Accounting Disclosure Quality, Cost of Capital and Interrelated Firm Effect

Abstract

This paper investigates the relation between disclosure quality and cost of capital by adding interrelated firm effect. Previous studies suggest that disclosure quality monotonically reduces cost of capital if a firm has a constant investment level, as if the disclosing firm is in a pure exchange economy. However, this study shows that this notion is not always valid: the relation between disclosure quality and cost of capital is more subtle than it apparently thought. This study demonstrates that in a production-based economy, disclosure quality has both an informational effect and a production effect on a firm's cost of capital. Given a positive correlation between two firms, the informational and the production effect invariably affect a disclosing firm's cost of capital in opposite ways. Therefore, there is an implicit endogenous trade-off of disclosure quality. Even when disclosures do not change a disclosing firm's own investment decisions or its own distribution of future cash flows, there are possibilities that disclosure quality affect the firm's cost of capital in a detrimental way where interrelated firms are priced in a capital market that values diversification.

1. Introduction

The incentives and economic consequences for firms to disclose information of a high quality has been a long-standing research question. A well-known argument is that higher quality of accounting disclosure reduces cost of capital[1]. On one hand, most, if not all, existing theoretical studies have predicted that when a disclosing firm cannot change its own investment decisions or its own distribution of future cash flows, disclosure quality

[1] For example, a widely cited speech given by Arthur Levitt, the former chairman of the Securities and Exchange Commission, is that, "The truth is, high [accounting] standards lower the cost of capital." (Levitt 1998, 82).

monotonically reduces cost of capital. On the other hand, empirical findings on the relation between disclosure quality and cost of capital have been mixed (e.g. Healy& Palepu, 2001; Francis, Khurana & Pereiram 2005). This study aims to narrow the gap between empirical evidence and theoretical research by providing a possible theoretical explanation of 'disclosure puzzles'. This study investigates the link between accounting information and cost of capital by adding interrelated firm effect. Specifically, I extend existing research by constructing a simple economic model based on Gao (2010) to investigate how the presence of 'real effects' relating to accounting disclosures might affect a firm's cost of capital in an economy with interrelated firms. The real effects relate to production or investment decisions made by the disclosing firm as well as, possibly, an interrelated firm. In such a setting, accounting disclosures not only affect investors' perceptions of a firm, they also affect the economic decisions made by firms.

A traditional view of the link between accounting information and cost of capital is built on information asymmetries between firms and investors: adverse selection creates potential costs between buyers and sellers of a firm's shares. Accounting disclosures can mitigate such information asymmetries and help the firm have a lower cost of capital (e.g., Diamond & Verrecchia 1991; Kim & Verrecchia 1994; Easley & O'Hara 2004). Recently however, Lambert, Leuz & Verrecchia (2007) (hereafter, LLV (2007)) provide a direct link between accounting information and cost of capital, without reference to investors' adverse selection. They demonstrate that disclosures can influence cost of capital both directly and indirectly. The indirect effect occurs because disclosure quality can affect a firm's real decisions. Gao (2010) further addresses this indirect effect on a firm's cost of capital in a single firm setting. Though LLV (2007) assume that there are multiple correlated firms in the economy, a very important implicit assumption of their study is that other firms' cash flows are not affected by a firm's disclosure. Gao (2010) further solely focuses on the interaction between a firm itself and the capital market. This research is built on the insights of LLV(2007) and Gao (2010) and explores the relation between disclosure quality and cost of capital by considering endogenous interrelated firm effect. I examine how an informed firm's disclosure quality might affect both its own investment decisions and those of an interrelated firm. I also investigate how these impacts flow back to affect both firms' costs of capital.

This study begins by modelling a general production-based economy model where two firms are interrelated and both their investment decisions can be affected by disclosures. This model attaches importance to two issues. First, information flows are bidirectional in the capital market and there are 'real effects' of accounting disclosures. Disclosed information not only flows out from firms to the capital market, but also updated information which is new to firms may flow back from the capital market to firms, guiding firms to revise their production or investment decisions. The bidirectional information flow is achieved through the renovation of share prices. Therefore, the capital market not only performs its usual role of assessing firms' future cash flows but also performs the role of re-allocating capital and directing firms' investment choices. (Tobin, 1984) If accounting disclosures help to improve pricing in a capital market, and improved capital market pricing results in reallocation of resources, disclosures can play an efficiency enhancing role regardless of whether the capital market is characterized by perfect competition or not (Dye, 2001). Second, risk-averse investors diversify their portfolios among different firms. A disclosing firm's idiosyncratic risk is diversifiable given a large economy. However, when disclosures introduce additional new risks to this whole economy, investors ask every interrelated firm to pay part of a new risk premium through diversification. Because of real effects of disclosures, investors' diversification behaviours may lead to 'un-diversifiable' results. Equilibrium of this general model suggests that interactions between disclosure quality and interrelated firms are very subtle.

Next, I examine two specific economies by simplifying the general model, namely a pure exchange economy and a mixed production-based economy. In a pure exchange economy, neither firm can change its investment decisions. Accounting information simply flows from firms to the capital market and the capital market only performs its usual role of assessing firms' future cash flows, so disclosure quality only has an informational effect in a pure exchange economy. Consistent with previous literature, analyses suggest that a higher quality disclosure monotonically increases a disclosing firm's share price and reduces its cost of capital. In addition, improving one firm's disclosure quality generates a positive externality on its interrelated firm's share price and cost of capital.

New, and probably the most interesting findings lie in the mixed economy case. This special production-based economy model assumes that one firm keeps its investment level across time, as if it is in a pure exchange economy while at the same time its interrelated firm makes investment decisions after disclosures. A real effect of disclosure is at work as accounting information flows turn to be bi-directional. The capital market instantly plays both the role of assessing firms' future cash flows and the role of re-allocating capital and directing firms' investment choices. In this mixed economy, disclosure quality has two distinguishing effects, an informational effect and a production effect respectively. The informational effect occurs because disclosure quality affects a disclosing firm's cost of capital by influencing investors' assessment of future cash flows. The production effect occurs because disclosure quality impacts the firm's cost of capital by influencing its interrelated firm's investment level (real cash flow). Strikingly, given a positive correlation between two firms, the informational and the production effect invariably affect a firm's cost of capital in opposite ways. There is an implicit and endogenous trade-off when a firm chooses whether or not to improve its disclosure quality. Under some circumstances, disclosure quality may have a threshold. If and only if disclosure quality is higher than this threshold, would an improvement in a firm’s disclosure quality guarantee an unambiguous decrease in this firm’s cost of capital. In the meantime, an improvement of one firm’s disclosure quality may generate either a positive or a negative externality on its interrelated firm’s share price and cost of capital.

In contrast to the pure exchange case, the relation between disclosure quality and cost of capital changes significantly due to changes of an interrelated firm, even though the disclosing firm is identical. Findings suggest that there are possibilities that a firm’s own disclosure quality can affect its own (or both firms) cost of capital in a detrimental way where interrelated firms are priced in a capital market that values diversification, even when the disclosure does not change its own investment decisions or its own distribution of future cash flows.

There are two main contributions of this study. First, I explore the relation between accounting disclosure quality and cost of capital by adding interrelated firm effect. This study reinforces and extends the argument that disclosure quality affects a firm’s cost of capital indirectly through influences on firms’ investment decisions. The model in this study allows me to differentiate a production effect and an informational effect of the impact of a firm’s disclosure quality on cost of capital. It also allows me to examine under what conditions one effect will dominate the other. Findings of this study may provide an additional theoretical explanation to some unsolved disclosure puzzles and they may also inform the inconsistent empirical findings on the relation between accounting information and cost of capital. Second, this research highlights two roles of the capital market. In addition to performing its usual role of assessing firms’ future cash flows, it performs the role of re-allocating capital and directing firms' investment choices. Accounting disclosures can facilitate both roles of the capital market. While the notion that there are feedback and feed forward effects between firms’ production activities and share prices is not a new argument, the study of bidirectional accounting flows is in its preliminary phases. This study advances our understanding of how accounting affects the performance of these two roles.

The reminder of this paper is organized as follows. The next section sets up a general model in a general production-based economy and discusses its main characteristics and its equilibrium. Section 3 and section 4 simplify this general model in two different ways by considering two specific economies. In each economy, equilibrium is characterized and comparative statics are conducted to address the main research questions. Section 5 discusses implications of findings, assumptions and three clarifications in the context of related literatures. Section 6 concludes this paper. All proofs are in the Appendix.

2. The General Model

In a multi-firm economy, a critical challenge is how to optimally allocate investors' savings to firms' investment opportunities. Not surprisingly, either new entries or existing companies would like to attract household savings to fund their business ideas. For investors, the key decision they have to make is that which company should they choose to invest in? Accounting information is demanded since it helps investors to assess their anticipation of firms' future performance before they make their investment choice. Investors choose their optimal demands of shares among firms in order to maximize their expected utilities. This resolution of uncertainty of firms' future cash flows also in turn guides firms to adjust their investment levels. Even in the absence of the concern of information adverse selection, in a rational expectations equilibrium, changes in investment levels affect the equilibrium stock prices and thus affect the required return of inventors (cost of capital) in the market. One limitation of a single firm setting is that we only consider the interaction between the firm and the capital market. Two important factors should also be addressed once the model is extended in a multi-security economy. First is diversification, which means that investors allocate their savings among different companies to reduce the risk of their investment portfolio. Second is interrelated firm effect: other firms are also affected by the disclosed information if firms are not wholly independent. To capture these two factors, I first consider a general production-based economy where disclosures affect firms' investment decisions.

A Description of the General Model

In this section, I extend Goo's model and consider an economy in which two firms [2](firm *i* and firm *j*) exist in the market and both of their shares are publicly traded. The two firms produce similar goods in the same industry, thus it is reasonable to assume that the firms' uncertain marginal profits are correlated with each other. Also without loss of generality, the expected return of the risk-free asset is assumed to be zero in order to simplify the notation. Investors are homogeneous and each of them has a CARA (constant absolute risk aversion) utility function with risk tolerance parameter τ which is defined by: $U(W_g) = -\exp^{-[w_g/\tau]}$. Investors' objectives are to maximize their expected utilities through submitting their optimal demands of the firms' shares. Figure 1 describes the time line of events of this setting.

