ESSAYS IN CORPORATE FINANCE

Dieter Vanwalleghem

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Supervisor of Dissertation

Itay Goldstein, Joel S. Ehrenkranz Family Professor, Professor of Finance

Graduate Group Chairperson

Eric T. Bradlow, K.P. Chao Professor, Professor of Marketing, Statistics and Education,
Vice-Dean and Director of Wharton Doctoral Programs,
Co-Director of the Wharton Customer Analytics Initiative

Dissertation Committee

Itay Goldstein (Chair), Joel S. Ehrenkranz Family Professor, Professor of Finance

Mark Jenkins, Assistant Professor of Finance

Christian Opp, Assistant Professor of Finance

ESSAYS IN CORPORATE FINANCE

Dedicated to my family

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ABSTRACT

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Dieter Vanwalleghem

Itay Goldstein

This dissertation examines the relationship between financial markets and firms investment decisions. In particular, it focuses on three distinct settings in which firms real and financial decisions are interconnected.

The first chapter looks at how firms investment and savings decisions are affected by strategic interactions in their product markets. In particular, current dynamic models in corporate finance ignore the potential for strategic interactions between firms. Empirical evidence nevertheless suggests that these strategic interactions are present and influence corporate saving behavior in a non-trivial way. The first chapter proposes a dynamic model of imperfect competition which captures the empirical evidence and provides insight into how product market interactions influence and are influenced by corporate saving behavior.

The second chapter turns to socially responsible investment (SRI) and develops a microstructure trading model which sheds new light on the relationship between SRI screening and a firms equity cost of capital. Previous research argued that SRI screening will lead firms shunned by socially responsible investors to trade at a discount, i.e. have a higher cost or capital, relative to non-shunned peer firms. The model acknowledges this fact but also shows that asymmetric information and heterogeneity in beliefs regarding the relationship between corporate social and financial performance can dampen and even reverse the cost of capital gap between shunned and non-shunned firms. As such the model in the paper delivers a richer set of predictions which help explain the mixed empirical support for a link between SRI screening and equity cost of capital.

Finally, the third chapter outlines a new reason for why firms may finance themselves through financial contracts which provide explicit incentives to generate a social alongside a financial return on investment. The argument developed in this chapter does not rely on investor altruism nor on an explicit link between financial and corporate social performance. Instead it argues that social financial contracts can emerge naturally as the solution to a credit constraint problem in a common agency moral hazard setting. The paper predicts an inverted U-shape relationship between the use of social financial contracts and financial strength.

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1.1. Introduction

1.1.1. Motivation

Traditionally, the notion of firms holding or hoarding cash has carried a negative connotation. The view was that all available liquid assets should either be invested in physical capital or, if no good investment opportunities are available, distributed to shareholders. This view is partly rooted in the fear that large cash balances risk inducing managerial slack and therefore destroy shareholder value. Moreover, a company's equity investors seek to get exposure to its production technology and business opportunities, not to the short term interest rate which they can achieve themselves at much lower transaction costs. The steady increase in corporate liquidity in the last two decades and in particular in the wake of the recent financial crisis, however, seems to suggest that holding a liquid balance sheet might have substantial virtues. Previous studies have suggested these virtues might come under the form of protection against underinvestment, Riddick and Whited (2009) and Opler et al. (1999), or even under the form of tax benefits for international firms.

In addition however, there is increasing evidence that cash has a strategic dimension and offers substantial benefits through this channel. Managers for instance often justify their cash hoarding behavior by referring to strategic flexibility vis--vis their industry competitors. Rocco Landesman, the Broadway producer now running the National Endowment for the Arts, once said:

> "The key to life is having a sense of possibility and the best way to achieve that is to carry no less than $ 10,000 in cash with you at all times. Cash gets you deals, enables you to act quickly and helps you sleep at night".

In addition to this anecdotal evidence, past empirical research has indicated that firms actively manage their cash balances to hedge themselves against predatory behavior by

their competitors, Haushalter et al. (2007). Others have argued that large cash balances are often held as war chests out of which companies can fund competitive strategies in order to gain market share, Fresard (2010). From a theoretical perspective however, the strategic dimension of cash balances has received relatively little attention. Though a few static models have been developed, firms' strategic use of cash thus far has not been explored in a dynamic setting.

The goal of this paper is to explore the strategic dimension of cash by examining in a dynamic setting how competitive forces drive firms' optimal cash policies and how in return firm's cash balances affect competitive behavior in the product market. The main tool used to answer this question is a dynamic model of imperfect competition where firms compete, invest and save in the presence of financial market imperfections

Before going into the model details, however, a quick summary is given regarding the ways in which cash is thought to have a strategic dimension. There are mainly two ways in which the literature has considered cash as potentially having a strategic dimension.

Firstly, holding cash might prevent a firm from falling behind its competitors when industry wide investment opportunities present themselves. That is, if external financing is costly, cash poor firms might not be able to fully invest in these opportunities allowing cash rich firms to fill the gap and potentially take a leadership position. This risk of underinvestment and loss of investment opportunities and market share to competitors is often referred to as predation risk. Haushalter et al. (2007) provide empirical evidence that firms actively manage predation risk by maintaining larger cash balances. Moreover, the effect of predation risk on cash holdings is stronger the larger the interdependence of a firm's growth opportunities with those of its rivals. In particular, controlling for standard determinants of cash holdings such as profitability, leverage, etc. , firms tend to hold larger cash balances in more concentrated industries, when their production technology is more similar to that of rivals and in industries where firms' growth opportunities, as measured by stock returns, are more highly correlated.

Secondly, large cash reserves can have strategic benefits in that they directly or indirectly affect behavior in a firm's product market. Bolton and Scharfstein (1990) for instance, argue that financial market imperfections can give financially unconstrained firms the incentive to prey on financially constrained firms by pursuing aggressive product market strategies. Cash reserves are thus viewed as a war chests to fund competitive strategies such as aggressive pricing or advertising. Furthermore, cash reserves might be beneficial as a signaling device to deter rivals from entering a market or make capital expenditures Benoit (1984). Fresard (2010) documents using a natural experiment that large cash balances are associated with large future gains in market share. Moreover, this effect tends to be stronger for firms facing financially weaker competitors and for industries where firms' growth opportunities are more interdependent.

1.1.2. Related literature

The model developed in this paper is novel from the perspective of two different strands of economic literature namely that of industrial organization and of corporate finance. On the one hand, in industrial organization, dynamic models of oligopolistic competition have become increasingly popular since Pakes and McGuire (1994) developed their dynamic industry model of imperfect competition. The model is based on a so called quality ladder structure in which the competitive strength of a firm is captured by a single variable, quality. Depending on the context of the model, a firm's quality can be interpreted as product quality resulting from accumulated R&D, a firms locked-in customers in a model with switching costs or a firm's physical capital in a Cournot model with capacity constraints. Naturally, in any real industry a wide variety of both independent and correlated variables determine a firm's competitive strength, however the key idea is that quality captures the most important of these. Besanko and Doraszelski (2004) for instance applies the Pakes and McGuire (1994) framework to study industry capacity dynamics under various assumptions on the nature of competition. In particular, he compares capacity constrained Cournot quantity competition with capacity constrained competition in price. The model developed in this paper is similar

to Besanko and Doraszelski (2004) in that as in his paper, the industry considered here only comprises two firms and abstracts away from entry and exit decisions by firms. The model differs however in that it does not assume the quality ladder structure and considers not only firms' real but also financial decisions. Indeed, the absence of firms' financial decisions is a common feature among all dynamic models in industrial organization developed up to this point. It is in this sense that the current model seeks to contribute to the existing literature in industrial organization.

In corporate finance however, a rich literature on dynamic models in which firms make both real and financial decisions has been developed in the last ten years. Hennessy and Whited (2005) and Hennessy and Whited (2007) for instance analyze and estimate a dynamic capital structure choice model for firms making joint real and financial decisions. An important contribution from these papers is that they highlight the importance of taking into account financial market imperfections when interpreting firm investment and financing decisions. Riddick and Whited (2009), develop a dynamic model of the firm to analyze firm's saving behavior in the presence of financial market imperfections. The model developed in this paper borrow heavily from theirs in that it assumes a very similar investment and financial environment. It differs crucially however, in that in theirs and as in all other dynamic corporate finance models, the implicit assumption is made that firms either operate in perfect competition or as stand-alone monopolists. In other words these models ignore the possibility that strategic interactions between firms determine their optimal real and financial decisions. As indicated above, however, empirical evidence suggests that strategic interactions are an important determinant of firm policy and should therefore not be neglected.

In sum, the dynamic duopoly model developed in this paper is new in the sense that it can be viewed as either a dynamic industrial organization model where firms take both real and financial decisions or a corporate finance model where strategic considerations affect firms' optimal policies. The model is closer in spirit to Hennessy and Whited (2005) and

Hennessy and Whited (2007) than to Pakes and McGuire (1994), because I chose not to adopt the Pakes and McGuire (1994) quality ladder set-up but rather stay closer to the corporate finance tradition with investment defined as a continuous variable.

In what follows I will describe the model.

1.2. Model

1.2.1. Overview

The model has an infinite horizon and time is discrete. The economic agents are two firms which periodically compete in the product market and make both real and financial decisions. Figure 1.1 gives a chronological overview of the main events occurring in each period t.

2. **Market shock**, $\tilde{z}_t$, and **private shocks**, $\tilde{\delta}_{i,t}$ are realized.

4. Firms jointly choose **next period capital**, $k_{i,t+1}$, and **next period cash**, $p_{i,t+1}$.

t $t+1$

1. Firms $i \in \{1, 2\}$ **arrive** with **capital**, $k_{i,t}$, and **cash**, $p_{i,t}$.

3. Firms choose $q_{i,t}$ in **Cournot** style. **Product market profit** $\pi_{i,t}$ is realized.

5. **Cash flow to equity**, $E_{i,t}$, is realized.
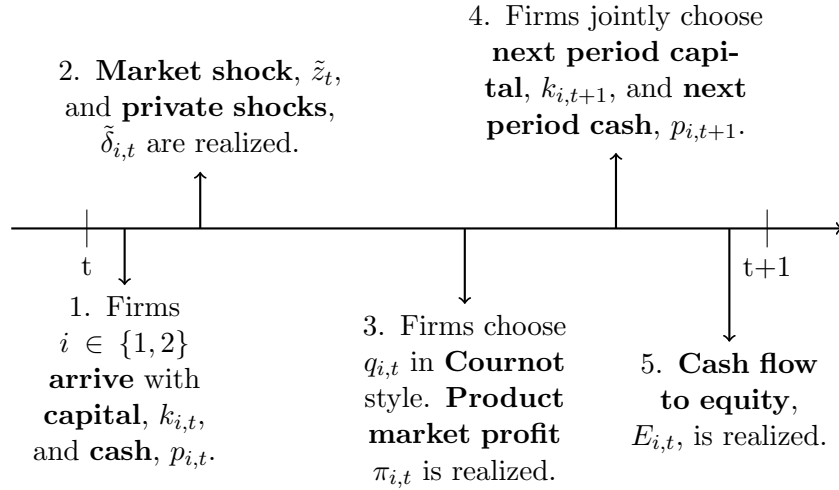
Figure 1.1: Time Line

At the beginning of each period t, the two firms indexed by $i \in \{1, 2\}$ arrive with an amount of capital, $k_{i,t}$ and a level of cash holdings, $p_{i,t}$ carried over from the previous period. Both firms publicly observe the realization of the market shock $\tilde{z}_t$ and each firm privately learns its depreciation shock $\tilde{\delta}_{i,t}$. Given the realization of the market shock and the firms' capital levels, the period t product market environment is completely determined. In particular, the market shock determines the size of the market, while the capital levels determines each

firm's cost structure. In the product market competition phase, firms then simultaneously choose their optimal production levels, $q_{i,t}$, consistent with a Cournot quantity competition equilibrium. The equilibrium production levels together with the market shock and the capital levels then determine each firm's profit from product market competition, $\pi_{i,t}$.

Given this product market cash flow, both firms then simultaneously choose next period's optimal level of capital, $k_{i,t+1}$, and the amount of cash, $p_{i,t+1}$, to carry over to the next period. In making these decisions firms realize that this pins down the cash flow to equity $E_{i,t}$. Moreover, raising external equity capital is assumed to be costly in the model in that negative realizations of $E_{i,t}$ will command an extra cost per dollar of external equity raised.

In what follows each component of the model will be discussed in detail.

1.2.2. Product market Demand

The two firms are assumed to periodically compete in a market with no entry or exit. Each firm produces one good and these goods are considered close substitutes in the eyes of the consumer. One example of such a market is a market for new cars operated by two firms. Though consumer preferences for one brand versus another create some form of market power for each firm, consumers switch relatively easily to their less preferred brand should that product be more readily available or offered at a lower price. The more substitutable the goods are in the eyes of the consumer, the lower a firm's market power and thus the fiercer the competition. Intuitively, as the goods become more substitutable, each unit produced by a firm's competitor snaps away a bigger portion of a firm's remaining market potential.

The inverse demand function, P, facing firm i is given by:

$$P(\tilde{z}_t, q_{i,t}, q_{j,t}) = \tilde{z}_t q_{i,t}^{\phi_o} q_{j,t}^{\phi_c}$$

Here, $\tilde{z}_t \geq 0$ denotes the common market shock affecting both firms, $\phi_0 < 0$ is a firm's own inverse price elasticity of demand and $\phi_c < 0$ is a firm's cross inverse price elasticity of demand. The standard assumption for these type of demand functions is that $|\phi_c| \leq |\phi_0|$, which implies that a firms own price matters more for its own demand than the price of its competitor. High (low) absolute values of ϕ_0, imply that the firm faces an inelastic demand in that large (small) increases in price are necessary to move the quantity demanded by the firm's consumers. ϕ_c on the other hand captures the degree of substitutability and hence the strength of competition between the two firms. Higher (lower) absolute values of ϕ_c imply that ceteris paribus, firm i has to set a lower (higher) price in order to sell the same number of units $q_{i,t}$. In other words, A High (low) absolute value of ϕ_c captures the extent to which the units sold a firm's competitor reduce its own market potential.

1.2.3. Production technology

The production technology of each firm depends crucially on its level of capital, $k_{i,t}$. In particular, capital in the model determines a firm's cost structure in that a higher level of capital ceteris paribus implies lower production costs. Moreover, because the firms are periodically engaged in Cournot quantity competition, capital is the primary strategic variable in the model. This is because in Cournot competition a lower (higher) cost structure implies a stronger (weaker) competitive position since firms with lower (higher) costs behave more (less) aggressive. The easiest way to think of capital is accumulated R&D efforts in the production process. The cost function, $C(q_{i,t}, k_{i,t})$ of both firms is given by:

$$C(q_{i,t}, k_{i,t}) = \gamma q_{i,t}^{\alpha} k_{i,t}^{\beta}.$$

Here $\alpha \geq 1$ implying that production costs are convex in the number of units produced. Furthermore, $\beta \leq 0$ capturing the negative relation between a firm's level of capital and its cost structure. Moreover, if $|\beta| > 1$ the technology is increasing returns to scale, if $|\beta| = 1$ the technology is constant returns to scale and if $|\beta| < 1$ the technology is decreasing returns

to scale. In the main solution of the model, it is assumed that $|\beta| < 1$.

1.2.4. Static product market equilibrium

By combining the above demand function and the production technology we get that firm i's profit before financing costs and capital investments, π, is given by:

$$\pi(k_{i,t}, k_{j,t}, \tilde{z}_t, q_{i,t}, q_{j,t}) = P(\tilde{z}_t, q_{i,t}, q_{j,t})q_{i,t} - C(q_{i,t}, k_{i,t}).$$

The model as thus specifies exhibits a static dynamic break up which substantially simplifies its computation. In particular, though the firm's optimal investment and financing decisions are dynamic decisions, made by taking into account their effect on future play, the optimal optimal quantity, $q_{i,t}^*$, in each period is a static decision. To see this, note that a firm's quantity produced affects only its current product market profit and has no additional dynamic implications. In particular, producing an output different from what is myopically optimal does not affect a firm's production capabilities in the future. It is for instance not the case that a lower number of units produced implies a lower future rate of depreciation.

Given this static dynamic break-up, both firms can do no better than to choose the output level that maximizes current period profits. Moreover, it is assumed that the firms simultaneously choose their quantities in a Cournot fashion so that the quantities produced are assumed to be Cournot equilibrium quantities.

In particular given $k_{1,t}, k_{2,t}$ and $\tilde{z}_t$, the optimal quantities of both firms are the equilibrium quantities from the following static Cournot quantity competition game:

$$\max_{q_{1,t}} \pi(k_{1,t}, k_{2,t}, \tilde{z}_t, q_{1,t}, q_{2,t})$$

$$\max_{q_{2,t}} \pi(k_{2,t}, k_{1,t}, \tilde{z}_t, q_{2,t}, q_{1,t})$$

The per period profit before financing and investment then reduces to:

$$\pi^*(k_{i,t}, k_{j,t}, \tilde{z}_t) = \pi(k_{i,t}, k_{j,t}, \tilde{z}_t, q^*_{i,t}, q^*_{j,t})$$

This greatly simplifies the model's computation, because it implies that a reduced form profit function $\pi^*(k_{i,t}, k_{j,t}, \tilde{z}_t)$ can be used when determining a firm's optimal investment and savings policies.

1.2.5. Capital investment

Each period, firms simultaneously choose how much to invest, $x_{i,t}$, in their capital stock $k_{i,t}$. Capital is subject to a one period time to build constraint and to stochastic depreciation. In particular, each period firms receive a privately observed depreciation shock $\delta_{i,t}$. One can think of stochastic depreciation as the sum of constant periodic depreciation plus a stochastic term reflecting unexpected machine failure, damage from fire,...etc. . This then gives the following law of motion for capital:

$$k_{i,t+1} = x_{i,t} + (1 - \tilde{\delta}_{i,t})k_{i,t}$$

1.2.6. Corporate saving

Shareholders in the model face an opportunity cost of funds equal to r. Each period firms decide on how much financial resources to carry over to the next period by deciding on next

period's cash balance $p_{i,t+1}$. Corporate savings are invested in a one period risk-free bond earning $r(1-\tau)$. This implies that the firm sets aside $\frac{p_{i,t+1}}{r(1-\tau)}$ in period t to realize a cash balance of $p_{i,t+1}$, next period. τ represents the cost of holding cash and is needed to ensure firms in the model have bounded savings. This cost of holding cash can be interpreted in several ways. For instance, the cost of cash could reflect an agency cost. This might arise because large cash balances might make it harder to give proper incentives to the manager of the firm to exert effort. An alternative interpretation is that holding cash implies a tax cost because interest earned on internal savings is taxed at the corporate tax rate τ_c. For simplicity this is the interpretation given to the cost of holding cash in this model. That is, internal savings earn the risk free after tax return $r(1-\tau_c)$.

1.2.7. Costly external finance

In any period t, if optimal investment and corporate savings exceed the cash flow from product market competition and cash carried over from last period, the firm needs to raise external equity capital. In the model, raising external equity capital is assumed to be costly in that per dollar of external equity raised the firm incurs both a fixed cost $\lambda_0 > 0$ and a variable cost of $\lambda_1 > 0$ per dollar of external equity financing. The fixed equity issuance costs can be interpreted as underwriting fees while the variable costs can be interpreted as costs due to asymmetric information as in Myers and Majluf (1984).

1.2.8. Distribution to equity holders

Now we are in a position to define the periodic distribution to the shareholders. For ease of notion, let $s_{i,t} = \{k_{i,t}, p_{i,t}, k_{j,t}, p_{j,t}\}$. Then, firm i's cash flow before financing is given by:

$$\Pi(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t}) = \pi^*(k_{i,t}, k_{j,t}, \tilde{z}_t) - x_i(k_{i,t+1}, k_{i,t}, \tilde{\delta}_{i,t})$$
$$+ p_{i,t} - \frac{p_{i,t+1}}{1+r(1-\gamma)}.$$

That is $\Pi(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t})$ gives firm i's cash flow before potential costs of rasing external financing have been taken into account.

Let firm i's cash flow to equity be denoted by $E(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t})$. The flow of funds equation for firm i is then given by:

$$E(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t}) = \Pi(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t})$$
$$- \mathbb{1}_{[E<0]}\lambda_0 - \mathbb{1}_{[E<0]}\lambda_1 |E(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t})|.$$

1.2.9. Value of the firm

Since shareholders discount future cash flows at the opportunity cost of funds r, the value of firm i is given by:

$$V_{i,t}(s_{i,t}, \tilde{z}_t, \tilde{\delta}_{i,t}) = \max_{\{k_{i,t+u}, p_{i,t+u}\}_{u=1}^{\infty}} \mathbb{E}_t \left[\sum_{u=0}^{\infty} \frac{E(s_{i,t+u}, s_{i,t+u+1}, \tilde{z}_{t+u}, \tilde{\delta}_{i,t+u})}{(1+r)^u} \right]$$

Or equivalently after rewriting in the Bellman form:

$$V_i(s_{i,t}, \tilde{z}_t, \tilde{\delta}_{i,t}) = \max_{k_{i,t+1}, p_{i,t+1}} \left\{ E(s_{i,t}, s_{i,t+1}, \tilde{z}_t, \tilde{\delta}_{i,t}) + \frac{1}{(1+r)} \mathbb{E}_t \left[V_i(s_{i,t+1}, \tilde{z}_{t+1}, \tilde{\delta}_{i,t+1}) \right] \right\}$$

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The solution strategy for this model is to search for an equilibrium of the above dynamic game. There are several equilibrium concepts that can be applied to this problem, but the one that will be applied here is that of a Markov perfect equilibrium (MPE), Maskin and Tirole (1988a) and Maskin and Tirole (1988b). The reason for choosing this equilibrium concept is twofold. First, in terms of computation the MPE is by far the simplest to compute because it allows the use of standard techniques in dynamic programming such as value function iteration. Secondly, the Markov perfect equilibrium is also attractive from a behavioral point of view in that it asserts that the equilibrium strategies of firms at point in time t are a function only of a limited set of state variables. In particular, this implies that the MPE does not consider equilibrium strategies that are path dependent. That is, all that matters for the firms equilibrium strategies is the current state of the world as captured by the state variables, $s_{1,t}, \tilde{z}_t$ and $\tilde{\delta}_{1,t}$ and not how this state was reached.

In equilibrium, the optimal capital and savings policies of the two firms will then jointly satisfy the system of Bellman equations:

$$V_1(s_{1,t}, \tilde{z}_t, \tilde{\delta}_{1,t}) = \max_{k_{1,t+1}, p_{1,t+1}} \left\{ E(s_{1,t}, s_{1,t+1}, \tilde{z}_t, \tilde{\delta}_{1,t}) + \frac{1}{(1+r)} \mathbb{E}_t \left[V_1(s_{1,t+1}, \tilde{z}_{t+1}, \tilde{\delta}_{1,t+1}) \right] \right\}$$

$$V_2(s_{2,t}, \tilde{z}_t, \tilde{\delta}_{2,t}) = \max_{k_{2,t+1}, p_{2,t+1}} \left\{ E(s_{2,t}, s_{2,t+1}, \tilde{z}_t, \tilde{\delta}_{2,t}) + \frac{1}{(1+r)} \mathbb{E}_t \left[V_2(s_{2,t+1}, \tilde{z}_{t+1}, \tilde{\delta}_{2,t+1}) \right] \right\}$$

1.3. Model solution

1.3.1. Model parameters

Due to the fact that this paper is the first dynamic corporate finance model to consider strategic interactions between firms, the current literature provides very little guidance as to what parameter values should be used in a baseline computation of the model. However,

because the model borrows heavily from the set-up by Riddick and Whited (2009) with regards to how a single firm is modelled in isolation, the approach taken in this paper is to choose parameter values close to the ones used in their paper wherever possible. As such, the only major difference in terms of parameter values between theirs and this paper is with regards to the modeling of the market environment and the technology. In particular, Riddick and Whited (2009) use a reduced form profit function, whereas in this paper, the profit function is constructed from first principles. Nevertheless, in order to keep the comparison as close as possible, the parameter values for the market and technology parameters were chosen so as to mimic as closely as possible the behavior of a firms' profits as a function of its own capital. In particular, the parameter values on the technology yield about the same range for a firm's profits as a function of its own capital as in Riddick and Whited (2009).

Profit parameters

The first component we need to describe is the process for the market shock $\tilde{z}_t$. This paper follows Riddick and Whited (2009) in specifying that $\tilde{z}_t$ follows an AR(1) in logs,

$$\ln(\tilde{z}_t) = \rho \ln(\tilde{z}_{t-1}) + \tilde{\nu}_t,$$

where $\tilde{\nu}_t \sim \mathcal{N}(0, \sigma_\nu^2)$. The baseline parameter choices for ρ and σ_ν are respectively 0.8 and 0.25. To numerically solve the model, I need to specify a finite state space for the $\tilde{z}_t$. The approach taken is to use Tauchen (1986) with 5 points on the state space with a range of plus/minus 2 standard deviation shocks.

The own and cross price elasticities of demand ϕ_0 and ϕ_c respectively, are both set to -0.3 in the baseline model. The fact that these two elasticities are equal, implies that the goods the two firms produce will be considered closely substitutable by consumers. This will generate a strong level of competition and hence amplify the strategic behavior of the two firms in

equilibrium.

α in the model determines the behavior of a firm's costs from operation for a given level of capital. In the baseline case α is set to 1.6, which implies that the firm is facing a convex cost function for a given level of capital $k_{i,t}$. β, determines the impact of higher capital on the cost structure of the firm. In the model, β is set to -0.85 reflecting a decreasing returns to scale technology for the individual firm in that an increase in capital does not translate into a one to one decrease in costs. Finally, γ is mainly used as a scaling parameter to bring the level of costs in line with the level of revenues generated by $\tilde{z}_t$. γ is set to 2 in our baseline computation.

These parameters taken together determine the reduced form profit function of a firm as a function of its own and its competitors capital. Recall that this reduced form profit is derived from assuming a Cournot equilibrium in quantities as outlined above in the model discussion. As already mentioned, most of the baseline parameter values were chosen to generate profit function behavior similar to that in Riddick and Whited (2009). In order to give an idea of the behavior of the reduced form profit function of an individual firm, figure 1.2 plots profit, π, as a function of a firm's own, k_1 and its competitor's, k_2, capital for 4 levels of the market shock, z. In figure 1.2, the numbers above the individual graphs indicate the grid point for which the profit function was plotted, 1 indicating the lowest level of z and 5 indicating the highest.

To summarize, the profit parameters in the baseline model are given in table 1.1:

parameter	ρ	σ_ν	ρ_0	ρ_c	α	β	γ
value	0.8	0.25	-0.3	-0.3	1.6	-0.85	2

Table 1.1: Baseline parameters

Investment parameters

The depreciation rate in the model, $\delta_{i,t}$, is a privately observed random variable for each firm. To model the randomness, the number of depreciation shocks a firm is subject to

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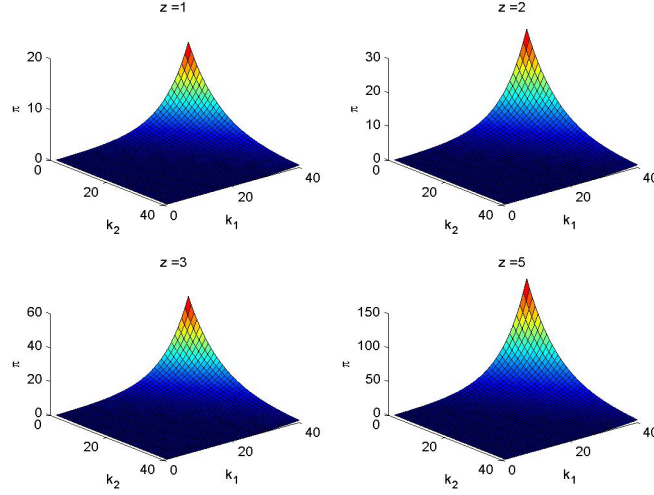
Figure 1.2: Profit plot

in a given period is assumed to be a truncated normal random variable where the lower truncation is set to 1 and the upper at M_d. Each depreciation shock destroys $\overline{\delta}$ of the capital in place in going from one period to the next. In the baseline model $\overline{\delta}$ is set to 0.15 where Mu_d is set to 3. So the firm is subject at least to a depreciation rate of 0.15 and can have a maximal depreciation rate of ≈ 0.52. The randomness in the depreciation rate allows for the two firms to have distinct paths and hence for the possibility that one firm will at some point trail or lead its competitor in terms of the level of capital. This will allow for the possibility to determine whether firms are able to catch up with their competitor under various scenarios of financial frictions.

Capital in the model is a choice variable and needs to be translated to a discrete state space. In the baseline model, capital lies on a 40 point grid,

$$\left[k_{\max}(1-\delta)^{39}, k_{\max}(1-\delta)^{38}, \ldots, k_{\max}(1-\delta), k_{\max} \right]$$

Financial parameters

Finally, we need to specify the parameters governing the firm's finances. First, the opportunity cost of funds in the model is set to 0.05. Secondly, the cost of holding cash τ is assumed to be equal to the corporate tax rate τ_c and is set to 0.3. The cost of holding cash is therefore interpreted as a tax related cost because internal savings of the firm are taxed at the corporate tax rate. This will ensure the model exhibits bounded levels of corporate savings.

