A Theory of Voluntary Disclosure and Cost of Capital

by

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ABSTRACT

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This dissertation explores the links between firms' voluntary disclosures and their cost of capital. I relate the differences in costs of capital between disclosing and non-disclosing firms to disclosure frictions and equity risk premia. Specifically, I show that firms that voluntary disclose their information have a lower cost of capital than firms that do not disclose. I also examine the extent to which reductions in cost of capital map onto improved risk-sharing and/or greater productive efficiency. I prove that high (low) disclosure frictions lead to overinvestment (underinvestment) relative to first-best. Economic efficiency decreases as the disclosure friction increases due to inefficient production in an underinvestment equilibrium. As the disclosure friction continues to increase, the equilibrium switches to overinvestment and further increases in the disclosure friction improve risk-sharing. Importantly the relation between average cost of capital and economic efficiency is ambiguous. A decrease in average cost of capital in the economy only implies an increase in economic efficiency if there is overinvestment.

CHAPTER I

Overview of Current Findings

Recently, the relation between corporate disclosure and cost of capital has received considerable attention among academics and regulators. Disclosure can refer either to mandatory or voluntary release of information about firms' financial positions and performance. The cost of capital is the minimum return demanded by investors to invest in a new project. Mandatory disclosures guide the content of financial statements, footnotes, management discussion and analysis among other regulatory filings. However because mandatory disclosures seem to be unsatisfactory, investors, financial markets and other key stakeholder encourage companies to voluntarily provide more comprehensive information about their long-term strategies and performance. As a response firms communicate voluntarily more and more information through press releases, management forecasts, their websites and conference calls. The Financial Accounting Standard Board, as well, urges firms to engage in more voluntary disclosures and has stressed the importance of reporting operational indicators, forward-looking data, and intangible assets in disclosures made by companies.[1] The common denominator in disclosure seems to be a desire for better quality and transparency. The cost of capital is used to measure the effects of disclosures. Empirical researchers

[1] In 2001, the Financial Accounting Standards Board (FASB) issued a special project report entitled "Insights into enhancing voluntary disclosures" to promote voluntary disclosures.

as well as regulators usually posit a negative relation between more disclosures and the cost of capital.

The purpose of this section is to explore the connections between disclosures and the cost of capital from an analytical point of view and to confront the theory with empirical findings. In section 1.1, I review the common beliefs about the relation between disclosures and cost of capital. I challenge them within the asset pricing framework and confront them to the findings in the newly developed analytical literature on cost of capital and the precision of information. In section 1.2, I explore the implications of the voluntary disclosure literature on the cost of capital and solutions to further expand the current theory on cost of capital and disclosure to find support for current and future research on empirical research questions.

1.1 Exogenous Information and Cost of Capital

The asset pricing literature demonstrates that investors investing in firms exposed to higher market risk receive a higher market return. In other words, it establishes a *positive* correlation between market risk and returns. But the impact of more precise information about the firm's cash flows is *ambiguous*. A recent strand of literature connects more precise information (taken as exogenous) to the cost of capital (*Easley and O'Hara* (2004), *Hughes et al.* (2007), *Lambert et al.* (2007,2008), *Christensen et al.* (2008) and *Gao* (2008)). These studies all show that more precise information reduces the cost of capital (on average and ex-post) for all firms in a pure exchange economy. However they *do not predict* cross-sectional results or whether a firm in an economy with more information will necessarily have a lower cost of capital than in an economy without information.

Firm-Specific Cost of Capital and Disclosure

Although analytical studies prove a negative relation between better information and cost of capital at the aggregate level but not an unambiguous relation cross-sectionally or even at the firm level, some members of diverse regulatory institutions view this relation always as unambiguous and believe in a *negative* correlation as illustrated next in the different assertions.

In 2001, the Financial Accounting Standards Board (FASB) in one report on voluntary disclosures[2] claims:

"A company's cost of capital is believed to include a premium for investors' uncertainty about the adequacy and accuracy of the information available about the company. To cite an extreme example, if a company disclosed nothing, its cost of capital, if any was available, would be very expensive. Informative disclosures that help investors interpret companies economic prospects are believed to reduce the cost of capital."

Cynthia Glassman, SEC commissioner, also believes in this negation association in her 2003 speech:[3]

"[...] better disclosure is its own reward. It will reward a company's shareholder value [...]. Perhaps more importantly, withholding information from investors appears to raise the cost of doing business because the market values having more and better information about a company and adds a risk premium if it does not have it."

More recently in 2007, over a meeting between FASB members and Investors Technical Advisory Committee (ITAC) members, [4] Adam Hurwichan, ITAC member and managing member of Calcine Management LLC, also embraces the idea of enhancing transparency of financial statements to reduce the cost of capital:

[2] The FASB issued in 2001 a special project report entitled "Insights into enhancing voluntary disclosures."

[3] Her 2003 speech is entitled "Improving Corporate Disclosure - Improving Shareholder Value."

[4] FASB Investors Technical Advisory Committee's document "Minutes of Meeting" January 11, 2007 provides further details.

"[...] in considering costs and benefits of new standards, [5] *preparers should understand that increased transparency of financial reporting will decrease a reporting entity's cost of capital."*

The beliefs can be reformulated in four statements. To illustrate them, I consider two firms, firm 1 and firm 2. I denote s_1 the signal about firm 1's cash flows. For $j \in \{1,2\}$, $E(R_j|\emptyset)$ and $E(R_j|s_1)$ are respectively the expected return of firm j in an economy without information and with information.

Beliefs 1.

(i) More information about firm 1*'s cash flows does imply a lower cost of capital for firm* 1 *relatively to firm* 2*:*

$$\forall s_1, \quad \mathbb{E}(R_1|s_1) \leq \mathbb{E}(R_2|s_1) \tag{1.1}$$

(ii) If ex-ante firm 1 *and firm* 2 *have the same cost of capital then relation* (1.1) *applies: If* $\mathbb{E}(R_1|\emptyset) = \mathbb{E}(R_2|\emptyset)$ *then relation 1.1 is true.*

(iii) More precise information about firm 1 *does lower its cost of capital:*

$$\forall s_1, \quad \mathbb{E}(R_1|s_1) \leq \mathbb{E}(R_1|\emptyset) \tag{1.2}$$

(iv) Firm 1 *has a lower expected return if and only if its market price has increased:*

$$\forall s_1, \quad \mathbb{E}(R_1|s_1) \leq \mathbb{E}(R_1|\emptyset) \Leftrightarrow \mathbb{E}(V_1|s_1) \geq \mathbb{E}(V_1|\emptyset) \tag{1.3}$$

where V_1 *is the value of firm* 1.

[5] The meeting was meant to discuss several topics including (a) the potential deferral of the effective date of FASB Interpretation No. 48, Accounting for Uncertainty in Income Taxes, (b) fair value accounting for financial instruments, and (c) transition approaches to new accounting standards.

To show that the relation between cost of capital and information at the firm level is not straightforward, I present numerical counterexamples.

Counterexample (i): For example consider two firms. Firm 1 is operating for one period in a cyclical market (e.g., selling cars or investment goods). Its core business pays off an expected cash flow 100 but, because it is cyclical and therefore exposed to systematic risk, it is discounted at rate 10%. Assume that this firm also has a side business which, one may assume, is a nearly acyclical (e.g. maintenance service). This maintenance service pays off an expected cash flow 10, but is discounted at a lower discount rate 6%. The difference in discount rates follows the standard asset pricing model, because the main business has a higher correlation to the market than the side business. In this example, firms are more likely to repair their equipment than purchase new one in a recession (thus the side business pays off more in a recession than in an expansion) and investors, for this reason, value the side business payments with a lower discount rate (for an equal expected payoff, they prefer high payoffs in a recession than in an expansion). In this initial setting, the expected value of the firm 1 is the sum of its two components, $100/1.1 + 10/1.06 = 90.91 + 9.43 = 100.34$. The average cost of capital is then given as: $90.91/100.34 \times 10\% + 9.43/100.34 \times 6\% = 9.62\%$. Now let us consider firm 2, which is only offering the maintenance service and is generating an expected cash flow 9 at the discounted rate 6%. Firm 2 has an expected value of 8.49 and a cost of capital of 6%. Now, assume that for various reasons (e.g., competition, increases in cost, lower demand), firm 1 announces that it will scale down its side business, and thus expects half of the cash flows that were originally expected. The new value of the firm is $100/1.1 + 5/1.06 = 90.91 + 4.72 = 95.63$. The new average cost of capital is then given as: $90.91/95.63 \times 10\% + 4.72/95.63 \times 6\% = 9.80\%$. In response to firm 1's disclosure, its cost of capital increased. Firm 2 at the same time does not revise its expected cash flows. Therefore after firm 1's disclosure, its cost of capital is even lower than Firm 1's cost of capital.

This finding is not surprising as I compare two firms which were not comparable in the first place, as their businesses were different, and as a consequence their costs of capital were different initially.

Counterexample (ii): A more reasonable scenario is to compare the impact of more information on firm 1 when the two firms are comparable pre-disclosure in the businesses where they operate and have also the same cost of capital. To do that I assume that firm 2 has also a core business identical to firm 1. It is generating an expected cash flow of 90. Its value is now equal to $90/1.1 + 9/1.06 = 81.81 + 8.49 = 90.30$. Its average cost of capital is now equal to $81.81\times10\%+8.49\times6\% = 9.62\%$. Thus firm 1 and firm 2 have the same cost of capital. However firm 1 is now announcing a revision of its expected cash flows for its side business down to 5. Thus its cost of capital is 9.8%. However firm 2 does not expect to change its cash flows upward or downward and thus its cost of capital remains 9.62%. Thus firm 1 has a higher cost of capital after disclosing information than another peer firm, which had the same cost of capital pre-disclosure.

Counterexample (iii): Firm 1's cost of capital pre-disclosure is clearly lower than its cost of capital post-disclosure as $9.62\% < 9.80\%$.

Counterexample (iv): I follow the same example with firm 1 before any information but I modify the type of information arriving. I assume that the government is giving subsidies to the car industry and thus the discount rate for both businesses is reduced. The discount rates are 6% for the core business and 3% for the side business. However firm 1 is still revising downward its expected cash flows for its side business. After updating for the new information, investors value firm 1 at $100/1.06 + 5/1.03 = 94.33 + 4.85 = 99.19 < 100.34$. The average cost of capital becomes $94.33/99.19 \times 6\% + 4.85/99.19 \times 3\% = 5.85\% < 9.62\%$. Therefore after disclosure the average cost of capital of firm 1 is lower than pre-disclosure but the market price of the firm is lower as well.

The recent empirical literature find evidence for beliefs (i) and (ii). More specifically *Welker* (1995) and *Sengupta* (1998) analyze firm disclosure rankings given by financial analysts and find that firms rated as more transparent have a lower cost of capital. *Botosan* (1997) and *Botosan and Plumlee* (2002) show that firms disclosing more information in their annual reports have lower cost of capital. *Francis et al.* (2004, 2005) and *Ecker et al.* (2006) proxy for accounting quality using residual accruals volatility and find similar results. *Chen et al.* (2006) also provide evidence that more firm-specific information in stock returns is related to a lower cost of equity. Finally, *Francis et al.* (2008) find that more voluntary disclosure is associated with a lower cost of capital. Recent analytical papers (*Easley and O'Hara* (2004), *Hughes et al.* (2007), *Lambert et al.* (2007,2008), *Christensen et al.* (2008) and *Gao* (2008)) do not provide implications for cross-sectional results. In general this literature does not claim that *any kind of* signal on one firm may or may not reduce ex-post cost of capital for this same firm relative to other firms (counterexamples (i) and (ii)) or whether a firm in a given economy with any kind of information as opposed to an economy without information will have unambiguously a lower cost of capital and a higher market price (counterexamples (iii) and (iv)). Their implications are not at the firm-specific level but rather at the aggregate level.

Aggregate Cost of Capital and Disclosure

The literature on cost of capital and exogenous information is explaining the determinants of time-series variations in aggregate cost of capital. *Lambert et al.* (2007) refers to this effect as the direct effect. Knowing some information about the firm's cash flows will have spill-over effects on the covariances with the other firms and therefore on the systematic uncertainty. Specifically more precision of the covariance matrix of future cash flows about a firm affects the assessed covariance with other firms. Isolating the impact on the assessed covariance with other firms, better information is decreasing the uncertainty about the systematic risk. Less uncertainty about the systematic risk will in turn lower the aggregate cost of capital. This literature is therefore focusing on the timing of the resolution of the uncertainty about the systematic risk. In these models the arrival of information is exogenous and firms' strategic decisions whether to disclose their information are not taken into account. Also the type of information about a firm considered in this type of literature must impact the market risk. In other words, it must be correlated with the macro-economic aggregates. However any impact of an incremental information about a firm on the market risk is on average not statistically significant: for example an incremental information about a firm in Canada producing timbers is unlikely to reveal anything about macro-aggregates. Even a big firm well represented in the market index has on average an incremental information which does not influence market risk. It is however true that isolated events such as one major bankruptcy like Lehman Brothers can significantly influence the market risk.[6]

More information about a firm's cash flows can also update the expected cash flows of this firm which can have adverse effects on the cost of capital. However if a firm has some information which only resolves part of the uncertainty of the systematic risk then its cost of capital is lower. Therefore this literature has empirical predictions for cross-country studies or changes to accounting standards. Several studies have examined the consequences on firm's average cost of capital of changes to accounting standards (which may or may not improve accounting quality). *Barth et al.* (2007) find evidence that firms applying IAS generally have higher value-relevant information than domestic standards. *Leuz and Verrecchia* (2000) report that a sample of firms

[6]The day before Lehman Brothers filed for bankruptcy, all stock market indexes dropped as learning of the invesment bank collapse on Monday, 15 September 2008. BBC news on that same day reports: "The US benchmark Dow Jones index had dropped some 500 points on Monday - its worst session since 11 September 2001. The FTSE 100 index of leading UK shares fell 178.6 points to 5025 at close of trade - having earlier dipped below 5,000 points for the first time since June 2005. Japan's Nikkei 225 index dropped 5% to a three-year low, shares in South Korea and Hong Kong shed almost 6% and Shanghai's index fell by about 3%."

voluntarily switching from German to IASB standards decreased their cost of capital. If IASB standards offer an environment with less systematic uncertainty, their empirical evidence support the direct effect, which establishes a negative association between cost of capital and more precise information.

If the conclusions of the analytical papers are similar, their models differ. In a multi-firm environment, *Easley and O'Hara* (2004), *Hughes et al.* (2007) and *Lambert et al.* (2008) model information asymmetry among investors. *Easley and O'Hara* (2004) find a higher cost of capital if there is more private information and less precise information in a finite economy. In their model, a proportion of investors receive information and the others do not. They explain that the uninformed investors will demand a higher risk premium for trading securities on which they face information risk. However, *Hughes et al.* (2007) prove that this result does not hold when the economy becomes large, as more information about the matrix of covariance about the firm's cash flows may only affect the (aggregate) market premium but not a firm's cost of capital directly. They prove that information about the systematic factor is the only information priced by the market. *Lambert et al.* (2007) derive whether the presence of additional information in a multi-asset economy would increase or decrease cost of capital. They find that if this information only resolves part of the uncertainty about the systematic risk a disclosing firm has a lower cost of capital than this same firm in the economy prior to disclosure; however, after disclosure has occurred, a disclosing firm may have a higher cost of capital than a firm that did not disclose. More specifically they show that the product of the disclosing firm's beta times the market risk premium decreases contrary to *Hughes et al.* (2007) who prove that this information does not affect the beta of the disclosing firm. *Armstrong et al.* (2008) also consider a multi-firm model where information quality affects cost of capital through systematic risk. They show that observed beta and information quality are negatively related for positive beta stocks but positively related for negative beta stocks.

One common feature of all the previous papers is that their models are derived within a pure exchange economy. Thus they cannot address any relationship between cost of capital, disclosures and economic efficiency. Usually economic efficiency refers to the efficient allocations of investment as well as the level of risk-sharing for risk-averse investors. This leads me to question whether it is true that cost of capital is a good metric for economic efficiency. If this research question is little explored by empirical research with some exceptions (*Morck et al.* (2000) and *Chen et al.* (2006)), regulators seem to especially care about it and often perceive a *negative* relation between cost of capital and economic efficiency as illustrated next.

In 2001, in the same report on voluntary disclosures, the FASB's perspective asserts that voluntary disclosures improves information quality, mitigates inefficiencies and lowers cost of capital:

"The basic premise underlying this Business Reporting Research Project is that improving disclosures makes the capital allocation process more efficient and reduces the average cost of capital."

In July 2006 the FASB in a Preliminary Views (PV) document,[7] highlights, among other issues, the positive role of better disclosure to social benefits:

"The benefits of financial reporting information include better investment, credit, and similar resource allocation decisions, which in turn result in more efficient functioning of the capital markets and lower costs of capital for the economy as a whole."

[7]The report is entitled "Conceptual Framework for Financial Reporting: Objective of Financial Reporting and Qualitative Characteristics of Decision-Useful Financial Reporting Information."

I reformulate next the common beliefs regarding disclosure, aggregate cost of capital and economic efficiency.

Beliefs 2.

(i) More information lowers the aggregate cost of capital ex post and also the ex-ante cost of capital.

(ii) More information decreases the cost of capital, which in turn improves economic efficiency.

Christensen et al. (2008) note that even if there are no real decisions, disclosure should only affect the timing of resolution of uncertainty, and thus a commitment to disclosure does not affect the *ex-ante* cost of capital. As the allocations are not affected it does not increase welfare of the manager disclosing or, even, that of investors. *Yee* (2007) and *Gao* (2008) also contribute to the literature on exogenous information and cost of capital by specifically analyzing the consequences of disclosure on risk premia and efficiency. *Yee* (2007) ties earnings quality and production to efficiency and shows that higher earnings quality leads a firm to invest less but increases investors' expected utilities. *Gao* (2008) focuses on the relationship between cost of capital and welfare. Adding investment, the accounting quality changes the investment decision and risk allocation. There is a discrepancy between cost of capital and investors' welfare arising from the fact that the cost of capital does not internalize risk allocation. However, both of these papers highlight that the results are derived within a single-firm economy and would become less clear in a large economy.

To summarize the literature on cost of capital and exogenous information actually prove the following assertions:

(i) Having more precise information about firm's cash flows reduces systematic uncertainty.

(ii) An economy with less systematic uncertainty will have a lower cost of capital.

(iii) Less systematic uncertainty reduces the firm's cost of capital.

(iv) Aggregate cost of capital is not a good measure on economic efficiency.

The analytical research studied so far considers information not as a strategic choice from the manager. Endogenizing the arrival of information could provide support to the empirical cross-sectional results. I explore next the findings in the voluntary disclosure literature.

1.2 Endogenous Information and Cost of Capital

Literature on Voluntary Disclosure and Cost of Capital

The second strand of literature on disclosure, the voluntary disclosure literature, studies firms' endogenous disclosure decisions and their consequences on the type of information disclosed (*Verrecchia* (1983) and *Dye* (1985)). These papers that put more focus on voluntary disclosures but do not have the asset pricing component described in the previous paragraph, are not well-suited to explain this empirical evidence. Consider the previous example in section 1.1, and to remove any asset pricing considerations, assume that both core and side businesses are discounted at rate 9.62%. Assume that there are some proprietary costs in reporting that the side business will be scaled down; for example, clients may purchase less because they expect less service if their equipment breaks down. The best solution for the manager is to stay silent. Yet, investors would have expected disclosure of good news and thus they interpret the silence as an indication that the firm's business will shrink by, for the sake of this example, 1%. The value of the firm will then respond to silence by decreasing from 100.34 to 99.34. After this decrease, the firm will produce a return equal to 9.62% (recall that there are no asset pricing effects) and therefore, after 6 months, the value of the firm will then be: $99.34 \times (1 + 9.62\%)^{6/12} = 104.01$. Now, assume that cost of capital is measured as the firm's total return from pre-disclosure to 6 months after the disclosure or $(104.01-100.34)/100.34 = 3.66\%$, or on an annual basis, 7.44%. In other words, a firm that does not disclose has a counter-factual lower cost of capital.[8]

To my knowledge, the only papers that focus on voluntary disclosures and systematic risk are those of *Kirschenheiter and Jorgensen* (2003, 2007). They focus on disclosures about risk, more applicable to financial products, such as value-at-risk, new ventures, exposure to interest rates and do not consider the impact of standard disclosures about expected or projected cash flows, such as asset values, earnings' forecasts, sales projections, expense reductions or asset acquisitions like in the standard voluntary disclosure literature. *Kirschenheiter and Jorgensen* (2003, 2007) find that the equity risk premium (or return on the market portfolio) is increasing in information availability. They provide support that a disclosing firm will have a lower cost of capital than a non-disclosing firm. However they note that these effects should become (arbitrarily) small in a large economy if the disclosure is about the asset's variance (*Jorgensen and Kirschenheiter* (2003)) but hold in a large economy if the disclosure is about sensitivity to systematic risk (*Jorgensen and Kirschenheiter* (2007)). In their paper the information asymmetry is between the firm and the manager. *Bertomeu et al.* (2008) focus on the information asymmetries among investors and study whether firms' voluntary disclosures can reduce asymmetric information in financial markets and lead to cheaper financing. They find that more disclosure occurs in environments with fewer informational frictions, matching the observed association between disclosure and aggregate cost of capital. However their metric of

[8] To complete this model, one should model the cost of capital for a disclosing firm. We do not do so, since this would require making the proprietary disclosure more formal. Moreover, the case of disclosing firms is symmetric to non-disclosure: disclosing firms would have an increase in their value and, as a result, would feature an increase in cost of capital. Note also that, when considering the cost of capital post disclosure, either disclosing or non-disclosing firms would have a constant cost of capital (return) equal to 9.62%.

cost of capital is not the expected market return required by investors as they do not model the notion of systematic risk.

