G$ borrower in case of the good project choice, and $2/(1+\alpha)$ for a type $B$ borrower or a type $G$ borrower in case of the bad project choice. The competitive full information interest factors that a lender could charge at the intermediate date would equal $1/\eta$ for a type $G$ borrower with a good project, and $1/\alpha$ otherwise. In the analysis that follows we assume that:

$$\frac{1}{\eta} \leq r^* \leq \frac{2}{1+\alpha} \quad (A-1)$$

The type $G$ borrower therefore would prefer to invest in the good project with outside financing at the full information interest factor for a good project, and would choose the bad project if financed at the full information interest factor for a type $B$ borrower (bad project). Observe that this assumption dictates that $\eta > (1+\alpha)/2$.

\textsuperscript{12} In the remainder of this chapter we use the terms interest factor and interest rate interchangeably.

\textsuperscript{13} This interest rate structure could also be interpreted as the borrower repaying the loan at the end of the first period, and refinancing the loan amount at preset terms at the intermediate date. The interpretation chosen does not affect our analysis.
Financial Market Financing

In the case of asymmetric information, the pooling competitive interest factor \( r_F \) charged with financial market financing depends on the proportion of type G borrowers in the economy. If the type G borrower chooses the good project, the competitive loan interest factor \( r_F \) solves:

\[
(r_F - 1) + \theta \eta r_F + (1 - \theta) \alpha r_F = 1 \quad \text{or}
\]

\[
r_F = \frac{2}{1 + \theta \eta + (1 - \theta) \alpha} \quad (2)
\]

If the type G borrower chooses the bad project the competitive loan interest factor equals:

\[
r_F = \frac{2}{1 + \alpha} \quad (3)
\]

The following result now can be derived.

**Lemma 1:** If \( \theta < \hat{\theta} \) there exists a Nash Equilibrium in which both the good and the bad borrower invest in the bad project, and the interest factor \( r_F \) charged in the financial market equals \( 2/(1 + \alpha) \). The social cost of the good borrower investing in the bad project is \( \eta Y - \alpha X \), the expected social costs incurred are \( \theta(\eta Y - \alpha X) \). If \( \theta \geq \hat{\theta} \) there exists a Nash Equilibrium in which the good borrower invests in the good project and the bad borrower invests in the bad project. The interest factor \( r_F \) charged in the financial market equals \( 2/[1 + \theta \eta + (1 - \theta) \alpha] \). In this Nash Equilibrium first best investment efficiency is realized. The cutoff proportion \( \hat{\theta} \) is defined in the Appendix.

Observe that the parametric condition (A-1) ensures that \( \hat{\theta} \in (0, 1) \). The intuition is as follows. If the proportion \( \theta \) of type G borrowers is relatively low \( (\theta < \hat{\theta}) \), the pooled interest rate set in a competitive market is high. Type G borrowers then suffer from significant negative externalities due to the presence of type B borrowers, that are characterized by lower success probabilities, and as a consequence they may make the wrong project choice. The adverse selection premium in the pooled funding costs then causes asset substitution moral hazard. This results in an expected social loss. For higher levels of \( \theta \) \( (\theta \geq \hat{\theta}) \), the pooled interest factor is relatively low. Although in this case a wealth redistribution still takes place from type G borrowers to type B borrowers, the
adverse selection premium in the interest rate does not lead to an ex post investment inefficiency on the side of the type G borrower. Observe however that, since in both cases the type G borrower is pooled with the type B borrower, he may seek for ways to be separated from the type B borrower (either at \( t=0 \) or at the intermediate date \( t=1 \), and therefore may prefer to be monitored by a bank.

**Bank Financing**

Banks invest in information production (i.e. monitor the borrower) at a cost \( M \), and receive a signal with respect to the borrower’s investment opportunities at the end of the first period. Based on this signal the bank may adjust the second period interest rate. Observe that since the bank can act on non-verifiable (and thus non-contractible) information, it has the capacity to extract rents from the borrower in the second period. Because any bank can choose to become informed at the beginning of the game, such ex post rent extraction would result in a lower ex ante (first period) interest rate for the borrower in a competitive market. The bank’s intermediate interest rate decision is influenced by the presence of less informed competitors (either outside banks or lenders in the financial market) at the end of the first period. Irrespective of the type of bank contract used, this imposes the following restrictions on the bank’s pricing strategy at the beginning of the second period subgame:

- The maximum interest factor \( r^+ \) that a bank can charge the borrower after having observed a perfect signal that the borrower is of type B equals \( 1/\alpha \). This is the interest rate that the borrower of type B would be charged by another lender at the intermediate date after perfectly revealing his type.

- The maximum interest factor that the bank can charge the type G borrower such that he would still weakly prefer the good project over the bad project equals \( r^* \), as given in equation (1).

- There is also an upper bound on the interest rate that the bank could charge the borrower after having observed that the borrower is of type G, or after having received an uninformative signal. This upper bound depends on proportion \( \theta \) of type G borrowers in the economy, and equals either \( r=1/[\theta \eta + (1-\theta)\alpha] \) (if this is smaller than \( r^* \)) or \( 1/\alpha \). The argument here is that an uninformed competing lender would not be able to distinguish between good and bad borrowers demanding funding, and therefore always charges a pooling rate.
**Enforceable Bank Contract**

The terms of an enforceable bank contract are legally binding. Enforceable bank contracts therefore do not allow the bank to increase the prespecified interest rate set at $t=1$, after having observed a signal that the borrower is of type $B$. However, the bank does have the option to decrease the interest rate for a type $G$ borrower in order to prevent asset substitution moral hazard. This increases the success probability of the type $G$’s project, and thus the probability of repayment on the loan. In a competitive market, the potential benefits from increased investment efficiency fully accrue to the borrower through a reduction in the ex ante (first period) interest rate charged by the bank. This effect can be denoted as an investment efficiency effect. Observe that since the bank cannot increase the interest rate for a type $B$ borrower, a borrower who is detected to be type $B$ pays equal interest payments in both periods. This causes additional complexity in determining the conjectured equilibrium of the second period subgame, since now the bank’s incentive compatibility constraints (conditional on the signal observed by the bank) and its individual rationality constraint interact. That is, the bank’s intermediate interest rate strategy depends on its breakeven rate over the whole game, which on its turn depends on the bank’s intermediate interest rate strategy. We define the competitive interest factor of an enforceable bank contract as a function of the bank’s quality $\gamma$ as $r_E(\gamma)$.

Dependent on the bank’s intermediate pricing strategy four types of enforceable bank contracts can be distinguished (each contract given below specifies the interest rate that the bank would charge the borrower after observing a perfect signal that the borrower is of type $G$, a perfect signal that the borrower is of type $B$, and an uninformative signal respectively):

(i) A contract denoted as $(r_E(\gamma),r_E(\gamma),r_E(\gamma))$, with $r_E(\gamma)\leq r^*$. With this contract the bank charges the borrower an interest factor $r_E(\gamma)$ in the first period and does not adjust the interest rate at the intermediate date, irrespective of the signal received.

(ii) A contract denoted as $(r^*,r_E(\gamma),r^*)$, with $r_E(\gamma)>r^*$. With this contract the bank charges the borrower an interest rate $r_E(\gamma)$ in the first period and charges a second period interest factor $r^*$ both after observing a perfectly informative signal that the borrower is of type $G$ and after observing an uninformative signal; the bank does not adjust the interest rate after observing a perfectly informative signal that the borrower is of type $B$.

(iii) A contract denoted as $(r^*,r_E(\gamma),r_E(\gamma))$, with $r_E(\gamma)>r^*$. With this contract the bank
charges the borrower an interest rate \( r_{E}(y) \) in the first period and charges a second period interest factor \( r^* \) only after having observed a perfectly informative signal that the borrower is of type \( G \); the bank does not adjust the interest rate otherwise.

**(iv)** A contract denoted as \((r_{E}(y), r_{E}(y), r_{E}(y))\), with \( r_{E}(y) > r^* \). With this contract the bank charges the borrower an interest rate \( r_{E}(y) \) in the first period and does not adjust the interest rate at the intermediate date, irrespective of the signal observed.

For contract (i) it can easily be seen that, given the bank’s intermediate interest rate strategy, the competitive interest factor \( r_{E}(y) \) equals \( (2+M)/(1+r \eta +(1-\theta)\alpha) \). For contract (ii) \( r_{E}(y) \) can be shown to satisfy:

\[
r_{E}(y) = \frac{2+M-\theta r \eta r^* - (1-y)(1-\theta)\alpha r^*}{1+y(1-\theta)\alpha} \tag{4}
\]

For contract (iii) the competitive interest factor \( r_{E}(y) \) equals:

\[
r_{E}(y) = \frac{2+M-\theta \eta r^* - \gamma \theta \eta r^*}{1+y(1-\theta)\alpha} \tag{5}
\]

Finally, for contract (iv) \( r_{E}(y) \) equals \( (2+M)/(1+y) \). The following result now can be derived.

**Lemma 2 (Equilibrium Second Period Subgame with Enforceable Bank Contracts):**

(a) If \( 0 \leq M \leq (1+y)r^* - 2 \) then borrowers with a quality \( \theta \in [\hat{\theta}_M, \tilde{\theta}] \) will be offered contract (i). Contract (ii) is offered to borrowers with a quality \( \theta \in [\hat{\theta}_M, \tilde{\theta}_M] \) and contract (iii) is offered to borrowers with \( \theta \in [\tilde{\theta}_M, \tilde{\theta}_M] \). Contract (iv) can not be offered.

(b) If \( (1+y)r^* - 2 < M \leq \frac{(1+y)\eta r^* - 2\alpha}{\alpha} \) then contract (ii) is offered to borrowers with a quality \( \theta \in [\hat{\theta}_M, \tilde{\theta}] \) and contract (iii) is offered to borrowers with \( \theta \in [\tilde{\theta}_M, \tilde{\theta}_M] \). Contract (i) and contract (iv) can not be offered.
(c) If $M > \frac{(1+\alpha)\eta t^* - 2\alpha}{\alpha}$ then contract $(iv)$ is offered $\forall \theta \in [\hat{\theta}, \tilde{\theta}]$. Contracts $(i)$, $(ii)$ and $(iii)$ can not be offered. The cutoff levels $\hat{M}_i \geq \hat{\theta}$ and $\tilde{M}_i$ are defined in the Appendix. With contract $(i)$ the type $G$ borrower invests in the good project. In all other equilibria the type $G$ borrower invests in the good project if charged $r^*$ and in the bad project otherwise. The expected social loss occurring from the use of contracts $(ii)$, $(iii)$ and $(iv)$ equals $0$, $(1-\gamma)\theta(\eta Y - \alpha X)$ and $\theta(\eta Y - \alpha X)$ respectively.

Lemma 2 describes which of the above presented enforceable bank contracts would be feasible for different levels of the bank's information production costs $M$ and the borrower’s quality $\theta$. Contract $(i)$ can only be offered to higher quality borrowers if the costs of information production are low. Both an increase in the bank’s information production costs and a reduction in the borrower’s quality would increase the pooled interest factor $r_E(\gamma)$ of enforceable bank contracts. For high levels of $M$ and low levels of $\theta$, $r_E(\gamma)$ becomes larger than $r^*$. Initially, contract $(ii)$ will then be offered. If $M$ increases further and/or $\theta$ decreases further, interest rate concessions by the bank at the end of the first period become less likely and investment inefficiencies may occur (this is the case with contract $(iii)$). If the costs of information production become even higher, then only contract $(iv)$ can be offered to all borrowers. In this case no interest rate adjustments are made at the end of the first period and the deviations from the socially efficient investment choices are most severe.

Discretionary Bank Contract

With a discretionary bank contract the bank has the flexibility to adjust the interest factor in both directions at the end of the first period. Discretionary contracts therefore allow the bank to 'fine-tune' the second period interest factor on the signal received from its information production. After having observed a signal that the borrower is of type $B$ the bank may increase the interest rate, whereas it may charge a lower interest rate to a type $G$ borrower in order to induce the good project choice. As a consequence, discretionary bank contracts can not only enhance ex post investment efficiency like enforceable bank contracts do (investment efficiency effect), but in addition may redistribute wealth from type $B$ to type $G$ borrowers (this effect can be denoted as a wealth redistribution effect). This distinguishes these contracts from enforceable bank contracts. Both these
effects result in a lower first period interest rate $r_D(\gamma)$ in a competitive credit market.

Observe that discretionary bank contracts increase the bank’s ability to exploit the borrower (i.e. to extract rents from the borrower) relative to enforceable bank contracts. That is, with a discretionary contract, the bank may decide to always increase the interest rate in the second period. In an ex ante competitive market, such rent extraction by the bank would reduce the first period (pooling) interest rate. As indicated above, the possibilities for second period rent extraction are limited by the presence of less informed outside lenders at $t=1$. We now consider the borrower’s project choice and the bank’s intermediate pricing strategy with discretionary contracts. We will focus on equilibria with intermediate interest rate strategies which result in the lowest ex ante interest rates charged in the first period$^{14}$. The following result can be derived.

**Lemma 3 (Equilibrium Second Period Subgame with Discretionary Bank Contract):** If $\theta < \bar{\theta}$ there exists a Nash Equilibrium in which the bank charges the interest factor $r^+$ after observing a signal that the borrower is of type B or after observing an uninformative signal, and charges $r^*$ after observing a signal that the borrower is of type G. The type G borrower invests in the good project if charged $r^*$ in the second period, and invests in the bad project if charged $r^+$. The type B borrower invests in the bad project. The expected social loss from inefficient investment equals $(1-\gamma)\theta(\eta Y - \alpha X)$. If $\theta > \bar{\theta}$ there exists a Nash Equilibrium in which the bank charges the interest factor $r^+$ after observing a signal that the borrower is of type B, and charges $r$ after observing that the borrower is of type G or after observing an uninformative signal. The type G borrower always invests in the good project. The type B borrower invests in the bad project. In this case the expected social loss equals 0. The cutoff level $\bar{\theta} > \bar{\theta}$ is defined in the Appendix.