<Figure 1 the time line of events in a general economy>

In this setting, each firm's situation is quite similar: for firm *i*, at t=1 it has an amount of existing production level of good A, denoted by m_i. The marginal profitability of the existing investment is characterized by a mean of π_i plus an uncertain component $\tilde{\pi}_i$, where $\tilde{\pi}_i$ follows a normal distribution of zero mean and a known variance $1/\alpha_i$ ($\tilde{\pi}_i \sim N(0, 1/\alpha_i)$). This information is common knowledge to the public. At t=2, firm *i* has an expanding opportunity. The profitability of the new investment is expected to be a mean θ_i and an uncertain component $\tilde{\pi}_i$, as that of the existing investment. It is further assumed that this new investment has an additional cost and the net cash flow of this new investment takes a

[2] Though I only study a 2-firms setting, the analysis is likely robust to a multi-firm settings. More discussion regarding this issue will be provided in detail later.

quadratic form. Also at t=2, firm *i* can observe a noisy information $\tilde{y}_i$ of $\tilde{\pi}_i$ ($\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i$, where $\tilde{\varepsilon}_i \sim N(0, 1/\beta_i)$. $\tilde{\pi}_i$ and $\tilde{\varepsilon}_i$ are independent. β_i represents the disclosure quality of firm *i*'s accounting information and is the main variable of interest: the higher β_i is, the better disclosure quality. This information $\tilde{y}_i$ is truthfully disclosed to the public before the firm makes the expanding decision. Thus in a two firm setting, firms' final cash flows are as follows:

$$\begin{cases} \tilde{V}_i = m_i(\tilde{\pi}_i + \pi_i) + k_i(\tilde{\pi}_i + \theta_i) - z_i / 2 \cdot k_i^{\,2} \\ \tilde{V}_j = m_j(\tilde{\pi}_j + \pi_j) + k_j(\tilde{\pi}_j + \theta_j) - z_j / 2 \cdot k_j^{\,2} \end{cases} \tag{1}$$

Where disclosed information of each firm is $\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i, \tilde{y}_j = \tilde{\pi}_j + \tilde{\varepsilon}_j$, $\tilde{\pi}_i \sim N(0, 1/\alpha_i)$, $\tilde{\pi}_j \sim N(0, 1/\alpha_j)$, $\tilde{\varepsilon}_i \sim N(0, 1/\beta_i)$ $\tilde{\varepsilon}_j \sim N(0, 1/\beta_j)$, $\tilde{\pi}_{i/j}$ *and* $\tilde{\varepsilon}_{i/j}$ *are fully independent*[3] *while* $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j) = 1/h$ [4]*;* $z_{i/j}$ *is the adjustment cost of firm's new investment opportunity.*

At t=3, firms and investors' beliefs are updated due to information that becomes available via the information set $\Phi = \{\tilde{y}_i, \tilde{y}_j\}$.Particularly, because the covariance of $\tilde{\pi}_i$ and $\tilde{\pi}_j$ is not zero, investors use one firm's disclosed information to reassess the other firm's future value. Both firms choose their optimal expanding investment level of $k_n(\Phi)$ (n= *i, j*) to maximize their own current share prices. Investors rationally anticipate the optimal investment levels and submit their demands for each firm's shares to maximize their expected utilities, and market is cleared. At t=4 both firms' cash flows are realized.

Main Characteristics of the Model

[3] This paper assumes noises ($\tilde{\varepsilon}_{i/j}$) are independent. A future interesting work might be to see what will happen if they are correlated across firms.

4 If not specifically mentioned, $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j)$ is assumed to be positive, which is more common for interrelated firms.

This model addresses two roles of capital market, real effects of accounting disclosures and interrelated firm effect. Although a firm's accounting information can be directed to various stakeholders other than outside investors, not much existing disclosure literature consider interrelated firm effect. One exception is research built on the proprietary cost hypothesis. The key argument of this hypothesis, which addresses a competitor's effect, is that there is a trade-off between a lower cost of capital gain against the cost of unintentionally divulging proprietary information to competitors through a firm's disclosure. Consistent with the proprietary cost hypothesis, this general model also assumes that there are no conflicts of interest between managers and shareholders so disclosed information is always credible. However, the model has two main differences with the one which is commonly used in proprietary cost studies.

（1）A usual setting of proprietary hypothesis is to model an imperfectly competitive product market characterized by Cournot (quantity-setting) competition, and to directly solve for equilibrium in the product market: each firm's production level is directly negatively associated with other firm's product price. However, in my setting and following Gao (2010), there is no explicit competition in the product market. In my setting, each firm's investment decision is indirectly affected by its interrelated firm's accounting disclosure quality. The underlying link between the two firms is because of the existence of the covariance of two firms' uncertain future profitability 1/*h*. ($\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j)$). The implicit production interrelation between the two firms is enforced by the capital market. Specifically, this production interrelation results from the truth that investors diversify their capital between the two firms. If at least one firm discloses new information regarding the future profitability about their expanding opportunity at t=2, new information flows from firms to the capital market and investors reassess each firm's future performance based on the information set $\Phi = \{\tilde{y}_i, \tilde{y}_j\}$ .Investors re-allocate their capitals among firms and both firms' share prices change accordingly. Meanwhile, each firm's objective is to maximize its current share price by choosing an optimal new production level. Thus, information also flows from the capital market (via share prices) to firms and guide their investment decisions. The bi-directional information flows occur simultaneously. In equilibrium, the optimal investment strategy of each firm is adjusted because of the capital re-allocation that occurs in the equity market. This setting highlights that capital market prices can perform their conventional role of assessing the future cash flow of firms' anticipated investment levels, while at the same time they perform the role of re-allocating capital and directing firms' investment choices. Accordingly, the disclosed accounting information has two different effects on a firm's cost of capital: namely an informational effect and a production effect. The informational effect only changes investors' assessed distribution of two firms' future cash flows while the production effect changes the real distribution of the future cash flow of an interrelated firm.

（2）Other main difference between Cournot (quantity-setting) model and this general model is firms' characteristics. In Cournot competition, each firm produces a homogeneous product and each firm's production decision affects the product's price. In this model, firms' products are not homogeneous and neither of them has the market power to alter the market price. When both firms produce an identical product, the uncertain future profitability of each firm is the same ($\mathrm{var}(\tilde{\pi}_i) = \mathrm{var}(\tilde{\pi}_j) = \mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j)$). Each firm's risk turns out to be the same. In such a special situation, investors are indifferent to firms since diversification result in the same portfolio risks. The functional role of capital market discussed in Tobin (1984) fails: the pooling of risks and their allocation.

A Description of the Equilibrium

In an economy with interrelated firms, for firm *i*, rational expectation equilibrium at t=3 is a pair of ($k_i^*(\Phi)$, $P_i^*(\Phi)$), where given $k_i^*(\Phi)$, $P_i^*(\Phi)$ clears the market and given $P_i^*(\Phi)$, $k_i^*(\Phi)$ maximizes $P_i^*(\Phi)$:

Lemma 1 given an information set Φ disclosed by firms, the equilibrium outcome of the optimal new investment level and share price pair at t=3 for firm i $(k_i^*(\Phi), P_i^*(\Phi))$ in a general economy is:

$$\begin{cases} k_i^*(\Phi) = \dfrac{(\theta_i + \mu_i)}{(z_i + \frac{2}{r}s_i) - \dfrac{(\frac{1}{r}s_{ij})^2}{(z_j + \frac{2}{r}s_j)}} - \dfrac{\frac{2}{r}s_i - \dfrac{(\frac{1}{r}s_{ij})^2}{(z_j + \frac{2}{r}s_j)}}{(z_i + \frac{2}{r}s_i) - \dfrac{(\frac{1}{r}s_{ij})^2}{(z_j + \frac{2}{r}s_j)}} \cdot m_i - \dfrac{(\frac{1}{r}s_{ij}) \cdot (\theta_j + \mu_j + z_j m_j)}{(z_i + \frac{2}{r}s_i) \cdot (z_j + \frac{2}{r}s_j) - (\frac{1}{r}s_{ij})^2} \\ P_i^*(\Phi) = E(\tilde{V}_i \mid \Phi) - \frac{1}{r}\left[\mathrm{var}(\tilde{V}_i \mid \Phi) + \mathrm{cov}(\tilde{V}_i, \tilde{V}_j \mid \Phi)\right] \end{cases}$$

Where $\mu_i = E[\tilde{\pi}_i|\Phi]$; $\mu_j = E[\tilde{\pi}_i|\Phi]$; $s_{ij} = \mathrm{cov}\left[\tilde{\pi}_i, \tilde{\pi}_j|\Phi\right]$; $s_i = \mathrm{var}\left[\tilde{\pi}_i|\Phi\right]$; $s_j = \mathrm{var}\left[\tilde{\pi}_j|\Phi\right]$;

Lemma 1 reveals that the optimal new investment level for each firm is affected by both its own situation and parameters of its interrelated firm. The non-zero covariance between the two firms, which represents the correlated risk of both firms' future profitability, is a key variable which links firms in the capital market. If $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j)$ =0, two firms are fully independent with each other, one firm's disclosed information will not change investors' assessment of another firm. Each firm is as if it is in a single-firm economy. Thus the optimal level of each firm, if $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j)$ =0, should be identical with the optimal new production level in a single-firm economy. In such a special case, the capital market can still direct a firm's investment decision but the function role that capital market can pool investment risks and reallocate savings among different firms fails. This 'function role failure' can also occur in another extreme case when $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j) \neq 0$ but the disclosure quality is ideally high that investors know exactly what they are going to have at t=4 for each firm. Mathematically, this is achieved when either β_i or β_j or both approaches to infinity. In such an ideal situation, investors have no incentives to diversify their investment portfolio to reduce firms' idiosyncratic risks. The beauty of the general model is its generalizability but it also causes problems for complicated interactions are not very easy to be separated and to be thoroughly analysed. To have a distinct and thorough understanding of these interactions, in the following two sections, I analyse two different special models.

