Essays on Corporate Finance and Financial Intermediation

Schmeits, A.

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CHAPTER 5

ISSUES IN VENTURE CAPITAL FINANCING

Abstract

In this chapter we analyze the market for venture capital as a financing source for entrepreneurial firms. We consider the institutional design of the venture capital market, and explore the informational roles of venture capitalists as financial intermediaries and the distinct contractual features of venture capital arrangements. Using a simple model structure we show that frictions on the supply side of the market for risk capital may result in market failure and an undersupply of entrepreneurial activity in the economy. This may warrant government intervention. We analyze the impact of different measures of government intervention on an entrepreneur’s incentives to develop projects and on a capital supplier’s incentives to screen and finance entrepreneurial firms, and derive implications for the optimal design of such measures. We finally evaluate recent Dutch measures of government intervention in the context of our model. Our analysis shows that public policy measures work best if there is substantial private sector involvement, since this guarantees co-sharing of risk and also induces some market discipline.
1 Introduction

In this chapter we focus on the market for venture capital as a financing source for entrepreneurial firms. We consider the institutional design of the venture capital market, and analyze the specific informational roles of venture capitalists as financial intermediaries, and the distinct contractual features of venture capital arrangements. Our main objective in this chapter is to develop a better understanding of the (informational) problems faced by start-up firms seeking venture capital financing and their solutions. In addition, we try to identify potential shortcomings in the supply of risk capital in an economy. Shortcomings in existing financing forms and/or institutional arrangements may adversely affect the level of entrepreneurial activity in the economy. This may point at a potential role for government intervention in the capital market. A second purpose of this chapter is to analyze the impact of specific measures of government intervention on the availability of venture capital in an economy and on firms’ investment decisions, and to derive implications for the optimal design of such measures.

Venture capital financing can be defined as investment by individual venture capitalists or specialized venture capital organizations (venture capital funds) in high growth, high risk, often high technology firms that need capital to finance product-development or growth and must, by the nature of their business, obtain this capital largely in the form of equity rather than debt (Sahlman (1990) and Black and Gilson (1998)). These firms generally have no or very limited access to other external financing sources. Several reasons can be identified for this lack of external financing opportunities. First, small new technology-oriented firms may be subject to significant levels of technological and/or market uncertainty, and face a high risk of failure. Neither the entrepreneur nor potential financiers know at the beginning whether the envisioned product or project will ever materialize. This reduces the willingness of risk averse investors to provide capital to these entrepreneurial firms. Second, informational asymmetries make it difficult to assess these firms, and permit opportunistic behavior by entrepreneurs after

1 Whereas in the US most venture capital has flown in the direction of start-up firms, more than half of Europe’s venture capital investments have been directed to finance changes in firms’ ownership and restructurings of more mature firms. In fact, less than 6% of Europe’s risk capital goes towards starting up new firms (see The Economist, January 25, 1997 and Black and Gilson (1998)). Furthermore, in Europe banks play an important role in the provision of venture capital, whereas informal investors do not seem to be included in its definition. There exists, therefore, a less integrated view on the precise nature of venture capital in different countries. In this chapter we focus on the more narrow Anglo-Saxon definition of venture capital as risk capital provided to start-up firms.
financing is received. The uncertainty associated with start-up firms furthermore may make fully state contingent contracting impossible, and the observability and verifiability of a firm’s actions may be limited. Information asymmetries thus make external financing more expensive, or may preclude it entirely (see e.g. Stiglitz and Weiss (1981) and Myers and Majluf (1984)). Third, the assets of technology start-ups are predominantly intangible and therefore can not be collateralized. This makes financing with (bank) debt problematic. Finally, market conditions and regulation in capital markets may not be optimally geared towards the provision of risk capital to new high technology companies.

Venture capital suppliers specialize in providing entrepreneurial firms with a combination of financial capital, monitoring and advisory services, and reputational capital. More specifically, venture capital financing entails the provision of risk capital to a firm in substantial blocks, coupled with a close monitoring of that investment (Warne (1988)). The investor is generally a financial intermediary who is typically involved as a director, advisor or even manager of the firm, and has substantial control rights. This combination of contractual features, monitoring and advise, and control rights is unique and distinguishes venture capital arrangements from any other financing source.

Although venture capital financing has grown in importance during the last decade (both in the US and in Europe, see The Economist, January 25, 1997), this type of financing has received relatively little academic attention. Existing papers mainly focus on a description of the institutional features of the venture capital market and on the organization and legal structure of venture capital funds. Only recently this work has been supplemented by interesting theoretical research that explores the form and function of venture capital arrangements in an environment with informational problems. This literature focuses on the informational role of the venture capitalist as a financial intermediary and on specific financial contracting issues. On the supply side of the market for risk capital, the role of government intervention to improve infant companies’ access to outside financing has been largely unexplored. In particular, the desirability and feasibility of public policy measures to stimulate the supply of risk capital in an economy so far has


The most important theoretical contributions will be discussed in Section 3 of this chapter. For a brief overview of some of the main insights of these papers, see also Chapter 2 of this dissertation.
received very little attention⁴.

In this chapter we will build on the scant research in venture capital financing. We review the most important theoretical contributions and highlight the main issues in this area of research, both from a demand and a supply perspective⁵. The organization of this chapter is as follows. In Section 2 we give an exposition of the main problems that entrepreneurial firms seeking external financing face. In this section we will focus both on informational problems and on relevant policy issues. In Section 3 we will discuss the potential solutions to these problems that have been offered in the academic literature. In this section we rationalize important contractual features of venture capital arrangements and explore the role of the venture capitalist as a financial intermediary. In Section 4 we take the perspective of the supply side of the venture capital market, and provide a rationale for government intervention. In this section we will present a simple model of government intervention and analyze the impact of specific public policy measures on the supply of risk capital and entrepreneurial activity in the economy. In Section 5 we will review and evaluate the recent Dutch measures of government intervention in the context of this model. Section 6 concludes with a discussion of the missing elements in the existing literature and an indication of avenues for future research.

2 Main Problems in the Financing of Entrepreneurial (Start-Up) Firms

Besides the substantial level of uncertainty that entrepreneurial start-up firms generally are subject to, the main problems that these firms face in seeking external financing can be divided in two categories⁶: informational problems between the firm and

⁴ Exceptions are Gompers and Lerner (1997) and Lerner (1997). These papers analyze the impact of the Small Business Innovation Research (SBIR) program, the largest US venture capital initiative, on the degree and dispersion of technological innovation in the US economy.

⁵ For an excellent recent overview of the empirical literature, see Gompers and Lerner (1998).

⁶ Uncertainty is a measure of the array of the potential outcomes for a firm's investment projects. By their very nature, young and restructuring firms are associated with significant levels of uncertainty. Uncertainty surrounds whether a research program or a new product will succeed, or can depend on the response of a firm's rivals. High uncertainty means that investors and entrepreneurs cannot confidently predict what the company will look like in the future (see e.g. Lerner (1997)). This uncertainty (which results in incomplete information) makes the entrepreneurial firm's external financing more difficult, even in the absence of any informational asymmetries between entrepreneurs and their potential financiers (see Sahlman (1991)). In this chapter we focus on the additional problems that may arise due to the existence of information asymmetry. The impact of uncertainty and risk on an entrepreneurial firm's cost of capital will be discussed in Section 4 of this chapter.
potential financiers and problems on the supply side of the market for risk capital. In this section we discuss both types of problems. In doing so, we will focus on the relation between entrepreneurs and venture capitalists.

2.1 Informational Problems between Entrepreneurial Firms and Financiers

Ex Ante (Pre-Contracting) Information Asymmetry

The primary sources for the occurrence of ex ante information asymmetry between an entrepreneur and a financier are:

(i) Uncertainty with respect to the quality of the firm’s investment project or the entrepreneur (Leland and Pyle (1977), Sahlman (1991)). That is, the entrepreneur may have better information on the prospects of his investment project or his technical skills prior to contracting. This may make it difficult for outside financiers to assess the competence of the entrepreneur and the success probability of the project.

(ii) Uncertainty with respect to the entrepreneur’s managerial skills (Barry (1994), Hellmann (1993), Gompers (1995), Gompers (1997)). This uncertainty may be enhanced due to lack of managerial experience on the side of the entrepreneur.

As discussed in Chapter 2, the existence of these ex ante informational problems may result in adverse selection and/or market failure, and could potentially lead to:

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7 We therefore will only address one side of the dual role that the venture capitalist has as an agent with respect to his (limited-partner) investors, and as a principal with respect to the entrepreneurs in his portfolio firms. For a more elaborate discussion of the first relation, see for example Berger and Udell (1998) and Gompers and Lerner (1998). We therefore abstract from incentive problems between a venture capitalist and investors in a venture capital fund or in the venture capital market (e.g. effort/monitoring aversion on the side of the venture capitalist, or grandstanding (see Gompers (1996), and Black and Gilson (1998)). Although informational and incentive problems between venture capital fund managers and investors affect the efficiency of capital provision to entrepreneurs, this is not the main focus of this chapter. Observe furthermore that in our discussion we restrict ourselves to discussing informational problems that we consider most relevant in the context of venture capital financing.

8 Observe that this type of uncertainty does not necessarily lead to asymmetric information between entrepreneur and financier. The entrepreneur may also not know his (managerial) skills before contracting and may have to learn his ability over time, along with the capital supplier (see e.g. Chan, Siegel and Thakor (1990)). It is also possible that the ex ante uncertainty with respect to the entrepreneur’s (managerial) skills will be resolved asymmetrically after contracting. Similarly, the entrepreneur may learn more (or faster) about the quality of his investment project. This may result in moral hazard on the side of the entrepreneur (see e.g. Trester (1998)).

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underinvestment and a lack of entrepreneurial activity in an economy\(^9\).

**Ex Post (Post-Contracting) Information Asymmetry and Moral Hazard**

Information asymmetry between an entrepreneur and an outside financier which develops after contracting may give rise to opportunistic behavior on the side of the entrepreneur. Several incentive problems can be distinguished:

(i) **Effort aversion moral hazard** (Warne (1988), Hellmann (1993), Barry (1994), Bergemann and Hege (1998), Repullo and Suarez (1998)). This incentive problem can arise if the entrepreneur’s effort can not be observed (or verified) by outsiders. Since effort exertion is (privately) costly to the entrepreneur and the entrepreneur has to share the benefits from effort with the outside capital supplier, he will choose a privately optimal effort level that is lower than first best.

(ii) **Perquisites consumption** (Hellmann (1993), Admati and Pfleiderer (1994), Bergemann and Hege (1998), Black and Gilson (1998), Gompers and Lerner (1998), Trester (1998)). This incentive problem occurs if an entrepreneur places significant weight on increasing his (monetary or non-monetary) private benefits at the expense of outside financiers. For example, the entrepreneur may engage in wasteful expenditures, because he benefits disproportionately from these, but only partly bears their costs. Similarly, an entrepreneur might invest in strategies, research or projects with high private returns (e.g. status in the academic community), but low expected monetary payoffs to the capital supplier. Or an entrepreneur who receives private benefits of control from managing his own firm may decide to continue a bad investment project, even if termination of the project would be optimal. In the case of debt financing, finally, the evolution of asymmetric information with respect to project quality after contracting may result in the entrepreneur extracting cash flows from the capital supplier by strategically defaulting on the debt, before the debtholder can foreclose the project.

(iii) **Risk shifting or asset substitution moral hazard** (Hellmann (1993), Admati and Pfleiderer (1994), Barry (1994), Gompers and Lerner (1998)).

\(^9\) Ex ante information asymmetry and high (project) uncertainty result in the capital supplier charging a high cost of capital. The quality of investment projects to be financed under these terms then has to be very (prohibitively?) high. This results in too little investment (innovation) in the economy. Using high discount rates furthermore has the unintended effect of driving the most competent entrepreneurs to seek alternative sources of capital, leaving only those with no other financing options. This adverse selection process could ultimately result in a total market breakdown (see also Section 4).

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problem arises if an entrepreneur has an incentive to increase the riskiness of his investment strategy at the expense of an outside debtholder, due to the limited liability of his claim on the firm. Because an entrepreneur’s equity stake is essentially a call option on the value of the firm, the entrepreneur may pursue highly volatile strategies, for example by rushing a product to market when further testing might be warranted. The entrepreneur benefits from the upside potential of such risk taking, whereas the debtholder suffers from the downside risk.

These incentive problems are 'standard' in the sense that they are inherent to the use of outside financing in the presence of informational problems between firms and different types of capital suppliers. However, due to the intangibility and specificity of their assets, the non-verifiability of an entrepreneur's actions and/or project outcomes, and the high level of uncertainty, the adverse effects of the informational problems discussed above appear to be felt much more by entrepreneurial start-up firms. Furthermore, the solutions that are generally offered to most of these informational problems may be less applicable to this type of firms (see Chapter 2). As a consequence, infant companies may face substantial problems in obtaining external financing.

2.2 The Supply Side of the Market for Risk Capital; Policy Issues

The financing difficulties that start-up firms face in obtaining outside financing also depend on the organization and structure of the financial sector and on the functioning of the financial market. Inefficiencies and/or frictions on the supply side of the capital market may directly increase firms' funding costs, or may make financing for specific types of firms impossible.

In particular, the supply of risk capital in an economy may be limited. One potential reason for this could be a risk averse investment attitude on the side of (institutional) investors (Gompers and Lerner (1998)). Second, there may be a lack of

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10 In the US, the Employee Retirement Income Security Act (ERISA) limited pension funds from investing substantial amounts of money into venture capital or other high-risk asset classes till the end of the 70s. A clarification of ERISA's 'prudent man rule' later on explicitly allowed pension managers to invest in risk capital (Gompers and Lerner (1998)). This marked the start-off of the development and the growth of the US venture capital market. In the Netherlands institutional investors (e.g. pension funds) have traditionally shown highly risk averse investment behavior. This has changed only recently. Furthermore, the supply of risk capital in the Netherlands has been relatively limited as a consequence of high institutional savings (see Boot and Schmeits (1996) and also Section 5).
expertise on the supply side of the market for risk capital, due to a coordination problem. That is, if no start-up firms are financed in the economy, then capital suppliers cannot develop expertise in this market segment. Since suppliers of risk capital then do not have sufficient information on comparable transactions to base their financing decisions on and to select good start-up investments, they are as a consequence less willing to finance start-up firms. This 'chicken and egg' problem results in an inefficient Nash equilibrium with underinvestment on the side of the entrepreneur, and an underdevelopment of skills on the side of the capital supplier. A third potential problem could be a lack of exit possibilities for venture capital investors. In order to make money on their investments, venture capitalists need to turn illiquid stakes in private companies into realized returns. Successful exits (mainly through IPOs) are critical to ensuring attractive returns for investors, and thus to induce availability of financing to entrepreneurial firms in the first place (Black and Gilson (1998)). The development of the venture capital industry thus depends on the development and liquidity of the financial markets in an economy. The absence of a well-developed stock market that allows new firms without long histories of positive earnings to issue new shares may hamper the development of a vibrant venture capital industry. Finally, and related to the previous issue, it could be the case that the dominance of banks or other private financing sources in an economy over public funding sources (debt and equity markets) may adversely affect the financing possibilities for small firms. A potential bottleneck in this respect could be that, due to concentration tendencies in the banking sector, large banks are less willing to finance smaller firms (see e.g. Berger and Udell (1995)).