The intuition behind Lemma 3 is as follows. If the proportion of type G borrowers in the economy is relatively low ($\theta < \bar{\theta}$), the pooling rate that a type G borrower would receive from an uninformed competing lender at the beginning of the second period would be too high to provide the right investment incentives (i.e. $r > r^*$). A type G borrower

$^{14}$ In an extension of the basic model in Section 5 we will explicitly incorporate an ex ante investment decision on the side of the borrower. The equilibria with discretionary contracts described in this section can be shown to be the most efficient equilibria in the sense that these enhance ex ante investment efficiency the most. Note however that other equilibria may be possible with discretionary bank contracts, for example equilibria that minimize the interest rate that the bank charges at $t=1$. Such equilibria may be preferred if a borrower’s ex post investment incentives are relatively more important.
therefore would invest in the bad project if financed by an outside lender. By charging an interest factor of \( r^* \) however, an inside bank can induce the type G borrower to invest in the good project after observing a perfect signal that the borrower is of type G, and benefit from a higher repayment probability due to increased investment efficiency. Note that the rents from this increase in investment efficiency fully accrue to the bank at the intermediate date. After observing an uninformative signal an inside bank would charge \( r^+ \), and a social loss occurs. The type G borrower thus invests in the bad project with a probability \((1-\gamma)\). For high levels of \( \theta (\theta \geq \tilde{\theta}) \), investment efficiency would be realized even if the type G borrower would run away from the incumbent bank. Competition from outside lenders now restricts the possibilities for rent extraction by the inside bank. The maximum interest rate that an inside bank can charge a type G borrower after observing a perfect signal that the borrower is of type G or an uninformative signal now equals \( r < r^* \). Observe that in this case no social loss is incurred.

For \( \theta < \tilde{\theta} \) the ex ante interest rate \( r_D(\gamma) \) that a bank with a quality parameter \( \gamma \) needs to charge the borrower to break even over both periods satisfies the following equation:

\[
\begin{align*}
    r_D(\gamma) - 1 + \gamma(\theta r^* + (1-\theta)\alpha r^*) + (1-\gamma)\alpha r^* &= 1 + M \\
    r_D(\gamma) &= 2 + M - (1-\gamma)\alpha r^* - \gamma(\theta r^* + (1-\theta)\alpha r^*) = 1 + M - \gamma[\eta r^* - 1] 
\end{align*}
\]

The discretionary contract offered to borrowers with \( \theta \in (0, \tilde{\theta}) \) can be denoted as discretionary contract (i). For \( \theta \geq \tilde{\theta} \) the ex ante interest rate \( r_D(\gamma) \) solves:

\[
\begin{align*}
    r_D(\gamma) - 1 + \gamma(\theta r^* + (1-\theta)\alpha r^*) + (1-\gamma)(\theta r^* + (1-\theta)\alpha r) &= 1 + M \\
    r_D(\gamma) &= 2 + M - \theta r^* - \gamma(1-\theta)\alpha r^* - (1-\gamma)(1-\theta)\alpha r = 1 + M - \gamma(1-\theta)[1-\alpha r] 
\end{align*}
\]

This contract can be denoted as discretionary contract (ii).

4.2 The Borrower's Choice of Contract Type and Funding Source

We now consider the first period subgame and analyze the borrower's choice of contract type and funding source at \( t=0 \). Each type of borrower chooses the contract type and funding source which maximize his expected payoff. A borrower's expected payoff is equal to the expected return on the project net of the borrowing costs. Define \( R_f^T(\gamma) \) as the
<table>
<thead>
<tr>
<th>Enforceable Financial Market Contract</th>
<th>Borrowers with Low Observable Quality ($0 \leq \theta &lt; \delta$)</th>
<th>Borrowers of Intermediate Quality ($\delta \leq \theta &lt; 1$)</th>
<th>Borrowers of High Quality ($\theta \leq 0 \leq 1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enforceable Bank Contracts</strong></td>
<td>$R^F_0 = C - (r_x - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0 = C - (r_x - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0 = C - (r_x - 1) + \eta(Y - r_x)$</td>
</tr>
<tr>
<td></td>
<td>$R^F_0 = C - (r_x - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0 = C - (r_x - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0 = C - (r_x - 1) + \alpha(X - r_x)$</td>
</tr>
<tr>
<td><strong>Contract (i)</strong> for $M \leq \bar{M}$</td>
<td>$R^F_0(i, \gamma) = C - (r_x(\gamma) - 1) + \eta(Y - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_x(\gamma) - 1) + \eta(Y - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_x(\gamma) - 1) + \eta(Y - r_x)$</td>
</tr>
<tr>
<td></td>
<td>$R^F_0(i, \gamma) = C - (r_x(\gamma) - 1) + \gamma \alpha(X - r_x(\gamma))$</td>
<td>$R^F_0(i, \gamma) = C - (r_x(\gamma) - 1) + \gamma \alpha(X - r_x(\gamma))$</td>
<td>$R^F_0(i, \gamma) = C - (r_x(\gamma) - 1) + \gamma \alpha(X - r_x(\gamma))$</td>
</tr>
<tr>
<td><strong>Contract (ii)</strong></td>
<td>$R^F_0(iii, \gamma) = C - (r_x(\gamma) - 1) + \alpha(X - r_x(\gamma))$</td>
<td>$R^F_0(iii, \gamma) = C - (r_x(\gamma) - 1) + \alpha(X - r_x(\gamma))$</td>
<td>$R^F_0(iii, \gamma) = C - (r_x(\gamma) - 1) + \alpha(X - r_x(\gamma))$</td>
</tr>
<tr>
<td></td>
<td>$R^F_0(iii, \gamma) = C - (r_x(\gamma) - 1) + \alpha(X - r_x(\gamma))$</td>
<td>$R^F_0(iii, \gamma) = C - (r_x(\gamma) - 1) + \alpha(X - r_x(\gamma))$</td>
<td>$R^F_0(iii, \gamma) = C - (r_x(\gamma) - 1) + \alpha(X - r_x(\gamma))$</td>
</tr>
<tr>
<td><strong>Discretionary Bank Contracts</strong></td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \gamma \eta(Y - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \gamma \eta(Y - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \gamma \eta(Y - r_x)$</td>
</tr>
<tr>
<td></td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \gamma \eta(Y - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \gamma \eta(Y - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \gamma \eta(Y - r_x)$</td>
</tr>
<tr>
<td></td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \alpha(X - r_x)$</td>
</tr>
<tr>
<td></td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \alpha(X - r_x)$</td>
<td>$R^F_0(i, \gamma) = C - (r_d(\gamma) - 1) + \alpha(X - r_x)$</td>
</tr>
</tbody>
</table>

Table 2: Overview of Good and Bad Borrower's Expected Return as a Function of Choice of Contract Type and Funding Source.
type j borrower’s expected net return if he chooses financial market financing, with \( j \in \{B, G\} \). Furthermore, let \( R_f(i, \gamma) \), \( R_f(iii, \gamma) \), \( R_f(iv, \gamma) \) and \( R_f(ii, \gamma) \) be the type j borrower’s expected net return as a function of the bank’s quality in the case of bank financing with enforceable contract (i) through (iv) and discretionary contract (i) and (ii) respectively. In order to derive the main results of the paper, we distinguish between three intervals with respect to the borrower’s observable quality \( \theta \) in the economy: low quality borrowers with an observable \( \theta \in [\bar{\theta}, \bar{\theta}] \), borrowers of intermediate (medium) quality for which \( \theta \in \left(\bar{\theta}, \bar{\theta}\right) \), and high quality borrowers with \( \theta \in [\bar{\theta}, \bar{\theta}] \). Table 2 gives an overview of each type of borrower’s expected net return as a function of his contract and funding source choices for those contracts that are relevant for the remainder of our analysis.

**Equilibria with Enforceable Bank Contracts**

We first compare financial market financing and bank financing with enforceable contracts. The following results can immediately be derived.

**Lemma 4:** Neither enforceable bank contract (i) nor enforceable bank contract (iv) can compete with financial market contracts for \( M > 0 \). For \( M = 0 \) both types of bank contracts are at best equivalent to financial market contracts.

This lemma states that enforceable bank contract (i) and enforceable bank contract (iv) are dominated by financial market contracts if the costs of information production by banks are positive. The intuition is that neither of these contracts changes the type G borrower’s investment behavior as compared to financial market financing, while both incur (positive) monitoring costs. Lemma 4 therefore implies that only the enforceable bank contracts (ii) and (iii) need to be explicitly considered in the analysis of the firm’s funding source choice at \( t = 0 \).

**Lemma 5:** Enforceable bank contracts (ii) and (iii) can only compete with financial market contracts for lower quality borrowers (i.e., for borrowers with \( \theta \in [\bar{\theta}, \bar{\theta}] \)) if they are feasible.

The intuition underlying this result is similar to the previous lemma. Since bank financing is more expensive than financial market financing (the bank needs to be
compensated for its investment in information production), enforceable bank contracts are dominated by financial market contracts for \( M > 0 \) unless they improve the type \( G \) borrower's project choice. If the borrower's quality parameter is larger than or equal to \( \hat{\theta} \), the type \( G \) borrower would invest in the good project with financial market financing. Costly information production by banks therefore would not add any value. If the quality of the borrower pool is low (i.e. for borrowers with \( \theta < \hat{\theta} \)) financial market financing would induce the type \( G \) borrower to choose the bad project. In this case the enforceable bank contracts (ii) and (iii) may be valuable, because the bank's intermediate interest rate strategy may improve investment efficiency. This lowers the pooling interest rate \( r_E(\gamma) \). We have the following corollary.

Corollary 1: For enforceable contracts (ii) and (iii) \( \frac{\partial r_E(\gamma)}{\partial \gamma} < 0 \) and \( \frac{\partial r_E(\gamma)}{\partial \theta} < 0 \) for \( \theta \in [\hat{\theta}, \hat{\theta}) \).

Corollary 1 states that the pooled funding rate for both enforceable bank contracts (ii) and (iii) decreases with the bank's quality (reputation) and with borrower quality. The intuition is that higher quality banks can better distinguish between type B and type G borrowers. With contract (ii) therefore 'unjustified' interest rate decreases for type B borrowers would occur less frequently, whereas with contract (iii) investment efficiency on the part of the type G borrower could be enhanced more often. Both effects reduce \( r_E(\gamma) \).

In addition, an increase in borrower quality increases investment efficiency in the case of bank financing on the interval \( \theta \in [\hat{\theta}, \hat{\theta}) \). This reduces \( r_E(\gamma) \).

Whether enforceable bank contracts are indeed preferred over financial market contracts by lower quality borrowers depends on the bank's quality or reputation \( \gamma \) at the beginning of the game and on the level of the monitoring costs \( M \). We now have the first two of our main results.

Proposition 1 (Equilibrium with Enforceable Bank Contract (ii)): Let \( M \leq \tilde{M} \) and let \( \theta \in [\hat{\theta}_M, \hat{\theta}) \). Then, if \( M \leq M(ii) \) both types of borrowers would prefer enforceable bank contract (ii) over financial market financing in a Pareto optimal pooling Bayesian Perfect Nash Equilibrium, irrespective of the bank's quality. If \( M(ii) < M \leq \tilde{M}(ii) \), both types of borrowers would prefer the pooling Bayesian Perfect Nash Equilibrium with bank contract.
(ii) over the pooling Bayesian Perfect Nash Equilibrium with financial market financing if the bank’s quality $\gamma \leq \gamma(ii)$. If $\gamma > \gamma(ii)$ on this interval for $M$, or if $M > \hat{M}(ii)$, both types of borrowers choose financial market financing at the pooling rate $r_F$ as defined in (3). There are no feasible separating equilibria. The cutoff levels $\hat{M}$, $\hat{M}(ii)$, $\hat{M}(ii)$ and $\gamma(ii)$ are defined in the Appendix.

Proposition 2 (Equilibrium with Enforceable Bank Contract (iii)): Let $\theta \in [\theta, \min\{\theta_M, \hat{\theta}\})$. Then if $M \leq \hat{M}(iii)$ there is a Pareto-optimal pooling Bayesian Perfect Nash Equilibrium in which both types of borrowers choose bank financing with enforceable contract (iii) if the bank’s quality $\gamma \geq \gamma(iii)$). If $\gamma < \gamma(iii)$, or if $M > \hat{M}(iii)$, both types of borrowers choose financial market financing at the pooling rate $r_F$ defined in (3). There are no feasible separating equilibria. The cutoff levels $\hat{M}(iii)$ and $\gamma(iii)$ are defined in the Appendix.

The intuition of these results is as follows. The attractiveness of enforceable bank contracts to both types of borrowers depends on a tradeoff between the higher costs of bank financing with the benefits from increased investment efficiency (through a decrease in $r_E(\gamma)$). First consider Proposition 1. With enforceable bank contract (ii) the bank always lowers the interest rate for a type G borrower at the intermediate date to $r^*$ (irrespective of the signal it receives), and investment efficiency always occurs. This reduces $r_E(\gamma)$ (investment efficiency effect). After observing an uninformative signal however, the bank incorrectly decreases the interest rate for a type B borrower. This partially offsets the beneficial effect from increased investment efficiency on $r_E(\gamma)$. In addition, $r_E(\gamma)$ increases with the costs of information production. For a given level of $\theta \in [\theta_M, \hat{\theta})$ therefore the type G borrower prefers enforceable bank contracts over financial market financing if the costs of information production are not too high (i.e. for $M$ smaller than $\hat{M}(ii)$). For low monitoring costs ($M \leq \hat{M}(ii)$), a type B borrower would have no option other than to mimic the type G borrower’s contract and funding source choice, since he would otherwise perfectly reveal his type and be charged the full information rate for a type B borrower in the financial market. Observe however that a type B borrower would also benefit from choosing enforceable bank contract (ii) in this pooling equilibrium (i.e. the equilibrium is Pareto optimal). The reason for this is twofold. First, the type B borrower faces a lower interest factor $r^* < r_F < r_E(\gamma)$ at the beginning of the second period if the bank has observed an uninformative signal (observe however that this increases $r_E(\gamma)$). Second,
the type B borrower would benefit from the type G borrower’s better project choice through a lower pooling interest factor \( r_E(\gamma) \). For higher quality borrowers (i.e. for \( \theta \in [\theta_M, \bar{\theta}] \)) the first effect on \( r_E(\gamma) \) is more than compensated for by the investment efficiency effect. For low levels of monitoring costs (i.e. for \( M \leq M(ii) \)), \( r_E(\gamma) \) will be low. This would induce the type B borrower to choose bank financing irrespective of the bank’s quality. If the costs of information production become higher (\( M(ii) < M \leq M(iii) \)), then the type B borrower will face a higher interest rate \( r_E(\gamma) \). In this case the type B borrower will only prefer bank financing if the probability of paying a lower interest rate in the second period is sufficiently large, i.e. if the bank’s reputation is not too high (smaller than or equal to \( \gamma(ii) \)). Observe that this is the case even though a higher bank reputation reduces \( r_E(\gamma) \) (see Corollary 1). Observe furthermore that it can be shown that \( \gamma(ii) \) decreases with \( M \). The higher the costs of information production, therefore, the lower the attractiveness of enforceable bank contract (ii) for a type B borrower. Separating equilibria in which both borrower types make a different contract and funding source finally are not possible, since it can be shown that the type B borrower would always want to mimic the type G borrower’s contract choice in equilibrium.