The firm faces costly external financing under the form of a fixed, λ_0 and a variable, λ_1 cost of raising external equity financing. In the model $\lambda_0 = 0.5$ while $\lambda_1 = 0.05$. These values are close to those chosen by Riddick and Whited (2009) except that their specification allows for convex costs of external financing while in this model only linear costs are considered for simplicity.

Lastly, savings in the model need to be translated to a discrete grid. In the baseline model, corporate savings lie on a 5 point equally spaced grid from 0 to 5.

1.3.2. Baseline model results.

The model is solved using a modified policy function iteration approach. In each iteration, first the capital and savings policies of the firm are updated using the value function in memory and then in a second step the value function is converged upon fixing the capital and savings policies. This approach substantially improved the converge behavior of the algorithm which can not rely on standard contraction mapping arguments that would guarantee a convergence.

In order to give a flavor of the strategic behavior that firms exhibit in the model, consider a state of the world in which a strong firm, w.l.o.g. here assumed to be firm 1, faces another firm, firm 2. Competitive strength in the model is derived from two sources. On the one hand technological strength determines the immediate cash flow generating ability of a firm

in the product market. On the other hand, financial strength determines the ability of a firm to respond cheaply to new investment opportunities that present themselves in the market. Indeed, because raising external financing is costly, cash rich firms face a considerably lower cost of investment than cash poor firms who have to rely on external financing. In what follows, firm 1 is assumed to have a capital of $k = 30$ and a level of cash holding $p = 4$. Firm 2's capital and savings on the other hand are allowed to vary. This will allow us to determine the impact of firm 2's relative strength or weakness on the optimal capital policy of firm 1.
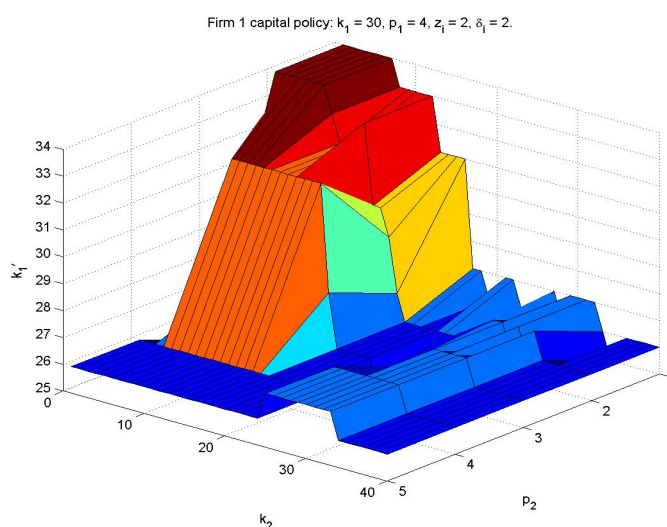
Figure 1.3: Capital policy strong firm

Figure 1.3 exhibits the capital policy of the strong firm 1, k_1', as a function of the capital, k_2 and savings, p_2 of firm 2. The policy function clearly indicates the predatory investment behavior of firm 1 as its competitor becomes weaker both technologically and/or financially. This is in line with Bolton and Scharfstein (1990) who indicate in a static model how similar predatory behavior can emerge endogenously in a model of financial market imperfections. The same story but now from the perspective of firm 2 is featured in figure 1.4.

Figure 1.4 exhibits the optimal capital policy, k_2', of firm 2 as a function of its own capital, k_2, and savings, p_2, when it is facing a strong competitor. This picture indicates that as
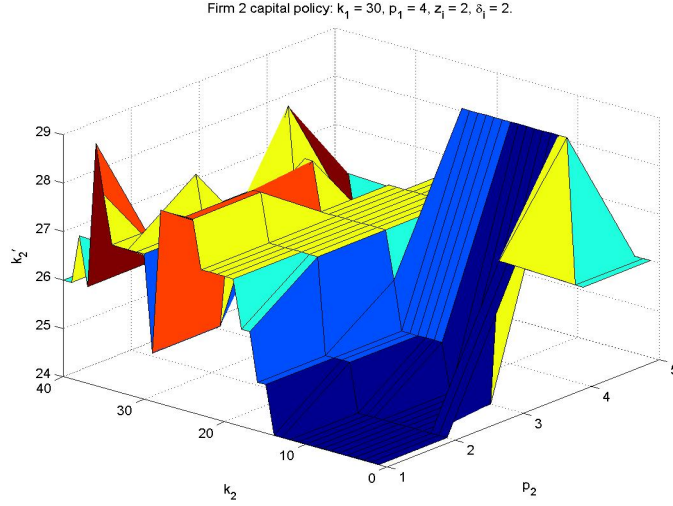
Figure 1.4: Capital policy weak firm

firm 2 becomes financially and technologically weaker, it is forced to scale back investment. It is precisely this gap that firm 1 fills and hence results in firm 1 taking a leading position in the industry. Notice that the capital difference between firm 1 and a weak firm 2 is substantial, amounting to about 10 points on the capital grid.

In order to understand the fundamental factors driving these results figures 1.5 and 1.6 capture the trade-offs firm 1 and 2 make in determining their optimal capital policies. For simplicity, assume that the fixed costs of external financing are zero.

Figure 1.5 represents the marginal benefits and marginal costs for firm 2 of an additional unit of next period capital as a function of the level of next period capital, k_2'. Naturally, the optimal level of next period capital is determined where the marginal cost and marginal benefit curves intersect. First let's consider how to interpret the individual curves. The marginal cost curve, MC_2, is the easiest. The marginal cost of an extra unit of installed capital at time $t+1$ is incurred at time t. For low levels of next period capital, the firm does not have to tap the external financial markets and the cost of an extra dollar worth of next period capital is simply one dollar. However, as the level of next period capital and thus the size of the investment increases, the firm depletes its internal cash sources and at some
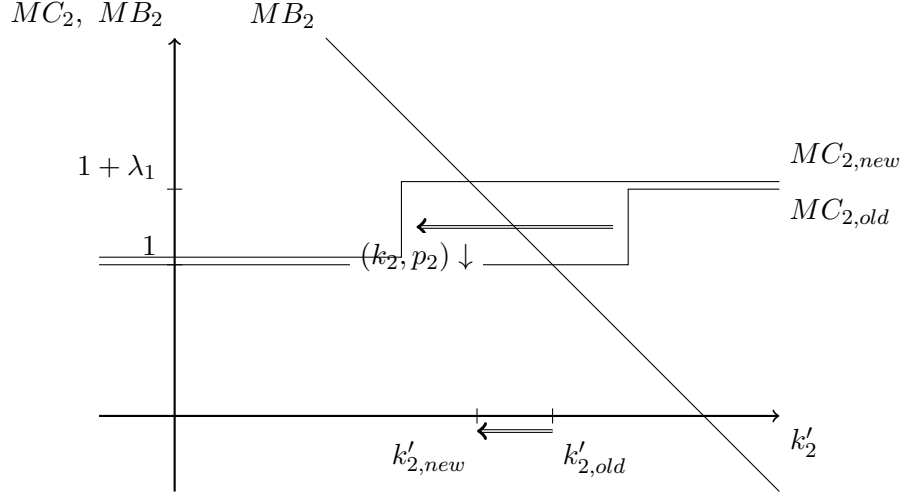
Figure 1.5: Marginal cost benefit analysis weak firm

point will have to start tapping into the external financial markets. This is the point where the marginal cost function jumps upward from a level of 1 to a level of $1 + \lambda_1$ reflecting the per dollar variable cost of external financing. The point at which the marginal cost curve jumps upward is determined amongst other things by the level of internal cash available which is in turn determined by the firm's current level of capital, k_2, and its current level of savings, p_2. As these variables decrease, the firm has less internal cash resources available forcing it to seek external financing at lower levels of k_2'. The marginal benefit of an extra unit of capital is given by the downward sloping line MB_2. This line is downward sloping because of the assumption of decreasing returns to scale. Now consider what happens as firm 2 becomes weaker financially and or in its level of capital. Initially, firm 2 has the $MC_{2,old}$ marginal cost curve and the optimal level of next period capital is given by $k_{2,old}'$. As firm 2 weakens its marginal cost curve shifts to the left to $MB_{2,new}$ reflecting the lower level of internal cash resources. This reduces the optimal level of next period capital to $k_{2,new}'$. As such the marginal benefit cost analysis in figure 1.5 captures the dynamics of the policy function in figure 1.4.

Now consider the optimal capital policy of the strong firm as it faces a competitor that becomes weaker. The interpretation of the marginal cost and benefit curves in figure 1.6 is
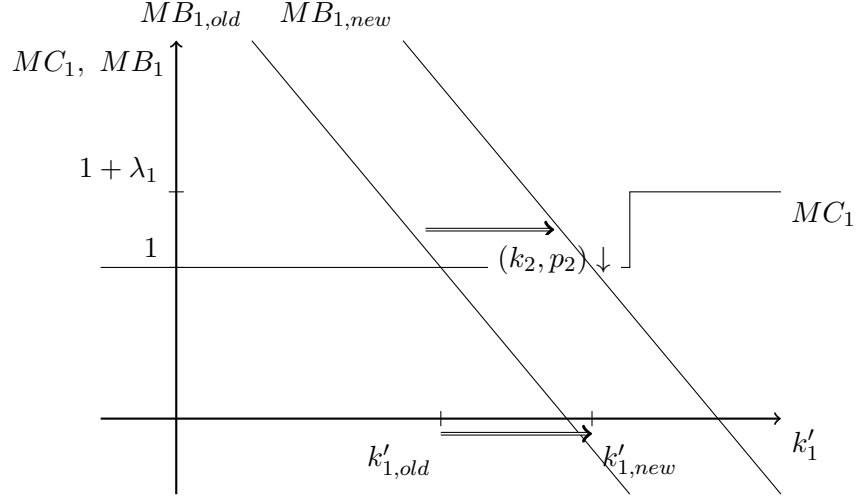
Figure 1.6: Marginal cost benefit analysis strong firm

the same as for the weak firm so won't be repeated here. As firm 2 becomes financially and or technologically weaker, the marginal benefits to firm 1 from an extra unit of installed capital tomorrow increase as reflected by the shift from the marginal benefit curve from $MB_{1,old}$ to $MB_{1,new}$. The reason for this is that as firm 2 becomes weaker, firm 1 realizes its competitor will optimally reduce its level of next period capital as outlined above. Firm 1 thus shifts its beliefs on firm 2's next period capital to the lower end of the capital distribution. However, the marginal benefits to a firm from an extra unit of installed capital increase as its competitor chooses lower levels of future installed capital. This is because the stronger firm now essentially has a larger market potential at its disposal. The shift in the marginal benefits then results in an increase in the optimal level of next period installed capital from $k'_{1,old}$ to $k'_{1,new}$, reflecting the dynamics of figure 1.3.

1.3.3. Comparative statics results.

In this section, a comparative statics exercise for the baseline model is carried out. Because this paper is primarily concerned with strategic interactions within a two firm or duopoly market, the most interesting insights come from looking at the steady state industry structure. To obtain the steady state industry structure, a simulation based approach is taken where the capital and savings policy functions are used to simulate the firms' investment

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and savings' behavior for, $T = 10000$[1] periods. Frequency tables then capture the fraction of periods the industry finds itself in a given capital (savings) state. A capital (savings) state is simply the level of capital (savings) chosen by firm 1 and firm 2 in a given period t.

First, the steady state will be analyzed for the base case parameters outlined in the previous section. In addition to the base case, a comparative statics exercise will be carried out by considering four different parameter set ups. In particular, what will be considered are the effects on the industry structure from changes in the cost of external financing, λ_0 and λ_1 respectively, and the intensity of competition, or ϕ_c relative to ϕ_o.

One interesting question we will be able to answer from the steady state analysis is whether the industry converges to a symmetric or asymmetric industry structure. The reason one might believe an asymmetric industry structure might arise is that costly external financing, and especially the fixed cost of external financing, might prevent laggard firms in the industry to catch up with the leader. Alternatively, costly external financing might not lead to a steady state asymmetric industry structure but simply reduce the speed with which the laggard firm catches up with the leader.

$k^2 \backslash k^1$	$k^1_{(1-4)}$	$k^1_{(5-8)}$	$k^1_{(9-12)}$	$k^1_{(13-16)}$	$k^1_{(17-20)}$	$k^1_{(21-24)}$	$k^1_{(25-28)}$	$k^1_{(29-32)}$	$k^1_{(33-36)}$	$k^1_{(37-40)}$
$k^2_{(1-4)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(5-8)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(9-12)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(13-16)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(17-20)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(21-24)}$	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
$k^2_{(25-28)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00
$k^2_{(29-32)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(33-36)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00
$k^2_{(37-40)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35

Table 1.2: Frequency table capital: base case

First consider the base case parameter set-up. Table 1.2 gives the frequency table for industry capital in the steady state. Because the state space for capital contains, $n_k = 40$, points, the different capital states are grouped together by four for convenience. For instance

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[1] Actual simulation contains T =10100 periods where the first 100 were dropped.

$p^2\backslash p^1$	p_1^1	p_2^1	p_3^1	p_4^1	p_5^1
p_1^2	0.35	0.00	0.00	0.00	0.00
p_2^2	0.00	0.03	0.00	0.00	0.00
p_3^2	0.00	0.01	0.20	0.03	0.00
p_4^2	0.00	0.00	0.02	0.35	0.00
p_5^2	0.00	0.00	0.00	0.00	0.00

Table 1.3: Frequency table savings: base case

the cell $(k_{(21-24)}^2, k_{(21-24)}^1)$ indicates that 6% of the time the industry structure is such that the capital levels of both firm 1 and firm 2 are between position 21 and 24 on the capital grid. In general, table 1.2 indicates that the industry always converges to a symmetric steady state in which capital is concentrated on the higher end of the capital grid.

Similarly, table 1.3 gives the frequency table for industry savings in the steady state. This indicates that industry savings is zero 35 % of the times and then concentrated around level 3 and 4 for the remainder of the time.

Note that the different sets of capital and savings concentrations in the above tables correspond to the different states of the industry as captured by the market shock, z. To illustrate this, tables 1.4 to 1.6 give industry savings in the steady state, but conditional on whether the state of the market is low, table 1.4, intermediate, table 1.5, or high, table 1.6.

$p^2\backslash p^1$	p_1^1	p_2^1	p_3^1	p_4^1	p_5^1
p_1^2	0.02	0.00	0.00	0.00	0.00
p_2^2	0.00	0.02	0.00	0.00	0.00
p_3^2	0.00	0.00	0.37	0.03	0.00
p_4^2	0.00	0.00	0.02	0.54	0.00
p_5^2	0.00	0.00	0.00	0.00	0.00

Table 1.4: Frequency table savings: base case, low market

$p^2\backslash p^1$	p_1^1	p_2^1	p_3^1	p_4^1	p_5^1
p_1^2	0.21	0.00	0.00	0.00	0.00
p_2^2	0.00	0.05	0.01	0.01	0.00
p_3^2	0.00	0.03	0.19	0.04	0.00
p_4^2	0.00	0.00	0.04	0.42	0.00
p_5^2	0.00	0.00	0.00	0.00	0.00

Table 1.5: Frequency table savings: base case, medium market

Not surprisingly, both firms save less (more) the better (worse) the market environment as

$p^2\backslash p^1$	p^1_1	p^1_2	p^1_3	p^1_4	p^1_5
p^2_1	0.77	0.00	0.00	0.00	0.00
p^2_2	0.00	0.02	0.00	0.00	0.00
p^2_3	0.00	0.00	0.06	0.01	0.00
p^2_4	0.00	0.00	0.01	0.12	0.00
p^2_5	0.00	0.00	0.00	0.00	0.00

Table 1.6: Frequency table savings: base case, high market

they adjust their behavior to the increase (decrease) in investment opportunities. In tables not reported here we find a similar picture for capital in that better market environments lead both firms to choose a higher level of capital. Note also that even conditional on the market environment there does not appear to be any indication of significant asymmetries arising in the structure of the industry.

Now consider what happens when the cost of external financing is altered. Tables 1.7 to 1.12 represent the steady state levels of capital and savings in the industry for different specifications of the external cost of financing. In particular, tables 1.7 and 1.8 represent the situation where the fixed costs of raising equity capital, λ_0, are set to zero.

$k^2\backslash k^1$	$k^1_{(1-4)}$	$k^1_{(5-8)}$	$k^1_{(9-12)}$	$k^1_{(13-16)}$	$k^1_{(17-20)}$	$k^1_{(21-24)}$	$k^1_{(25-28)}$	$k^1_{(29-32)}$	$k^1_{(33-36)}$	$k^1_{(37-40)}$
$k^2_{(1-4)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(5-8)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(9-12)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(13-16)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(17-20)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(21-24)}$	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00
$k^2_{(25-28)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00
$k^2_{(29-32)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00
$k^2_{(33-36)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.33	0.00
$k^2_{(37-40)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34

Table 1.7: Frequency table capital: $\lambda_0 = 0$

$p^2\backslash p^1$	p^1_1	p^1_2	p^1_3	p^1_4	p^1_5
p^2_1	0.85	0.00	0.00	0.00	0.00
p^2_2	0.00	0.15	0.00	0.00	0.00
p^2_3	0.00	0.00	0.00	0.00	0.00
p^2_4	0.00	0.00	0.00	0.00	0.00
p^2_5	0.00	0.00	0.00	0.00	0.00

Table 1.8: Frequency table savings: $\lambda_0 = 0$

Table 1.8 indicates that the main driver for holding cash is the presence of fixed issuance

costs, which is in line with what is documented by Riddick and Whited [2006]. In 85 % of

the periods, both firms hold no cash compared to only 35 % of the periods in the presence

of fixed costs. On the other hand, setting the fixed costs to zero has virtually no discernible

effect on capital as indicated by table 1.7.

$k^2 \backslash k^1$	$k^1_{(1-4)}$	$k^1_{(5-8)}$	$k^1_{(9-12)}$	$k^1_{(13-16)}$	$k^1_{(17-20)}$	$k^1_{(21-24)}$	$k^1_{(25-28)}$	$k^1_{(29-32)}$	$k^1_{(33-36)}$	$k^1_{(37-40)}$
$k^2_{(1-4)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(5-8)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(9-12)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(13-16)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(17-20)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(21-24)}$	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
$k^2_{(25-28)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
$k^2_{(29-32)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
$k^2_{(33-36)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.33	0.00
$k^2_{(37-40)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32

Table 1.9: Frequency table capital: $\lambda_1 = 0$

$p^2 \backslash p^1$	p^1_1	p^1_2	p^1_3	p^1_4	p^1_5
p^2_1	0.42	0.01	0.00	0.00	0.00
p^2_2	0.01	0.34	0.00	0.00	0.00
p^2_3	0.00	0.01	0.01	0.02	0.00
p^2_4	0.00	0.00	0.02	0.16	0.00
p^2_5	0.00	0.00	0.00	0.00	0.00

Table 1.10: Frequency table savings: $\lambda_1 = 0$

$k^2 \backslash k^1$	$k^1_{(1-4)}$	$k^1_{(5-8)}$	$k^1_{(9-12)}$	$k^1_{(13-16)}$	$k^1_{(17-20)}$	$k^1_{(21-24)}$	$k^1_{(25-28)}$	$k^1_{(29-32)}$	$k^1_{(33-36)}$	$k^1_{(37-40)}$
$k^2_{(1-4)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(5-8)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(9-12)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(13-16)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(17-20)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(21-24)}$	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
$k^2_{(25-28)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00
$k^2_{(29-32)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
$k^2_{(33-36)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00
$k^2_{(37-40)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32

Table 1.11: Frequency table capital: $\lambda_1 = 0.05$

In contrast to lowering the fixed cost of external capital, tables 1.9 to 1.12 indicate that

lowering the variable cost of external financing has very little effect on optimal level of

savings and capital in the industry. Though savings is somewhat reduced as λ_1 is lowered,

firms on average still save in low market states rather than distribute cash to shareholders.

$p^2\backslash p^1$	p^1_1	p^1_2	p^1_3	p^1_4	p^1_5
p^2_1	0.32	0.00	0.00	0.00	0.00
p^2_2	0.00	0.04	0.01	0.01	0.00
p^2_3	0.00	0.02	0.18	0.04	0.00
p^2_4	0.00	0.00	0.03	0.36	0.00
p^2_5	0.00	0.00	0.00	0.00	0.00

Table 1.12: Frequency table savings: $\lambda_1 = 0.05$

That is the fixed costs of external financing are the crucial driver of the precautionary savings motive in the model.

$k^2\backslash k^1$	$k^1_{(1-4)}$	$k^1_{(5-8)}$	$k^1_{(9-12)}$	$k^1_{(13-16)}$	$k^1_{(17-20)}$	$k^1_{(21-24)}$	$k^1_{(25-28)}$	$k^1_{(29-32)}$	$k^1_{(33-36)}$	$k^1_{(37-40)}$
$k^2_{(1-4)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(5-8)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(9-12)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(13-16)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(17-20)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(21-24)}$	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
$k^2_{(25-28)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00
$k^2_{(29-32)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$k^2_{(33-36)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00
$k^2_{(37-40)}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39

Table 1.13: Frequency table capital: $\phi_c = -0.1$

$p^2\backslash p^1$	p^1_1	p^1_2	p^1_3	p^1_4	p^1_5
p^2_1	0.40	0.00	0.00	0.00	0.00
p^2_2	0.00	0.03	0.02	0.00	0.00
p^2_3	0.00	0.02	0.16	0.01	0.00
p^2_4	0.00	0.00	0.03	0.33	0.00
p^2_5	0.00	0.00	0.00	0.00	0.00

Table 1.14: Frequency table savings: $\phi_c = -0.1$

Finally, tables 1.13 and 1.14 capture a novel result not documented by previous dynamic models in corporate finance. In particular, tables 1.13 and 1.14 indicate how a change in the strength of competitive interactions between firm 1 and 2 change their optimal capital and savings policies. In tables 1.13 and 1.14, the financial parameters are as in the base case model, but the strength of competitive interaction is reduced by lowering the cross price elasticity parameter, ϕ_o, from -0.3 to -0.1. In practice this means that both firms have more market power in their own market segment and hence have to worry less about consumers defecting to the competition. While the effect on the industry level of capital is minor, the

effect on savings is that both firms lower their savings when competition is reduced. That is the industry savings distribution shifts to lower levels of savings. This indicates that conditional on costly external financing, firms hold lower cash balances when the level of competition is reduced. This is explained by the fact that predatory investment behavior is less profitable when the firms are more distinct in the eyes of the consumer, i.e. lower ϕ_o, so that the firms have less incentives to build up a cash buffer to ensure competitive viability in the future.

1.4. Conclusion

Dynamic models of firm financial decision making have received increasing attention in recent years. These models however, usually depart from either monopolistic or perfect competition and thus ignore the effect strategic considerations might have on firms' optimal real and financial policies. Moreover, empirical evidence suggests that strategic interactions between firms are indeed present and have a non trivial impact on firms' financial decisions and in particular on their cash holding strategies. In a dynamic duopoly model of the firm, this paper documents the tendency for financially strong firms to prey on weaker firms by investing aggressively in an attempt to capture market share of their competitor. This threat of predation by competitor firms generates a precautionary motive for hoarding cash not present in monopolistic models or models of perfect competition. In particular, the model indicates that controlling for the cost of external financing, as the strength of competitive interaction increases, firms in the industry tend to hold larger cash balance on average. Another interesting feature of the model is that costly external financing does note appear to be able to endogenously generate an asymmetric industry structure. In other words, costly external financing does not prevent laggards in the industry to catch up with the leader. All results in this paper however are based on a rather loose parameterization as the current literature provides little guidance as to how to set the various parameters in the model. An interesting question for future research would therefore be to estimate the parameters of the model via simulated methods of moments as in for instance Hennessy and

Whited (2005). This exercise would be particularly valuable with respect to the competition parameters, since for these parameters little guidance was available and the results show they have a non trivial impact on firms' cash holding strategies.

CHAPTER 2 : The real effects of socially responsible investing

2.1. Introduction

2.1.1. Motivation

Socially responsible investment (SRI) has become an increasingly popular investment practice in recent years. The US Social Investment Forum (USSIF), a national not-for-profit organization that promotes the concept, practice and growth of socially responsible investing, reports that in 2010 12.2 % of the $25.2 trillion in total assets under management tracked by Thomson Reuters Nelson is involved in some strategy of socially responsible investing.

One of the primary goals of SRI is to allow consumers to align their investment savings decisions with their personal values and its most popular application at the moment is the use of socially responsible investment screens. These investment screens are applied within otherwise standard financial investment analysis and effectively reduce the universe of stocks to a subset of shares who are deemed morally or ethically acceptable to socially responsible investors.

Broadly speaking, a socially responsible investment screen is a set of environmental, social or ethical criteria which determine which shares are eligible for trade to an investor who wishes to invest only in firms whose practices and policies are in line with his personal values. As such the portfolio allocation decisions of socially responsible investors are a function of not only financial but also non-financial factors reflecting the personal attitude of these investors towards certain corporate practices and policies.

Advocates of SRI however claim that SRI screens are more than a mere tool allowing investors to meet their moral obligations towards investing. In particular they argue that by selectively investing in firms exhibiting a high corporate social performance (CSP) socially responsible investors lower these firms cost of capital thus stimulating firms in general to

improve their CSP.

Research in finance examining this claim about the real effects of SRI however is scarce and therefore relatively little is known about its validity. This is unfortunate since research in finance is increasingly examining how financial markets feed back into the investment decision by firms as evidenced for instance by work by Chen et al. (2007) and Bond et al. (2012). By analyzing SRI, a new channel through which financial markets determine firm investment decisions can therefore be explored.

The goal of this paper is to partly fill this gap in the literature by revisiting the question on equilibrium equity cost of capital formation when the financial market is populated by socially responsible investors. Socially investors differ from traditional investors in two ways.

First, socially responsible investors apply SRI screens and invest only in firms which exhibit a high CSP.

Secondly, socially responsible investors believe that firms with a higher CSP also have a higher corporate financial performance (CFP). This so called "doing well while doing good" hypothesis is currently hotly debated in both professional and academic circles.

Nevertheless many SRI practitioners claim that the screening of firms on their CSP not only allows them to selectively invest in virtuous firms but also that it unearths valuable insights into firms' competitiveness and profitability. As such socially responsible investors can be expected to condition their trades above and beyond the screening outcome on this additional piece of information about a firm's fundamental.

Previous research which looked into the effects of socially responsible investors on a firm's equilibrium cost of capital, primarily focussed on the impact of SRI screening, Angel and Rivoli (1997) and Heinkel et al. (2001). This paper adds to the existing literature by not only assuming the application of SRI screens by socially responsible investors, but also the

active trading of socially responsible investors on information related to the firm's corporate social performance.

Moreover, traditional investors are assumed to not to trade on this CSP information because they regard it as irrelevant. As such socially responsible and traditional investors are assumed to openly disagree on the cash flow importance of a firm's corporate social performance.

The main point this paper will then seek to make is that although SRI screens have the potential to lower the cost of capital of firms with a high CSP, this need not be the case if socially responsible investors trade on and disagree with traditional investors about the importance of CSP information.

The reason for this is that although trading on so called environmental, social and governance (ESG) information, which captures corporate social performance, has gained momentum among investors, it is primarily socially responsible investors who are leading this trend. Most traditional investors still dismiss the relevance of ESG risks and opportunities and hence largely ignore it as a source of information on the firm's future cash flow performance.

This apparently open disagreement between traditional and socially responsible investors on the importance of CSP information is what might lead the investment strategies of socially responsible investors to harm the cost of capital of high CSP firms or to at least make the cost of capital gap between high and low CSP firms to be smaller than what standard theory in finance might predict.

In particular, socially responsible investment screens imply that high CSP firms will have a larger investor base than low CSP firms, all else equal, because the former are more likely to be included into the portfolios of socially responsible investors. Standard theory in finance then predicts that in a simple economy with risk averse investors, high CSP firms will enjoy a relatively lower cost of capital because their risk is spread out over more investors.

In a Grossman and Stiglitz (1980) economy with open disagreement on the value of CSP information this argument still holds, but needs to be complemented by the fact that traditional investors will perceive the trading by socially responsible investors on CSP information as an additional source of noise trading. If traditional investors are not fully informed on this CSP noise such that they can not fully anticipate the effects on the equilibrium share price, they will charge a risk premium for trading the shares of high CSP firms which might offset the discount these firms enjoys because of their larger investor base.

This negative externality on the risk premium charged however is not the only effect the open disagreement has on a firm's cost of capital. In particular, in addition to the above risk compensation channel, open disagreement affects a firm's equilibrium cost of capital through a mean return channel. The effect will moreover be positive or negative depending on what the true underlying relationship is between CSP and CFP, that is whether the beliefs of socially responsible or of traditional investors are correct.