3. A Special Model: 2 Firms in a Pure Exchange Economy

A Description of the Special Model

In this section, the general model is simplified into a special case when interrelated firms are in a pure exchange economy. Again, each firm's situation is quite similar: for firm *i*, at t=1 it has m_i units of existing investment. The marginal profitability of the existing investment has a mean of π_i plus an uncertain component $\tilde{\pi}_i$. At t=2, firm *i* observes a noisy information $\tilde{y}_i$ regarding $\tilde{\pi}_i$ and truthfully disclose it to the public. Figure 2 describes the time line of events of this mixed Economy.

< Figure 2 the time line of events in a pure exchange economy >

A very important feature of this special case is that neither firm can change its investment level after disclosures. Thus, the two firms' final cash flows are expected as follows:

$$\begin{cases} \underset{pe}{\tilde{V}_i} = m_i(\tilde{\pi}_i + \pi_i) \\ \underset{pe}{\tilde{V}_j} = m_j(\tilde{\pi}_j + \pi_j) \end{cases} \tag{2}$$

Where disclosed information of each firm is $\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i$, $\tilde{y}_j = \tilde{\pi}_j + \tilde{\varepsilon}_j$, $\tilde{\pi}_i \sim N(0, 1/\alpha_i)$, $\tilde{\pi}_j \sim N(0, 1/\alpha_j)$, $\tilde{\varepsilon}_i \sim N(0, 1/\beta_i)$ $\tilde{\varepsilon}_j \sim N(0, 1/\beta_j)$, $\tilde{\pi}_{i/j}$ *and* $\tilde{\varepsilon}_{i/j}$ *are fully independent while* $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j) = 1/h$.

At t=3, firms and investors' beliefs are updated via the information set $\Phi = \{\tilde{y}_i, \tilde{y}_j\}$ and at t=4 both firms' cash flows are realized.

A Description of the Equilibrium and Comparative Statics

Lemma 2 given an information set Φ disclosed by firms, the equilibrium share prices ($\underset{pe}{P_i^*}(\Phi)$, $\underset{pe}{P_j^*}(\Phi)$) for the two firms in a pure exchange economy are:

$$\begin{cases} \underset{pe}{P_i^*}(\Phi) = m_i(\mu_i + \pi_i) - \frac{1}{\tau} m_i (m_i s_i + m_j s_{ij}) \\ \underset{pe}{P_j^*}(\Phi) = m_j(\mu_j + \pi_j) - \frac{1}{\tau} m_j (m_j s_j + m_i s_{ij}) \end{cases}$$

Where $\mu_i = E[\tilde{\pi}_i|\Phi]$; $\mu_j = E[\tilde{\pi}_i|\Phi]$; $s_{ij} = \text{cov}[\tilde{\pi}_i, \tilde{\pi}_j|\Phi]$; $s_i = \text{var}[\tilde{\pi}_i|\Phi]$; $s_j = \text{var}[\tilde{\pi}_j|\Phi]$;

Based on Lemma 2, I first examine disclosure quality effect on firms' risks. Then after deriving both conditional and unconditional cost of capital, I conduct comparative statics to investigate effects of disclosure quality on each firm's equilibrium prices and cost of capital.

Remark 1 (Disclosures in a pure exchange economy): in a pure exchange economy, disclosures can reallocate risks among investors but cannot change total risk of this economy.

Firstly, the disclosure affects a firm' risk allocation but this impact is very limited in a pure exchange economy. For firm *i*, the *ex ante* uncertainty of the after-disclosure price is $\text{var}\left[\underset{pe}{P_i^*}(\Phi)\right] = m_i^2 \,\text{var}[\mu_i]$ and the total risk of the firm's future cash flow is:

$$\text{var}[\tilde{V}_i] = m_i^2 \,\text{var}[\tilde{\pi}_i] = m_i^{\,2}(\text{var}(\mu_i) + s_i) = \text{var}\left[\underset{pe}{P_i^*}(\Phi)\right] + m_i^2 s_i\,. \qquad (3)$$

In a pure exchange economy, firm *i*'s future value (cash flow) risk can be divided into two components: its price risk ($\text{var}\left[\underset{pe}{P_i^*}(\Phi)\right]$) and the remaining unknown cash flow risk (s_i). Because a pure exchange economy setting excludes possible real effects of disclosures on firms' investment decisions, an interrelated firm cannot affect a disclosing firm's *ex ante* risk structure via the capital market. The absence of 'real effects' might be a critical factor that explains why early analytical disclosure studies cannot justify the important of accounting information in the capital market. Though existing research has already extended a single-firm setting into a multi-firms setting, interrelated firm effect is often ignored. For example, Easley & O'Hara (2004) assumes that there are multiple securities in the capital market but they further assume that firms' future cash flows are not correlated with each other. Therefore, their setting is equivalent to a single-firm setting because investors make wholly independent investment decisions among firms. LLV (2007) relax Easley & O'Hara's assumption and assume that firms' cash flows are correlatedm, but one important implicit assumption of their analyses is that the real distributions of other firms' cash flows are not affected by the disclosing firm. Thus, both papers examine the relation between accounting information and cost of capital in a specific situation when other firms (or all firms) are as if they are in a pure exchange economy. As will be discussed greater in detail soon, this specific situation limits our ability of understanding complex and subtle interactions between firms and investors in the capital market.

Given one generation in the capital market: holding firms' shares until the cash flows are realized, the role of accounting information here is very weak since disclosure can alter neither firm's risk structure but re-allocate a firm's risk every time new information is publically available. In such a static economy, accounting disclosures at t=2 have a one-time effect: better information helps investors to maximize their current utilities. If all inventors stay in the market until both firms' cash flows are realized, investors do not have strong incentives to demand for a higher disclosure quality. One possible way to make disclosures more attractive is to adopt forced divestiture assumption (e.g. Samuelson 1958; Dye 1988; Gao 2010). This assumption describes a circumstance when one group of shareholders is forced by life-cycle consideration to sell shares to another group of shareholders before a firm' cash flow is realized. Because of this forced-sale assumption, investors in two groups face different risks of a firm's future cash flow. The link between the two groups is the capital market where current investors sell their shares to new investors. According to equation (3), if current investors sell all shares to new investors after the disclosure, current investors bear the entire trading price risk and new investors take the residual cash flow risk thus new investors ask for a risk premium in return. When firm *i* discloses information alone, increasing disclosure quality results in a lower residual cash flow risk for new investors while a higher trading price risk for current investors (s_i decreases while $\mathrm{var}(\mu_i)$ increases as disclosure quality increases). Thus, in a pure exchange economy, disclosures can re-allocate the risk between current and new investors, but cannot change total risk.

Secondly, how disclosure quality affects both firms' equilibrium share prices and costs of capital is investigated. Firm *i*'s cost of capital is defined as investors' expected return on the firm's equity. The conditional expected return after disclosures of firm *i* can be expressed as: $E(R_i|\Phi) = \dfrac{E(\tilde{V}_i \mid \Phi) - P_i^*}{P_i^*}$. The conditional expected return depends on the realized value of the disclosed information set ($\hat{\Phi} = \{\hat{y}_i, \hat{y}_j\}$). To emphasize how *ex ante* accounting disclosure quality might have an effect on its cost of capital, I adopt Gao (2010)'s approach and characterize firm *i*'s cost of capital as the unconditional expected return on equity: $E(R_i) = \dfrac{E[E(\tilde{V}_i \mid \Phi)] - E[P_i^* \mid \Phi]}{E[P_i^* \mid \Phi]}$. This unconditional expected return on equality measures cost of capital over all possible information realizations. It represents the return for an investor who invests the same firm over time or simultaneously in many similar firms. So this cost of capital is from investors' perspective, not from a firm's perspective. By a further re-arrangement we have: $E(R_i) = \dfrac{1}{\tau \cdot H_i - 1}\, where H_i = \dfrac{E[E(\tilde{V}_i \mid \Phi)]}{E[\mathrm{var}(\tilde{V}_i \mid \Phi)] + E[\mathrm{cov}(\tilde{V}_i, \tilde{V}_j \mid \Phi)]}$. H_i is the determinant of firm *i*'s unconditional expected return.[5]

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[5] $\mathrm{H}_{i\ conditional} = \dfrac{E[\tilde{V}_i \mid \Phi]}{\mathrm{var}[\tilde{V}_i \mid \Phi] + \mathrm{cov}[\tilde{V}_i, \tilde{V}_j \mid \Phi]}$ is the determinant of the conditional expected return, which is a simplified version of 'H' in LLV(2007)

In a pure exchange economy, each firm's *ex ante* future cash flow is fixed ($E[E(\tilde{V}_i \mid \Phi)]$ is irrelevant with firms' disclosure quality). The sole factor which drives the change of a firm's cost of capital after disclosures is the new equilibrium share price. Therefore, the disclosure effect on the equilibrium share price is always parallel with the disclosure effect on a firm's after-disclosure cost of capital. To simply analyses and to highlight my main research interests, I examine a special case when only firm *i* discloses information ($\Phi = \{\tilde{y}_i\}$, $\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i$, $\tilde{\pi}_j \sim N(0, 1/\alpha_j)$, $\tilde{\varepsilon}_i \sim N(0, 1/\beta_i)$).

Proposition 1 (Disclosure Quality, Share Prices and Costs of Capital)

In a pure exchange economy, , by improving a firm's disclosure quality, both the disclosing firm and its interrelated firm's equilibrium share prices monotonically increase and costs of capital monotonically decrease.