For Proposition 2 the intuition is analogous. Observe however that in this case the type B borrower would prefer the bank’s quality to be higher than some lower bound \( \gamma(iii) \), since investment efficiency with contract (iii) can only be realized if the bank observes a perfectly informative signal that the borrower is of type G, and the type B borrower would always pay \( r_E(\gamma) \) in the first and the second period.

Corollary 2: \( \bar{M}(iii) < \bar{M}(ii) \).

From Corollary 2 it can be seen that the maximum level of monitoring costs for which bank financing would still be attractive for both types of borrowers is higher for enforceable bank contract (ii) than for enforceable contract (iii). The intuition is that for higher levels of \( M \) enforceable bank contract (ii) would be offered to better quality borrowers on the interval \( \theta \in [\bar{\theta}, \bar{\theta}] \), i.e. \( \bar{\theta}_M \) increases. The expected adverse effect of ‘misjudging’ type B borrowers on \( r_E(\gamma) \) then would become smaller, whereas the expected increase in investment efficiency on the side of the type G borrower (which is now present with a higher probability) would become higher.

We now consider the funding source choice of higher quality borrowers. Lemma 5 implies that for \( \theta \in [\bar{\theta}, \bar{\theta}] \), the type G borrower would always prefer the pooling Bayesian
Perfect Nash Equilibrium with (enforceable) financial market contracts over the equilibrium with feasible enforceable bank contracts. With enforceable contracts, we therefore would only expect borrowers of low observable quality to choose bank financing\(^{15}\). For higher quality borrowers the pooling financial market rate \(r_F\) defined in (5) would be sufficiently low to induce investment efficiency on the side of the type \(G\) borrower, and bank financing would not add any value.

*Equilibria with Discretionary Bank Contracts*

Next we consider the conjectured equilibria of the total game for each category of observable borrower quality in the presence of discretionary bank contracts. We have the following results.

**Proposition 3 (Equilibrium with Discretionary Contracts):** Let 
\[
\gamma = \frac{M(1+\alpha)}{\theta[(1+\alpha)\eta r^*-2\alpha]}
\]
and \(M \leq M(iii)\). The type \(G\) borrower’s expected return in a pooling Nash Equilibrium with discretionary bank contracts is higher than his equilibrium expected return with enforceable (bank or financial market) contracts if the bank’s reputation \(\gamma \in [\gamma_L, 1]\) is sufficiently high. The type \(G\) borrower therefore would prefer the pooling equilibrium with discretionary bank contract (i) if and only if:

(a) \(\gamma \geq \gamma_L(iii)\) (for \(\theta \in [\theta_M, \hat{\theta}]\)) or \(\gamma \geq \gamma_L(iii)\) (for \(\theta \in [\hat{\theta}, \theta_M]\)) for borrowers of low observable quality.

(b) \(\gamma \geq \gamma_M\) for borrowers of intermediate quality (\(\theta \in [\hat{\theta}, \bar{\theta}]\)).

The type \(G\) borrower would prefer the pooling Nash Equilibrium with discretionary bank contract (ii) if and only if:

(c) \(\gamma \geq \gamma_H\) for borrowers of high quality (\(\theta \in [\bar{\theta}, \hat{\theta}]\)).

All the pooling Nash Equilibria with discretionary bank contracts are Sequential Equilibria and survive the Universal Divinity Refinement by Banks and Sobel (1987). There are no feasible separating equilibria. The respective cutoff values of \(\gamma\) are defined in the Appendix.

\(^{15}\) This result is consistent with e.g. Diamond (1991), Berlin and Mester (1992) and Boot and Thakor (1997).
Corollary 3: \( \frac{\partial r_D(\gamma)}{\partial \gamma} < 0 \quad \forall \theta \in [\tilde{\theta}, \bar{\theta}]. \) Furthermore \( \frac{\partial r_D(\gamma)}{\partial \bar{\theta}} < 0 \) on \( \theta \in [\tilde{\theta}, \bar{\theta}], \) and

\( \frac{\partial r_D(\gamma)}{\partial \bar{\theta}} > 0 \) on \( \theta \in [\tilde{\theta}, \bar{\theta}]. \)

Corollary 4: \( \frac{\partial \gamma_L}{\partial \bar{\theta}} > 0, \) \( \frac{\partial \gamma_M}{\partial \bar{\theta}} > 0 \) and \( \frac{\partial \gamma_H}{\partial \bar{\theta}} < 0 \) (or non-monotonic in \( \theta \)).

Corollary 5: \( \lim_{\theta \uparrow \bar{\theta}} \gamma_L(\theta) < \gamma_M(\bar{\theta}) \) and \( \gamma_H(\bar{\theta}) < \lim_{\theta \downarrow \tilde{\theta}} \gamma_M(\theta) \).

The intuition of Proposition 3 is as follows. Each type of borrower again trades off the benefits and costs of bank financing and financial market financing in order to determine his contract and funding source choice. For a type G borrower the benefits from a discretionary bank contract stem from two sources. First, the bank’s intermediate interest rate strategy may enhance ex post investment efficiency by mitigating asset substitution moral hazard; this reduces \( r_D(\gamma) \) (investment efficiency effect). Second, since the bank can increase the interest rate for a type B borrower, a lower ex ante interest factor \( r_D(\gamma) \) is needed for the bank to break even in a competitive credit market (wealth redistribution effect). Observe however that by giving the bank discretion, the type G borrower exposes himself to an incorrect interest rate increase by a low quality bank at the intermediate date with discretionary contract (i). This prevents investment efficiency and therefore is costly (i.e. increases \( r_D(\gamma) \)). Together with the costs of information production these costs represent the total costs of bank financing with discretionary contract (i). For discretionary contract (ii) the total costs of bank financing only consist of the information production costs. A type G borrower therefore would prefer discretionary bank financing only if the costs of information production are not too high and/or the bank’s quality is sufficiently high. For a type B borrower the benefit from discretionary bank financing stems from a reduction in the ex ante pooling interest rate \( r_D(\gamma) \) due to increased investment efficiency. For discretionary contract (ii) this effect is combined with paying a lower second period (pooling) interest rate to a lower quality bank (observe however that this effect increases \( r_D(\gamma) \)). The costs of discretionary bank financing for a type B borrower
consist of monitoring costs and a potentially higher second period interest rate with bank financing.

Now first consider borrowers with a low observable quality \( (\theta \in [\theta, \hat{\theta}) \) . For these borrowers, the pooling interest factor \( r_F \) with financial market financing is too high to induce investment efficiency. With discretionary bank contract \((i)\), the bank would increase the interest rate for a type B borrower to \( r^+ \) and charge an interest factor \( r^* \) to a type G borrower at the intermediate date after observing an informative signal. After receiving an uninformative signal, the bank would charge the full information interest rate \( r^+ \) for a type B borrower. As compared to financial market financing therefore a type G borrower benefits from increased investment efficiency (through a lower ex ante interest factor \( r_F \)) and from a wealth redistribution between the type G and type B borrower if the bank observe a perfect signal. Since the type G borrower will be confronted with an incorrect interest factor increase if the bank observes an uninformative signal, he will only prefer discretionary bank contract \((i)\) over financial market financing if the bank's expected quality or reputation is sufficiently high. Observe that with enforceable bank contract \((iii)\) the same investment efficiency effect could be realized for \( \theta \in [\theta, \theta_m) \) as with discretionary contract \((i)\), whereas enforceable bank contract \((ii)\) could achieve even higher investment efficiency on the better range of the low quality borrowers with \( \theta \in [\theta_m, \hat{\theta}) \). With these contracts, however, the type G borrower cannot benefit from the wealth redistribution effect ex ante. Since on the interval \( \theta \in [\theta, \hat{\theta}) \) the type G borrower suffers significantly from the presence of the type B borrower, this wealth redistribution effect is large. Although with a discretionary contract the type G borrower faces a higher second period interest rate from a low quality bank than with either of the two types of enforceable contracts, discretionary bank contract \((i)\) is preferred for a given level of \( M \) if the bank's expected quality is sufficiently high (i.e. if \( \gamma \geq \gamma_L(ii) \) and \( \gamma \geq \gamma_L(iii) \) respectively).

In this case the wealth redistribution effect more than compensates the type G borrower for incorrect interest rate increases and the resulting lower ex ante benefits from reduced investment efficiency. Although a type B borrower will always face a second period interest factor \( r^+ > r_F \) with discretionary contract \((i)\), he will prefer the equilibrium with this contract over financial market financing, since the ex ante benefits from investment efficiency are sufficiently high. Observe however that in this equilibrium the type B borrower is always worse off than in the equilibria with enforceable bank contract \((ii)\) and \((iii)\) respectively, since his expected total interest payments will be higher with discretionary bank contract \((i)\). Despite this fact, the type B borrower chooses discretionary bank
contract (i) because he would otherwise be unambiguously identified as a type B borrower and be charged the full information interest rate $r^*$. If $\theta$ increases, the investment efficiency effect becomes larger, whereas the wealth redistribution effect becomes smaller. Since the second effect dominates, the minimum quality that the bank needs to have in order to attract the borrowers then has to increase (see Corollary 4).

For borrowers of intermediate quality ($\theta \in [\bar{\theta}, \tilde{\theta})$) the pooling interest factor $r_F$ with financial market financing is sufficiently low to induce the type G borrower to invest in the good project. Since with discretionary bank contract (i) investment efficiency will only occur if the bank receives a perfectly informative signal, no ex ante benefit of bank financing can be realized from increased investment efficiency as compared to financial market financing. For a given level of $M$ therefore a type G borrower could only benefit from discretionary bank contract (i) if the loss in investment efficiency with bank financing is not too large and the expected wealth redistribution effect is sufficiently high. This is the case if the probability that the bank receives an informative signal with respect to the borrower’s type is sufficiently high (i.e. $\gamma \geq \gamma_M$). For a type B borrower the argument is similar to the case of low quality borrowers. For higher levels of $\theta$, the wealth redistribution effect becomes smaller. This then would make bank financing relatively less attractive vis-à-vis financial market financing and increases $\gamma_M$ (see Corollary 4). Observe finally that in the equilibrium for borrowers with intermediate quality wealth redistribution from a type B to a type G borrower takes place at social cost.

Borrowers of high quality ($\theta \in [\tilde{\theta}, 1)$) choose between discretionary bank contract (ii) and financial market financing. With discretionary bank contract (ii) the bank would increase the interest factor for a type B borrower and charge an interest factor $r < r^*$ either after observing that the borrower is of type G or after observing an uninformative signal. This interest factor $r$ is enforced by the presence of competition from outside lenders at the intermediate date. With both types of contracts investment efficiency on the side of the type G borrower would always be realized. In comparison with the previous case therefore the type G borrower does not need to be compensated for a loss in investment efficiency in the case of bank financing. Since a type G borrower however always pays a higher second period interest rate with a discretionary bank contract than with financial market financing (i.e. $r^* > r > r_F$), he would prefer bank financing only if for a given level of $M$ the wealth redistribution effect is sufficiently large. This is the case if the bank’s reputation is sufficiently high ($\gamma \geq \gamma_H$). A type B borrower again is worse off with discretionary bank contract (ii), but has no option other than to mimic the type G borrower’s contract.
and funding source choice, since he would otherwise perfectly reveal his type and be charged the full information interest factor $r^+$ for a type B borrower. Note that in this equilibrium only wealth redistribution occurs. If $\theta$ increases, both the wealth redistribution effect and the interest factor $r$ and $r_f$ decrease. Since $r$ is more sensitive to $\theta$, this initially decreases the minimum reputation that the bank needs to have in order to attract borrowers. For higher levels of $\theta$ however the reduction in wealth redistribution may become dominant and $\gamma_H$ may increase (see Corollary 4).

An increase in the bank’s reputation increases both the investment efficiency effect and the possibility for wealth redistribution, since it improves the informativeness or precision of the bank’s signal. This implies that $r_B(\gamma)$ decreases with $\gamma$ (see Corollary 3). For low and medium quality borrowers furthermore $r_B(\gamma)$ decreases with $\theta$. The intuition is that for a higher observable borrower quality $\theta$, the expected gain from increased investment efficiency becomes larger. Since type G borrower suffer less from the presence of type B borrowers, the lower wealth redistribution effect becomes relatively less important vis-à-vis this investment efficiency effect. For high quality borrowers however $r_B(\gamma)$ increases with $\theta$. A higher level of $\theta$ decreases the drawback of ‘misjudging’ type B borrowers. However, the benefits from wealth redistribution also go down. Furthermore, the bank is more and more restricted in its intermediate pricing policy by competition from outside lenders. As a result, $r_D(\gamma)$ increases with $\theta$. Finally, observe that the jumps in the minimum bank reputation needed to attract medium and high quality borrowers to discretionary bank financing can be explained by a discrete change in the type G borrower’s investment strategy.