This second strand of literature seems to be promising as it could provide answers on the cross-sectional results well-documented in empirical research. However so far the voluntary disclosure does not provide any cross-sectional answers on voluntary disclosures about expected cash flows (the most standard and tested disclosures) in presence of systematic risk.

Unsolved Research Questions

Although the evidence is still relatively recent, a majority of empirical studies document a negative association between disclosure and cost of capital cross-sectionally. Some empirical papers (*Skaife et al.* (2004), *Nikolaev and Van Lent* (2005), and *Cohen* (2008)) highlight the endogeneity issue raised by most cross-section results as disclosure is also a firm's strategic decision. One modeling feature to include should then take disclosure itself as a choice and embed it with a systematic factor.

To further explore the research question on the connection between cost of capital (defined as the expected return required by investors) and economic efficiency, one could borrow some of the features from a third strand of literature. This literature analyzes the benefits and costs associated with disclosure and their potential impacts on economic efficiency. These studies focus predominantly on the "real" costs associated with disclosure or non-disclosure (competition, trading costs, manipulation). This literature documents that coarsening information may be desirable for shareholders (*Arya et al* (1998), *Demski* (1998), *Arya and Glover* (2008) and *Einhorn and Ziv* (2008)). Another set of papers further consider the real consequences of disclosure, and whether particular disclosures can lead to higher surplus for shareholders. *Arya and Mittendorf* (2007) show that more voluntary disclosure by firms can lead to less disclosure by outside information providers; leading to lower overall proprietary information publicly revealed and higher value for shareholders. *Kanodia* (1980) studies changes to accounting information quality and their effects on investment efficiency.[9] *Kanodia et al.* (2005) also provide insights on the role of disclosure on investment opportunities and identify how more or less disclosure is socially desirable. This last strand of literature addresses issues on the role of disclosure at the macroeconomic level. Including real effects is undoubtedly important to connect disclosure, cost of capital and economic efficiency.

The purpose of this dissertation is to unify the three strands of literature in a common theory that speaks to differences between the cost of capital of disclosing and non-disclosing firms but also aggregate risk premia and economic efficiency. To my knowledge, my study is the first to link together voluntary disclosure on cash flows, cost of capital and economic efficiency. The theoretical motivations for considering these questions as part of a single framework are clear. Regulation of accounting practices should be concerned with the overall improvement in economic efficiency, which requires the use of observable metrics such as the cost of capital. However, such regulation needs to take into account its effect on the strategic decisions of managers and how such decisions will impact cross-sectional empirical studies. Further, I develop a model in which the predictions hold in a large economy which allows me to separate diversifiable from non-diversifiable risk and derive cross-sectional implications. Contrary to the existing literature, my results do not require the normality assumption. However I require constant relative risk-aversion (not the constant absolute risk aversion utility) and view this assumption as relatively reasonable as the CRRA utility fits better observed risk-taking behavior than constant absolute risk-aversion (*Camerer and Ho* (1994)). Finally, I provide several empirical implications: disclosure should

[9] *Kanodia and Lee* (1998) also consider the interaction between investment and disclosure and how disclosure in periodical performance reports influences the managers' real decisions. *Liang and Wen* (2006) investigate the effects of the accounting measurement basis on the capital market pricing and efficiency of the firm's investment decisions. Other papers show the disclosure effect on measuring intangibles (*Kanodia et al.* (2004)) and also accounting for derivatives (*Kanodia et al.* (2000)).

be associated with lower cost of capital in cross-sectional studies, and disclosing to reduce cost of capital (as often stated in empirical studies) is equivalent to disclosing to maximize value. The model has also implications for the use of accounting information in asset pricing models. From an asset pricing perspective, accounting has traditionally been viewed as producing information about expected cash flows, i.e. the numerator of a net present value calculation. My framework further suggests measures of voluntary disclosure quality as possible proxies for the firm's exposure to systematic risk, i.e. the denominator or beta in a net present value calculation. In Appendix A, I present different tables to position my dissertation specifically in the cost of capital literature.[10]

[10] As shown in table A.3, many of the results are new and do not fit in preexisting frameworks.

CHAPTER II

Introduction

In this dissertation, I study the effect of voluntary disclosure on cost of capital and economic efficiency, where economic efficiency is a combination of productive efficiency and efficient risk sharing. First, I isolate the firm-specific cost of capital effect caused by firms endogenous disclosure decisions from the overall cost of capital effect caused by exogenous changes in economy-wide information factors. Then, I analyze aggregate cost of capital differences across economies, and production and risk sharing efficiency caused by these economy-wide factors. In particular, I address two questions: First, at the individual firm level, do firms that voluntarily disclose more information experience a lower cost of capital? Second, at the macroeconomic level, do endogenous firm disclosures affect average cost of capital in aggregate and what are the consequences of voluntary disclosure on overall economic efficiency? Answering the first question allows us to better understand the economic forces underlying firms' disclosures, their effects on an individual firm's cost of capital, and the cross-sectional differences in costs of capital between disclosing and non-disclosing firms. Providing an answer to the second question could provide rule makers a useful criterion in setting disclosure policy. As noted by *Sunder* (2002): "cost of capital is an overall social welfare criterion rooted in equilibrium concept."

The first of these two questions refers to the implications of disclosure on cost of capital at the individual firm level within an existing environment. Although the evidence is still relatively recent, a majority of empirical studies document a negative association between disclosure and cost of capital cross-sectionally. When disclosure itself is a choice, the interpretation of empirical results must take into account the issue of endogeneity (*Skaife et al.* (2004), *Nikolaev and Van Lent* (2005), and *Cohen* (2008)). To capture the endogenous disclosure decision, this dissertation provides a model in which firms choose their disclosure to maximize their market value. In the model, firms with favorable private information are more likely to disclose. Such disclosure of favorable information reveals to the market the firm's lower exposure to systematic risk. Responding to such a disclosure, investors rationally offer a higher price to disclosing firms, leading to a lower cost of capital. This is the first result of the dissertation. This result delivers the observed cross-sectional association between disclosure and cost of capital within an economy. In other words, different firms endogenously choose different disclosures. Investors in turn rationally value firms at different prices, leading to different costs of capital. Thus disclosure and cost of capital, both endogenous in the model, appear to be negatively associated and are driven by the underlying voluntary disclosure incentive.

The second question refers to the effects of an economy-wide exogenous information factor on the relation between overall cost of capital in the economy and efficiency at the macroeconomic level. Several empirical papers attempt to connect cost of capital to economic efficiency (e.g., *Morck et al.* (2000) and *Chen et al.* (2006)). Similar to *Dye* (1985), this dissertation introduces a disclosure friction under which investors are unable to fully distinguish between firms that choose not to disclose and firms that cannot disclose. The disclosure friction is a measure of the overall information availability in the economy. I show that average cost of capital captures how well financial markets function at insuring imperfectly diversified investors against disclosure risk.

Building on the firm-level result, in contrast to existing literature, I show that greater information availability in the economy increases the average cost of capital because more information increases the dispersion of prices post disclosure; this itself leads, as noted by *Hirshleifer* (1971), to lower risk-sharing efficiency.[1]

Furthermore, at the macroeconomic level, information availability affects real decisions (investment) as well as risk-sharing (among risk-averse investors facing remaining uncertainty associated with the firms' cash flows). In this dissertation, I distinguish the efficiency effect due to improved risk-sharing from the efficiency effect due to improved productive decisions. The second main result of this dissertation is that the average cost of capital is a good proxy for efficiency only if one starts from a disclosure friction that is relatively high. A higher disclosure friction improves risk-sharing. In contrast if the disclosure friction is relatively low, decreasing the friction increases efficiency as it improves productive inefficiency. Overall economic efficiency is maximal when financial disclosures are either perfectly informative or completely noisy. In other words, I show that regulators will have to balance the productive efficiency problem against the risk-sharing problem in setting public disclosure policy. Empirically the result further suggests that different cross-country characteristics among regulatory environments and accounting practices are driven by their economic primitives.

The model in this dissertation extends a voluntary disclosure model (*Dye* (1985)) by incorporating an asset pricing framework (commonly referred as Mossin-Lintner-Sharpe model). In the economy, each of a large number of risk-averse investors owns a firm's new project whose expected cash flows, if financed, contain an idiosyncratic and a common cash flow component. Each firm decides whether or not to disclose private

[1] In resolving uncertainty, information also erodes risk-sharing opportunities when it is publicly revealed before trading. "Public information . . . in advance of trading adds a significant distributive risk" (Hirshleifer 1971, p. 568). However, my result differs from *Hirshleifer* (1971) in that I show how changes to voluntary disclosure may lead to greater price dispersion and study aggregate cost of capital, while Hirshleifer focuses on efficiency after price dispersion has increased.

information about its idiosyncratic cash flows. Investors observe public disclosures (if any) and rationally price each firm. Similar to *Dye* (1985), there exists a disclosure friction: some firms cannot credibly communicate their information. Consequently, firms that disclose but cannot get their message out are pooled with those firms that intentionally did not disclose. This disclosure friction might be interpreted as information asymmetry between firms and investors or as a proxy for the complexity of the economic operations to be disclosed.[2] Alternatively, one might view this friction as a summary measure of the regulatory oversight of corporate disclosure and the quality of accounting standards.[3] This disclosure friction affects the proportion of firms voluntarily disclosing and I show how it can work to reduce cost of capital, both at the firm level (if a particular firm discloses more relative to its peers) and at the aggregate market level (if all firms disclose more overall). The model highlights information asymmetries between firms and investors, rather than among different investors. The results are derived with constant relative risk averse investors and general probability distributions (not necessarily the normal distribution).

Next I elaborate on the economic intuition for my results. First, I find that, if the disclosure friction is sufficiently high, firms making more voluntary disclosures have a lower cost of capital. The rationale for this result is the relation between voluntary disclosures and investors' updated estimate of the firms' systematic risk per dollar of expected cash flows. Conditional on a voluntary disclosure, investors expect more expected cash flows which dilute the firms' sensitivity to systematic risk, in turn decreasing cost of capital and increasing market value. Indeed, I show that, from the perspective of managers, firms disclose if and only if such a disclosure reduces their

[2]For example, it may be easier to disclose information in a well-established industry than in a new venture or a firm engaging in complex financial operations. Investors may also not pick up the information sent by firms, either because they did not pay attention to the release of information or cannot understand the firm's information.

[3]A common measure in mandatory disclosure of accounting quality is the variance on the information disclosed. Although this disclosure friction is related to voluntary disclosure, these two metrics are similar in that it measures the level of information inferred by markets.

cost of capital, consistent with the common use of the statement in the empirical literature (although not with prior analytical work in this area). In summary, the model matches the observed cross-sectional association between disclosure and cost of capital. It shows that firms that disclose do so to increase their market value, which in turn, reduces their cost of capital, while the remaining firms do not disclose because they were unable to due to the disclosure friction, or doing so would have increased their cost of capital.

Second, I consider the overall cost of capital of all firms in the economy, averaging the market returns of all disclosing and non-disclosing firms. I distinguish two sources of economic (in)efficiency: imperfect risk-sharing for the initial owners of the firms and productive inefficiencies tied to the asymmetric information about firms that did not disclose. I compare overall cost of capital and economic efficiency. When the disclosure friction is high, I show that, if more firms voluntarily disclose their information, the dispersion of market prices increases, which implies an increase in average cost of capital and worsens risk-sharing. In this situation, an increase in cost of capital is perfectly aligned with a deterioration in risk-sharing and therefore is a valid metric for the analysis of the efficiency consequences of disclosure. The nature of the productive inefficiency depends on the disclosure friction. If the disclosure friction is relatively low, firms that do not disclose are viewed as having low value and high cost of capital and do not invest. As a result, a low disclosure friction leads to underinvestment by some high-value firms which may not have disclosed because they were unable to due to the disclosure friction. Conversely, if the disclosure friction is high, investors anticipate that more firms that did not disclose are high-value firms that could not disclose; therefore, non-disclosing firms are priced higher and, thus, are able to invest which leads to an overinvestment problem. Finally, I examine the tension between risk-sharing and investment efficiency, and find that economic efficiency depends on the level of the disclosure friction, with risk-sharing concerns less (more) important than productive efficiency with a low (high) disclosure friction and underinvestment (overinvestment).

The formal analysis yields several key observations that I will discuss in more detail later. One, given that asset pricing theory captures the firm's exposure to non-diversifiable risk, it requires a proper understanding of firm's strategic disclosure. Two, the links between the disclosure friction and the cost of capital are very different at the firm and the aggregate level. Three, the disclosure friction affects the disclosure decision of managers and, given that such disclosures are then used by investors, has real productive effects and also affects risk-sharing. Fourth, from an empirical perspective, I show that the relation between disclosure and cost of capital depends on the economic primitives.

CHAPTER III

The model

3.1 Timeline

The economy is populated by a large number of investors and firms. I briefly describe the main sequence of events.

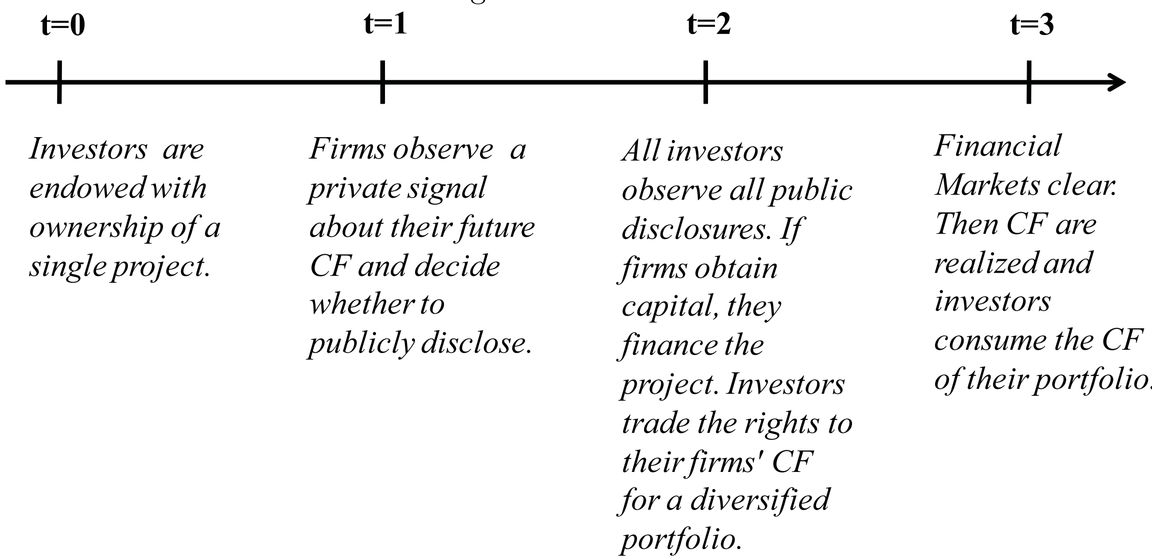
At date 0, each investor is endowed the ownership of a single project, which entitles the owner to the future cash flows (CF) of the project if the firm is eventually financed. I later refer to this project as "the firm."

At date 1, each firm receives private information about the future cash flow of the project and may then choose to disclose. The disclosure problem is described in more details in Subsection "Firm Sector."

At date 2, all investors observe all public disclosures (if any). Firms' projects valued at a positive price are financed. Investors trade the rights to their firms' cash flow for a diversified portfolio. Their portfolio choice decision is described in Subsection "Investors' Problem."

At date 3, financial markets clear; the market-clearing prices are determined in Subsection "Competitive Equilibrium." Then, uncertainty about the firm's cash flows is realized, and investors consume the cash flows received from their portfolio.

Figure 3.1: Timeline



3.2 Firm Sector

I discuss here the characteristics of the firms and describe the events occurring at date 1.

Firm's Cash Flows

There is a continuum of firms, and each can generate a (potential) stochastic cash flow π if the firm is financed, net of the required investment, and zero otherwise.[1] To focus on a multi-firm economy, I restrict attention to a setting in which the project is financed or not, and do not consider the scale of investment.

I assume that $\pi = \epsilon + y$, where ϵ is a firm-specific i.i.d. random variable (the indexation on each firm is omitted to save space) and y is a systematic risk factor (common for all firms). This factor model approach is similar to *Jorgensen and Kirschenheiter* (2003, 2007) and *Hughes et al.* (2007).[2]

[1]The role of firms is identical to the neo-classical view. Firms are only executing the project if financed. Their role is to maximize the value of the current owner.

[2]Note that under the assumptions of the capital asset pricing model (e.g., *Mossin* (1966)), firms' cash flows can always be decomposed into an idiosyncratic and a (suitably constructed) systematic

The firm-specific shock ϵ captures the firm's idiosyncratic (diversifiable) risk, has a distribution $H(.)$, density $h(.)$ with mean $\mathbb{E}(\epsilon) = \theta$ and full support over $\mathbb{R}$ and is independent of y.

The common shock y is assumed to have a density $f(.)$ and full support over $[\underline{y}, +\infty)$ (where $\underline{y} > -\theta$) and $\mathbb{E}(y) = 0$.[3] Without loss of generality, I normalize the "mass" of all firms in the economy to one; therefore, defining $CF_m(y)$ as the payoff in unit of consumption of all firms (hereafter "market portfolio"), $CF_m(y)$ must be equal to $Prob(Inv)(\mathbb{E}(\epsilon|Inv) + y)$, where Inv represents the event that the firm is financed and $Prob(Inv)$ is the probability of a firm to be financed. For example, if all firms are financed, $CF_m(y) = \theta + y$. Following this observation, I will denote a realization of y as a "state of the world."

Disclosure Decisions

All firms observe a perfect signal s on their idiosyncratic cash flow ϵ.[4] The role of the factor model presented earlier is to focus the analysis on information about the idiosyncratic component of firm's cash flows, and exclude any information about the systematic component that would clearly work to realize some of the systematic risk and thus reduce risk premia (*Hughes et al.* (2007), *Lambert et al.* (2007, 2008)). In practice, one would expect a single firm's disclosures to contain relatively little information about the state of the overall economy, as compared to information about the firm's own business.[5] Thus, for firms that are not too large relative to the economy,

factor and thus, such a decomposition is without loss of generality.

[3] The restriction to $\mathbb{E}(y) = 0$ is without loss of generality; if $\mathbb{E}(y) \neq 0$, one could relabel $y' = y - \mathbb{E}(y)$, with mean zero, and $\epsilon' = \theta + \mathbb{E}(y)$, with no change to the results or analysis. In other words, a revision of the economy's growth would be captured in this model by the common mean of the firm-specific factor θ.

[4] The results, and proofs, are unchanged if one assumes instead that firms receive a noisy signal, say ρ, on ϵ. Given that the estimation risk on ϵ is purely idiosyncratic, it would not be priced, and thus one could relabel the model by replacing ϵ by $\epsilon' = \mathbb{E}(\epsilon|\rho)$. Using ϵ', all the results will carry over.