Frictions on the supply side of the market for venture capital may aggravate the informational problems associated with the financing of start-up firms. As a consequence, well-deserving investment projects may not receive financing, which may ultimately result in an undersupply of entrepreneurial activity in the economy. In the remainder of this chapter we present two types of potential solutions to the problems described in this

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11 In many countries, policy makers face a dilemma. The relatively few entrepreneurs active in these markets face numerous daunting regulatory restrictions, a paucity of venture funds focusing on investing in high-growth firms, and illiquid markets where investors do not welcome IPOs by young firms without an earnings history. This is, for example, the case in Europe. Europe's venture capital business has grown impressively in the last decade. However, it has failed to spur the kinds of dynamic start-ups that are observed in the US. Potential reasons are the lack of willing investors (the venture capital industry is dominated by banks, which may lack in-depth expertise in certain industries and are potentially more 'conservative'), and the absence of liquid, transnational stock markets (see The Economist, January 25, 1997, and also Gompers and Lerner (1997)).
section. In Section 3 we discuss how the design of venture capital arrangements may resolve the main informational problems associated with the financing of start-up firms. In Section 4 the focus is on the role of government intervention in stimulating the supply of risk capital in the economy.

3 Solutions to Informational Problems in the Financing of Start-Up Firms

If information asymmetries could be eliminated, the financing constraints that entrepreneurial firms face would become less severe. Venture capitalists as financial intermediaries can address these problems. By intensively scrutinizing firms before providing capital and then monitoring them afterwards, venture capitalists can alleviate some of the information gaps and reduce capital constraints. Furthermore, venture capital arrangements can be designed in such a way as to mitigate specific adverse selection and moral hazard problems.

Existing theoretical papers examine the role that venture capitalists play in attenuating agency conflicts between entrepreneurial firms and outside investors. Improvements in efficiency might be due to the active monitoring and advice that is provided (Cornelli and Yosha (1997), Hellmann (1998)), the screening mechanisms employed (Chan (1983)), the incentives to exit (Berglöf (1994)), the proper syndication of the investment (Admati and Pfleiderer (1994)), or the staging of the investment (Bergemann and Hege (1998)). This work has increased our understanding of the factors that affect the relationship between venture capitalists and entrepreneurs. In the remainder of this section we distinguish between information production and contractual features in our discussion of the main contributions in this area.

3.1 Information Production

The information production role of venture capitalists consists of three parts:

(i) Screening: this allows the venture capitalist to gather substantial amounts of information prior to investing, and thus can reduce adverse selection problems (Chan (1993), Barry (1994)).

(ii) Monitoring/assistance: this reduces different types of incentive problems on the side of the entrepreneur that arise due to the unobservability and/or non-verifiability of an entrepreneur’s actions after contracting (Warne (1988), Hellmann (1993), Barry (1994), Repullo and Suarez (1998)).

(iii) Certification in IPOs: information production by the venture capitalist during
earlier stages of the financing relationship gives the venture capitalist credibility in certifying the quality of an IPO with third party financiers. This results in lower underpricing and better exit possibilities for the venture capitalist. Reputational capital and reputational incentives generally prevent the venture capitalist from misrepresenting the firm’s quality to outsiders (Admati and Pfleiderer (1994), Barry (1994)).

Warne (1988) analyzes the role of the venture capitalist as an intermediary who finances entrepreneurial projects, with a focus on the effect of the venture capitalist’s assistance. Using a series of principal-agent models with risk neutral venture capitalists and risk averse respectively risk neutral entrepreneurs, the paper investigates under which conditions capital and assistance would best be provided jointly by a venture capitalist, and when both should be provided separately in competitive markets. In the model the payoffs generated by venture capital projects depend on the amount of entrepreneurial effort provided, the amount of capital invested, the amount of assistance supplied by the venture capitalist, and unobservable random events. The paper solves the problem of optimal risk sharing in the presence of effort aversion moral hazard on the side of the entrepreneur and the venture capitalist under different informational conditions. The somewhat surprising result of the analysis is that the entrepreneur never strictly prefers venture capital financing over the separate provision of capital and assistance. The model thus does not explain when venture capital financing is superior to other financing alternatives12.

Repullo and Suarez (1998), on the other hand, offer a convincing rationale for the complementarity of the advising and financing role of a venture capitalist in the presence of a two-sided moral hazard problem between an entrepreneur and a financier. In that paper combining financing and advice optimizes effort incentives on the side of both contracting parties, since in this case the entrepreneurial firm’s cash flows can be fully

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12 The results in Warne (1988) are relatively unsatisfactory, and very much depend on the assumption that both capital and independent assistance can be acquired separately in competitive markets. This assumption seems to contrast with the existing empirical evidence (see also Section 2). Furthermore, the analysis ignores potential cost efficiencies that may be associated with the joint provision of capital and assistance by a venture capitalist. Finally, the focus on debt contracts (for reasons of risk sharing) in the analysis deviates from the equity-linked claims that we observe in the practice of venture capital financing. Nevertheless, Warne (1988) was the first study which explicitly considered incentive problems on the side of both the firm and the capital supplier in the context of venture capital financing, and thus provided a good starting point for later work.
distributed between the entrepreneur and his advisor, without loss to any third party financier (see later).

Pre-investment screening and post-investment monitoring are generally not efficiently performed by large numbers of investors. In this case there can either be too much of these activities because of duplication of effort, or too little, owing to the tendency of investors to free-ride on each other. Delegating these activities to a single venture capitalist which serves as a financial intermediary therefore may be optimal (see e.g. Chan (1983), Hellmann (1993) and Diamond (1984)). Chan (1983) develops a model that illustrates the value of intermediation in the venture capital industry. The paper shows that in an economy with a large number of ex ante uninformed investors that each have positive search costs a lemon's problem may result, in the sense that only projects of low quality are offered to investors and are financed at terms that reflect their low quality. Using a venture capitalist as an informed intermediary solves this adverse selection problem, and allows good entrepreneurial projects to come to the market.

3.2 Contractual Features

In this section we subsequently discuss and rationalize the most important contractual features of venture capital arrangements that can be observed in practice. The optimality of these features very much depends on the assumptions made with respect to the (resolution of) informational problems that exist between entrepreneur and venture capitalist. Observe that information production on the side of the venture capitalist is generally necessary for the enforcement of specific contractual features. Similarly, contracts can be designed in order to stimulate information production on the side of the venture capitalist.

Stage financing

In the case of stage financing the venture capitalist commits only a fraction of the capital needed for the ultimate development of a project at the outset. Subsequent financing then is tied to the successful completion of intermediate objectives or the availability of new favorable information with respect to the project. The venture capitalist finances the project in stages, retaining the option to abandon the project at any stage whenever the forward looking net present value (NPV) of the project is negative. Benefits of stage financing are:

(i) Stage financing serves as a signalling device: the willingness of the entrepreneur to
accept stage financing provides information about the entrepreneur’s confidence in the prospects of the project (Sahlman (1991)). This reduces adverse selection problems.

(ii) By staging the commitment of capital the venture capitalist gains the option to abandon or revalue the project as new information arrives. This reduces the venture capitalist’s risk, and thus the stake he requires in the start-up in return for his initial investment. Since the entrepreneur can minimize the dilution he suffers from bringing in outside capital, this also improves incentives on the side of the entrepreneur (Sahlman (1991), Admati and Pfleiderer (1994), Cornelli and Yosha (1997)).

Drawbacks of stage financing are:

(i) Stage financing may create incentives to aim for short-term success rather than long-term value creation (short-termism or myopia), since entrepreneurs become excessively pre-occupied with short-term performance (Sahlman (1991), Hellmann (1993), Cornelli and Yosha (1997)).

(ii) Stage financing may create underinvestment on the side of the venture capitalist if the capital needed for future financing rounds has to be fully provided by him, but he only receives a fraction of the payoffs. Similarly, stage financing may result in overinvestment on the side of the venture capitalist if the capital needed for future financing rounds is partly provided by new, less informed outside capital suppliers (Admati and Pfleiderer (1994)).

(iii) Stage financing may result in an inefficient termination of good projects, in particular towards the end of the project horizon (Bergemann and Hege (1998)).

Bergemann and Hege (1998) analyze the dynamic interaction of the provision of capital and the acquisition of information (learning) in venture capital arrangements in the presence of moral hazard. The paper presents a model in which a wealth-constrained risk neutral entrepreneur offers an investment opportunity to a risk neutral venture capitalist. The project can either succeed or fail. Successful completion of the project requires funds for the development of the project. The rate of investment in the project controls the project’s probability of success. A higher investment level accelerates successful completion of the project. At the start neither the entrepreneur nor the venture capitalist know the project’s success probability. As the project continues to receive financing without achieving success, both agents update their assessment of the prospects of the project. The
project is terminated if the posterior probability assessment that the project is good becomes too low. The entrepreneur's allocation of capital and his investment effort are unobservable to the venture capitalist. This causes moral hazard, since the entrepreneur can divert cash flows for private consumption and delay completion of the project by choosing a lower than first best effort level. In doing so, the entrepreneur also controls the flow of information about the project. If the entrepreneur shirks, the entrepreneur's and the venture capitalist's assessment of the project's prospects will diverge, since the entrepreneur - knowing that he hasn't invested in the project - will not downgrade his beliefs with respect to project quality in the absence of success, whereas the venture capitalist does. The entrepreneur now trades off the costs and benefits of cash flow diversion and effort aversion in each period. In order for the entrepreneur to exert effort, he needs to be compensated for the foregone private benefits, and also for the downgrading of his beliefs with respect to the project's quality in the absence of successful project completion. The paper shows that the longer the project horizon, the larger is the option value in the entrepreneur's remuneration scheme of the entrepreneur's compensation for the divergence in beliefs with respect to the project's prospects. If the entrepreneur's compensation for effort exertion would become too large, an inefficient premature liquidation of the project may result.

Type of Financing Contract

The financing contracts used in venture capital arrangements typically are equity or equity-linked claims (e.g. straight equity, convertible debt and/or convertible preferred stock, or strip financing). Venture capitalists have concentrated stakes in the firms that they finance, since they are generally either the sole investor or the designated lead investor in a small syndicate of investors. The use of preferred stock gives the venture capitalist a senior claim on the entrepreneurial firm's cash flows, and also a senior claim on the liquidation value of the firm if the venture is unsuccessful. The incorporation of a conversion feature allows the venture capitalist to benefit from the upside potential of the venture. Benefits of the use of (convertible preferred) equity or convertible debt are:

(i) The use of preferred stock shifts risk from the venture capitalist to the entrepreneur. This allows the venture capitalist to smoke out the entrepreneur, and get the entrepreneur to signal whether he really believes the forecasts in the business plan (Sahlman (1991)). The ability of entrepreneurs to signal their prospects credibly may resolve adverse selection.
By requiring a preferred stake the venture capitalist provides the strongest possible incentives to the entrepreneur to do at least as well as projected (Sahlman (1991)). This reduces effort aversion moral hazard, thereby increasing the probability of a favorable project outcome\textsuperscript{13}.

The use of the conversion feature can also separate out bad entrepreneurs, and furthermore limits incentives for excess risk taking and other moral hazard problems on the side of the entrepreneur (Cornelli and Yosha (1997), Gompers (1997)). The convertible claim will be converted to common equity when the investment has been revealed to be successful, either at the time of an initial public offering, or when certain performance targets have been achieved. Since the entrepreneur may hold convertible securities in his firm as part of his compensation package, this motivates him to exert the desirable effort level. Furthermore, since the entrepreneur would have to share the benefits of excess risk taking with the venture capitalist in case of conversion, this curbs improper risk choices.

The use of convertible debt makes control in the entrepreneurial firm state-contingent. This may increase the proceeds from an exit of the investment to the venture capitalist (Berglöf (1994)).

Most of the recent theoretical contributions on venture capital focus on rationalizing the use of conversion options in venture capital contracts. Cornelli and Yosha (1997) explain the extensive use of convertible debt as a response to potential short-termism induced by stage financing. That is, with stage financing, the entrepreneur may bias positively the short-term performance of a project in order to reduce the probability that the project will be liquidated. The use of convertible debt may attenuate these adverse investment incentives. The intuition is that, by shifting resources to improving short-term performance ('window dressing') the entrepreneur reduces the probability of liquidation, but at the same time increases the probability that, in the event of refinancing, the venture capitalist will decide to exercise the debt conversion option, thus becoming the owner of a

\textsuperscript{13} Note however that both benefits could also be obtained by the use of debt contracts (see also Trester (1998)). They therefore do not provide a rationale for convertible preferred equity per se.
substantial fraction of the venture. If the terms of conversion are set in advance to be sufficiently favorable to the venture capitalist, the entrepreneur faces a situation in which good news about the project entails a reduction in his profit because of debt conversion by the venture capitalist. This discourages him to engage in myopic behavior. This intuition is formalized in a two-period model, in which a risk neutral entrepreneur with no initial wealth seeks venture capital financing for a project with uncertain returns. The project requires financing at the beginning of the first and the second period. At the end of the first period, a non-verifiable signal about project quality is generated. This signal is observed by both the entrepreneur and the venture capitalist. In the first period the entrepreneur can engage in signal manipulation by artificially improving short-term performance. Such activity does not improve the long-term return of the project, but only decreases the probability that the project is revealed to be bad at the end of the first period. This signal manipulation is unobservable to the venture capitalist. After observing the signal the venture capitalist decides whether to continue the project or to liquidate. If the project is refinanced, second period cash flows will be distributed between the venture capitalist and the entrepreneur according to the contract that has been agreed upon at the beginning of the first period. The venture capitalist can provide funding to the entrepreneur by supplying (a combination of) debt and equity, or by offering a convertible debt contract which specifies the conversion ratio at the beginning of the first period. In the case of convertible debt the venture capitalist decides whether to convert his debt into equity at the moment of refinancing the project (or before the end of the second period). Given the contract that is in effect, the entrepreneur decides whether to manipulate the signal so as to maximize his ex ante payoff. Since an entrepreneur provides no financing, and furthermore has limited liability, his expected payoff from continuation of the project exceeds his liquidation payoff. The entrepreneur consequently always prefers the project to be continued. With combined debt-equity financing therefore the entrepreneur has incentives to engage in signal manipulation. A venture capitalist which rationally anticipates this conflict of interest then may decide not to finance the project at all. With convertible debt financing, on the other hand, signal manipulation may trigger conversion of the debt by the venture capitalist. The central property of the convertible debt contract thus is the threat that, if the project performs too well in the short term, debt will be converted at a low price, which hurts the entrepreneur and induces him to refrain from signal manipulation. The same effect can be realized by the use of debt and warrants and/or convertible preferred equity.
Hellmann (1993) focuses on the same drawback of stage financing as Cornelli and Yosha (1997). In this paper, however, the entrepreneur’s incentives to engage in short-termism can be reduced by (non-contractible) monitoring on the side of the venture capitalist. The structure of the financial claim then is aimed at optimizing the venture capitalist’s incentives to monitor and provide assistance. The paper presents a three-period model which explicitly considers two-sided incentive problems between an entrepreneur and a venture capitalist. At the beginning of the first period a wealth constrained risk neutral entrepreneur seeks external financing from a risk neutral investor in a competitive market. The project requires investments at the beginning of the first and the second period. These periods are risky product development stages. At the end of the second period, all uncertainty with respect to the project’s success or failure will be resolved. In the third period the entrepreneur engages in the production and marketing of the product (assisted by the venture capitalist), and cash flows will be realized. The venture capitalist can choose whether he provides long-term financing, in which case he invests the total required investment outlay at the beginning of the first period, or stage financing. At the end of the first and the second period the project is either refinanced or liquidated. Since the entrepreneur always wants to continue the project, the venture capitalist prefers stage financing if the probability of project failure is sufficiently high. Stage financing however induces the entrepreneur to sacrifice value-maximizing long-term investments in order to boost short-term performance, as long as this action remains unobserved by the venture capitalist. This inefficiency may be resolved if the venture capitalist monitors in order to assess the long-term investments made in the firm. This monitoring guarantees the entrepreneur a well-informed refinancing decision and relieves him from inefficient short term pressures. Since the venture capitalist’s monitoring decision is non-contractible, however, the venture capitalist must be given incentives to exert monitoring effort. In this setting, it can be shown that it is optimal to give the venture capitalist (as the single monitor of the entrepreneur) a concentrated equity stake in the firm. In the production stage (the third period) a two-sided incentive problem develops: effort aversion on the side of the entrepreneur and aversion to commit (non-contractible) assistance on the side of the venture capitalist. These incentive problems may be reduced by the choice of the mix of debt and equity in the financial structure of the firm. The analysis in the paper shows that the optimal financing mix arises from a tradeoff between the entrepreneur’s and the venture capitalist’s marginal effort incentives: the more equity is used, the more the venture capitalist participates in capital gains, and thus the stronger the venture capitalist’s
marginal incentives to increase the value of the firm through assistance. For a given elasticity of effort supply by the entrepreneur, therefore, the entrepreneurial firm’s leverage should be lower, the more elastic the venture capitalist’s effort supply. This effect becomes stronger when incentives for risk taking are explicitly considered. This is the case since debt creates a wedge in risk preferences. The use of equity financing aligns interests, and mitigates the entrepreneur’s and the venture capitalist’s attempt to influence the project’s risk in opposite directions. A substantial proportion of equity financing therefore is optimal.\textsuperscript{14}