4.3 Discussion

The following insights can be derived from our analysis. Discretionary contracts allow banks to optimally condition their contracts on more subtle - potentially non-contractible - information than financial markets can. This facilitates more informative decision-making by the lender, which can enhance investment efficiency in the economy. The benefits of this flexibility and discretion however crucially depend on the expected quality (reputation) of the banking system. Since lower quality banks may not be able to optimally use the information produced on the borrower, giving the bank flexibility is only attractive if the bank’s expected quality or reputation is sufficiently high. The extent to which this needs to be the case depends on the quality of the borrower pool in the economy. Our results imply that flexibility in bank contracts is most attractive for either
low quality borrowers or high quality borrowers, but for different reasons. If the quality of the borrower pool is low, the use of discretion may improve real decisions on the side of good borrowers and results in a significant wealth redistribution between bad and good borrowers. For borrowers with a high observable quality, discretion in bank contracts does not increase (ex post) investment efficiency in comparison with financial market financing. However, high quality borrowers may still benefit from wealth redistribution. For borrowers of intermediate quality discretionary contracts are relatively less attractive. For these borrowers financial market financing is available at an attractive rate, which guarantees investment efficiency. Since discretionary contracts may decrease investment efficiency, the borrower needs to be compensated for this loss, and therefore will only prefer discretionary bank contracts if the reputation of the bank offering these contracts is sufficiently high.

The implications of the previous results for the bank's market share in a competitive credit market are summarized in Proposition 4.

**Proposition 4:** The use of discretionary contracts increases the market share of banks vis-à-vis financial markets for intermediate and higher quality borrowers; as a consequence it increases the pool of borrowers in the economy that are monitored (i.e. on which information is produced).

For borrowers of low observable quality the use of discretion in bank contracts does not affect the total market share of banks vis-à-vis financial markets, but merely changes the composition of bank financing with respect to its contractual type. For borrowers of intermediate or high quality however the bank's market share vis-à-vis financial markets increases for banks of sufficiently high quality. In the presence of discretionary bank contracts we therefore would not only expect a choice for monitored bank financing by low quality borrowers (as was the case with enforceable bank contracts), but possibly also by intermediate and high quality borrowers.

4.4 A Numerical Example

The results presented in the previous section now will be illustrated by a numerical example. The (exogenous) parameters are the following: \( \eta = 0.75, \alpha = 0.25, Y = 4, X = 9 \) and \( M = 0 \). From this it can be derived that \( r^* = 1.50, r^t = 4.00, \theta_{M} = 0.0304, \hat{\theta} = 0.1667 \) and \( \hat{\theta} = 0.8333 \). *Table 3* provides results of a numerical analysis of the model and shows...
the different cutoff levels for the bank's expected quality $\gamma \in (0,1]$ as a function of the proportion of type $G$ borrowers in the economy. Figure 1 shows how the borrower’s choice of contract type and financing source change as a function of his observable quality $\theta$.

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$\gamma(iii)$</th>
<th>$\gamma(ii)$</th>
<th>$\gamma_L(iii)$</th>
<th>$\gamma_L(ii)$</th>
<th>$\gamma_M$</th>
<th>$\gamma_H$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.0000</td>
<td>-</td>
<td>0.0000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.0304 = $\hat{\theta}_M$</td>
<td>-</td>
<td>0.0000</td>
<td>-</td>
<td>0.0307</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.10</td>
<td>-</td>
<td>0.0000</td>
<td>-</td>
<td>0.1140</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.1667 = $\hat{\theta}$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1942</td>
<td>-</td>
</tr>
<tr>
<td>0.30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.3775</td>
<td>-</td>
</tr>
<tr>
<td>0.40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.4982</td>
<td>-</td>
</tr>
<tr>
<td>0.50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.6062</td>
<td>-</td>
</tr>
<tr>
<td>0.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.7029</td>
<td>-</td>
</tr>
<tr>
<td>0.70</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.7896</td>
<td>-</td>
</tr>
<tr>
<td>0.8333 = $\hat{\theta}$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2394</td>
</tr>
<tr>
<td>0.90</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1960</td>
</tr>
<tr>
<td>1.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1428</td>
</tr>
</tbody>
</table>

Table 3: Overview Results Numerical Analysis of Basic Model (for $M=0$)

5 Model Extensions and Further Analysis

In this section we present some extensions of the basic model and discuss further implications of our analysis. We will particularly focus on the incorporation of the borrower’s ex ante incentives to invest in effort and on the bank’s incentives to invest in information production. These extensions allow us to provide a link between a firm’s contract, maturity and funding source choices and the type of its investment projects, and between the types of contracts offered and the level of information production by banks in the economy. Finally, we will discuss some implications for financial system design and for the design of bank loan commitments.
5.1 Ex Ante Investment Incentives, Project Types and the Borrower’s Contract Choice

Our model thus far only explicitly incorporated an ex post investment decision on the side of the borrower. As emphasized in the Introduction however, the different types of contracts may also vary with respect to their effect on the borrower’s ex ante investment incentives. Although we have given a rationale for the use of discretion in bank contracts even if ex ante incentive effects are absent, we will now extend our basic model in order to analyse such effects in some detail\textsuperscript{16}. For simplicity of exposition we assume that $M=0$ and $\gamma=1$.

Perhaps the easiest way to address these issues in our basic model framework would be to have the borrower’s expected payoff from his investment project depend on an (unobservable) effort choice $\beta \in [0,1]$. The (private) costs of effort equal $V(\beta)$, with $V'(\beta)>0$ and $V''(\beta)>0$. We assume that the borrower’s investment project generates a first period project cash flow $C$ with a probability $\beta$, and 0 with a probability $(1-\beta)$. Furthermore, we assume that ex ante effort exertion by the borrower increases the success probability of the good project to $\eta(1+\beta)$ in the second period\textsuperscript{17}. Finally, we assume that a borrower with an observable quality parameter $\theta$ learns his own type at the intermediate date $t=1$. In this modified structure the following result can be derived\textsuperscript{18}.

**Proposition 5:** Discretionary bank contracts stimulate ex ante investment incentives more than either enforceable bank contracts or financial market contracts.

The intuition is straightforward. The lower ex ante interest rate with a discretionary contract increases the borrower’s marginal return to effort. Although the potentially

\textsuperscript{16} Observe that, since we put a heavy weight on the borrower’s first period interest payment in our basic model framework by setting the first period success probability equal to 1, the benefits of a lower ex ante interest rate have already been hinted at in our earlier analysis.

\textsuperscript{17} Another way to capture the ex ante incentive effect on the expected project return would be to assume that ex ante effort exertion increases the good project’s second period cash flow conditional upon success. Although this would generate similar results, we prefer to model this effect through the success probability of the good project. This allows us to explicitly incorporate the marginal costs of a higher second period interest rate in the tradeoff of the marginal benefits and costs of effort. An even more complete picture of the relevant tradeoffs is provided in Jaggia and Thakor (1994), where the long-term return on firm investment depends on the cumulative amount of effort exerted in both periods.

\textsuperscript{18} For a similar type of argument, see also Section 2 in Chapter 2.
higher second period interest rate that a borrower faces with such a contract may partially offset this benefit, the borrower chooses a higher ex ante effort level with a discretionary bank contract. This makes the safer project more attractive, and therefore also reduces ex post asset substitution moral hazard.

Observe that in our model structure in Section 3 it was suggested that a borrower should ideally invest in safer, better quality projects. Bank financing may be attractive because it mitigates the adverse incentive effects of an adverse selection premium in a borrower's funding costs on his project choice. Discretionary bank contracts furthermore improve a borrower's ex ante incentives, thereby enhancing the safe project's expected returns. This would stimulate these conservative project choices even more. The benefits of discretion in bank contracts however are not restricted to these types of projects. The improvement of ex ante effort incentives may also be important for riskier projects. This would for example be the case for (start-up) firms with innovative, R&D-type investments (these firms typically have low θ's and risky investment projects). For such firms a significant level of ex ante firm-specific effort is generally necessary to guarantee success in the long run. With either enforceable bank contracts or financial market financing, the privately optimal investments in firm-specific effort may be too low to induce these firms to pursue risky, but valuable innovative investment projects. We will now show that also in this case discretion in bank contracts may prove to be of value.

In order to explore this issue, consider the following alteration of our model. Suppose that a borrower with an observable quality parameter θ can invest in a risky, innovative project at t=0 and has to decide on the amount of (unobservable) firm-specific effort to exert at that date. As before, firm-specific effort increases the borrower’s first period success probability β, but also incurs (private) convex costs V(β). The impact of firm-specific effort on the project’s second period return depends on the quality of the borrower (or the prospects of his project). The borrower learns his quality at t=1, before the bank does. If the borrower is bad, firm-specific effort does not pay off in the second period and the project generates a cash flow X with a probability α, and 0 otherwise. If the borrower is good, firm specific effort enhances the risky project’s success probability to α(1+β). A good borrower however can also switch to a safer project which generates a cash flow Y with a probability η and 0 with a probability (1-η)19. Let β* be the first best

19 This assumption captures the notion that good quality borrowers are more likely to have alternative investment opportunities.
level of firm-specific effort chosen by the borrower in case of complete self-financing. Furthermore, let \(0 < \alpha(1+\beta^*) < \eta < 1\) and \(\alpha(1+\beta^*)X > \eta Y > \alpha X\). The innovative project therefore is riskier, but may be socially optimal if it is supported by a sufficiently high level of firm-specific effort. We again assume that \(M=0\) and \(\gamma=1\). The following result then can be derived.

**Proposition 6:** For certain parameter values there exists an equilibrium in which good borrowers would invest in innovative projects with discretionary bank contracts, but not with either enforceable bank contracts or financial market financing.

Proposition 6 states that the use of discretion in bank contracts may stimulate innovative investment projects in the economy. The intuition behind this result is again that the lower ex ante interest rate that is feasible with discretionary bank contracts stimulates ex ante effort incentives more than any of the other contracts. This may tilt the value of promising risky projects above the value of more conservative project choices, and thus makes innovative projects attractive. This result emphasizes the additional value of discretionary contracts as compared to enforceable contracts. Enforceable bank contracts can enhance ex post efficiency with respect to project risk choice, but cannot ensure ex ante efficiency in all cases. The reason is that the ex ante interest rate of an enforceable contract may be too high to induce the right incentives on the side of the borrower at the beginning of the game. The lower ex ante interest rate of a discretionary contract on the other hand may be low enough to improve ex ante incentives; Furthermore, these contracts provide ex post investment efficiency. Discretionary contracts therefore may be superior.

These considerations allow us to relate a firm’s choice of contract type and funding source (and thus the ‘implied’ interest rate structure that the firm faces over time) to the type of its investment projects. Our theory therefore proposes a (tentative) typology of the financing sources of firms based on the relative importance and the trade off between ex ante and ex post investment incentives.

### 5.2 Long-Term versus Short-Term Contracts

In our analysis so far we have focused on long-term (two-period) financial market contracts and long-term renegotiable bank contracts. We will now compare these contracts with short-term loans, which can by definition be renegotiated after one period. First, we
assume - as before - that outside lenders cannot learn from the borrower’s repayment behavior at the end of the first period, i.e. short-term financial contracts cannot act as a signalling device with respect to the borrower’s investment opportunity set\textsuperscript{20}. With short-term financial market financing then the information asymmetry with respect to the borrower’s type will not be resolved at the end of the first period, since lenders in the financial market do not invest in information production. Observe that the distinction between enforceable and discretionary bank contracts disappears if we allow for short-term bank contracts, since the bank may adjust the interest rate in either direction upon renewal of the loan, based on the information received with respect to the borrower’s type.

Consider the extended model structure presented in Section 5.1 in which a borrower has to decide whether to invest in a risky, innovative project or in a more conservative project. In this setting it is intuitive that long-term renegotiable bank contracts dominate both short-term financial market contracts and short-term bank contracts. The reason is that since short-term contracts need to break even on a period by period basis, they provide no possibility for the borrower and the bank to intertemporally share surplus. With long-term contracts, the possibility to intertemporally share surplus allows for a lower ex ante interest rate in a competitive market, which increases the borrower’s ex ante incentives and improves the expected return on the borrower’s investment project. Short-term contracts thus cannot improve the borrower’s ex ante investment incentives as much as long-term renegotiable bank contracts do, and therefore do not add any value in the absence of a signalling role\textsuperscript{21}. This result is in line with Berlin and Mester (1992).

It is interesting to analyze how a borrower’s funding source and maturity choices would be affected if we would allow for the possibility that good borrowers have a higher first period repayment probability than bad borrowers, and outside lenders could therefore

\textsuperscript{20} Observe that although this assumption provides a rather narrow perspective on the maturity issue, it allows us to focus on the interest rate structure implied by the use of short-term contract as compared to long-term bank or financial market contracts. We analyze the maturity issue in the extended model structure which incorporates both ex ante and ex post investment incentives. It can be shown that in the basic model structure in Section 3 short-term contracts would only potentially be observed for borrowers in the low quality pool (with $\theta \in [\tilde{\theta}, \hat{\theta})$). Good borrowers in this quality pool would be indifferent between the pooling Bayesian Perfect Nash Equilibrium with short-term financial market contracts and the pooling equilibrium with long-term financial market contracts.

\textsuperscript{21} Note however that short-term financial market contracts stimulate ex ante effort incentives more than long-term financial market contracts, and therefore may be preferred by a specific type of borrowers.
learn from the borrower's repayment behavior at the end of the first period. Although in this case bad borrowers may partly be 'smoked out' at the end of the period, good borrowers may still prefer long-term discretionary bank contracts over short-term financial market financing, even though the second period interest rate they face with long-term discretionary bank contracts may be higher than the interest rate on a short-term financial market contract. The intuition is that since a good borrower knows that a high quality bank is going to learn his good quality at the intermediate date, he has nothing to gain from separating out by choosing short-term contracts. In fact, it is not in the good borrower's interest that the bad borrowers would be identified either, since this decreases the possibilities for wealth redistribution between bad and good borrowers in the second period of the bank-firm relationship. Since this second-period wealth redistribution will be reflected in a lower ex ante interest rate, the pool of bad borrowers which enters the second period of the bank-firm relationship will be higher with discretionary bank financing. Bad borrowers again would have no incentive to deviate from the good borrower's funding source and maturity choices, since they would otherwise perfectly reveal their type to the market and be charged the full information rate for a bad borrower. This type of argument then suggests that good borrowers for which ex ante investment incentives are relatively important would prefer long-term discretionary bank contracts from high quality banks, even though they could (partly) reveal their type to the market by choosing short-term contracts. The argument again is that discretion in bank contracts allows for intertemporal sharing of surplus, which is particularly attractive for this type of borrowers. If the bank's quality is low however, short-term financial market contracts may be preferred.