[5] The aggregation of information of all small firms should unravel some information about the state of the economy. *Seyhun* (1992) reports evidence that aggregate insider trading in small firms

the effect of information about systematic risk - if any - is likely to be small for the vast majority of firms.[6]

Firms decide whether to release their private information. As is common in the voluntary disclosure literature, I assume that disclosure must be truthful. If the firm chooses to voluntarily disclose, then with probability $\eta \in (0, 1)$, the message sent by the firm is not received; thus η is a measure of the disclosure friction. Investors cannot distinguish between firms which chose not to disclose from firms whose disclosures were not received. Conversely, with probability $1 - \eta$, firms choosing to disclose succeed in disclosing and their private signal becomes public information.[7] Like a "lock and key", disclosure and the probability it is received are both needed for a private signal to become public: first, the firm needs to choose to release its information (the lock) and then investors need to receive it correctly (the key).

The disclosure friction η is a modeling device to capture the informational asymmetry between firms and outside investors. One can think of all firms choosing to provide either an informative disclosure or a noisy one. With probability $1 - \eta$, an informative disclosure is understood by the receiver. Of course, none of the noisy disclosures can be understood. One can also view η as a proxy for the complexity of the economic operations to be disclosed or whether a firm lacks sufficient credibility for truthful disclosure (*Stocken* (2000)). Investors may also not pick up the information sent by firms, either because they did not pay attention to the release of information or cannot understand the firm's information (*Hirshleifer and Teoh* (2003)). The probability η may also be interpreted as a measure of the accounting quality of ac-

predicts future stock returns in larger firms. However it is unlikely that a small firm alone would provide significant information about the common shock.

[6] I do not mean that this effect would necessarily vanish in a large economy, since it is always theoretically possible to have a disclosure by a very small firm to be very informative on all other firms (and thus, incidently, on systematic uncertainty); however, this result is economically implausible, as very little would likely be learnt about the economy (e.g., GDP or consumption growth, level of the index) through the incremental disclosure of one firm.

[7] This friction does not correspond to the Dye's specification but is mentioned in his paper as one alternative assumption to model non-proprietary information. In my model, using the alternative formulation is more analytically tractable.

counting standards: a firm will report mandatory disclosures but may then schedule a presentation (*Bushee et al.* (2008)) and/or additional financial notes/disclosures that may or may not guide the investors in understanding the information released. In the model investors either internalize the firms' disclosures or do not.[8] I will refer to the parameter η as a disclosure friction. But the reader can refer to the different interpretations mentioned before to relate to a more specific context.

Firms take the set of possible prices as given when they disclose. I define P_ϵ (to be endogenously determined) as the market price if the firm's signal $s = \epsilon$ is observed. The price $P_\emptyset$ is offered if no additional signal is revealed, pooling firms that voluntarily retained their information with firms that disclosed but the information was not received. Further, a negative price implies that the firm is not financed, thus producing a certain cash flow of zero.

Firms maximize the value of their current owner and disclose if and only if $P_\epsilon \geq P_\emptyset$. I denote the optimal disclosure threshold ϵ^*, above which all firms decide to voluntarily disclose.

[8]There may be costs associated in decreasing η (e.g., often cited implementation costs of the Sarbanes-Oxley Act as noted in *Gao et al.* (2008)). Such costs would endogenize η in a straightforward manner and thus are not incorporated explicitly in the model.

3.3 Investors' Problem

Now I discuss the characteristics of investors, and describe the events occurring at date 2.

Preferences

Investors are each initially endowed with one firm.[9] They have a constant relative risk-aversion (CRRA) utility function $u(x) = x^{1-\alpha}/(1-\alpha)$, where x is final consumption and $\alpha > 0$ is an investor's Arrow-Pratt relative risk-aversion coefficient.[10] Each investor is initially undiversified; thus, it is optimal for him to sell the project and invest in a diversified portfolio.[11]

Portfolio Choice

At date 2, investors observe the information disclosed by all firms and sell their asset in a competitive market; and (optimally) want to diversify away their idiosyncratic risk.

Post disclosure, investors differ in the disclosure of their firm. If the firm did not disclose, the investor can sell his firm for a price $P_\emptyset$. There is also a continuum of investors who can sell their firm for a price P_ϵ where $\epsilon \in \mathbb{R}$. In short-hand, I denote the value of a firm P_δ, where $\delta \in \{\emptyset\} \cup \mathbb{R}$. Because the conditions for two-fund

[9]All the results of the model carry over for: (i) other types of ownership (certain investors own multiple projects or share ownership), (ii) if some investors do not own a project, (iii) if all investors also have an i.i.d. personal wealth, in addition to their project. The only required assumption is that not all investors are perfectly diversified ex-ante. One of the main results (the difference in returns between disclosing or non-disclosing firms) is robust to any strictly concave utility function but the CRRA assumption is required for the comparative statics and efficiency comparisons.

[10]if $\alpha = 1$, $u(.)$ is set to $u(x) = \ln(x)$. As the CRRA utility is not defined for negative values, I assume that if $x < 0$ then u(x) goes to $-\infty$.

[11]If the investor was also the manager, issues relating to signalling with security design could arise; for example, entrepreneurs/investors may possibly have used debt finance and signal their information by retaining some of their firm's cash flow(see *Bertomeu et al.* (2008) for a model in which the firm is financed with debt). The role of investors as managers is studied within the context of partnerships in *Huddart and Liang* (2005).

separation hold in this economy (see *Cass and Stiglitz* (1970)), investors trading in a complete financial market would always choose to hold only a combination of the market portfolio and the risk-free asset. Their portfolio choice problem can thus be written as follows:

$$
\begin{aligned}
(\Gamma_\delta) \qquad & \max_{\gamma_{\delta f},\gamma_{\delta m}} \int f(y) U \left\{ P_\delta(\gamma_{\delta f} + \gamma_{\delta m} \frac{CF_m(y)}{P_m}) \right\} dy \\
& \text{s.t} \;\; P_\delta \geq P_\delta \gamma_{\delta f} + P_\delta \gamma_{\delta m} \qquad (3.1)
\end{aligned}
$$

Problem (Γ_δ) corresponds to the portfolio choice problem of an investor whose firm disclosed δ. In this problem, P_m is the price of the market portfolio, defined as

$$P_m = \mathbb{E}(CF_m(y))/\mathbb{E}(R_m)$$

The market price P_m (equivalently $\mathbb{E}(R_m)$) is taken as given by investors but is endogenized in the next section. Note that P_m is the *ex-ante* price, before y is realized. Let $\gamma_{\delta f}$ be the proportion of the initial wealth the investor puts in the risk-free asset and $\gamma_{\delta m}$ be the proportion of the wealth he invests in the market portfolio. Equation (3.1) is the investor's budget constraint. That is, the investor can use his current wealth, as determined by his holdings in the single firm disclosing δ, to purchase any combination of the risk free asset and market portfolio.

3.4 Competitive Equilibrium

I discuss here the sequence of events occurring at date 3; specifically, I state the definition of a competitive equilibrium and derive the equilibrium market prices.

No-Arbitrage

As a result of the factor decomposition, each firm's cash flow contingent on a disclosure can be written in terms of a basket of the market portfolio and the risk-free asset; in the absence of arbitrage, its value can be computed as the value of this basket of securities.

Assume initially that all firms in the economy invest. Consider a firm disclosing ϵ. An investor is willing to value this firm but only knows the value of the market portfolio P_m. The value of this firm disclosing ϵ can be written in terms of P_m, because:

(i) Holding the firm yields the investor a cash flow $\epsilon + y$, where ϵ is known and y is not yet known.

(ii) Holding $\epsilon - \mathbb{E}(\epsilon)$ units of the risk-free asset and one unit of the market portfolio yields a cash flow $\epsilon - \mathbb{E}(\epsilon) + \mathbb{E}(\epsilon) + y = \epsilon + y$.

If the investor is rational, he should value these two investments identically and thus should value this disclosing firm at $P_m + \epsilon - \mathbb{E}(\epsilon)$. Recall that the unit price of the risk-free asset can be normalized to one. This concludes the argument when firms all invest. More generally, if some firms do not invest, the cash flow can be decomposed as follows:

$$\underbrace{\epsilon - \mathbb{E}(\epsilon|Inv)}_{\text{units of risk-free asset}} + \underbrace{\frac{1}{Prob(Inv)}}_{\text{units of market portfolio}} \underbrace{Prob(Inv)\left(\mathbb{E}(\epsilon|Inv) + y\right)}_{CF_m}$$

In other words, the firm's cash flow is the sum of $\epsilon - \mathbb{E}(\epsilon|Inv)$ units of a risk-free bond and $\frac{1}{Prob(Inv)}$ units of the market portfolio. The unit price of the market portfolio P_m is equal to $\frac{\mathbb{E}(CF_m)}{\mathbb{E}(R_m)}$, where $\mathbb{E}(R_m)$ is the expected market portfolio return. When valuing this basket of assets, the firm's no-arbitrage price must be:

$$P_\epsilon = \epsilon - \mathbb{E}(\epsilon|Inv) + \frac{1}{Prob(Inv)} \frac{\mathbb{E}(CF_m)}{\mathbb{E}(R_m)}$$

Second, consider a firm that does not disclose and is financed. The firm's cash flow is $\epsilon + y$, where ϵ is unknown to investors but can be perfectly diversified by holding a portfolio of all non-disclosing firms. As a result the price $P_\emptyset$ of this firm should be that of a firm paying $\mathbb{E}(\epsilon|ND) + y$, where ND represents the event that the firm did not disclose. By no-arbitrage, it must hold that:

$$P_\emptyset = \mathbb{E}(\epsilon|ND) - \mathbb{E}(\epsilon|Inv) + \frac{1}{Prob(Inv)} \frac{\mathbb{E}(CF_m)}{\mathbb{E}(R_m)}$$

If a non-disclosing firm is not financed, I set $P_\emptyset = 0$.

Market-Clearing and Risk Premium

I close the model by recovering the expected market return $\mathbb{E}(R_m)$ from equilibrium restrictions. To avoid situations with multiple equivalent equilibria, I assume that a firm that does not expect to be financed conditional on its disclosure will not disclose (e.g., if there is some small cost for disclosure).[12] It follows that only firms that did not disclose may not be financed. Therefore, there are two possible equilibrium candidates: (1) overinvestment equilibria, in which all firms invest and receive a positive price even if they do not disclose, (2) underinvestment equilibria, in which firms that do not disclose - whether voluntarily or involuntarily - are not financed.

[12]The results are unchanged when this restriction is lifted; except that there may be many economically equivalent equilibria in which some low-value firms choose to disclose but still do not receive financing.

I now introduce the overinvestment equilibrium, where the optimal disclosure threshold ϵ^* is replaced by ϵ^{over}.

Definition 1. *An "overinvestment" competitive equilibrium is a set of optimal portfolio choice, expected market portfolio return and disclosure threshold* $(\gamma_{\delta f}^{over}, \gamma_{\delta m}^{over}, \mathbb{E}(R_m^{over}), \epsilon^{over})$ *such that:*

(i) $\gamma_{\delta f}^{over}, \gamma_{\delta m}^{over}$ *solve the maximization problem* (Γ_δ)

(ii) $P_{\epsilon^{over}} = P_\emptyset$

(iii) $P_\emptyset \geq 0$ *and all firms are financed.*

(iv) $\forall y, \;\; 0 = (1-(1-\eta)(1-H(\epsilon^{over})))\gamma_{\emptyset f}^{over} P_\emptyset + (1-\eta)\int_{\epsilon^{over}}^{+\infty} \gamma_{\epsilon f}^{over} P(\epsilon) h(\epsilon) d\epsilon$

Condition (i) is the optimality condition for investors. Condition (ii) is the optimality for firms: the optimal disclosure threshold ϵ^{over} is determined so that a firm receiving signal ϵ^{over} is indifferent between disclosing or retaining its private information. It should be noted from the previous discussions that $P_{\epsilon^{over}}$ and $P_\emptyset$ depend on the expected market return. Condition (iii) ensures that all firms invest in the economy. Finally, condition (iv) represents the market-clearing constraint in the risk-free asset: the supply in the risk-free asset is equal to the demand in the risk-free asset.

$$\underbrace{0}_{\text{net supply}} = \underbrace{(1-(1-\eta)(1-H(\epsilon^{over})))\gamma_{\emptyset f}^{over} P_\emptyset}_{\text{non-disclosing firms' total demand}} + \underbrace{(1-\eta)\int_{\epsilon^{over}}^{+\infty} \gamma_{\epsilon f}^{over} P(\epsilon) h(\epsilon) d\epsilon}_{\text{disclosing firms' total demand}}$$

Investors in non-disclosing firms demand the same quantity of risk-free asset $\gamma_{\emptyset f}^{over} P_\emptyset$, whereas investors in disclosing firms differ in the quantity of the risk-free asset they demand conditional on the disclosure ϵ, $\gamma_{\epsilon f}^{over} P(\epsilon)$. The risk-free asset is in zero net supply; then, by Walras Law, market-clearing of the risk-free asset and the investor's budget constraints imply market-clearing for the market portfolio, and this second market-clearing condition can be omitted.

Conditions (i) and (iii) are standard in the general equilibrium literature and condition (ii) is standard in the disclosure literature; the model nests both general equilibrium concerns and endogenous disclosure in a common framework. Further, the disclosure decision and the expected market return are inter-related. On one hand, both $P_{\epsilon^{over}}$ and $P_{\emptyset}$ are functions of the expected market return $\mathbb{E}(R_m^{over})$ and thus solving for ϵ^{over} requires some knowledge of the expected market return. On the other hand, the market clearing constraint (iv) depends on the disclosure threshold ϵ^{over}.

I next consider the underinvestment equilibrium with the optimal threshold ϵ^* replaced by ϵ^{under}.

Definition 2. *An "underinvestment" competitive equilibrium is a set of optimal portfolio choice, expected market portfolio return and disclosure threshold* $(\gamma_{\delta f}^{under}, \gamma_{\delta m}^{under}, \mathbb{E}(R_m^{under}), \epsilon^{under})$ *such that:*

(i) $\gamma_{\delta f}^{under}, \gamma_{\delta m}^{under}$ *solve the maximization problem* (Γ_δ)

(ii) A non-disclosing firm receives $P_\emptyset = 0$ *and is not financed*

(iii) $P_{\epsilon^{under}} = 0$

(iv) $\forall y,\;\; 0 = (1-(1-\eta)(1-H(\epsilon^{under})))\gamma_{\emptyset f}^{under} P_\emptyset + (1-\eta)\int_{\epsilon^{under}}^{+\infty} \gamma_{\epsilon f}^{under} P_\epsilon h(\epsilon) d\epsilon$

The definition of the equilibrium is similar to the previous one in terms of conditions (i), (iii), and (iv). The main difference is that firms whose information is not received (either voluntarily withheld or because they were unable to transmit) are not financed. Specifically condition (ii) corresponds to firms that would be priced negatively by investors, were their projects executed and, thus, are not financed (their cash flow is zero). Therefore the market portfolio cash flow in state y is $CF_m(y) = (1-\eta)\int_{\epsilon^{under}}^{+\infty}(\epsilon + y)h(\epsilon)d\epsilon$. This corresponds to the firms successfully disclosing their information and a positive pricing in equilibrium.

At this stage, the term overinvestment and underinvestment may seem an abuse of language, given that no such property has yet been formally shown. However, stepping ahead, I will demonstrate in Sections 3 and 4 that such labels are indeed justified; hopefully, the reader will pardon this logical misstep and benefit from the convenience of using the terminology early in the discussion.

3.5 First-Best Benchmark

The first-best solution to the model is defined as the optimal financing threshold ϵ^{FB} chosen by a fully-informed, efficiency-maximizing planner. Note that, in the first-best, all investors should be given the same well-diversified portfolio ex-ante and thus the first-best problem is equivalent to maximizing the ex-ante CRRA utility of the investor.[13]

$$\max_{\tilde{\epsilon}} \frac{1}{1-\alpha} \int f(y) \left(\int_{\tilde{\epsilon}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon \right)^{1-\alpha} dy$$

Proposition 1. *Firms are financed if and only if their signal about future cash flows ϵ is above ϵ^{FB} where ϵ^{FB} is uniquely defined as follows:*

$$\epsilon^{FB} = -\frac{\int y f(y) (\int_{\epsilon^{FB}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon)^{-\alpha} dy}{\int f(y) (\int_{\epsilon^{FB}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon)^{-\alpha} dy} \in (0, \theta) \tag{3.2}$$

First-best prescribes not to finance firms whose expected cash flows are too low. The fundamental tension in the first-best solution is between increasing expected aggregate consumption, and decreasing total aggregate risk by closing down some firms. The first-best threshold lies between 0 and θ. At one extreme, financing a firm with zero idiosyncratic value ($\epsilon = 0$) would increase risk without increasing aggregate consumption. At the other extreme, a firm with the expected unconditional cash flow ($\epsilon = \theta$) yields a positive non-diversifiable cash flow component $\theta + y$, which is always strictly greater than the payoff if the firm is not financed.

[13] For convenience, I focus on the "anonymous" or symmetric solution, in which the planner does not advantage certain investors over others. The solution ϵ^{FB} is unchanged if one considers the complete set of Pareto-efficient solutions in which the planner may favor certain investors over others.

CHAPTER IV

Results

4.1 Overinvestment Equilibrium

I first solve for the overinvestment equilibrium. This equilibrium exists if the non-disclosing price $P_\emptyset$ is positive. I decompose the problem in three steps. First, I take the expected market portfolio return $\mathbb{E}(R_m)$ as given and derive the optimal disclosure threshold from condition (ii) in definition (1). Second, I solve for the expected market return $\mathbb{E}(R_m)$ based on constraints (i) and (iv) from definition (1). Third, I collect these results and formally state the competitive equilibrium of the model.

4.1.1 Disclosure Threshold Dependent on the Disclosure Friction

Non-Disclosure Price

To find the optimal threshold, it is first helpful to consider the price offered to firms which do not disclose as a function of different possible disclosure thresholds $\hat{\epsilon}$ (the latter being not necessarily the optimum); to stress the dependence on the disclosure threshold, I denote this price $P_\emptyset(\hat{\epsilon})$.

Lemma 1. *$P_\emptyset(\hat{\epsilon})$ is U-shaped in $\hat{\epsilon}$, attainting a global minimum at a unique point $\hat{\epsilon}^{over}$ given by:*

$$\int_0^{\hat{\epsilon}^{over}} H(\epsilon)d\epsilon = \eta \int_{\hat{\epsilon}^{over}}^{+\infty} (1 - H(\epsilon))d\epsilon \tag{4.1}$$

The fact that $P_\emptyset(\hat{\epsilon})$ is non-monotonic in $\hat{\epsilon}$ is not surprising. Suppose for example that $\hat{\epsilon}$ is small (all firms want to disclose). Then, investors know that non-disclosure is involuntary and thus they will offer a price corresponding to the unconditional cash flow expectation θ. At the other extreme, suppose that $\hat{\epsilon}$ is large (no firm discloses). Then, investors observe only firms not disclosing in the economy and thus also give a price corresponding to the expected cash flow θ. In-between these two extremes, the market infers that firms with high signals are more likely to disclose, self-selecting out of the non-disclosure outcome.

More precisely, the function $P_\emptyset$ is U-shaped and driven by the tension between two conflicting effects. The first effect is the *dilution* effect: if the threshold increases, the proportion of firms intentionally (unintentionally) not disclosing increases (decreases). The price is driven down, as high-value firms are diluted. The second effect is the *self-selection* effect: as the threshold increases, firms deliberately withholding their information receive higher signals on their future cash flows and thus the price increases.

For low values of $\hat{\epsilon}$ (most firms disclose), the dilution effect dominates and $P_\emptyset$ is decreasing in $\hat{\epsilon}$. In other words, moving to a regime in which fewer firms disclose decreases the price offered to firms that do not disclose. As the threshold increases, more firms *voluntarily* withhold and their average ϵ increases. The self-selection effect prevails for high values of $\hat{\epsilon}$ (few firms disclose) and $P_\emptyset$ is increasing in $\hat{\epsilon}$.

Optimal Disclosure Threshold

The optimal disclosure threshold ϵ^{over} is the signal at which the firm is indifferent between disclosure and non-disclosure, i.e. $P_{\epsilon^{over}} = P_{\emptyset}$. Proposition 2 shows that an optimal disclosure threshold exists and is unique.

Proposition 2. *There exists a unique optimal disclosure threshold* ϵ^{over} *such that*

(i) if $\epsilon < \epsilon^{over}$, *the firm retains its private information.*

(ii) if $\epsilon \geq \epsilon^{over}$, *the firm discloses it.*

ϵ^{over} *does not depend on the expected market portfolio return* $\mathbb{E}(R_m)$, *and satisfies* $\epsilon^{over} = \hat{\epsilon}^{over}$ *(obtained in Lemma 1).*

As in standard disclosure models, firms with favorable news disclose and those with less favorable news withhold. While P_{δ} depends on the expected market return $\mathbb{E}(R_m)$, the disclosure threshold ϵ^{over} does not.