Trester (1998) rationalizes the use of convertible preferred equity in early stage venture capital contracting. In this paper it is suggested that, besides the project uncertainty itself, the risk that an entrepreneur learns about the project’s quality before the venture capitalist may play a role in the contract type selection. The paper presents a multi-period model in which the optimal contract choice is driven by considerations of monitoring difficulty in an environment of ex post asymmetric information with moral hazard. At the start, the entrepreneur and the venture capitalist contract under symmetric information. Subsequent to the first contract, however, a condition of asymmetric information may arise between the entrepreneur and the venture capitalist with respect to the quality of the project. Dependent on the information and the contract chosen, the project then could be terminated or continued. In the case of continuation the project requires new financing by the venture capitalist. In this setting, three contract types are compared: debt, preferred equity and common equity. The use of debt gives the venture capitalist the option to foreclose the project at the intermediate date after observing that the project is bad (or in a default state). If the entrepreneur learns the project quality before the venture capitalist, however, the foreclosure option embedded in the debt contract may give the entrepreneur the incentive to strategically default on the debt and capture the project payoffs before termination of the project by the venture capitalist. For sufficiently high probabilities of post-contract asymmetric information, therefore, debt may not be desirable or feasible. Under these circumstances an equity contract may be a feasible alternative, due to the lack of foreclosure rights. However, without the foreclosure option the entrepreneur might choose to continue a bad project if the venture capitalist is willing to refinance the project and provide financing for the second stage. For the venture capitalist this inefficiency is

\textsuperscript{14} Observe that this paper does not provide a rationale for the use of debt financing in the first place. This raises the question whether the same incentive effects on the side of the entrepreneur and the venture capital supplier could be achieved with full equity financing (see Hellmann (1993)).
less harmful than strategic default with a debt contract, since the venture capitalist can expect to generate at least some payoffs in the case of inefficient continuation of the project, whereas he receives nothing in the case of strategic default. A preferred or convertible equity contract on its turn may dominate straight equity, because such a contract eliminates the foreclosure option while at the same time preserving some seniority in the event of default. Preferred equity therefore can be obtained at more favorable terms than common equity. The model explains the predominant use of preferred equity in early stage venture capital financing. Debt and common equity are used less frequently in venture capital financing. Where they do appear it is usually in later stage financings and/or in industries where monitoring is less difficult. In these cases the probability of ex post asymmetric information is generally much lower.

Repullo and Suarez (1998) provide a theory of venture capital financing which is based on the complementarity between the advising and financing role of the venture capitalist. This paper rationalizes the use of convertible preferred stock as a contractual solution to a two-sided incentive problem between an entrepreneur and a venture capitalist in the context of stage financing. The paper presents a model in which a wealth constrained entrepreneur needs start-up financing for the initiation of a project, and additional financing for project continuation after the resolution of uncertainty with respect to the project’s profitability. If the expansion investment is undertaken, the entrepreneurial firm’s future profits depend on the extent in which the project is successful. Project success requires a contribution of effort by both the entrepreneur and an independent advisor in the expansion stage. The information with respect to the project’s profitability that becomes available before the expansion decision has to be made is non-verifiable, and thus can not be contracted upon. Furthermore, neither the entrepreneur’s nor the advisor’s effort choices are observable. This creates a two-sided moral hazard problem that interacts with the manner in which the project is financed in the two stages. It can be shown that the optimal contractual arrangement in this setting is for the independent advisor to combine the financing and advising of the entrepreneurial firm in the expansion stage (and thus to act as a venture capitalist). This allows the project returns to be used entirely for incentive purposes, and thus optimizes incentives, since none of the project returns need to be given away to an outside financier as a compensation for the provision of finance in this stage. This arrangement however implies that the venture capitalist needs to buy back any claims that were previously issued in order to finance the start-up investment in the initiation stage. Since this investment is sunk when these claims are bought back,
guaranteeing a repayment to the initial financiers requires protecting their claims against dilution. This imposes an additional burden on the project, since the venture capitalist needs not only to be compensated for the new investment, but also for the costs of paying off the initial financier. The claim of the initial financier thus should be structured such that the costs of this burden are minimized across the states in which the project is continued. The paper shows that the optimal contract should have no or low payments to the initial financier at the lower tail of the distribution of project returns, and high payments at the upper tail. Such a claim closely resembles convertible preferred stock.

Admati and Pfleiderer (1994) analyze the role of common equity 'fixed fraction' contracts in venture capital financing. In this paper the focus is on the dual role of the venture capitalist as an informed provider of finance and as a sender of project quality signals to third party external financiers. The paper presents a two-period model in which an entrepreneur seeks two-stage external financing for a project idea. At the end of the first stage a decision must be made whether the project should be continued (in which case new external financing is required) or abandoned. It is assumed that the entrepreneur receives private (non-contractible) information about the project’s profitability at the end of the first stage. If the project continuation decision is made by the entrepreneur, he always wants to continue the project and overinvestment will occur. As explained before, this is the case since the entrepreneur is not putting up the money needed to continue the project, but stands to gain if the option to continue pays off. This overinvestment problem may be solved if an inside investor (i.e. a venture capitalist) who observes the private information about the project’s profitability is involved in making the subsequent investment decision. The use of an inside investor however can create three types of incentive problems. First, if the venture capitalist has to fully provide the new financing needed for project continuation, but only partly shares in the benefits, he may be inclined to underinvest. Second, the project-specific information that the venture capitalist obtains in his monitoring activities can give him significant bargaining power vis-à-vis the entrepreneur in subsequent rounds of financing. Third, if outside investors are also involved in providing capital to the firm, then they would be at an informational disadvantage relative to the entrepreneur and the venture capitalist. This may induce the venture capitalist to misrepresent the true quality of the project to these investors. The paper shows that the use of fixed fraction contracts, in which the venture capitalist always receives a fixed fraction of the project's payoff and finances that same fraction of future investments, guarantees optimal investment decisions on the side of the firm, and furthermore elimina-
tes any incentives on the side of the venture capitalist to misprice securities in later financing rounds. This unique (renegotiation-proof) contract ensures efficiency in the firm’s continuation decision, and gives the venture capitalist an equity-like position in the firm, so that he is paid a fraction of the total payoffs and finances that same fraction of any future investment. An important feature of such a fixed fraction contract is that, although the venture capitalist purchases new securities in the second financing round, his payoff is independent of the pricing of any newly issued securities. Since the venture capitalist can not gain by mispricing the new securities, he therefore can be given the responsibility of pricing those securities and revealing the information he knows (certification role).

Control Issues

Venture capital contracts explicitly assign substantial control rights to the venture capitalist. These control rights are generally disproportionate to the size of the venture capitalist’s equity investment. This induces a separation of the allocation of control rights from the allocation of cash flow rights in venture capital arrangements\(^{15}\). For example, venture capital arrangements typically incorporate well-specified covenants which assign control to the venture capitalist over actions that could be particularly damaging to him, especially when there is a large scope for conflicts of interest between entrepreneur and financier. Examples are prohibitions of asset sales, restrictions on the purchase of assets, restrictions on the issuance of senior securities, rights of first refusal, mandatory redemption rights, rights to fire the entrepreneur after poor performance and investor rights agreements (see Gompers (1997)). In addition, venture capitalists often maintain voting control and board representation in the firms that they finance. Potential benefits of disproportionate control on the side of the venture capitalist are:

(i) The covenants incorporated in venture capital arrangements reduce moral hazard between firms and financiers, and thus improve financing terms for entrepreneurial firms (Chan, Siegel and Thakor (1990), Gompers (1997), Black and Gilson (1998)).

\(^{15}\) For example, convertibles typically carry the same voting rights as if they already had been converted into common stock. Similarly, board representation is more than proportional relative to the voting rights associated with the venture capitalist’s equity stake. The contributions discussed in this section suggest that it may be optimal to separate the allocation of control rights from the allocation of cash flows in venture capital arrangements.
An efficient allocation of control between entrepreneur and venture capitalist may mitigate distributional conflicts associated with the exit of the venture capitalist through either a future sale of the firm or an IPO (Berglöf (1994), Black and Gilson (1998)).

Chan, Siegel and Thakor (1990) provide a rationale for bundling a venture capitalist’s risky claim on an entrepreneurial firm with disproportionate control, and furthermore explain the use of explicit covenants permitting a passage of control from the entrepreneur to the venture capitalist following a poor performance by the entrepreneur. The paper presents an agency model with symmetric information between an entrepreneur and a venture capitalist as to the entrepreneur’s skills prior to contracting, and post-contract learning that affects the distribution of a project’s state-contingent payoffs, as well as the question of who should control production. The model captures a two-period economy consisting of competitive, risk neutral venture capitalists and risk averse entrepreneurs. In the first period, the entrepreneur approaches a venture capitalist for financing in order to invest in a project that he owns. The project’s payoff at the end of the second period depends both on the skill of the agent in control of the project and on an effort choice by that agent. An agent’s effort choice is ex post unobservable to other agents. Both the entrepreneur and the venture capitalist can manage production. The venture capital’s skill is common knowledge, but the entrepreneur’s skill is unknown to all at the time of contract negotiation and capital investment. The project has two phases. The first period is a developmental phase during which a cash flow is generated and reinvested in the project. This cash flow reveals the entrepreneur’s skill to the entrepreneur and to the venture capitalist. Based on this information, the venture capitalist determines whether to allow the entrepreneur to control production for the second period (the final or production phase of the project) or to transfer control to himself. The agent in control chooses the second period action. At the end of the second period a cash flow is realized, which is shared by the entrepreneur and the venture capitalist in accordance with initially agreed upon contractual provisions. In this model structure it can be shown that the optimal (renegotiation proof) contract between the entrepreneur and the venture capitalist is for the venture capitalist to pay the entrepreneur a fixed compensation if he controls production in the second period. This ensures efficient risk sharing between the risk averse entrepreneur and the risk neutral venture capitalist and eliminates moral hazard. Furthermore, the optimal venture capital contract contains the performance requirement.
that the entrepreneur retains control in the second period if and only if his revealed skill level exceeds a critical minimum value. If the entrepreneur remains in control, finally, both the entrepreneur and the venture capitalist receive risky payoffs, which depend on the skill level of the entrepreneur.

Berglöf (1994) analyzes how an entrepreneur and a venture capitalist can allocate revenues and control among themselves in a venture capital relationship, given that they want to liquidate their holdings in the future. This paper demonstrates how the parties to venture capital arrangements should design the firm's capital structure in order to mitigate the distributional conflicts associated with a future sale of the firm, and provides a rationale for the use of convertible securities (convertible preferred stock or convertible debt). The argument developed in the paper is that the (state-contingent) allocation of returns and control that is achieved by convertible securities protects the initial contracting parties as much as possible against dilution and extracts rents from a future buyer of the firm. This argument is explored in an incomplete contracting framework in which the allocation of the right to sell control in the entrepreneurial firm determines who bargains with a new owner-manager. Once in control, the new owner-manager (buyer) takes over management from the entrepreneur and either increases the value of the claims of the non-controlling party (if a good state occurs) or dilutes them by stripping assets (in the bad state). The old controlling party is protected against dilution, but can not free-ride on efficiency improvements brought about by a new owner/manager; the reverse is true for the old non-controlling party. In particular, when the venture capitalist has control, he bargains with the buyer and makes sure his claims are paid in full. The new manager then fires the entrepreneur without appropriate compensation. When the entrepreneur has control, he bargains with the buyer and will not sell unless he is fully compensated for his private benefits of controlling the firm. The claims of the venture capitalist in this case increase in value following efficiency improvements (in the good state), but decrease in case of dilution (in the bad state). Private benefits are more important in good states of nature, whereas asset stripping is more likely to occur in the bad state (since the firm's assets then are worth more in alternative uses outside the firm). Since the prevailing state of nature is non-verifiable (and hence non-contractible), the optimal contract can not be made contingent on the optimal actions in the good and bad state (continuation and liquidation respectively), but allocates control to the party which can extract the highest rents from the future buyer of the firm in the respective states. The paper thus shows that control should be state-contingent. That is, the entrepreneur should have control in the
good state, in order to be guaranteed adequate compensation for his private benefits of control, whereas the venture capitalist should be in control in the bad state, since he cares more about firm value. Although this control allocation can be obtained by the use of straight debt, the payoff structure to the contracting parties can further be improved upon by the use of convertible debt or convertible preferred equity. The intuition is that the use of a convertible security allows the venture capitalist to benefit from efficiency improvements made by the buyer by converting his debt or preferred stock into common equity. This increases the venture capitalist’s expected payoff and reduces the financing costs to the entrepreneur.

Black and Gilson (1998) also consider the venture capitalist’s exit decision, but focus on exit by the venture capitalist through an IPO\textsuperscript{16}. The paper presents an informal control theory which links the success of venture capital financing to the development of the stock market in an economy. The potential for the venture capitalist to exit an investment in a successful start-up firm through an IPO allows the venture capitalist and the entrepreneur to enter into a valuable implicit contract concerning the future control of the firm. The intuition behind this argument is as follows. Entrepreneurs place a substantial private value on control in their own firm. However, uncertainty with respect to the entrepreneur’s skills results in the venture capitalist requiring substantial control during the early stage of the financing relationship. Once the start-up firm succeeds and entrepreneurial skill has become known, it may be beneficial to return control to the entrepreneur. The possibility to exit through an IPO now allows the entrepreneur and the venture capitalist to enter into a self-enforcing implicit contract over control, in which the venture capitalist agrees to return control to a successful entrepreneur by exiting through an IPO. That is, the venture capitalist commits ex ante to transfer control back to the entrepreneur, conditional on success of firm. The opportunity to acquire control through an IPO exit if the company is successful gives the entrepreneur a powerful incentive beyond the purely financial gains from the increased value of his shares in the firm. In effect, the prospect of an IPO exit gives the entrepreneur a call option on control, exercisable contingent on the firm’s success. This improves the entrepreneur’s incentives. Observe that such an improvement in incentives can not easily be duplicated if sale of the portfolio company is

\textsuperscript{16} The three most common ways for the venture capitalist to exit his investment are: (1) an initial public offering; (2) sale of the portfolio company to another (larger) company, and (3) leveraging the portfolio company such that it can repurchase the venture capitalist’s stake (this option is generally not available for fast growing entrepreneurial start-up firms (see e.g. Black and Gilson (1998))).
the only exit option, since in this case control passes to the acquirer instead of the entrepreneur.