For instance, if in reality CSP has no effect on the firm's CFP yet socially responsible investors believe there is, then their trading generates an additional demand for the shares of high CSP firms which is reflected in the equilibrium price but not in the expectation of the firm's fundamental. This will lead a high CSP firm's cost of capital to be too low relative to what it should be.

On the other hand, if socially responsible investors are correct in their beliefs, then a high CSP firm's cost of capital will be too high relative to what it should be. This is because although the firm's fundamental will now fully reflect the CSP - CFP relationship, the equilibrium price will only partly do so since only socially responsible investors incorporate the true relationship into the equilibrium price.

The arguments put forward in this paper might therefore shed some light on why it has been hard to find empirical evidence on the impact of socially responsible investment strategies on firms' cost of capital, despite the growing popularity of socially responsible investing.

Future empirical research might then be guided by the propositions in this paper in order to see whether corporate social performance effect on firms' cost of capital can be identified.

In addition, the paper has implications for policy makers who want to stimulate socially responsible investing as a mechanism to make firms internalize environmental or social externalities. In particular, if traditional and socially responsible investors continue to disagree on the relevance of CSP information, then the screening efforts by socially responsible investors can be rendered less effective or even ineffective as a tool to make make firms internalize their externalities via the cost of capital channel. For socially responsible investment screens to be more effective, policy makers need to control as much as possible the noise premium charged by traditional investors.

The noise premium however is a result of traditional investors being less informed than socially responsible investors about the firm's CSP. If traditional investors were equally well informed, they would be able to filter out the impact of socially responsible investor's trading activities on the equilibrium price. CSP information would then no longer appear as a source of noise for traditional investors in the price signal and they would no longer charge an additional noise premium.

In the next section an overview will be given of the current state of the socially responsible investment sector. Following that, there will be a brief discussion of past research on socially responsible investing in the finance literature.

2.1.2. Socially responsible investment sector

Socially responsible investing in the United States has experienced strong growth in the last 15 years. Growing substantially faster than the broader universe of conventional investment assets under professional management, table 2.1 reports that assets following SRI strategies grew from \$639 billion in 1995 to \$ 3.07 trillion in 2010. This represents a growth of 380 % in just over 15 years. Furthermore, during the recent financial crises, from 2007 to 2010, the overall universe of professionally managed assets has remained roughly flat while SRI

(In Billions)	1995	1997	1999	2001	2003	2005	2007	2010
ESG Incorporation	$162	$529	$1,497	$2,010	$2,143	$1,685	$2,098	$2,512
Shareholder Advocacy	$473	$736	$922	$897	$448	$703	$739	$1,497
Community Investing	$4	$4	$5	$8	$14	$20	$25	$41.7
Overlapping strategies	N/A	($84)	($265)	($592)	($441)	($117)	($151)	($981.18)
Total	**$639**	**$1,185**	**$2,159**	**$2,323**	**$2,164**	**$2,290**	**$2,711**	**$3,069**

Table 2.1: SRI in the United States 1995-2010

assets have enjoyed a healthy growth.

Table 2.1 furthermore indicates that there are roughly three broad categories of socially responsible investment strategies: first, the incorporation of ESG criteria in standard investment analysis, secondly, shareholder advocacy strategies and finally, investing in community development projects. This paper is concerned with the first, and largest, category which represents the use of socially responsible investment screens based on environmental, social and governance criteria.

Of the $2.51 trillion of assets under management that apply ESG screening strategies, $691.9 billion are identified within specific investment vehicles managed by money managers, while at least $2.03 trillion are identified as owned or administered by institutional investors. These figures indicate that not only is the market share of SRI screening strategies sizeable, the ESG screens are applied by professional, informed investors who carry out research and trade on private information in order to make speculative profits.

When a socially responsible investment fund applies an SRI screen it focusses on one or several dimensions of corporate environmental, social or governance performance. In addition, socially responsible investors can implement the screens in a positive, negative restrictive or negative exclusionary manner.

Positive screening implies seeking out firms who excel their industry peers along a certain dimension of ESG performance. Negative restrictive and exclusionary screening on the other hand implies avoiding firms who perform badly on ESG criteria. Restrictive screens differ from exclusionary screens in that the former are usually interpreted in a more flexible

manner. In particular, restrictive screens sometimes allow investment in relatively poor ESG performers if it is deemed necessary to ensure the viability of the investment portfolio for instance to ensure the portfolio is sufficiently diversified. For exclusionary screens, no such exceptions are allowed and the fund applying them commit to divest from any firms or industries whose ESG performance falls below a certain benchmark. An example of a popular positive screen is clean technology. Funds applying such a screen actively seek out investment in firms who outperform in the procurement of electricity from alternative energy sources such as wind or water. As such, they tilt their portfolios towards these clean tech firms potentially over and above what might be deemed optimal from a purely financial perspective.

Positive screens also differ from negative screens in that the former usually do not imply divestment from entire industries. In particular, firms from the heavy manufacturing industry for instance might by the very nature of their energy needs find it difficult to purchase all their electricity from alternative sources. A negative clean tech screen would then divest from all heavy manufacturing firms. A positive clean tech screen however would seek out those firms that outperform their industry peers in the procurement of clean energy, although on an absolute basis these firms perform much worse than say software developers.

Finally, popular negative screens are those that screen out firms involved in the tobacco, alcohol or gambling industries. Historically these are probably the first examples of socially responsible investment screens. In particular, dating as far back as the 19th century methodists and quakers in the United States are known to apply these screens to align their investments with their religious beliefs.

2.1.3. Related literature

The question about the real effects of socially responsible investment screening is not new. It has previously been addressed theoretically in at least two papers.

First, Angel and Rivoli (1997) used the model of Merton (1987) to argue that stocks of

firms who are shunned from the portfolios of socially responsible investors will have a higher cost of capital relative to non shunned firms all else equal. The central intuition is that socially responsible investing creates market segmentation effects akin to those generated by incomplete information in Merton (1987).

Secondly, Heinkel et al. (2001) analyze in a simple model of capital market equilibrium whether firms may have an incentive to take a costly action to change their technology from a dirty to an environmentally friendly one in the presence of socially responsible investors. Central to the paper is the idea that socially responsible investors shun the stocks of firms with a dirty technology out of ideological motivations. This will cause the risk of dirty technology firms to be carried by a smaller number of investors limiting the potential for risk diversification and causing traditional investors to charge a risk premium in order to invest in dirty technology firms. Firms could then be expected to be willing to change their technology if the cost of doing so is less than the discount in their market valuation if they stick to the old technology.

Both papers suggest a reason for why the shares of stocks shunned by socially responsible investors should have a higher cost of capital than otherwise comparable shares which face no boycott. The current paper differs importantly from both papers in that its central conclusion is that stocks actively traded may trade at a discount or a premium depending on the model parameter and is therefore richer in the predictions it makes.

The framework of the current paper has most in common with Heinkel et al. (2001) in that it does not rely on an asset pricing model such as Angel and Rivoli (1997), but differs importantly in that the model assumes asymmetry of information between investors and heterogeneity of beliefs regarding the relationship between corporate social and financial performance. In particular, the main factor driving the different conclusions of the current paper are generated by the asymmetry of information and the trading behavior of socially responsible investors who are assumed to trade actively on corporate social performance information.

The only paper which thus far has been able to provide evidence that SRI screening may result in a cost of capital gap between virtuous and non-virtuous firms is Hong and Kacperczyk (2009). The paper documents that sin stocks, defined as shares of firms involved in the production of alcohol, tobacco and gambling, have a higher expected return than comparable non-sin stocks. The paper argues that this is a result of SRI screening rather than unobserved risk factors to which sin stocks are exposed. The main argument they provide to back this claim is that sin stocks are held to a much lesser extent by institutional investors who are more exposed to pressure not to invest in shares of firms involved in the so called sin-stock industries.

Besides the above theoretical arguments cited above, the paper is also related to a large swath of empirical research pertaining to the relationship between corporate social and financial performance. Indeed, one of the paper's main assumptions is that traditional and socially responsible investors differ in their beliefs regarding the cash flow importance of responsible corporate behavior. Apart from the anecdotal evidence on observed investment strategies by institutional investors, the disagreement in beliefs can be justified in light of the mixed evidence in academic journals on the relationship between corporate social and financial performance.

Responsible corporate behavior can be defined along several dimensions such as environment, community relationships, human resources, customer and supplier relationships, human rights and corporate governance. Although socially responsible investors screen and trade on all of the above dimensions, the academic literature is far from clear on which if any of the above dimensions of responsible corporate behavior may boost a firm's financial performance.

A different variety of approaches has been used in the past in order to shed empirical light on the doing well while doing good hypothesis.

First, a series of event studies have focussed on corporate environmental performance and

have sought to link it to stock prices. In particular, papers such as Shane and Spicer (1983) , Hamilton (1995) , Klassen and McLaughlin (1996) and Karpoff et al. (2005) all document significant stock price reactions in response to news related to firms' environmental pollution record. Moreover, Klassen and McLaughlin (1996) documents that downward price movements after negative news about pollution records are stronger than upward movements after positive news. Furthermore, Karpoff et al. (2005) finds that downward movements in share prices are closely related to expected penalties and fines firms may be exposed to after bad environmental performance. As such these papers suggest that investors pay more attention to potential short term negative implications in terms of fines and penalties of firms with a bad environmental record rather than potential long term future benefits in terms of productivity gains.

Next a strand of literature seeks to shed light on the relationship between financial and social or environmental performance by analyzing the returns of socially screened stock portfolios and comparing them to the returns of traditional stock portfolios. The key distinguishing feature among the papers taking this approach is usually how the SRI screens are defined and hence which firms are included in the socially screened portfolios. Furthermore, whether or not socially responsible portfolios outperform appears to depend on the specific screens used.

Cohen et al. (1997) examines the relationship between financial and environmental performance by constructing two industry balanced portfolios of S&P 500 companies and comparing the stock returns of the "higher polluter" and "lower polluter" portfolio. Overall, the paper finds no penalty nor extra return for the green portfolio.

Derwall et al. (2005) on the other hand finds that a portfolio of eco-efficient companies significantly outperforms less environmentally efficient companies even after controlling for commonly used asset pricing factors.

Kempf and Osthoff (2007) documents that a long short portfolio strategy which entails

buying stocks with a high social performance ratings while selling stocks with low social performance ratings delivers high abnormal returns which are robust to reasonable transaction costs. In order to obtain the high abnormal returns, the social performance ratings are based on a combination of several criteria and several dimensions of responsible behavior do not yield abnormal returns when looked at in isolation.

In particular, in contrast to Derwall et al. (2005), long short strategies which invest in high versus low environmental performance firms does not yield abnormal returns. The biggest contributors to abnormal returns on the other hand appear to be firm performance on employee relations and community relations.

It should be noted however that Derwall et al. (2005) and Kempf and Osthoff (2007) differ crucially in how firm performance on the different dimensions is defined. In particular, Derwall et al. (2005) uses a proprietary database of Innovest a fundmanager advisory firm while Kempf and Osthoff (2007) uses the publicly available social ratings from Kinder, Lindenberg and Domini (KLD).

The results in Edmans (2011) are in line with the findings in Kempf and Osthoff (2007) regarding the importance of employee relations by finding that a portfolio consisting of the 100 best companies to work for significantly outperforms a comparable base portfolio.

Nelling and Webb (2009) find a weak correlation between measures of corporate social responsibility and financial performance. Moreover, their analysis suggests that high corporate social performance is driven by rather than drives high financial performance. That is, firms engage in CSR because they have the necessary financial resources rather than because it will boost their financial performance.

In addition to studies on stock prices and portfolio returns, researchers have also looked at valuation measures such as tobin's Q in order to determine whether good social performance leads to higher than average valuation.

Jiao (2010) looks at the effect of corporate social performance on firm valuation as defined by Tobin's Q. The social performance ratings are constructed using the KLD rating data and overall the paper finds that a high score on a broad stakeholder welfare measure leads to positive valuation effects. The results depend strongly however on how the stakeholder measure is constructed. In particular, although employee welfare and environmental performance generate positive valuation effects, diversity, community relations and product quality do not seem to matter. Therefore, although certain stakeholder groups appear to be generally important for valuation others do not.

Finally, Ghoul et al. (2011) use the approach from Pstor et al. (2008) to estimate the ex-ante expected cost of capital. This approach combines both market data and analyst forecasts to obtain a cleaner measure of a firm's equity cost of capital. The main finding from the paper is that corporate social responsibility is associated with lower equity cost of capital in particular when responsible behavior is defined along employee relations, environmental performance and product strategies.

2.2. Model

2.2.1. Outline

I analyze the impact of socially responsible investment (SRI) strategies on a firm's equilibrium cost of capital in a two stage Grossman and Stiglitz (1980) type model with two classes of investors.

In particular, the model is populated by a continuum of investors with mass n. A proportion λ^T of these investors belongs to the first investor class and are called "traditional" investors, while a proportion λ^S belongs to the second investor class and are called "socially responsible" investors.

There is a single firm in the economy with a measure Ω of shares outstanding, traded in the financial market at a price $\widetilde{P}$. In addition to the firm's shares, investors in the model

are able to invest in a risk free asset which is in unlimited supply and with payoff and price normalized to one.

In contrast to the standard Grossman and Stiglitz (1980) model, the trading stage in this model is preceded by a pre-trading stage during which socially responsible investors decide whether they will trade the shares of the firm or not. During the socially responsible screening stage, only socially responsible investors are assumed to play a role. Moreover, the exposition of the screening stage is moreover kept as simple as possible since the focus of the current paper is to examine the cost of capital and price formation implications of socially responsible investment strategies under heterogenous beliefs. Though analyzing the precise structure of the screening stage might nevertheless prove insightful, this needs to be relegated to future research.

The next two sections describe respectively the socially responsible screening stage and the trading stage.

2.2.2. Socially responsible screening stage

During the screening stage, socially responsible investors determine whether they will trade the firm's shares during the subsequent trading stage. In essence, during the screening stage socially responsible investors determine whether the firm scores sufficiently high on its corporate social performance in order for its shares to be eligible for trade. To this end, socially responsible investors collect information on the firm's corporate social performance and apply a performance threshold.

Through the screening procedure, socially responsible investors seek to align their investment savings decisions with their personal values.

The firm's corporate social performance is modelled as the sum of two components: the firm's average corporate social performance, $\widetilde{\mu}_{\Xi}$ and a zero mean shock component, $\widetilde{\delta}$.

$$\widetilde{\Xi} = \widetilde{\mu}_\Xi + \widetilde{\delta}.$$

The firm's average corporate social performance is modelled as a binary random variable,

$$\widetilde{\mu}_\Xi = \begin{cases} \mu_H & \text{with prob.} \quad p \\ \mu_L < \mu_H & \text{with prob.} \quad 1-p \end{cases}.$$

The shock component is a zero mean normally distributed random variable,

$$\widetilde{\delta} \sim \mathcal{N}\left(0, \sigma_\delta^2\right).$$

When socially responsible investors collect information on the firm's corporate social performance , it will be assumed that they perfectly learn its two components, $\widetilde{\mu}_\Xi$ and $\widetilde{\delta}$. Although the assumption of perfect learning is strong, it is mainly made to maintain tractability throughout the model.

In particular, as will become clearer from the discussion on the trading stage, this assumption avoids a situation in which the price would be informative about two fundamentals. In such a case, solving for the equilibrium price becomes much more cumbersome and would not add anything to the point this paper seeks to make regarding the negative externality socially responsible investors have on traditional investors under heterogeneity of beliefs.

In addition it should be noted that the information collection process is not modelled explicitly in this paper. This is in part done in order to simplify the exposition but also because it is upfront not clear how the information process should be modelled.

In particular, since socially responsible screening is at least in part driven by the non-

pecuniary motive to align investment savings decisions with personal values, modelling information collection would require a stance on how to model the utility derived from this utility and more importantly a stance on how it relates to utility derived from financial gains. Though research in social psychology has attempted to shed light on modelling this non-profit motive, a consensus is far from reached. As such this paper will avoid going into this complication and will assume that socially responsible investors become perfectly informed about the firm's corporate social performance during the screening stage.

Next, the paper will assume that the screening decision by socially responsible investors is assumed to be based solely on the firm's average corporate social performance , $\widetilde{\mu}_\Xi$ and not $\widetilde{\delta}$. In particular, the straightforward screening rule socially responsible investors apply is that they will trade the firm's shares if $\widetilde{\mu}_\Xi = \mu_H$ and not otherwise.

The assumption that screening is based on $\widetilde{\mu}_\Xi$ is made primarily for tractability. Together with another assumption made below, it will ensure that the remaining uncertainty faced by traders during the trading stage is normally distributed. Without this assumption, uncertainty of a binary nature would be introduced in the model causing loss in tractability since a closed form solution of the equilibrium would no longer be available in the CARA utility Grossman and Stiglitz (1980) set-up.

Nevertheless, the assumption is less strong than may seem in the first place since evidence suggests that socially responsible investors base their screening decisions primarily on firms' long run corporate social performance and to a lesser extent on short run shocks.

The set-up as described above now seems to introduce a new type of uncertainty for traditional investors. In particular, in so far as traditional investors are not perfectly informed about the firm's corporate social performance , they technically do not know whether socially responsible investors are present in the market and hence whether they trade the

firm's shares. This makes it harder for traditional investors to condition their demand on the equilibrium stock price, and hence makes trading for them riskier.

However, there is ample reason to believe that although this source of uncertainty is likely present, it is of only secondary importance. The main reason for this is that there exist a number of public information sources which indicate whether or not a firm is likely to be screened in or out of the portfolios of socially responsible investors .

The first such source are socially responsible investment indices, such as for instance the KLD 400 social index, the Dow Jones sustainability index or the FTSE4good index. These are indices comprising firms who according to the companies managing the indices have positive environmental, social and governance (ESG) characteristics. The composition of these indices is publicly available and can be thought of as reflecting the average consensus among socially responsible investors regarding which firms are eligible for adoption into a socially responsible investment portfolio.

Secondly, socially responsible financial intermediaries such as ethical or social banks aim to lend only to firms with positive ESG characteristics and apply a policy of transparent reporting on the firms adopted in their portfolios. To the extent that social and ethical banks use SRI screens similar to the ones used by the broader SRI community, their lending decisions are a second good public source of which firms are included or excluded from the portfolios of socially responsible investors .

In order to reflect this, the paper will continue under the assumption that the screening rule used by socially responsible investors is common knowledge and that the outcome of the screening process is publicly observed. As such traditional investors will perfectly learn the value of $\widetilde{\mu}_\Xi$ at the end of the screening stage and will be able to condition their trades on it during the subsequent trading stage.

The above discussion is summarized in assumption 2.1

Assumption 2.1. *Information during the screening stage:*

- *Socially responsible investors perfectly learn $\widetilde{\mu}$ and $\widetilde{\delta}$ during the screening stage.*

- *Traditional investors perfectly learn $\widetilde{\mu}$ during the screening stage.*

The screening stage will then determine whether only traditional investors or both traditional and socially responsible investors will trade the firm's shares in the financial market.

2.2.3. Trading stage

During the trading stage, all investors seek to earn speculative trading profits on the information they have about the firm's fundamental. Both traditional and socially responsible investors are endowed with CARA utility preferences defined over end of period wealth and have a risk aversion of $\frac{1}{\gamma}$. All investors also have the same initial wealth $\overline{W}$.

Though both types of investors are motivated by the same speculative trading profit motive, socially responsible and traditional investors are assumed to disagree on how the firm's fundamental should be defined. In particular, socially responsible investors believe the firm's corporate social performance is a key additional factor driving its financial performance while traditional investors consider it irrelevant.

Furthermore, as was indicated above, socially responsible investors have a informational advantage, $\widetilde{\delta}$, over traditional investors which they inherited from the socially responsible screening stage. Since socially responsible investors believe corporate social performance drives cash flow performance, they will trade on the additional information they have and incorporate it into the equilibrium price.

In so far as traditional investors do not believe $\widetilde{\delta}$ is relevant however, they will view the equilibrium price as having been contaminated by an additional factor of noise similar to the noise introduced by noise traders. If they are informed about $\widetilde{\delta}$, then they can remove its effect from the equilibrium price. If they remain uninformed however, traditional investors will charge an additional risk premium for trading the firm's shares since the equilibrium price is less informative about what they view is the firm's fundamental. The trading

behavior and the informational advantage of socially responsible investors then has a negative externality on traditional investors putting upward pressure on the firm's cost of capital.

To model the trading process, the following elements are introduced.

First, apart from its corporate social performance , $\widetilde{\Xi}$, the firm is characterized by a random variable $\widetilde{\Theta}$ which represents "traditional" sources of financial performance. Both traditional and socially responsible investors agree on the importance of $\widetilde{\Theta}$ as a driver of financial performance.

Conditional on the firm passing the screening process, $\widetilde{\Xi}$ is normally distributed since the uncertainty about the mean component is resolved by the time the trading process begins. In particular, the joint distribution between $\widetilde{\Theta}$ and $\widetilde{\Xi} = \mu_H + \widetilde{\delta}$ is given by

$$
\begin{pmatrix} \widetilde{\Theta} \\ \widetilde{\Xi} \end{pmatrix} \sim \mathcal{N} \begin{pmatrix} 0 & , & \sigma_\Theta^2 & 0 \\ \mu_H & , & 0 & \sigma_\delta^2 \end{pmatrix},
$$

$$
\tau_\Theta = \frac{1}{\sigma_\Theta^2}, \ \tau_\delta = \frac{1}{\sigma_\delta^2}.
$$

Secondly, let ϕ^t, $t \in \{S, T\}$ represent the contribution of corporate social performance to financial performance according to investor class t. Then socially responsible investors believe $\phi^S \geq 0$, while $\phi^T = 0$. This is summarized in assumption 2.2.

Assumption 2.2. *Let ϕ^t, $t \in \{S, T\}$ denote the contribution of corporate social performance to financial performance according to investor class t then,*

- *Traditional investors believe $\phi^T = 0$,*

- *Socially responsible investors believe $\phi^S \geq 0$.*

The cash flow fundamental for traditional investors, $\widetilde{V}^T$, is then given by

$$\widetilde{V}^T = \widetilde{\Theta}.$$

The cash flow fundamental for socially responsible investors, $\widetilde{V}^S$, is then given by

$$\widetilde{V}^S = \widetilde{\Theta} + \phi^S \widetilde{\Xi}.$$

As was indicated above, all investors are motivated the possibility to earn speculative trading profits on the information they have about the firm's fundamental. In what follows, the information set of the different investor types will be discussed.

First, both traditional and socially responsible investors are assumed to be endowed with a private signal about $\widetilde{\Theta}$,

$$\widetilde{s}_i = \widetilde{\Theta} + \widetilde{\epsilon}_i$$

and

$$\widetilde{\epsilon}_i \sim \mathcal{N}\left(0, \sigma_\epsilon^2\right) \ , \tau_\epsilon = \frac{1}{\sigma_\epsilon^2} \ , \ \widetilde{\epsilon} \perp \widetilde{\Theta}.$$

By trading on their private signal $\widetilde{s}_i$, all investors make the price informative about the cash flow fundamental $\widetilde{\Theta}$, causing investors to seek to learn from the equilibrium price.

Secondly, socially responsible investors are perfectly informed about $\widetilde{\Xi}$. In particular, during the screening stage socially responsible investors learn both $\widetilde{\mu}$ and $\widetilde{\delta}$.

Traditional investors however only learn $\widetilde{\mu}$ and not necessarily $\widetilde{\delta}$. Because one of goals of the model is to analyze the implications of the informational disadvantage between traditional and socially responsible investors, traditional investors will be assumed to belong to one of the following two subgroups.

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First, a proportion λ^{TI} of traditional investors is assumed to observe both $\widetilde{\mu}$ and $\widetilde{\delta}$. This set of traditional investors is implicitly assumed to have collected additional information about the firm's corporate social performance in order to learn $\widetilde{\delta}$.

For simplicity this information collection process is not modelled explicitly since it would not yield additional insights into the point the paper wants to make. The proportion of informed traditional investors will therefore be assumed to be given exogenously. Nevertheless, it should be intuitively clear why traditional investors might be interested in collecting information about $\widetilde{\delta}$. Indeed, even though traditional investors do not believe in the cash flow relevance of corporate social performance , knowing $\widetilde{\delta}$ allows them to make the equilibrium price more informative about $\widetilde{\Theta}$ because it allows them to remove what they interpret as corporate social performance noise incorporated by socially responsible investors.

Secondly, the remaining proportion of traditional investors, $\lambda^{TU} = \lambda^{T} - \lambda^{TI}$ is assumed to have access only to the public signal $\widetilde{\mu}$ which is revealed by observing the outcome of the screening process.

Finally, in addition to the informed investors, there is a measure ρn of noise traders who trade for liquidity reasons. Each noise trader is assumed to demand $-\widetilde{z}$ where

$$\widetilde{z} \sim \mathcal{N}\left(0, \sigma_z^2\right).$$

In addition it will be assumed that the measure of noise traders in the market is independent of whether the firm passes or fails the SRI screen. This seems reasonable if one assumes that noise trading is carried out for liquidity reasons and is unlikely to depend on the corporate social performance of the firm.

Finally, all investors can condition their trades on the equilibrium stock price. However, because not all investors have the same information set, the equilibrium stock price will not be equally informative to all investors.

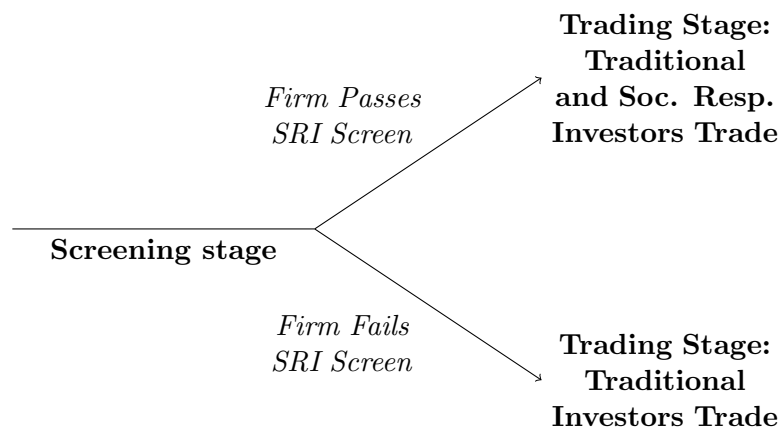Figure 2.1 gives a quick summary of the two stages of the model

Figure 2.1: Timeline.

2.3. Model solution

The structure of the firm's equilibrium share price is a function of whether the firm fails or passes the SRI screen. Furthermore, because of assumption 2.1, all investors during the trading stage know the outcome of the screening stage and hence know whether socially responsible investors are present or not. In the next two section the equilibrium share price and cost of capital are derived for respectively the case where the firm passes the SRI screen and when it fails it.

2.3.1. Equilibrium cost of capital when the firm fails the SRI screen

As a benchmark, the equilibrium price and cost of capital will be derived when the firm fails the SRI screen. In this case only traditional investors are present who share the same beliefs and who have the same informational disadvantage. The benchmark case is the basic solution to the Grossman and Stiglitz (1980) model.

In order to solve for the equilibrium, a conjecture is made about the equilibrium price which is then later verified. The equilibrium price when the firm fails the SRI screen is conjectured to take the following linear form.

$$\widetilde{P} = q_0 + q_1\widetilde{\Theta} + q_2\widetilde{z}$$

Traditional investors: inference and demand

When the firm fails the SRI screen, only traditional investors trade the firm's shares. This implies that the total number of investors trading the firm's shares is not n but $\lambda^T n$ where $\lambda^T = \left(\lambda^{TI} + \lambda^{TU}\right)$. All else equal, the lower informed investor base will render the equilibrium price less informative since a smaller number of investors trade on their private signal $\widetilde{s}_i$.

Furthermore, since there are no socially responsible investors to incorporate the corporate social performance information into the equilibrium price, there is no difference between the inference and demand of informed versus uninformed traditional investors.

Under CARA preferences and normally distributed fundamentals, the equilibrium demand of traditional investors takes the following form

$$x_i^T = \gamma \frac{\mathbb{E}\left[\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right] - \widetilde{P}}{\operatorname{Var}\left(\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right)}.$$

The equilibrium price then constitutes a signal $\widehat{P}$ of the cash flow fundamental $\widetilde{\Theta}$, given by

$$\widehat{P} = \frac{\widetilde{P} - q_0}{q_1} = \widetilde{\Theta} + \frac{q_2}{q_1}\widetilde{z},$$

with precision τ_P

$$\tau_P = \left\{\left(\frac{q_2}{q_1}\right)^2 \sigma_z^2\right\}^{-1}.$$

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Since all random variables are normally distributed, we obtain the expressions for the inference on $\widetilde{\Theta}$ by applying Bayes' rule.

$$\mathbb{E}\left[\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right] = \frac{\tau_\epsilon \widetilde{s}_i + \tau_P \widehat{P}}{\tau_\Theta + \tau_\epsilon + \tau_P}$$
$$\mathrm{Var}\left(\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right) = \frac{1}{\tau_\Theta + \tau_\epsilon + \tau_P}$$

After plugging these expressions in we obtain the equilibrium share demand of traditional investors.

$$x_i^T = \gamma\left(\tau_\epsilon \widetilde{s}_i + \tau_P \widehat{P} - (\tau_\Theta + \tau_\epsilon + \tau_P)\widetilde{P}\right).$$

Equilibrium

The equilibrium condition when the firm fails the SRI screen equates total demand of the firm's shares to total supply,

$$\lambda^T \int x_i^T \, di - \rho \widetilde{z} = \frac{\Omega}{n}.$$

Using the equilibrium condition we can then solve for the equilibrium price coefficients. Proposition 2.1 summarizes the result and the proof is relegated to appendix A.1.