5.3 Information Production in Financial Markets and Reputation Formation

In our model analysis in Section 4 the bank's expected quality or reputation entered through the quality parameter $\gamma$, which was defined as the commonly known prior probability that a bank receives a perfectly informative signal from its investment in information production. Although this quality parameter can be interpreted as the bank's reputation at a given moment in time, this interpretation does not capture the dynamic process of reputation formation by banks in financial markets. We have shown that even in a setting where reputational considerations are absent banks can credibly offer discretionary contracts to borrowers in a competitive credit market. The reason is that in the basic model setup the gains to the bank stemming from ex post investment efficiency are
sufficiently large to prevent the bank from exploiting the borrower (see the parametric condition (A-1)). If this is not the case, banks may take actions at the expense of the borrower with discretionary contracts, and reputational considerations may become relevant to sustain these contracts (see Boot, Greenbaum and Thakor (1993)).

We will now relax assumption (A-1) and discuss the impact of reputational considerations on the bank’s intermediate interest rate strategy, and on its incentives to produce information on borrowers for both types of bank contracts. In order to do so, we extend our horizon to repeated borrower-lender interactions (i.e. a finite number of repetitions of our two-period model). We assume that the bank’s pricing behavior at the end of the first period is observable, and hence that outsiders can update their beliefs with respect to the bank’s quality (using Bayes’ rule), conditional on the interest rate that the bank charges the borrower in the second period. This learning process affects the interest rate that the bank can charge the borrower on future loans. We furthermore assume that the bank knows its own quality at the beginning of the game, and that its incentives to produce information (i.e. monitor the borrowers) are endogenous.

In such a setting it can be shown that there exist parameter values for which a bank would always increase the borrower’s second period interest rate with a discretionary bank contract in a one-shot borrower-lender interaction. The use of discretionary contracts therefore results in ex post investment inefficiency. Similarly, the bank may not be willing to decrease the interest rate at the intermediate date with an enforceable bank contract in order to enhance ex post investment efficiency.

In a repeated game structure, however, the bank may forego the short-term rents from exploiting the borrower in order to build a reputation with respect to its intrinsic quality as a monitor. By ‘correctly’ adjusting the interest rate high quality banks (which receive more informative signals from monitoring) may distinguish themselves from lower quality banks (which receive more noisy signals). The reputational rents stemming from this may induce the right incentives on the side of high quality banks. Analogous to Boot, Greenbaum and Thakor (1993) the benefits from reputation formation arise on the asset side of the bank’s balance sheet. That is, since the borrower is informationally captured, a bank with a reputation $\psi > \gamma$ can charge a good borrower a relatively higher interest rate on future loans as compared to a (de novo) bank with a reputation $\gamma$ (or the financial market).

Observe that this reputation building in itself is not restricted to the use of discretionary contracts, but may also apply to enforceable bank contracts which only allow
for intermediate interest rate decreases. That is, by correctly decreasing the interest rate in an enforceable bank contract the same reputational effects can be realized by a bank. The use of a discretionary contract therefore will not necessarily result in a faster accumulation of bank reputation than the use of enforceable contracts. Whether this is the case depends on the parametric conditions that are imposed. However, even if discretionary and enforceable contracts would have similar reputational consequences, the benefits of reputation formation for high quality banks can be expected to be higher with a discretionary contract than with an enforceable contract. The intuition is that since a good borrower benefits from both an investment efficiency effect and a wealth redistribution effect with a discretionary contract, he is willing to pay a higher ex ante interest rate with a discretionary contract than with an enforceable bank contract, even if the reputation accumulation under both contracts is the same. The use of discretion therefore expands the potential for reputation enhancement. This then will also affect the bank's incentives to become informed at $t=0$. It can therefore be expected that the level of information production in the economy would increase with discretionary bank contracts, since information production with these contracts could still be attractive for higher levels of $M$.

5.4 Implications for Comparative Financial Systems

Our analysis also has some implications for financial system design. In particular, it provides a link between the intrinsic quality of banks as information producers (or more generally, the quality of the 'banking system'), and the way firms are financed in an economy\textsuperscript{22}. These implications are based on the interpretation of the levels of $\gamma$ and $M$, and possibly also on the type of a firm's investment opportunities (through $\theta$).

If the noisiness of the signal that banks receive is high (i.e. $\gamma$ is low), banks will not be able to optimally use flexibility in their contracts. In this case the use of discretionary contracts may lead to incorrect interest rate adjustments, which may distort both ex ante and ex post investment incentives on the side of borrowing firms. It therefore could be expected that in lower quality or less developed banking systems more enforceable bank contracts would be observed, and bank-firm relationships would thus be more rigid. Discretionary bank contracts would predominantly be observed in financial systems with

\textsuperscript{22} Observe that, contrary to Boot and Thakor (1997), our paper does not assign an 'active' informational role to financial markets. We will therefore focus on the relation between the sophistication of the banking system and the types of projects that will be financed in our discussion of the firm's funding source choice.
high bank quality.

In new financial systems, or in financial sectors in transition economies, the quality or reputation \( \gamma \) of banks as information producers is likely to be low, and the costs of information production \( M \) are generally high. As suggested in Boot and Thakor (1997), this may be caused by the historical absence of profit-motivated banks in such economies. As a consequence, informational frictions between lenders and borrowers may be severe, and the average observable quality \( \theta \) of the borrower pool may be low. This may result in large adverse selection premiums in funding costs with financial market financing, which may cause moral hazard and eventually may even result in credit rationing and underinvestment (see Chapter 2). By mitigating moral hazard problems banks could be expected to play a crucial role in the development of such economies. In less developed or transition economies policy attention should thus be focused on the development of a well functioning banking system (by decreasing \( M \) and increasing \( \gamma \)). Since these economies are generally characterized by traditional industries with 'standard' production technologies (see Allen (1993)), enforceable bank financing would be valuable, since it reduces (ex post) moral hazard problems. Observe that in these economies the level of sophistication necessary for discretionary contracts would not immediately be required.

In economies with well-developed (sophisticated) banking systems on the other hand discretionary bank contracts may become relatively more important. These contracts may stimulate the financing of credit constrained (and low \( \theta \)) start-up firms with risky R&D-type investments, for which ex ante relationship specific investments are important. Furthermore, discretionary bank contracts increase the bank’s market share in financing larger borrowers with better credit reputations.

Our analysis therefore suggests a different role for bank financing in different economies, dependent on the level of sophistication of the banking system and on the types of industries which are dominant. In economies with standard production technologies the enforceability of bank contracts is important. In economies with more advanced production technologies, banks may stimulate firm-specific investments. These arguments are consistent with observed financing patterns in industrialized economies (see e.g. Mayer (1988) and Allen (1993)). Furthermore, our analysis predicts a larger role and market share of sophisticated banks in the financing of larger, better quality borrowers in economies with advanced technologies, e.g. in Japan. This is consistent with empirical findings in e.g. Hoshi, Kashyap and Scharfstein (1991).
5.5 Application to Bank Contracts; Loan Commitments

An example of a bank loan contract which leaves the bank at least some discretion in the course of lending is a bank loan commitment. Bank loan commitments are contracts which give the borrower an option to borrow up to a certain amount in the future at a predetermined interest rate in return for an initial ('up-front') fee paid at the outset. Essentially, the bank sells the customer a put option that contractually ties the bank to make a future loan but gives the customer the option of taking or not taking it. It has been shown that loan commitments improve investment efficiency because they reduce moral hazard related losses caused by information asymmetry between borrower and lender (Boot, Thakor and Udell (1987) and Chapter 2).

Bank loan commitments typically contain a Materially Adverse Change clause, which gives the bank the option to renege on its contractual obligation if the borrower’s credit quality has deteriorated between the time of issue of the loan commitment and the time of takedown. The bank’s decision as to whether to honor the commitment or not is generally based on non-contractible and non-verifiable information. The Materially Adverse Change clause therefore gives the bank some discretion to deny the borrower credit at the prespecified rate.

This feature is especially attractive for fixed rate loan commitments, which 'insure' the borrower not only for adverse (spot) interest rate developments but also for a decrease in credit quality. Fixed rate loan commitments therefore may induce moral hazard between the time of commitment purchase and takedown since the borrower’s commitment-related payoff at exercise increases with a deterioration in its financial condition prior to exercise. Banks may curb this opportunistic behavior both by monitoring and by invoking the Materially Adverse Change clause when appropriate. The use of discretion in bank contracts may also be relevant for variable rate loan commitments, which specify a spread on the risk free spot interest rate which depends on the borrower’s credit quality. Discretion then gives the bank the flexibility to increase the credit spread for borrowers with bad investment opportunities.

The discretionary bank contract used in our analysis could be interpreted as a (fixed or variable rate) loan commitment contract with an exercise rate equal to r*. Our analysis then suggests that the effectiveness of the Materially Adverse Change clause can be enhanced by allowing the bank to increase the interest rate of lower quality borrowers to the competitive interest rate in financial markets, instead of totally denying credit to the
This may decrease the ex ante loan commitment fee. Exchange-traded put options cannot be designed in this way. This would predict a higher use of loan commitments by better quality borrowers in the economy.

6 Conclusions

In this chapter we have provided a rationale for the use of flexibility and discretion in bank loan contracts. The argument developed in the chapter is that discretionary contracts enable banks to optimally condition the contract terms of their loans on the non-verifiable information obtained from monitoring a borrower. A simple model structure was used to show that discretionary contracts may enhance both ex ante and ex post investment efficiency on the side of the borrower. Our analysis has implications for a borrower's choice of contract type and funding source in a competitive credit market. We have shown that better quality borrowers will prefer discretionary contracts offered by higher quality banks, and that the use of discretion in bank contracts is most attractive if the quality of the pool of borrowers in the economy is relatively low. Discretionary bank contracts may also foster the development of reputation formation on the side of the bank, and increase the level of information production in the economy. Furthermore, we have discussed some implications for financial system design. In particular, we have argued that discretionary contracts are most optimally used if the quality of the banking system is high, and that the use of flexibility in bank contracts can improve the competitive position of banks vis-à-vis the financial market in an economy. An implication of our analysis is that banks facing increased competition from financial markets can maintain their competitive edge by focusing on relationship lending (see also Boot and Thakor (1998)). Finally, a first attempt was made to relate the type of a firm's investment projects to its contract and funding source choice by trading off the relative importance of ex ante end ex post investment efficiency for borrowers with different types of investment projects and by focusing on the incentives for renegotiation and flexibility. Future work in this direction may generate a typology of firms which matches observed choices of contract type, maturity and funding source by firms.

Empirical evidence implies that banks only very rarely invoke the Materially Adverse Change clause and deny credit to the borrower at the prespecified loan commitment rate. This may be caused by reputational considerations (see Boot, Greenbaum and Thakor (1993)). We suggest a possible alternative rationale for this observation.
APPENDIX

Proof of Lemma 1: With financial market financing two cases can be considered, dependent on the proportion $\theta$ of type G firms in the economy. If the pooled interest rate $2/[1 + \theta \eta + (1-\theta)\alpha]$ is smaller than $r^*$ the type G borrower invests in the good project, otherwise he invests in the bad project. The cutoff rate $\hat{\theta}$ for which the type G borrower would be indifferent between the project strategies then follows from (A.1):

$$\frac{2}{1 + \theta \eta + (1-\theta)\alpha} = r^* \quad \Rightarrow \quad \hat{\theta} = \frac{2 - (1+\alpha)r^*}{(\eta - \alpha)r^*} \quad (A.1)$$