Hellmann (1998) finally examines the effects of the allocation of control rights in venture capital contracts (including the right to fire the entrepreneur) on the venture capitalist’s incentives to search for a superior management team to replace the entrepreneur in later financing stages. This paper addresses the question why entrepreneurs voluntarily relinquish control rights to the venture capitalist in the start-up stage, even though the contractual arrangements they enter into afford little protection in case they are fired. The author presents a model in which entrepreneurs capture private benefits of control. A change of management involves a conflict of interest, since entrepreneurs want to protect their own private benefits, whereas venture capitalists want to maximize their financial returns. The level of private benefits is endogenous, since entrepreneurs take non-verifiable actions which affect the output of the firm by trading off the financial performance of the firm and their private benefits. This reflects that entrepreneurs may not act solely in the interest of the firm. Since entrepreneurs are wealth-constrained this problem can not fully be solved by giving entrepreneurs an equity stake in their company. Venture capitalists need to invest in search effort to find a superior management team. In the case of entrepreneurial control, entrepreneurs can hold up replacement and extract rents from renegotiation, resulting in insufficient search effort on the side of the venture capitalist. Allocating control rights to the venture capitalist would protect the venture capitalist from this hold up problem. This provides the correct incentives for the venture capitalist to search for a superior management team. In this context the author derives the entrepreneur’s optimal base wage, his equity stake, a severance package (including the terms of vesting) and the allocation of control rights. The paper shows that if the net benefit of a change in management is positive, the entrepreneur always wants to relinquish control rights to the venture capitalist. If the net benefit of change is negative, then the entrepreneur trades off giving the venture capitalist either more favorable financial terms (by retaining a smaller equity stake in the company) or more favorable control terms. The former increases agency costs, and thus reduces the value of the firm, whereas the latter increases the probability of a value-reducing change in management and a loss of private benefits of control. The model also explains why entrepreneurs accept vesting of their stock and low severance.
3.3 Other Features of Venture Capital Financing

Use of Syndicates

Venture capitalists generally tend to syndicate their investments, especially in the first round of financing (see Lerner (1994)). Potential benefits of syndication are:

(i) Syndication allows the venture capitalist to diversify. By syndicating investments, venture capitalists can invest in more projects and largely diversify away firm-specific risk.

(ii) Syndication can reduce adverse selection problems. Venture capitalists are more comfortable with an investment opportunity when other venture capitalists of similar (or better) expertise are willing to invest as well. Involving other venture capital firms provides a second opinion on the investment opportunity. Syndicating first round venture investments thus may lead to better decisions about whether to invest in firms (Barry (1994), Lerner (1994)).

(iii) Syndication may serve as a commitment device of a lead venture capitalist to ensure that outside investors are available for future financing rounds. This is the case since information sharing within the syndicate reduces the lead venture capitalist’s informational monopoly, and creates outside competition (Hellmann (1993)).

A drawback of syndication is that it may provide a mechanism through which venture capitalists exploit informational asymmetries and collude with other syndicate members to overstate their performance to potential outside (third-party) investors\(^ {17} \).

Admati and Pfleiderer (1994) develop a rationale for syndication in later financing rounds that is based on the existence of information asymmetry between the initial venture capital investor and other potential investors. A venture capitalist who is involved in the firm’s daily operations may exploit this informational advantage, overstating the proper price for the securities in the next financing round. The only way to avoid this opportunistic behavior is if the lead venture capitalist maintains a constant share of the firm’s equity (see Section 3.2). This implies that later round financings must be syndicated.

\(^{17}\) Note however that this can also occur in the presence of only one venture capitalist (see Admati and Pfleiderer (1994)).
Performance Based Payment

A final feature of venture capital arrangements that could be mentioned is the use of performance based compensation in the entrepreneur's remuneration scheme. The entrepreneur generally receives a low base salary (Chan, Siegel and Thakor (1990)), and an equity interest in his firm. The dilution of the entrepreneur's equity interest over time furthermore is related to the start-up's performance. That is, the venture capitalist can significantly dilute the entrepreneur's stake in subsequent financings if the firm fails to meet its targets (Barry (1994), Sahlman (1990)). Remuneration schemes like these serve as a signalling device with respect to the entrepreneur's quality, and also improve entrepreneurial effort (Sahlman (1991)). In addition, venture capitalists can fire inefficient entrepreneurs. In this case venture capitalists generally require vesting of the entrepreneur's stock or options over a multi-year period. In this way the entrepreneur can not leave the firm and take his shares (Gompers and Lerner (1998), Hellmann (1998)).

Finally, lock-up provisions may prohibit corporate insiders (entrepreneurs and venture capitalists) from selling part of their shares in the firm at the time of an initial public offering. This reduces potential conflicts on interest between insiders and investors in the certification process (Gompers and Lerner (1998)).

4 Shortcomings in Financing Forms and Institutional Arrangements; Government Intervention

The financing of entrepreneurial start-up firms in an economy can only be

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18 Most of the existing literature that addresses compensation issues focuses on the design of remuneration schemes for the venture capitalist in order to mitigate potential incentive problems between managers of venture funds and investors (see e.g. Sahlman (1990) and Gompers and Lerner (1998)). Since our focus is on the relationship between venture capitalist and entrepreneur, we do not discuss these contributions in this chapter.

19 This is similar to the use of an 'earn-out arrangement' in early stage venture capital financing. Earn-outs are used when the entrepreneur's valuation of the venture differs a lot from the venture capitalist's estimate of the value of the firm. In order to facilitate financing, both parties may then agree to the venture capitalist paying a fixed amount of capital at the outset, and an additional amount conditional on the early stage performance of the venture. Since these arrangements are comparable with stage financing, we do not discuss them separately in this chapter.

20 A final contractual feature that could be mentioned is that venture capital arrangements often specify that the entrepreneur needs to stay with the firm for a specified period of time, or cannot start a competing company. This ensures that the manager cannot run away with the venture capitalist's money and invest it in another venture.
guaranteed sufficiently if the 'institutional arrangements' in the economy (i.e. the supply channels of capital and the available contractual arrangements and financing forms) are developed and function at a satisfying level\textsuperscript{21}. If this is not the case, technological innovation may be frustrated, resulting in an undersupply of entrepreneurial activity. This may warrant government intervention in the economy. In this section we discuss how a government may stimulate entrepreneurial activity in the economy by intervening in the market for venture capital.

4.1 Rationales for Government Intervention in the Market for Venture Capital

A lack of entrepreneurial initiative and innovation in an economy may be caused by problems on the demand side and/or the supply side of the market for risk capital. In both cases government intervention may be desirable.

On the supply side, private sector financiers may provide insufficient amounts of risk capital to new firms in particular industries. Four potential reasons for this observation have been discussed in Section 2 of this chapter. A first rationale for government intervention therefore would be to stimulate the supply of risk capital in the economy. A government can do this \textit{directly} through either direct subsidization of entrepreneurial firms (i.e. by supplying capital herself), or through public policy measures that are directed towards increasing the attractiveness to capital suppliers in the private sector of providing financing to start-up firms\textsuperscript{22}. Furthermore, a government could play an important \textit{indirect} role in identifying firms for which investments will ultimately yield high social and/or private returns, and in certifying the quality of entrepreneurial firms to third-party (private sector) investors. This allows the government to address specific information asymmetries that might otherwise preclude investments by conveying information to other potential investors (Lerner (1998))\textsuperscript{23}. As a consequence, the provision of funds to start-up compa-

\textsuperscript{21} For a more elaborate discussion of the unique role of banks and venture capitalists in addressing and overcoming problems of asymmetric information and market failure, see Chapter 2.

\textsuperscript{22} Examples of public policy measures that are aimed at increasing the supply of risk capital will be discussed later in this chapter (see Section 4.3 and Section 5).

\textsuperscript{23} The informational advantage of a government over venture capital investors may arise from government officials’ or institutes’ superior knowledge of relevant developments in particular industries. Government certification may be a valuable signaling device in technology-intensive industries, where traditional financial measures are insufficient or misleading. For example, specialists at the National Institute for Health may have considerable insight into which biotechnological innovations are the most promising (see
nies may increase, since start-up firms may be able to attract additional capital in the private sector in order to grow more rapidly. In addition, this may attenuate the 'chicken and egg' problem discussed in Section 2 and stimulate the development of expertise in the venture capital industry.

On the demand side, an important rationale for government intervention stems from the potential divergence between an entrepreneur's private returns from investing in innovation and the social returns from such investments. The social returns associated with innovation generally exceed the private returns. Investment in R&D-expenditures may have positive externalities (spillovers) that benefit other firms or society as a whole\(^2\). But because firms that make these investments are unlikely to capture all the surplus, these firms tend to invest below the socially optimal level of R&D (Lerner (1998)). Public intervention then may be an appropriate response, since the government could compensate the entrepreneur for the favorable externality associated with this investment.

This argument can be illustrated in more detail in the context of risk. Entrepreneurs in start-up firms face high uncertainty, and furthermore may need to take large equity stakes in their own firms due to informational problems (see Leland and Pyle (1977)). Two possible cases may occur. If the entrepreneur is sufficiently wealth constrained, he may not be able to take the desired equity stake, and external financing is precluded (see Section 2 and also Chapter 2). This results in underinvestment. But even if a risk averse entrepreneur is less wealth constrained, he is forced to bear a significant amount of idiosyncratic risk. The systematic risk of the project in this case is not a sufficient statistic of the entrepreneur's project risk. This induces the entrepreneur to impose a higher cost of capital on his project. As a consequence, the project may become a negative NPV project because of its high idiosyncratic risk, and thus may not be undertaken. The high cost of capital implies that only projects with a (prohibitively?) high quality could be financed. Since an individual entrepreneur does not take the positive externalities of his investment project into account in making his investment decision, the degree of innovative activity in the society thus depends on the degree of risk aversion on the side of the entrepreneur. This results in too little innovation and entrepreneurial

\(^{2}\) An example would be the large investments in the defense industry and NASA that have been subsidized and financed by several US government programs in the past decades. These investments resulted in inventions and innovations with a broad applicability and a large value to society. Another example would be investments in pollution control equipment, which clearly benefit the whole society.
initiative in the economy (Keynes’ animal spirits)\textsuperscript{25}.

Although the risks that an entrepreneur needs to absorb can be enormous, these risks may be quite bearable for a society at large. That is, the risk-absorbing capacity of any individual entrepreneur is less than that of society. From a societal point of view, this would lead to an undersupply of entrepreneurial activity. Government intervention may then try to shift some of the risks away from the individual, and could thus stimulate entrepreneurship. One possible way for a government to intervene would be through the process of patenting across industries and firms. The use of patents prevents an immediate distribution and dispersion of innovation, and thus allows the entrepreneurial firm to capitalize on its investments ex post, thus stimulating innovative activity. The use of licensing and patents however is only an option in certain industries. An alternative, more general and potentially superior, means to stimulate investments would be to make capital effectively less expensive, by reducing the cost of capital for entrepreneurial firms in the venture capital market. This will be our main focus in the remainder of this section.

Government policy can have a dramatic impact on the current and long-term viability of the venture capital sector. Only very recently have researchers begun to examine the ways in which policy makers can catalyze the growth of venture capital and the companies in which they invest\textsuperscript{26}. In the remainder of this section we present a simple model that analyzes the effect of different policy measures on the supply of risk capital and on the supply of entrepreneurial activity in the economy. In Section 5 we will subsequently review and evaluate the Dutch measures of government intervention in the market for risk capital in the context of this model structure.

\textsuperscript{25} Note that with venture capital financing the discount rate imposed on highly uncertain long-term projects is high as well. Although this may result in adverse selection and moral hazard problems (see Section 2), venture capitalists argue that by playing a positive role in the venture, they can increase a start-up firm’s value enough to offset the high cost of capital they charge, for example by reducing adverse selection and by screening entrepreneurs to make sure they are qualified (see also Sahlman (1991)).

\textsuperscript{26} Empirical studies with a focus on the US have shown that government policy has had a positive and significant impact on economic growth. Some of America’s most dynamic technology companies received support through government programs, like the SBIR program (e.g. Apple, Compaq, Federal Express and Intel). In addition, publicly sponsored funds contributed to the development of expertise in the venture capital sector (see Gompers and Lerner (1997) and Lerner (1997)).
4.2 A Simple Model of Government Intervention in the Market for Risk Capital

Model Setup

Consider an economy with a large number of risk neutral entrepreneurs, which all need to invest an amount \( k \) in search costs or innovative activity in order to find an investment project (or to generate a project idea). Each investment project needs $1 of external financing. The contractible end-of-period return of each project has a probability distribution with a two-point support: with a probability \( p \in [0,1] \) the end-of-period project return will be \( X > 1 \), with a probability \( 1-p \) the end-of-period project return will be zero. If an entrepreneur invests \( k \) he will find a project with a success probability \( p \), with \( p \) uniformly distributed on the interval \([0,1]\). The probability \( p \) that the project is successful can be viewed as an indicator of project quality. We assume that entrepreneurs do not differ with respect to the quality of the project that they find. Entrepreneurs can be characterized by the level of their search costs \( k \), with \( k \) uniformly distributed on \([k,k]\). Although entrepreneurs know their own search costs, \( k \) is not observable by outsiders\(^{27}\).

Each entrepreneur who invests in search effort will seek external financing from a risk neutral capital supplier. If the entrepreneur does not invest in his project he can invest in an alternative investment project which yields him an expected net return equal to zero\(^{28}\). The capital supplier provides risk capital (risky debt and/or equity). For expositional reasons we assume that the capital supplier provides risky debt\(^{29}\). The potential

\(^{27}\) We can think of the entrepreneurs as having a level of initial wealth equal to \( k \). We assume that each entrepreneur then either invests \( k \) in search effort or fully consumes \( k \) at \( t=0 \). The level of search costs could be interpreted as an indicator of the entrepreneur's skills. Better quality entrepreneurs would be able to find attractive projects with lower search costs. Alternatively, we can interpret \( k \) as the amount of (costly) personal effort that the entrepreneur needs to exert in order to learn the quality (or success probability) of his project.

\(^{28}\) The assumption that an entrepreneur who invests in search effort will always seek external financing captures the idea that the entrepreneur may derive private benefits from running his own firm (see Section 2). We have not explicitly modeled these private benefits. Incorporating such benefits however would not qualitatively change our results, as long as the entrepreneur always prefers to invest in the innovative project if this is beneficial to him, i.e. if his private rents are preserved in the case of project investment.