Proposition 2 shows that the equilibrium threshold is located exactly at the (interior) value of ϵ that minimizes $P_{\emptyset}$. Therefore, the disclosure game points to the outcome that makes not disclosing the least attractive. I interpret this result as a partial unraveling of types: market forces minimize payoffs to firms which do not voluntarily give their information. The disclosure friction $\eta \in (0, 1)$, however, prevents this payoff from becoming small, as low-signal firms know that they can be pooled to other firms who did not disclose involuntarily. While I will focus on endogenous disclosure in the rest of the dissertation, the result also points to certain practical cases in which actual accounting rules are able to set the threshold, such as materiality rules or conservative accounting practices (*Basu* (1997), *Heitzman et al.* (2008)). In my model, such rules would always decrease the price difference between the disclosing and non-disclosing firms, making both types of firms more alike and qualitatively weakening the effects of the voluntary disclosure regime.

Comparative Statics

The optimal threshold might potentially depend on the exogenous parameters of the model: the disclosure friction η and the risk aversion of the investors α. In corollary 1, I describe several comparative statics tying the disclosure decisions to these fundamental characteristics of the economy.

Corollary 1. *The threshold ϵ^{over}: (i) is increasing in the disclosure friction η, (ii) is positive and less than θ, (iii) does not depend on the risk-aversion of investors α.*

As is common in the disclosure literature, a higher disclosure friction increases the proportion of firms *voluntarily* withholding. This comparative static is well-understood in the disclosure literature and thus I do not pursue it further here. Firms that should not have invested in first-best do not disclose yet are financed; in this respect, the equilibrium is consistent with its terminology of overinvestment. The asymmetric information between firms and outside investors, combined with a high disclosure friction, leads investors to infer that non-disclosing firms, are predominantly firms unable to disclose and thus are likely to have favorable news. Non disclosing firms have a higher valuation when disclosure frictions are higher, which leads to inefficient investments being financed. Effectively, there are three types of firms that do not disclose: (a) firms that should be financed in first best that wanted to disclose but could, (b) firms that should be financed in first-best but voluntarily withheld, (c) firms that should not be financed in first-best and withheld. Only type (c) causes the investment inefficiency; type (b) may not be blamed on the grounds of efficiency since its voluntary non-disclosure only causes a reallocation of wealth from type (a).

The disclosure threshold ϵ^{over} does not depend on the market risk premium and thus on the risk-aversion parameter α. All firms are financed and once they execute their projects, they are identically affected by the common shock y, which is additively separable from the idiosyncratic cash flow ϵ. An empirical implication of this property is that the amount of voluntary disclosure should be insensitive to the business cycle. For example, according to the model, one should not observe much time series variation in aggregate levels of disclosure as compared to, say, cross-country or cross-industry variations. Moreover, the aggregate level of disclosure should not be related to characteristics of the overall economy, such as GDP growth or market return.

4.1.2 Market Risk Premium

I determine next the expected market portfolio return $\mathbb{E}(R_m^{over})$ and the competitive equilibrium of the economy.

Proposition 3. *For high levels of disclosure frictions ($\eta \geq \eta^{over}$), there exists an overinvestment competitive equilibrium ($\gamma_{\delta f}^{over}, \gamma_{\delta m}^{over}, \mathbb{E}(R_m^{over}), \epsilon^{over}$), where:*

(i) $\gamma_{\delta f}^{over} = 0$ *and* $\gamma_{\delta m}^{over} = 1$

(ii) the expected market return is equal to:

$$\begin{aligned} \mathbb{E}(R_m^{over}) &= \frac{\theta}{\theta + Q^{over}} \\ \textit{where } \; Q^{over} &= \frac{\int y f(y)(\theta + y)^{-\alpha} dy}{\int f(y)(\theta + y)^{-\alpha} dy} < 0 \end{aligned}$$

(iii) and the optimal disclosure threshold is ϵ^{over} defined in equation (4.1)

After the disclosure stage, agents have personal wealth P_δ (where δ may vary across agents), the market value of their firm. Each agent, then, makes different portfolio choice decisions, choosing a different quantity of risk-free asset and market portfolio. Under the assumption of CRRA utilities, agents invest a fixed share of their wealth in the market portfolio that does not depend on their wealth (they invest in proportion to their wealth). Aggregating all such consumers yields a simple expression for the equity premium that corresponds to the market premium for a representative agent owning all the firms and having the same CRRA utility function as each individual consumers.[1]

The expected market portfolio return $\mathbb{E}(R_m^{over})$ given in equation (4.2) can be rewritten as follows:

$$\underbrace{\mathbb{E}(R_m^{over}) - 1}_{\text{risk premium}} = \frac{-Q^{over}}{\theta + Q^{over}} = \frac{-Q^{over}}{P_m^{over}} \tag{4.2}$$

The expected market return has, as predicted by the asset pricing theory, a return higher than the risk-free rate because the market portfolio is exposed to undiversifiable systematic risk. The term $-Q^{over}/P_m^{over}$ corresponds to the equity premium in the CAPM framework.

One important aspect of the model is that the equity premium does not depend on the informational frictions and/or characteristics of the disclosure environment. By Proposition 3, the equity premium can be fully characterized by the behavior of the representative agent who, by construction, owns all the wealth and thus does not bear the extra risk due to disclosure. The result may be surprising given existing results in the CARA-Normal framework, where it is typically obtained that the risk-premium decreases in the disclosure friction (*Jorgensen and Kirschenheither* (2003)) or, in a pure exchange economy, may decrease in exogenous accounting quality (*Lambert et al.* (2007), *Gao* (2008)). One limitation of CARA is its unappealing risk-taking properties; for example, CARA implies that a wealthy investor would own as much (in total dollar amount) of the market portfolio as a poor investor; the richer investor would invest all of his/her extra wealth in the risk-free asset. The idea that risk premia

[1]The result also suggests some caution in interpreting single-agent models of disclosure outside of the CRRA framework. If utility functions are CARA, for example, there will exist a representative agent; however, the preference of this representative agent will depend on the wealth of all agents, which in turn will depend on the disclosure threshold ϵ^*; as a result, a comparative static on the disclosure threshold would require adjusting the preferences of the representative agent - which would lead to considerable analytical difficulties.

should decrease with a greater disclosure friction is, to some extent, an artefact of the CARA formulation, which does not occur if investors invest in the market portfolio relative to their wealth which seems realistic.

4.2 Underinvestment Equilibrium

4.2.1 Risk Premium and Optimal Disclosure Threshold

The underinvestment equilibrium shares with the previous equilibrium the existence of a representative agent, specifically risk premia can be obtained from the solution in a one-person economy. However, one major difference in this economy is that the total consumption available in the economy (the payoff of the market portfolio) depends on how many firms are financed (and thus not financed), which depends on the probability of disclosure and the disclosure friction. Therefore, the disclosure friction may now affect risk premia, through its real effects on aggregate wealth.

Proposition 4. *If the level of disclosure frictions is low ($\eta \leq \eta^{under}$), there exists an underinvestment competitive equilibrium, which is given as follows:*

(i) $\epsilon^{under} = \epsilon^{FB}$

(ii) $\gamma_{\delta f}^{under} = \gamma_{\emptyset m}^{under} = 0$ *and* $\gamma_{\epsilon m}^{under} = 1$

(iii) $\mathbb{E}(R_m^{under})$ *is given as follows:*

$$\begin{aligned}
\mathbb{E}(R_m^{under}) &= \frac{\int_{\epsilon^{under}}^{+\infty} \epsilon h(\epsilon) d\epsilon}{\int_{\epsilon^{under}}^{+\infty} \epsilon h(\epsilon) d\epsilon + (1 - H(\epsilon^{under}))Q^{under}} \\
\textit{where} \;\; Q^{under} &= \frac{\int y f(y) (\int_{\epsilon^{under}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon)^{-\alpha} dy}{\int f(\tilde{y}) (\int_{\epsilon^{under}}^{+\infty} (\epsilon + \tilde{y}) h(\epsilon) d\epsilon)^{-\alpha} d\tilde{y}} < 0
\end{aligned}$$

In the underinvestment equilibrium, all firms that should not have invested in first-best do not disclose and therefore are not financed. Thus, this equilibrium prescribes efficient shut-down of all low-value firms. However, there are also high-value firms that, with probability η, could not disclose and are not financed, leading to underinvestment relative to first-best.

Neither the optimal disclosure threshold nor the risk premium depend on the disclosure friction η. Intuitively, the economy functions in a "constrained" first-best environment, in which a proportion η of efficient firms are simply not financed, but for the remaining proportion $1-\eta$ of efficient firms, investments are made according to the first-best rule.

The expected market portfolio return $\mathbb{E}(R_m^{under})$ can be written as follows:

$$\mathbb{E}(R_m^{under}) - 1 = \frac{-(1-H(\epsilon^{under}))Q^{under}}{\int_{\epsilon^{under}}^{+\infty} \epsilon h(\epsilon)d\epsilon + (1-H(\epsilon^{under}))Q^{under}} > 0$$

Notice that in the underinvestment equilibrium, some firms do not invest and this leads to a decrease in the exposure of the market portfolio to the systematic risk.

4.2.2 Uniqueness of Equilibrium

I investigate next the type of equilibrium that can be sustained as a function of the disclosure friction. Let $Q(x)$ be defined as follows:

$$Q(x) = \frac{\int yf(y)(\int_x^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon)^{-\alpha}dy}{\int f(y)(\int_x^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon)^{-\alpha}dy}$$

Expression $Q(x)$ is a measure of the risk premium required by investors depending on the financing threshold x. Specifically as x increases fewer firms are financed. Note that if x converges to $-\infty$, $Q(x)$ converges to Q^{over} whereas if x is equal to ϵ^{FB} then $Q(x) = Q^{under}$. Ordering Q^{under} and Q^{over} boils down to study the variations of $Q(x)$ for a change in x. An increase in x means fewer firms are financed. Risk-averse investors' wealth diminishes as some firms with positive cash flows do not execute their project. In response to the negative wealth effect investors require a higher risk premium, which translates into a lower $Q(x)$. Simultaneously reducing the number of financed firms also decreases their exposure to systematic risk. Investors require less insurance and thus a lower risk premium or equivalently a higher $Q(x)$.

Lemma 2. *(i) If $Q(x)$ increases in x then $\epsilon^{under} \leq \epsilon^{over}$ and $\eta^{under} \leq \eta^{over}$.*

(ii) If $Q(x)$ decreases in x then $\epsilon^{under} \geq \epsilon^{over}$ and $\eta^{under} \geq \eta^{over}$.

The overinvestment equilibrium exists as long as the non-disclosing firms invest. This condition is satisfied if investors believe that many high-value firms could not disclose, i.e. the disclosure friction η is high. Conversely, when the disclosure friction is low, investors are able to identify non-disclosing firms as low-value firms and therefore they do not invest in a non-disclosing firm. Confronting these two forces, I show that one can be confronted with two scenarios. Case (i) corresponds to the case where there is a unique underinvestment equilibrium for a given η if $\eta \leq \eta^{under}$ whereas there exists a unique overinvestment equilibrium for a given η if $\eta \geq \eta^{over}$. However between η^{under} and η^{over} there is neither an underinvestment nor an overinvestment.[2] Case (ii) implies a multiplicity of equilibria between η^{under} and η^{over}. The overinvestment and underinvesment equilibria overlap.

In both scenarios a large decrease in the disclosure friction worsens the lemon's problem conditional on non-disclosure and thus may cause a reduction in investment even if this means also not financing some high-value firms. The result suggests that sufficiently large decreases in the disclosure friction should reduce the total aggregate level of investment. The analysis points to possibly unwelcome consequences of greater disclosure. For example, during the 2008 financial crisis, a move toward mark-to-market accounting in bank financial statements may have provided more accurate information, but simultaneously may have triggered the shutdown of other (possibly)

[2] For $\eta \in (\eta^{under}, \eta^{over})$ there exist mixed-strategy equilibria where non-disclosing firms are not financed with a positive probability. These equilibria are not studied as they are not very realistic.

healthy institutions that were unable to disclose because of the complexity of their net positions and financial instruments.

The results presented in the next sections hold independently of the variation of $Q(x)$ in x.

4.3 Disclosure and Cost of Capital

4.3.1 Expected Cash Flows and Market Sensitivity

In this Section, I relate a firm disclosure to its cost of capital. Assume that the economy is such that $\eta \geq \eta^{over}$. Prices of a disclosing and a non-disclosing firm are characterized by the two following components:

$$P(\epsilon) = \underbrace{\epsilon}_{\text{Idiosyncratic CF}} + \underbrace{Q^{over}}_{\text{Systematic pricing}}$$

$$P_{\emptyset} = P(\epsilon^{over}) = \underbrace{\epsilon^{over}}_{\text{Idiosyncratic CF}} + \underbrace{Q^{over}}_{\text{Systematic pricing}}$$

The first component in the above equation corresponds to inferences about the idiosyncratic cash flow. It is increasing in the signal and, given that firms that do not disclose have, on average, low value, it is also greater for firms disclosing than for firms not disclosing. The second component corresponds to the pricing of the firm's systematic risk, and is identical for disclosing and non-disclosing firms. While the total amount of systematic risk borne by the disclosing and non-disclosing firms is identical, the total amount of risk per unit of expected cash flow is not. Because disclosing firms have higher cash flows, the sensitivity to systematic risk is diluted. This rationalizes the empirical positive association between voluntary disclosure and earnings quality documented, for example, by *Francis et al.* (2008).

4.3.2 Disclosure and Market Beta

To convert these results into statements about firm's expected returns, I define next a firm's cost of capital as investors' expected cash flow over the market price. To set up ideas, the risk premium corresponds to the cost of capital for the market portfolio.

Formally, let $R_\delta \equiv (\mathbb{E}(\epsilon|\delta))/P_\delta$ be defined as the expected return for a firm disclosing δ (i.e., the ratio of its expected cash flow to its price), where $\delta \in \{\emptyset\} \cup \mathbb{R}$. Finally, let $R_D = \mathbb{E}(R_\delta|\delta \neq \emptyset)$, be the expected return conditional on disclosure.

From asset pricing models, one knows that a firm less (more) sensitive to systematic risk has a lower (higher) expected market return. The measure of the firm's sensitivity to systematic risk is the market β measured by the covariance of the firm's return with the market portfolio return over the variance of the market portfolio return. I relate the market β to the cost of capital in this model.

Lemma 3. *Suppose $\eta \geq \eta^{over}$. The firm's cost of capital can be expressed as follows:*

$$
\begin{aligned}
R_\emptyset &= \underbrace{1}_{\textit{Risk-free}} + \beta_\emptyset \underbrace{(\mathbb{E}(R_m^{over}) - 1)}_{\textit{Risk Premium}} \\
R_D &= \underbrace{1}_{\textit{Risk-free}} + \beta_D \underbrace{(\mathbb{E}(R_m^{over}) - 1)}_{\textit{Risk Premium}}
\end{aligned}
$$

where:

$$
\begin{aligned}
\beta_\emptyset &= \underbrace{\frac{V(y)}{P_\emptyset P_m^{over}}}_{\textit{covariance}} / \underbrace{\frac{V(y)}{P_m^{over2}}}_{\textit{market variance}} \\
\beta_D &= \underbrace{\int_{\epsilon^{over}}^{+\infty} \frac{V(y)}{P(\epsilon) P_m^{over}} \frac{h(\epsilon)}{(1 - H(\epsilon^{over}))} d\epsilon}_{\textit{covariance}} / \underbrace{\frac{V(y)}{P_m^{over2}}}_{\textit{market variance}}
\end{aligned}
$$

Disclosing and non-disclosing firms differ by their sensitivity to the risk premium. Note at this point that non-disclosing firms have an additional variance term due to the fact that their signal is imperfectly known; however, this extra variance is diversifiable and therefore it is not priced. In particular, the variance due to the estimation risk on ϵ does not appear in $\beta_{\emptyset}$.

4.3.3 Firms' Cost of Capital and Disclosure

Proposition 5 compares average expected returns of disclosing firms R_D (averaged over all firms who disclosed successfully) and non-disclosing firms $R_{\emptyset}$.

Proposition 5. *In the overinvestment equilibrium region ($\eta \geq \eta^{over}$), $\beta_D < \beta_{\emptyset}$. That is, disclosing firms have a lower cost of capital than non-disclosing firms, i.e. $R_D < R_{\emptyset}$.*

The market beta of firms disclosing is lower than the market beta of firms that do not disclose. This effect is due to the fact that disclosing firms have, on average, higher idiosyncratic cash flows than non-disclosing firms. In turn, these future gains dilute some of the sensitivity to the systematic shock, offsetting the systematic risk. In contrast, non disclosure implies low cash flows, and thus more systematic risk per unit of cash flow and a higher beta. Proposition 5 establishes that non-disclosing firms earn a higher return than disclosing firms in environments where the disclosure friction is relatively high.

Discussion

This result sheds light on the mixed empirical findings in the current capital market literature on cost of capital. *Welker* (1995) and *Sengupta* (1998) analyze firm disclosure rankings given by financial analysts and find that firms rated as more transparent have a lower cost of capital. *Botosan* (1997) and *Botosan and Plumlee* (2002) show that firms disclosing more information in their annual reports have lower cost of capital. *Francis et al.* (2004, 2005) and *Ecker et al.* (2006) proxy for accounting quality using residual accruals volatility and find similar results. *Chen et al.* (2006) also provide evidence that more firm-specific information in stock returns is related to a lower cost of equity. Finally, *Francis et al.* (2008) find that more voluntary disclosure is associated with a lower cost of capital. Most of these papers relate to information that is in large part voluntarily given, and thus where strategic considerations about what to disclose play an important role. This dissertation provides a simple intuitive framework to better identify some of the economic forces at play in these empirical findings. Note that, in comparison, models with exogenous disclosures do not have this implication, because once the signal is disclosed, the cost of capital of a disclosing firm is not necessarily lower than that of its peers.

The result should be separated from other standard models of disclosure (e.g., *Verrecchia* (1983) or *Dye* (1985)) that do not incorporate systematic risk. In such models, the primary object of interest is the instantaneous response of the market price to disclosure. Such response would also exist here (the non-disclosing firm's price would decrease) but the notion of cost of capital studied here is measured as the return for the (possibly long) period post disclosure, excluding the disclosure event. The benefit of using this approach is that it predicts long-term effects of disclosure, as observed empirically, versus a short adjustment. Further, the standard model predicts that, when not disclosing, a firm's market price would decrease which would lead to negative returns and/or the counterfactual empirical implication that the cost of capital of non-disclosing firms (as proxied by their market return) would be lower than the cost of capital of disclosing firms.

An additional remark to be made at this point is that, in their decision process, value-maximizing firms that disclose, do so to reduce their cost of capital, as noted in many empirical studies. In the model, if a firm with $\epsilon > \epsilon^{over}$ has not disclosed, it would have received a price $P_\emptyset$ and a higher cost of capital. This does not mean, however, that all firms may disclose to reduce their cost of capital. Firms that voluntarily withhold, also do so to reduce their cost of capital. Voluntary disclosure policy is driven by the problem of minimizing cost of capital in financial markets.

Finally, the discussion focuses on the overinvestment equilibrium; if the disclosure friction is low, non-disclosing firms are not financed and therefore one cannot compare the costs of capital between disclosing and non-disclosing firms. More realistically, in the data there may be noise in observing whether firms disclose. If with some probability, some disclosing firms are classified as non-disclosing by the econometrician, then, in the underinvestment equilibrium, firms that did not disclose due to a measurement error should have in expectation the same return as disclosing firms.[3] Thus, a mild extension of the model would suggest that, when the disclosure friction becomes small so that the underinvestment equilibrium occurs, there should not be any difference in costs of capital between disclosing and non-disclosing firms. Controlling for the level of the disclosure friction, in this respect, would help refine the empirical findings.

4.3.4 Disclosure Friction and Average Cost of Capital

Price Dispersion

Before the average cost of capital in the economy is formally stated, it is useful to first derive the price dispersion induced by the disclosure friction. I provide in Lemma 4 two additional technical properties of the model.

Lemma 4. *Denote $\Delta(.;\eta)$ the distribution of P_δ. Let $\eta \geq \eta'$:*

(i) In the overinvestment region, $\Delta(.;\eta)$ second-order stochastically dominates $\Delta(.;\eta')$.