(The determinant of firm i's cost of capital is $\underset{pe}{H_i} = \dfrac{\pi_i}{m_i s_i + m_j s_{ij}}$ ($\underset{pe(conditional)}{H_i} = \dfrac{\mu_i}{m_i s_i + m_j s_{ij}}$)[6])

TABLE 1

Effects of firm *i*'s Disclosure Quality on Its Share Price and Cost of Capital

in This Pure Exchange Economy

Circumstance	Threshold of Disclosure Quality	Share Price	Cost of Capital
ALL	None	Increase	Decrease

Obviously, by improving the disclosure quality (increasing β_i), the strength of the association between the conditional expected value of firm *i*'s cash flow and the disclosed information (μ_i) monotonically increases and the assessed variance of the firm *i*'s cash flow (s_i) monotonically decreases. Meanwhile, the magnitude of the conditional covariance of the

[6] 'pe' stands for 'pure exchange'. The determinate of firm *j*'s cost of capital is symmetric in this pure exchange model.

two firms (s_{ij}) decreases[7]. Thus, the three factors combine to reduce the firm's cost of capital (investors' expected return). This is an informational effect of disclosure quality on firm *i*'s cost of capital. The informational effect changes neither firm's real cash flow but helps investors to have a better understanding of the risks of uncertain profitability of both good A and good B. Since cost of capital measures the per-dollar risk premium, a lower cost of capital results from the informational effect is a reward from risk-averse investors because the disclosing firm provides useful information. This analysis reinforces the direct effect discussed in LLV (2007). LLV (2007) point out that the direct effects of information on cost of capital occurs because disclosures affect investors' perceptions of firms' future cash flow risks while firms' real decisions are held to be constant. They further demonstrate that in a large economy, although the assessed variance effect of a disclosing firm can be diversify away, the covariance effect of the disclosing firm and other firms can't be eliminated. This special model in section 3 neatly illustrates their 'nondiversifyable' argument: covariance effect (s_{ij}) exists in both firms' price equations thus s_{ij} *is* in both firms' cost of capital functions (Lemma 2 and proposition 1). The interrelated firm *j* is affected by firm *i*'s disclosure quality too. A higher quality of firm *i*'s disclosure quality leads to a lower conditional variance of firm *j*'s cash flow (s_j) if the two firms are positively correlated with each other. Consequently firm *j* also 'enjoys' a higher share price and a lower cost of capital. Firm *i*'s disclosure generates a positive externality on firm *j*'s share price and cost of capital.

This first special model is a simple version of pure exchange economy models in existing literatures. Driven by Wilson's famous paper in 1968, the role of public information in a pure exchange economy was a keen research question during the early disclosure research period (from the 1970s to 1980s). (e.g., Marshall, 1974; Ng, 1975; Ohlson, 1984; Ohlson & Buckman, 1981) At first glance, if firms cannot change its investment levels after

7 The conditional covariance gets closer to zero by improving disclosure quality. This paper assumes cov (π_i,π_j) is positive, which seems to be more usual among interrelated firms.

disclosures, information appears to have “no social benefit” in a pure exchange economy. Ohlson & Buckman (1981) demonstrate that this impression is not justified as a general conclusion. They argue that information can affect individuals’ perceived risks and therefore will ultimately affect the entire risk-sharing arrangement in the economy. However, they admit that this does not preclude situations when information may ‘worsen’ the risk-sharing arrangement. The central message of these early research in a pure exchange setting is that (additional) public information can have a positive role, but in a weak sense and also under ‘reasonable’ assumptions. More sadly, since Wilson (1968), it is believed that models in a pure exchange economy cannot create an endogenous demand for accounting information. A general but very striking claim of these research for (analytical) accounting disclosure studies is “……models of pure exchange with risk-averse traders, predict that no public accounting information will exist.” (Dye, 2001) People in a pure exchange economy are playing a zero-sum game. The future wealth is not alterable and accounting can only result in the redistribution of wealth among people. Though models in the pure exchange evaluate accounting information poorly, it doesn’t mean that accounting is insignificant in the capital market. The real economy is dynamic: firms adjust their production or investment decisions according to available capital and their knowledge (assessments) of uncertain future profitiabilities. The pure exchange economy is a limited setting in which to study the function of accounting information. In contrast, in a production-based economy, firms’ real activities can be (will be) altered by updating information because accounting disclosures have real effects on firms’ production or investment decisions via the capital market. These real effects either impact the disclosing firm itself or its interrelated firms. Therefore, in a production-based economy, accounting can play nontrivial economically important roles in may unexplored situations. In the following section, this pure exchange economy is extended into a specific production-based economy. This slightly modified model yields some interesting and meaningful results which advance our understanding of how accounting information can become economically significant in the capital market.

4. Another Special Model: 2 Firms in a Mixed Economy

In this section, the pure exchange economy assumption was relaxed and one firm was assumed to make its investment decision after disclosures. Firm *i* still has a constant investment level, as if it is in a pure exchange economy. Firm *j* doesn't have existing investment before disclosures (m_j=0) but it is going to choose an optimal production level of k^*_j after disclosures. Thus, the economy becomes a mixture of a pure exchange economy and a production-based economy.

New Features of the Mixed Economy

< Figure 3 the time line of events in a mixed economy >

At t=1, only firm *i* has active productivity: the production level of good A is m_i units. The marginal profitability of the existing investment is a mean of π_i plus an uncertain component $\tilde{\pi}_i$. Its interrelated firm *j* doesn't produce any goods at t=1 but it is common knowledge that firm *j* will produce good B to compete with firm *i* after disclosures[8].The profitability of the new investment is expected to be a mean θ_j and an uncertain component $\tilde{\pi}_j$. This uncertainty is correlated with firm *i*'s uncertain component π_i: $\operatorname{cov}(\tilde{\pi}_i, \tilde{\pi}_j) = 1/h$. The cash flow of firm *j*'s new investment follows a quadratic form with the adjustment cost z_j. In such a mixed economy, firms' cash flows are expected to be:

$$\begin{cases} \tilde{V}_i = m_i(\tilde{\pi}_i + \pi_i) \\ \tilde{V}_j = k_j(\tilde{\pi}_j + \theta_j) - z_j / 2 \cdot k_j^{\ 2} \end{cases} \tag{4}$$

Where disclosed information of each firm is $\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i$, $\tilde{y}_j = \tilde{\pi}_j + \tilde{\varepsilon}_j$, $\tilde{\pi}_i \sim N(0, 1/\alpha_i)$, $\tilde{\pi}_j \sim$

[8] Firm *j* can also disclose a piece of information at t=2. The public available information set at t=2 is $\Phi = \{\tilde{y}_i, \tilde{y}_j\}$

N (0, 1/ α_j), $\tilde{\varepsilon}_i \sim N(0, 1/\beta_i)$ $\tilde{\varepsilon}_j \sim N(0, 1/\beta_j)$, $\tilde{\pi}_{i/j}$ and $\tilde{\varepsilon}_{i/j}$ are fully independent[9] *while* $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j) = 1/h$ [10]*;* z_j *is the adjustment cost of firm j 's new investment opportunity.*

At t=2, firm *i* truthfully discloses a piece of information regarding its own future profitability: $\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i$. Firm *j* can also disclose a piece of information at t=2. The public available information set at t=2 is $\Phi = \{\tilde{y}_i, \tilde{y}_j\}$ .At t=3, firms and investors' beliefs are updated. Firm *i*'s investment decision is held to be constant so the disclosed information does not affect the real cash flow of firm *i*. Firm *j*'s object is to choose an optimal investment level k_j* to maximize its share price after disclosures. Once the accounting information is disclosed, the expected distribution of the future cash flow of firm *i* is reassessed by investors. Particularly, because the covariance of $\tilde{\pi}_i$ and $\tilde{\pi}_j$ is not zero, investors also use this information to update their beliefs about the interrelated firm *j*'s future cash flow. Firm *j*'s share price updates and the updating share price guides firm *j* to choose its optimal investment level k_j*. This is a real effect of disclosures on an interrelated firm's investment decision. Investors rationally anticipate this effect and use this endogenous information, together with the disclosed information set *per se* to decide how much they would like to re-allocate in firm *i*. In equilibrium, firm *i*'s share price also updates and consequently its cost of capital changes.

Once again, this second special model emphasizes that the capital market has both the role of assessing firms' future cash flows and the role of re-allocating capital and directing firms' investment choices. More importantly, this second special model allows me to examine the two roles of the capital market separately and how accounting information differently facilitates both roles of the capital market. Analyses of this special production-based

[9] This paper assumes noises ($\tilde{\varepsilon}_{i/j}$) are independent. A future interesting work might be to see what will happen if they are correlated across firms.

10 If not specifically mentioned, $\mathrm{cov}(\tilde{\pi}_i, \tilde{\pi}_j)$ is assumed to be positive, which is more common for interrelated firms.

economy enable us to have a better understanding of: (1) how disclosure quality can impact a firm's cost of capital by influencing investors' assessment of future cash flows, I call this effect an informational effect . In a pure exchange economy, this is the sole effect of disclosure quality; (2) to what extend the firm's disclosure quality impacts the firm's cost of capital by influencing its interrelated firm' investment level (real cash flow), I call this effect a production effect, which emerges in a production-based economy (3) under what conditions would the production effect dominate the informational effect so that an increase in accounting disclosure quality actually increases the firm's cost of capital, rather than decreases it?

A Description of the Equilibrium

Lemma 3 given an information set Φ disclosed by firms, the equilibrium outcome firm *i* ($\underset{c}{k_i^*}(\Phi)$, $\underset{c}{P_i^*}(\Phi)$) and firm *j* ($\underset{new}{k_j^*}(\Phi)$, $\underset{new}{P_j^*}(\Phi)$) in a mixed economy are[11]:

$$\begin{cases} \underset{c}{k_i^*}(\Phi) = 0 \\ \underset{c}{P_i^*}(\Phi) = m_i(\mu_i + \pi_i) - \frac{1}{\tau} m_i (m_i s_i + \underset{new}{k_j^*} s_{ij}) \end{cases}$$

$$\begin{cases} \underset{new}{k_j^*}(\Phi) = \dfrac{\theta_j + \mu_j - \frac{1}{\tau} s_{ij} m_i}{z_j + \frac{2}{\tau} s_j} \\ \underset{new}{P_j^*}(\Phi) = E(\tilde{V}_j \mid \Phi) - \frac{1}{\tau}\left[\operatorname{var}(\tilde{V}_j \mid \Phi) + \operatorname{cov}(\tilde{V}_i, \tilde{V}_j \mid \Phi)\right] \end{cases}$$

Where $\mu_i = E[\tilde{\pi}_i|\Phi]$; $\mu_j = E[\tilde{\pi}_i|\Phi]$; $s_{ij} = \operatorname{cov}\left[\tilde{\pi}_i, \tilde{\pi}_j|\Phi\right]$; $s_i = \operatorname{var}\left[\tilde{\pi}_i|\Phi\right]$; $s_j = \operatorname{var}\left[\tilde{\pi}_j|\Phi\right]$;

Remark 2 (Disclosures in a production-based economy): in a production-based economy, disclosures introduce new risks to the whole economy because of real effects of disclosures on firms' investment decisions.