\(^{29}\) This assumption allows us to illustrate the incentive effects of (partial) loss-sharing arrangements later on. The assumption is consistent with the contractual claims used in early stage venture capital financing, since venture capitalists generally provide funding in the form of convertible (or subordinated) debt and/or convertible preferred stock (see Sahlman (1990) and Section 3 of this chapter). Since the focus in this section is on the impact of government intervention on the supply of entrepreneurial activity in the economy, we do not address contracting issues, and thus do not worry about conversion of the debt or preferred equity in later stages.
capital supplier of the firm does not know the success probability of the project, but can learn about project quality by investing in costly screening effort \( e \) prior to financing. The costs of screening equal \( C(e) \) with \( C(0)=0 \), \( C'(e)>0 \) and \( C''(e)>0 \). If the capital supplier chooses a level of screening effort \( e \), he will learn the project quality with a probability \( e \in [0,1] \). With a probability \( 1-e \) he will learn nothing about the project. If the capital supplier learns nothing, he will not invest in the project but instead will invest in a riskless storage technology which generates a certain payoff equal to 1 (we assume that the riskfree interest rate is zero). We assume that the market for risk capital is not completely competitive. That is, entrepreneurs would incur some fixed costs in order to find another capital supplier and/or better financing terms in the market. This gives the capital supplier the possibility to extract rents equal to \( R \in (0,1) \) from the entrepreneur\(^30\).

The sequence of events in the model is as follows. At \( t=0 \) entrepreneurs decide whether or not to invest in search effort in order to find a project. At \( t=1 \) they seek external financing if they invested in search effort. The capital supplier then invests in screening effort, potentially learns project quality, and subsequently decides whether or not to finance the project. If the capital supplier wants to finance the project he sets the financing terms (i.e. the interest rate). The entrepreneurs then decide whether or not to invest in their project. At \( t=2 \) cash flows are realized and repayments are made if possible. In the remainder of this section we analyze an entrepreneur's incentives to invest in search effort and his ultimate investment decision, and the capital supplier's screening decision. All the proofs of the results that we derive in this section are given in the Appendix.

**Analysis**

We first consider the case of complete selffinancing. In the absence of outside financing each entrepreneur who has exerted a search for a project would want to invest in the project if and only if \( pX-1 \geq 0 \), i.e. if \( p \geq X^{-1} = p^* \). Given this optimal investment

\(^30\) In our model formulation we assume that part of these 'rents' \( R \) is a compensation for the capital supplier's screening costs. This compensation allows the capital supplier to break even in the absence of any 'true' rent extraction. For simplicity reasons, we assume that \( R \) is strictly larger than the screening costs that correspond with the capital supplier's first best effort decision, and - more importantly - that \( R \) is constant. This assumption implies that \( R \) would not vary with the capital supplier's screening intensity, and thus that the 'true' control rents as a proportion of \( R \) would decrease monotonically in \( e \). Although this assumption is restrictive (it implies a significant rigidity in the interest rate set by the capital supplier), it makes the model analysis more tractable by allowing us to 'separate' the entrepreneur's investment decision from the capital supplier's screening decision. We will return to this issue in Section 4.4.
strategy an entrepreneur only wants to exert search effort if 
\[-k + \int_0^1 [pX-1] dp \geq 0,\]
i.e. if \( k \leq \frac{(X-1)^2}{2X} = k^* \). If we normalize the entrepreneurs in the economy such that

they have a (Lebesgue) measure 1, and define \( K = \frac{k-k}{k-k} \), the first best measure of

entrepreneurs in the market equals \( K^* \) and the first best measure of projects undertaken
equals \( K^*(1-p^*) \).

In the case of outside financing the entrepreneur would want to invest in his project if and only if \( p[X-r] \geq 0 \), i.e. if \( r \leq X \). For any project that the capital supplier would be willing to finance he charges an interest rate \( r \) which yields him rents equal to \( R \), i.e. he

sets \( r \) equal to \( \frac{1+R}{p} \). We assume that \( X<2 \). This assumption guarantees that the capital

supplier would not want to finance a project if he doesn’t learn about the project’s quality
after screening, or if he doesn’t screen. We now have the following result.

Result 1: Define \( \hat{p} \) as the minimum project quality for which the entrepreneur would want
to invest in the case of outside financing, and define \( \hat{k}(e) \) as the maximum search costs for
which the entrepreneur would want to engage in innovative activity. Then \( \hat{k}(e)<k^* \) and
\( \hat{p}>p^* \). Furthermore, \( \hat{k}(e) \) is monotonically increasing in \( e \).

Result 1 states that outside financing results in too little entrepreneurial activity in
the economy. The intuition of this result is straightforward. In the case of outside
financing an entrepreneur would only choose the first best levels of investment in search
effort and project quality if he is charged the full information rate in a perfectly competi­
tive market. Since the capital market is not fully competitive, the capital supplier extracts
some rents from the entrepreneur if he finances the project. This makes outside financing
more expensive. Entrepreneurs therefore would only be willing to finance projects with a
higher gross expected payoff, i.e. with a higher \( p \) (\( \hat{p}>p^* \)). Observe that if \( X<1+R \)
complete market failure occurs, and no investment projects would be financed. Furthermore, since due to the informational asymmetry the entrepreneur would get financing only with a probability \( e < 1 \), the marginal return to exerting search effort decreases. This reduces the entrepreneur's incentives to find projects. As a result, fewer entrepreneurs will be in the market (i.e. the measure of entrepreneurs investing in search effort decreases from \( K^* \) to \( \hat{K}(e) \)) and the measure of projects undertaken decreases to \( \hat{K}(e)(1-\hat{p}) \).

Next we consider the capital supplier's screening decision. Given his financing strategy and the entrepreneur's investment strategy, the capital supplier solves the following optimization problem:

\[
\max_{e} \int \left[ p \times r - 1 \right] dp - C(e)
\]

subject to expression (1) being larger than or equal to zero. The following result can now be derived.

**Result 2:** Let \( \hat{C} = (1-\hat{p})R \). Then, if \( C(\hat{e})\hat{e}^{-1} < \hat{C} \) the capital supplier chooses a level \( \hat{e} \) of screening effort, and entrepreneurs with a measure \( \hat{K}(\hat{e}) \) would invest in innovation. If \( C(\hat{e})\hat{e}^{-1} > \hat{C} \) the capital supplier chooses screening effort \( \hat{e} < \hat{e} \). In this case only entrepreneurs with a measure \( \hat{K}(\hat{e}) < \hat{K}(\hat{e}) \) choose to invest in search effort. The effort levels \( \hat{e} \) and \( \hat{e} \) are defined in the Appendix.

The intuition is as follows. If the capital supplier's screening costs are not too high, he makes a positive profit if he chooses his profit-maximizing level of screening effort \( \hat{e} \). In this case all entrepreneurs with search costs \( k \leq \hat{K}(\hat{e}) \) choose to invest in search effort and to enter the capital market. For high screening costs, the capital supplier will not be able to break even if he chooses \( \hat{e} \). In this case the level of screening effort \( \hat{e} \) chosen is determined by his zero profit condition, and hence is smaller (corner solution). Since this decreases the probability that the capital supplier learns about the entrepreneur's project quality, the probability that he will finance the project will be lower. Entrepreneurs which rationally anticipate this will therefore have lower incentives to enter the market. The measure of entrepreneurs who invest in a search for innovation thus decreases (\( \hat{K}(\hat{e}) < \hat{K}(\hat{e}) \)).

Both Result 1 and Result 2 thus illustrate that informational asymmetries and/or
other capital market imperfections may frustrate the development of entrepreneurial activity in the economy, and may even result in a total market breakdown (this is the case if $X < 1 + R$). We next consider how government intervention may mitigate the underinvestment in both value-generating projects and in entrepreneurial search effort by reducing market frictions.

4.3 Measures of Government Intervention

We distinguish three ways in which a government could intervene in the capital market in this economy\(^{31}\). The first two ways address the supply side of the market for risk capital, whereas the third measure is directed towards the demand side. First, the government can provide a government subsidy which allows the capital supplier to (partially) recover his screening costs. This subsidy could be interpreted as a one-time payment which compensates the capital supplier for the 'start-up' costs of entering a specific industry. Later on, the capital supplier then may benefit from information reusability and developed expertise. Second, the government could (partially) guarantee loans extended by capital suppliers in the private sector (such as banks and/or private venture capitalists) in order to facilitate the provision of risk capital by those capital suppliers. In this case private sector capital suppliers are partially compensated for the potential losses that they may incur in the financing of entrepreneurial firms. As will be shown below, each of these measures is aimed at increasing the level of screening effort on the side of the capital supplier, and thus the number of projects in the economy that could be financed. This, on its turn, would increase the level of entrepreneurial activity (see Result 1). Third, the government could provide direct financing to entrepreneurial firms, either as a single financier, or as part of a syndicate. This could embody the provision of risk capital, but could also represent direct government support and subsidies to entrepreneurs, in order to compensate them for the positive externalities which are associated with their investments\(^{32}\). We will analyze the impact of each of these public measures described below are roughly consistent with the public policy measures observed in different countries (see Gompers and Lerner (1997) for an overview of the main features of these measures in a large number of OECD countries, and Lerner (1997) for a more detailed description for the US). The specific case of the Netherlands will be discussed in Section 5.

Note that in this case no private sector involvement would be necessary. The provision of direct financing, however, would be no solution to the capital market imperfections discussed earlier in this chapter, since it is not directly aimed at correcting market failure.
policy measures below.

Government Subsidy to Capital Suppliers

In the case of a government subsidy, the government could pay the capital supplier either a lump sum payment $\gamma$ or a subsidy equal to a proportion $\delta \in (0,1]$ of the capital supplier's screening costs $C(e)$. The following result shows that a lump sum payment could be beneficial if the capital supplier's screening costs are relatively high. This may particularly be the case if the capital supplier has little expertise in the industry in which the entrepreneur operates.

**Result 3:** A lump sum government subsidy $\gamma$ improves the capital supplier's screening intensity only if his screening costs are relatively high, i.e. if $C(\hat{e})\hat{e}^{-1} > \hat{C}$. The maximum measure of entrepreneurs that invest in innovation with this measure equals $\hat{K}(\hat{e})$. The corresponding level of the lump sum subsidy equals $\gamma = C(\hat{e})\hat{e}^{-1} - \hat{C}$.

The intuition is as follows. Government intervention through the use of a subsidy is aimed at increasing the level of screening effort exerted by the capital supplier. Since a lump sum government subsidy does not directly affect the capital supplier's optimal choice of screening effort (i.e. $\gamma$ doesn't enter the capital supplier's first order condition), it can only increase the capital supplier's screening intensity if it relaxes his zero profit constraint. This is the case if the capital supplier's costs of screening are relatively high (i.e. if $C(\hat{e})\hat{e}^{-1} > \hat{C}$). Since the capital supplier's zero profit condition then is binding for a level of screening effort $\hat{e} < \hat{e}$, a government subsidy $\gamma$ may make a higher level of screening effort feasible. The maximum level of screening effort $\hat{e}$ then can be attained for a government subsidy $\gamma = C(\hat{e})\hat{e}^{-1} - \hat{C}$. In this case the measure of entrepreneurs that engages in search effort and enters the capital market equals $\hat{K}(\hat{e})$ and the measure of projects that are undertaken equals $\hat{K}(\hat{e})(1-p)$. If the capital supplier's screening costs are relatively low, a lump sum government subsidy is not needed, since it would not improve the capital supplier's screening effort, but would only transfer wealth from the government to the capital supplier. We next consider a government subsidy which is proportional to the capital supplier's screening costs $C(e)$. The following result can be derived.

**Result 4:** A proportional government subsidy $\delta C(e)$ always increases the capital supplier's screening effort. As a consequence, the measure of entrepreneurs in the economy who
The intuition is as follows. A government subsidy which is proportional to the capital supplier’s screening costs directly affects his screening intensity (i.e., $\delta$ enters the capital supplier’s first order condition). This improves the capital supplier’s incentives to screen irrespective of the level of his screening costs. In addition, the subsidy relaxes the capital supplier’s zero profit constraint. Consequently, the maximum level of effort that can feasibly be attained with a proportional subsidy is higher than in the absence of a government subsidy. Since the higher level of screening intensity exerted by the capital supplier increases the probability that an entrepreneur can finance his project, the entrepreneur’s willingness to invest in innovation increases. As a consequence, the measure of entrepreneurs who search for innovative projects becomes larger. The following result compares the capital supplier’s screening incentives for both types of subsidies.

**Result 5:** There exists a minimum proportion $\hat{\delta} \in (0,1)$ for which a proportional government subsidy would always result in a higher level of screening effort than a lump sum subsidy, and thus would maximize the supply of entrepreneurial initiative in the economy. The proportion $\hat{\delta}$ is defined in the Appendix.

From Result 4 it is clear that the effort level which optimizes the capital supplier’s expected profit with a proportional subsidy is higher than with a lump sum subsidy. Whether such a higher screening intensity will materialize, however, depends on the capital supplier’s zero profit constraints under both types of subsidies. If the capital supplier’s zero profit constraint without a government subsidy is non-binding, then the capital supplier’s screening effort always improves with a proportional government subsidy, since such a subsidy relaxes the capital supplier’s (non-binding) zero profit constraint and makes higher effort levels feasible. If the capital supplier’s zero profit constraint in the absence of a government subsidy is binding, then the resulting level of screening intensity depends on the extent in which the respective government subsidies relax the capital supplier’s zero profit constraint. Different cases can be distinguished. If the capital supplier’s zero profit constraint is non-binding under both subsidy types, then the screening intensity increases most with a proportional subsidy (the higher optimal effort level with a proportional subsidy then is feasible). If the capital supplier’s zero
profit constraint is non-binding under a lump sum subsidy, but binding under a proportiona
l subsidy, then screening incentives can improve only if the zero profit constraint with a
proportional subsidy is sufficiently lax. This is the case for \( \delta \) sufficiently large (\( \delta \geq \delta_0 \)). If
the capital supplier’s zero profit constraint with a lump sum subsidy is binding, whereas it
is not with a proportional subsidy, then again a higher screening intensity would be
feasible. Finally, if both zero profit constraints are binding, then incentives with a
proportional subsidy will improve only if the capital supplier’s zero profit constraint is
less strict for a proportional subsidy than for a lump sum subsidy, i.e. for \( \delta \) sufficiently
large (\( \delta \geq \delta_0 \)).

As a final remark, observe that the use of government subsidies is only beneficial
if these subsidies positively affect the capital supplier’s screening incentives. The potential
unobservability of the capital supplier’s actual screening choices however may give rise to
effort aversion moral hazard on the side of the capital supplier after the subsidy is
provided. This problem could be mitigated if an outside auditor or other third party could
either directly observe the screening exerted by the capital supplier (note that this is only
possible if the level of screening effort is verifiable), or could measure the amount of
financing that the capital supplier is willing to provide as a consequence of the availability
of government subsidies. The argument here is that, since \( X < 2 \), it is not beneficial for
the capital supplier to provide financing to an entrepreneur if he doesn’t screen. Such a
solution could guarantee an efficient implementation of this measure of government
intervention.

**Loss-Sharing Arrangement (Provision of Government Guarantees)**

In the case of a loss-sharing arrangement (or equivalently, a government guarantee)
the government compensates the capital supplier for (a fraction of) the potential losses that
he incurs on the capital provided to the entrepreneur. Let \( \rho \in (0,1] \) be the proportion of
the losses that are guaranteed by the government. Since the capital supplier now will be
repaid with a higher probability, the interest rate \( r(\rho) \) that he charges in the imperfectly
competitive capital market equals \( \frac{1+R}{p+(1-p)\rho} \). The following result can be derived.