(ii) In the underinvestment region, $\Delta(.;\eta')$ first-order stochastically dominates $\Delta(.;\eta)$.

The first part of lemma 4 (i) demonstrates that a lower disclosure friction increases the variability of market prices in the overinvestment region. That is, more disclosure

[3] The model extends readily to such a measurement error, but to save on notations, I did not include it.

implies a wider range of reported signals while less disclosure implies an "average" price for non-disclosing firms. It follows that a profit-maximizing but risk-averse investor would always prefer a greater disclosure friction in the overinvestment region. This finding echoes to some extent the finding in *Levine and Smith* (2008) who show that more variance does not mean less usefulness. The second part (ii) shows that the result is reversed when the disclosure friction is sufficiently low and falls in the underinvestment region. In the underinvestment equilibrium region, decreasing the disclosure friction raises the chances of a successful disclosure, which implies, because the disclosure threshold coincides with first-best, that more firms choose the efficient investment.

Analysis of Average Cost of Capital

I analyze next the average cost of capital in the economy ($\mathcal{R} \equiv \mathbb{E}(R_\delta)$), which is the unconditional expected return averaging all the firm-specific returns in the economy. The average cost of capital captures the regression output in a cross-sectional equally-weighted empirical study. It is typically different from the risk premium, which is computed as the return of the market portfolio. However, a link between the two concepts is that the latter corresponds to the return of each firm, weighted by its size in the market portfolio (or value-weighted).

Proposition 6. *(i) In the overinvestment region, disclosing and non-disclosing firms' average cost of capital decrease in the disclosure friction. Further overall average cost of capital decreases in the disclosure friction.*

(ii) In the underinvestment region, average cost of capital does not depend on the disclosure friction.

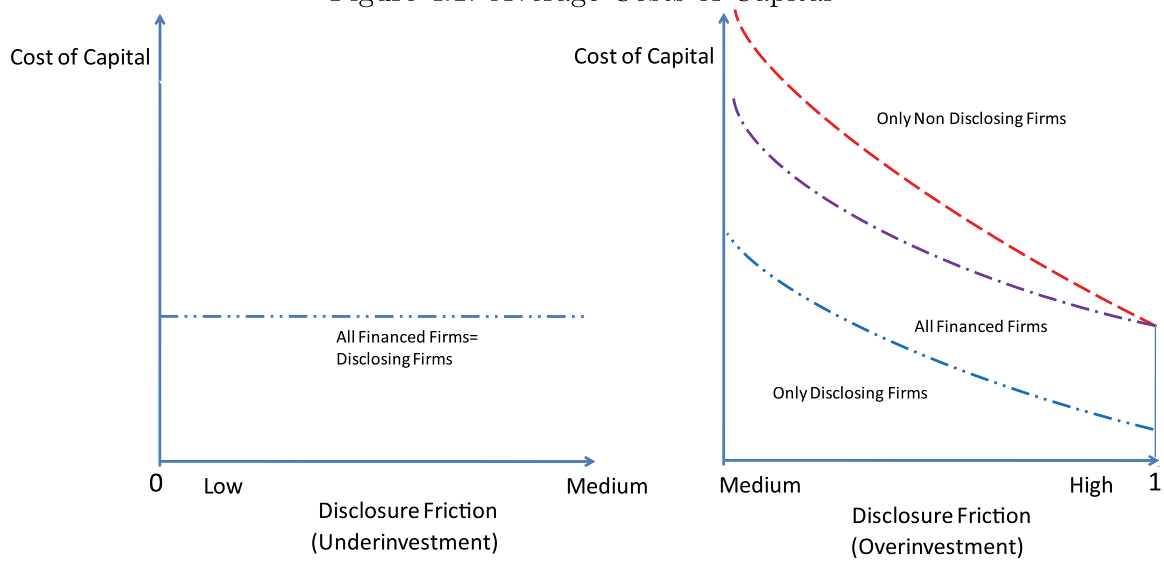
Proposition 6 provides the result that maps the disclosure friction to average cost of capital. In the overinvestment if regulators' objective is to lower the average cost of capital for disclosing firms, they would achieve this by increasing the disclosure friction (i.e., making it harder for firms to disclose when they want to). A lower disclosure friction increases the number of disclosures which in turn causes more cross-sectional dispersion in market prices. On a value-weighted basis, this would not affect the market risk premium . On an equally-weighted basis, firms with lower prices and higher costs of capital are over-represented (as compared to the value-weighted portfolio) implying a greater average cost of capital.

The overinvestment equilibrium and interior disclosure friction leads to the highest possible average cost of capital (see Figure 4.1). For any level of the disclosure friction such that $\eta \leq \eta^{under}$ (underinvestment equilibrium), firms receive an average cost of capital equal to the cost of capital of all disclosing firms.[4] In the underinvestment region non-disclosing firms are no longer financed and aggregate cost of capital falls and remains constant for all $\eta \leq \eta^{under}$. I confront in Figure 4.1 the average cost of capital in the economy with the average costs of capital of disclosing firms (R_D) and non-disclosing firms (R_{ND}) as a function of the exogenous disclosure friction. Figure 4.1 illustrates that if the disclosure friction is low (if underinvestment), disclosing firms' average cost of capital is flat whereas it decreases with a higher disclosure friction if the disclosure friction is relatively high (if overinvestment). Non-disclosing firms' average cost of capital becomes extremely large when the disclosure friction is equal to η^{over} as investors offer them a price close to zero. As drawn on the figure on the right hand side, the overall average cost of capital is a weighted average of the disclosing and non-disclosing firms' cost of capital.

A comparison between the risk premium and the average cost of capital highlights the importance of the choices made in designing empirical cross-sectional studies. In the overinvestment region, the value-weighted cost of capital does not depend on the disclosure friction while the equally-weighted cost of capital is decreasing in the dis-

[4]The average cost of capital in the economy is an unconditional expectation whereas the average cost of capital of disclosing and non-disclosing firms is a conditional expectation.

Figure 4.1: Average Costs of Capital



closure friction. Increased voluntary disclosures are one of the often stated objectives of regulators. From a regulatory perspective, the SEC in its 2003 report on "Management's Discussion and Analysis of Financial Condition and Results of Operations" proposes increasing disclosure quality.[5] The MD&A requirements encourage firms to disclose any useful information to investors even if not mandated: "...in identifying, discussing and analyzing known material trends and uncertainties, companies are expected to consider all relevant information, even if that information is not required to be disclosed."[6] My analysis shows that such rules should lead to more voluntary disclosures, but possibly also higher average cost of capital in the overinvestment region.

[5] see the 2003 report "Commission Guidance Regarding Management's Discussion and Analysis of Financial Condition and Results of Operations."

[6] A detailed report "Interpretation: Commission Guidance Regarding Management's Discussion and Analysis of Financial Condition and Results of Operations" SEC 17 CFR Parts 211, 231 and 241, Release Nos. 33-8350; 34-48960 is available at http://www.sec.gov/rules/interp/33-8350.

Discussion

The model has implications for existing research on cost of capital. Recently, several studies have examined the consequences on firm's average cost of capital of changes to accounting standards (which may or may not improve accounting quality). *Barth et al.* (2007) find evidence that firms applying IAS generally have higher value-relevant information than domestic standards. *Leuz and Verrecchia* (2000) report that a sample of firms voluntarily switching from German to IASB standards decreased their cost of capital. The interpretation of this empirical finding depends on whether this shift was: (i) a voluntary disclosure, (ii) an exogenous change in accounting quality (e.g., if firms needed to use IFRS for other non-strategic reasons). Under (i), the model would be consistent with IFRS having more quality than German standards, since only high-value firms would have chosen to shift (and reduce their cost of capital). Under (ii), the model predicts that the decrease in cost of capital should have been caused by a decrease in accounting quality (interpreted here as an increase in the disclosure friction) in the IAS standard. Comparing (i) and (ii), the interpretation of IFRS having more accounting quality than German standards depends on whether the shift was predominantly a strategic choice or a natural experiment.

4.4 Efficiency and Average Cost of Capital

Finally I address the relation between the exogenous disclosure friction and economic efficiency; and from a policy evaluation standpoint, whether economic efficiency can be measured by the average cost of capital. I use the term of efficiency to describe how well the accounting system maximizes investors' ex-ante expected utility (another common term is welfare). The term of efficiency is preferred here to that of welfare to stress that I look at the ex-ante utility of identical agents, and not at other important but unmodeled redistributive implications (see *Kanodia* (1980) or

Gao (2008) for discussions on these issues). Analyzing efficiency is useful, because in theory any efficient outcomes could lead to welfare improvements in an economy with non-identical agents if a planner were to make fixed transfers (second-welfare theorem); separating efficiency from welfare considerations, in this respect, allows me to distinguish accounting from reallocative effects.

Economic efficiency in the model can be decomposed in two aspects: productive efficiency, i.e. whether a lower disclosure friction implements more efficient production, and risk-sharing efficiency, i.e. to what extent can financial markets help investors insure against diversifiable risk.

4.4.1 Productive Efficiency

I look first at the productive distortions which appear in second-best. In shorthand, I define as productive efficiency the extent to which firms' investment decisions correspond to the first-best investment decisions.[7]

Proposition 7. *(i) In the overinvestment region, productive efficiency does not depend on the disclosure friction.*

(ii) In the underinvestment region, productive efficiency decreases in the disclosure friction.

The model predicts that a lower disclosure friction leads to higher productive efficiency if the disclosure friction is initially sufficiently low. Since the disclosure friction is low enough that the equilibrium is one of underinvestment, further lowering the friction will reduce the underinvestment. A lower friction allows fewer high-value firms to be pooled with low-value firms.

[7] As most notions of efficiency, productive efficiency is, in general, an incomplete order, in that the efficiency of different economies may not be comparable (if two economies have different firms that invest or do not invest). However, in my model, productive efficiency in one type of equilibrium is always comparable: the disclosure friction increases or decreases the mass of firms that underinvest or overinvest.

In contrast, when the equilibrium has overinvestment, increases or decreases to the disclosure friction do not affect the productive efficiency. All firms are financed regardless of the disclosure friction and, thus, the accounting system fails to function as an informative signal for investment decisions.

4.4.2 Risk-Sharing Efficiency

Financial markets help ex-ante undiversified investors diversify their idiosyncratic risk ϵ in the financial market, thus leading to improved risk-sharing. However, as noted in Lemma 4, a lower disclosure friction may imply more dispersion in personal wealth, leading to additional disclosure risk. I define here risk-sharing efficiency by considering investors' expected utility for a given investment.[8]

Proposition 8.

(i) In the overinvestment region, risk-sharing efficiency increases in the disclosure friction.

(ii) In the underinvestment region, risk-sharing efficiency decreases in the disclosure friction.

I show that the risk-sharing efficiency depends on whether the disclosure friction is used for investment purposes. If there is overinvestment, the disclosure friction does not affect the firms' investment decision and thus disclosure has no purpose in that respect. However lowering the disclosure friction, because trades are realized after the disclosure decision, increases risk for ex-ante investors.[9] In comparison, I find that, whenever the disclosure friction is used to decide on investment decisions, a lower disclosure friction always leads to less underinvestment but the range of prices

[8] Again, as in the case of productive efficiency, I define the term only loosely here. A formal definition is available on request.

[9] However, it should still be noted that the fact that accounting is not used for investment purposes $\eta \geq \eta^*$ is endogenously derived from the model; and thus the statement requires a proper analysis of investment and disclosure.

is not affected by the disclosure friction. A lower disclosure friction always leads to better risk-sharing, in that it makes the likelihood of the low payoff associated to firm shutdown less likely.

4.4.3 Economic Efficiency

I derive the investors' expected utility (or economic efficiency) for a change in the level of the disclosure friction. To compute economic efficiency, one needs to contrast both productive efficiency with ex-ante risk-sharing motives.

Proposition 9. *Economic efficiency is maximum at either* $\eta = 0$ *or* $\eta = 1$*.*

As the disclosure friction moves away from η^{over} or η^{under}, either productive efficiency or risk-sharing improves, leading to an overall improvement in economic efficiency. Proposition 9 shows that the global efficiency optimum takes the form of a corner (or "bang-bang") social policy with either a complete resolution of the risk-sharing with no disclosure (maximum disclosure friction), or a complete resolution of the production inefficiency with full disclosure (no disclosure friction).

Corollary 2. *An increase in average cost of capital implies a decrease in economic efficiency in the overinvestment region.*

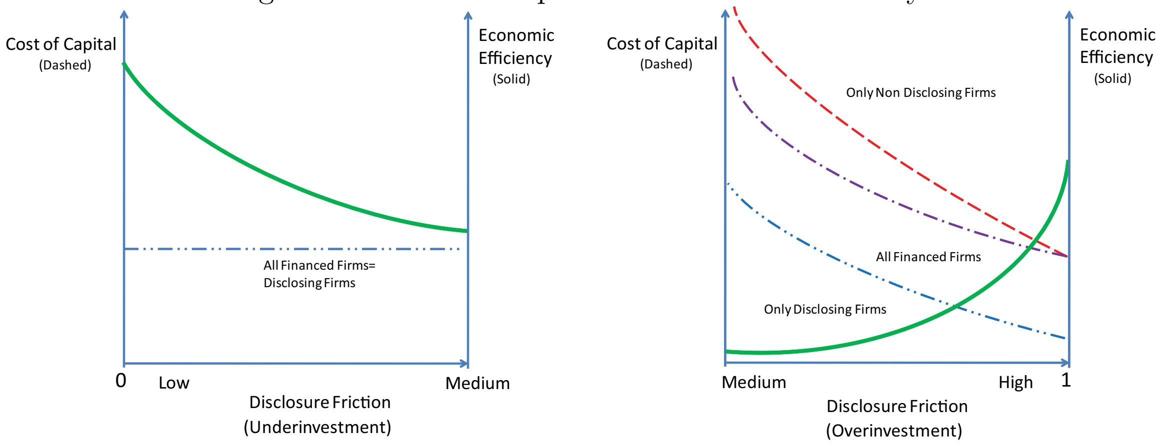
As noted in the introduction, linking cost of capital to efficiency is important, since cost of capital is a metric that can be empirically observed to evaluate a new accounting regulation. I show that the average cost of capital is always aligned with economic efficiency in the overinvestment region. The average cost of capital is a proxy for economic efficiency when the disclosure friction is high; specifically, in my model, the average cost of capital captures how well financial markets function at diversifying idiosyncratic risk. However, when the disclosure friction is relatively low, the average cost of capital may be artificially low because high-beta non-disclosing firms are not financed. I represent the overall costs of capital and investors' expected utility (called on Figure 4.2 “Economic Efficiency”) as a function of the disclosure friction on Figure 4.2. As illustrated when the disclosure friction is above η^{over} (overinvestment), the investors’ expected utility and the average cost of capital (and also disclosing and non-disclosing firms’ average costs of capital) are negatively associated. Shyam Sunder’s (2002) question “How would the rule maker know which rule will reduce the cost of capital?” can be addressed as follows: if the initial disclosure friction is relatively high and cannot be substantially decreased without large cost to the economy, rule makers should try to increase it to decrease average cost of capital.

Further when one compares the efficiency with no friction versus the maximum disclosure friction, if efficiency is greater without the disclosure friction, then average cost of capital and efficiency are misaligned (as shown on the left hand side of Figure 4.2). It is easy to verify that this condition will be verified when risk-aversion is low, so that the production efficiency concerns dominates risk-sharing concerns. The condition, however, is not sufficient to maximize efficiency, given that average cost of capital is constant when $\eta < \eta^{under}$; in this case, maximizing efficiency requires also maximizing the aggregate level of investment.

On the other hand, average cost of capital is aligned with efficiency when risk-sharing motives dominate productive efficiency concerns (i.e., when $\eta = 1$ is preferred to $\eta = 0$). In this case, the efficient accounting policy minimizes average cost of capital and, in the overinvestment region, a decrease in average cost of capital implies an increase in efficiency. This condition will be satisfied when risk-aversion is large or few firms have signals below ϵ^{FB}.

In summary, I show that the alignment between average cost of capital and economic efficiency depends on investors’ risk-aversion and the distribution of firm’s cash flows. From a practical perspective, then, an implication of the result is that policy evaluation using average cost of capital should depend on which economy is being analyzed. In developed economies, for example, one may possibly expect more high-

Figure 4.2: Cost of Capital vs Economic Efficiency



value firms because such firms are filtered by existing institutions. Further, because the state may be offering a safety welfare net, one may also expect investors to be less risk-averse. One would then expect in such economies regulators to implement a lower disclosure friction and relatively high average cost of capital for disclosing firms. This prediction would be reversed in the case of emerging economies. In such economies, one would expect investors to be more risk-averse due to possible liquidity needs or more severe lemon's problems due to the lack of pre-established institutions.[10] A testable empirical implication is that countries that are well-developed should choose a low disclosure friction, and higher average cost of capital for disclosing firms, moderate to high average cost of capital and higher investment as compared to emerging economies.

4.4.4 Mandatory Disclosures

Regulators often prone transparency. I discuss next the benefits of exogenously imposing the release of information by those firms that strategically chose not to disclose. Of course, doing so may not be costless, the costs of implementing more transparency

[10] A recent literature discusses whether developing economies may have more severe informational frictions than developed countries and examines implications for growth.

have been criticized in the implementation of the Sarbanes-Oxley Act. Given that the downside of these additional costs is logically straightforward, I focus instead on the benefits of such mandatory disclosures and how such benefits will be perceived in firms' cost of capital.

Corollary 3. *In the overinvestment region, mandatory disclosure implies productive efficiency; however, in the underivestment region, mandatory disclosure does not change productive efficiency or risk-sharing.*

The first part of the statement is intuitive. Mandatory disclosure complements the accounting system in detecting low-value firms. The effect of mandatory disclosure, however, is ambiguous, given that it puts additional risk on ex-ante investors. However, it can be easily verified that mandatory disclosure always increases efficiency if $\eta = 0$ is preferred to $\eta = 1$ under the no-mandatory disclosure regime. However, mandatory disclosure fails to produce any real effects in the case of a low disclosure friction. This means that if imposing such regulation were to be costly, it would be a pure deadweight loss to the economy.

These observations can be reframed in the context of current discussions about the success of the regulations surrounding the Sarbanes-Oxley Act. One question is whether accounting quality (measured here by a disclosure friction) was too low, and led to overinvestment on many low-value firms. If full disclosure was the preferred level of information availability, lowering the disclosure friction would have been optimal. However, if the latter was infeasible or impractical, a surrogate policy consists of mandatory disclosures. On the other hand, if the disclosure friction was already low, and the sequence of corporate scandals around the year 2000 was a one-time event; then, mandatory disclosures may not have improved efficiency.

CHAPTER V

Conclusion

5.1 Robustness Checks and Extensions

I further explore the sensitivity of some of my results to the modeling assumptions.

5.1.1 The CRRA Utility Assumption

The CRRA utility assumption seems to better fit individual behaviors as noted before relatively to other standard utilities. The cross-sectional result presented in proposition 5 is robust to any strictly increasing and concave utility function but the CRRA assumption is required for the comparative statics and efficiency comparisons.

More precisely, the CRRA utility is necessary to build the representative agent as the investors are not perfectly diversified ex-ante. Thus they are facing risk-sharing problems. However, if one assumes instead they are perfectly diversified, building a representative agent is not a problem anymore. Any increasing and concave utility function could be used. A benefit of considering perfectly diversified investors would be to use a utility function defined over $\mathbb{R}$.

Assuming perfectly diversified investors would affect the aggregate level analysis regarding the risk-sharing inefficiency. As investors do not face risk-sharing problems, their average cost of capital is flat and independent of the disclosure friction η. Proposition 6 is thus altered. It follows that proposition 9 is modified as well: economic efficiency would be maximized at $\eta = 0$ with full disclosure, as the only potential inefficiency comes from the investment problem.