Observe that for $\theta = \hat{\theta}$ it is assumed that the type G borrower invests in the good project. Now first consider the case where $\theta < \hat{\theta}$. To prove that the conjectured equilibrium in the Lemma describes a Nash Equilibrium, we first establish that the market’s pricing policy is a best response to the respective borrower types’ project choice. Given the choice of the bad project by both a type G and a type B borrower, the financial market lender’s best response would be to charge $2/(1+\alpha)$. If the lender were to choose a higher interest rate, he would lose the borrower to a competing lender, whereas a lower interest rate would cause the lender to suffer an expected loss. Next we need to prove that given the lender’s pricing strategy, both the type G and the type B borrower prefer to choose the bad project. Since $2/(1+\alpha) > r^*$ it follows readily that the type G borrower selects the bad project. The bad borrower doesn’t have a project choice. The Nash Equilibrium concept also requires us to specify what happens for o.o.e. moves. Since no restrictions are imposed on reactions to o.o.e. moves, we can assume any reaction. Assume that the lender in the financial market reacts to an o.o.e. move by charging $2/(1+\alpha)$. Then neither type of borrower would wish to defect from his equilibrium strategy. That sustains the equilibrium. The expected social loss is equal to the probability $\theta$ that this loss actually occurs multiplied by the magnitude of the loss $(\eta Y - \alpha X)$. Next consider the case where $\theta \geq \hat{\theta}$. The proof of this part of the Lemma is analogous. Given the type G and the type B borrowers’ investment choice the lender’s best response is to charge an interest rate $r_F = 2/[1 + \theta \eta + (1-\theta)\alpha]$. Charging a higher rate would cause the borrower to go to a competing lender, whereas charging a lower rate would violate the lender’s zero profit constraint. Given the lender’s pricing policy, the type G borrower’s best response is to choose the good project, since $r_F < r^*$. For an o.o.e. move again assume that the market reacts by charging $2/(1+\alpha)$. That sustains the equilibrium. $\square$
Proof of Lemma 2: Define $A = \gamma \alpha (\eta - \alpha) r^*$, $B = (1 + \alpha + \gamma \alpha)(\eta - \alpha) r^*$ and $C = \alpha [2 + M - (1 + \alpha) r^*]$. Furthermore, let $\hat{\theta}_M = \frac{2 + M - (1 - \alpha) r^*}{(\eta - \alpha) r^*} = \hat{\theta} + \frac{M}{(\eta - \alpha) r^*}$ and define $\theta_M$ as

$$\theta_M = \frac{-B - \sqrt{(B^2 - 4AC)}}{2A}.$$ 

Note that $\hat{\theta}_M$ increases linearly in $M$ and $\theta_M$ is monotonically increasing and concave in $M$. The feasibility of the conjectured Nash Equilibria with contracts (i) through (iv) can be analyzed by first checking the consistency of the bank’s incentive compatibility constraints (conditional on the signal received at $t = 1$) and the individual rationality constraint for each contract. First consider contract (i). For this contract incentive compatibility requires that $r_E(\gamma) \leq r^*$, with $r_E(\gamma) = (2 + M)/[1 + \theta \eta + (1 - \theta) \alpha]$ in order to induce participation by the bank. From this it follows that contract (i) can be offered to borrowers with $\theta \geq \hat{\theta}_M$. It can easily be seen that $\hat{\theta}_M \leq 1$ if and only if $M \leq (1 + \eta) r^* - 2$. Next consider contract (ii). For this contract the interest factor $r_E(\gamma)$ which satisfies the bank’s individual rationality constraint in competitive markets is given in equation (4). It can be seen that $r_E(\gamma) > r^*$ if $\theta < \hat{\theta}_M$. Incentive compatibility furthermore requires that $[\theta \eta + (1 - \theta) \alpha] r^* \geq \alpha r_E(\gamma)$, i.e. that $\theta \geq \hat{\theta}_M$. If $M \leq (1 + \eta) r^* - 2$ contract (ii) can be offered $\forall \theta \in [\hat{\theta}_M, \hat{\theta}_M] \subseteq (0, 1)$. For $(1 + \eta) r^* - 2 < M \leq [(1 + \alpha) \eta r^* - 2\alpha] / \alpha$ contract (ii) can be offered to borrowers with $\theta \in [\hat{\theta}_M, 1)$. If $M > [(1 + \alpha) \eta r^* - 2\alpha] / \alpha$ contract (ii) cannot be offered. For contract (iii) $r_E(\gamma)$ is given in equation (5). The condition that $r_E(\gamma) > r^*$ dictates that $\theta < \hat{\theta}_M/\gamma$. The incentive compatibility constraint $\eta r^* \geq \alpha r_E(\gamma)$ conditional on the signal that the borrower is of type $G$ dictates that $M \leq [(1 + \alpha) \eta r^* - 2\alpha] / \alpha$. The incentive compatibility constraint $[\theta \eta + (1 - \theta) \alpha] r^* < \alpha r_E(\gamma)$ conditional on an uninformative signal furthermore imposes that $\theta < \hat{\theta}_M$. Finally consider contract (iv). For this contract $r_E(\gamma)$ equals $(2 + M)/(1 + \alpha)$ which is larger than $r^*$. Incentive compatibility based on the signal that the borrower is of type $G$ guarantees that $M > [(1 + \alpha) \eta r^* - 2\alpha] / \alpha$. Given these contracts, the implications for the project choices by the borrower and social efficiency are straightforward. That completes the proof. Finally, it can be shown that $\theta_M \leq \hat{\theta}$ if $M < \hat{M} = \frac{[2 - (1 + \alpha) r^*][(\eta - \alpha) r^* + \gamma \alpha ((1 + \eta) r^* - 2)]}{(\eta - \alpha) r^*} > 0$. □
Proof of Lemma 3: To prove that the equilibria described in the Lemma are Nash Equilibria we first verify that the bank's intermediate interest rate decision is a best response given the type $G$ and the type $B$ borrowers' investment strategies. The cutoff rate $\hat{\theta}$ follows from equating $r$ and $r^*$ and satisfies:

$$\frac{1}{\theta \eta + (1-\theta) \alpha} = r^* \iff \hat{\theta} = \frac{1-\alpha r^*}{(\eta - \alpha) r^*}$$

(A.2)

Based on the signal that the bank receives three cases can be distinguished. If the bank observed a perfectly informative signal that the borrower is of type $B$, then its best response is to charge $r^*$. By charging a higher rate the bank loses the borrower, whereas charging a lower rate will result in a higher ex ante interest rate (this can easily be seen from the bank's zero profit constraint). Now first assume that $\theta < \hat{\theta}$. Observe that in this case $r > r^*$. If the bank observed a perfectly informative signal that the borrower is of type $G$, then the bank can charge either $r^*$ or $r^+$. If it charges $r^*$, its expected payoff equals $\eta r^* > 1$ (see assumption ($A.1$)). If the bank charges $r^+$, its expected payoff equals $1$. The bank therefore will charge $r^*$. If the bank observed an uninformative signal, it can again charge either $r^*$ or $r^+$. Given the good borrower's investment strategy then the expected payoff to the bank from charging $r^*$ equals $[\theta \eta + (1-\theta) \alpha] r^*$, which is smaller than 1. The expected payoff from charging $r^+$ equals $\alpha r^+ = 1$. The bank therefore charges $r^+$ after observing an uninformative signal. From equation (1) it follows that given the bank's pricing strategy the type $G$ borrower invests in the good project if charged $r^*$, and in the bad project if charged $r^+$ (observe that $r^+ > r^*$ since $\alpha^* > 2(1+\alpha)^2$). Since a bank receives an uninformative signal with a probability $(1-\gamma)$ the expected social loss equals $(1-\gamma) \theta (\eta Y - \alpha X)$. Next assume that $\theta \geq \hat{\theta}$. Since in this case $r \leq r^*$ the bank's best response after observing either a perfectly informative signal that the borrower is of type $G$, or an uninformative signal, is to charge $r$. By charging a higher interest factor the bank would lose the borrower to a competing lender, whereas charging a lower interest factor would increase the ex ante interest rate $r_D(\gamma)$ in a competitive market. Given the bank's pricing strategy the good borrower will always invest in the good project. The bad borrower's investment strategy is trivial. Note for completeness that it can be shown that $\theta_M < \hat{\theta}$ if $M < (1+\gamma) r^* - 2$, and that $\theta_M > \hat{\theta}$ if

$$M > \tilde{M} = \frac{(\eta - \alpha) r^* \{(1+\alpha+\gamma \alpha)(1-\alpha r^*) - \alpha [2-(1+\alpha) r^*] \}}{(\eta - \alpha) \alpha r^*}.$$

\[\square\]
Proof of Lemma 4: This result follows directly from comparing $r_E(\gamma)$ for contract (i) and (iv) with equations (2) and (3) respectively. On the interval $[\hat{\theta}_M, \hat{\theta}]$ the type G borrower would choose the good project both with enforceable bank contract (i) and with financial market financing. Since $r_E(\gamma) \geq r_F \forall M \geq 0$, contract (i) and the financial market contract can at best be equivalent. For contract (iv) the argument is similar. If $\theta \in [\hat{\theta}, \hat{\theta}]$ the type G borrower would choose the bad project both with enforceable bank contract (iv) and with market financing. Since contract (iv) can only be offered for $M > \frac{(1+\alpha)\eta r^* - 2\alpha}{\alpha}$ it can easily be seen that $r_E(\gamma) > r_F$. The financial market contract therefore dominates. For $\theta \in [\hat{\theta}, \hat{\theta}]$ the type G borrower would always prefer the good project with financial market financing and the bad project with enforceable bank contract (iv). Since $r_r < r^* < r_E(\gamma)$ on this interval for $\theta$ for all $M > 0$ it can easily be seen that $C - (r_F - 1) + \eta(Y-r_F) > C - (r_F - 1) + \alpha(X-r_F) > C - (r_E(\gamma) - 1) + \alpha(X-r_E(\gamma))$. The type G borrower’s expected return with financial market financing therefore is larger than with enforceable bank contract (iv). That completes the proof.

Proof of Lemma 5: First consider enforceable bank contract (ii). From Lemma 2 it can be seen that this contract can feasibly be offered to borrowers with $\theta \in [\hat{\theta}_M, \hat{\theta}_M]$. If $M < \hat{\theta}$ enforceable contract (ii) can be offered to some borrowers with a quality parameter $\theta$ in the interval $[\hat{\theta}, \hat{\theta}_M]$. Now consider the case where $\theta \in [\hat{\theta}, \hat{\theta}_M]$ with $M > 0$. In this case the type G borrower would always prefer the good project, both with bank financing and with financial market financing. Since $r_E(\gamma) > r^* \geq r_F$ it then can easily be seen that $C - (r_F - 1) + \eta(Y-r_F) > C - (r_F - 1) + \eta(Y-r^*) > C - (r_E(\gamma) - 1) + (Y-r^*)$. The type G borrower thus prefers financial market financing. On the interval $[\hat{\theta}_M, \hat{\theta}]$ the type G borrower would always invest in the good project with enforceable bank contract (ii), whereas he would choose the bad project with financial market financing. In this case the type G borrower therefore trades off an increase in investment efficiency with bank financing with the higher costs of information production for $M > 0$. Next consider enforceable bank contract (iii). From Lemma 2 it can be seen that this contract can be offered to borrowers with $\theta \in [\hat{\theta}, \hat{\theta}_M]$. Let $M > \hat{\theta}_M$ and focus on the interval $\theta \in [\hat{\theta}, \hat{\theta}_M]$. In this case the type G borrower would always prefer the good project with financial market financing, whereas with bank financing investment efficiency is only realized with a probability $\gamma$. Since $r_E(\gamma) > r^* > r_F$ on this interval it can easily be seen that $C - (r_F - 1) + \eta(Y-r_F) > C - (r_F - 1)$.
Proof of Proposition 1: We start by defining 

\[ M(iii) = \frac{\theta[(1+\eta)r_\star -2]}{1+\alpha}, \]

\[ \bar{M}(ii) = \theta(\eta-\alpha)r_\star < \bar{M}, \text{ and } \gamma(ii) = \frac{\theta(\eta-\alpha)r_\star - M}{\alpha(M - \theta[(1+\eta)r_\star - 2])} \] (\bar{M} is defined in Lemma 2). We first show that \( \forall \theta \in [0, \bar{\theta}) \) and \( \forall \alpha, \eta, X \) and \( Y \) there exists a pooling Bayesian Perfect Nash Equilibrium in which both types of borrowers choose financial market financing at the pooling rate \( r_F \) given in equation (3). It can easily be seen that the conjectured equilibrium is a Nash Equilibrium. Given the market’s pricing strategy, each type of borrower’s best response is to choose a financial market contract for \( M > 0 \). Given the type \( G \) and type \( B \) borrower’s contract and project choices furthermore the market’s best response in a competitive market would be to set the interest rate equal to \( r_F \) as given in equation (3). The out of equilibrium (o.o.e.) moves that need to be considered in order to proof that this equilibrium is Bayesian Perfect are the borrower choosing no contract or choosing enforceable bank contract (ii) respectively. Choosing no contract always yields the borrower a zero expected net return and therefore is a dominated strategy (this o.o.e. move therefore will be neglected in the rest of the analysis). Now consider the choice of enforceable bank contract (ii). If the bank observes this o.o.e. move and if it assigns the posterior probability assessment \( \mu(B \mid E(ii)) \) that the deviating borrower is of type \( B \) with a probability 1, then the bank’s best response is to charge an interest factor \( (2+M)/(1+\alpha) \). But then neither type of borrower would wish to defect for \( M \geq 0 \). That sustains the equilibrium. Similarly, we can show that under the conditions stated in Proposition 1, there exists a pooling Bayesian Perfect Nash Equilibrium in which both
types of borrowers choose enforceable bank contract (ii) at the interest factor \( r_B(\gamma) \) defined in equation (4). This equilibrium is again sustained by the posterior probability assessment \( \mu(B \mid F) \) that a borrower who deviates by choosing financial market financing is of type B with a probability 1. Note that enforceable bank contract (ii) can only be offered to borrowers with observable qualities \( \theta \in (0, \breve{\theta}) \) if \( M < \breve{M} \). It can furthermore easily be seen that given each type of borrower's contract and project choices, the bank's best response in a competitive market would be to charge \( r_B(\gamma) \) as defined in (4). Given the bank's pricing strategy then the type G borrower would prefer enforceable bank contract (ii) over financial market financing if and only if \( C - (r_B(\gamma)-1) + \eta(Y-r^*) \geq C - (r_F-1) + \alpha(X-r_F) \)

i.e. if and only if \( \gamma \geq \frac{M - \theta(\eta - \alpha)r^*}{(1-\theta)\alpha[2 - \alpha r^*]} \). A type B borrower would choose bank financing if and only if \( C - (r_B(\gamma)-1) + \gamma\alpha(X-r^*) + (1-\gamma)\alpha(X-r_B(\gamma)) \geq C - (r_F-1) + \alpha(X-r_F) \)

i.e. if \( M - \theta(\eta - \alpha)r^* + \gamma\alpha[M - \theta((1 + \eta)r^* - 2)] \leq 0 \). For \( M \in (0, \breve{M}(ii)) \) both conditions are satisfied \( \forall \gamma \in (0, 1) \). If \( M \in (\breve{M}(ii), \breve{M}(ii)) \) it can be seen that the type G borrower prefers bank financing \( \forall \gamma \in (0, 1) \), whereas a type B borrower prefers to pool if \( \gamma \leq \gamma(ii) \). If \( M > \breve{M}(ii) \) or \( \gamma > \gamma(ii) \), then the conjectured pooling equilibrium in which both types of borrowers choose enforceable bank contract (ii) is not feasible. Since on the interval \( \theta \in (0, \breve{\theta}) \) the pooling rate \( r_F \) in financial markets equals the full information rate for a type B borrower, it can easily be seen that both types of borrowers would prefer the pooling Bayesian Perfect Nash Equilibrium with enforceable bank contract (ii) over the equilibrium with financial market financing if the equilibrium with bank financing is feasible. This equilibrium therefore is Pareto optimal. Finally, since the type B borrower would always envy the type G borrower in a separating equilibrium, it can easily be shown that separating equilibria are not feasible. That completes the proof.