**Result 6:** Let \( X > 1+R \). Then there exists an optimal proportion \( \rho^* \in (0,1) \) of loss-sharing,
such that the entrepreneur makes the first best project investment decision. For \( \rho < \rho^* \)
underinvestment (as described in Result 1) will persist, whereas \( \rho > \rho^* \) will result in overinvestment. The proportion \( \rho^* \) is defined in the Appendix.

The intuition is straightforward. Since the government partially subsidizes the capital supplier’s losses, the capital supplier will be repaid with a higher probability. The interest rate that he needs to charge in order to yield a rent equal to \( R \) consequently is lower. This makes lower quality projects more attractive to entrepreneurs, thus decreasing the minimum quality \( \hat{p}(\rho) \) of the projects that he is willing to undertake. This drives the entrepreneur’s project choices more towards first best. If \( X > 1 + R \), the minimum project quality \( \hat{p}(\rho) \) of the projects that will be undertaken furthermore decreases with the proportion \( \rho \) of loss-sharing. If \( \rho \) is too low (i.e. \( \rho < \rho^* \)) underinvestment will still occur, since \( \hat{p}(\rho) > p^* \). However, since \( \hat{p}(\rho) < \hat{p} \) for all \( \rho \in (0, \rho^*) \) the degree of underinvestment is smaller than in the absence of a government guarantee. On the other hand, if \( \rho \) is too high (i.e. \( \rho > \rho^* \)) negative NPV projects would be financed (overinvestment), since \( \hat{p}(\rho) < p^* \). In the extreme, in the case of full risk-sharing (i.e. for \( \rho = 1 \)) the capital supplier’s loan becomes riskless. In this case entrepreneurs would always want to invest if \( X > 1 + R \). First best project investment therefore would only be realized in the case of partial risk-sharing, i.e. for an interior optimal level \( \rho^* \in (0,1) \). We now consider the consequences of loss-sharing for the capital supplier’s screening incentives and the entrepreneur’s incentives to invest in innovation.

Result 7: Let \( \hat{e}(\rho) \) be the capital supplier’s screening effort in the case of a loss-sharing agreement with a proportion \( \rho \), and let \( \hat{K}(\hat{e}(\rho)) \) be the measure of entrepreneurs that search for innovative projects. Furthermore, let \( X \leq 2(1+\rho)^{-1} \). Then \( \hat{e}(\rho) > \hat{e} \) and \( \hat{K}(\hat{e}(\rho)) > \hat{K}(\hat{e}) \) for all \( \rho \in (0,1) \).

Result 7 states that a (partial) loss-sharing arrangement improves the capital supplier’s screening incentives. This is the case because the government guarantee increases the entrepreneur’s willingness to undertake investment projects (see Result 6). Since the capital supplier can extract rents from each project that he finances, screening now becomes more attractive. The entrepreneur’s incentives to invest in innovative search effort now improve for two reasons. First, the measure of projects that are attractive to the entrepreneur increases (i.e. \( \hat{p}(\rho) < \hat{p} \)). Second, the probability that the capital supplier is willing to finance these projects increases (i.e. \( \hat{e}(\rho) > \hat{e} \)). As a consequence, the measure
of entrepreneurial projects undertaken in the economy increases, i.e. \( \hat{K}(\hat{\epsilon}(\rho))(1-\hat{\rho}(\rho)) > \hat{K}(\hat{\epsilon})(1-\hat{\rho}) \).

As stated in Result 6, a drawback of a proportional government guarantee is that it may result in too many projects being undertaken in the economy. This is the case if the proportion \( \rho \) of loss-sharing is relatively large (i.e. \( \rho > \rho^* \)). This would not only result in the entrepreneur seeking financing for negative NPV projects, but it would also increase the probability that the capital supplier is willing to provide the funds for those projects (see Result 7). This inefficiency may be reinforced if the government guarantee induces the capital supplier to finance even projects for which he has not received an informative signal on their quality. This, in turn, would reduce the capital supplier’s incentives to screen. This intuition is captured in the following result.

**Result 8:** Let \( \rho > \rho^* \) and \( X > 2(1+\rho)^{-1} \). Then the capital supplier finances all the projects for which the entrepreneur seeks external financing and will not invest in screening effort. The degree of overinvestment on the side of the entrepreneur in this case is most severe.

Result 8 shows that the loss-sharing arrangement makes the capital supplier less careful in his financing decisions. If the proportion of losses compensated for by the government is sufficiently high, then the capital supplier may provide financing even if he doesn’t learn from his screening effort. This is the case since the capital supplier fully benefits from project successes (the capital supplier captures more rents the more projects he finances), whereas the government bears the costs of project failures. This fully mitigates the capital supplier’s incentives to screen (and thus to develop expertise). Even though the increased willingness of the capital supplier to provide financing may boost entrepreneurial search effort, this also increases the probability that negative NPV projects will be financed.

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33 This moral hazard problem is equivalent to the overinvestment and risk shifting problems described in Section 2.1. It also resembles the moral hazard problems caused by the presence of fixed price federal deposit insurance in the context of banking (see e.g. Boot, Bhattacharya and Thakor (1996)).

34 Note that in our model formulation it is not clear which of the cases discussed here would be optimal from a social welfare point of view. The higher measure of entrepreneurs that enter in the market if the capital supplier always provides financing does not only increase the number of negative NPV projects that are undertaken, but also the measure of positive NPV projects. The latter obviously enhance social welfare (see also Section 4.4).
The negative incentive effects described in Result 8 could be reduced if the government requires the capital supplier to match the amount of government-guaranteed financing with a certain amount of risk capital without loss-sharing provisions. Such a more symmetric arrangement allows for a co-sharing of risk between the government and the private sector, and consequently makes the capital supplier more subject to market discipline. Let \( \phi \in (0,1) \) be the proportion of capital that is not guaranteed by the government, and that the capital supplier thus needs to provide at his own risk, and let \( 1-\phi \) be the fraction of funding which is guaranteed up to a proportion \( \rho \). The capital supplier thus participates for a fraction \( \phi \) in the gains and the losses of the firms he invests in. The following result now can be derived.

**Result 9:** Let \( \rho > \rho^* \). Then there exists a \( \phi^* \in (0,1) \) such that the entrepreneur's overinvestment incentives are reduced for \( \phi \leq \phi^* \). Furthermore, if \( X \in (2(1+\rho)^{-1}, 2(1+\rho(1-\phi))^{-1}) \) the capital supplier's aversion to screen is also mitigated.

From Result 6 through Result 9 we can conclude that the provision of government guarantees may be very beneficial for the development of entrepreneurial activity in the economy, since it increases the efficiency of entrepreneurs' project choices, and improves innovative activity on the side of entrepreneurs and screening incentives on the side of the capital supplier (the maximum measure of innovative projects that can be financed efficiently in the economy now equals \( K(\rho^*)(1-p^*) \)). However, loss-sharing arrangements could also severely disrupt investment efficiency in an economy, since they may distort a capital supplier's financing decisions (and as a consequence his incentives to develop expertise). Government guarantees therefore should be designed in such a way that they will only partially cover capital suppliers for the losses incurred by their investments in entrepreneurial firms. Furthermore, they should preferably be complemented by co-sharing of risk with private capital suppliers. We next consider a third measure of government intervention, which is directed towards the demand side of the market for risk capital.

**Direct Financing to Entrepreneurs**

A government could also directly provide risk capital to entrepreneurial start-up firms. By doing so, the government may stimulate both the supply and the demand of risk capital in the economy. The supply of risk capital would particularly increase if the
government requires private sector investors (e.g. venture capitalists) to match the amount of government financing to a certain extent (co-financing with the private sector). This guarantees some co-sharing of risk with the private sector and thus imposes market discipline. Furthermore, if government financing is subordinated, this enhances the private capital supplier's willingness to provide additional (matching) financing to start-up firms.

Alternatively, the government could supply government support and subsidies to induce initiatives for innovation on the side of entrepreneurial firms. In this way the government can compensate individual entrepreneurs for the social benefits associated with their investment. In the context of our model, this could be incorporated by partially subsidizing entrepreneurs for their search costs $k$, or by increasing the proportion of the project cash flow $X$ that the entrepreneur gets to keep in the case of project success. In the first case $k(e)$ increases directly, whereas in the second case $p$ decreases, resulting in an increase of $k(e)$\textsuperscript{35}, and thus in the measure of projects that can be financed in the economy.

### 4.4 Potential Caveats and Possibilities for Extensions

In Section 4.2 and Section 4.3 we have analyzed a simple and stylized model in order to study the interaction between a government, capital suppliers and entrepreneurial firms in the market for risk capital in an economy, and to examine the impact of different commonly observed measures of government intervention on the supply of entrepreneurial initiative in the economy. In doing so, we have focused on the effect of public policy measures on a firm's investment incentives and on a capital supplier's incentives to screen entrepreneurial projects and to develop expertise in financing start-up firms. Our analysis has shown that public policy measures differ in the extent in which they improve an entrepreneur's incentives to search and undertake innovative projects, and affect a capital supplier's willingness to screen and provide financing.

Our analysis however does not allow us to draw inferences with respect to the optimality of the respective measures for government intervention, since we are not able to unambiguously assess their impact on social welfare. Even though we can determine and compare the measure of entrepreneurs that enter the market and the measure of entrepreneurial projects that receive financing - and thus are undertaken - for each policy measure,

\textsuperscript{35} Note that a potential drawback of government subsidies in this case could be that they could result in the acceptance of negative NPV projects by the entrepreneur.
the measures for government intervention also differ in their costs to the government. Without a clearly defined objective function therefore no statements can be made with respect to the preferred design of instruments for government intervention. In our model the ranking of the different instruments could potentially change with the value of the different parameters.

Furthermore, in our analysis we have restricted ourselves to examining the incentive effects of public policy measures that are widely observed in practice. Ideally, the design of the public policy measures should be derived endogenously as an optimal solution to a formal mechanism design problem. There may be other measures that can improve the supply of entrepreneurial effort in the economy, or that can achieve the same incentives in a more cost effective manner, and thus may be superior to the exogenous arrangements we have analyzed in our model. In addition, we have examined the incentive effects of each instrument in isolation. Combining the features of different policy measures could provide additional benefits in terms of improving incentives or reducing costs.

On a more technical note, the 'jump' or 'shift' in the capital supplier's screening intensity from $C(\hat{e}(\rho))$ to 0 that occurs for $X > 2(1+\rho)^{-1}$ for a given level of $\rho$ (see Result 7 and Result 8 in Section 4.3) is caused by the stylized two-state nature of our model. That is, the probability that an entrepreneurial project receives financing increases with the proportion of the loan that is guaranteed, irrespective of the level of the cash flow $X$ that the project generates. The capital supplier's incentives to screen however completely disappear if $X$ (and as a consequence the expected project return under the government guarantee in the absence of screening) becomes sufficiently high. If this is the case screening doesn't add value. It would be interesting to see how our results would be affected if we used a continuous cash flow distribution instead of the two-state probability distribution examined above. This would also allow us to consider the priority issue in the case of co-financing arrangements in which both the government and private sector capital suppliers would provide financing to entrepreneurial firms. In this respect we would like to explain the subordinated nature of government guaranteed loans.

Finally, even though our analysis captures the interaction between the incentives of capital suppliers and entrepreneurs in an economy, it is a partial analysis, in the sense that it ignores a direct relation between the capital supplier's screening decision (and costs) and the financing terms he imposes on the entrepreneur (see footnote 30). As a consequence, the entrepreneur's search decision and his project selection decision are completely separable in our model. This assumption makes our analysis very tractable, but could
become problematic in a more competitive market. A logical extension of our analysis therefore would be to explicitly consider the implications of endogenizing the interest rate the capital supplier charges the entrepreneur, by making it depend on his screening choice.

5 Overview and Evaluation of Dutch Measures for Government Intervention in the Market for Venture Capital

The potential shortcomings in the supply of risk capital that have been discussed in Section 2.2 of this chapter are also relevant for the Dutch economy. Institutional investors in the Netherlands have traditionally demonstrated highly risk averse investment behavior (see Boot and Schmeits (1996)). The supply of risk capital by these investors in this country therefore has been relatively restricted. Furthermore, the Dutch financial sector is characterized by a very active private (over-the-counter) capital market and a relatively modest role of the public market in the funding of corporations. This observation refers both to the extremely 'thin' corporate bond market, and to the relatively low number of equity issues in the IPO market that have taken place (see Boot, Ligterink and Schmeits (1997) and Black and Gilson (1998)). This reduces exit possibilities for venture capitalists. It also reflects the relatively high importance of bank financing in the Netherlands. Potential bottlenecks in this respect could be that the dominance of banks in the venture capital industry results in 'conservatism' in the financing of entrepreneurial firms, and that the concentration that recently has occurred in the Dutch banking sector reduces large banks' willingness to finance smaller firms. As discussed in Section 4.1 government intervention in the Dutch capital market thus may be warranted.

In the course of the last few decades the Dutch government has intervened in the functioning of the capital market and in the provision of financing to entrepreneurial firms by the creation of new institutions, the provision of government guarantees and by direct funding36. The creation of institutions was predominantly aimed at improving the supply channels for risk capital in the Dutch economy. These institutional arrangements embodied the founding of a bank (the 'Nationale Investerings Bank (NIB)') and two types of venture capital suppliers (the 'Maatschappij voor Industriële Projecten (MIP)' and the 'Regionale Ontwikkelings Maatschappijen (ROMs)'). Each of these institutions has served as a channel for direct government support and/or provided risk capital and government

36 For a detailed and comprehensive overview of the Dutch measures of government intervention, see Boot and Schmeits (1996). That paper also contains the numerous Dutch references that we have drawn upon in the remainder of this section.
guaranteed (subordinated) loans to small and medium-size firms. The objective of the government guarantees has been to facilitate the provision of risk capital by private sector capital suppliers (e.g. commercial banks and venture capitalists). Three important arrangements can be distinguished in this respect: the 'Garantiering Participatiemaatschappijen (GPPM)' (a loss-sharing arrangement for venture capitalist firms), the 'Regeling Bijzondere Financiering (RBF)' and the 'Borgstellingsregeling Midden- en Kleinbedrijf (BMKB)' (both representing government guaranteed financing arrangements for mainly small and medium-size firms)\(^37\). In the case of direct financing, the Dutch government directly provides risk capital to individual firms, either as a single financier, or as part of a conglomerate, or provides government support and subsidies.

In this section we present and evaluate the Dutch instruments of government intervention in the capital market in the context of our model analysis in Section 4. We will concentrate on the three - in our view - key arrangements which directly address the frictions in the capital market discussed in Section 2.2 and Section 4.1, and enhance the supply of risk capital to entrepreneurial firms: the 'Loss-Sharing Arrangement for Venture Capitalist Firms (GPPM)', the 'Special Financing Arrangement (RBF)' and the 'Government Guarantees for Small and Medium-Size Companies (BMKB)'. In addition, we will briefly discuss two recently implemented measures for government intervention: the 'Industry Facility (IF)' and the 'Technological Start-up Fund (TSF)'.

5.1. Key Arrangements; Government Guarantees

*Loss-Sharing Arrangement for Venture Capitalist Firms (GPPM)*

The 'Loss-Sharing Arrangement for Venture Capitalists (GPPM)' was introduced in 1981 in order to increase the supply of risk capital to smaller and medium-size corporations by stimulating the development of private venture capital firms. The arrangement embodied a government guarantee to compensate 50% of the losses made on the financing provided by venture capital firms (mainly through equity participations).