Proposition 2.1. *There exists a unique linear rational expectations equilibrium*

$$\widetilde{P} = q_0 + q_1 \widetilde{\Theta} + q_2 \widetilde{z}.$$

The coefficients $q_0 < 0, q_1 > 0, q_2 < 0$ are a function of the exogenous parameters and are

given in appendix A.1.

Using the expressions for the equilibrium price coefficients, we can now derive an expression for the firm's ex-ante cost of capital conditional on the firm having failed the socially responsible investment screen. In the model however, different investors share different beliefs regarding the relationship between the firm's social and its financial performance.

Rather than taking a specific stance on whether traditional or socially responsible investors are correct, the ex ante cost of capital will be defined with respect to the true underlying relationship between a firm's financial and social performance to be denoted by $\overline{\phi}$ and which will be assumed to lie between traditional investors' and socially responsible investors' beliefs $\overline{\phi} \in [0, \phi^S]$. In doing so the paper follows Easley et al. (2012) who in a model of ambiguity aversion about a model parameter define the ex-ante cost of capital with respect to the true underlying value. By varying $\overline{\phi}$ over the beliefs interval, the extent to which one investor group can be viewed as over or underestimating the relationship between corporate social and corporate financial is changed.

The ex-ante cost of capital conditional on the firm failing the investment screen is then defined as

$$\mathbb{E}^F \left[\widetilde{V} - \widetilde{P} \right] = \mathbb{E}^F \left[\widetilde{\Theta} + \overline{\phi}\widetilde{\Xi} - \widetilde{P} \right].$$

Proposition 2.2 then gives the expression for the equilibrium cost of capital conditional on failing the socially responsible investment screen.

Proposition 2.2. *The firm's ex-ante cost of capital conditional on failing the socially responsible investment screen is given by*

$$\mathbb{E}^F \left[\widetilde{V} - P \right] = \overline{\phi}\mu_L + \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \tau_P \right]},$$

where,

$$\tau_P = \left\{ \left(\frac{\rho}{\gamma \lambda^T \tau_\epsilon} \right)^2 \sigma_z^2 \right\}^{-1}.$$

2.3.2. Equilibrium cost of capital when the firm passes the SRI screen

When the firm passes the investment screen, both traditional and socially responsible investors will trade the firm's shares. This has implications for the firm's equilibrium price which will now be a function not only of $\widetilde{\Theta}$ but also of $\widetilde{\Xi}$. Although the higher number of investors will have a positive effect on the firm's cost of capital, the heterogeneity in beliefs will be shown to potentially offset this.

In order to solve for the equilibrium, a conjecture is made about the equilibrium price which is then later verified. The equilibrium share price when the firm passes the SRI screen is conjectured to take the following linear form

$$\widetilde{P} = p_0 + p_1 \widetilde{\Theta} + p_2 \widetilde{\Xi} + p_3 \widetilde{z}.$$

Corporate social performance informed traditional investors

Under CARA preferences and normally distributed fundamentals, the equilibrium demand of $\widetilde{\Xi} = \mu_H + \widetilde{\delta}$ informed traditional investors takes the following form

$$x_i^{TI} = \gamma \frac{\mathbb{E}\left[\widetilde{\Theta} | \widetilde{s}_i, \widetilde{\Xi}, \widetilde{P}\right] - \widetilde{P}}{\text{Var}\left(\widetilde{\Theta} | \widetilde{s}_i, \widetilde{\Xi}, \widetilde{P}\right)}.$$

Conditional on the information of informed traditional investors, the equilibrium price constitutes a signal $\overline{P}$ of the cash flow fundamental $\widetilde{\Theta}$, given by

$$\overline{P} = \frac{\widetilde{P} - p_0 - p_2\widetilde{\Xi}}{p_1} = \widetilde{\Theta} + \frac{p_3}{p_1}\widetilde{z},$$

with precision τ_P^I

$$\tau_P^I = \left\{ \left(\frac{p_3}{p_1}\right)^2 \sigma_z^2 \right\}^{-1}.$$

The intuition behind this is straightforward. First, traditional investors attempt to infer from the equilibrium price the private information about $\widetilde{\Theta}$ incorporated by other investors. Secondly however, traditional investors do not believe that corporate social performance information is relevant for the value of the firm. Because the trading behavior of socially responsible investors however incorporates corporate social performance information into the equilibrium price, corporate social performance informed traditional investors will use their information on $\widetilde{\Xi}$ to remove its effect on the equilibrium share price. In this way informed traditional investors obtain a price signal that is more precise about $\widetilde{\Theta}$.

The inference on $\widetilde{\Theta}$ made by traditional informed investors is then given by

$$\mathbb{E}\left[\widetilde{\Theta}|\widetilde{s}_i, \widetilde{\Xi}, \widetilde{P}\right] = \frac{\tau_\epsilon\widetilde{s}_i + \tau_P^I\overline{P}}{\tau_\Theta + \tau\epsilon + \tau_P^I}$$
$$\text{Var}\left(\widetilde{\Theta}|\widetilde{s}_i, \widetilde{\Xi}, \widetilde{P}\right) = \frac{1}{\tau_\Theta + \tau\epsilon + \tau_P^I}$$

The equilibrium demand by informed traditional investors is then given by

$$x_i^{TI} = \gamma\left(\tau_\epsilon\widetilde{s}_i + \tau_P^I\overline{P} - \left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)\widetilde{P}\right).$$

Corporate social performance uninformed traditional investors

Under CARA preferences and normally distributed fundamentals, the equilibrium demand of $\widetilde{\Xi}$ uninformed traditional investors takes the following form

$$x_i^{TU} = \gamma \frac{\mathbb{E}\left[\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right] - \widetilde{P}}{\text{Var}\left(\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right)}.$$

Because $\widetilde{\Xi}$ is not contained in the information set of uninformed traditional investors, the equilibrium price constitutes a different signal, $\overline{\overline{P}}$, about the fundamental $\widetilde{\Theta}$. $\overline{\overline{P}}$ is given by

$$\overline{\overline{P}} = \frac{\widetilde{P} - p_0 - p_2\mu_H}{p_1} = \widetilde{\Theta} + \frac{p_2}{p_1}\widetilde{\delta} + \frac{p_3}{p_1}\widetilde{z}.$$

with precision τ_P^U

$$\tau_P^U = \left\{\left(\frac{p_2}{p_1}\right)^2 \sigma_\delta^2 + \left(\frac{p_3}{p_1}\right)^2 \sigma_z^2\right\}^{-1}.$$

One immediately notices that uninformed traditional investors indeed face a less informative price signal than their informed counterparts due to the factor $\left(\frac{p_2}{p_1}\right)^2 \sigma_\delta^2$.

$$\tau_P^U = \left\{\overbrace{\left(\frac{p_2}{p_1}\right)^2 \sigma_\delta^2}^{\text{CSP noise effect}} + \left(\frac{p_3}{p_1}\right)^2 \sigma_z^2\right\}^{-1} < \left\{\left(\frac{p_3}{p_1}\right)^2 \sigma_z^2\right\}^{-1} = \tau_P^I.$$

Moreover, the precision decreases in $\widetilde{\delta}$ which reflects the uncertainty regarding the firm's corporate social performance and $\frac{p_3}{p_1}$ which captures the relative importance of $\widetilde{\Xi}$ as a component of the equilibrium price.

The inference on $\widetilde{\Theta}$ made by traditional uninformed investors is then given by

$$\mathbb{E}\left[\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right] = \frac{\tau_\epsilon \widetilde{s}_i + \tau_P^U \overline{\overline{P}}}{\tau_\Theta + \tau_\epsilon + \tau_P^U}$$

$$\mathrm{Var}\left(\widetilde{\Theta}|\widetilde{s}_i, \widetilde{P}\right) = \frac{1}{\tau_\Theta + \tau_\epsilon + \tau_P^U}$$

The equilibrium demand by uninformed traditional investors is then given by

$$x_i^{TU} = \gamma\left(\tau_\epsilon \widetilde{s}_i + \tau_P^U \overline{\overline{P}} - \left(\tau_\Theta + \tau_\epsilon + \tau_P^U\right)\widetilde{P}\right).$$

Socially responsible investors

Under CARA preferences and normally distributed fundamentals, the equilibrium demand of socially responsible investors takes the following form

$$x_i^S = \gamma \frac{\mathbb{E}\left[\widetilde{\Theta} + \phi^S \widetilde{\Xi}|\widetilde{s}_i, \widetilde{\Xi}, \widetilde{P}\right] - \widetilde{P}}{\mathrm{Var}\left(\widetilde{\Theta} + \phi^S \widetilde{\Xi}|\widetilde{s}_i, \widetilde{\Xi}, \widetilde{P}\right)}.$$

Given the information of socially responsible investors, the equilibrium price constitutes the following signal of the firm's fundamental

$$\overline{P} = \frac{\widetilde{P} - p_0 - p_2 \widetilde{\overline{\Xi}}}{p_1} = \widetilde{\Theta} + \frac{p_3}{p_1}\widetilde{z},$$

with precision τ_P^I

$$\tau_P^I = \left\{\left(\frac{p_3}{p_1}\right)^2 \sigma_z^2\right\}^{-1}.$$

The precision of the price signal for socially responsible investors is as precise as it is for $\widetilde{\Xi}$ informed traditional investors since socially responsible investors are assumed to have perfect information on the firm's corporate social performance and hence understand the different sources of variation of the equilibrium price.

Socially responsible investors differ from traditional investors however in that their trades are conditional on the firm's corporate social performance since they believe $\widetilde{\Xi}$ is a cash flow relevant fundamental. The extent to which the trades are a function of $\widetilde{\Xi}$ is a function of ϕ^S. It is because the trades of socially responsible investors are conditioned on $\widetilde{\Xi}$ that the equilibrium price is a function of both $\widetilde{\Xi}$ and $\widetilde{\Xi}+\widetilde{\delta}$. The dependence on $\widetilde{\Xi}+\widetilde{\delta}$ comes from the fact that uninformed traditional investors use the public signal on the firm's corporate social performance to filter out some of the corporate social performance information incorporated into the equilibrium price.

The equilibrium demand for socially responsible investors as a function of ϕ^S is given by

$$x_i^S = \gamma \left(\tau_\epsilon \widetilde{s}_i + \tau_P^I \overline{P} + \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right) \phi^S \widetilde{\Xi} - \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right) \widetilde{P} \right).$$

Equilibrium

The equilibrium condition when the firm passes the SRI screen equates total demand of the firm's shares to total supply,

$$\lambda^{TI} \int x_i^{TI} di + \lambda^{TU} \int x_i^{TU} d_i + \lambda^S \int x_i^S d_i - \rho \widetilde{z} = \frac{\Omega}{n}.$$

Using the equilibrium condition we can then solve for the equilibrium price coefficients. Proposition 2.3 summarizes the result and the proof is relegated to appendix **??**.

Proposition 2.3. *There exists a unique linear rational expectations price equilibrium*

$$\widetilde{P} = p_0 + p_1 \widetilde{\Theta} + p_2 \widetilde{\Xi} + p_3 \widetilde{z}.$$

The coefficients $p_0 < 0, p_1 > 0, p_2 > 0, p_3 < 0$ are a function of the exogenous parameters and are given in appendix ??.

In line with the previous section, the firm's ex ante cost of capital conditional on passing the SRI screen will be defined with respect to the true underlying relationship between corporate financial and social performance $\overline{\phi}$.

The firm's ex ante cost of capital conditional on passing the socially responsible investment screen can then be defined as

$$\mathbb{E}^P \left[\widetilde{V} - \widetilde{P} \right] = \mathbb{E}^P \left[\widetilde{\Theta} + \overline{\phi} \widetilde{\Xi} - \widetilde{P} \right]$$

Proposition 2.4 then gives the expression for the firm's ex ante cost of capital conditional on it failing the SRI screen.

Proposition 2.4. *The firm's ex-ante cost of capital conditional on passing the socially responsible investment screen is given by*

$$\mathbb{E}^P \left[\widetilde{V} - \widetilde{P} \right] = \overline{\phi} \mu_H - \frac{\phi^S \mu_H \lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right)}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U} + \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U \right]},$$

where,

$$\tau_P^I = \left\{ \left(\frac{\rho}{\gamma \tau_\epsilon} \right)^2 \sigma_z^2 \right\}^{-1},$$

and

$$\tau_P^U = \left\{ \left(\frac{\phi^S \lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right)}{\tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I} \right)^2 \sigma_\delta^2 + \left(\frac{\rho}{\gamma \tau_\epsilon} \right)^2 \sigma_z^2 \right\}^{-1}.$$

2.4. Analysis

After having characterized the equilibrium cost of capital, we can now turn to an analysis of how SRI screening affects a firm's cost of capital when socially responsible differ from traditional investors in their view on the cash flow importance of corporate social performance.

There are two main channels which can be identified with respect to the impact of SRI screening: a mean-return channel and a risk compensation channel. In the next two sections both channels will be discussed.

2.4.1. Risk compensation channel

First lets consider the risk compensation channel. The risk compensation channel is represented by

$$\frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \tau_P \right]}$$

when the firm fails the SRI screen and by

$$\frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U \right]}$$

when the firm passes the SRI screen.

We immediately see that the difference between the two risk compensation components lies in the precision of the price as signal of the cash flow fundamental, $\widetilde{\Theta}$, as viewed from the perspective of the different investor groups, τ_P, τ_P^I and τ_P^U.

In particular, when the firm fails the SRI screen, the traditional investors trading the stock all face the same precision of the price signal,

$$\tau_P = \left\{ \left(\frac{\rho}{\gamma \lambda^T \tau_\epsilon} \right)^2 \sigma_z^2 \right\}^{-1}.$$

On the other hand when the firm passes the SRI screen, socially responsible and informed traditional investors face a precision of,

$$\tau_P^I = \left\{ \left(\frac{\rho}{\gamma \tau_\epsilon} \right)^2 \sigma_z^2 \right\}^{-1},$$

while uninformed traditional investors face a price precision of

$$\tau_P^U = \left\{ \underbrace{\left(\frac{\phi^S \lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right)}{\tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I} \right)^2 \sigma_\delta^2}_{\textbf{CSP noise effect}} + \left(\frac{\rho}{\gamma \tau_\epsilon} \right)^2 \sigma_z^2 \right\}^{-1}.$$

Let's first look at what happens to the precision of the price signal for informed traditional investors when the firm transitions to being adopted into the SRI screen. From the expressions of τ_P and τ_P^I, it is easy to see that $\tau_P^I > \tau_P$, or in words the price becomes more informative about the $\widetilde{\Theta}$ fundamental when the firm passes the SRI screen. This is due to the fact that when the firm passes the SRI screen, a larger number of investors trade on their private signal about the cash flow fundamental $\widetilde{\Theta}$, making the price more informative.

Only informed traditional investors however benefit unambiguously in this way from the entry of socially responsible investors. In particular, though uninformed investors also benefit from a higher amount of trading on signals of $\widetilde{\Theta}$, they are negatively affected by the trading on the corporate social performance information which socially responsible investors incorporate into the equilibrium price and which uninformed traditional investors are unable

to remove. This corporate social performance (CSP) noise effect is captured by the first term in the expression of τ_P^U.

The CSP noise component is driven by several model parameters but importantly by ϕ^S which governs the beliefs socially responsible investors have regarding the relationship between corporate social and corporate financial performance. In particular, when $\phi^S = 0$, then the CSP noise effect goes away and uninformed traditional investors are unambiguously positively affected by the entry of socially responsible investors. For ϕ^S high enough however, the CSP noise effect will start to dominate the beneficial effect of a higher number of informed traders and uninformed traditional investors will face a lower precision of the price signal, that is $\tau_P^U < \tau_P$.

These findings are summarized in proposition 2.5

Proposition 2.5. *There exists a belief threshold ϕ^{S*} such that for $\phi^S > \phi^{S*}$, $\tau_P^U < \tau_P$.* ϕ^{S*} *is given by*

$$\phi^{S*} = \left(\frac{\tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I}{\phi^S \lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)} \right) \frac{\rho}{\gamma \tau_\epsilon} \frac{\sigma_z}{\sigma_\delta} \left(\frac{1}{\lambda^{T2}} - 1 \right)^{\frac{1}{2}}.$$

Using the expression for ϕ^{S*} we can arrive at some comparative statics results.

First, consider $\frac{\sigma_z}{\sigma_\delta}$. This ratio captures the importance of noise caused by liquidity traders relative to CSP noise as perceived by uninformed traditional investors. As can be seen from 2.5, ϕ^{S*} is increasing in $\frac{\sigma_z}{\sigma_\delta}$. Intuitively, the more important liquidity trading noise becomes relative to CSP noise, the stronger the beliefs need to be in order for the CSP noise effect to dominate the beneficial effect of a higher number of informed investors.

Secondly, an increase in λ^{TI}, keeping λ^T constant, increases ϕ^{S*}. The higher the proportion of informed traditional investors, the more aggressive the amount of trading on the $\widetilde{\Theta}$ signals. In particular, informed traditional investors trade more aggressively on their information because they face a lower overall uncertainty due to their knowledge of the

CSP information. This causes dampens the negative effect of socially responsible investors on price informativeness.

Thirdly, the effect of λ^S on ϕ^{S*} is ambiguous. Although socially responsible investors on the one hand also trade more aggressively on their private information, they also introduce the CSP noise effect which harms the price informativeness for uninformed traditional investors.

2.4.2. Mean return channel

The second channel through which SRI screening affects the cost of capital is the mean return channel. The mean return channel in the model appears foremost because the different investor groups are allowed to disagree amongst each other about the contribution of corporate social to corporate financial performance and because the firm's corporate social performance does not necessarily has a zero mean.

The mean return channel is represented by

$$\overline{\phi}\mu_L$$

when the firm fails the SRI screen and by

$$\overline{\phi}\mu_H - \frac{\phi^S \mu_H \lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U}$$

when the firm passes the SRI screen.

First let's consider the case when the firm fails the SRI screen.

The mean component appears because the traditional investors trading the firm's shares do not consider that the cash flow fundamental is driven by the firm's corporate social performance. In particular, under the true relationship between social and financial performance, $\overline{\phi}$, the expected value of the firm will have a non-zero mean component if $\widetilde{\Xi}$ has a non-zero

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mean. If investors trading the firm's shares were to agree with the true relationship, then the equilibrium price would correctly reflect the non-zero mean of the fundamental and the ex-ante cost of capital would only show a risk compensation component.

Depending on whether $\mu_L < 0$ or $\mu_L > 0$, this will increase the cost of capital for the firm relative to what it would be if $\overline{\phi}$ were equal to zero. In particular, if $\mu_L < 0$, then traditional investors overestimate the mean return of the firm generating a cost of capital which is too low. On the other hand if $\mu_L > 0$, traditional investors underestimate the mean return of the firm generating a cost of capital which is too high.

Secondly, consider the case when the firm passes the SRI screen.

In this case, their are two components to the mean return channel. The first component reflects the unconditional mean of the firm's value, $\overline{\phi}\mu_H$, while the second component reflects the extent to which socially responsible investors take into account the fact that the firm's mean return is non-zero. In particular, in line what was said above, the equilibrium price will not reflect the true mean value of the firm if the investors trading the firm's shares do not agree with the true underlying $\overline{\phi}$. In fact if $\phi^S = \overline{\phi}$, so that socially responsible investors agree with the true underlying relationship and if $\lambda^S = 1$ so that only socially responsible investors trade the firm's shares, then the mean return component drops away.

Furthermore, under the assumption that $\mu_H > 0$, the question on whether the cost of capital is under or overestimated depends on the extent to which $\overline{\phi}$ is lower than ϕ^S and the remaining model parameters. In particular, under the initial model assumption that $\overline{\phi} < \phi^S$, and if only socially responsible investors are present, then the cost of capital would always be weakly underestimated. The reason for this is that socially responsible investors put upward pressure on the equilibrium price of the firm which is however not warranted given the true mean return of the firm.

However, in reality not only socially responsible but also traditional investors trade the firm's shares. That is why even though socially responsible investors tend to put pressure towards

underestimating the firm's true cost of capital, the firm's cost of capital may well still be overestimated if the number of socially responsible investors is too small. In particular, even when socially responsible investors' beliefs are in line with the true underlying relationship, $\phi^S = \overline{\phi}$, then because not all investors incorporate this into their trading strategies, the equilibrium cost of capital of the firm will be overestimated. This result is summarized in 2.1.

Lemma 2.1. *If* $\overline{\phi} \in \left[0, \phi^S\right]$, *then the equilibrium cost of capital is overestimated if*

$$\lambda^S < \frac{\overline{\phi}}{\phi^S} \frac{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U}{\tau_\Theta + \tau_\epsilon + \tau_P^I}.$$

2.4.3. Cost of capital

After having discussed the two channels through which the cost of capital is affected when the firm passes the SRI screen, we now turn to an analysis of the cost of capital itself and examine conditions under which passing the SRI screen will not necessarily lower the firm's cost of capital. In order to make the analysis as clear as possible, the analysis will proceed in two steps.

First the mean return channel will be artificially shut down by assuming that $\overline{\phi} = 0$ and $\mu_H = 0$. Next, the impact of passing the SRI screen will be analyzed under general parameter assumptions.

Cost of capital: risk compensation channel only

When $\overline{\phi} = 0$ and $\mu_H = 0$, then the cost of capital of the firm is entirely determined by the risk compensation channel. The interesting question is now if it is possible that passing the SRI screen will increase the firm's cost of capital rather than lowering it as is generally assumed. That is, is it possible that

$$\mathbb{E}^F\left[\widetilde{V}-\widetilde{P}\right] = \frac{\Omega}{\gamma n\left[\tau_\Theta + \tau_\epsilon + \tau_P\right]} \overset{?}{<} \frac{\Omega}{\gamma n\left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI}+\lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U\right]} = \mathbb{E}^P\left[\widetilde{V}-\widetilde{P}\right].$$

After performing some straightforward algebra the condition for the above condition to hold is given by

$$\lambda^{TU}\left(1-\frac{\tau_P^U}{\tau_P}\right) > \left(\lambda^{TI}+\lambda^S\right)\left(\frac{1}{\lambda^{T2}}-1\right). \tag{C1}$$

A necessary condition for this is that

$$\lambda^{TU} > \left(\lambda^{TI}+\lambda^S\right)\left(\frac{1}{\lambda^{T2}}-1\right),$$

which after some algebraic manipulations reduces to.

$$\lambda^{TU} > 1 - \lambda^{T2}. \tag{C2}$$

In other words a necessary condition for the cost of capital to increase after passing the SRI screen there need to be a sufficiently large number of uninformed investors. Intuitively, the negative effect on the cost of capital comes from the higher risk premium uninformed traditional investors demand compared to informed traditional investors and socially responsible investors.

If C2 holds then as ϕ^S increases, τ_P^U approaches 0 such that eventually C1 will hold.

In short, under the parameter assumptions such that only the risk compensation channel matters, we need a sufficiently large number of uninformed traditional investors and sufficiently strong beliefs held by socially responsible investors for the cost of capital of the firm to increase when it passes the SRI screen.

The above is summarized in proposition 2.6

Proposition 2.6. *Assume* $\overline{\phi} = 0$ *and* $\mu_H = 0$.

Then if λ^{TU} *satisfies*

$$1 > \lambda^{TU} > 1 - \lambda^{T2}$$

there exists a belief threshold $\phi^{**} > \phi^* > 0$ *such that*

$$\mathbb{E}^P \left[\widetilde{V} - \widetilde{P} \right] > \mathbb{E}^F \left[\widetilde{V} - \widetilde{P} \right].$$

ϕ^{**} *is given by*

$$\phi^{**} =$$

$$\frac{1}{\sigma_\delta} \left(\frac{\tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I}{\lambda_S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right)} \right) \frac{\rho}{\gamma \lambda^T \tau_\epsilon} \sigma_z \left(\frac{1}{1 - \left(\frac{1}{\lambda^{TU}} - 1 \right) \left(\frac{1}{(\lambda^T)^2} - 1 \right)} - \left(\lambda^T \right)^2 \right)^{\frac{1}{2}}.$$

Cost of capital: mean return and risk compensation channel

In this section the gap between the cost of capital of the firm when it passes the SRI screen and when it fails the SRI screen will be analyzed in full generality. That is, the findings regarding the impact of the risk compensation channel of the previous section will be combined with the findings on the mean return channel.

In the previous section it was shown how the risk compensation channel alone already contributes to pushing the cost of capital of the firm when it passes the SRI screen above the cost of capital when it fails it. Now the question remains whether the risk compensation

and mean return channel combined can generate this result.

Indeed it was already indicated above that disagreement among investors about the mean return of the firm can both push the cost of capital when the firm passes the SRI screen both higher or lower. In what follows it will be therefore be examined under what conditions the mean return channel can amplify or dampen the effects of the risk compensation channel on the firm's cost of capital.

In order to simplify the analysis, the simplifying assumption will be made that $\mu_L = 0$. Although this is not entirely without loss of generality, it allows for an easier derivation of the conditions leading to a widening or shrinking of the cost of capital gap. Under this assumption, the cost of capital gap becomes,

$$
\mathbb{E}^P \left[\widetilde{V} - \widetilde{P} \right] - \mathbb{E}^F \left[\widetilde{V} - \widetilde{P} \right] =
$$

$$
\underbrace{\mu_H \left(\overline{\phi} - \phi^S \frac{\lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right)}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U} \right)}_{\textbf{Mean return channel}} +
$$

$$
\underbrace{\frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U \right]} - \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \tau_P \right]}}_{\textbf{Risk compensation channel}}.
$$

Under this additional assumption, the extent to which the mean return channel amplifies or dampens the risk compensation channel depends in large part on whether socially responsible investors overestimate the cash flow importance of corporate social performance, $\overline{\phi} < \phi^S$ or whether their beliefs are in line with the true underlying relationship $\overline{\phi} = \phi^S$.

First consider the case in which socially responsible investors correctly assess the importance of corporate social performance. In this case the mean return channel becomes,

$$\phi^S \mu_H \left(1 - \underbrace{\frac{\lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right) \tau_P^I + \lambda^{TU} \tau_P^U}}_{<1} \right).$$

Since the term between brackets is always positive, it is easy to see that when socially responsible investors' beliefs are aligned with the true relationship, the mean return channel unambiguously amplifies the risk compensation channel.

Moreover, when $\lambda^{TU} > 1 - \lambda^{T2}$ and $\phi^S > \phi^{**}$ then both the mean return and risk compensation channel positively contribute to pushing cost of capital of the firm when it passes the SRI screen above the cost of capital when it fails it. Traditional investors first charge a risk premium for trading the shares of the firm when the price is less informative about the cash flow fundamental $\widetilde{\Theta}$. Secondly, because only socially responsible investors believe that $\phi^S > 0$, the equilibrium price does not fully reflect the true expected value of the firm. To the extent that the firm's expected corporate social performance is strictly positive, this leads traditional investors to underestimate the firm's expected performance thus leading to an overestimation of its equilibrium cost of capital.

These findings are summarized in proposition 2.7

Proposition 2.7. *Assume $\mu_L = 0$.*
Then if $\overline{\phi} = \phi^S$, $\phi^S > \phi^{**}$ and $\lambda^{TU} > 1 - \lambda^{T2}$, the firm's cost of capital when it passes the SRI screen unambiguously exceeds the cost of capital when it fails the SRI screen. That is,

$$\mu_H \left(\overline{\phi} - \phi^S \frac{\lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right) \tau_P^I + \lambda^{TU} \tau_P^U} \right) > 0$$

and

$$\frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right) \tau_P^I + \lambda^{TU} \tau_P^U\right]} - \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \tau_P\right]} > 0.$$

Secondly, assume traditional investors are correct in that the firm's social performance does not affect its financial performance. In particular, $\overline{\phi} = 0$ and $\phi^S > 0$. The mean return

channel in this case can be rewritten as,

$$-\phi^S \mu_H \frac{\lambda^S \left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right) \tau_P^I + \lambda^{TU} \tau_P^U}.$$

When their is no underlying relationship between social and financial performance, the trading of socially responsible investors puts a downward pressure on the firm's cost of capital when it passes the SRI screen. Even though the true mean return of the firm is zero, socially responsible investors hold artificially high expectations of the future return of the firm and push the equilibrium price downwards underestimating the cost of capital.