Two properties of this equilibrium are examined: real effect of disclosure and diversification effect. To start with, there is a real effect of firm *i*'s disclosure on firm *j*'s investment decision: the optimal investment level of firm *j* is conditional on firm *i*'s

[11] The notation c stands for 'constant' and 'new' stands for the firm has no existing production level.

disclosure. Meantime, $k_{j_{new}}^*(\Phi)$ depends not only on its own investment factors but also on its interrelated firm *i*'s existing production level m_i. When firm *j* is in the capital market alone (or if the cash flow of firm *j* does not correlated with any other firms in the capital market), its optimal production level should be $k_{j_{new}}^*(\Phi) = \frac{\theta_j + \mu_j}{z_j + \frac{2}{r} s_j}$. Referring to Lemma 3, the optimal investment level of firm *j* becomes less in a positively interrelated economy. There is a production compromise because of its interrelated firm's existing investment level m_i. Simultaneously, this real effect of discourse in turn affects firm *i* because of investors' diversification. In equilibrium, firm *i*'s share price is its conditional expected future cash flow with a risk premium adjustment. The risk premium is based on both its own production level m_i and its interrelated firm's expected investment level $k_{j_{new}}^*$. The higher the interrelated firm's expanding investment level, the higher the additional risk of firm *j*'s new investment. Consequently the higher risk premium investors ask for from firm *i*[12].

Next, to have a close look at how 'diversification' works differently in the presence of a real effect of disclosure on an interrelated firm, I examine risk structures of each firm before and after disclosures in the mixed economy. For firm *i*, since its investment level does not change across time, its total risk (var($\tilde{V}_i$)) can still be divided into the *ex ante* risk of the future cash flow and the residual cash flow risk after disclosures: var($\tilde{V}_{i_c}$) $= m_i^2 \operatorname{var}(\tilde{\pi}_i) = m_i^2 (\operatorname{var}(\mu_i) + s_i)$. However, different from the situation in a pure exchange economy, firm *i*'s trading price risk (var ($P_{i_c}^*(\Phi)$)) is no longer tantamount to the *ex ante*

[12] Again, if not mentioned specifically, I assume $\operatorname{cov}(\tilde{\pi}_i, \tilde{\pi}_j) = h$ is positive.

uncertainty of the firm's cash flow ($\mathrm{var}(\mu_i)$). In this mixed economy, firm *i*'s trading price risk can be written as:

$$\mathrm{var}\,(\underset{c}{P_i^*}(\Phi)) = m_i^{\,2}\,\mathrm{var}(\mu_i) + m_i^{\,2}\cdot(\tfrac{1}{\tau}s_{ij})^2\,\mathrm{var}(\underset{new}{k_j^*}(\Phi)) - 2\cdot m_i^{\,2}\cdot\tfrac{1}{\tau}s_{ij}\cdot\mathrm{cov}(\mu_i, k_j^*(\Phi)) \tag{5}$$

The difference between firm *i*'s trading price risk and *ex ante* uncertainty is:

$$\mathrm{T} = (\mathrm{var}\,(\underset{c}{P_i^*}(\Phi)) - m_i^{\,2}\,\mathrm{var}(\mu_i))/m_i^{\,2}$$

$$= \tfrac{1}{\tau}s_{ij}s_i\cdot\frac{1}{z_j+\frac{2}{\tau}s_j}\cdot\left(\frac{\alpha_i}{h}\right)\cdot\left(\tfrac{1}{\tau}s_{ij}s_i\cdot\frac{1}{z_j+\frac{2}{\tau}s_j}\cdot\left(\frac{\alpha_i}{h}\right)-2\right)\quad(\mathrm{T} > \text{or} < 0) \tag{6}$$

As can be seen, firm *i*'s trading price risk now can be either less or more than the *ex ante* uncertainty of the firm's cash flow. Firm *i* cannot pass all the *ex ante* risk to current share holders: shareholders can have either less or more risk than the firm *i* as a whole has. This inequality occurs because a real effect of disclosure is at work. The real effect of accounting information leads to an incremental investment level of the whole economy. In other words, firm *i*'s disclosure introduces an additional investment risk on firm *j*'s future cash flow:

$$\mathrm{var}\,(\underset{new}{k_j^*}(\Phi)) = \frac{\mathrm{var}(\tilde{\mu}_j)}{(z_j+\frac{2}{\tau}s_j)^2} = \frac{\mathrm{var}(\tilde{\pi}_j)-s_j}{(z_j+\frac{2}{\tau}s_j)^2} \tag{7}$$

Accounting information affects this additional risk and consequently the total risk structure of this economy is changed. Though firm *i*'s total risk is still irrelevant with disclosures, the interrelated firm *j* now becomes essential because investors value firm *j*'s additional risk through portfolio diversification: diversification helps current investors to re-structure their trading price risks. Although from a firm's perspective, firm *i* has nothing to do with firm *j*'s new investment risk, rational investors tend to diverse this incremental risk among different firms in the capital market. Furthermore, holding other parameters constant, a higher disclosure quality imposes a higher investment risk on firm *j* but a higher disclosure quality does not invariably reduce firm *i*'s trading price risk. Therefore, a higher disclosure quality cannot guarantee the disclosing firm to enjoy a lower cost of capital after disclosures.

Again, when the forced divestiture assumption is considered, new investors value this additional investment risk thus they ask for an additional risk premium in return. Because the effect of this additional investment risk on firm *i*'s trading price is ambiguous, the relation between a firm's disclosure quality and its cost of capital becomes much more complicated and much more sensitive to disclosure quality than that in a pure exchange economy.

Comparative Statics and Main Findings

In this sub-section, comparative statics is conducted to address the main research question: how disclosure quality affects the share price and cost of capital for each firm in this special production-based economy? To be consistent with analyses in the pure exchange economy model, I focus on the special case when only firm *i* discloses information ($\Phi = \{\tilde{y}_i\}$, $\tilde{y}_i = \tilde{\pi}_i + \tilde{\varepsilon}_i$, $\tilde{\pi}_j \sim N(0, 1/\alpha_j)$, $\tilde{\varepsilon}_i \sim N(0, 1/\beta_i)$).

The conditional expected return after disclosure of firm *i* in the mixed economy is:

$$E(R_{\underset{c}{i}}|\Phi) = \frac{E(\tilde{V}_{\underset{c}{i}} \mid \Phi) - P^*_{\underset{c}{i}}}{P^*_{\underset{c}{i}}} = \frac{1}{\dfrac{\tau \cdot E(\tilde{V}_i \mid \Phi)}{\operatorname{var}(\tilde{V}_i \mid \Phi) + \operatorname{cov}(\tilde{V}_i, \tilde{V}_j \mid \Phi)}} \frac{1}{\dfrac{\tau \cdot (\mu_i + \pi_i)}{m_i s_i + k^*_{\underset{new}{j}} s_{ij}} - 1} \tag{8}$$

Firm *i*'s conditional cost of capital after disclosures is a function of the expected cash flow of the firm itself, the variance of the firm's cash flow and the covariance of the firm's cash flow with its interrelated firm *j*'s cash flow, which in turn can be expressed as a function of $k^*_{\underset{new}{j}}$.

Same as that in a pure exchange economy, the informational effect of disclosure quality on firm *i*'s cost of capital is at work: by improving the disclosure quality (increasing β_i), the strength of the association between the conditional expected value of firm *i*'s cash flow and the disclosed information (μ_i) monotonically increases and the assessed variance of the firm *i*'s cash flow (s_i) monotonically decreases. Meanwhile, the magnitude of the conditional covariance of the two firms (s_{ij}) decreases. However, in this mixed economy, though the accounting information disclosed by firm *i* has no impact on its own real cash flow, it influences its interrelated firm *j*'s real investment decision through equity market's capital re-allocation function. An production effect of disclosure quality changes firm *j*'s distribution of cash flows ($k^*_{\underset{new}{j}}$ is a function of β_i) which will, in turn, affect the joint distribution of the two firms' cash flows as perceived by investors($\text{cov}(\tilde{V}_i, \tilde{V}_j | \Phi)$). Ultimately this effect flows back into the equilibrium price of firm *i* that investors are willing to pay and firm *i*'s cost of capital is affected.