5.1.2 The Firm-Specific Result

In my model, I consider a purely additive and separable structure of the idiosyncratic component ϵ and the systematic component y. More generally the idiosyncratic component could interact with the systematic component. Let define the positive function $\psi(.)$ such that the cash flow of the firm is $\epsilon + \psi(\epsilon)y$. Under this new assumption, in the overinvestment equilibrium, the cost of capital by disclosing ϵ is:

$$\frac{\epsilon}{\epsilon + \psi(\epsilon)Q^{over}}$$
$$\text{where } Q^{over} < 0$$

Proposition 5 remains true if the cost of capital is decreasing in ϵ. Differentiating the cost of capital in ϵ, it yields:

$$\frac{\psi'(\epsilon)}{\psi(\epsilon)} \leq \frac{1}{\epsilon}$$

Sufficient conditions to guarantee the cross-sectional result are that $\psi(.)$ is a positive decreasing function. Intuitively a disclosing firm receives a lower cost of capital relatively to a non-disclosing firm as long as its disclosure " swamps" the negative impact of the systematic risk. For example, a firm disclosing that it has a better technology than other firms (higher ϵ), will also lower its sensitivity to the systematic shock (lower $\psi(\epsilon)$) as already clients pre-order the new product. However if an oil company drilling pits in a very unstable political country turns out to finally find the natural resource, it clearly revises upward its future cash flows ϵ, but at the same time it is more exposed to the political instability (higher $\psi(\epsilon)$). Thus it would be more ambiguous to determine whether a disclosing firm will have a lower cost of capital than a non-disclosing firm.

This cross-sectional result was also derived within an overinvestment equilibrium. In an underinvestment equilibrium, the non-disclosing firms were shut down and thus were not present in the economy. As a consequence, no cross-sectional implications could arise. Now assume firms whether they invest or not receive a constant cash flow of $\mu > 0$. Adding this constant term would render the construction of the representative agent untractable. To avoid this issue one needs to assume that the investors are perfectly diversified *ex-ante*. If it is the case, non-disclosing firms would be priced μ. Their cost of capital would obviously be the risk-free rate (they are not exposed to the systematic risk). Therefore in an underinvestment equilibrium, non-disclosing firms would have a lower cost of capital relatively to non-disclosing firms. This finding could shed light on some of the mixed findings in empirical research. One additional empirical prediction is that in a boom (where all firms are likely to find financing), disclosing firms would have a lower cost of capital, whereas in recession (where only firms clearly able to convince the banks they carry good projects), disclosing firms would have a higher cost of capital than non-disclosing firms.

5.1.3 The Fixed Investment Assumption

I assume that firms either invest or not. A more general assumption would be to consider instead a variable investment. However in order to implement this analysis, investors must be perfectly diversified ex-ante. Adding a variable investment brings new issues: I can explore whether firms will choose the first-best level of investment and how the level of investment will affect the pricing of the firm. However the determination of the disclosure threshold and the other results are less likely to be as tractable. I derive below some results under this new assumption, but illustrate some difficulties that might arise to recast the results of the dissertation within this framework.

The cash flow of a firm becomes $(\epsilon + y)I - \frac{c}{2}I^2$, where I is the level of investment chosen by the firm. I restrict my attention to the case where $\epsilon + y > 0$. Assume the firms choose their level of investment before the markets price them. Their level of investment is public information.

First, I determine some properties of the equilibrium prices and the interaction between the investment decision and the disclosure strategy. Clearly a firm disclosing ϵ will choose its level of investment as a function of ϵ. However for firms, which on purpose want to retain their private information, they know for sure the markets will never observe their private information. Thus there is no reason to believe that the choice of their investment should be conditional on their own ϵ. Otherwise markets from observing their investments could infer they are non-disclosing firms on purpose.

If firms willing to disclose choose a level of investment $\hat{I}(\epsilon)$ and ϵ^* is the equilibrium threshold determining for a firm whether it wants to disclose its information instead of retaining it, firms hiding their information on purpose will only take levels of investments in the range $[\hat{I}(\epsilon^*), \hat{I}(b)]$, where b is the upper bound of the support of the ϵ.

Observation 1. *Each firm with $\epsilon \leq \epsilon^*$ does not disclose and mixes over the levels of investment $I \in [\hat{I}(\epsilon^*), \hat{I}(b)]$ according to $\phi(I)$, the probability to invest I.*

Observation 1 implicitly assumes that firms retaining their information adopt a symmetric behavior. Firms hiding their information mimic the investment choice of firms willing to disclose their information. Straightforwardly firms with an ϵ above the threshold will prefer an investment increasing in ϵ.

Proposition 10. $\forall I \in [\hat{I}(\epsilon^*), \hat{I}(b)]$, *the price of a non-disclosing firm investing I, $P_\emptyset(I)$ is constant in I.*

If the non-disclosing price were to depend on the investment level I, then it would be possible to have $P_\emptyset(\hat{\epsilon}, I_1) > P_\emptyset(\hat{\epsilon}, I_2)$. Thus a firm willing to disclose and choosing an investment level I_2 given its private information would deviate by retaining its information and investing I_1. Therefore the non-disclosing price must be flat in I to avoid any deviation from firms willing to disclose their information.

I turn next to the equilibrium price of disclosing firms. As noted before firms deciding to disclose their information will condition their investment choice on their cash flows ϵ. Their optimal investment $\hat{I}$ maximizes:

$$(1-\eta)(\epsilon + Q)I - \frac{c}{2}I^2 + \eta P_\emptyset(I) \tag{5.1}$$

where Q is a measure of the risk premium as defined in the previous sections. By proposition 10, $P_\emptyset$ is constant, it follows that a disclosing firm will choose the first-best level of investment as stated next:

Proposition 11.

(i) Firms willing to disclose their information choose the first-best level of investment: $\hat{I}(\epsilon) = I^{FB}(\epsilon) = \frac{\epsilon + Q}{c}$.

(ii) $P(\epsilon, \hat{I}(\epsilon)) = (\epsilon + Q)^2/(2c)$

To summarize firms willing to disclose always choose the efficient level of investment whereas firms voluntarily retaining their information take an inefficient level of investment. Firms willing to disclose their information have an investment increasing in ϵ.

I finally determine the disclosure threshold if the investment is variable:

Proposition 12. *The optimal disclosure threshold ϵ^* exists and is defined by:*

$$1 = \int_{I^{FB}(\epsilon^*)}^{I^{FB}(b)} \frac{\eta h(cI - Q)(\frac{(cI)^2}{2c} - \frac{(\epsilon^*+Q)^2}{2c})}{H(\epsilon^*)(\frac{(\epsilon^*+Q)^2}{2c} - \mathbb{E}(\epsilon + Q|\epsilon \leq \epsilon^*)I - \frac{c}{2}I^2)} dI \tag{5.2}$$

Equation (5.2) implicitly defines the optimal threshold. If the existence of the threshold is straightforward, the uniqueness is not. Additional structure on the probability distributions would be necessary to establish the uniqueness. If the optimal threshold is unique, the results in the overinvestment equilibrium would be very close to the results within this framework: all firms invest ($\hat{I} > 0$) and firms which retained their information on purpose overinvest relatively to first-best.

Introducing a variable investment is an interesting problem where one can relate firms' choice of different levels of investment to the first-best. However, it makes the framework much less tractable to study the optimal disclosure strategy. To address the effects of this assumption on the results derived earlier, additional assumptions should be considered. Thus developing the model with a variable investment implies a loss of generality at other levels.

5.2 Concluding Remarks

My dissertation provides a theory that ties together voluntary disclosure, cost of capital and economic efficiency. My model captures three main salient components: there are multiple firms and investors, voluntary disclosures are endogenous but affected by an exogenous disclosure friction,and the disclosure friction has real efficiency consequences on risk-sharing and production. I make several main observations.

(i) If the disclosure friction is high, firms that disclose have lower cost of capital than firms that do not disclose.

(ii) An increase from a low to a high disclosure friction implies an increase in aggregate investment.

(iii) Economies with a high disclosure friction feature overinvestment, while those with a low disclosure friction feature underinvestment.

(iv) If the disclosure friction is high (low), a decrease in the disclosure friction implies an increase (no change) in average cost of capital and an decrease (increase) in economic efficiency.

(v) Mandatory disclosures may increase efficiency only if the initial disclosure friction is relatively high.

As a path for future work, the analysis suggests several links between information availability driven by the disclosure friction and asset pricing; if one interprets information availability in our model as a proxy of accounting quality then empirical analysis should offer a more systematic methodology to use accounting quality as an asset pricing factor. Moreover, more work is necessary to unravel how to measure changes to accounting quality that fit well the cross-section of stock returns. Finally, I focused on a one-period economy, in order to use results on aggregation with a disclosure game with multiple firms. However, a dynamic model would complement my analysis to understand the time-series properties of disclosures in which investors can smooth their consumption over time.

APPENDICES

APPENDIX A

Tables

The objective of this appendix is to position my dissertation within the literature on cost of capital, defined as the expected market return. As mentioned before, the literature on cost of capital is predominantly divided into the literature using endogenous information (voluntary disclosure) on one hand and the literature on exogenous information on the other hand. I present next in table A.1 the different assumptions used in the cost of capital literature and in my dissertation and in table A.2 the questions addressed in the literature. I finally gather in table A.3 the main results of the papers in the literature and mine.

Table A.1: Assumptions

	Production	Multiple firms	CARA utility	normality distribution	Voluntary disclosure
Easley and O'Hara (2004)		X	X	X	
Hughes, Liu and Liu (2007)		X	X	X	
Lambert, Leuz and Verrecchia (2007)		X		X	
Lambert, Leuz and Verrecchia (2008)		X	X	X	
Gao (2008)	X		X	X	
Jorgensen and Kirschenheiter (2003, 2007)		X	X	X	X
My model	X	X			X

Table A.2: Questions Addressed

	Disclosing vs Non Disclosing Firms' CoC	Association Risk Premium/ Disclosure	Association Risk Premium/ Efficiency	Association CoC Efficiency
Easley and O'Hara (2004)		X		
Hughes, Liu and Liu (2007)		X		
Lambert, Leuz and Verrecchia (2007)		X		
Lambert, Leuz and Verrecchia (2008)		X		
Gao (2008)		X	X	
Jorgensen and Kirschenheiter (2003, 2007)	X	X		
The model	X	X	X	X

Table A.3: Results

	Disclosing vs Non-Disclosing firms' CoC	Association Disclosure /Risk Premium (RP)	Association Disclosure / overall CoC	Association overall CoC /Efficiency
accounting conventional wisdom	**lower CoC for disclosing firms**	**negative**	**negative**	**negative**
the model	**lower CoC for disclosing firms if overinvestment**	**RP independent of the disclosure friction in a given equilibrium**	**no impact (positive) if underinvestment (overinvestment)**	**negative (no impact) if overinvestment (underinvestment)**
Jorgensen and Kirschenheiter (2003)	**lower CoC for disclosing firms only in finite economy**	**positive**	**no prediction**	**no prediction**
Jorgensen Kirschenheiter (2007)	**lower CoC for disclosing firms**	**positive**	**no prediction**	**no prediction**
Easley and O'Hara (2004)	**no prediction**	**negative**	**no prediction**	**no prediction**
Hughes et al. (2007)	**no effect**	**negative**	**no prediction**	**no prediction**
Lambert et al. (2007)	**no prediction**	**negative**	**no prediction**	**no prediction**
Lambert et al. (2008)	**no prediction**	**negative**	**no prediction**	**no prediction**
Gao (2008)	**no prediction**	**negative if high investment adjustment cost**	**no prediction**	**ambiguous**

APPENDIX B

Proofs

Proof of Proposition 1: The social planner solves the following maximization problem:

$$\max_{\tilde{\epsilon}} \int f(y) U\left(\int_{\tilde{\epsilon}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon\right) dy \tag{B.1}$$

The FOC of the maximization problem (B.1) yields:

$$-h(\epsilon^{FB}) \int f(y)(\epsilon^{FB} + y) U' \left(\int_{\epsilon^{FB}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon\right) dy = 0 \tag{B.2}$$

As $h(\epsilon^{FB}) > 0$, one can rewrite the above Equation (B.2) as $\Phi(\epsilon^{FB}) = 0$ where:

$$\begin{aligned}
\Phi(\epsilon^{FB}) &= -\int f(y)(\epsilon^{FB} + y) U' \left(\int_{\epsilon^{FB}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon\right) dy = 0 \\
\epsilon^{FB} &= -\frac{\int y f(y) U' \left(\int_{\epsilon^{FB}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon\right)}{\int f(y) U' \left(\int_{\epsilon^{FB}}^{+\infty} (\epsilon + y) h(\epsilon) d\epsilon\right)} dy
\end{aligned} \tag{B.3}$$

Expression (B.3) corresponds to Equation (3.2) in Proposition 1. To prove that ϵ^{FB} is unique and in $(0, \theta)$, it is sufficient to show that: (i) $\Phi' < 0$ and, (ii) $\Phi(0) > 0$ and $\Phi(\theta) < 0$.

$$\Phi'(\tilde{\epsilon}) = \int f(y)(\tilde{\epsilon}+y)^2 h(\tilde{\epsilon}) U''\left(\int_{\tilde{\epsilon}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy - \int f(y)U'\left(\int_{\tilde{\epsilon}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy < 0 \tag{B.4}$$

Further

$$\begin{aligned}\Phi(0) &= -\int yf(y)U'\left(\int_0^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy \\ &= \underbrace{-\int_0^{+\infty} yf(y)U'\left(\int_0^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy}_{A} \\ &\quad \underbrace{-\int_{\underline{y}}^{0} yf(y)U'\left(\int_0^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy}_{B}\end{aligned}$$

The first part A is equal to

$$\int_0^{+\infty} yf(y)U'\left(\int_0^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy < \int_0^{+\infty} yf(y)U'\left(\int_0^{+\infty}\epsilon h(\epsilon)d\epsilon\right)dy$$

because U is strictly concave. Likewise, the second part B is equal to

$$\int_{\underline{y}}^{0} yf(y)U'\left(\int_0^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)dy < \int_{\underline{y}}^{0} yf(y)U'\left(\int_0^{+\infty}\epsilon h(\epsilon)d\epsilon\right)dy$$

Therefore:

$$\Phi(0) > -\int_{\underline{y}}^{+\infty} yf(y)U'\left(\int_0^{+\infty}\epsilon h(\epsilon)d\epsilon\right)dy = -U'\left(\int_0^{+\infty}\epsilon h(\epsilon)d\epsilon\right)\int_{\underline{y}}^{+\infty} yf(y)dy = 0$$

Moreover by assumption $\theta + y > 0$ for all y, it follows

$$\Phi(\theta) = -\int f(y)(\theta + y)U'\left(\int_{\theta}^{+\infty} (\epsilon + y)h(\epsilon)d\epsilon\right) dy < 0$$

Proof of Lemma 1:

$$P_{\emptyset}(\hat{\epsilon}) = \underbrace{\frac{1}{\eta + (1-\eta)H(\hat{\epsilon})}\left(\eta\int_{\hat{\epsilon}}^{+\infty} \epsilon h(\epsilon)d\epsilon + \int_{-\infty}^{\hat{\epsilon}} \epsilon h(\epsilon)d\epsilon\right) - \theta}_{\text{value of investment in risk-free asset}} \underbrace{+\frac{\theta}{\mathbb{E}(R_m)}}_{\text{value of investment in market portfolio}}$$

I differentiate $P_{\emptyset}(\hat{\epsilon})$ with respect to $\hat{\epsilon}$:

$$\begin{aligned}\frac{\partial P_{\emptyset}(\hat{\epsilon})}{\partial \hat{\epsilon}} &= -\frac{(1-\eta)h(\hat{\epsilon})\eta}{(\eta + (1-\eta)H(\hat{\epsilon}))^2}\int_{\hat{\epsilon}}^{+\infty} \epsilon h(\epsilon)d\epsilon \\ &\quad -\frac{(1-\eta)h(\hat{\epsilon})}{(\eta + (1-\eta)H(\hat{\epsilon}))^2}\int_{-\infty}^{\hat{\epsilon}} \epsilon h(\epsilon)d\epsilon + \frac{(1-\eta)\hat{\epsilon}h(\hat{\epsilon})}{\eta + (1-\eta)H(\hat{\epsilon})} \qquad \text{(B.5)}\end{aligned}$$

By integration by part and rearranging expression (B.5), I obtain:

$$\begin{aligned}\frac{\partial P_{\emptyset}(\hat{\epsilon})}{\partial \hat{\epsilon}} &= -\frac{(1-\eta)h(\hat{\epsilon})}{(\eta + (1-\eta)H(\hat{\epsilon}))^2}(\eta + (1-\eta)H(\hat{\epsilon}))\hat{\epsilon} \\ &\quad -\frac{(1-\eta)h(\hat{\epsilon})}{(\eta + (1-\eta)H(\hat{\epsilon}))^2}\left(\eta\int_{\hat{\epsilon}}^{+\infty} (1 - H(\epsilon))d\epsilon - \int_{-\infty}^{\hat{\epsilon}} H(\epsilon)d\epsilon\right) \\ &\quad +\frac{(1-\eta)\hat{\epsilon}h(\hat{\epsilon})}{\eta + (1-\eta)H(\hat{\epsilon})} \qquad \text{(B.6)}\end{aligned}$$

After simplifying expression (B.6), it yields:

$$\frac{\partial P_{\emptyset}(\hat{\epsilon})}{\partial \hat{\epsilon}} = \frac{(1-\eta)h(\hat{\epsilon})}{(\eta + (1-\eta)H(\hat{\epsilon}))^2}\left(\int_{-\infty}^{\hat{\epsilon}} H(\epsilon)d\epsilon - \eta\int_{\hat{\epsilon}}^{+\infty} (1 - H(\epsilon))d\epsilon\right) \qquad \text{(B.7)}$$

I determine $\hat{\epsilon}^{over}$ such that $\frac{\partial P_{\emptyset}(\hat{\epsilon})}{\partial \hat{\epsilon}}|_{\hat{\epsilon}=\hat{\epsilon}^{over}} = 0$:

$$\int_{-\infty}^{\hat{\epsilon}^{over}} H(\epsilon)d\epsilon - \eta \int_{\hat{\epsilon}^{over}}^{+\infty} (1 - H(\epsilon))d\epsilon = 0 \tag{B.8}$$

Let us define

$$\Psi(\hat{\epsilon}) = \int_{-\infty}^{\hat{\epsilon}} H(\epsilon)d\epsilon - \eta \int_{\hat{\epsilon}}^{+\infty} (1 - H(\epsilon))d\epsilon \tag{B.9}$$

The function Ψ is increasing in $\hat{\epsilon}$ as

$$\Psi'(\hat{\epsilon}) = \eta + (1 - \eta)H(\hat{\hat{\epsilon}}) \geq 0$$

Further when $\hat{\epsilon}$ converges to $-\infty$ then Ψ converges to $-\eta \int_{-\infty}^{+\infty}(1 - H(\epsilon))d\epsilon < 0$ and when $\hat{\epsilon}$ converges to $+\infty$, Ψ converges to $\int_{-\infty}^{+\infty} H(\epsilon)d\epsilon > 0$. If $\hat{\epsilon} \in (-\infty, \hat{\epsilon}^{over}]$ (resp. $\hat{\epsilon} \in (\hat{\epsilon}^{over}, +\infty)$), expression (B.9) is negative (resp. positive). To summarize $P_{\emptyset}(\hat{\epsilon})$ is decreasing (resp. increasing) if $\hat{\epsilon} \in (-\infty, \hat{\epsilon}^{over}]$ (resp. if $\hat{\epsilon} \in (\hat{\epsilon}^{over}, +\infty)$) where $\hat{\epsilon}^{over}$ is the minimum of $P_{\emptyset}(\hat{\epsilon})$.

Proof of Proposition 2: Notice that any disclosure equilibrium is determined by a threshold.

I need to solve $P_{\emptyset}(\hat{\epsilon}) = P(\hat{\epsilon})$ to find the optimal threshold(s). First I prove the existence of this optimal threshold and second its uniqueness.

Existence of the threshold Let $\hat{\epsilon}$ be a threshold (not necessarily the optimal threshold). Notice that $P_{\emptyset}$ also depends on the threshold $\hat{\epsilon}$. So $P_{\emptyset} = P_{\emptyset}(\hat{\epsilon})$. I compare $P_{\emptyset}(\hat{\epsilon})$ with $P(\hat{\epsilon})$ at the extreme values of $\hat{\epsilon}$. If $\hat{\epsilon}$ goes to $-\infty$, then the price is equal to $-\infty$ and it is less than $P_{\emptyset} = \mathbb{E}(P(\epsilon)) = \frac{\theta}{\mathbb{E}(R_m)}$. If $\hat{\epsilon}$ goes to $+\infty$, then $P(\hat{\epsilon})$ goes to $+\infty$ and it is greater than $P_{\emptyset} = \mathbb{E}(P(\epsilon)) = \frac{\theta}{\mathbb{E}(R_m)}$. Therefore by the theorem of intermediary values, there exists a threshold ϵ^{over} such that $P_{\emptyset}(\epsilon^{over}) = P(\epsilon^{over})$.