Nevertheless, when $\overline{\phi} = 0$, but $\phi^S > 0$ socially responsible investors still have a negative externality on traditional investors through the risk compensation channel. Therefore, in this situation there are two counteracting forces at work. On the one hand the mean return channel pushes the equilibrium cost of capital when the firm passes the SRI screen lower while on the other hand the risk compensation channel pushes for a premium relative to when the firm fails the SRI screen. The question then remains which of the two forces will dominate.

The main conclusion is that eventually the mean return channel should be expected to dominate.

For large ϕ^S, eventually the mean return channel can be expected to dominate. To see this it should be noted that the contribution of the risk compensation channel to the cost of capital gap is bounded below. Indeed, in the limit as ϕ^S becomes larger, τ_P^U approaches zero and the gap due to the risk compensation channel becomes

$$\frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + (\lambda^{TI} + \lambda^S) \tau_P^I\right]} - \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \tau_P\right]}$$
$$= \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + (1 - \lambda^{TU}) \tau_P^I\right]} - \frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \lambda^{T2} \tau_P^I\right]}.$$

This is strictly positive for $\lambda^{TU} > 1 - \lambda^{T2}$ as was indicated above and represents the upper bound for the cost of capital gap resulting from the risk compensation channel. The mean return channel however is unbounded below as ϕ^S increases. The mean return channel can therefore be expected to eventually dominate the risk compensation channel and the cost of capital when the firm passes the SRI screen can be lower than when the firm fails the SRI screen.

2.5. Conclusion

Owing to the growing popularity of socially responsible investment (SRI), researchers have increasingly started to look into its real effects. That is, is SRI merely a tool which allows investors to align their investment savings decision with their personal values or does it also stimulate firms into adopting more responsible business practices.

The current paper revisits this question by analyzing how socially responsible investors may affect a firm's equilibrium cost of capital. Traditionally, socially responsible investment screens were believed to lower the cost of capital of high corporate social performance (CSP) firms relative to low CSP firms. Since a firm's equity cost of capital is also the internal rate of return it uses to make its investment decisions, SRI screens would have the potential to stimulate investment by firms exhibiting responsible business practices.

Empirical evidence on this claim however is mixed and this paper provides a possible explanation for this. In particular, socially responsible investors not only screen firms on their CSP they also trade on information regarding a firm's CSP. That is, socially responsible

investors believe CSP information is relevant to predict a firm's future financial performance. Moreover, traditional investors do not appear to follow this logic and view most CSP information as irrelevant for cash flow prediction.

The paper then shows how this open disagreement generates two novel channels through which socially responsible investors can affect the cost of capital of high CSP firms relative to low CSP firms. First, socially responsible investors have a negative externality on traditional investors when the latter are not informed about the CSP information the former trade on. In the eyes of traditional investors, socially responsible investors contaminate the equilibrium price with an additional source of noise making it less informative and causing traditional investors to charge a higher risk premium for trading the shares of high CSP firms. This risk compensation channel therefore negatively affects the cost of capital of responsible firms relative to irresponsible ones.

Secondly, depending on the true underlying relationship between CSP and CFP, the expected equilibrium price is either too high or too low relative to the expected fundamental. The analysis in the paper shows that this mean return channel affects the cost of capital of responsible firms positively or negatively relative to their less responsible peers. In particular, when in reality there is no relationship between CSP and CFP, the equilibrium price is always too high relative to the fundamental because part of the firm's investor base believes the firm's responsible practices on average pay off financially. The equilibrium cost of capital of responsible firms will then be pushed downward due to this optimistic view of socially responsible investors on the financial implications of high CSP.

On the other hand when socially responsible investors are correct in their assumed relationship between CSP and CFP, then the equilibrium price is too low because only part of the investor base correctly prices in the higher average financial performance owing to the firm's responsible business practices. The equilibrium cost of capital will then be too high relative to what it should be.

Overall, this paper shows that by adding the assumption of disagreement on the relationship between CSP and CFP, a novel rich set of predictions regarding the cost of capital gap between responsible and irresponsible firms is obtained. The hope is that these predictions may guide future empirical research which looks into this topic and help explain the thus far inconclusive evidence on the real effect of socially responsible investment screens.

CHAPTER 3 : Impact investing and social financial contracts

3.1. Introduction

3.1.1. Impact investing and social financial contracts

In recent years a relatively new development in finance has been gaining more traction. In particular, a growing number of investors strategically deploy their capital in established firms and start-up enterprises in order to further a social or environmental goal such as for instance improving employee working conditions, supporting local community projects or engaging in environmental or wildlife protection.

Often coined impact investors these investors actively seek to generate a social alongside a financial return on investment, with the latter ranging from below to above market rates depending on investor preferences. In order to secure their social return on investment, impact investors write financial contracts with clauses and incentive schemes which explicitly promote the delivery of a positive social or environmental impact. These contracts can therefore be viewed as social financial contracts in that they deliver societal benefits which stretch beyond the economic value generated for the investor and the firm or entrepreneur being financed.

At this point however, very little is known about why we observe such social financial contracts in practice. That is, why do impact investors spend time and resources on delivering positive externalities on other members in society? The main goal of this paper is to advance a new micro theoretical explanation for why we observe these social financial contracts.

Before going into the theory of the model however, it is worthwhile to align thoughts on what is impact investing and shed some light on the general characteristics of the impact investment industry.

The global impact investing network, (GIIN) a not-for-profit organization dedicated to

increasing the scale and effectiveness of impact investing, defines impact investing as follows:

Definition (Impact investing (GIIN)). *Investments made in companies or organisations with the intention to generate a measurable, beneficial social or environmental impact alongside financial return.*

Although impact investing is often categorized as a form of socially responsible investing, it distinguishes itself from traditional forms of socially responsible investing. In particular, impact investing moves beyond socially responsible investment screening which screens investment portfolios in order to prevent allocating resources to socially harmful or sinful firms. Impact investing also differs from social and environmental investor activism which mainly seeks to influence corporate policy through shareholder resolutions and proxy voting.

Instead, impact investors seek to invest in firms or enterprises with the potential to deliver a significant positive social or environmental contribution and use traditional tools and structures in finance to achieve this goal. A prominent example of impact investing for instance comes from social venture capital funds which often combine active monitoring and high powered incentives to ensure that their investments indeed live up to their social or environmental return potential.

Who is involved in impact investing? Impact investors can be distinguished along a variety of dimensions. For instance from an institutional perspective, impact investing is carried out by philanthropic foundations such as de Omidyar Network, financial institutions such as J.P. Morgan's social finance desk and high net worth individuals who can use the resources offered by RSF social finance to identify and select impact investment projects. A different institutional set-up is also often accompanied by a different focus in terms of whether financial or social return on investment is prioritized.

However, even within an institutional category impact investors differ in the priority they place on financial return. This can for instance be illustrated by looking at the investment objective of two social venture capital funds, Renewal2 and the EcoEnterprises fund. The

former fund describes its investment philosophy as follows:

"Renewal Funds is catalyzing an emerging asset class of social venture financing. Our model is to deliver above market returns by investing in businesses in Canada and the US that provide the finest sustainability solutions."

In Renewel2's investment philosophy, impact investing is identified as a new asset class with the potential to generate above market returns. The EcoEntreprises fund on the other hand describes its mission as:

"EcoEnterprises Fund provides growth capital to community-based sustainable companies to achieve scale – generating lasting results that help address the critical environmental and social challenges of our time. Because these companies are often too small, or in unconventional sectors eschewed by traditional financiers these businesses struggle to access expansion capital and hand-holding necessary for long-term success."

Though financial return undoubtedly matters for this fund as well, the emphasize lies more on delivering social return which is obtained by providing effective solutions to pressing social and environmental challenges.

Although investing for impact has recently grown in popularity and is expected to grow toward the future, it is at this point not clear what has sparked this spurge in interest from investors. Why do investors actively seek to promote social or environmental change through financial contracts? At least two main explanations have thus far been advanced in both the scientific and popular press:

First, at a least part of the recent interest in impact investing stems from investors who view it as a new asset class with the potential to deliver higher yields than traditional investment opportunities [1]. As argued by Porter and van der Linde (1995) and Porter and Kramer (2011), firms and investors need to move beyond the traditional view that business policies which focus on delivering societal benefits also harm profitability. Instead,

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[1] O' Donohoe et al. (2010)

providing innovative solutions to societal and environmental problems in a market context can increase the total value to be shared and deliver both societal benefits and enhance firm profitability.

Because impact investing often targets firms and enterprises which engage in significant process or business innovation in order to implement a desired social or environmental change, finance first impact investors believe they invest in companies that will have a competitive advantage relative to their industry peers in a world in which the ability to handle environmental and social tensions is increasingly becoming a key business success factor. Finance first impact investors can therefore be viewed as investors who contribute to implementing solutions to social or environmental problems as a side effect in their search for high yielding investment opportunities.

In a 2013 survey carried out by GIIN and the J.P. Morgan social finance desk [2], 65 % of impact investors surveyed expected their investments to deliver at least market rates of return.

Secondly however, not all impact investors expect or seek to obtain market rates of return on their investments and instead prioritize on generating a social return on investment. A prime example of this class of impact investors are venture philanthropists who not even seek their initial principal investment to be returned. However, not all impact investors can afford to loose their principal investment and choose to invest for instance in social impact bonds which seek to return the principal investment plus a bonus if the social impact bond project succeeds.

According to the same GIIN J.P. Morgan survey, 23 % of impact investors expect a below market rate of return closer to market rates while % 12 expect a below market rate of return closer to capital preservation. Under the assumption that these impact investors act rationally, the survey results indicate that about a third of impact investors is willing to trade off financial return for social return.

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[2]For the online version of the survey:Perspectives on Progress: The impact investor survey, January 2013

Although the above two explanations for impact investing likely have some validity, they do respectively rely on the assumption of a positive, or absence of a negative, relationship between financial and social performance and the assumption that at least a subsection of investors have altruistic motives in that they are willing to trade-off financial for social return on investment.

Because empirical evidence on the presence of a social financial return link is mixed and altruistic motives in society are limited, this paper seeks to advance a third reason for impact investing which does not rely on these two assumptions.

In particular, this paper seeks to advance the idea that social financial contracts can solve a credit constraint problem which may emerge in a common agency moral hazard economic environment. In what follows the key idea of the paper will be outlined by describing the common agency moral hazard set-up.

Consider an economic environment in which a penniless entrepreneur, the agent, seeks financing to start up a project which he initially owns. The entrepreneur can obtain financing from a financier, who will assume the role of the first principal in the model. In order to ensure that his project is financially sound however, that is generates a positive net present value, the entrepreneur needs to take a costly effort action. In the paper this effort action will be referred to as financial effort to distinguish it from a second effort action to be introduced below.

In addition, the financial effort action is assumed to be only privately observable by the entrepreneur, creating a moral hazard problem for the financing of the entrepreneur's project. In particular, if the financier assumes the entire investment cost of the project, it is not ex ante obvious that the entrepreneur would not prefer to laze about on the job and avoid to take the costly effort action. Therefore, the financier will only be willing to provide the necessary funding if the financial contract he writes with the entrepreneur puts in place the

necessary incentives for the entrepreneur to work diligently on his project.

In addition to having discretion over the profitability of his own project, the entrepreneur is also assumed to be able to deliver a positive social impact. More precisely, the entrepreneur is assumed to be able to operate his project in such a way that it improves the profitability of the project or firm of a third party agent in the economy. In order to deliver this positive social impact however, the entrepreneur needs to take a costly effort action which will be referred to as externality effort. The name externality effort is meant to reflect the fact the positive social impact action only affects the profitability of the third party agent's project but not the profitability of the entrepreneur's project. If the entrepreneur takes the externality effort action, to an outside observer it would seem that the entrepreneur's project has a positive externality on the third party agent.

In the absence of altruistic preferences, it is clear that the entrepreneur will not choose to deliver the positive impact unless he is given explicit incentives. However, in a similar way as for financial effort, externality effort in the model is assumed to be only privately observable so that the provision of incentives will be subject to a moral hazard problem.

There are many ways to interpret the set-up in which the entrepreneur can have a positive impact on a third party agent. The following three examples for instance may help to put the set-up in a real life perspective

First, suppose the entrepreneur wants to start up a plant on a site next to a river and that the third party is a hotel owner located nearby. The entrepreneur needs the water for cooling and suppose in addition that the quality of the river is poor due to the activities of the previous owner of the site. Because the entrepreneur only needs the water for cooling however, the poor water quality does not affect his profitability. Suppose now that by spending some effort redesigning his plant, the entrepreneur can release water of a better quality that when it was pumped up. Then though it would not improve the profitability of his own project, it may boost the profitability of the hotel because its guests may now

use the river for leisure activities.

Secondly, consider an example from the software industry. Suppose the entrepreneur is a talented programmer who wants to start up his own software company. Suppose the entrepreneur can use his programming skills to write a piece of software which may serve as a platform for other software applications, but which does not necessarily allow him to generate additional profit for his own business. The entrepreneur may then have a positive social impact by writing and releasing the software code as open source code, allowing another third party entrepreneur to improve the IT platform of his business and generate additional profits.

Finally, an example in an educational setting. Suppose the entrepreneur is a school located in a community in which a local arts and crafts industry finds it difficult to find skilled, motivated young people who want to work in the arts and crafts business. The school may then have a positive social impact on the community by offering classes after regular school hours in which students can learn the skills necessary to work in the local arts and craft industry. Such classes may be too specific to form part of the school's regular curriculum, but in offering them after hours the school may still allow the businesses of the local arts and craft industry to have better access to skilled workers boosting their profitability.

In the above set-up a natural prediction to make is then that the financier will first attempt to finance the entrepreneur through a financial effort incentive compatible contract and that the third party will then seek to incentivize the entrepreneur through a separate contract which ensures that the entrepreneur also exerts externality effort and hence delivers the positive social impact.

The first prediction the paper makes however is that if the financier and the entrepreneur each non-cooperatively offer separate incentive contracts, the entrepreneur may not be able to obtain financing from the financier if the latter is restricted to using standard financial contracts to finance the entrepreneur's project. A standard financial contract in the paper

will be defined as one which grants the entrepreneur a simple stake in the success of his own project. What the model will then show is that under certain conditions, the incentive contract offered by the third party may interfere with the incentives put in place by the financial contract and all together prevent the financier from writing a standard financial contract which ensures that the entrepreneur will exert financial effort.

As will be shown, the main reason for this is that after the financial contract has been put in place, the third party will have an incentive to collateralize the entrepreneur's stake in the success of his own project so as to reduce the cost of providing incentives for externality effort. This however will have the effect of reducing the entrepreneur's stake in the success of his own project and hence reduce his incentives for financial effort. The paper will first show that under certain conditions, the financier can not offer a stake to the entrepreneur which is collateralization proof and guarantees incentives for financial effort. If the entrepreneur is not financed then not only will the economic value of the entrepreneur's project be lost but also the value generated through the positive social impact.

The first conclusion of this paper should be put in perspective to the argument made in Coase (1960) which predicts that in a situation with production externalities the socially efficient outcome can often be achieved if the parties involved can freely bargain and this regardless of how initial property rights are divided. The Coase argument however assumes an absence of transaction costs and symmetric information between the agents involved. Especially the last assumption breaks down in the model discussed in the current paper since externality effort is assumed to be unobservable to the third party agent. Previous papers such as Farrell (1987) have already indicated how the Coase argument may fail to hold in set-ups with asymmetric information and the current paper can be viewed as falling into this category.

The second prediction the paper will then make however is that if the financier is credit constrained under standard financial contracts, then under certain conditions he may obtain financing under a social financial contract which is a contract offered by the financier and

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which puts in place both incentives for financial and externality effort. If incentives for effort on both dimensions are in place, then the entrepreneur no longer needs to write a separate incentive contract which may collateralize cash flow streams stipulated in the financial contract. The social financial contract in a way pre-empts a contractual offering by the third party and allows the third party to enjoy the benefits of the positive impact action without having to write a costly incentive contract.

To be sure however, the above reasoning relies on a set of assumptions on the contracting environment. In particular, why focus on standard financial contracts in the first place? First note that in the absence of the financier being able to stipulate covenants in the financial contract, such standard financial contracts will be shown to be optimal in the set-up of the model to be detailed below. Briefly, in the absence of covenants the optimality of a standard financial contract will stem from assuming that all agents in the model are protected by limited liability, lack outside financial reserves and that the financial contract can not stipulate a non-pecuniary penalty conditional on the failure of the entrepreneur's project.

Nevertheless, given that the credit constraint problem is caused by the third party ex-post collateralizing the financial contract, the question begs why the financier can not simply include a covenant in the financial contract preventing the third party from offering a contract which collateralizes the financial contract?

A couple of points can be raised in reply to this. First, note that even if covenants can be written into the contract, they will remain dead letter unless they can be enforced in court. If non-pecuniary penalties for covenant violations are ruled out, then covenants can only be enforced by contractually stipulating financial penalties. However, throughout the paper it is assumed that the agents in the model are protected by limited liability and lack outside financial resources so that it will be impossible to enforce covenants through financial penalties.

Secondly, even if covenants were enforceable in court through non-pecuniary penalties then two general types of covenants can be distinguished. On the one hand, the financier could stipulate in a covenant that the entrepreneur is not allowed to contract with the third party at all. Such a simple covenant is easy to write but as will be shown in the model, it might then prevent the socially optimal outcome in which the positive social impact is delivered from being achieved. Because of this, the lawmaker might decide that such covenants are illegal and hence can not be written.

On the other hand, the financier may be able to write a more detailed covenant which prevents the third party from collateralizing the cash flows from the financial contract. In this case the socially efficient outcome can be obtained, but such a financial contract could then itself then be interpreted as a type of social financial contract in that it ensures that the socially efficient outcome is obtained. The non-covenant type social financial contract on which this paper focusses should then be interpreted as one which may arise in a setting in which specific non-collateralization contracts are infeasible or not enforceable due to the lack of non-pecuniary penalties.

In the next section, the paper will be linked to the existing literature on corporate social responsibility and responsible investing and also to the literature on common agency with which the set-up shares some elements.

3.1.3. Related literature

Corporate social responsibility and socially responsible investing

To date, the finance literature has paid relatively little attention to impact investing or socially responsible investing in general. Much of the research that has been produced on the topic is empirical in nature and seeks to answer the question of whether there is a link between corporate social and corporate financial performance. In other words whether it pays to do good or whether it ends up being financially detrimental to firms and investors.

It might be useful in light of the scope of this paper to quickly browse the literature on this topic since impact investing is often justified because it is considered to be an alternative asset class with attractive investment opportunities. This paper on the other hand makes an argument for impact investing not related to its financial performance. Given that to date there is mixed empirical evidence for a link between impact investing and higher financial performance, the argument presented in this paper might therefore constitute an attractive alternative explanation.

There are two general methodologies which have been followed in the past to examine the relationship between corporate social and corporate financial performance. First, a series of event studies focusses mainly on the short run financial implications, i.e. abnormal returns, of responsible or irresponsible corporate behavior. These papers look primarily at stock price reactions following news related to a firm's corporate social performance, but yield mixed results on the relationship between social and financial performance.

For instance, papers such as Shane and Spicer (1983) , Hamilton (1995) , Klassen and McLaughlin (1996) and Karpoff et al. (2005) all document significant stock price reactions in response to news related to firms' environmental pollution record. However, Wright and Ferris (1997) found a negative relationship when looking at firms announcing support for the South African boycott in the 1980's. Finally, Teoh et al. (1999) finds no relationship between social and financial performance when looking at the financial implications of participating

in the South Africa boycott.

A second set of papers seeks to examine the relationship between some measure of corporate social performance and long term financial performance. The latter is usually captured using accounting or financial measures of profitability. Similarly to the results from event study analyses, the results here are mixed as well. For instance, Aupperle et al. (1985) found no relationship between a firm's social orientation and financial performance. Furthermore, McGuire et al. (1988) found that past financial performance was more related to corporate social performance than future financial performance. This suggests a resource based rationale of corporate social responsibility in that wealthier firms tend to spend more on corporate social responsibility because they can afford to do so, rather than that superior corporate social performance leads to better financial performance. A similar conclusion is reached by Moore (2001) after examining evidence from the UK supermarket industry. Waddock and Graves (1997) on the other hand do find a positive relationship between an index of corporate social performance and various financial performance measures such as ROA in the following year. Simpson and Kohers (2002) reaches a similar conclusion using data from the banking industry. Finally, Brammer and Millington (2008) finds that both firms with unusually poor and usually good corporate social performance have higher financial performance than other firms. Moreover, unusually poor corporate social performers tend to have superior financial performance in the short run while unusually good social performers exhibit superior financial performance in the longer run.

In light of the mixed empirical evidence on the link between social and financial performance, there appears to be a need for arguments which explain the observance of impact investing strategies without having to rely on assumptions regarding financial performance. The argument in this paper does not rely on such assumptions and is therefore advanced as an alternative explanation.

Common agency

From an economic theory perspective, the model in this paper can be considered to fall under the category of multi-principal agency problems also known as a common agency problems.

The first papers which explicitly recognized the importance of problems of common agency were Bernheim and Whinston (1985) and Bernheim and Whinston (1986) who extended the bilateral principal-agent model with moral hazard of Hölmstrom (1979) and Grossman and Hart (1983), to situations in which several principals independently influence a single agent.

Though previous papers such as Baron (1985) or Bernheim and Whinston (1985) already had multiple principals in their models, the set-ups were highly specialized and Bernheim and Whinston (1986) was the first paper who made an attempt at formalizing a general framework for problems of common agency.

In particular, Bernheim and Whinston (1986) considers a set-up in which a single agent can choose an action from an available set and where this action will affect the utility of the members of a group of principals. These principles however are assumed to have distinct preferences and hence disagree over what action the agent should take. Though the action choice itself is unobservable, the output it influences is not and the principals will seek to offer incentive contracts inducing the agent to take their most preferred action. The principals are assumed to move simultaneously and non-cooperatively in their contractual offerings and the agent takes the action which maximizes his utility after having aggregated the incentive schemes offered by the different principles.

Though the current paper shares with Bernheim and Whinston (1986) the idea of multiple principals acting non-cooperatively, it differs in at least two ways.

First, the principals in the model offer their contracts sequentially rather than simultane-

ously. In particular, the financier who finances the project of the first entrepreneur acts as a Stackelberg leader and makes his contractual offering before the third party agent provides incentives for the socially desirable action. This is to reflect a natural situation in which a project or firm is first financed and started up after which other parties can then deal with the firm.

The consequence of this is that the third party agent will take the financing contract as given when he makes his contractual offering for the externality action. Moreover, since the third party agent is assumed to behave non-cooperatively, the paper will argue that his contractual offering may destroy the incentives put in place by the financial contract because he only partly internalizes the effects his contract has on the entrepreneur's incentives.

Baron (1985) is an applied paper who also uses a Stackelberg leader game set-up rather than a simultaneous move game.

Secondly, the two dimensions of actions over which the entrepreneur who seeks financing has control, each enter directly into the utility function of only one principal. In particular, only the financier cares directly about financial effort and only the third party agent cares directly about externality effort. In Bernheim and Whinston (1986) on the other hand, each action the agent can take affects the utility of all principals such that the paper can also be interpreted as falling under the category of papers dealing with contracting problems under externalities. A rather large literature starting with ? discusses such situations in which a single contracting variable affects directly the utility of several principals. The more important externality problem in the current paper is the potentially negative externality the externality contract can have on the incentives put in place by the financial contract.

After Bernheim and Whinston (1986), the concept of common agency problems has been applied to a wide variety of problems most notably in the area of political economy. In particular, papers such as Grossman and Helpman (1994), Martimort (1996), Dixit et al. (1997), Martimort and Semenov (2008) have used a common agency set-up to model com-

petition between interest or lobby groups in the political arena.

The current paper differs from this applied work however in that either the models assume symmetrical information or adverse selection type asymmetric information problems, rather than a problem of moral hazard on which the focus lies here.

Since the agent in the model has control over actions on two dimensions, the paper is also related to the multi-task principal agent model of Hölmstrom and Milgrom (1991). In that paper a single principal decides on how to construct an optimal incentive scheme when the agent has control over effort on several task dimensions. The particular difficulty in such a situation is how to optimally provide incentives so that the agent does not overemphasize one task over another due for instance to the fact that effort on one task dimension is more easily measurable than on another or that effort on one dimension is less costly. Because a single principal however is in charge of the agent controlling multiple tasks, he will offer an optimal incentive scheme which ensures that the agent appropriately allocates his time to the different tasks. In the multi-principal set-up of this paper however, each principal has a direct interest in effort on a different dimension.

The novelty of this paper is then to show that one of the principals, in this case the financier, may be willing not only to incentivize the agent to work hard and ensure the financial success of his project but also to incentivize high effort on a socially beneficial action even though the effect of this action does not enter directly into the financier's utility function.

Finally, models of common agency have also been discussed in the finance literature. For instance Winton (1995) and Khalil et al. (2007) study costly state verification models in which multiple investors finance and monitor a single agent. The main focus of these papers is the analysis of equilibrium levels of monitoring and the role contractual design, such as seniority, plays in this regard. In the moral hazard model of the current paper, there is no active monitoring on behalf of the principals such that limited comparison with the results of these papers can be made.

3.2. Model

3.2.1. Model overview

Before diving into the details, this section first outlines the general set-up of the model.

The economy is a three stage game, populated by three agents: the financier, F, the entrepreneur, E, and the third party, TP. All agents in the model are assumed to be risk neutral and are protected by limited liability. The latter assumption will imply that all agents can only be made financially liable for resources which they own.

The entrepreneur, E, owns the idea to a project, P_1, which requires an upfront investment at the beginning of the game, $t = 0$, and which generates a random return at the end of the game $t = 3$. E is assumed to be penniless and therefore needs outside financing to make the upfront investment and start up his project. Financing for his project is available from the financier who has the necessary resources to fund P_1, but only P_1. In particular, after having made the initial investment in the entrepreneur's project, the financier is assumed to have depleted his financial resources. His wealth and future income then stem from the stake he has in P_1.

The third party, TP, owns the idea to a project, P_2, which is already fully funded and which also generates a random return at the end of the game $t = 3$. As was discussed in the introduction, the third party can be interpreted in many ways but for simplicity it is easiest to think of him as a second entrepreneur.

The entrepreneur, E, is assumed to have discretion over exerting effort on two different dimensions: working diligently on his own project, i.e. exerting financial effort, and delivering a positive social impact on the third party, i.e. exerting externality effort. Both effort types are assumed to be costly to the entrepreneur and only privately observable by him. This renders it far from certain at the onset whether the entrepreneur will choose to make effort on either one or both dimensions.

The financier, however, wants the entrepreneur to exert financial effort because it determines whether he can break even on his project or not. That is, P_1 will be positive net present value only if the entrepreneur makes financial effort. The third party on the other hand has no immediate interest in financial effort but wants the entrepreneur to deliver externality effort because it boosts the profitability of his project, P_2. The financier and the third party would therefore like to ensure that the entrepreneur is incentivized to deliver effort on the dimension in which each is respectively interested and they may seek to achieve this by writing contracts with the entrepreneur.

First, the financier has the opportunity to put in place incentives for financial effort through the financial contract which he writes at entrepreneur at time $t = 0$. This is the time at which the financier essentially decides whether to provide funding for the initial investment and allow the entrepreneur to start up his project or not.

After the project has been financed and started up, the third party then has the opportunity to incentivize the entrepreneur to deliver a positive social impact. That is at time $t = 1$, the third party may offer the entrepreneur a contract which makes externality effort incentive compatible. Note however that the third party will not necessarily have to offer a separate externality contract. Indeed the main conclusion of the paper will be that in equilibrium externality effort may have to be incentivized through the financial contract, making it unnecessary for the third party to offer any additional contract.

Based on the aggregate incentives provided by the financial and externality contract, the entrepreneur then decides at time $t = 2$ whether or not he will exert financial and or externality effort. This will then determine the probabilities with which P_1 and P_2 succeed at the end of the game $t = 3$.

Note that the timing assumption implying that the entrepreneur and the financier first write the financial contract and the third party then secondly has the opportunity to offer an externality contract is meant to reflect a natural situation in which for practical reasons

the third party can only contract with the entrepreneur until after P_1 has been financed and started up. This could be interpreted by assuming that the third party, which is in most cases is an outsider to P_1, does not know yet the potential of E to deliver a positive impact until after P_1 has taken concrete shape. The insiders, the financier and the entrepreneur, however can be expected to anticipate the fact that the third party may approach the entrepreneur to put in place incentives for externality effort if the financial contract has not already done so.

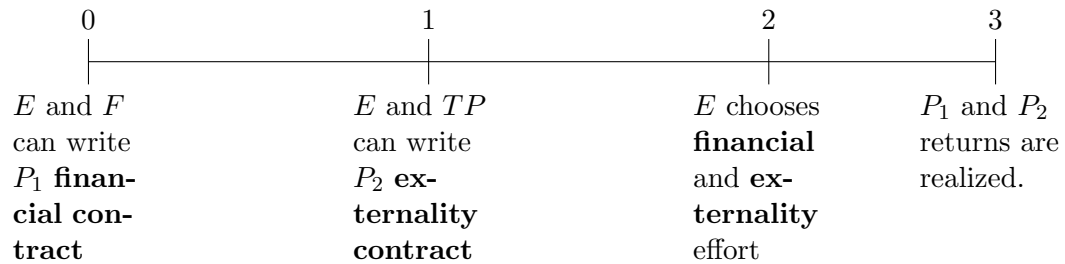The following timeline 3.1 summarizes the above discussion and gives a quick overview of the model.