To emphasize how *ex ante* accounting disclosure quality might have an effect on its cost of capital, I further characterize firm *i*'s cost of capital as the unconditional expected return on equity:

$$\underset{c}{E}(R_i) = \frac{1}{\dfrac{r \cdot m_i \pi_i}{E[\text{var}(\tilde{V}_i | \Phi)] + E[\underset{new}{\text{cov}}(\tilde{V}_i, \tilde{V}_j | \Phi)]} - 1} = \frac{1}{\dfrac{r \cdot \pi_i}{\underset{c}{\Pi}} - 1} \tag{9}$$

Where $\underset{c}{\Pi} = (m_i s_i + E(k^*_{\underset{new}{j}} | \Phi) s_{ij})$

Firm *i* cannot change its own investment level after the disclosure, so firm *i*'s *ex ante* future expected value is still irrelevant with disclosure quality. Same with that in a pure exchange economy, as disclosure quality changes, firm *i*'s expected equilibrium share price and its unconditional cost of capital moves in parallel. According to $\underset{c}{\Pi}$, disclosure quality has a direct informational effect on firm *i*'s cost of capital via changing investors' assessment of the risk of its own uncertain profitability *(*s_i*)*.This direct informational effect can always reduce firm *i*'s cost of capital given an increase in firm *i*'s disclosure quality. However, disclosure quality also has both an indirect informational effect on s_{ij} and a production effect on $E(k^*_{\underset{new}{j}} | \Phi)$ through its interrelated firm *j*. The disclosed accounting information can change the real cash flow of its interrelated firm *j*: increasing β_i can always lead to a more aggressive new investment level $E(k_{\substack{j \\ new}}^{*}|\Phi)$ and at the same time a higher disclosure quality monotonically decrease s_{ij}. Consequently, the covariance of the two firm's cash flows ($E(\text{cov}(\tilde{V}_i, \tilde{V}_j|\Phi) = m_i E(k_{\substack{j \\ new}}^{*}|\Phi)s_{ij}$) may either increase or decrease.

Interrelated Firm Effect

To have a deeper understanding of how disclosure quality affect firm *i*'s cost of capital through an interrelated firm, I start with identifying the relation between firm *i*'s disclosure quality (β_i) and the joint distribution of the two firms' cash flows ($E[\text{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)]$). When $\frac{\partial(E[\text{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)])}{\partial(\beta_i)}$<0, there is a positive interrelated firm effect of disclosure quality. This is because given this condition, a higher disclosure quality of firm *i* can monotonically reduce two firms' covariance, which in turn helps the firm move towards a higher share price and a lower cost of capital. In contrast, when $\frac{\partial(E[\text{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)])}{\partial(\beta_i)}$>0, an increase of disclosure quality in fact introduces more risks to the disclosing firm and investors tend to ask for more per-dollar risk premium, which is measured by cost of capital. Therefore, there is a negative interrelated firm effect. Before stating proposition, I sketch possible interrelated effect by writing $E[\text{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)]$'s partial derivative with respect to β_i as follows:

$$\frac{\partial(E[\text{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)])}{\partial(\beta_i)} = k_j s_{ij}\left[\frac{k_j'}{k_j} + \frac{s_{ij}'}{s_{ij}}\right] = s_{ij}s_{ij}'\left[\frac{k_j'}{s_{ij}'} + \frac{k_j}{s_{ij}}\right] \quad \textit{Where } k_j = E(k_{\substack{j \\ new}}^{*}|\Phi) \textit{ for short} \qquad (10)$$

$k_j' = \frac{\partial(k_j)}{\partial(\beta_i)}$ is the production effect of firm *i*'s disclosure quality through its interrelated firm *j* and k_j' is always positive if the future profitabilites of firm *i* and *j* are positively correlated with each other (h>0). Meanwhile, s_{ij} captures the degree of the two firms' interrelation. The higher s_{ij},, the stronger of the interrelation is. $s'_{ij} = \frac{\partial(s_j)}{\partial(\beta_i)}$ represents the indirect informational effect of firm *i*'s disclosure quality and it is always negative. Since k'_j and s'_{ij} always move oppositely when disclosure quality changes, the overall interrelated firm effect becomes ambiguous. One sufficient and necessary condition for the above derivative to be negative (which means there is a positive interrelated firm effect) is $\frac{k'_j}{k_j} < \frac{s'_{ij}}{s_{ij}}$. Intuitively, this condition says for firm *i* to always has a positive interrelated firm effect, the disclosure quality elasticity of interrelated firm's new investment level (the elasticity of production effect) must be less than the disclosure quality elasticity of the disclosed information on firm *j* (the elasticity of indirect informational effect). Subsequently a further question, the question of which firm *i* might be particularly interested in, is that: "under what condition would the elasticity of indirect informational effect overwhelm the elasticity of production effect all the time so that the disclosing firm *i* can enjoy an unambiguous positive interrelated firm effect?" Focusing on the role of the existing investment level of firm *i*, the following proposition 2 answers this puzzle.

Proposition 2 (Disclosure Quality and Interrelated Firm Effect)

In a mixed economy where firm i has a constant investment level while its interrelated firm j makes investment decisions after disclosures:

i. *When firm i's existing investment level is low enough (m_i <min ((m^*_{i1}, m^*_{i2}))), the indirect informational effect invariably overwhelms the production effect and leads to a positive interrelated firm effect of disclosure quality;*

ii. *When firm i's existing investment level is large enough ($m_i > m^*_{i2}$), there is one* *threshold of disclosure quality $\beta^{*}_{ci\_U}$. If and only if the disclosure quality is higher than this threshold, would an improvement in its disclosure quality result in a positive interrelated firm effect;*

iii. When firm i's existing investment level is modest ($m^{*}_{i1} < m_i < m^{*}_{i2}$), disclosure quality has two thresholds($\beta^{*}_{ci\_D}$ and $\beta^{*}_{ci\_U}$). If and only if firm i's disclosure quality is lower enough or high enough, would an improvement in its disclosure quality result in a positive interrelated firm effect

(The proof and all cut-off points are provided in the Appendix: proof of proposition 2 and table A-1)

The intuition of proposition 2 centres on the implicit production interrelation between firm *i* and firm *j*. Firm *i*'s disclosure guides its interrelated firm *j* to choose its optimal investment level. At the same time the optimal investment level k_j^* is compromised by firm *i*'s investment level m_i because of scarce wealth in the capital market. Interestingly, though m_i does not affect informational effect, it affects firm *j*'s real decision and thus in turn affects the joint distribution of two firms' future cash flow perceived by investors. Proposition 2 indicates that when m_i is sufficiently low, though a real effect of disclosure on firm *j* (production effect) still exists, this production effect is too weak to surpass an indirect informational effect. Consequently, a pleasant positive interrelated firm effect can be expected all the time. Whereases in a situation when m_i is sufficiently high, the response of firm *j*'s real decision to firm *i*'s disclosure quality can be very rapid. As disclosure quality moves within a low range, the percent change in firm *j*'s investment level is actually faster than that in informational content (the elasticity of production effect is higher than the elasticity of indirect informational effect). Therefore, a stronger production effect yields an unpleasant negative interrelated firm effect by improving firm *i*'s disclosure quality. If and only if disclosure quality increases within a high range, the indirect informational effect weights more than the production effect. In addition, given a modest m_i, the interaction between production effect and indirect information effect is much more subtle than above two cases. In this instance, if and only if disclosure quality moves within a very low range or a very high range, would the disclosing firm *i* have a positive interrelated firm effect by improving its disclosure quality. Intuitively, if firms are in a poor disclosure economy, the informativeness of firm *i*'s disclosure is so low that the disclosure effect on firm *j*'s real decision is powerless. The production effect is merely at work thus the indirect information effect is always influential enough to help firm *i* to have a positive interrelated firm effect. If the disclosure environment is already very rich, an incremental effect of disclosure quality on firm *j*'s real decision may be obvious. But in this circumstance, the elasticity of indirect informational effect is even steeper than that of production effect. The indirect informational effect again sweeps over the production effect. In contrast to the very low or very high cases, if disclosure quality moves within middle, the elasticity of production effect is higher than the elasticity of indirect informational effect thus a negative interrelated firm effect is expected.

Disclosure quality and Cost of Capital

Having analysing the interrelated firm effect, I conduct further comparative statics to address the most important research question of this paper: how would disclosure quality of firm *i* affect cost of capital in such a mixed economy? According to equation (9), $\prod_c$ is the determinant of firm *i*'s cost of capital. The partial derivative of $\prod_c$ with respect to β_i can be written as:

$$\frac{\partial(\prod_c)}{\partial(\beta_i)} = m_i^2 \frac{\partial(s_i)}{\partial(\beta_i)} + \frac{\partial(E\left[\operatorname{cov}(\tilde{V}_i, \tilde{V}_j | \Phi)\right])}{\partial(\beta_i)} \tag{11}$$

If $\frac{\partial(\prod_c)}{\partial(\beta_i)} > 0,$ a higher disclosure quality β_i leads to a higher $\prod_c$ thus a higher cost of capital ($E_c(R_i)$); if $\frac{\partial(\prod_c)}{\partial(\beta_i)} < 0,$ a higher disclosure quality β_i yields a lower cost of capital $E_c(R_i)$.

Since $\frac{\partial(s_i)}{\partial(\beta_i)}$<0 always, $\frac{\partial(E\left[\operatorname{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)\right])}{\partial(\beta_i)}$ <0 is a sufficient condition for equation (11) to be negative. This sufficient condition emphasizes that if firm *i*'s disclosure quality can ensure a positive interrelated firm effect, firm *i* can always enjoy a lower cost of capital by improving its *ex ante* disclosure quality. However, we cannot always infer that there must be a positive interrelated firm effect by observing a lower cost of capital after disclosures. A lower cost of capital after disclosures might be a case that a higher disclosure quality of firm *i* actually result in a negative interrelated firm effect but this negative interrelated firm effect is not powerful enough to surpass the direct informational effect. Moreover, we cannot exclude possibilities that the production effect is big enough to overwhelm the overall informational effect (sum of the direct informational effect of firm *i* itself and the indirect informational effect of firm *j*). Under these circumstances, the production effect becomes the detrimental dominant effect. A higher disclosure quality leads to a higher cost of capital of firm *i*. Proposition 3 clearly identifies necessary and sufficient conditions under which improving firm *i*'s disclosure quality increases its own cost of capital.