Uniqueness of the threshold

I show next that there is a unique solution ϵ^{over} such that $P_{\emptyset}(\epsilon^{over}) = P(\epsilon^{over})$.

$$
\begin{aligned}
P_{\emptyset}(\hat{\epsilon}) &= \frac{1}{\eta+(1-\eta)H(\hat{\epsilon})}\left(\eta\int_{\hat{\epsilon}}^{+\infty}\epsilon h(\epsilon)d\epsilon+\int_{-\infty}^{\hat{\epsilon}}\epsilon h(\epsilon)d\epsilon\right)-\theta \\
&+\frac{\theta}{\mathbb{E}(R_m)}
\end{aligned}
$$

Integrating by parts and simplifying, I can expressed the above price as follows:

$$
\begin{aligned}
P_{\emptyset}(\hat{\epsilon}) &= \hat{\epsilon}+\frac{\eta}{\eta+(1-\eta)H(\hat{\epsilon})}\int_{\hat{\epsilon}}^{+\infty}(1-H(\epsilon))d\epsilon \\
&-\frac{1}{\eta+(1-\eta)H(\hat{\epsilon})}\int_{-\infty}^{\hat{\epsilon}}H(\epsilon)d\epsilon-\theta+\frac{\theta}{\mathbb{E}(R_m)}
\end{aligned}
$$

Similarly $P(\hat{\epsilon})$ can be expressed as:

$$
P(\hat{\epsilon}) = \hat{\epsilon}-\theta+\frac{\theta}{\mathbb{E}(R_m)}
$$

I compute the difference $D(\hat{\epsilon})$ between $P_{\emptyset}(\hat{\epsilon})$ and $P(\hat{\epsilon})$:

$$
D(\hat{\epsilon})=\frac{1}{\eta+(1-\eta)H(\hat{\epsilon})}\left(\eta\int_{\hat{\epsilon}}^{+\infty}(1-H(\epsilon))d\epsilon-\int_{-\infty}^{\hat{\epsilon}}H(\epsilon)d\epsilon\right) \tag{B.10}
$$

One important feature of the optimal threshold is its independence on the expected market portfolio return as equation (B.10) does not depend on it.

Further the difference is equal to zero at $\hat{\epsilon}^{over}$, implicity solution to equation:

$$
\eta\int_{\hat{\epsilon}^{over}}^{+\infty}(1-H(\epsilon))d\epsilon-\int_{-\infty}^{\hat{\epsilon}^{over}}H(\epsilon)d\epsilon=0 \tag{B.11}
$$

The LHS is equal to $-\Psi$. Therefore for $\hat{\epsilon}\in(-\infty,\hat{\epsilon}^{over}]$, $P_{\emptyset}(\hat{\epsilon})\geq P(\hat{\epsilon})$ and for $\hat{\epsilon}\in(\hat{\epsilon}^{over},+\infty)$, $P_{\emptyset}(\hat{\epsilon})<P(\hat{\epsilon})$. I proved that the optimal threshold ϵ^{over} is unique and equal to the minimum $\hat{\epsilon}^{over}$.

Proof of Corollary 1 The threshold ϵ^{over} is independent of the expected market portfolio return and thus on the risk aversion α.

The function Ψ also depends on the parameter η, and to stress the dependence I denote $\Psi(\eta, \epsilon^{over}) = 0$. As there exists a unique solution ϵ^{over} to $\Psi(\eta, \epsilon^{over}) = 0$, there exists a unique function $J(\eta)$ such that $\epsilon^{over} = J(\eta)$.

- $J(1)$ verifies $\Psi(1, J(1)) = 0$, which gives $J(1) = \theta$.
- $J(0)$ verifies $\Psi(0, J(0)) = 0$, which gives $J(0)$ converging to $-\infty$.

Applying the implicit function theorem,

$$\begin{aligned} J'(\eta) &= -\frac{\partial \Psi}{\partial \eta}(\eta, \hat{\epsilon}) / \frac{\partial \Psi}{\partial \hat{\epsilon}}(\eta, \hat{\epsilon}) \\ &= \frac{\int_{\hat{\epsilon}}^{+\infty} (1 - H(\epsilon)) d\epsilon}{\eta + (1-\eta) H(\hat{\epsilon})} \end{aligned} \tag{B.12}$$

Therefore $J'(\eta)$ is positive and ϵ^{over} is increasing in η.
Proof of Proposition 3:

I solve the maximization problem of an investor:

$$\begin{aligned} (\Gamma_\delta) \qquad & \max_{\gamma_{\delta f}, \gamma_{\delta m}} \int f(y) U \left\{ P_\delta (\gamma_{\delta f} + \gamma_{\delta m} \frac{(\theta + y)}{P_m}) \right\} dy \\ & \text{s.t} \quad P_\delta = P_\delta \gamma_{\delta f} + P_\delta \gamma_{\delta m} \end{aligned}$$

As the utility function $U(.)$ is a CRRA utility, and simplifying the budget constraint, it yields

$$\begin{aligned} (\Gamma_\delta) \qquad & \max_{\gamma_{\delta f}, \gamma_{\delta m}} \frac{1}{1-\alpha} \int f(y) \left\{ P_\delta (\gamma_{\delta f} + \gamma_{\delta m} \frac{(\theta + y)}{P_m}) \right\}^{1-\alpha} dy \\ & \text{s.t} \quad 1 = \gamma_{\delta f} + \gamma_{\delta m} \end{aligned}$$

The dependence on δ is due to the price P_δ. But from the program Γ_δ, P_δ is only a constant multiplicative term of the objective function and the maximizers $\gamma_{\delta f}$ and $\gamma_{\delta m}$ do not depend on P_δ and so on δ. Thus $\gamma_{\emptyset f}^{over} = \gamma_{\epsilon f}^{over} = \gamma_f^{over}$ and $\gamma_{\emptyset m}^{over} = \gamma_{\epsilon m}^{over} = \gamma_m^{over}$.

The aggregate demand of all investors in the risk-free asset is equal to:

$$\begin{aligned}
& (\eta + (1-\eta)H(\epsilon^{over}))P_{\emptyset}\gamma_{\emptyset f}^{over} + (1-\eta)\int_{\epsilon^{over}}^{+\infty} P(\epsilon)\gamma_{\epsilon f}^{over} h(\epsilon)d\epsilon \\
= \; & \gamma_f^{over}\left((\eta + (1-\eta)H(\epsilon^{over}))(\epsilon^{over} - \theta + \frac{\theta}{\mathbb{E}(R_m)})\right) \\
& + \gamma_f^{over}\left((1-\eta)\int_{\epsilon^{over}}^{+\infty}(\epsilon - \theta + \frac{\theta}{\mathbb{E}(R_m)})h(\epsilon)d\epsilon\right) \\
= \; & \gamma_f^{over}\left(\frac{\theta}{\mathbb{E}(R_m)} - \theta + (\eta + (1-\eta)H(\epsilon^{over}))\epsilon^{over}\right) \\
& + \gamma_f^{over}(1-\eta)\int_{\epsilon^{over}}^{+\infty}\epsilon h(\epsilon)d\epsilon
\end{aligned} \tag{B.13}$$

I rewrite expression $\int_{\epsilon^{over}}^{+\infty}\epsilon h(\epsilon)d\epsilon$ by integrating by parts as follows:

$$\int_{\epsilon^{over}}^{+\infty}\epsilon h(\epsilon)d\epsilon = \int_{\epsilon^{over}}^{+\infty}(1 - H(\epsilon))d\epsilon + \epsilon^{over}(1 - H(\epsilon^{over})) \tag{B.14}$$

I substitute this expression into equation (B.13) and obtain

$$\begin{aligned}
& \gamma_f^{over}\left(\frac{\theta}{\mathbb{E}(R_m)} - \theta + (\eta + (1-\eta)H(\epsilon^{over}))\epsilon^{over}\right) \\
& + \gamma_f(1-\eta)\left(\int_{\epsilon^{over}}^{+\infty}(1 - H(\epsilon))d\epsilon + \epsilon^{over}(1 - H(\epsilon^{over}))\right)
\end{aligned} \tag{B.15}$$

Moreover by equation (B.8), I simplify equation (B.15) to:

$$\gamma_f^{over}\left(\frac{\theta}{\mathbb{E}(R_m)} - \theta + \epsilon^{over} + \int_{\epsilon^{over}}^{+\infty}(1 - H(\epsilon))d\epsilon - \int_{-\infty}^{\epsilon^{over}} H(\epsilon)d\epsilon\right) \tag{B.16}$$

I also know that the mean θ can be rewritten as:

$$\begin{aligned}\theta &= \int_{-\infty}^{+\infty} \epsilon h(\epsilon)d\epsilon = \int_{\epsilon^{over}}^{+\infty} \epsilon h(\epsilon)d\epsilon + \int_{-\infty}^{\epsilon^{over}} \epsilon h(\epsilon)d\epsilon \\ &= \int_{\epsilon^{over}}^{+\infty} (1-H(\epsilon))d\epsilon + \epsilon^{over}(1-H(\epsilon^{over})) - \int_{-\infty}^{\epsilon^{over}} H(\epsilon)d\epsilon + \epsilon^{over}H(\epsilon^{over})\end{aligned}$$

Finally expression (B.16) is equal to $\gamma_f^{over}(\theta + \frac{\theta}{\mathbb{E}(R_m)} - \theta) = \gamma_f^{over}\frac{\theta}{\mathbb{E}(R_m)}$. As the net supply is equal to zero, it yields $\gamma_f^{over} = 0$.

I determine next the expression of the expected market portfolio return in this economy. Injecting the budget constraint (B.13), the maximization problem is equivalent to:

$$(Q_\delta) \qquad \max_{\gamma_m} \frac{P_\delta^{1-\alpha}}{(1-\alpha)} \int f(y) \left\{1 + \gamma_m(\frac{(\theta+y)}{P_m} - 1)\right\}^{1-\alpha} dy$$

The FOC from the investor's maximization problem with respect to γ_m is equal to:

$$\mathbb{E}\left\{\left\{\frac{(\theta+y)}{P_m} - 1\right\}\left\{1 + \gamma_m(\frac{(\theta+y)}{P_m} - 1)\right\}^{-\alpha}\right\} = 0 \qquad \text{(B.17)}$$

As from the market clearing condition, I showed that $\gamma_f^{over} = 0$ then $\gamma_m^{over} = 1$. Thus the FOC is reduced to:

$$\mathbb{E}\left\{\{\mathbb{E}(R_m)(\theta+y) - \theta\}(\theta+y)^{-\alpha}\right\} = 0 \qquad \text{(B.18)}$$

Simplifying,

$$\begin{aligned}\mathbb{E}(R_m^{over}) &= \frac{\theta\mathbb{E}((\theta+y)^{-\alpha})}{\mathbb{E}((\theta+y)(\theta+y)^{-\alpha})} \\ &= \frac{\theta}{\theta + \mathbb{E}(y(\theta+y)^{-\alpha})/\mathbb{E}((\theta+y)^{-\alpha})}\end{aligned}$$

I prove next that Q^{over} is negative.

$$Q^{over} = \int \frac{yf(y)U'(\theta + y)}{\int f(y)U'(\theta + y)dy} dy$$

By additivity of the integral,

$$\begin{aligned} & \int_{\underline{y}}^{+\infty} yf(y)U'(\theta + y)dy \\ = & \int_{0}^{+\infty} yf(y)U'(\theta + y)dy + \int_{\underline{y}}^{0} yf(y)U'(\theta + y)dy \end{aligned}$$

Moreover $\int_0^{+\infty} yf(y)U'(\theta + y)dy < \int_0^{+\infty} yf(y)U'(\theta)dy$ as U is strictly concave. Likewise $\int_{\underline{y}}^{0} yf(y)U'(\theta + y)dy < \int_{\underline{y}}^{0} yf(y)U'(\theta)dy$. By assumption $\int_{\underline{y}}^{+\infty} yf(y)dy = E(\tilde{y}) = 0$ and it yields

$$\int_{\underline{y}}^{+\infty} yf(y)U'(\theta + y)dy < U'(\theta) \int_{\underline{y}}^{+\infty} yf(y)dy = 0$$

Under the overinvestment equilibrium, the non-disclosing price $P_{\emptyset}(\epsilon^{over})$ is equal to

$$P(\epsilon^{over}) = \epsilon^{over} + Q^{over}$$

As Q^{over} is independent of η, the derivative of $P(\epsilon^{over})$ w.r.t to η is equal to $J'(\eta) \geq 0$. Thus the non-disclosing price is increasing in the disclosure friction η. Further it implies that there exists a unique η^{over} such that $P_{\emptyset}(\epsilon^{over}(\eta^{over})) = 0$ and ϵ^{over} is always positive.

Proof of Proposition 4:

If the investor has a non-disclosing firm then $\gamma_{\emptyset f}^{under} = \gamma_{\emptyset m}^{under} = 0$ and their utility is equal to zero. However if an investor has a disclosing firm then he solves the maximization problem

(Γ_ϵ).

$$(\Gamma_\epsilon) \qquad \max_{\gamma_{\epsilon f},\gamma_{\epsilon m}} \int f(y) U \left\{ P_\epsilon(\gamma_{\epsilon f} + \gamma_{\epsilon m} \frac{(1-\eta)\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon}{P_m}) \right\} dy$$
$$\text{s.t} \;\; P_\epsilon = P_\epsilon \gamma_{\epsilon f} + P_\epsilon \gamma_{\epsilon m}$$

Simplifying,

$$(\Gamma_\epsilon) \qquad \max_{\gamma_{\epsilon f},\gamma_{\epsilon m}} \frac{P_\epsilon^{1-\alpha}}{1-\alpha} \int f(y) \left\{ \gamma_{\epsilon f} + \gamma_{\epsilon m} \frac{(1-\eta)\int_{\epsilon^{under}}^{+\infty}(\epsilon+\tilde{y})h(\epsilon)d\epsilon}{P_m} \right\}^{1-\alpha} dy$$
$$\text{s.t} \;\; 1 = \gamma_{\epsilon f} + \gamma_{\epsilon m}$$

I notice that the maximizers of an individual investor having a disclosing firm do not depend on P_ϵ and thus ϵ. Therefore $\forall \epsilon$, $\gamma_{\epsilon f}^{under} = \gamma_f^{under}$ and $\gamma_{\epsilon m}^{under} = \gamma_m^{under}$.

The aggregate demand of all investors for the risk free asset is equal to:

$$\begin{aligned} & (\eta + (1-\eta)H(\epsilon^{under}))\gamma_{\emptyset f}^{under} P_\emptyset + (1-\eta) \int_{\epsilon^{under}}^{+\infty} \gamma_{\epsilon f}^{under} P(\epsilon) d\epsilon \\ = \; & \gamma_f^{under}(1-\eta) \int_{\epsilon^{under}}^{+\infty} P(\epsilon) d\epsilon \end{aligned} \tag{B.19}$$

As the net supply is equal to zero, it yields $\gamma_f^{under} = 0$.

Taking the FOC of the investor problem, it yields

$$\mathbb{E}\left\{ \left(\frac{(1-\eta)\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon}{P_m} - 1 \right) \left(1 + \gamma_m \left(\frac{(1-\eta)\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon}{P_m} - 1 \right) \right)^{-\alpha} \right\} = 0$$

By the market clearing condition, $\gamma_f^{under} = 0$ thus $\gamma_m^{under} = 1$. The FOC is then reduced to:

$$\mathbb{E}\left\{\left(\mathbb{E}(R_m)\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon - \int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon\right)\left(\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)^{-\alpha}\right\} = 0$$

Simplifying

$$\mathbb{E}(R_m^{under}) = \frac{\mathbb{E}\left((\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon)(\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon)^{-\alpha}\right)}{\mathbb{E}\left(\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon(\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon)^{-\alpha}\right)}$$

Rearranging

$$\mathbb{E}(R_m^{under}) = \frac{\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon}{\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon + (1-H(\epsilon^{under}))\frac{\mathbb{E}\left(y(\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon)^{-\alpha}\right)}{\mathbb{E}\left((\int_{\epsilon^{under}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon)^{-\alpha}\right)}} \tag{B.20}$$

I now turn to the determination of the disclosure threshold ϵ^{under}.

The firm observing ϵ^{under} has a cash flow:

$$\epsilon^{under} + y = \underbrace{\epsilon^{under} - \frac{\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon}{1-H(\epsilon^{under})}}_{\text{units of the risk free asset}} + \underbrace{\frac{1}{(1-\eta)(1-H(\epsilon^{under}))}}_{\text{units of the market portfolio}} CF_m$$

Its price is then $\epsilon^{under} - \frac{\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon}{1-H(\epsilon^{under})} + \frac{1}{(1-\eta)(1-H(\epsilon^{under}))}P_m^{under} = 0$ as by definition this firm has a market price of zero, where

$$\begin{aligned} P_m^{under} &= (1-\eta)\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon + (1-\eta)(1-H(\epsilon^{under}))Q^{under} \\ \text{with } Q^{under} &= \int_{\underline{y}}^{+\infty}\frac{yf(y)\left(\int_{\epsilon^{**}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)^{-\alpha}}{\int_{\underline{y}}^{+\infty}f(y)\left(\int_{\epsilon^{**}}^{+\infty}(\epsilon+y)h(\epsilon)d\epsilon\right)^{-\alpha}dy}dy \end{aligned}$$

Replacing P_m^{under} by its expression and simplifying it yields:

$$\epsilon^{under} = -\frac{\int y f(y)(\int_{\epsilon^{under}}^{+\infty}(\epsilon + y)h(\epsilon)d\epsilon)^{-\alpha}dy}{\int f(\tilde{y})(\int_{\epsilon^{under}}^{+\infty}(\epsilon + \tilde{y})h(\epsilon)d\epsilon)^{-\alpha}d\tilde{y}}$$

The disclosure threshold ϵ^{under} is independent of the disclosure friction η.

I now prove that Q^{under} is negative. This is similar to the proof of $Q^{over} < 0$.

$$Q^{under} = \int_{\underline{y}}^{+\infty} \frac{y f(y)\left(\int_{\epsilon^{under}}^{+\infty}(\epsilon + y)h(\epsilon)d\epsilon\right)^{-\alpha}}{\int_{\underline{y}}^{+\infty} f(y)\left(\int_{\epsilon^{under}}^{+\infty}(\epsilon + y)h(\epsilon)d\epsilon\right)^{-\alpha}dy}dy$$

As the utility function is strictly concave,

$$\begin{aligned}
&\int_0^{+\infty} y f(y)\left(\int_{\epsilon^{under}}^{+\infty}(\epsilon + y)h(\epsilon)d\epsilon\right)^{-\alpha}dy \\
&< \int_0^{+\infty} y f(y)\left(\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon\right)^{-\alpha}dy
\end{aligned} \tag{B.21}$$

Likewise

$$\begin{aligned}
&\int_{\underline{y}}^{0} y f(y)\left(\int_{\epsilon^{under}}^{+\infty}(\epsilon + y)h(\epsilon)d\epsilon\right)^{-\alpha}dy \\
&< \int_{\underline{y}}^{0} y f(y)\left(\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon\right)^{-\alpha}dy
\end{aligned} \tag{B.22}$$

By assumption $\int_{\underline{y}}^{+\infty} y f(y)dy = \mathbb{E}(\tilde{y}) = 0$ which yields

$$Q^{under} < \left(\int_{\epsilon^{under}}^{+\infty}\epsilon h(\epsilon)d\epsilon\right)^{-\alpha}\int_{\underline{y}}^{+\infty} y f(y)dy = 0$$

Further in the underinvestment region the threshold of a firm indifferent between disclosing and not disclosing is still determined by equation (4.1) as it is independent of the risk premium. The difference here is that the components of the price for non-disclosing firms such that they have exactly a price of zero are different than in the overinvestment region as the expression for Q^{under} is different from Q^{over}. The turning point η^{under} to fall into the underinvestment region is thus determined by $J(\eta^{under}) = -Q^{under}$.

Proof of Lemma 2

If $Q(x)$ is increasing in x then $Q^{under} \geq Q^{over}$ so $\epsilon^{under} \leq \epsilon^{over}$, which implies that $\eta^{under} \leq \eta^{over}$. If $Q(x)$ is decreasing in x then $Q^{under} \leq Q^{over}$, which implies that $\eta^{under} \geq \eta^{over}$.