\[ Q.E.D. \]

**Proof of Proposition 2:** For the proof that \( \forall \theta \in [\hat{\theta}, \breve{\theta}) \) and \( \forall \alpha, \eta, X \) and \( Y \) there exists a pooling Bayesian Perfect Nash Equilibrium in which both types of borrowers choose financial market financing at an interest rate \( r_F \) as defined in equation (3), see the proof of Proposition 1. For completeness, we need to consider what happens for the o.o.e. move of choosing enforceable bank contract (iii). If the bank observes a choice of enforceable bank contract (iii), and if it assigns a posterior probability assessment \( \mu(B \mid E(iii)) \) that the deviating borrower is of type B with a probability 1, then the bank's best response is to charge \( (2+M)/(1+\alpha) \). But then neither the type B borrower nor the type G borrower

107
would wish to defect. That sustains the equilibrium. We furthermore need to show that there exists a pooling Bayesian Perfect Nash Equilibrium in which both the type G and the type B borrower choose bank financing with enforceable bank contract (iii) if the bank's quality γ exceeds a minimum cutoff level \( \gamma(iii) = \frac{M(1-\alpha)}{\theta[(1-\alpha)\eta r^* - 2\alpha]} \). Since the pooling interest rate \( r_f \) in the case of financial market financing equals the full information rate for a bad borrower, both types of borrowers would prefer the equilibrium with bank financing with enforceable contract (iii) if this equilibrium is feasible (i.e., the equilibrium is Pareto optimal). Given each type of borrower's contract and project choices, the bank's best response in a competitive market would be to charge an interest factor \( r_E(y) \) as defined in equation (5). First consider the type B borrower. Given the bank's pricing strategy, the type B borrower would prefer the pooling equilibrium with enforceable bank contract (iii) if and only if \( C - (r_E(\gamma)-1) + \alpha(X-r_E(\gamma)) \geq C - (r_f-1) + \alpha(X-r_f), \) i.e., if and only if \( r_E(\gamma) \leq r_f \). This condition is satisfied for \( \gamma \geq \gamma(iii) \). It can easily be seen that if the type B borrower prefers enforceable bank contract (iii), the type G borrower will prefer (iii) as well. The cutoff quality \( \gamma(iii) \leq 1 \) if \( M \leq M(iii) = \frac{\theta[(1+\alpha)\eta r^* - 2\alpha]}{(1+\alpha)} \). This equilibrium is sustained by the posterior probability assessment \( \mu(B \mid F) \) that a borrower who deviates with a financial market contract is of type B with a probability 1. Finally, it can be shown that there are no separating equilibria since the type B borrower would always want to mimic the type G borrower's strategy. That completes the proof.

**Proof of Corollary 2:** This result can easily be derived by comparing \( M(ii) \) and \( M(iii) \) (as defined in Proposition 1 and 2 respectively) on the relevant interval \( \theta \in [\hat{\theta}, \tilde{\theta}) \).

**Proof of Proposition 3:** Let \( \tilde{M}_L = \theta(\eta r^* - 1), \) \( \bar{M}_M = \min\{\theta(\eta r^* - 1), \theta(\eta r^* - 1) + (1 - cr^*) + (1+\eta)r_F - (\eta - \alpha)r^* - 2\} \) and \( \bar{M}_H = \theta(\eta r^* - 1) + (1+\eta)r_F - (1+\eta)r^* \). Observe first that it can be shown that the different pooling Bayesian Perfect Nash Equilibria with financial market financing exist for \( \theta, \alpha, \eta, X \) and \( Y \). Similarly, it can be shown that the different pooling Bayesian Nash Equilibria with bank financing exist if the conditions stated in Proposition 3 are satisfied. All these equilibria are sustained by the posterior probability assessment \( \mu(B \mid k) \) that a borrower which deviates by choosing contract \( k \in \{E(i), E(ii), D(i), D(ii), F\} \)
as an o.o.e. move is of type B with a probability 1. The market’s respectively the bank’s best response then would be to charge the full information interest rate for a type B borrower (in case of bank financing grossed up with the information production costs $M>0$), in which case neither type of borrower would wish to defect from his equilibrium strategy. Now first consider borrowers with $\theta\in[\bar{\theta},\hat{\theta})$. The pooling Bayesian Perfect Nash Equilibrium in which both types of borrowers with $\theta\in[\bar{\theta},\hat{\theta})$ would choose discretionary bank contract (i) is preferred over the equilibrium with financial market contracts if it generates the type G borrower a higher expected return. With $r_F$ as defined in equation (3) and $r_D(\gamma)$ as defined in equation (6) we can derive that the type G borrower would prefer the equilibrium with discretionary bank contract (i) if and only if $r_F(\gamma) + \gamma\alpha\gamma^* + (1-\gamma)\alpha\gamma^* \leq 2$, i.e. if $\gamma \geq \frac{M}{\theta(\eta \gamma^*-1) + (1-\alpha\gamma^*)}$. For $\theta\in[\theta_M,\hat{\theta})$ the type G borrower’s expected return in the equilibrium with discretionary bank contract (i) is higher than his expected net return in the equilibrium with enforceable bank contract (ii) (with $r_E(\gamma)$ defined as in equation (4)) if and only if $r_E(\gamma) + \alpha\gamma^* \leq 2$, i.e. if the bank’s reputation $\gamma \geq \frac{-E+\sqrt{E^2-4DF}}{2D}$, with $D=(1-\theta)\alpha\{\theta(\eta \gamma^*-1) + (1-\alpha\gamma^*)\}$, $E=\theta(\eta \gamma^*-1) + (1-\alpha\gamma^*) - (1-\theta)\alpha[2+M-(1+\alpha)r^*]$ and $F= -\theta(\eta-\alpha)r^*$. For $\theta\in[\theta_M,\hat{\theta})$ the type G borrower prefers the discretionary contract (i) over enforceable bank contract (iii) (with $r_E(\gamma)$ as defined in expression (5)) if and only if $r_E(\gamma) + \gamma\alpha\gamma^* + (1-\gamma)\alpha r_E(\gamma) \leq 2$, i.e. if $\gamma \geq \frac{1+M-r^*}{\theta(\eta \gamma^*-1)}$.

The type B borrower wants to mimic the type G borrower’s contract choice if and only if the bank’s quality $\gamma \geq \frac{M}{\theta(\eta \gamma^*-1)}$. Let $\gamma_L(ii) = \max\{\frac{M}{\theta(\eta \gamma^*-1) - E+\sqrt{E^2-4DF}}}{2D}\}$ and let $\gamma_L(iii) = \frac{M}{\theta(\eta \gamma^*-1)}$. Then part (a) of the proof follows immediately. By partially differentiating $\gamma_L(ii)$ and $\gamma_L(iii)$ with respect to $M$ and $\theta$ respectively it can be seen that both increase with $M$ and decrease with $\theta$. Next consider borrowers with $\theta\in[\hat{\theta},\hat{\theta})$. With $r_F$
as defined as in equation (2) and \( r_D(\gamma) \) as defined in equation (6) the type G borrower would prefer the pooling equilibrium with discretionary bank contract \((i)\) over the equilibrium with financial market financing if and only if the following condition holds:

\[
r_D(\gamma) + \gamma r_F + (1-\gamma)\alpha r + (1-\gamma)(\eta Y - \alpha X) \leq (1+\eta)r_F,
\]

i.e. if the total expected interest payments with discretionary contract \((i)\) and the expected loss in investment efficiency (which occurs with a probability \((1-\gamma)\)) are smaller than the total expected interest payments with financial market financing. This condition is satisfied for

\[
\gamma \geq \frac{2 + \theta r^* + (\eta - \alpha)r^* - (1+\eta)r_F}{\theta(\eta r^* - 1) + (1-\alpha)r^*}.
\]

If the market assigns a posterior probability assessment \( \mu(B \mid F) = 1 \) to a deviating borrower, then the type B borrower would have no option other than to mimic the type G borrower's contract choice if \( \gamma \geq \frac{M}{\theta(\eta r^* - 1)} \). With

\[
\gamma_m = \max \left\{ \frac{2 + \theta r^* + (\eta - \alpha)r^* - (1+\eta)r_F}{\theta(\eta r^* - 1) + (1-\alpha)r^*}, -\frac{M}{\theta(\eta r^* - 1)} \right\}
\]

then part (b) follows immediately. For

\[
\theta \in [\hat{\theta}, \hat{\theta}] \quad \text{and with } r_F \text{ as defined in equation (2) and } r_D(\gamma) \text{ as in equation (7), the type G borrower generates a higher expected net return in the equilibrium with discretionary contract \((ii)\) than with financial market financing if and only if } r_D(\gamma) + \eta r \leq (1+\eta)r_F, \text{ i.e.}
\]

\[
\gamma \geq \frac{M + \eta r - (1+\eta)r_F}{\theta(\eta r - 1)} = \gamma_H.
\]

If the market assigns a posterior probability assessment \( \mu(B \mid F) = 1 \) to a deviating borrower, then the type B borrower would always want to mimic the type G borrower. This completes part (c). For all \( \theta \in (0,1) \) furthermore it can be shown that no feasible separating equilibria exist in which a type G borrower chooses bank financing (either with an enforceable or a discretionary contract) and the type B borrower chooses financial market financing, since the type B borrower would always want to mimic the type G borrower's contract and funding source choice in such an equilibrium. The same holds for separating equilibria in which one type of borrower chooses enforceable bank financing (either contract\((ii)\) or\((iii)\)) and the other borrower chooses discretionary bank contract \((i)\). Observe that in a separating equilibrium each
borrower's contract and funding source choice would immediately reveal his type, which would make information production on the part of the bank obsolete (i.e. it would be plausible to assume that \( M=0 \)). If we assume that the bank's monitoring decision is exogenous, however, no feasible separating equilibria exist if \( M \leq \theta(\eta-\alpha)r \). Details are available upon request. It can easily be verified that the pooling equilibria with discretionary bank financing derived above satisfy the Intuitive Criterion of Cho and Kreps (1987), since we cannot rule out any type as a potential defector. In order to proof that these pooling equilibria are universally divine we proceed as follows. Since choosing no contract is always a dominated strategy (because it would yield the borrower zero expected return), the o.o.e. moves that we need to consider are choosing a financial market contract and choosing enforceable bank contract (ii) and (iii) respectively. For \( i \in \{B,G\} \) define \( D_i(k) \) as the set of best responses (i.e. interest rates charged) for which a type \( i \) borrower would wish to defect with o.o.e. move \( k \), and let \( D_i^0(k) \) be the set of best responses for which type \( i \) would be indifferent between defecting and not defecting. Furthermore, let \( R = \left[ \frac{2}{(1+\eta)},r^* \right] \cup \{ \frac{2}{1+\alpha} \} \). First, consider the o.o.e. move \( k=F \). For \( \theta \in (0,\tilde{\theta}) \) it can be shown that \( D^0_B(F) = \emptyset \) and \( D^0_B(F) = \{ r \in R \mid r \leq r^* \} \). For a type \( G \) borrower we can show that \( D^0_G(F) = \emptyset \) and \( D^0_G(F) = \{ r \in R \mid r \leq r^* \} \) if \( \gamma \in \left[ \frac{M}{\theta(\eta r^* - 1)}, \tilde{\gamma}_L \right] \), and \( D^0_G(F) = \{ R_L \} \) and \( D^0_G(F) = \{ r \in R \mid r < R_L < r^* \} \) for \( \gamma \in \left[ \max \left\{ \frac{M}{\theta(\eta r^* - 1)}, \tilde{\gamma}_L \right\}, 1 \right] \), with \( \tilde{\gamma}_L = \gamma_L + \frac{2-(1+\alpha)r^*}{\theta(\eta r^* - 1) + (1-\alpha)r^*} \) and \( R_L = \frac{r_{L}(\gamma) + \gamma \alpha r^* + (1-\gamma) \alpha r^* + (\eta-\alpha) r^*}{1+\eta} \). For all \( \gamma \in [\gamma_L,1] \) then it can be seen that \( D^0_B(F) \cup D^0_G(F) \subseteq D_B(F) \). We therefore can rule out type \( G \) as a potential defector and assign the posterior probability assessment \( \mu(B \mid F) = 1 \) after observing o.o.e. move \( F \). The market's best response then would be to charge \( r_F = \frac{2}{(1+\alpha)} \). But in this case neither type of borrower would wish to defect from his equilibrium strategy. For \( \theta \in (\tilde{\theta},\bar{\theta}) \) the proof is similar. Now define \( R_M \) as \( \frac{r_{D}(\gamma) + \alpha r^*}{1+\alpha} \).
If \( \gamma < \bar{\gamma}_M \) it can be shown that \( R_M > r^* \). In this case \( D^0_G(F) = \emptyset \) and \( D_B(F) = \{ r \in \mathbb{R} \mid r \leq r^* \} \). For \( \gamma > \bar{\gamma}_M \) \( R_M < r^* \) in which case \( D^0_G(F) = \{ R_M \} \) and \( D_B(F) = \{ r \in \mathbb{R} \mid r < R_M \} \). For \( \gamma < \bar{\gamma}_L \) it can be seen that \( R_M > r^* \). The defection sets for the type \( G \) borrower then equal \( D^0_G(F) = \emptyset \) and \( D^0_B(F) = \{ r \in \mathbb{R} \mid r < R_M \} \). For all \( \gamma \in [\gamma_M, 1] \) then this implies that \( D^0_G(F) \cup D^0_B(F) = D_B(F) \) and we can rule out type \( G \) as a potential defector. With \( \mu(B \mid F) = 1 \) the market’s best response would be to charge an interest factor \( 2/(1 + \alpha) \), in which case neither type of borrower would wish to defect with \( k = F \). Finally, for \( \theta \in [\hat{\theta}, 1] \) let \( R_H = \frac{r_D(\gamma) + \gamma \alpha r^* + (1 - \gamma)(1 - \alpha^* r^*)}{1 + \alpha} \) and \( R_H = \frac{r_D(\gamma) + \eta r}{1 + \eta} < R_H \). Using similar procedures it can be shown that \( D^0_B(F) = \{ R_H \} \) and \( D_B(F) = \{ r \in \mathbb{R} \mid r < R_{Hi} \} \) for a type \( B \) borrower and \( D^0_B(F) = \{ R_M \} \) and \( D_B(F) = \{ r \in \mathbb{R} \mid r < R_M \} \). Again \( D^0_G(F) \cup D^0_B(F) = D_B(F) \) and \( \mu(B \mid F) = 1 \). This completes the analysis of o.o.e. move \( F \). Next consider o.o.e. move \( k = E(\text{ii}) \) on \( \theta \in [\hat{\theta}_M, \hat{\theta}] \). Then it can be shown that \( D^0_G(E) = \{ r_D(\gamma) + (1 - \gamma)(1 - \alpha^*) \} \) and \( D_B(E) = \{ r \in \mathbb{R} \mid r < r_D(\gamma) + (1 - \gamma)(1 - \alpha^*) \} \). Furthermore, \( D^0_G(E) = \{ [r_D(\gamma) - (1 - \gamma)(1 - \alpha^*)] / (1 + \gamma \alpha) \} \) and \( D_B(E) = \{ r \in \mathbb{R} \mid r < [r_D(\gamma) - (1 - \gamma)(1 - \alpha^*)] / (1 + \gamma \alpha) \} \). Since \( r_D(\gamma) + (1 - \gamma)(1 - \alpha^*) \leq [r_D(\gamma) - (1 - \gamma)(1 - \alpha^*)] / (1 + \gamma \alpha) \) for \( \gamma \geq \gamma_L(\text{ii}) \) it can be seen that \( D^0_G(E) \cup D^0_B(E) = D_B(E) \). Therefore, we can rule out type \( G \) as a potential defector and set \( \mu(B \mid E) = 1 \). The bank’s best response then would be to charge the full information interest factor for a type \( B \) borrower, in which case neither type of borrower would wish to defect. Finally consider o.o.e. move \( k = E(\text{iii}) \) on \( \theta \in (0, \hat{\theta}_M) \). It can be derived that \( D^0_G(E) = \{ [r_D(\gamma) + (1 - \gamma)(1 - \alpha^*)] / (1 + \gamma \alpha) \} \), \( D_B(E) = \{ r \in \mathbb{R} \mid r < [r_D(\gamma) + (1 - \gamma)(1 - \alpha^*)] / (1 + \gamma \alpha) \} \) and that \( D^0_G(E) = \{ [r_D(\gamma) + \alpha r^*] / (1 + \alpha) \} \) and \( D_B(E) = \{ r \in \mathbb{R} \mid r < [\gamma_D(\gamma) + \alpha r^*] / (1 + \alpha) \} \). Since \( [r_D(\gamma) + (1 - \gamma)(1 - \alpha^*)] / (1 + \gamma \alpha) \leq [r_D(\gamma) + \alpha r^*] / (1 + \alpha) \) \( \forall \gamma \geq \gamma_L(\text{iii}) \) it follows that \( D^0_G(E) \cup D^0_B(E) = D_B(E) \), i.e. that \( \mu(B \mid E) = 1 \). The bank’s best response then again would be to charge \( (2 + M)/(1 + \alpha) \). But the neither type of borrower would wish to defect. The pooling equilibria with discretionary bank contracts therefore survive the Universal Divinity Refinement of Banks and Sobel (1987). That completes the proof.
**Proof of Corollary 3:** This result follows from differentiating \( r_D(\gamma) \) with respect to \( \gamma \) and \( \theta \) on their relevant intervals.