0	1	2	3
E and F can write P_1 **financial contract**	E and TP can write P_2 **externality contract**	E chooses **financial** and **externality** effort	P_1 and P_2 returns are realized.

Figure 3.1: Timeline

3.2.2. Model set-up

In this section, the economic agents and the projects will be described in detail.

The penniless entrepreneur, E, owns a project P_1 which requires an investment I at time 0 and generates a binary random return $\widetilde{R}_1$ at time 3, the final stage of the game. With probability p_1, P_1 succeeds and $\widetilde{R}_1 = R_1$, while with probability $1 - p_1$, P_1 fails and $\widetilde{R}_1 = 0$.

$$\widetilde{R}_1 = \begin{cases} R_1 & \text{with prob.} \quad p_1 \\ 0 & \text{with prob.} \quad 1 - p_1 \end{cases}.$$

E has discretion over the probability with which P_1 succeeds through the effort action $e_a \in \{0, 1\}$. If E sets $e_a = 0$, he exerts no financial effort and P_1 succeeds with a base probability $p_1 = p_L$. If E sets $e_a = 1$, he makes financial effort and P_1 succeeds with a probability $p_1 = p_L + \Delta$, $\Delta > 0$.

$$p_1 = p_L + \Delta e_a,$$

where

$$0 < p_1 < 1.$$

Exerting financial effort is assumed to be costly to E in that he foregoes private benefits in the amount of B. These private benefits can be interpreted broadly as any utility benefits which the entrepreneur obtains when he does not work hard on the job or utility benefits he obtains when he implements his project in a way which leads to a lower success probability, but which is more fun to execute, delivers benefits to his friends, etc. .

P_1 is positive net present value only if E exerts effort and this even when taking account of the entrepreneur's private benefits. That is,

$$p_L R_1 + B < I$$

and

$$\left(p_L + \Delta\right) R_1 > I.$$

This assumption then also immediately implies that financial effort is socially desirable,

$$\Delta R_1 > B$$

.

Financial effort, e_a, is assumed to be unobservable to agents other than E and can not be contracted upon. $\widetilde{R}_1$ on the other hand is observable and contractible. The financier may then attempt to overcome the moral hazard problem associated with financial effort by granting E a sufficiently stake in P_1.

In order to arrange thoughts on the moral hazard problem, it might be helpful to first consider a simplified setting in which only the entrepreneur and the financier are present. E is assumed to be protected by limited liability and is penniless. Therefore, the only resource he initially starts with is the idea to his project P_1. The financier, only has an amount I which he can invest in P_1 to allow E to start up his project.

Assuming the entrepreneur and the financier can not stipulate non-pecuniary penalties conditional on the outcome of the project P_1, the optimal financial contract will grant E a stake R^S, $0 \leq R^S \leq R_1$, when P_1 succeeds and nothing when P_1 fails. The financial contract will then make financial effort incentive compatible if R^S satisfies

$$\left(p_L + \Delta\right) R^S \geq p_L R^S + B$$

or

$$R^S \geq \frac{B}{\Delta}.$$

That is $\frac{B}{\Delta}$ is the smallest stake which will induce financial effort. E will then be able to obtain financing if the financier can at least break even under this minimum incentive compatible stake. That is if,

$$(p_L + \Delta)\left(R_1 - \frac{B}{\Delta}\right) \geq I.$$

Throughout the model, it will be assumed that the above condition holds and that E can receive financing in the absence of the third party, TP. Assumption 3.1 then serves as a benchmark which highlights how under a set of assumptions on the contracting environment the presence of TP, may render financing more difficult or even impossible.

Assumption 3.1. *The entrepreneur, E, can obtain financing from the financier in the absence of the third party, TP, that is,*

$$R_1 \geq \frac{B}{\Delta} + \frac{I}{p_L + \Delta}.$$

The third party, TP, owns a project P_2 which is fully funded at the beginning of the game and which generates a binary random return $\widetilde{R}_2$ at time 3. With probability p_2, P_2 succeeds and $\widetilde{R}_2 = R_2$, while with probability $1 - p_2$, P_2 fails and $\widetilde{R}_2 = R_2$.

$$\widetilde{R}_2 = \begin{cases} R_2 & \text{with prob.} & p_2 \\ 0 & \text{with prob.} & 1 - p_2 \end{cases}$$

In addition to having discretion over financial effort, e_a, E is assumed to have discretion over the probability with which P_2 succeeds through $e_b \in \{0, 1\}$. If E sets $e_b = 0$, he exerts no externality effort and P_2 succeeds with a base probability $p_2 = p_L$. If E sets $e_b = 1$, he

exerts externality effort and P_2 succeeds with a probability $p_2 = p_L + \Delta$, $\Delta > 0$.

$$p_2 = p_L + \Delta e_b,$$

where

$$0 < p_2 < 1.$$

e_b is the positive social impact the entrepreneur can have through his project. Referring back to the examples in the introduction, $e_b = 1$ respectively captures efforts by E to redesign his plant to improve the water quality of the local river, time spent by E writing open source software code and time and resources spent by the school to organize an after hours arts and crafts class. $e_b = 0$ is then the flip side when the entrepreneur does not make any effort to deliver the positive social impact.

Similarly to financial effort, exerting externality effort is assumed to be costly to E in that he foregoes private benefits in the amount of B. These private benefits can be thought of as any utility benefits from not having to think through novel ways to use his project to deliver a positive social impact. [3]

Though externality effort boosts the profitability of TP's project, it is assumed not to be necessary for the viability of P_2. The third party will operate his project regardless of e_b. Referring back to the examples in the introduction, the hotel is profitable even if its guests can not use the river for leisure, other firms can still operate their businesses profitably without the open source software code and the local arts and craft industry can survive without the school's help. Nevertheless, like financial effort, externality effort is assumed

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[3]It should be noted that the model does not introduce heterogeneity in the parameters capturing the moral hazard problem for financial and externality effort. In particular, the private benefits of shirking on financial and externality effort are the same at B and effort increases the success probability of P_1 and P_2 by Δ. This assumption greatly simplifies the tractability and exposition of the paper and comes at little loss of generality even when discussing comparative statics results. An empirical analysis of the model, however, could easily incorporate heterogeneity in B and Δ because such a model could be solved numerically rather than analytically in closed form. Introducing heterogeneity in B and Δ might then be a worthwhile extension for future empirical research where it should come at little cost in terms of estimation.

to be socially desirable,

$$\Delta R_2 > B.$$

In a way similar to financial effort, externality effort, e_b, is assumed to be unobservable to agents other than E. $\widetilde{R}_2$ on the other hand is publicly observable and hence contractible. Since setting $e_b = 1$ does not affect the profitability of P_2 but is privately costly, E will need explicit incentives to exert externality effort. If E has a sufficiently large stake in the success of P_2, he can be expected be incentivized to deliver the positive impact.

In order to put some further restrictions on the model parameters, it will be assumed that the third party would find it worthwhile to provide E with incentives for externality effort if he were restricted to using a contract which can only stipulate a stake in the success of P_2. That is such a contract can not stipulate a non-pecuniary reward or penalty conditional on the outcome of P_2, nor can it stipulate a financial penalty should P_2 fail. The inability of stipulating a financial penalty is what will be relaxed in what follows and will be shown to give rise to a credit constraint problem. Let r^S, $0 \leq r^S \leq R_2$ denote E's stake in the success of P_2. Then exerting externality effort is incentive compatible if

$$\left(p_L + \Delta\right) r^S \geq p_L r^S + B$$

or

$$r^S \geq \frac{B}{\Delta}.$$

TP will then find incentivizing E worth his while if he is better-off offering the incentive contract than by keeping with the default situation. That is if,

$$\left(p_L + \Delta\right) \left(R_2 - \frac{B}{\Delta} \right) \geq p_L R_2.$$

Assumption 3.2 captures this assumption which is held throughout the paper.

Assumption 3.2. *The third party, TP, can incentivize externality effort through a simple incentive contract which grants the entrepreneur, E, a stake in the success of P_2. That is,*

$$R_2 \geq \frac{(p_L + \Delta)}{\Delta} \frac{B}{\Delta}$$

Based on assumptions 3.1 and 3.2 it would seem at first that the socially efficient outcome in the model can be easily obtained. In particular, if E and the financier write a financial contract granting E a stake $R^S \geq \frac{B}{\Delta}$ in the success of P_1, while TP and E write an externality contract stipulating a stake $r^S \geq \frac{B}{\Delta}$ in the success of P_2, then the minimum incentive compatible stakes for financial and externality effort would be in place. The question now however is whether it can be expected that these contracts will indeed be the ones offered and written.

Suppose for the sake of argument that E and the financier first write a financial contract which stipulates a stake $R^S \geq \frac{B}{\Delta}$. In other words, the financial contract puts in place incentives for financial effort through a simple stake in the success of P_1. In addition, suppose the third party can make a take it or leave it offer to the entrepreneur to incentivize externality effort. Then if the third party acts economically rational, he will seek to provide incentives in the cheapest way possible, while ensuring that the entrepreneur is willing to accept his contractual offer. In the absence of non-pecuniary penalties and rewards, the third party can then attempt to reduce the expected cost of the externality contract by shifting incentive provision from a reward, r^S, upon the success of P_2 to a penalty, r^F, upon P_2's failure.

Financial penalties however, can only be collected when the entrepreneur has financial resources available. Since E is assumed to be penniless and protected by limited liability, this implies that penalties can only be collected when the entrepreneur's project P_1 succeeds. But if E is potentially penalized when his project succeeds, then a penalty will effectively

reduce the entrepreneur's stake in the success of his own project and reduce his incentives to exert financial effort. Then even though immediately after the financial contract has been written E might have incentives in place for financial effort, this may no longer be the case after the third party has offered his externality contract.

The first main task of the paper is to show that in response to a financial contract stipulating $R^S \geq \frac{B}{\Delta}$, the third party may offer an externality contract with penalties which the entrepreneur is willing to accept yet destroys his incentives for financial effort. Moreover, it will be shown that under certain conditions no stake $R^S \geq \frac{B}{\Delta}$ will exist which ex-ante ensures that the entrepreneur remains incentivized for financial effort after the third party's offer and which allows the financier to break even on his investment. The third party will be shown not to fully internalize the effects of his contractual offering. If the financier is then restricted to financial contracts which only allow for E to have a stake R^S in P_1's success, then the entrepreneur will effectively become credit constrained since the financier can not offer a contract which puts incentives in place and allows him to break even.

It should be noted that the above argument relies on the assumption that the third party has sufficient bargaining power to push for an externality contract with the lowest expected cost to him. In the paper this is modelled by assuming that the third party can make a take it or leave it (TIOLI) offer. Though this is an extreme form of shifting bargaining power to the third party, it is not crucial for the results of the paper but greatly simplifies the exposition of the paper.

In a real life situation, the source of the superior bargaining position of the third party agent can be viewed as coming from for instance local community support for the third party or social pressure which is put on the entrepreneur. In the following section, the assumption of the TIOLI offer and how it can be interpreted will be discussed in greater detail.

Before going into the solution of the model, it is worthwhile at this point to refer back to the introductory arguments regarding the use of covenants in the financial contract. The above

discussion makes it clear that the negative effect of the third party on incentives for financial effort stems from his ability to stipulate a penalty in the externality contract. In effect, such a penalty collateralizes the financial contract or the cash flows which it generates. Therefore, if the financier were to be able to stipulate in the financial contract that the third party may not collateralize the cash flow streams it generates, then the socially efficient outcome could be easily obtained by granting E a stake $R^S \geq \frac{B}{\Delta}$ in the success of P_1 and a stake $r^S \geq \frac{B}{\Delta}$ in the success of P_2.

Such a financial contract with covenant however could be interpreted as another form of a social financial contract because it ensures that the socially efficient outcome is obtained. Indeed, if it is possible for the financier to write a specific non-collateralization covenant, then it should be expected that a much easier covenant which prevents E from contracting with TP altogether is also possible [4]. Such a covenant would also solve the credit constraint problem and allow E to be financed but would be socially inefficient since absent altruistic preferences the positive impact action would not be delivered. Therefore to the extent that a perhaps more difficult to write non-collateralization covenant is used, it should equally be viewed as a non-traditional, social, financial contract. The social financial contract focussed upon in this paper however, assumes that covenants of the types just discussed are not feasible or illegal.

3.2.3. Model solution

Financing under standard financial contract

In the following section it will first be shown how the credit constraint problem under standard financial contracts may arise. That is, if the financial contract is restricted to a stake R^S, $0 \leq R^S \leq R_1$, for E when his project, P_1, succeeds and a payment 0 when it fails, then under certain conditions, the entrepreneur can be credit constrained in the presence of the third party, TP.

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[4]Assuming the lawmaker has not legally stipulated which covenants can or can not be written.

Definition 1. *A standard financial contract between the entrepreneur, E, and the financier grants E a stake R^S, $0 \leq R^S \leq R_1$, in the success of P_1 and 0 in its failure.*

The standard financial contract 1 is easily recognized as the financial contract that would be written between the financier and the entrepreneur in a set-up without the third party. Indeed, the optimal financial contract takes the form of a standard financial contract if the penniless entrepreneur protected by limited liability seeks to secure financing from the outside financier.

Apart from ruling out covenants, which were discussed at length in the previous sections, it should also be noted that the standard financial contract rules out two state contingent payment streams: first, it rules out a bonus payment for the entrepreneur when both P_1 and P_2 succeed and secondly, it rules out penalizing E when P_2 fails.

The use of a bonus payment contingent on the success of P_1 and P_2 is precisely what will give rise to the social financial contract which will be discussed at length in the last section of the paper. Indeed, the goal of the paper is to show that it may be necessary to use such a bonus payment in order to allow the entrepreneur to obtain financing from the financier.

The use of the penalty on the other hand is discussed in appendix B.1. There it is shown that through such a penalty the financier may prevent the credit constraint problem from arising. In particular, appendix B.1 shows that if the financier stipulates a sufficiently large penalty in the financial contract, then he can make certain that the third party has no choice but to offer the entrepreneur an externality contract which respects the incentives for financial effort. Moreover, such a financial contract does not even have to stipulate a reward for the entrepreneur when P_1 succeeds, implying that E extracts negative rents from the financial contract, because the entrepreneur can expect to extract sufficient rents from his future dealing with the third party.

Such a financial contract however, can be viewed as holding the third party hostage and allows the entrepreneur and the financier to use their first mover advantage to excessively

extract rents from the third party's project. Although the contract would lead to the socially efficient outcome, the lawmaker may likely prevent it from being written because allowing for the penalty may lead to an inequitable division of the surplus generated by P_1 and P_2.

In addition, from a legal perspective it may also be technically hard to write such a financial contract because it essentially collateralizes the cash flow streams of a contract which is yet to be written. Indeed, in the limited liability set-up of the paper, the penalty can only be stipulated in expectation of the externality contract which the entrepreneur and the third party will write in the future. There might therefore be costs involved with such a contract which though it might be legal might make it infeasible. In light of this, the paper will therefore continue under assumption 3.3 which stipulates that penalties in the financial contract is impossible or infeasible.

Assumption 3.3. *The payments stipulated in the externality contract can not be collateralized by the financial contract.*

After the financial contract has been written, the third party can choose to offer an externality contract to induce the entrepreneur to exert externality effort. Since the financial contract is in place, E is at that point entitled to a stake R^S if P_1 succeeds and the third party will take the financial contract into account when making his offer. Furthermore, in the paper it is assumed that the third party can make a take it or leave it (TIOLI) offer to the entrepreneur for an externality contract.

Assumption 3.4. *The third party agent, TP, can make a take it or leave it offer to the entrepreneur, E, for an externality contract.*

As was discussed in the introduction, assumption 3.4 is meant to reflect a setting in which the third party has sufficient bargaining power to allow it to make a contractual offer which transfers as little rents to the entrepreneur as possible. The lower bound on the rents ultimately transferred is determined by the incentives which need to be provided and the fact that the entrepreneur needs to be left at least as well off. Although the TIOLI assumption may seem extreme, the results of the paper follow through if the third party

has a smaller degree of bargaining power as well. Making the TIOLI assumption, however, greatly simplifies the exposition of the model.

The origin of the third party's bargaining power can stem from a variety of sources. For instance, the entrepreneur's local community or social network might sympathize with the third party's cause so that the entrepreneur prefers to avoid seeking high rent taking at the negotiation table. In addition, pressure groups such as NGO's or labour unions may back the cause of the third party and may be able to influence the public image of the entrepreneur through publicity campaigns or consumer labels. If the entrepreneur is then willing to accept terms which merely compensate him for his foregone private benefits or if he restricts himself to purely informational rents to overcome the moral hazard problem, then the NGO my reward the entrepreneur by enhancing his corporate reputation or societal legitimacy.

Under assumption 3.4, the third party can be expected to provide part of the incentives through a penalty conditional on P_2's failure, because this will allow him to lower the expected cost of the externality contract. The penalty however will be restricted to the stake which the entrepreneur has in P_1.

In particular the externality contract is assumed to be a pair $\left(r^S, r^F\right)$ where $0 \leq r^S \leq R_2$ is E's stake in the success of P_2 and $0 \leq r^F \leq R^S$ is a penalty E needs to pay TP when P_2 fails.

Definition 2. *An externality contract is a pair $\left(r^S, r^F\right)$ where $0 \leq r^S \leq R_2$ is E's stake in the success of P_2, while $0 \leq r^F \leq R^S$ is a penalty paid by E to TP.*

Two remarks should be made about the externality contract as it is stated in definition 2. First, the limited liability assumption in the paper implies that the entrepreneur can only pay the penalty r^F when his project P_1 succeeds. Indeed, since E is penniless, his only source of income is his stake in his own project. The penalty however then effectively reduces E's success in the success of his own project and will reduce E's incentives to exert

financial effort even though ample incentives may have been in place immediately after the financial contract has been written.

Secondly, the externality contract does not allow for a payment conditional on the success of P_1 and P_2. In appendix B.2, it is shown that allowing for a payment conditional on the success of P_1 and P_2 would resolve the credit constraint problem if P_2 is sufficiently profitable or if P_2 is not sufficiently profitable prevent the social financial contract from being a solution to the credit constraint problem. In order for the social financial contract to appear, it therefore needs to be assumed that the third party can not make use of such a more elaborate externality contract.

In reality however, it seems to some extent unrealistic that the third party would write an externality contract with such bonus. In particular, it would require not only require knowledge of his own project but also more elaborate knowledge of the entrepreneur's project. The writing costs of an externality contract with such a bonus might then prevent it from being feasible. Several papers in the finance and economics literature, such as Grossman and Hart (1986) and Hart and Moore (1988) have relied on writing or complexity costs to argue why contracts may have some contractual incompleteness. As such the paper will continue under assumption 3.5 stating that the externality contract does not contain a bonus payment conditional on the success of P_1 and P_2.

Assumption 3.5. *The externality contract can not stipulate a payment conditional on the success of both P_1 and P_2.*

The financier in the model is assumed to be perfectly rational and hence anticipates the future contracting opportunity between the entrepreneur and the third party. Moreover, the financier will only finance E's project if he is certain that in the end E will work diligently on his project and exert financial effort. This implies that the financier will need to be able to write a financial contract which ensures that E continues to be motivated for financial effort after he has written the externality contract with the third party.

Under the standard financial contract restriction maintained in this section, the model solution below will show that the financier can enhance E's incentives for financial effort by granting him a larger stake R^S in P_1. The question is however whether a stake can be offered which is sufficiently high to maintain financial effort incentives post the externality contract and which still allows the financier to break even on his investment. If it is impossible for the financier to offer such a stake, then the financier will not be willing to finance the entrepreneur because he would certainly loose out on his investment. The entrepreneur will then be said to be credit constrained under standard financial contracts.

In order to derive the conditions under which the credit constraint problem arises, the model is solved through backward induction. First, as a function of R^S, the externality contract (r^S, r^F) which the third party offers the entrepreneur is derived. Then as function of the expected externality contract that will be offered, it is determined when the financier can offer a stake R^S which ensures incentives for financial effort and allows him to break even.

Because effort choice in the model is binary, effort or no effort, the third party essentially has the choice between offering two types of externality contracts: first, he can offer the "social" externality contract which incentivizes externality effort while keeping incentives in place for E to exert financial effort and secondly, he can offer the "non-social" externality contract which incentivizes externality effort but does not lead to E being incentivized for financial effort.

Earlier in the paper it was argued that the prime cause for the potentially negative effect of the externality contract, stems from the third party wanting to provide incentives as cheaply as possible. It was suggested in particular that this leads TP to make excessive use of penalties rather than rewards. It might then be surprising at first that the non-social contract which puts less restrictions on the use of penalties is not necessarily the one TP will offer.

There are two reasons however why the non-social externality contract is not necessarily

the cheapest. First, E is always free to accept or reject the take it or leave it offer from TP and will only accept if he is left at least as well off. Furthermore, a contract which destroys E's incentives for financial effort, also reduces the expected revenue he expects to extract from his project. In order to leave the entrepreneur at least as well off under the non-social contract, TP will then need to compensate E for the expected loss in utility resulting from his reduced incentives.

Secondly, the financial contract becomes more valuable as a source of collateral when it generates a positive cash flow more frequently. Though the non-social contract allows for a larger penalty and hence all else equal cheaper incentive provision, it also implies that P_1 will succeed less frequently. All else equal this makes incentive provision more expensive since the penalty can be collected less frequently. To sum up though the non-social contract chews up more of R^S as a penalty, R^S is generated less frequently overall reducing the ability of the non-social contract to reduce the expected cost of incentive provision.

The social and non-social externality contracts TP may offer E each solve a constrained optimization program. First, the social externality contract solves the following program.

$$\min_{r^S, r^F \geq 0} (p_L + \Delta)\, r^S - (1 - (p_L + \Delta))\, (p_L + \Delta)\, r^F$$

subject to

$$r^S - (1 - (2p_L + \Delta))\, r^F \geq \frac{B}{\Delta} + \frac{B}{\Delta} - R^S \qquad (IC_1^s)$$

$$r^F \leq \frac{1}{1 - (p_L + \Delta)} \left(R^S - \frac{B}{\Delta} \right) \qquad (IC_2^s)$$

$$r^S + (p_L + \Delta)\, r^F \geq \frac{B}{\Delta} \qquad (IC_3^s)$$

$$(p_L + \Delta)\, r^S - (1 - (p_L + \Delta))\, (p_L + \Delta)\, r^F \geq B \qquad (IR_1^s)$$

$$(p_L + \Delta)\, r^S - (1 - (p_L + \Delta))\, (p_L + \Delta)\, r^F \leq \Delta R_2 \qquad (IR_2^s)$$

$$r^S \leq R_2 \qquad (LL_1^s)$$

$$r^F \leq R^S \qquad (LL_2^s)$$

The social externality contract minimizes the expected cost to E of providing incentives for externality and financial effort. The constraints reflect the incentive compatibility, individual rationality and limited liability bounds the contract must satisfy.

In particular the three incentive compatibility constraints, IC_1^s, IC_2^s and IC_3^s, reflect the bounds such that E prefers to exert effort on both dimensions rather than, shirk on both dimensions, only exert effort on the externality dimension and only exert effort on the financial dimension.

Next, the individual rationality constraint IR_1^s ensures that E is at least as well off by

accepting the contract rather than refusing it and IR_2^s ensures that TP finds it worthwhile to offer the social externality contract.

Finally, the limited liability constraints LL_1^s and LL_2^s ensure that TP can only reward E out of what P_2 generates and that TP can not penalize E over and above E's stake in P_1.

The constraints of the social externality contract immediately indicate that a social externality contract does not exist for $R^S < \frac{B}{\Delta}$. In particular, if $R^S < \frac{B}{\Delta}$, then the IC_2^s implies that $r^F < 0$ which is in violation with the fact that $r^F \geq 0$ because of limited liability.

Intuitively, when $R^S < \frac{B}{\Delta}$ then E is not incentivized to exert financial effort through the financial contract. When TP is restricted to using a contract which specifies a reward upon P_2's success and a penalty upon P_1's failure however, he can not provide additional incentives for financial effort. The solution for the optimal social externality contract is therefore only defined for $R^S \geq \frac{B}{\Delta}$.

Next consider the non-social externality contract. When solving for the optimal non-social contract, a distinction has to be made between the case in which the financial contract puts in place incentives for financial effort, $R^S \geq \frac{B}{\Delta}$, and when it doesn't, $R^S < \frac{B}{\Delta}$. The reason for this is that the two cases imply different outside options for when E refuses the non-social externality contract and hence different individual rationality constraints.

In particular, if the financial contract does not provide incentives for financial effort, $R^S < \frac{B}{\Delta}$, E's expected utility when he refuses the externality incentive contract is

$$p_L R^S + B.$$

The individual rationality constraint for E in this case becomes

$$(p_L + \Delta)\, r^S - (1 - (p_L + \Delta))\, p_L r^F \geq B. \qquad (IR_1^{ns})$$

On the other hand, if the financial contract puts in place incentives for financial effort, $R^S \geq \frac{B}{\Delta}$, E's expected utility when he refuses the externality incentive contract is

$$(p_L + \Delta) R^S.$$

The individual rationality constraint for E in this case then becomes

$$(p_L + \Delta) r^S - (1 - (p_L + \Delta)) p_L r^F \geq \Delta R^S. \qquad (IR_1^{ns'})$$

These two individual rationality constraints can now be used in the formulation of the optimization program for the non-social externality contract.

$$\min_{r^S, r^F \geq 0} (p_L + \Delta) \, r^S - (1 - (p_L + \Delta)) \, p_L r^F$$

subject to

$$r^S + p_L r^F \geq \frac{B}{\Delta} \qquad\qquad (IC_1^{ns})$$

$$r^S + r^F \geq R^S \qquad\qquad (IC_2^{ns})$$

$$r^F \geq \frac{1}{1 - (p_L + \Delta)} \left(R^S - \frac{B}{\Delta} \right) \qquad\qquad (IC_3^{ns})$$

$$(p_L + \Delta) \, r^S - (1 - (p_L + \Delta)) \, p_L r^F \geq B \qquad\qquad (IR_1^{ns})$$

$$(p_L + \Delta) \, r^S - (1 - (p_L + \Delta)) \, p_L r^F \geq \Delta R^S \qquad\qquad (IR_1^{ns'})$$

$$(p_L + \Delta) \, r^S - (1 - (p_L + \Delta)) \, p_L r^F \leq \Delta R_2 \qquad\qquad (IR_2^{ns})$$

$$r^S \leq R_2 \qquad\qquad (LL_1^{ns})$$

$$r^F \leq R^S \qquad\qquad (LL_2^{ns})$$

The incentive compatibility constraints, IC_1^{ns}, IC_2^{ns} and IC_3^{ns} ensure that E prefers to exert externality effort and shirk on financial effort over respectively, shirk on both effort dimensions, exert financial effort but shirk on externality effort and exert effort on both effort dimensions.

The IR_1^{ns} and $IR_1^{ns'}$ constraints ensure that E is willing to accept the non-social externality incentive contract respectively in the case in which $R^S < \frac{B}{\Delta}$ and $R^S \geq \frac{B}{\Delta}$.

IR_2^{ns} ensures that TP is willing to offer the externality contract and finally LL_1^{ns} and LL_2^{ns} are the limited liability constraints ensuring that TP does not reward beyond what is generated by P_2 and TP does not penalize over and above what E obtains from the

financing contract.

By looking more closely at the constraints we can already see that in order for the $IR_1^{ns'}$ and IR_2^{ns} constraints to be compatible, we need to have that $R^S \leq R_2$ and that in order for the IC_3^{ns} and LL_2^{ns} constraints to be compatible we need that $R^S \leq \frac{1}{(p_L+\Delta)} \frac{B}{\Delta}$. In order for a non-social contract to exist we therefore need $R^S \leq \min\left\{\frac{1}{(p_L+\Delta)} \frac{B}{\Delta}, R_2\right\}$. This will be reflected in the solution of the optimal non-social contract below.

In order to determine whether TP will offer E the social or non-social externality contract, the above constrained optimization programs need to be solved and the expected cost of both types of contracts need to be determined. For a given R^S, TP will then make a take it or leave it offer for the contract with the lowest expected cost.