Proposition 3 (Disclosure quality, Correlation and Cost of Capital of Firm *i*)

In a mixed production-based economy, as long as firms are interrelated with each other, there are possibilities that a disclosing firm i has a disclosure threshold on cost of capital. Specifically, the existence of threshold depends on the degree of firms' correlation and may also be conditional upon firm i's existing investment level:

(i) *When two firms' correlation is sufficiently low ($(1/h)<h_d^{*}$), an increase in disclosure quality leads to an unambiguous decrease of firm i's cost of capital;*

(ii) When two firms' correlation is sufficiently high ($(1/h)>h_u^{*}$),disclosure quality has a threshold (β_i^{*}).If and only if the disclosure quality is higher than this threshold (β_i^{*}), would an improvement in its disclosure quality lead to an unambiguous decrease in firm i's cost of capital;

(iii)When two firms' correlation is modest ($h_d^{*}<(1/h)< h_u^{*}$), the effect of disclosure quality conditions on firm i's existing investment level m_i:

(a) If and only if m_i is low enough($m_i< m_{Ri}^{*}$), would an increase in disclosure quality leads to an unambiguous decrease of firm i's cost of capital;

(b) If and only if m_i is not too low ($m_i> m_{Ri}^{*}$), disclosure quality has a threshold (β_i^{*}). If and only if the disclosure quality is higher than this threshold (β_i^{*}), would an increase in disclosure quality lead to an unambiguous decrease in firm i's cost of capital.

(The proof and all cutoff points are provided in the Appendix: proof of proposition 3 and table A-2)

TABLE 2

Effects of firm *i*'s Disclosure Quality on Its Share Price and Cost of Capital in This Mixed Economy

Circumstance	Threshold of Disclosure Quality	Share Price	Cost of Capital
Low Correlation	None	Increase	Decrease
High Correlation	One	Decrease/Increase	Increase/Decrease
Modest Correlation and Low Existing Investment	None	Increase	Decrease
Modest Correlation and Not Low Existing Investment	One	Decrease/Increase	Increase/Decrease

This proposition reveals that when interrelated firm effect is considered, how the general notion regarding the relation between disclosure quality and a firm's cost of capital might be modified. In a production-based economy where some (not necessarily all) firms can make investment decisions after disclosures, there are possibilities that a firm's own disclosure quality can affect its own cost of capital in a detrimental way event when the disclosure doesn't change the firm's own investment decisions after disclosures. This 'reluctant' economic consequence occurs purely because disclosures can affect real decisions of an interrelated firm where both firms are priced in a capital market that values diversification. Because of real effects of disclosures, disclosure quality can possibly affect not only its own investment decisions but also those of its interrelated firms. Real effects of disclosures introduce additional risks to the economy and investors ask for incremental premiums because of these new risks. Even if the disclosing firm itself keeps a constant investment level all the times, its disclosure can still have a real effect on other interrelated firms' investment decisions through the capital market. A disclosing firm impose an additional real investment risk on its interrelated firm. At the meantime, the disclosing firm is enforced to 'share' this additional risk with its affected interrelated firm, because risk-averse investors tend to diversify this additional risk through interrelated firms. Thus, there is an implicit and endogenous trade-off when a firm chooses whether or not to improve disclosure quality. On one hand, investors reward firms who provide a higher disclosure quality because of resolution of future informational uncertainty (the informational effect of disclosure). On the other hand, a higher disclosure quality can result in an even higher additional production risk (the production effect of disclosure) and investors ask for additional premium of this new risk. The disclosing firm is responsible for a part of this premium no matter whether this investment risk is result from its own production or from interrelated firms.

Proposition 3 suggests that this trade-off highly depends on the degree of two firms' correlation and may be determined by the disclosing firm's existing productivity. When two firms are weakly correlated with each other, the disclosure of firm *i* only has a small impact on firm *j*'s real decision. Informational effect dominants production effect and an increase in disclosure quality leads to an unambiguous decline in firm *i*'s cost of capital. When firms are highly correlated, it's reasonable to expect stronger and more explicit interrelated firm effects. Given a poor disclosure environment, investors don't reward an improvement of disclosures too much. Meanwhile, conservative (risk-averse) investors ask more for additional production risks. If and only if a disclosure environment of the capital market is high enough (above the disclosure threshold β_i^*), would investors value more by observing a disclosure of high quality. Therefore, in this instance, a disclosing firm may not be able to enjoy a lower cost of capital after a disclosure of a higher quality all the time, even if the firm' future cash flow is not affected by this disclosure. When the correlation of two firms' future profitabilities is modest, the relation between firm *i*'s disclosure quality and its cost of capital conditions on its existing investment level (m_i). If m_i is low, there is no intense conflict between firm *i* and firm *j*. First, firm *i* does not occupied too much investors' wealth. Second, two firms are not strongly correlated thus the joint risks of them is moderate. As disclosure quality changes, the incremental tension between production effect and informational effect is at a low level. (This 'incremental tension' will be discussed in detail in the following paragraph.) Under this circumstance, firm *i* does not have to overmuch worry being negatively affected by firm *j* by improving its disclosure quality. If however, firm *i* already has had a considerable investment amount, conflicts of two firms turn to be more obvious at the time investors re-allocate their money. Incremental tension of disclosure quality can reach a very high level, particularly when disclosure quality varies within a low range. Once more, under this circumstance, production effect empowers informational effect and firm *i* has an even low share price and a higher cost of capital by improving its disclosure quality.

To make the intuition that underlies proposition 3 more transparent, let us further re-arrange Equation (11) as follows:

$$\frac{\partial(\underset{c}{\Pi})}{\partial(\beta_i)} = h^{-1}\varepsilon k_j\left[\frac{k_j'}{k_j} + \Omega\cdot\frac{\varepsilon_i'}{\varepsilon_i}\right] = h^{-1}\varepsilon\varepsilon'\left[\frac{k_j'}{\varepsilon_i'} + \frac{k_j + \frac{h}{\alpha_i}\cdot m_i}{\varepsilon_i}\right] \tag{12}$$

$$where\ \varepsilon = \frac{\mathrm{var}(\varepsilon_i)}{\mathrm{var}(y_i)}; \Omega = 1 + \frac{h}{\alpha_i}\frac{(z_j + \frac{2}{\tau}s_j)\cdot m_i}{(\theta_j - \frac{1}{\tau}s_{ij}m_i)}$$

ε measures the relative disclosure quality. A higher ε means a nosier disclosure. $\varepsilon_i' = \dfrac{\partial(\varepsilon_i)}{\partial(\beta_i)}$ is the direct informational effect and it is always negative. Ω can be viewed as a multiple which indicates the degree of firms' interrelation. If two firms are fully independent, Ω=1; if two firms' future profitabilities are positively correlated, like firm *i* and firm *j* here, Ω>1[13]. Since Ω >1 and k_j' and ε_i' always move towards to opposite ways as disclosure quality changes, the overall effect of disclosure quality on the disclosing firm *i*'s cost of capital is vague. If and only if $\dfrac{k_j'}{k_j} < \Omega\cdot\dfrac{\varepsilon_i'}{\varepsilon_i}$, would equation (12) to be negative. Intuitively this sufficient and necessary condition states that if and only if the elasticity of production effect is less than the multiple-adjusted elasticity of informational effect (the elasticity of overall informational effect), would an increase of firm *i's* disclosure quality guarantee that the disclosing firm has a lower cost of capital after disclosures. Proposition 3 reveals that regardless of the values of other parameters, if and only if two firms' correlation is sufficiently low, would the elasticity of the overall informational effect invariably surpass the

[13] The statement when Ω>1 is restricted by the assumption that θ_j is big enough to ensure a positive *kj**

elasticity of the production effect. In any other situations, production effect might be the eventual dominance. Alternatively, the sufficient and necessary condition of a negative derivative can be written as $\left|\frac{k_j'}{\varepsilon_i'}\right| < \frac{k_j + \frac{h}{\alpha_i} \cdot m_i}{\varepsilon_i}$ [14]. $\left|\frac{k_j'}{\varepsilon_i'}\right|$ is an incremental change in the interrelated firm *j*'s expanding investment level caused by a marginal increase in disclosure quality. (This study calls it an 'incremental tension of disclosure quality'), $\frac{k_j + \frac{h}{\alpha_i} \cdot m_i}{\varepsilon_i}$ stands for the pre-change information weighted production level of both firms. Another interpretation is that if and only if incremental tension of disclosure quality is small enough (less than the pre-change information weighted production level), would firm *i* always have a lower cost of capital by improving its disclosure quality. Recalling proposition 3, we can see that a sufficiently low correlation case is least likely to have a significant incremental tension. Having a sufficiently high correlation with another firm, the disclosing firm *i* can be harmed by an overwhelming incremental tension in a poor disclosure economy. When firms are less strongly interrealted, as disclosure quality changes, the degree and also changing rates of this incremental tension depends on firm *i*'s existing production level.

A general theme in the previous literature is that if a firm cannot change its production level after disclosures, as if the firm is in a pure exchange economy, disclosure of a high quality can always reduces the firm's cost of capital (e.g., LLV 2007; Gao 2010). Analytically, this theme is proved by that a higher disclosure quality reduces the conditional variance (or covariance) of the firm's future cash flow, while at the same time the mean of the firm's future cash flow is not affected by changes of disclosure quality. However, the second mixed economy of this study suggests that this theme may not be general enough. The

[14] Please note that $\frac{k_j'}{\varepsilon_i'}$ is always a negative number.

large previous literature that assumes a disclosing firm has a constant production level places great emphasis on direct informational effect ($\frac{\varepsilon_i'}{\varepsilon_i}$) (e.g., Easley & O'Hara, 2004). Other possible effects resulting from an interrelated firm are not attached equal importance. Based on equation (12), it can be clearly seen that an interrelated firm imposes two effects on the disclosing firm's cost of capital. One is production effect, which is captured by ($\frac{k_j'}{k_j}$) and the other is indirect informational effect, the degree of which is indicated by Ω. In the direct effect category, LLV (2007) demonstrates that disclosures of higher quality affect the firm's assessed covariances with other firms' cash flows, which is nondiversifiable. They consider indirect informational effect but production effect is still ignored. Consistent with LLV (2007), production effect and indirect informational effect imposed by an interrelated firm on a disclosing firm's cost of capital is not diversifiable because both these effects go with the interrelated firms' covariances. Even in an economy with a whole lot of firms, as long as firms are not fully independent and as long as some, not necessarily all, interrelated firms' real decisions can be changed (made) after disclosures, there are production effect and informational effect of a disclosure and the two effects always impact a disclosing firm's cost of capital in opposite way. It is important to emphasize once again that all findings in this paper is based on a positive correlation assumption. If firms are negatively correlated, which is less likely to be found in reality, findings possibly change but changes are not symmetrical with the results of a positive correlation assumption. This negative correlation assumption however is beyond the focus of this paper and it might be an interesting subject of future work.