In the 1980s the number of private venture capital suppliers increased significantly. In the period 1981-1995, the total amount of venture capital that was invested under this facility equaled $462.5 million. The GPPM was terminated at the end of 1995. The accumulated losses imposed on the government under this guarantee had reached $90

\(^37\) In the remainder of this section we will use Anglo-Saxon equivalents for the names of the respective government measures.
million by the end of 1996. During the last five years of its existence the market share of venture capital investments under the GPPM arrangement dropped from 65% to 14% of the total amount of venture capital provided. Overall, the market for venture capital has continued to grow (even after the termination of the GPPM). The supply of venture capital now amounts to approximately $300 million per year.

As indicated above, the GPPM has increased the supply of venture capital significantly. The number of venture capitalists has gone up from virtually zero to over one hundred in one decade. As illustrated in Result 7 in Section 4.3 the substantial proportion of loss-sharing (\(p = \frac{1}{2}\)) increases the venture capitalist’s willingness to enter the market for risk capital and to finance start-up firms. That is, venture capitalists with relatively high screening costs \(C(e)\) could find it attractive to enter the market under this arrangement. A potential point of criticism however is that the expertise of venture capital firms has not kept equal pace with this high rate of growth. Despite the government guarantees, venture capitalists have made substantial losses on their investments in start-up firms. The gross returns on investments in start-up firms was -6% per year during the period 1986-1994, whereas the average gross return on all venture capital investments was approximately equal to 12%. In the context of our analysis in Section 4, the losses on the investments in start-up firms could be caused by an increase in the probability that venture capitalist firms invest in lower quality projects (i.e. projects with \(p(\rho) < p^*\)) under the loss-sharing arrangement. Furthermore, a substantial proportion of loss-sharing might induce capital suppliers to finance projects without screening, since the expected return on their guaranteed loans in the absence of screening is positive (this corresponds with the case where \(X > 2(1+\rho)^4\) in Result 8). The realized return on their investments however could be negative if \(p < E(p)+(1-E(p))\rho\). Observe that such low success probabilities may be more likely for start-up firms than for more established firms. In response to their losses on start-up firms, the venture capitalists reduced the provision of seed-capital to such firms substantially. The GPPM thus has quite a mixed record. It has stimulated venture capitalist activities significantly, but simultaneously has not allowed venture capitalists to invest successfully in start-up firms.

A potentially fundamental drawback of the GPPM is that this loss-sharing arrangement may induce moral hazard on the side of the venture capital firm. For example, it may be in the interest of the venture capitalists to engage in risk shifting (or asset substitution) moral hazard. After all, the downward risk of this investment strategy is partially borne by the government, whereas the venture capitalist completely (i.e. solely)
benefits from the upward potential. Similarly, negative net present value projects may become (marginally) attractive to the venture capitalist due to the 'subsidy' which is captured in the GPPM. This may result in overinvestment (observe that this is the case if \( \hat{p}(\rho) < p^* \)). This intuition has been captured in Result 8 in Section 4.3. It is difficult to estimate the importance of these distortions in incentives. The significant fraction of risk which is (still) borne by the venture capitalist may mitigate distortions. However, as illustrated in Result 9, it is our impression that the supply of venture capital could have been increased in a more responsible and cost-efficient way by a different design of the loss-sharing arrangement. For example, a more 'symmetric' risk sharing agreement (in which the private sector participates in both the gains and the losses arising from its investments, and thus \( \phi > 0 \)) instead of the 'asymmetric' loss sharing agreement embodied in the GPPM could have improved incentives on the side of venture capitalists, resulting in lower losses. As we will see below, such a structure would resemble the risk sharing arrangement incorporated in the RBF and the BMKB.

The Special Financing Arrangement (RBF)

The objective of the 'Special Financing Arrangement (RBF)', which originated in 1971, is to resolve capital market frictions in the financing of medium-size and large companies. Under this arrangement the government facilitates the provision of risk capital by offering companies which are not able to obtain either direct financial market financing or bank financing at acceptable terms the possibility to obtain (partially) government-guaranteed funding from the 'National Investments Bank (NIB)' in the form of loans, guarantees or equity participations. The currently most important financing facility under this arrangement (the 'AA-loan' or Adjusted Subordinated Credit Facility) is a subordinated long-term loan under a 90% government guarantee. An important aspect of this facility is its credit-generating ability, since the facility is designed to induce complementary bank financing. During the last three years the average annual amount of financing under the RBF was equal to $150 million. Both the financing amount per corporation and the participation of commercial banks increased in this period.

Evaluations of the RBF have shown that this facility has satisfied large financing needs. In particular, the arrangement has generated substantial additional private sector financing. In about 75% of the financing arrangements made between 1990 and 1995 bank credit lines were extended in conjunction with the provision of guaranteed loans. The RBF therefore has induced substantial private sector involvement. This guarantees co-sharing of
risk between the government and the private sector (and thus mitigates the distortions caused by the loss-sharing arrangement under the GPPM) and introduces market discipline, which makes it more likely that positive net present value projects are supported (see Result 9 in Section 4.3). The arrangement furthermore appears to be relatively cost-efficient, with very small subsidies (i.e. losses imposed on the government).

**Government Guarantees for Small and Medium-Size Companies (BMKB)**

Government guarantees for small and medium-sized companies (BMKB) are aimed at facilitating the provision of financing to smaller and medium-size firms. Under this arrangement banks provide commercial, non-subordinated and (mostly) non-secured loans under a government guarantee of 90%. The loans are guaranteed due to lack of possibilities for collateralization. Banks need to match the amount of state-guaranteed financing with funding at their own risk on a one for one basis. For start-up firms the government guarantee equals 100% and banks need to supplement the facility only on a 0.5 for 1 basis. The annual government budget supporting the guarantees is $350 million.

The BMKB is probably the least controversial financing arrangement and satisfies large financing needs. This is not surprising, since from our overview of the financial intermediation literature in Chapter 2 (and also from Section 2 in this chapter) it has become clear that especially the types of firms targeted by this facility are likely to experience external financing problems. About 2,000 firms per year obtain financing under this arrangement. The execution of the BMKB is entirely in the hands of the private sector (the commercial banks). Furthermore, the matching of funds provided under this facility with private sector financing ensures co-sharing of risk and introduces market discipline. The costs of this arrangement to the government therefore are very limited.

**5.2 Recent Measures**

**The Industry Facility (IF)**

The 'Industry Facility (IF)' was created in 1993 in order to increase the availability of medium to long-term risk capital (subordinated debt, convertible debt and/or equity) to medium and large-size firms which can not obtain direct funding by banks and/or the financial market at reasonable terms. The risk capital is provided by a permanent syndicate of the Dutch government (represented by the Ministry of Economic Affairs) and private sector investors (8 insurance companies, 14 pension funds, 3 commercial banks, and the NIB). The total amount of financing available under this facility is $446.1 million.
Since its creation only two companies have drawn upon this facility, for a total amount of $35 million. It is not obvious whether the design of the Industry Facility can be considered optimal. Even though the syndication between the government and private sector parties in the facility may provide diversification benefits to the respective capital suppliers and also induces some market discipline, the structure of this facility may also result in conflicts of interest. In the first place, it is not clear why private sector investors would be willing to finance firms under this arrangement, whereas they would not be willing to provide financing themselves (i.e. on their own account). Second, the syndication in this arrangement may result in a 'moral hazard in teams' effect (see Holmström (1982)). Finally, it is not clear why the pooling of risk in the syndicate requires participation in the form of direct financing by the government. For example, if the willingness of private sector investors to provide financing depends on a certification role of the government, there may be other (less expensive) ways for the government to achieve this (see also Gompers and Lerner (1997), Lerner (1997) and Lerner (1998)). Note finally that the Industry Facility does not focus on start-up firms.

The Technological Start-up Funds (TSF)

The objective of the 'Technological Start-Up Funds (TSF)' is to facilitate the provision of risk capital to small technological start-up firms through direct financing by the government in combination with private venture capital firms.

At this point it is unclear to what extent this arrangement actually supplements the significant amount of venture capital that is currently present in the market. Given the large supply of risk capital in the private sector, government interference would only be desirable in this respect if the government would perform a certification role which would increase private venture capitalists' willingness to invest in technological start-up firms. To the extent in which the smaller scale of projects may be a distinctive factor in the TSFs, a one-shot government subsidy may cover the 'fixed costs' of private venture capital firms in investing in these start-up firms (without causing additional risk for the government). This has been illustrated in Result 3 through 5 in Section 4.3.

5.3 Evaluation

Recent experiences with government intervention in the Dutch capital market have been largely favorable. An important aspect of most of the arrangements discussed in this section is that they were designed to induce additional (matching) financing by private
parties in the market (e.g. commercial banks and/or venture capitalists). This private sector involvement guarantees co-sharing of risk and also introduces some market discipline. Market discipline is further enhanced by only partially guaranteeing the losses incurred by private sector investors in risk capital. This ensures more symmetric risk sharing between the government and the private sector.

Although the Dutch policy measures have successfully stimulated the supply of risk capital in the economy, their success in the financing of start-up firms is less unambiguous. In particular, under the GPPM, venture capital firms consistently have made losses on participations on starting corporations, and consequently reduced the provision of seed capital to infant companies. The reason is that the dramatic shift in entrepreneurship caused by the GPPM induced by the government was short on expertise. Venture capital firms were too eager to invest and lacked expertise in the financing of start-up firms.

Two questions remain. The first question is a skeptical one: have the government measures discussed in this section really facilitated the activities that they support? In other words, would entrepreneurial firms not have been able to obtain external funding from the private sector without government intervention? This question is difficult to answer. Our overview in Section 2 and Section 5.1 points at the presence of capital market imperfections, which are induced and/or enhanced by information asymmetries. These imperfections are particularly relevant for companies with substantial growth opportunities and relatively small firms. The more successful Dutch arrangements were directed towards these types of corporations. Moreover, an evaluation of Dutch financing patterns suggests a somewhat risk-averse supply of funding. These observations therefore suggest a possibly affirmative answer to the first question. Government intervention therefore may add value. This answer also directs us to a more fundamental question. Does the private initiative of entrepreneurial activity need to be subsidized, and/or partially insured? The answer to the first question suggests an affirmative answer to this question as well. A more fundamental (affirmative) answer is that the risk-absorbing capacity of any individual is less than that of society. Government intervention may then try to shift some of the risks away from the individual, and could thus stimulate entrepreneurship. The answer to the second question may then be indeed affirmative. Unless, of course, Keynes' 'animal spirits' are the true trade of mankind.

6 Concluding Remarks and Avenues for Future Research

In this chapter we have highlighted some important issues in venture capital
financing, both from a theoretical and from a policy-oriented perspective. The most interesting theories discussed in this chapter focus primarily on the demand side of the market for venture capital, and explore the form and function of venture capital arrangements in the presence of informational problems. The scarce policy-oriented contributions emphasize the role that a government may play in resolving frictions on the supply side of the market for risk capital, in order to facilitate infant companies’ access to external funding.

Venture capital arrangements are an extremely complex financing mode. In recent years a large strand of empirical literature on venture capital financing has evolved, which has improved our knowledge of the institutional features of the market for venture capital and venture capital financing arrangements. These contributions have recently been complemented by theories that attempt to rationalize the informational role of venture capitalists and the specific contractual features of venture capital arrangements. In this chapter we have discussed the main insights that can be derived from these papers. Although these theories have contributed to our understanding of the design of venture capital arrangements, some unresolved issues remain. These issues suggest interesting avenues for future research, and will be discussed below.

First, most of the existing theories that aim to explain the distinct features of venture capital arrangements focus on specific features in isolation. As a consequence, they can not capture the interactions between the different dimensions of the relation between firm and financiers, which are both unique and central to venture capital financing. In general, the efficiency of venture capital arrangements crucially depends on the interactions between contracting features (both in terms of cash flow claims and in terms of control rights), and an active screening, monitoring and assisting role on the side of the venture capitalist. In order to fully grasp the richness of venture capital financing arrangements these interactions need to be explicitly taken into account. Although this would make the analysis of formal models in venture capital much more complex, such an approach may also increase our understanding of the differences in the informational roles of venture capitalists and more traditional financing sources (e.g. banks) in the financing of

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38 Exceptions are Chan, Siegel and Thakor (1990), Hellmann (1993) and Repullo and Suarez (1998). As discussed in Section 3 of this chapter Chan, Siegel and Thakor simultaneously derive different contractual features in venture capital arrangements (including the disproportionate allocation of control to the venture capitalist). Hellmann (1993) and Repullo and Suarez (1998) combine the monitoring and assistance role of the venture capitalist with several contracting issues.
specific types of firms or investment projects. From a more technical point of view, interesting insights can be expected to arise from the analysis of models that endogenize both the entrepreneur’s incentives and the venture capitalist’s incentives to produce information on the entrepreneur and to provide assistance (see e.g. Chan, Siegel and Thakor (1990) and Repullo and Suarez (1998)).

Second, even though the existing literature has given considerable attention to the stage financing feature of venture capital financing, so far we lack a full understanding of the dynamics of the financing choices made by an entrepreneurial firm at different stages of its lifecycle. In particular, it would be interesting to find out how differences in informational and incentive problems that occur over time interact with the firm’s financing choices and the financing contracts that are used.

Third, the venture capitalist’s exit strategy has received very little attention. For example, it is not clear what the main factors are that determine the firm’s and the venture capitalist’s choice between different exit alternatives (IPO or sale of the firm to another company), and how this affects the allocation of cash flow rights and control rights in earlier financing stages. We will return to this issue later.

On the supply side, the existing venture capital literature focuses mainly on the organization of venture capital funds, and on the relation between fund managers (venture capitalists) and venture capital investors. This literature addresses empirically how the design of the legal and organizational structure of venture capital firms and the structure of compensation contracts can mitigate informational and incentive problems within those firms. Although an efficient resolution of these problems could directly increase investors’ willingness to provide risk capital in the economy, we have not explored this issue further. Instead, we focused on the relation between entrepreneurs and venture capitalists, and examined how informational and incentive problems between these parties could be mitigated by the use of venture capital arrangements. Our analysis of the supply side of the market for risk capital focused on the resolution of frictions in the supply of risk capital to entrepreneurial firms through government intervention. So far, this important issue has been largely unexplored. These frictions in the supply of risk capital could be caused by inefficiencies in the intermediation process, but also by several other reasons (see Section 2). Our analysis therefore is relevant, even if we abstract from the existence of informational and incentive problems between venture capitalists and their investors.

In order to develop a better understanding of venture capital financing, however, it would be useful to expand our scope in this respect. Most of the recent research on
agency issues in venture capital examines the contracting technology between entrepre­neurs and venture capitalists or between venture capitalists and investors separately, and takes the narrow perspective of analyzing agency problems in isolation from other realities of the venture capital process. The relationship between a venture capitalist and an entrepreneur however can be expected to be affected by the relationship between the venture capitalist and his investors. This interaction should be explored further in future work. In this respect it is also interesting to investigate how the venture capitalist’s effort incentives can be optimized by performance based compensation.