The expected cost of the optimal social externality contract as a function of R^S is given in proposition 3.1

Proposition 3.1. *The expected cost of the optimal social externality contract as a function of R^S is as follows.*

- *For $0 \leq R^S < \frac{B}{\Delta}$:*

$$\text{There is no feasible social externality contract.}$$

- *For $\frac{B}{\Delta} \leq R^S \leq \left(1 + \frac{(1-(p_L+\Delta))p_L}{(1-\Delta)(p_L+\Delta)}\right) \frac{B}{\Delta}$:*

$$(p_L + \Delta) \frac{B}{\Delta} - \frac{(p_L + \Delta)(1 - \Delta)}{1 - (p_L + \Delta)} \left(R^1 - \frac{B}{\Delta}\right).$$

- *For $\left(1 + \frac{(1-(p_L+\Delta))p_L}{(1-\Delta)(p_L+\Delta)}\right) \frac{B}{\Delta} < R^S$:*

$$B.$$

Proof. See technical appendix.[5] □

Proposition 3.1 tells us that R^S splits the optimal social externality contract into three regions. First, for $R^S < \frac{B}{\Delta}$, a social externality contract is not feasible because, as mentioned above, the incentive compatibility and limited liability constraints are incompatible.

Secondly, for $\frac{B}{\Delta} \leq R^S \leq \left(1 + \frac{(1-(p_L+\Delta))p_L}{(1-\Delta)(p_L+\Delta)}\right) \frac{B}{\Delta}$, we see that TP is unable to extract all economic rents when offering the incentive contract. This leaving E strictly better off than without the contract. Intuitively, when R^S is relatively low, TP is limited in his ability to provide incentives by penalizing E when P_2 fails. This is reflected in the fact that for this

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[5]The technical appendix is available from the author by request.

region of R^S the IC_2^s constraint binds indicating that for higher r^F, TP would destroy E's incentives for financial effort. The expected cost of the social externality contract in this region is given by

$$(p_L + \Delta) \frac{B}{\Delta} - \frac{(p_L + \Delta)(1 - \Delta)}{1 - (p_L + \Delta)} \left(R^S - \frac{B}{\Delta} \right).$$

Not surprisingly, the expected cost is decreasing in R^S since TP can make more use of penalties rather than rewards to incentivize E. The expected cost is also increasing in B, the private benefits E foregoes when he exerts effort.

Finally, for higher R^S, $\left(1 + \frac{(1-(p_L+\Delta))p_L}{(1-\Delta)(p_L+\Delta)} \right) \frac{B}{\Delta} < R^S$, TP is able to provide incentives without leaving additional rents for E. E is then left equally well off after accepting the externality contract in that the expected cost of the incentive contract equals E's private benefits of shirking on externality effort, B.

Next, the expected cost of the non-social externality contract is given in proposition 3.2.

Proposition 3.2. *The expected cost of the optimal non-social externality contract as a function of R^S is given as follows:*

- *For $0 \leq R^S < \frac{B}{\Delta}$:*

$$(p_L + \Delta)\frac{B}{\Delta} - p_L R^S.$$

- *For $\frac{B}{\Delta} \leq R^S \leq \min\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, R_2\right\}$:*

$$\Delta R^S.$$

- *For $\min\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, R_2\right\} < R^S$:*

There is no feasible non-social externality contract.

Proof. See technical appendix. □

Proposition 3.2 first reveals that there is a non-monotonic relationship in the expected cost of the non-social contract. This non-monotonicity is a direct consequence of the binary nature of incentives in the model and in particular of whether the financial contract puts in place incentives for financial effort or not.

In particular, for $0 \leq R^S < \frac{B}{\Delta}$, the expected cost of the non-social externality contract is decreasing in R^S. This is because over this range TP can make more use of penalties to incentivize E, while at the same time TP does not have to compensate E for not being motivated anymore to exert financial effort since he was not motivated in the first place.

For larger R^S, TP can still make more use of penalties but now he will also have to com-

pensate E for the loss in incentives for financial effort. This compensation is equal to the difference in P_1's success probability under financial effort times the compensation received when P_1 succeeds.

For $\frac{B}{\Delta} \leq R^S \leq \min\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, R_2\right\}$, TP can offer an incentive compatible contract which precisely compensates E for shirking on financial effort. That is, the $IR_1^{ns'}$ constraint binds. Of course, since the expected loss to E due to reduced incentives is increasing in his stake in P_1, the cost of this compensation and hence the expected cost of the non-social externality contract will be increasing in R^S.

For $\min\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, R_2\right\} < R^S$, TP can no longer offer the non-social externality contract since respectively the $IR_1^{ns'}$ and IR_2^{ns} and the IC_3^{ns} and LL_2^{ns} constraints contradict each other.

The results of propositions 3.1 and 3.2 are illustrated in figure 3.2.

6

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^{6}Note that the following holds:

$$\max\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, \frac{(p_L+\Delta)}{\Delta}\frac{B}{\Delta}\right\} > \left(1 + \frac{(1-(p_L+\Delta))\,p_L}{(1-\Delta)\,(p_L+\Delta)}\right)\frac{B}{\Delta}$$

if $1 > p_L + \Delta$.

The last inequality holds by assumption since P_1 would otherwise be allowed to succeed with certainty.
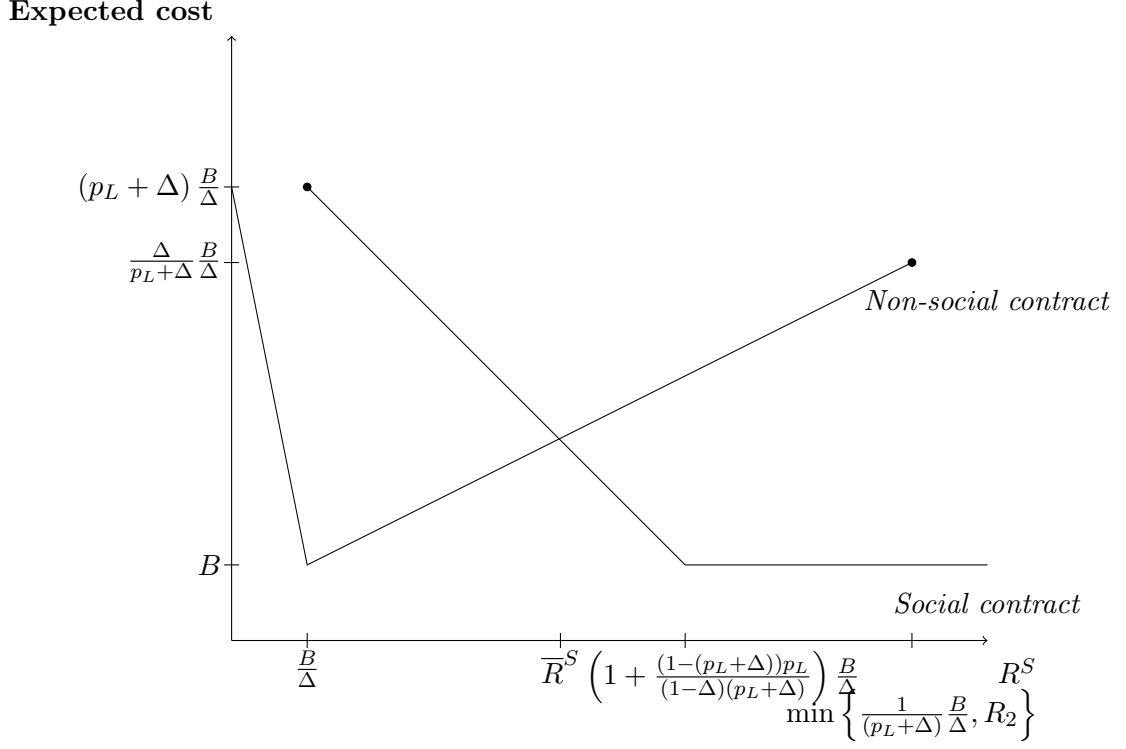
Expected cost

Figure 3.2: Social and non-social externality contract

Figure **??** and propositions **??** and **??** indicate that for $R^S < \frac{B}{\Delta}$ TP can only incentivize E through the non-social externality contract while for $R^S > \max\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, \frac{(p_L+\Delta)}{\Delta}\frac{B}{\Delta}\right\}$ only the social contract is available. For $\frac{B}{\Delta} \leq R^S \leq \max\left\{\frac{1}{(p_L+\Delta)}\frac{B}{\Delta}, \frac{(p_L+\Delta)}{\Delta}\frac{B}{\Delta}\right\}$ on the other hand, TP has the choice to incentivize E either through the social or through the non-social externality contract. Since TP is assumed to be a rational non-altruistic agent, he will choose the cheapest of the two incentive contracts to incentivize E.

TP will make a take it or leave it offer for the non-social externality contract if the expected cost of the social externality contract exceeds that of the non-social externality contract. That is if,

$$\Delta R^S < (p_L + \Delta) \frac{B}{\Delta} - \frac{(p_L + \Delta)(1 - \Delta)}{1 - (p_L + \Delta)} \left(R^S - \frac{B}{\Delta} \right)$$

$$\Leftrightarrow R^S < \overline{R}^S \equiv \left(1 + \frac{(1 - (p_L + \Delta)) p_L}{(1 - \Delta)(p_L + \Delta) + \Delta (1 - (p_L + \Delta))} \right) \frac{B}{\Delta}.$$

Clearly we have that,

$$\overline{R}^S < \left(1 + \frac{(1 - (p_L + \Delta)) p_L}{(1 - \Delta)(p_L + \Delta)} \right) \frac{B}{\Delta}.$$

In other words, the region of R^S over which TP prefers the non-social contract is a subsection of the region over which the social contract does not break even.

In summary we then have that for $0 \leq R^S < \overline{R}^S$, TP will provide E with incentives to exert externality effort through the non-social externality contract, while for $\overline{R}^S \leq R^S$, TP will incentivize E through the social externality contract.

This is summarized in proposition 3.3

Proposition 3.3. *There exists a* $\overline{R}^S > \frac{B}{\Delta}$ *such that for*

$$0 \leq R^S < \overline{R}^S,$$

the third party, TP, offers the non-social externality contract to incentivize externality effort, while for

$$\overline{R}^S \leq R^S,$$

the third party, TP, offers the social externality contract to incentivize externality effort.
$\overline{R}^S$ *is given by*

$$\left(1 + \frac{(1 - (p_L + \Delta))\, p_L}{(1 - \Delta)\,(p_L + \Delta) + \Delta\,(1 - (p_L + \Delta))}\right) \frac{B}{\Delta}.$$

The conclusion of proposition 3.3 is that if the financier is restricted to financing the entrepreneur through a standard financial contract, he needs to offer him a stake R^S in P_1 which exceeds $\overline{R}^S$. Moreover, it can be easily observed that $\overline{R}^S > \frac{B}{\Delta}$ so that the financier needs to grant the entrepreneur a larger stake in P_1 compared to the situation in which the third party were not present to offer an externality contract.

This may result in the entrepreneur to be credit constrained in the presence of the third party even though it was assumed that he could obtain financing if TP were absent. That is not all projects may be profitable enough to allow the financier to break even on his investment after having granted the minimal incentive compatible stake of $\overline{R}^S$.

Corollary 3.1 gives the condition under which the entrepreneur can be credit constrained when the financier has to finance P_1 through a standard financial contract.

Corollary 3.1. *The entrepreneur, E, is credit constrained under standard financial con-*

tracts if

$$(p_L + \Delta)\left(R_1 - \overline{R}^S\right) < I.$$

Financing under a social financial contract

Characterizing the social financial contract   The previous section showed that despite the fact that the entrepreneur, E, can obtain financing for P_1 in the absence of the third party, TP, he can become credit constrained in his presence when the financier is restricted to using a standard financial contract. This section will now show how under certain conditions, the credit constraint problem can be resolved if the financier finances E through a contract which provides incentives for both financial and externality effort.

In the model, this alternative financing contract will be called a social financial contract and it represents financial contracts which make financing conditional on the entrepreneur operating his project in a responsible way. Various forms of impact investing or socially responsible investing can be interpreted in this way, since all these investment options have in common that they seek not only to generate a financial return but also ensure that the project financed is operated in a responsible way. Translated into an economic vocabulary, the goal of these contracts is to make entrepreneurs internalize the externalities their operations might have on other agents in the economy.

For the model in this paper, this means that the social financial contract will provide explicit incentives to E to exert externality effort at the time P_1 is financed. The social financial contract will then differ from the standard financial contract in that it allows for a bonus conditional on the success of P_1 and P_2 and allows the financier to provide incentives for externality effort alongside financial effort.

If the financing contract provides E with the necessary incentives for externality effort, TP will no longer need to offer an externality contract which may distort E's incentives for

financial effort. In a way it appears TP is able to free ride of the social financial contract in that his project is rendered more profitable without him having to compensate E or the financier.

This is also what makes the social financial contract resemble real life examples of impact investing in that impact investing usually constitutes a dealing between investors and the entrepreneur raising capital. The third party agents benefitting from the entrepreneur's responsible behavior usually do not get involved in the provision of incentives for responsible behavior.

It is important to reiterate at this point that the only difference between the standard and social financial contract is the availability of a bonus conditional on the success of both P_1 and P_2. In particular, the financier is assumed to be subject to the same limited liability constraints and all transfers from the financier to the entrepreneur need to be payable out of P_1 alone.

The social financial contract is defined as follows. First, it stipulates a stake $\mathcal{R}^S$ for E when P_1 succeeds where $\mathcal{R}^S$ is bounded below by 0 and above by R_1. In addition, the social financial contract stipulates a bonus $\mathcal{R}^{2S}$ for E bounded below by 0 and above by $R_1 - \mathcal{R}^S$, to be paid when both P_1 and P_2 succeed. This is summarized in definition 3.

Definition 3. *A social financial contract is a pair* $\left(\mathcal{R}^{2S}, \mathcal{R}^S\right)$, *where* $\mathcal{R}^S$, $0 \leq \mathcal{R}^S \leq R_1$ *is a payment E receives conditional on the success of P_1 and where* $\mathcal{R}^{2S}$, $0 \leq \mathcal{R}^S + \mathcal{R}^{2S} \leq R_1$ *is a bonus E receives conditional on the success of P_1 and P_2.*

The argument showing how a social financial contract can emerge in equilibrium as the solution to the credit constrained problem described above, will proceed in two steps:

First, as a function of the model parameters, the cheapest contract incentivizing both financial and externality effort and satisfying the limited liability constraints will be derived. Cheapest here is viewed from the perspective of the financier and therefore refers to the incentive compatible contract implying he lowest expected payment to E. If the financier

can break even under the cheapest social financial contract, then it is feasible for E to obtain financing.

Secondly, if there is a parameter configuration for which E is credit constraint under a standard financial contract but which allows financing under a social financial contract, then the social financial contract will be said to emerge naturally as a potential solution to the credit constraint problem. In particular, from the previous section we know that if the following condition holds

$$R_1 < \frac{I}{p_L + \Delta} + \left(1 + \frac{(1 - (p_L + \Delta)) \, p_L}{(1 - \Delta) (p_L + \Delta) + \Delta (1 - (p_L + \Delta))}\right) \frac{B}{\Delta},$$

then E can not obtain financing under a standard financial contract. However, if for a parameter configuration satisfying the above condition there exists a feasible social financial contract, then it will be said that the social financial contract can solve the credit constraint problem.

In order to identify the cheapest feasible social financial contract, the following constrained optimization program needs to be solved.

$$\min_{\mathcal{R}^{2s}, \mathcal{R}^{S} \geq 0} (p_L + \Delta) (p_L + \Delta) \left(\mathcal{R}^{2S} + \mathcal{R}^{S}\right) + (p_L + \Delta) (1 - (p_L + \Delta)) \mathcal{R}^{S}$$

subject to

$$(2p_L + \Delta) \mathcal{R}^{2S} + \mathcal{R}^S \geq \frac{B}{\Delta} + \frac{B}{\Delta} \qquad (IC_1^{sf})$$

$$(p_L + \Delta) \mathcal{R}^{2S} + \mathcal{R}^S \geq \frac{B}{\Delta} \qquad (IC_2^{sf})$$

$$(p_L + \Delta) \mathcal{R}^{2S} \geq \frac{B}{\Delta} \qquad (IC_3^{sf})$$

$$(p_L + \Delta)(p_L + \Delta) \mathcal{R}^{2S} + (p_L + \Delta) \mathcal{R}^S \leq (p_L + \Delta) R_1 - I \qquad (IR_1^{sf})$$

$$(p_L + \Delta)(p_L + \Delta) \mathcal{R}^{2S} + (p_L + \Delta) \mathcal{R}^S \geq 2B \qquad (IR_1^{sf})$$

$$\mathcal{R}^{2S} + \mathcal{R}^S \leq R_1 \qquad (LL_1^{sf})$$

$$\mathcal{R}^S \leq R_1 \qquad (LL_2^{sf})$$

The first thing to note is that in order for there to be a solution to the above optimization program, we need the following assumption on the parameters of the model

Assumption 3.6.

$$R_1 \geq \frac{I}{p_L + \Delta} + \frac{2(p_L + \Delta)}{2p_L + \Delta} \frac{B}{\Delta}.$$

If 3.6 is violated, then the IC_1^{sf} and IR_1^{sf} constraints contradict each other and there doesn't exist a contract $\left(\mathcal{R}^{2S}, \mathcal{R}^S \right)$ which satisfies the social financial contract constraint set. Intuitively, if R_1 is too low, then P_1 does not generate sufficient revenues to allow the financier to break even after having incentivized E through positive stakes in the cash flow generated by P_1.

Secondly, the solution to the optimization program turns out to depend on wether R_1 is larger than or smaller than $\frac{1}{p_L + \frac{\Delta}{2}}$. If R_1 exceeds $\frac{1}{p_L + \frac{\Delta}{2}}$, then incentives for high financial and high externality effort can be provided through a contract which only rewards E_1 when both projects succeed.

If R_1 is strictly less than $\frac{1}{p_L + \frac{\Delta}{2}}$ however, then the financier has to see whether he can provide

incentives through a contract specifying both a non-negative payment $\mathcal{R}^S$ and bonus $\mathcal{R}^{2S}$.

Intuitively, since the ultimate goal is to incentivize effort on both dimensions, the strongest incentives will be provided through a contract stipulating a non-zero payment only when both P_1 and P_2 succeed. However, if all incentives are provided through a reward in a single state, the payment in this state, $\mathcal{R}^{2S}$, needs to be relatively high in order to satisfy the individual rationality constraints and P_1 may not generate sufficient resources to allow for such high-powered incentive payment. In this case, part of the incentives need to be provided through a non-negative payment when P_1 alone succeeds.

When R_1 becomes too low however, even a social financial with a non-negative payment $\mathcal{R}^S$ will not be feasible and the financier will not be able to finance P_1 through a contract incentivizing high effort on both the financial and externality dimension.

The cheapest feasible social financial contract and its expected cost as a function of R_1 are given respectively by proposition 3.4 and 3.2.

Proposition 3.4. *The social financial contract,* $\left(\mathcal{R}^{2S}, \mathcal{R}^S\right)$, *implying the lowest expected transfer for entrepreneur 1 is given as follows.*

- ***For*** $R_1 \geq \frac{1}{p_L + \frac{\Delta}{2}} \frac{B}{\Delta}$,

$$\mathcal{R}^{2S} = \frac{1}{p_L + \frac{\Delta}{2}} \frac{B}{\Delta}, \ \mathcal{R}^S = 0.$$

- ***For*** $\overline{M} \equiv \max\left\{2\frac{B}{\Delta} + \frac{1-(2p_L+\Delta)}{p_L+\Delta}\frac{B}{\Delta}, 2\frac{B}{\Delta} + \frac{1-(2p_L+\Delta)}{1-(p_L+\Delta)}\frac{I}{p_L+\Delta}\right\} \leq R_1 < \frac{1}{p_L+\frac{\Delta}{2}}\frac{B}{\Delta}$ ***and*** $2p_L + \Delta < 1$.

$$\mathcal{R}^{2S} = \frac{1}{1 - (2p_L + \Delta)}\left(R_1 - 2\frac{B}{\Delta}\right), \ \mathcal{R}^S = \frac{1}{1 - (2p_L + \Delta)}\left(2\frac{B}{\Delta} - (2p_L + \Delta) R_1\right).$$

- **Otherwise**

There is no feasible social financial contract.

Proof. See technical appendix. □

Corollary 3.2. *The **expected cost** of the social financial contract, $\left(\mathcal{R}^{2S}, \mathcal{R}^{S}\right)$, implying the lowest expected transfer for the entrepreneur is given as follows.*

- **For** $R_1 \geq \frac{1}{p_L + \frac{\Delta}{2}} \frac{B}{\Delta}$,

$$\frac{2\left(p_L + \Delta\right)^2}{2p_l + \Delta} \frac{B}{\Delta}.$$

- **For** $\overline{M} \equiv \max\left\{2\frac{B}{\Delta} + \frac{1-(2p_L+\Delta)}{p_L+\Delta}\frac{B}{\Delta}, 2\frac{B}{\Delta} + \frac{1-(2p_L+\Delta)}{1-(p_L+\Delta)}\frac{I}{p_L+\Delta}\right\} \leq R_1 < \frac{1}{p_L+\frac{\Delta}{2}}\frac{B}{\Delta}$ **and** $2p_L + \Delta < 1$.

$$\frac{(p_L + \Delta)}{1 - (2p_L + \Delta)}\left(2\left(1 - (p_L + \Delta)\right)\frac{B}{\Delta} - p_L R_1\right).$$

- **Otherwise**

There is no feasible social financial contract.

Proof. See technical appendix. □

In order to provide more insight in the social financial contract, its expected cost is graphed
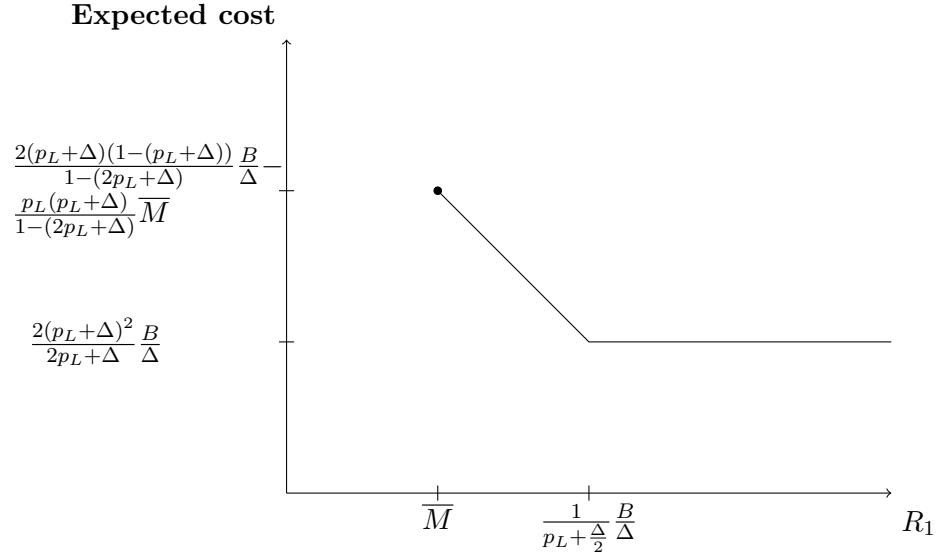
in figure 3.3.

Expected cost

The y-axis labels:
$$\frac{2(p_L+\Delta)(1-(p_L+\Delta))}{1-(2p_L+\Delta)}\frac{B}{\Delta}$$
$$\frac{p_L(p_L+\Delta)}{1-(2p_L+\Delta)}\overline{M}$$

$$\frac{2(p_L+\Delta)^2}{2p_L+\Delta}\frac{B}{\Delta}$$

The x-axis labels: $\overline{M}$, $\frac{1}{p_L+\frac{\Delta}{2}}\frac{B}{\Delta}$, R_1

Figure 3.3: Expected cost social financial contract

Figure 3.3 clearly indicates that the expected cost of the social financial contract is (weakly) decreasing in R_1, the revenues generated when P_1 succeeds. Indeed, the cheapest way to provide incentives for both financial and externality effort is by granting E a positive payment only when both P_1 and P_2 succeed and nothing otherwise. Such a contract is feasible for $R_1 \geq \frac{1}{p_L+\frac{\Delta}{2}}\frac{B}{\Delta}$.

The assumption of limited liability however may prevent a contract which piles all incentives in a single state to be feasible when R_1 is relatively low, i.e. when $R_1 < \frac{1}{p_L+\frac{\Delta}{2}}\frac{B}{\Delta}$. In this case, the financier needs to shift rewards from the state in which both projects succeed to the state in which P_1 succeeds but P_2 fails. That is, $\mathcal{R}^S$ becomes strictly positive.

Providing incentives when the limited liability constraint binds however can be seen to be more costly as the expected cost of the incentive contract increases as R_1 falls below $\frac{1}{p_L+\frac{\Delta}{2}}\frac{B}{\Delta}$.

Finally, for $R_1 < \overline{M}$, there is no more feasible social financial contract and the financier can not finance P_1 while incentivizing both financial and externality effort.

Social financial contract as a solution to the credit constraint problem After having characterized the social financial contract we can now turn to an analysis of the conditions under which it can solve the credit constraint problem identified above. To make the exposition as clear as possible, a graphical analysis will be carried out which identifies the conditions under which a project is credit constrained or not and when it can be financed through a social financial contract.

These conditions are captured by the following set of bounds on the model parameters and summarize the findings of the above sections.

$$R_1 < \frac{I}{p_L + \Delta} + \left(1 + \frac{(1 - (p_L + \Delta)) \, p_L}{(1 - \Delta) \, (p_L + \Delta) + \Delta \, (1 - (p_L + \Delta))}\right) \frac{B}{\Delta}. \tag{CC}$$

$$R_1 \geq \frac{I}{p_L + \Delta} + \frac{2 \, (p_L + \Delta)}{2p_L + \Delta} \frac{B}{\Delta} \tag{EB}$$

$$R_1 \geq \frac{1}{p_L + \frac{\Delta}{2}} \frac{B}{\Delta}, . \tag{LB_1}$$

$$\overline{M} \equiv \max \left\{ 2\frac{B}{\Delta} + \frac{1 - (2p_L + \Delta)}{p_L + \Delta} \frac{B}{\Delta}, 2\frac{B}{\Delta} + \frac{1 - (2p_L + \Delta)}{1 - (p_L + \Delta)} \frac{I}{p_L + \Delta} \right\} \leq R_1 < \frac{1}{p_L + \frac{\Delta}{2}} \frac{B}{\Delta} \tag{LB_2}$$

and $2p_L + \Delta < 1$.

First, the CC bound reflects when P_1 is credit constrained under standard financial contracts. Then, if the credit constraint problem is to be resolved through a social financial contract the existence bound EB needs to be satisfied. Finally, the project can ultimately be financed through a social financial contract if it satisfies either the bound LB_1 or LB_2. In the former case the social financial contract paying off only when both P_1 and P_2 succeed is feasible, in the latter case the social financial contract pays of in the state in which only P_1 succeeds as well.

Figures 3.4, 3.5 and 3.6 now display the bounds on R_1 as a function of one of the model
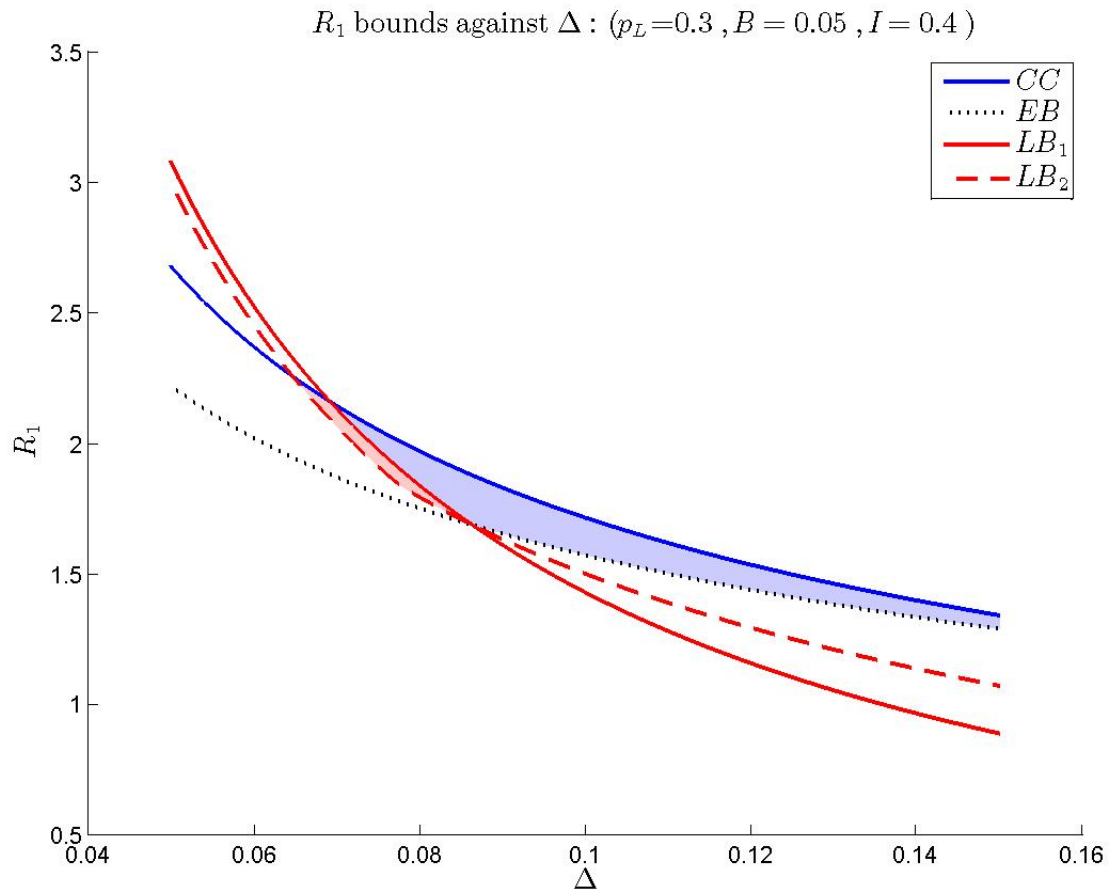
123

parameters.