Proof of Lemma 3:

The costs of capital of non-disclosing firms and disclosing firms are respectively:

$$\begin{aligned} R_{\emptyset} &= \frac{\mathbb{E}(\epsilon|ND)}{P_{\emptyset}} = \frac{\epsilon^{over}}{P(\epsilon^{over})} \\ R_D &= \int_{\epsilon^{over}}^{+\infty} \frac{\epsilon}{P(\epsilon)} \frac{h(\epsilon)}{(1-H(\epsilon^{over}))} d\epsilon \end{aligned}$$

As $P_{\emptyset} = P(\epsilon^{over}) = \epsilon^{over} + Q^{over}$ and $P(\epsilon) = \epsilon + Q^{over}$, a simple rewriting of the costs of capital yields:

$$\begin{aligned} R_{\emptyset} &= 1 - \frac{Q^{over}}{P_{\emptyset}} \\ R_D &= 1 - Q^{over} \int_{\epsilon^{over}}^{+\infty} \frac{h(\epsilon)}{P(\epsilon)(1-H(\epsilon^{over}))} d\epsilon \end{aligned}$$

Looking closely at the prices, I can express them as a CAPM formulation:

$$\begin{aligned} R_{\emptyset} &= \underbrace{1}_{\text{Riskfree}} + \underbrace{\frac{P_m^{over}}{P_{\emptyset}}}_{\beta_{\emptyset}} \underbrace{(\mathbb{E}(R_m^{over}) - 1)}_{\text{Risk Premium}} \\ R_D &= \underbrace{1}_{\text{Riskfree}} + \underbrace{\int_{\epsilon^{over}}^{+\infty} \frac{P_m^{over}}{P(\epsilon)} \frac{h(\epsilon)}{(1-H(\epsilon^{over}))} d\epsilon}_{\beta_D} \underbrace{(\mathbb{E}(R_m^{over}) - 1)}_{\text{Risk Premium}} \end{aligned}$$

I derive the beta β as an expression of the covariance between the firm's return and the market portfolio return over the variance of the market portfolio return.

$$\beta_\emptyset = \frac{P_m^{over}}{P_\emptyset} = \underbrace{\frac{V(y)}{P_\emptyset P_m^{over}}}_{\text{covariance}} / \underbrace{\frac{V(y)}{P_m^{over2}}}_{\text{market variance}}$$

$$\beta_D = \int_{\epsilon^{over}}^{+\infty} \frac{P_m^{over}}{P(\epsilon)} \frac{h(\epsilon)}{(1-H(\epsilon^{over}))} d\epsilon = \underbrace{\int_{\epsilon^{over}}^{+\infty} \frac{V(y)}{P(\epsilon)P_m^{over}} \frac{h(\epsilon)}{(1-H(\epsilon^{over}))} d\epsilon}_{\text{covariance}} / \underbrace{\frac{V(y)}{P_m^{over2}}}_{\text{market variance}}$$

Proof of Proposition 5:

Further $P_\emptyset(\epsilon^{over}) = P(\epsilon^{over})$. As $\forall \epsilon \geq \epsilon^{over}$, $P(\epsilon^{over}) \leq P(\epsilon)$, $R_\emptyset \geq R_D$.

Proof of Lemma 4:

(i) Let us prove that if $\eta \geq \eta^{over}$, for $\eta < \eta'$, $\Delta(.;\eta')$ second-order stochastically dominates $\Delta(.;\eta)$.

For a price $p < P_\emptyset(\epsilon^{over}(\eta))$, $\Delta(p;\eta) = 0$ otherwise for a price $P_\emptyset(\epsilon^{over}(\eta)) \leq p \leq \overline{p}$, $\Delta(p;\eta) = \{\eta + (1-\eta)H(\epsilon^{over}(\eta))\} + (1-\eta)\{H(p - Q^{over}) - H(\epsilon^{over}(\eta))\}$. Let us define $\eta < \eta'$ and $T(\overline{p})$ as the area between the two curves $\Delta(;\eta)$ and $\Delta(;\eta')$ in $[P_\emptyset(\epsilon^{over}(\eta)), \overline{p}]$, specifically $T(\overline{p}) = \int_{P_\emptyset(\epsilon^{over}(\eta))}^{\overline{p}} (\Delta(p;\eta) - \Delta(p;\eta'))dp$. By additivity of the integral I rewrite $T(\overline{p})$:

$$T(\overline{p}) = \int_{P_\emptyset(\epsilon^{over}(\eta))}^{P_\emptyset(\epsilon^{over}(\eta'))} (\Delta(p;\eta) - 0)dp + \int_{P_\emptyset(\epsilon^{over}(\eta'))}^{\overline{p}} (\Delta(p;\eta) - \Delta(p;\eta'))dp$$

Let us consider $\eta' = \eta + \mu$, then $T(\overline{p})$ becomes:

$$\begin{aligned} T(\overline{p}) = & \int_{P_\emptyset(\epsilon^{over}(\eta))}^{P_\emptyset(\epsilon^{over}(\eta+\mu))} \Delta(p;\eta)dp \\ & + \int_{P_\emptyset(\epsilon^{over}(\eta+\mu))}^{\overline{p}} (\Delta(p;\eta) - \Delta(p;\eta+\mu))dp \end{aligned}$$

Let us further define

$$\begin{aligned}
A(\mu) &= \int\limits_{P_{\emptyset}(\epsilon^{over}(k))}^{P_{\emptyset}(\epsilon^{over}(\eta+\mu))} \Delta(p;\eta)dp \\
B(\mu) &= \int\limits_{P_{\emptyset}(\epsilon^{over}(\eta+\mu))}^{\overline{p}} (\Delta(p;\eta) - \Delta(p;\eta+\mu))dp
\end{aligned}$$

I differentiate the above expressions w.r.t μ:

$$\begin{aligned}
A'(\mu) &= \frac{\partial \epsilon^{over}(\eta+\mu)}{\partial \eta}\Delta(P_{\emptyset}(\epsilon^{over}(\eta+\mu));\eta) \\
B'(\mu) &= -\frac{\partial \epsilon^{over}(\eta+\mu)}{\partial \eta}\left\{\Delta(P_{\emptyset}(\epsilon^{over}(\eta+\mu));\eta) - \Delta(P_{\emptyset}(\epsilon^{over}(\eta+\mu));\eta+\mu)\right\} \\
&\quad - \int\limits_{P_{\emptyset}(\epsilon^{over}(\eta+\mu))}^{\overline{p}} ((1 - H(\epsilon^{over}(\eta+\mu))) \\
&\quad +(1-\eta-\mu)h(\epsilon^{over}(\eta+\mu))\frac{\partial \epsilon^{over}(\eta+\mu)}{\partial \eta} \\
&\quad -H(p - Q^{over}) + H(\epsilon^{over}(\eta+\mu)) \\
&\quad -(1-\eta-\mu)h(\epsilon^{over}(\eta+\mu))\frac{\partial \epsilon^{over}(\eta+\mu)}{\partial \eta})dp \\
&= -\frac{\partial \epsilon^{over}(\eta+\mu)}{\partial \eta}\left\{\Delta(P_{\emptyset}(\epsilon^{over}(\eta+\mu));\eta) - \Delta(P_{\emptyset}(\epsilon^{over}(\eta+\mu));\eta+\mu)\right\} \\
&\quad - \int\limits_{P_{\emptyset}(\epsilon^{over}(\eta+\mu))}^{\overline{p}} \left(1 - H(p - Q^{over})\right) dp
\end{aligned}$$

When $\mu = 0$, A' can be simplified to:

$$\frac{\partial \epsilon^{over}(\eta)}{\partial \eta}\Delta(P_{\emptyset}(\epsilon^{over}(\eta));\eta) \geq 0$$

Likewise B' is equal to:

$$-\int\limits_{P_{\emptyset}(\epsilon^{over}(\eta))}^{\overline{p}} \left(1 - H(p - Q^{over})\right) \leq 0$$

Replacing $\frac{\partial \epsilon^{over}(\eta)}{\partial \eta}$ by expression (B.12) and simplifying, I compute $A'(0) + B'(0)$:

$$\int_{\epsilon^{over}(\eta)}^{+\infty} (1 - H(\epsilon))d\epsilon - \int_{P_{\emptyset}(\epsilon^{over}(\eta))}^{\overline{p}} (1 - H(p - Q^{over}))\, dp$$

Consider the change in variable $\epsilon = p - Q^{over}$, I further simplify the above expression by:

$$\int_{\epsilon^{over}(\eta)}^{+\infty} (1 - H(\epsilon))d\epsilon - \int_{\epsilon^{over}(\eta)}^{\overline{\epsilon}} (1 - H(\epsilon))d\epsilon \qquad \text{(B.23)}$$

If $\overline{\epsilon}$ converges to $+\infty$ then expression (B.23) is equal to zero. Thus $\forall \overline{\epsilon}$, expression (B.23) is positive. It also means that $\forall \overline{p}$, $T(\overline{p}) \geq 0$ i.e. the probability mass of $\Delta(;\eta)$ is more spread out than the probability mass of $\Delta(;\eta')$, which implies that $\Delta(;\eta)$ is "riskier" than $\Delta(;\eta')$.

(ii) Let us prove that if $\eta \leq \eta^{under}$, for $\eta' < \eta$, $\Delta(.;\eta')$ first-order stochastically dominates $\Delta(.;\eta)$.

It has been proven that $P(\epsilon^{under})$ does not depend on η. Thus the range of prices is the same for a given η or η'. Let us take the difference between $\Delta(p;\eta')$ and $\Delta(p;\eta)$ for $p \in [0, \overline{p}]$.

$$\begin{aligned}
& \Delta(p;\eta') - \Delta(p;\eta) \\
= \; & (\eta' + (1-\eta')H(\epsilon^{under})) + (1-\eta')\Big(H(p - Q^{under}) - H(\epsilon^{under})\Big) \\
& - \Big((\eta + (1-\eta)H(\epsilon^{under})) + (1-\eta)\Big(H(p - Q^{under}) - H(\epsilon^{under})\Big)\Big)
\end{aligned}$$

Replacing η by $\eta' + \mu$ it yields

$$\begin{aligned}
& \Delta(p;\eta') - \Delta(p;\eta' + \mu) \\
= \; & (\eta' + (1-\eta')H(\epsilon^{under})) + (1-\eta')\Big(H(p - Q^{under}) - H(\epsilon^{under})\Big) \\
& - \Big((\eta' + \mu + (1-\eta'-\mu)H(\epsilon^{under})) + (1-\eta'-\mu)\Big(H(p - Q^{under}) - H(\epsilon^{under})\Big)\Big) \\
= \; & -\mu(1 - H(\epsilon^{under})) + \mu\Big(H(p - Q^{under}) - H(\epsilon^{under})\Big) \\
= \; & -\mu\Big(1 - H(p - Q^{under})\Big) \leq 0
\end{aligned}$$

Therefore $\Delta(;\eta')$ first order stochastically dominates $\Delta(;\eta)$.

Proof of Proposition 6:

If $\eta \geq \eta^{over}$, I will prove that R_D is decreasing in η.

$$R_D = 1 - \int_{\epsilon^{over}(\eta)}^{+\infty} \frac{Q^{over}}{P(\epsilon)} \frac{h(\epsilon)}{(1 - H(\epsilon^{over}(\eta)))} d\epsilon$$

Differentiating R_D w.r.t η, it yields

$$-\frac{1}{(1 - H(\epsilon^{over}))^2} h(\epsilon^{over}) J'(\eta) \int_{\epsilon^{over}}^{+\infty} \frac{Q^{over} h(\epsilon)}{P(\epsilon)} d\epsilon + J'(\eta) \frac{Q^{over} h(\epsilon^{over})}{(1 - H(\epsilon^{over}))P(\epsilon^{over})}$$

Simplifying it yields

$$-\frac{J'(\eta) Q^{over} h(\epsilon^{over})}{(1 - H(\epsilon^{over}))} \left(\frac{1}{(1 - H(\epsilon^{over}))} \int_{\epsilon^{over}}^{+\infty} \frac{h(\epsilon)}{P(\epsilon)} d\epsilon - \frac{1}{P(\epsilon^{over})}\right) \tag{B.24}$$

As $P(\epsilon^{over}) \leq P(\epsilon)$,

$$\left(\frac{1}{(1 - H(\epsilon^{over}))} \int_{\epsilon^{over}}^{+\infty} \frac{h(\epsilon)}{P(\epsilon)} d\epsilon - \frac{1}{P(\epsilon^{over})}\right) \leq 0 \tag{B.25}$$

Also $J'(\eta) \geq 0$ and $Q^{over} < 0$ thus the derivative of R_D with respect to η given by expression (B.24) is negative. Therefore R_D is decreasing in η.

$P_{\emptyset}(\epsilon^{over}) = P(\epsilon^{over}) = \epsilon^{over} + Q^{over}$. Differentiating $P(\epsilon^{over})$ with respect to η, it yields $J'(\eta) \geq 0$. Thus $R_{\emptyset}$ is decreasing in η.

If $\eta \leq \eta^{under}, \epsilon^{under}$ and Q^{under} do not depend on η, so R_D is independent of η.

$$R_D \;=\; 1 - Q^{under} \int_{\epsilon^{under}}^{+\infty} \frac{h(\epsilon)}{P(\epsilon)(1 - H(\epsilon^{under}))} d\epsilon$$

I turn to the comparative statics on the average cost of capital $\mathcal{R}$.

If $\eta \geq \eta^{over}$, $R_\delta = 1 - \frac{Q^{over}}{P_\delta}$. Thus ordering $\mathcal{R}(\eta)$ and $\mathcal{R}(\eta')$ boils down to ordering $1/P_\delta(\eta)$ and $1/P_\delta(\eta')$. I know that the function $1/P_\delta$ is a convex and decreasing function. I further proved that for $\eta' < \eta$, $\Delta(;\eta)$ second order stochastically dominates $\Delta(;\eta')$. This implies that $\mathbb{E}(1/P_\delta(\eta)) \leq \mathbb{E}(1/P_\delta(\eta'))$.

If $\eta \leq \eta^{under}$ then $\mathcal{R} = R_D$ as non-disclosing firms are not financed and $R_D = 1 - Q^{under} \int_{\epsilon^{under}}^{+\infty} \frac{h(\epsilon)}{P(\epsilon)(1-H(\epsilon^{under}))} d\epsilon$, independent of η.

Proof of Proposition 7:

For $\eta \geq \eta^{over}$, the non-disclosing price is positive therefore all the firms in the economy invest. Therefore there is always overinvestment.

For $\eta \leq \eta^{under}$ the non-disclosing firms are not financed and there is a proportion of firms $\eta(1-H(\epsilon^{under}))$ which was unable to disclose their information, although they were efficient firms. Obviously the underinvestment is increasing in η. At $\eta = 0$, all efficient firms invest.

Proof of Proposition 8

By Lemma 4,

(i) If $\eta \geq \eta^{over}$, risk-sharing is improved if the disclosure friction η increases.

(ii) If $\eta \leq \eta^{under}$, the range of prices is not affected by the disclosure friction. However a decreasing disclosure friction affects the distribution of prices. It resolves under-investment. All in all lowering the disclosure friction improves risk-sharing (in the sense of second-order stochastic dominance).

Proof of Proposition 9:

For $\eta \geq \eta^{over}$, the investor's indirect utility function with a firm disclosing δ is equal to

$$\frac{1}{1-\alpha} P_\delta^{1-\alpha} \int f(y)(\theta + y)^{1-\alpha} dy$$

The indirect utility is concave in P_δ. Further I know that for $\eta < \eta'$, $\Delta(.;\eta')$ second order stochastically dominates $\Delta(.;\eta)$, which implies that

$$\begin{aligned} &\frac{1}{1-\alpha} \int P_\delta^{1-\alpha} \int f(y)(\theta + y)^{1-\alpha} dy d\Delta(P_\delta;\eta') \\ &\geq \frac{1}{1-\alpha} \int P_\delta^{1-\alpha} \int f(y)(\theta + y)^{1-\alpha} dy d\Delta(P_\delta;\eta) \end{aligned}$$

For $\eta \leq \eta^{under}$, the investors' aggregate expected utility for a given η is equal to

$$(1-\eta)\int_{\epsilon^{under}}^{+\infty}\frac{1}{1-\alpha}P(\epsilon)^{1-\alpha}\int f(y)\left(\int_{\epsilon^{under}}^{+\infty}(1-\eta)(\epsilon+y)h(\epsilon)d\epsilon\right)^{1-\alpha}dyh(\epsilon)d\epsilon$$

consider $\eta > \eta'$

$$(1-\eta)\int_{\epsilon^{under}}^{+\infty}\frac{1}{1-\alpha}P(\epsilon)^{1-\alpha}\int f(y)\left(\int_{\epsilon^{under}}^{+\infty}(1-\eta)(\epsilon+y)h(\epsilon)d\epsilon\right)^{1-\alpha}dyh(\epsilon)d\epsilon$$
$$\leq (1-\eta')\int_{\epsilon^{under}}^{+\infty}\frac{1}{1-\alpha}P(\epsilon)^{1-\alpha}\int f(y)\left(\int_{\epsilon^{under}}^{+\infty}(1-\eta')(\epsilon+y)h(\epsilon)d\epsilon\right)^{1-\alpha}dyh(\epsilon)d\epsilon$$

Proof of Corollary 2:

By Proposition 6, it has been proven that the average cost of capital in the economy is decreasing in the disclosure friction η, if $\eta \geq \eta^{over}$. Further by Proposition 9, the investors' expected utility increases in the disclosure friction η, if $\eta \geq \eta^{over}$.

Proof of Corollary 3:

For $\eta \geq \eta^{over}$, if mandatory disclosure forces firms which retained voluntarily their information to disclose, all inefficient firms would have to disclose their information and therefore would be closed. For $\eta \leq \eta^{under}$ all firms investing are all efficient, thus mandatory disclosure would not mitigate underinvestment.

Proof of Proposition 10:

To prove the result, I make a reasoning by contradiction. Suppose $P_{\emptyset}(I_1) > P_{\emptyset}(I_2)$. Define the set $\{\epsilon : \hat{I}(\epsilon) = I_2\}$. There exists ϵ^{**} such that $P(\epsilon^{**}, I_2) \leq P_{\emptyset}(I_2)$. The expected price of a firm willing to disclose ϵ^{**} and investing I_2 is $(1-\eta)P(\epsilon^{**}, I_2) + \eta P_{\emptyset}(I_2)$, which is stricty lower than the price $P_{\emptyset}(I_1)$ if this firm is deviating to not disclose on purpose and investing I_1. This is a contradiction.

Proof of Proposition 11:

As the non-disclosing price is independent of I, the result follows.

Proof of Proposition 12:

In equilibrium $P_\emptyset = \frac{(\epsilon^*+Q)^2}{2c} = P_\emptyset(I)$. Further

$$P_\emptyset(I) = \frac{\eta h(cI-Q)\frac{(cI)^2}{2c} + H(\epsilon^*)\phi(I)(\mathbb{E}(\epsilon+Q|\epsilon \le \epsilon^*)I - \frac{c}{2}I^2)}{\eta h(cI-Q) + H(\epsilon^*)\psi(I)} \tag{B.26}$$

Substituting $P_\emptyset(I)$ by $\frac{(\epsilon^*+Q)^2}{2c}$ and rearranging it yields equation:

$$\phi(I) = \frac{\eta h(cI-Q)(\frac{(cI)^2}{2c} - \frac{(\epsilon^*+Q)^2}{2c})}{H(\epsilon^*)(\frac{(\epsilon+Q)^2}{2c} - \mathbb{E}(\epsilon+Q|\epsilon \le \epsilon^*)I - \frac{c}{2}I^2)} \tag{B.27}$$

Integrating equation (B.27) from $I^{FB}(\epsilon^*)$ to $I^{FB}(b)$ yields equation (5.2) as $\int_{I^{FB}(\hat{\epsilon})}^{I^{FB}(b)} \phi(I)dI = 1$.

Define the function $k(\hat{\epsilon})$ as

$$k(\hat{\epsilon}) = 1 - \int_{I^{FB}(\hat{\epsilon})}^{I^{FB}(b)} \frac{\eta h(cI-Q)(\frac{(cI)^2}{2c} - \frac{(\hat{\epsilon}+Q)^2}{2c})}{H(\hat{\epsilon})(\frac{(\epsilon+Q)^2}{2c} - \mathbb{E}(\epsilon+Q|\epsilon \le \hat{\epsilon})I - \frac{c}{2}I^2)} dI \tag{B.28}$$

At $\hat{\epsilon} = -Q$, $k(\hat{\epsilon}) \to -\infty$. At $\hat{\epsilon} = b$, $k(b) = 1 > 0$. Thus there exists ϵ^* such that $k(\epsilon^*) = 0$.

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