Our analysis of the different measures of government intervention in Section 4 and Section 5 has offered valuable insights in the incentive effects and the supply of entrepre­neurial activity associated with each policy instrument. It also allows us to interpret and evaluate the observed practice in the Dutch market for venture capital. However, our model can not explain why a relatively similar design of public policy measures aimed at stimulating the supply of risk capital in different countries has affected the availability of financing to start-up firms in such different ways. As indicated in footnote 1 and footnote 11, in particular the difference between the US (and the UK) and Continental Europe is striking in this respect. Even though a sufficient amount of risk capital seems to be available, too little capital flows in the direction of technological start-up firms. Potential explanations for this phenomenon again take us back to the design of the financial sector in the respective economies. As argued by Black and Gilson (1999) the attractiveness of financing start-up companies may be linked to the development of the stock market in an economy. A well-developed stock market guarantees better exit possibilities for the venture capitalist, and thus increases his willingness to invest in these start-up firms. In this light the recent initiatives that have been taken in Europe to facilitate exit possibilities for venture capitalists (e.g. EASDAQ) may have a favorable impact on (the financing of) technological innovation.

39 To our knowledge, only Gompers (1996) has recognized this interaction explicitly. This empirical paper finds that young venture capital firms tend to take companies public earlier than older venture capital firms, in order to develop a reputation and successfully raise capital for new funds. This phenomenon, also known as grandstanding, results in a higher degree of underpricing in IPOs.
APPENDIX

**Proof of Result 1:** Note that in the case of full information the interest rate \( r \) set by the capital supplier for a project with a success probability \( p \) would equal \( 1/p \) in a competitive capital market. It can easily be seen that this interest rate would result in the first best project choice \( p^* \). In the case of full information (and thus \( e=1 \)) furthermore all entrepreneurs with \( k<k^* \) would exert search effort. Since the market for risk capital is not fully competitive the interest rate charged by the capital supplier in case of outside financing would equal \( r=(1+R)p^{-1} \). At this interest rate entrepreneurs will only invest if \( p[X-r] > 0 \), i.e. if \( p \geq (1+R)^{-1} = \hat{p} > p^* \). This implies underinvestment in good quality projects. Given this investment strategy the entrepreneur invests in search effort if

\[
-k + e \int_p^1 p[X-r]dp \geq 0. 
\]

This condition holds if \( k = k(e) \leq \hat{k}(e) = e \int_p^1 p[X-r]dp \).

Observe that since \( e \int_p^1 p[X-r]dp < e \int_p^1 p[X-1]dp < e \int_p^1 p[X-1]dp \) it can easily be seen that \( \hat{k}(e) < k^* \) for all \( e \in [0,1] \). The level of search effort exerted by the entrepreneur in case of outside financing therefore is lower than first best. Finally, by taking the first order derivative of \( \hat{k}(e) \) with respect to \( e \) it can easily be be seen that \( \hat{k}(e) \) is increases monotonically with \( e \). That completes the proof.

**Proof of Result 2:** Let \( \hat{e} \) be the level of screening effort which maximizes (1). This effort level then should satisfy the first order condition \( (1-p)R - C'(e) = 0 \). Effort level \( \hat{e} \) is feasible if and only if the capital supplier’s zero profit constraint is satisfied, i.e. if \( C(\hat{e})\hat{e}^{-1} \leq (1-p)R = \hat{C} \). Since \( C(e) \) is convex it can easily be seen that \( C(e)e^{-1} \) is monotonically increasing in \( e \). Two cases now can be considered. First, if \( C(\hat{e})\hat{e}^{-1} \leq \hat{C} \) the capital supplier makes at least zero profit at his optimal level of screening effort. Entrepreneurs, anticipating the effort choice \( \hat{e} \), will now invest in search effort if \( k \leq k(\hat{e}) = \hat{k} \). If \( C(\hat{e})\hat{e}^{-1} > \hat{C} \), however, the capital supplier is forced to choose screening effort \( \hat{e} < \hat{e} \), with \( \hat{e} \) satisfying \( C(\hat{e})\hat{e}^{-1} = \hat{C} \) (corner solution). Since \( \hat{k}(e) \) increases monotonically in \( e \) this implies that only entrepreneurs with \( k \leq \hat{k}(\hat{e}) < \hat{k}(\hat{e}) \) would invest in search effort. That completes the proof.
Proof of Result 3: If \( C(\hat{e})\hat{e}^{-1} \leq \hat{C} \) a lump sum government subsidy does not increase the level of screening effort chosen by the capital supplier, and thus would not affect the number of projects undertaken in the economy. Thus all entrepreneurs with \( k \leq k(\hat{e}) = \hat{k} \) would invest in innovation. If the costs of screening are higher, i.e. if \( C(\hat{e})\hat{e}^{-1} > \hat{C} \), the feasible level of screening effort exerted by the capital supplier equals \( \hat{e} < \hat{e} \). In this case a lump sum government subsidy would make the capital supplier’s zero profit condition less binding, thus allowing higher screening effort. The maximum attainable level of \( e \) equals \( \hat{e} \). In this case the number of entrepreneurs entering the capital market equals \( \hat{K} \) and \( \gamma \) equals \( C(\hat{e})\hat{e}^{-1} - \hat{C} = \hat{\gamma} \). That completes the proof.

Proof of Result 4: If the government subsidy is proportional to the capital supplier’s screening costs his optimization problem is given by Max \( e \left\{ (p \times r - 1)dp - (1-\delta)C(e) \right\} \) subject to this expression being larger than or equal to zero. The optimal effort level \( \bar{e}(\delta) \) in this case satisfies the first order condition \( (1-\bar{e})R - (1-\delta)C'(\bar{e}(\delta)) = 0 \), with \( \bar{e}(\delta) > \hat{e} \) for all \( \delta \in (0,1) \). This effort level is feasible if it satisfies the capital supplier’s zero profit constraint, i.e. if \( C(\bar{e}(\delta))\bar{e}(\delta)^{-1} \leq (1-\hat{e})R(1-\delta)^{-1} = \hat{C}(1-\delta)^{-1} \). If \( C(\bar{e}(\delta))\bar{e}(\delta)^{-1} > \hat{C}(1-\delta)^{-1} \) the capital supplier would make negative profits if he chooses effort level \( \bar{e}(\delta) \). He therefore chooses the effort level \( \bar{e}(\delta) < \hat{e}(\delta) \) which yields him zero expected profits. Due to the convexity of the function \( C(e)e^{-1} \) the corner solution \( \bar{e}(\delta) \) is always larger than the break even effort \( \hat{e} \) in the absence of a government subsidy. The entrepreneur now invests in innovation for all \( k \leq \hat{k}(\bar{e}(\delta)) \) if \( C(\bar{e}(\delta))\bar{e}(\delta)^{-1} \leq (1-\hat{e})R(1-\delta)^{-1} \) and for \( k \leq \hat{k}(\bar{e}(\delta)) \) if \( C(\bar{e}(\delta))\bar{e}(\delta)^{-1} > \hat{C}(1-\delta)^{-1} \). The measure of entrepreneurs who search projects thus increases. That completes the proof.

Proof of Result 5: In order to proof this result we compare the capital supplier’s zero profit constraints for a lump sum subsidy and a proportional subsidy respectively. Define \( \bar{e}(\gamma) \) as the corner solution of the capital supplier’s optimization problem in the case of a lump sum subsidy. Dependent on the parameter values for \( \hat{p} \), \( R \), \( \gamma \) and \( \delta \), different cases can be distinguished. If \( C(\bar{e}(\delta))\bar{e}(\delta) \leq \hat{C} \), then \( \bar{e}(\delta) > \hat{e} \) for all \( \delta \in (0,1) \). If \( C(\hat{e})\hat{e}^{-1} \leq \hat{C} \) and \( \hat{C} < C(\bar{e}(\delta))\bar{e}(\delta) \leq \hat{C}(1-\delta)^{-1} \), then \( \bar{e}(\delta) > \hat{e} \) for all \( \delta \in (0,1) \). If \( C(\hat{e})\hat{e}^{-1} \leq \hat{C} \) and \( C(\bar{e}(\delta))\bar{e}(\delta) \leq \hat{C}(1-\delta)^{-1} \), then \( \bar{e}(\delta) > \hat{e} \) for all \( \delta \in (0,1) \). If \( \hat{C} < C(\hat{e})\hat{e}^{-1} \leq \hat{C} + \gamma e^{-1} \) and
C(ê(ô))ô(ô) ≤ Ĉ(1-ô)1, then ê(ô)≥ô for all ô∈(0,1) and γ>0. If Ĉ < C(ê)ô-1 ≤ Ĉ+γô-1 and C(ô(ê))ô(ô) ≥ Ĉ(1-ô)1, then ô(ô)≥ô if ô ≥ C(ê)-ôC C(ê) . If C(ê)ô-1 > Ĉ+γô-1 and C(ô(ê))ô(ô) ≤ Ĉ(1-ô)1, then ô(ô)≥ô(γ) for all ô∈(0,1) and γ>0. Finally, if C(ê)ô-1 > Ĉ+γô-1 and C(ô(ê))ô(ô) > Ĉ(1-ô)1, then ô(ô)≥ô(γ) if ô ≥ γô-1 C+γô-1 . Now define

\[ \hat{d} = \text{Max} \left[ \frac{\gamma}{C+\gamma}, \frac{C(ê)-ôC}{C(ê)} \right] \]

Then it follows directly that a proportional government subsidy improves screening effort if ô≥\hat{d}. Finally, it can easily be seen that \( \hat{d} \in (0,1) \). That completes the proof.

Proof of Result 6: In the case of a proportional loss-sharing arrangement the interest rate charged by the capital supplier equals \( r(\rho) = (1+R)[p+(1-p)\rho]^{-1} \). Given this interest rate, an entrepreneur would want to undertake his investment project if \( r(\rho) \leq X \), i.e. if \( p \geq \hat{p}(\rho) \)

\[ \hat{p}(\rho) = \frac{1+R-\rho X}{(1-\rho)X} \]

From partially differentiating \( \hat{p}(\rho) \) with respect to \( \rho \) it can easily be seen that \( \hat{p}(\rho) \) decreases monotonically in \( \rho \) if \( X > 1+R \). Furthermore, it is clear that \( \hat{p}(\rho) < \hat{p} \) for all \( \rho \in (0,1) \). Define \( \rho^* \) as \( \frac{R}{X-1} \). Then we can easily derive that \( \hat{p}(\rho^*) = p^* \). Furthermore, since \( X > 1+R \) it follows that \( \rho^* \in (0,1) \). Therefore, there exists an optimal proportion of risk sharing for which first best investment efficiency could be obtained. If \( \rho < \rho^* \) underinvestment persists, since \( \hat{p}(\rho) > p^* \). If \( \rho > \rho^* \), \( \hat{p}(\rho) < p^* \) and the entrepreneur would invest in negative NPV projects (overinvestment). Note finally that with \( \rho = 1 \) the capital supplier’s loan becomes essentially riskfree. The corresponding interest rate that he charges then equals the riskfree rate \( 1+R \). If \( X > 1+R \) the entrepreneur then always would want to invest. If \( X < 1+R \) on the other hand, the entrepreneur would never want to invest. This corresponds with the market failure argument presented in Result 1. That completes the proof.
Proof of Result 7: With a proportional loss-sharing arrangement the capital supplier’s optimization problem is given by \[ \max_e \int_0^1 \left( \left[ p + (1-p)\rho \right] \times r(\rho) - l \right) dp - C(e) \], subject to this expression being non-negative. The corresponding first order condition is given by \((1 - \hat{p}(\rho))R - C'(\hat{e}(\rho)) = 0\). Since \(\hat{p}(\rho) < \hat{p}\) for all \(\rho \in (0,1)\) it follows immediately that \(\hat{e}(\rho) > \hat{e}\) for all \(\rho \in (0,1)\). An entrepreneur now invests in search effort if \(-k + \hat{e}(\rho) \int_0^1 p[X-r(\rho)] dp \geq 0\), i.e. if \(k \leq \hat{k}(\hat{e}(\rho)) = \hat{e}(\rho) \int_0^1 p[X-r(\rho)] dp\). It can easily be seen that \(\hat{k}(\hat{e}(\rho)) > \hat{k}\) for all \(\rho \in (0,1)\). The optimization problem described above however is only relevant if the loss-sharing arrangement does not increase the capital supplier’s willingness to extend financing to the entrepreneur in the absence of information production (screening). As will be shown in Result 8, this would be the case if \(X < 2(1+p)^{-1}\). That completes the proof. \(\square\)

Proof of Result 8: An entrepreneur who searches an investment project always seeks financing from the capital supplier. If the capital supplier is uninformed (or equivalently, doesn’t learn from his screening) he therefore assigns a success probability \(E(p)\) to the project, which equals the unconditional mean of the uniform distribution \(U[0,1]\). In the absence of a government guarantee \(E(p) = \frac{1}{2}\). Since we have imposed that \(X < 2\), this implies that the capital supplier would not be willing to finance a project if he doesn’t receive a sufficiently informative signal with respect to the project’s quality. In the presence of a loss-sharing arrangement with a proportion \(\rho\) the capital supplier’s unconditional assessment of the probability of repayment would equal \(E(p) + (1-E(p))\rho = \frac{1}{2}(1+\rho)\). Financing the project in the absence of an informational signal then becomes attractive if and only if \(\frac{1}{2}(1+\rho)X > 1\), i.e. if \(X > 2(1+\rho)^{-1}\). The capital supplier’s optimization problem now rewrites to \(\max_e \int_0^1 [p \times r(\rho) - 1] dp - C(e)\). From this it can
easily be seen that $e(\rho) = 0$. That completes the proof.

**Proof of Result 9:** In the presence of a government guarantee in combination with co-sharing of risk, the interest rate $r(\rho, \phi)$ that a capital supplier charges an entrepreneur equals

$$\frac{1 + R}{p + (1 - p)\rho(1 - \phi)} > r(\rho).$$

Since entrepreneurs now only want to invest if

$$p \geq \hat{p}(\rho, \phi) = \frac{1 + R - \rho X (1 - \phi)}{[1 - \rho(1 - \phi)]X} > \hat{p}(\rho)$$

for $\rho > \rho^*$, overinvestment is reduced. In particular, if $\phi = \phi^* = \frac{\rho - \rho^*}{\rho} = 1 - \frac{R}{\rho(X - 1)}$ the entrepreneur's first best project choices could be implemented, i.e. $\hat{p}(\rho, \phi) = p^*$. Furthermore, for $\phi > 0$ the interval of values of $X$ for which the capital supplier would want to finance projects in the absence of an informative signal with respect to their quality changes from $(2(1 + \rho)^{-1}, 2)$ to $(2(1 + \rho(1 - \phi))^{-1}, 2)$, and thus becomes smaller. This improves the capital supplier's incentives to screen (see also the proof of Result 8). The measure of negative NPV projects that the capital supplier is willing to finance thus decreases. That completes the proof.
Proof of Theorem 1: An entrepreneur who wishes to launch an investment project always needs financing from the capital supplier. If the capital supplier is uninformed (or equivalently, doesn’t learn from his own doing), he therefore assigns a prior probability $E(p)$ to the project, which equals the unconditional mean of the uniform distribution $U[0,1]$ in the absence of a government guaranteed $E(p)$ signal $X$. Since we have supposed that $X < 2$, this implies that the capital supplier would not be willing to finance a project if he didn’t receive a sufficiently informative signal with respect to the project’s quality. In the presence of a loss-sharing arrangement with a proportion $a$ the capital supplier’s unconditional assessment of the probability of repayment would equal $E(p)+E(1-E(p))=\frac{a}{1+\nu}$. Financing the project in the absence of an informational signal then becomes attractive if and only if $(a+\rho)X > 1$, i.e., if $X > 2(1+\rho)^{-1}$. The capital supplier's optimization problem now reduces to: \[ \max_{p} \left\{ p \cdot \mathbb{E}(1-p) \cdot (X - C(p)) \right\} \] From this it can