Figure 3.4: R_1 bounds against Δ.

Figure 3.4 first plots the R_1 bounds against Δ.

Δ represents the extent to which shirking on either financial or externality effort can be detected by observing the projects' outcomes. As such it is inversely related to the severity of moral hazard in the model. That is, the larger Δ, the less severe is the moral hazard problem in the model and this is reflected in the downward slope of the CC, EB, LB_1 and LB_2 bounds. [7]

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[7]As was commented above, Δ drives both the moral hazard problem for financial and externality effort in the model. This assumption greatly simplifies the analytical exposition of the model and comes at little loss of generality in terms of comparative statics results. In particular, if shirking on either financial or externality effort is harder to detect, i.e. lower Δ, then the credit constraint problem will appear for a

In the graph, the blue and red shaded areas represent those credit constrained projects which can obtain financing through a social financial contract. First, the blue shaded area represents the credit constrained projects that are profitable enough to be financed through a social financial contract which concentrates all rewards in the state in which both P_1 and P_2 are successful.

Secondly, the red shaded area represents the credit constrained projects which are not profitable enough to be financed through a social financial contracting all rewards in the double success state, but which can be financed through a social financial contract which also rewards success of P_1 alone.

Figure 3.4 shows that as Δ increases, both the blue and red shaded area come to represent projects with lower R_1. This is because the credit constraint problem first of all becomes less severe and only poorer projects become struck by it, but also because the solution in the form of social financial contracts becomes feasible for projects with a lower R_1. Overall, as Δ increases, social financial contracts can be expected to appear for projects with a lower payoff R_1.

In figure 3.5, the R_1 bounds are plotted against B.

The logic here is very similar to that of figure 3.4 since B is also a direct measure of the severity of the moral hazard problem. The larger is B, the larger the private benefits from shirking and hence the larger the incentive payments needed to ensure that the entrepreneur

wider range of projects and the social financial contract will be less likely to appear as a solution to the credit constraint problem. To see this, first note that when financial effort is harder to detect then P_1 is all else equal harder to finance because the entrepreneur needs to retain a larger fraction in his project in order not to shirk on financial effort. This then reduces the chances that the financier can break even on his project especially in light of the third party's externality contract. A deterioration in the moral hazard problem for financial effort thus increases the chance that the credit constraint problem under standard financial contracts appears. Next suppose externality effort is harder to detect. Then, all else equal, it will be more expensive for the third party to incentivize the entrepreneur using only rewards. The third party's incentives for using penalties then increases which again increases the chance that the credit constraint problem appears. Finally, the social financial contract incentivizes both financial and externality effort at the same time and therefore becomes more expensive if either type of effort is harder to observe. If the social financial contract becomes more expensive, it becomes less likely that it can serve as a solution to the credit constraint problem.
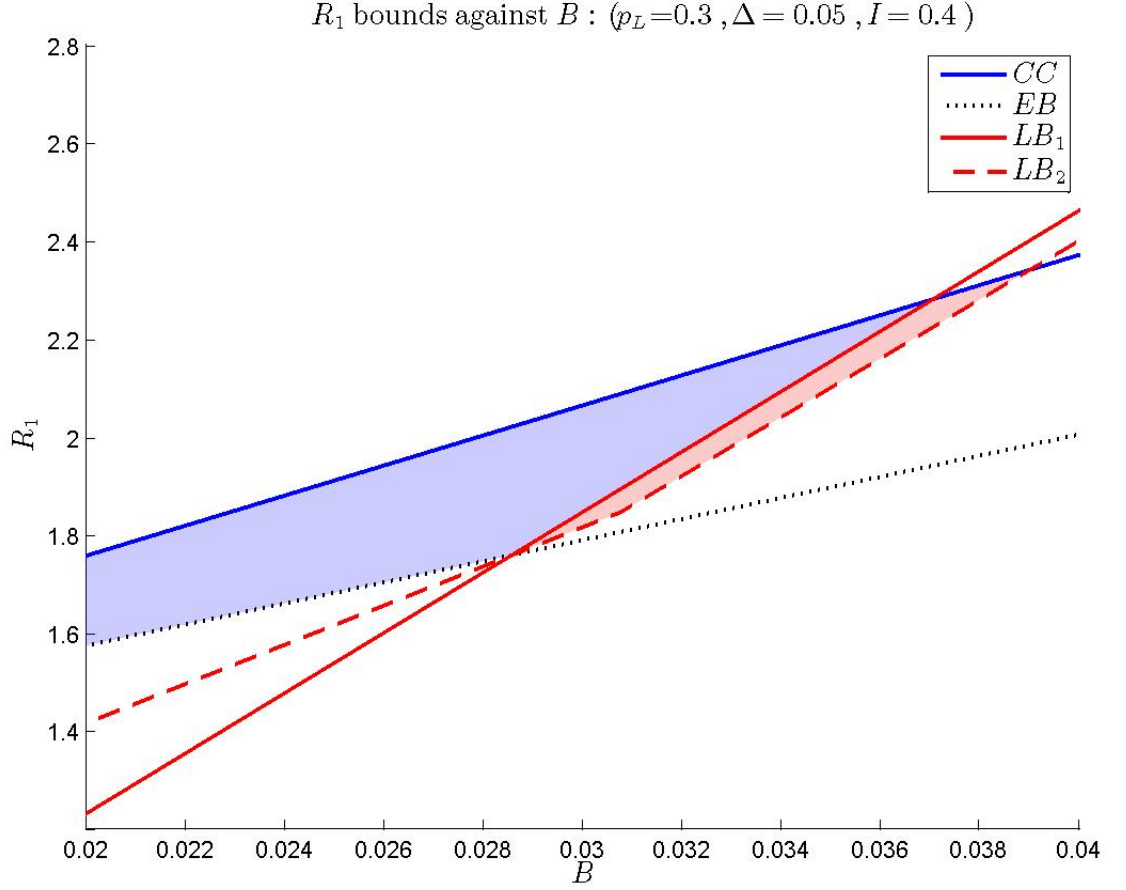
Figure 3.5: R_1 bounds against B.

exerts either financial or externality effort.[8]

We see the same pattern appearing as for figure 3.4 in that as the moral hazard problem worsens only projects with relatively higher R_1 can be expected to be financed through social financial contracts.

Furthermore we see that for low B, the credit constraint problem is primarily resolved through a social financial contract with a single state reward concentration. As B increases and the credit constraint problem becomes more severe, the financier can first resort to two state reward social financial contract in order to finance projects with lower R_1's and then

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[8]A similar remark as for Δ applies regarding the introduction of heterogeneity in B.
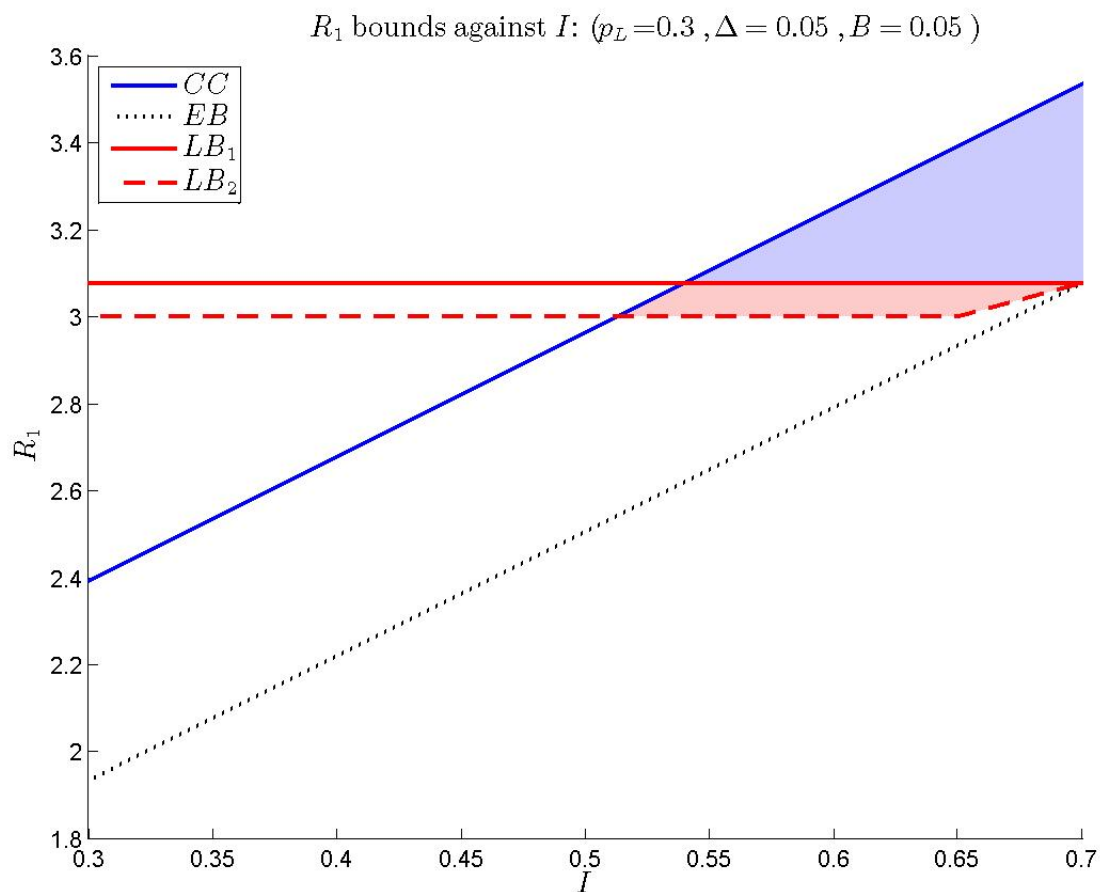
to single state reward contracts for projects with higher R_1's.

Figure 3.6: R_1 bounds against I.

Finally, figure 3.6 plots the R_1 bounds against I.

We see that for low I only projects with low R_1 are credit constrained. At the same time however, these projects can not obtain financing through a social financial contract to solve the credit constraint problem.

Only when I increases and the credit constraint problem worsens will financing be able to be provided to credit constrained projects through a social financial contract. In fact social financial contracts of both types are observed in equilibrium: contracts which pay-off only in one state and contracts which pay-off in two states.

3.2.4. Empirical implications

The model in the paper leads to two main empirical predictions regarding the use of social financial contracts, both which could be tested empirically in future research.

First, the paper predicts an inverted U-shape relationship between a project's financial performance, as defined by the revenues it generates, and the extent to which a project is financed through a social financial contract. In particular, the model results indicate that a project needs to be sufficiently poor in order not to be financeable through a standard financial contract, yet sufficiently rich so that it can be financed through a social financial contract.

Anecdotal evidence seems to back this prediction. In particular, impact investors often claim that their actions provide financing to projects which traditional investors are not willing to fund either because they are too small or not profitable enough. This may hint at a credit constraint problem for poorer projects in line of what was identified in the model. Though the model predicts that any investor may then provide financing through a social financial contract, in reality it might be that some level of expertise is needed in order to offer social financial contracts. Impact investors may then step up to the plate and solve the credit constraint problem by financing certain projects through a social financial contract.

Secondly, in the discussion of the model it was emphasized that the results in the paper rely on the presence of a third party agent with strong bargaining power. The strong bargaining position of the third party is necessary in the model in order to allow him to provide incentives through penalties and minimize the rents flowing to the entrepreneur. In addition, it was suggested in the paper that the strong bargaining power can originate from a variety of sources ranging from social pressure from the local community or the entrepreneur's social network but also pressure groups which support the third party's cause.

All else equal, the model then suggests that social financial contracts might be expected to

be observed more often when well organized pressure groups backing the third party agent are present or when the entrepreneur himself is strongly embedded in the third party's local community. In addition, membership of the entrepreneur to various social organizations might also suggest whether a relatively poor entrepreneur may need to resort to social financial contracts in order to obtain financing for his project. Though such data might not be easy to come by, it would be interesting to find proxies for the above variables and test the relationship between impact investing on the one hand and social pressure and pressure groups on the other.

3.3. Conclusion

Why do we sometimes observe investors providing firms or entrepreneurs with incentives to deliver a social or environmental impact through financial contracts? Two motivations have traditionally been put forward for the existence of what can be called social financial contracts.

First, to the extent that there is a direct positive link between a firm's financial and its social or environmental performance, firms that do good may also be expected to do well. Under this logic, investors who prioritize on financial performance have an immediate interest in ensuring that firms pay sufficient attention to their social or environmental impact. Impact investing can then be viewed as a new asset class which may deliver attractive returns.

Secondly, in the absence of such a direct link, impact investing may be driven by investors with altruistic motives. In particular, to the extent that delivering a positive social or environmental impact is costly, it is not trivial that firms would have the necessary incentives in place to exert positive externalities. Investors can put these incentives in place, but this is likely to be a costly activity and only altruistic motives may be able to explain why these investors are willing to accept a lower return on investment.

This paper however advances a third reason for why we might observe social financial contracts. In particular, social financial contracts solve a credit constraint problem caused by ex-post contracting between a firm which can exert a positive externality and a third party agent benefitting from it.

In particular, if the entrepreneur does not have a direct interest in the positive externality, he will need outside incentives to deliver it. The third party agent can provide these incentives, but the paper shows that he may interfere with the incentives for financial effort put in place by the financier financing the entrepreneur's project. In particular, if the financier is restricted to using standard financial contracts, he may not be able to prevent the third party agent from disincentivizing the entrepreneur for making financial effort. If

the financier can not break even when the entrepreneur shirks on financial effort, he will not be willing to finance the entrepreneur's project. The entrepreneur is said to be credit constrained under standard financial contracts.

A social financial contract can solve this problem because it removes the need for ex-post externality contracting. In particular, through a social financial contract the financier puts incentives in place not only for financial effort but also for the third party agent to deliver the social or environmental impact. The feasibility of such a contract however relies on the entrepreneur's project being sufficiently profitable.

The main empirical prediction this paper makes is then that impact investing can be expected to be observed for projects which are neither too rich, so that they are struck by the credit constraint problem under standard financial contracts, and neither too poor, so that financing is still feasible under a social financial contract.

APPENDIX A

A.1. Proof proposition 2.1

Proof. Using the expressions for the share demands of the different investor classes, we obtain the equilibrium condition for trading in the financial market,

$$
\lambda^T n\gamma \left(\tau_\epsilon \widetilde{\Theta} + \tau_P \left(\frac{\widetilde{P} - q_0}{q_1} \right) - (\tau_\Theta + \tau_\epsilon + \tau_P) \widetilde{P} \right)
$$

$$
- \rho n \widetilde{z}
$$

$$
= \Omega.
$$

By collecting terms on the different random variables and a constant we can rewrite this as,

$$
- \frac{\Omega}{\gamma n} - \lambda^T \tau_P \frac{q_0}{q_1}
$$

$$
+ \lambda^T \tau_\epsilon \widetilde{\Theta}
$$

$$
- \frac{\rho}{\gamma} \widetilde{z}
$$

$$
= \left[\tau_\Theta + \tau_\epsilon + \tau_P - \lambda^T \tau_P \frac{1}{q_1} \right] \widetilde{P}.
$$

By matching coefficients with the conjectured price we can then solve for the equilibrium price coefficients,

- q_1

$$q_1 = \lambda^T \tau_\epsilon \left[\tau_\Theta + \tau_\epsilon + \tau_P - \lambda^T \tau_P \frac{1}{q_1} \right]^{-1}$$

$$\Leftrightarrow q_1 = \frac{\lambda^T \tau_\epsilon + \lambda^T \tau_P}{\tau_\Theta + \tau_\epsilon + \tau_P}$$

- $\frac{q_2}{q_1}$

$$\frac{q_2}{q_1} = -\frac{\rho}{\gamma \lambda^T \tau_\epsilon}$$

- $\frac{q_2}{q_1}$ and q_1 then determine q_2.

- q_0

$$q_0 = -\left(\frac{\Omega}{\gamma n} + \lambda^T \tau_P \frac{q_0}{q_1} \right) \left[\tau_\Theta + \tau_\epsilon + \tau_P - \lambda^T \tau_P \frac{1}{q_1} \right]^{-1}$$

$$\Leftrightarrow q_0 = -\frac{\Omega}{\gamma n \left[\tau_\Theta + \tau_\epsilon + \tau_P \right]}$$

$\square$

A.2. Proof proposition 2.3

Proof. Using the expressions for the share demands of the different investor classes, we obtain the equilibrium condition for trading in the financial market,

$$\lambda^{TI} n\gamma \left(\tau_\epsilon \widetilde{\Theta} + \tau_P^I \left(\frac{\widetilde{P} - p_0 - p_2 \widetilde{\Xi}}{p_1} \right) - \left(\tau_\theta + \tau_\epsilon + \tau_P^I \right) \widetilde{P} \right)$$

$$+\lambda^{TU} n\gamma \left(\tau_\epsilon \widetilde{\Theta} + \tau_P^U \left(\frac{\widetilde{P} - p_0 - p_2 \mu_H}{p_1} \right) - \left(\tau_\theta + \tau_\epsilon + \tau_P^U \right) \widetilde{P} \right)$$

$$+\lambda^S n\gamma \left(\tau_\epsilon \widetilde{\Theta} + \tau_P^I \left(\frac{\widetilde{P} - p_0 - p_2 \widetilde{\Xi}}{p_1} \right) + \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right) \phi \widetilde{\Xi} - \left(\tau_\theta + \tau_\epsilon + \tau_P^I \right) \widetilde{P} \right)$$

$$-n\rho\widetilde{z}$$

$$=\Omega$$

By collecting terms on the different random variables and a constant we can rewrite this as,

$$-\frac{\Omega}{\gamma n} - \left[\left(\left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U \right) \frac{p_0}{p_1} + \lambda^{TU} \tau_P^U \frac{p_2}{p_1} \mu_H \right]$$

$$+\tau_\epsilon \widetilde{\Theta}$$

$$+\left(-\left(\lambda^{TI} + \lambda^S \right) \tau_P^I \frac{p_2}{p_1} + \lambda^S \phi \left(\tau_\Theta + \tau_\epsilon + \tau_P^I \right) \right) \widetilde{\Xi}$$

$$-\frac{\rho}{\gamma} \widetilde{z}$$

$$=\left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U - \left(\left(\lambda^{TI} + \lambda^S \right) \tau_P^I + \lambda^{TU} \tau_P^U \right) \frac{1}{p_1} \right] \widetilde{P}$$

By matching coefficients with the conjectured price we can then solve for the equilibrium price coefficients,

- $\frac{p_2}{p_1}$

$$\frac{p_2}{p_1} = \frac{1}{\tau_\epsilon}\left(-\left(\lambda^{TI} + \lambda^S\right)\tau_P^I \frac{p_2}{p_1} + \lambda^S \phi\left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)\right)$$
$$\Leftrightarrow \frac{p_2}{p_1} = \frac{\phi\lambda^S\left(\tau_\Theta + \tau_\epsilon + \tau_P^I\right)}{\tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I}$$

- $\frac{p_3}{p_1}$

$$\frac{p_3}{p_1} = -\frac{\rho}{\gamma\tau_\epsilon}$$

- p_0

$$p_0 = \left[-\frac{\Omega}{\gamma n} - \left(\left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U\right)\frac{p_0}{p_1} - \lambda^{TU}\tau_P^U \frac{p_2}{p_1}\mu_H\right] \times$$
$$\left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U - \left(\left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U\right)\frac{1}{p_1}\right]^{-1}$$
$$\Leftrightarrow p_0 = -\frac{\Omega}{\gamma n\left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U\right]} - \frac{\lambda^{TU}\tau_P^U\mu_H}{\left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U\right]}\frac{p_2}{p_1}$$

- p_1

$$p_1 = \tau_\epsilon\left[\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U - \left(\left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U\right)\frac{1}{p_1}\right]^{-1}$$
$$\Leftrightarrow p_1 = \frac{\tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U}{\tau_\Theta + \tau_\epsilon + \left(\lambda^{TI} + \lambda^S\right)\tau_P^I + \lambda^{TU}\tau_P^U}$$

$$\square$$

APPENDIX B

B.1. Financial contracting with penalty: $\left(R^S, R^F\right)$

In this appendix it is shown that if the financier is allowed to collateralize the externality contract, he can offer a financing contract which ensures that TP will offer E a social externality contract. If TP offers a social externality contract, then the financier for sure will finance E.

In order to make the argument, an additional assumption needs to be made on the profitability of P_2. In particular, P_2 will need to be sufficiently profitable to allow the financing contract which will be suggested below to indeed lead TP to be able to offer the social externality contract. This assumption significantly simplifies the exposition without affecting the main point the paper seeks to make.

As has been argued in the paper, since both the financier and E obtain the same expected utility under the financing contract which collateralizes the externality contract and under the social financial contract, both contracts can appear in equilibrium.

Consider now a financial contract which can collateralize the externality contract. Such a contract is a pair, $\left(R^S, R^F\right)$, where R^S is a stake in the success of P_1 and R^F a penalty when P_1 fails but P_2 succeeds. In order to show that the credit constraint problem disappears, it suffices to show that the financier can stipulate a contract which E will accept and which will lead TP to offer a social externality contract with probability one.

Consider the following financing contract

$$R^S = 0, \ R^F \geq \frac{1}{p_L + \Delta}\left(\frac{B}{\Delta} + \epsilon\right), \tag{A_1}$$

where $\epsilon > 0$ and small.

First, it will be shown that the non-social externality contract is not feasible for TP by focussing on one of the incentive compatibility constraints and one of the limited liability constraints which define a non-social externality contract.

In particular, in order for a non-social externality contract to be incentive compatible, E has to prefer to shirk on the financial dimension and exert effort on the externality dimension over exerting effort on both dimensions. That is, he needs to prefer $e_a = 0$, $e_b = 1$ over $e_a = 1$, $e_b = 1$.

Conditional on a contract $\left(R^S, R^F \right)$, this incentive constraint can be written as

$$r^F \geq \frac{1}{1 - (p_L + \Delta)} \left(R^S - \frac{B}{\Delta} \right) + \frac{p_L + \Delta}{1 - (p_L + \Delta)} R^F. \qquad (A_2)$$

In addition, in order for a non-social externality contract to be feasible the penalty r^F needs to be restricted by the stake R^S, E has in P_1. This is because under the assumption of limited liability, E can only be penalized in the externality contract to the extent that the finance contract stipulates a positive stake R^S. In particular,

$$r^F \leq R^S. \qquad (A_3)$$

If we now plug in financial contract A_1 in the incentive compatibility constraint A_2 and the limited liability constraint A_3, they can be rewritten as respectively

$$r^F \geq \frac{1}{1 - (p_L + \Delta)} \left(0 - \frac{B}{\Delta} \right) + \frac{p_L + \Delta}{1 - (p_L + \Delta)} \frac{1}{p_L + \Delta} \left(\frac{B}{\Delta} + \epsilon \right) \qquad (A_2)$$
$$r^F \geq \frac{\epsilon}{1 - (p_L + \Delta)} > 0.$$

and

$$r^F \leq 0. \tag{A_3}$$

In other words, the incentive compatibility constraint A_2 requires r^F to be strictly greater than 0, while the limited liability constraint A_3 requires r^F to be no greater than 0. Clearly, the incentive compatibility constraint A_2 and the limited liability constraint A_3 contradict each other. Therefore, TP can not offer a non-social externality contract if the financier offers a financing contract A_1.

The social externality contract on the other hand is feasible as long as P_2 is sufficiently profitable. Otherwise, TP will prefer not to write any externality contract at all.

The cheapest social externality contract TP can offer in response to the finance contract can be shown to be a contract

$$r^S = \frac{1+\Delta}{p_L + \Delta} \frac{B}{\Delta}, r^F = 0. \tag{A_4}$$

This contract satisfies all constraints of a social externality contract provided that P_2 is sufficiently profitable. In particular R_2 needs to satisfy the following condition,

$$R_2 \geq \left(\frac{1+\Delta}{\Delta}\right) \frac{B}{\Delta}.$$

As indicated above, to simplify the exposition of the arguments in the paper, it will be assumed that this condition holds.

Assumption B.1.
$$R_2 \geq \left(\frac{1+\Delta}{\Delta}\right) \frac{B}{\Delta}$$

What now remains to be shown however is that E and the financier are willing to sign financing contract A_1. For the financier it is clear that such a contract allows him to break even since the contract only consists of a penalty. It is not so clear however that E will accept such a contract. E will accept the contract however through the expected revenue he expects to get from the externality contract offered by TP.

If E refuses the contract, he remains with his outside option of shirking on both tasks since he can't contract with TP if he does not have his project. This leaves him a utility of $2B$.

If E accepts the offer from the financier, he essentially accepts the penalty stipulated for failure in the financing contract and the expectation of contracting with TP for the externality.

In total, the expected utility of E is given by

$$\left(2 + \frac{p_L}{\Delta}\right) B.$$

Since this exceeds $2B$, E can be expected to accept the financier's offer.

B.2. Externality contracting with bonus: $\left(r^{2S}, r^S, r^F\right)$

In this section it will be argued that TP needs to be limited in offering a contract of the form $\left(r^S, r^F\right)$ in order for the credit constraint problem to appear. In particular, if TP has the contractual freedom to offer a contract $\left(r^{2S}, r^S, r^F\right)$, which allows for a payment r^{2S} conditional on the success of both P_1 and P_2, then the credit constraint problem disappears under the assumptions made in the paper.

In order to make the argument, it suffices to focus on the case in which the social externality constraint does not bind at E's individual rationality constraint. This is the case in which E walks away with some rents from P_2 when contracting with TP.

The reason for this is that if both the social and non-social externality contract were to bind

at their respective individual rationality constraints for E, the social externality contract would automatically be cheaper. This results from the fact that if the non-social externality contract is offered, TP always has to compensate E for any loss in expected utility from accepting a contract which removes his incentives to exert high effort. The social externality contract does not suffer from this drawback.

In particular, E's individual rationality constraint for the social contract binds at B, while for the non-social contract it binds at $\Delta R^S > B$ for $R^S > \frac{B}{\Delta}$. As was argued above, the financier needs to set $R^S \geq \frac{B}{\Delta}$ for there to be any chance that the social externality contract dominates the non-social contract.

Consider now the region of R^S for which the social externality contract fails to bind at E's individual rationality constraint. This region is given by

$$\frac{B}{\Delta} \leq R^S \leq \frac{B}{\Delta} - \frac{p_L}{1-(p_L+\Delta)}\left(R_2 - \frac{(1-p_L)}{p_L+\Delta}\right)\frac{B}{\Delta},$$

where

$$1 \geq 2p_L + \Delta$$

and

$$R_2 < \frac{(1-p_L)}{p_L+\Delta}.$$

For this parameter region, the expected cost of the social externality contract is given by

$$\frac{(p_L+\Delta)\left(1-(p_L+\Delta)\right)}{1-(2p_L+\Delta)}\frac{B}{\Delta} - \frac{p_L\left(p_L+\Delta\right)}{1-(2p_L+\Delta)}R_2 - \frac{(p_L+\Delta)\left(1-(p_L+\Delta)\right)}{1-(2p_L+\Delta)}\left(R^S - \frac{B}{\Delta}\right),$$

while the expected cost of the non-social externality contract is given by

$$B + \Delta\left(R^S - \frac{B}{\Delta}\right).$$

From the above we see that in order for the social externality contract not to break even, R_2 needs to satisfy an upper bound. This upper bound is given by,

$$R_2 < \frac{(1 - p_L)}{p_L + \Delta}.$$

However in appendix B.1 assumption B.1 states that,

$$R_2 \geq \frac{1 + \Delta}{\Delta} \frac{B}{\Delta}.$$

It is now easy to show that these two conditions contradict each other since,

$$\frac{1 + \Delta}{p_L + \Delta} \frac{B}{\Delta} > \frac{1 - p_L}{p_L + \Delta} \frac{B}{\Delta}$$

$$\Leftrightarrow p_L + \Delta + p_L \Delta + \Delta^2 > \Delta - \Delta p_L$$

$$\Leftrightarrow p_L + p_L \Delta + \Delta^2 > -\Delta p_L$$

Therefore, under the lower bound on R_2 assumed in the paper, TP can always offer a social externality contract for which E's individual rationality constraint binds. This will imply that the social externality contract will always be chosen by TP and will prevent the credit constraint problem from occurring. As was mentioned in the paper, the assumption that TP can't include a conditional payment r^{2S} in his contract can be justified by arguing that complexity and writing costs prevent TP from writing a contract which conditions payments both on the success of P_1 and P_2.

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