**Proof of Corollary 4:** This result follows from differentiating the cutoff levels \( \gamma_L, \gamma_M \) and \( \gamma_H \) with respect to \( \theta \).

**Proof of Corollary 5:** This result can easily be derived by substituting \( \theta=\hat{\theta} \) and \( \theta=\bar{\theta} \) in the respective cutoff levels \( \gamma_L, \gamma_M \) and \( \gamma_H \).

**Proof of Proposition 4:** This result follows directly from Lemma 4, Lemma 5 and Proposition 3.

**Proof of Proposition 5:** To proof this result we solve the modified model backwards. Given the first period effort choice \( \beta \), a borrower would be indifferent between the good and the bad project at \( t=1 \) if and only if
\[
1 + \frac{(\alpha + \lambda) r^*(\beta)}{\eta(1+\beta) - \alpha X} \leq r = \frac{\eta(1+\beta) Y - \alpha X}{\eta(1+\beta) - \alpha}.
\]
Since \( \eta(1+\beta) Y > \eta Y > \alpha X \quad \forall \beta \in [0,1] \) the first best effort level \( \beta^* \) that a borrower would choose at \( t=0 \) in the case of complete selffinancing maximizes \( BC + \theta(1+\beta) Y + (1-\theta)\alpha X - V(\beta) \) and satisfies \( V'(\beta^*) = C + \theta\eta Y \). In the case of outside financing the long-term pooling interest factor \( r_F \) in a competitive market equals \( 1+\beta)/[\beta+\theta(1+\beta)+(1-\theta)\alpha] \) if the borrower chooses the good project, and \( 1+\beta)/[\beta+\alpha] \) otherwise. The pooling financial market rates at the intermediate date would equal \( r = 1/[\theta(1+\beta)+\theta(1-\theta)\alpha] \) and \( 1/\alpha \) respectively. Let \( \hat{\theta}(\beta) \) equal \( \frac{1+\beta - (\alpha + \lambda) r^*(\beta)}{(\eta-\alpha) r^*(\beta)} \) and \( \bar{\theta}(\beta) = \frac{1-\alpha r^*(\beta)}{\eta(1+\beta) - \alpha} \). Then the borrower’s privately optimal effort choice \( \beta_F \) with financial market financing satisfies \( V'(\beta_F) = C + 1 - (1+\beta)/[\beta+\alpha] \) if \( \theta<\hat{\theta}(\beta) \), and \( V'(\beta_F) = C + 1 + \theta(1+\beta)/[\beta+\theta(1+\beta)+(1-\theta)\alpha] \) for \( \theta\geq\hat{\theta}(\beta) \). For \( \gamma=1 \), we only need to consider one enforceable bank contract offered on the interval \( \theta \in [\bar{\theta}(\beta), \hat{\theta}(\beta)] \). The pooling rate \( r_E \) of this enforceable bank contract equals \( r_E = \frac{1+\beta - \theta \eta r^*}{\beta + (1-\theta)\alpha} \). The corresponding privately optimal effort choice \( \beta_E \) then satisfies \( V'(\beta_E) = C + 1 - r_E + \theta\eta[Y - r^*] \). With discretionary bank
financing, the break even interest factor \( r_D \) is given by \( \frac{\beta + \theta [1 - \eta (1 + \beta) r^*]}{\beta} \) for \( \theta \in [\hat{\theta}, \tilde{\theta}(\beta)] \) and \( \frac{\beta + \theta [1 - \eta (1 + \beta) r]}{\beta} \) for \( \theta \in [\hat{\theta}(\beta), \tilde{\theta}] \). The privately optimal effort choice \( \beta_D \) then satisfies \( V'(\beta_D) = C + 1 - r_D + \theta \eta [Y - r] \) for \( \theta \in [\hat{\theta}(\beta_D), \tilde{\theta}] \) and \( V'(\beta_D) = C + 1 - r_D + \theta \eta [Y - r] \) for \( \theta \in [\hat{\theta}(\beta_D), \tilde{\theta}] \). From comparing the different first order conditions and after some algebra it can be seen that \( \beta_F < \beta_B < \beta_D < \beta' \) for \( \theta \in [\hat{\theta}(\beta_D), \tilde{\theta}] \). That completes the proof.

**Proof of Proposition 6:** To prove this result we solve the model backwards. At \( t=1 \) the good borrower decides whether or not to switch from the innovative to the conservative project, given the level of firm-specific effort \( \beta \) chosen at \( t=0 \). At \( t=1 \) the innovative project is socially efficient if and only if \( (1 + \beta \alpha X) > \eta Y \). The parametric condition \( (1 + \beta^*) \alpha X > \eta Y \) guarantees that the good borrower would choose the innovative project with complete self-financing. In this case the first best level \( \beta^* \) of firm-specific effort satisfies \( C + \theta \alpha X - V'(\beta^*) = 0 \). Since we assumed that \( 0 < \alpha (1 + \beta^*) < \eta < 1 \), the good borrower would always prefer to choose the innovative project with outside financing if \( (1 + \beta \alpha X) > \eta Y \). This is socially efficient. If \( (1 + \beta \alpha X) < \eta Y \), then the borrower chooses the now socially efficient conservative project if the second period interest rate charged to the borrower is smaller than \( \frac{\eta Y - (1 + \beta) \alpha X}{\eta - \alpha (1 + \beta)} = r^*(\beta) \). If the second period interest rate exceeds \( r^*(\beta) \), then the borrower prefers the innovative project. Observe that this project now is socially inefficient. Define the ex ante effort level with financial market financing for the innovative project as \( \beta_F^c \) and for the conservative project as \( \beta_F^c \). Similarly, define the effort levels with enforceable bank contracts and discretionary bank contracts as \( \beta_E, \beta_B, \beta_D \) and \( \beta_D \) respectively. Let \( \beta_F = \text{Max}\{\beta_F^c, \beta_F^c\}, \beta_E = \text{Max}\{\beta_E, \beta_E\} \) and \( \beta_D = \text{Max}\{\beta_D, \beta_D\} \). We will now specify the parametric conditions for which \( (1 + \beta_D) \alpha X > \eta Y > \text{Max}\{(1 + \beta_B) \alpha X, (1 + \beta_F) \alpha X\} \). The following conjectured equilibrium strategies constitute Nash equilibria. With financial market financing, the good borrower chooses the conservative project at \( t=1 \) if \( \theta \geq \hat{\theta}(\beta_D^E) \) and the socially inefficient risky, innovative strategy if
\( \theta < \hat{\theta}(\beta^i) \). The market charges \( r_F^i = \frac{1+\beta_C^i}{\beta_C^i+\theta\eta+(1-\theta)\alpha} \) and \( r_F^i = \frac{1+\beta_C^i}{\beta_C^i+\alpha+\theta\beta_C^i\alpha} \) respectively.

The cutoff level \( \hat{\theta}(\beta^i) \) is defined as \( \frac{(1+\beta_C^i)-(\beta_C^i+\alpha)r^*(\beta_C^i)}{(\eta-\alpha)r^*(\beta_C^i)} \) for \( i \in \{I,C\} \). In the equilibrium with enforceable bank contracts the borrower always chooses the conservative project, and the bank charges \( r_E = \frac{1+\beta_C^E-\theta\eta r^*}{\beta_C^E+(1-\theta)\alpha} \). In the equilibrium with discretionary bank contracts the borrower chooses the socially efficient innovative strategy. The bank charges \( r_D = \frac{\beta_B^0+\theta(1-(1+\beta_B^0)\alpha)r^*}{\beta_B^0} < 1 \), with \( r^i \) equal to \( \frac{1}{\alpha+\beta\alpha\theta} \). Now first consider the equilibrium with financial market financing. Given the borrower’s ex ante effort choice and his project choice at \( t=1 \), the financial market lender’s best response is to charge \( r_F^i \) if \( \theta \geq \hat{\theta}(\beta_C^i) \) and \( r_F^i \) if \( \theta < \hat{\theta}(\beta_C^i) \). Given the financial market lender’s optimal strategy the good borrower chooses the conservative project at \( t=1 \) if \( r_F^i \leq r^*(\beta_C^i) \), i.e. if \( \theta \geq \hat{\theta}(\beta_C^i) \) and the risky project if \( r_F^i > r^*(\beta_C^i) \). The borrower’s ex ante investment in firm-specific effort follows from maximizing \( \beta[C-(r^i_0-1)] + \theta\eta[Y-r^i_0] + (1-\theta)\alpha[X-r^i_0] - V(\beta) \) if \( \theta \geq \hat{\theta}(\beta_C^i) \) and \( \beta[C-(r^i_0-1)] + \theta\alpha(1+\beta)[X-r^i_0] + (1-\theta)\alpha[X-r^i_0] - V(\beta) \) if \( \theta < \hat{\theta}(\beta_C^i) \). The first order conditions for these cases are \( V'(\beta_C^i) = C - r^i_0 + 1 \) and \( V'(\beta^i) = C + 1 + \theta\alpha X - (1+\theta\alpha)r^i_0 \) respectively. Next consider the equilibrium with enforceable bank contracts. In this case the bank decreases the interest rate for a good borrower to \( r^*(\beta_C^i) \) in order to induce the borrower to choose the socially efficient conservative project. Given the borrower’s ex ante and ex post investment strategies, the bank’s optimal response is to charge \( r_E^i = \frac{1+\beta_C^E-\theta\eta r^*}{1+(1-\theta)\alpha} \). Given the bank’s strategy, the borrower’s optimal ex ante investment in firm-specific effort maximizes \( \beta[C-(r^E_C-1)] + \theta\eta(Y-r^*) + (1-\theta)\alpha(X-r^E_C) - V(\beta) \) and \( \beta_C^E \).
satisfies \( V'(\beta^D_0) = C + 1 - r^D_C \). Finally, consider the equilibrium with discretionary bank financing. Given the borrower’s ex ante investment in firm-specific effort and the project choice at \( t=1 \), the bank’s best response is to charge \( r_D \). Given the bank’s strategy the borrower’s ex ante investment in effort follows from the optimization of \( \beta[C-(r_D-1)] + \theta \alpha X - r_D^1 \). The optimal effort level \( \beta^1_D \) satisfies \( V'(\beta^1_D) = C + 1 + \theta \alpha X - r_D^1 \). Our conjecture with respect to the parametric conditions then is correct if and only if \( r_D^1 + \theta \alpha r^1 < (1+\theta \alpha)r_D^E = (1+\theta \alpha)r^E \). By substituting the respective interest rates it can be seen that this condition is satisfied. We therefore have shown that there exist parametric conditions for which the conjectured strategies with the different financial contracts constitute equilibria. That completes the proof. \( \Box \)