Corollary 1 (Disclosure quality and Cost of Capital of Firm *j*)

In a production-based economy with interrelated firms, there are possibilities that a disclosing firm has a different disclosure threshold ($\beta^*_{i\_j}$) on its interrelated firm's cost of capital ($\beta^*_{i\_j} \neq \beta^*_i$) .A firm's disclosure can generates either positive or negative externality on an interrelated firm's cost of capital.

Firm *j*'s cost of capital can be written as:

$$E(R_j) = \frac{1}{\tau \cdot H_j - 1} where H_j = \frac{\theta_j - \frac{z_j}{2} E(k_j^{\ *})}{E(k_j^{\ *}) s_j + m_i s_{ij}} \tag{13}$$

According to equation (13), firm *i*'s disclosure quality also affects firm *j*'s cost of capital in different ways: firm *j*'s real decision ($E(k_j^{\ *})$) and investors' assessment of the risk of firm *j*'s uncertain future profitability (s_j) and two firms' underlying joint risk (s_{ij}). Although the covariance effect of disclosure quality per production unit is the same for both firm (s_{ij}), the magnitude of the total informational effect of disclosure quality on each firm's cost of capital is not equivalent. This is because the degree of disclosure quality effect on investors' re-assessment of each firm's idiosyncratic risk is not equal. ($s_j \neq s_i$) In addition, as production effect and informational effect always move oppositely, the overall effect of firm *i*'s disclosure quality on its interrelated firm *j*'s cost of capital is inconclusive too. Corollary 1 reveals that the magnitude of the impact of one firm's disclosure on a particular firm's cost of capital is unambiguous and must be different, as long as the two firms are not identical. Particularly, the disclosure quality of firm *i* may also has a threshold of firm *j*'s cost of capital: a higher quality of firm *i*'s disclosure quality cannot ensure a lower cost of capital of firm *j*. Importantly, this threshold is different from the threshold of the disclosing firm's own cost of capital and two thresholds cannot subsume with each other. Eventually, there might be a case that the disclosing firm generates a negative externality on its interrelated firm's cost of capital. Also, there might be another trickier case that firm *i* suffers from a higher cost of capital and a lower share price by improving its disclosure quality; while on the contrary, firm *j* positively 'free ride' on this information: having an aggressive investment level and enjoys a lower cost of capital and higher share price.

5. Discussion

Two implications of findings, the 'real effects' assumption and three clarifications are discussed in this section, in the context of related literature. A core conclusion of the previous literature about the role of information in the capital market is that the assumption of perfect competition in combination with pure exchange leaves little opportunity for disclosure studies. In response to this reluctant result, a large group of research relaxes the assumption of perfect competition and investigates the disclosure role in an imperfect economy. (e.g. Kyle 1985; Diamond & Verrecchia 1991, Easley & O'Hara, 2004) For example, in Verrecchia's disclosure review paper (2001), he remarks that:

''*…all of these models assume that markets are perfectly competitive, and perfect competition is a poor vehicle for studying efficiencies that arise from disclosure. To my mind disclosure's greatest potential role in the context of efficiency is the one arising from ameliorating the adverse selection problem inherent in the exchange of assets of varying degrees of informedness.'*(Verrecchia 2001, page 83-84)

Previous studies seem to suggest that imperfect competition in the capital market is essential to create an efficiency-based rationale for disclosure. This belief though is justifiable if accounting information merely flows from firms to the capital market. The first special model of this study reveals that a pure exchange economy model only captures one role of the capital market: assessing firms' future cash flows. Disclosure effects accordingly are monadical and lack of economical prominence. Impressively, the second special model indicates that the core result from previous literature may not as gray as it thought. While models of a pure exchange economy are poor vehicles in evaluating accounting information, it neither means the role of accounting information in a more general production-based economy is trivial, nor it means in a more general economy disclosures of high quality is invariably beneficial. In a production-based economy, even when information asymmetry is out of concern, the role of accounting information is substantial, even if it cannot change a disclosing firm's own production or investment level, as if the firm is in a pure exchange economy. Because of the existence of interrelated firms and real effects of disclosures, one firm's investment decisions may be affected by another interrelated firm's disclosures. Simultaneously, the disclosing firm itself is affected by these endogenous effects. By improving disclosure quality, the interrelated firm may take (or more) advantages of the disclosing information than the disclosing firm itself, if production effect overwhelms informational effect. Consequently, the disclosing firm has an even higher cost of capital by providing a higher quality of disclosure. Although a little bit striking new findings might be, they are intuitively appealing. Possible 'undesirable disclosure effects' serve as a caveat on disclosure studies. While a production-based economy may be a more attractive setting for disclosure research, there are some situations in which accounting information of high quality (too much accounting information) are not that welcomed, and this undesirability may have nothing to do with information asymmetry.

This interesting find may also provide a (possible) explanation of the unsolved question that why management might withhold information which is not proprietary (or why some information is disclosed with a very low quality even though the information seems to have no real great effect on the disclosing firm itself). Non-proprietary information is usually considered if its disclosure will not alter the distribution of a firm's future cash flow. Based on the adverse selection argument, it seems that researchers in accounting, finance and economics will agree that a firm's optimal strategy regarding the non-proprietary information is to release it publically (and truthfully) once the firm possess such kind of information.

However, in reality sometimes firms are reluctant to disclose non-proprietary information. Dye (1985) provides and examines two theories about the non-proprietary information withholding puzzle. Consistent with other research, he considers non-proprietary information as any information whose disclosure will not alter the distribution of a firm's future cash flow. Initially, Dye argues that there are three possible explanations for the non-proprietary information puzzle. The third possible explanation is vetoed immediately and the rest of his paper focuses on a principal-agent problem between shareholders and managers, which is build on the information asymmetry premise. The 'early died' third explanation is that the disclosure of non-proprietary information would be costly either directly or indirectly. Dye (1985) argues that

"…… *this is not an acceptable explanation since, by definition, the release of non-proprietary information incurs no direct or indirect dissemination costs, except possibly through its effect on the manager's compensation'*. (Dye 1985, p126)

I emphasize that I do not dispute the principal-agent explanation. Following Dye's definition that non-proprietary information means its disclosure will not alter the distribution of a firm's future cash flow (this suits firm *i*'s situation in two special models), the third, an alternative explanation may rebirth from this study. A firm may suffer an implicit cost by disclosing non-proprietary information. In some situations, a firm's share price (cost of capital) may decrease (increase) by improving disclosure quality. This cost incurs through disclosure effects on an interrelated firm, and this cost incurs even if information is symmetric among insiders and outsiders.

The results of this study are based on 'real effect' of disclosures assumption. The effect that accounting disclosures influence a firm's investment decisions via capital market is called a real effect of accounting disclosure and this real effect is first formulated by Kanodia (1980). Kanodia (1980) shows that disclosure of accounting information has an impact not only upon the behavior of equilibrium share prices, but also upon corporate production or investment decisions. Later Dye and Sridhar (2002) also demonstrate formally how firms' disclosures can help direct firms' strategy choices without making any presumption of imperfect competition in the capital market. LLV (2007) first analyze the real effect of accounting information on a firm's cost of capital and Gao (2010) examines how disclosure quality can affect cost of capital in a single-firm setting. The two papers both pay attention to disclosure effects on a disclosing firm's own investment decisions. This study extends their work by investigating a real effect of disclosures on an interrelated firm.

A classic theory explanation of the link between accounting information and cost of capital is based on imperfect competition premise. This study which extends the work of LLV (2007) and Gao (2010) is couched in a setting of perfect competition. The first thing should be emphasized is that there is no conflict between the traditional information asymmetries argument and the relevant new incomplete but symmetric information argument. The later is an alternative and maybe a more direct explanation of the link between accounting information and cost of capital. The second thing should be highlighted is the definition of cost of capital. There are many definitions of cost of capital in research and they correspond to different empirical measurements. LLV (2007) define a firm's cost of capital as the expected return on the firm's share price. They focus on the investors' conditional expected return after disclosures ($E(\tilde{R} \mid y) = \dfrac{E(P_1|y) - P_0(y)}{P_0(y)}$ [15]). Gao (2010) uses the value-weighted average of the conditional investor's expected return on the firm's share price $E(\tilde{R}) = \dfrac{E(E(P_1|y)) - E(P_0(y))}{E(P_0(y))}$ [16] and his main interest is to examine how the *ex ante*

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[15] *y* stands for the disclosed accounting information. P_0 is the share price before the disclosure and $P_1$is the share price after the disclosure.
[16] Please see more detailed explanation in Gao (2010), page10, footnote 5

disclosure quality change this cost of capital he defines. Therefore, the cost of capital in Gao (2010) is not the cost of capital for the firm to undertake new investment. It is the required return from investors' perspective. Probably a more common view in finance is that the change of cost of capital will force a firm to re-judge those possible investment opportunities. This is from a firm's perspective. But, in this research following Gao (2010), the expanding investment decision is not driven by the change of cost of capital. The change of 'cost of capital' is a consequence of the expanding investment decision: the expanding investment changes a firm's future cash flow so that the investors' cost of capital (expected return on the firm's equity) changes.

Last but not least, it is important to clarify that an 'interrelated firm' is not equivalent to a 'competitor'. 'Interrelation' describes a more subtle (general) relationship between two firms than 'competition'. The term 'competition' in industrial organization literature refers to a situation that firms compete directly via strategically choosing optimal quantity or price in the same market. Firms in proprietary cost hypothesis studies are embedded by this 'competitive' nature. Dye (2001) criticizes these studies by saying that 'this (disclosure) trade-off (which depends on the nature of competition) is so special that it sheds little new light on this trade-off'. Differing from the proprietary cost hypothesis, this study does not model direct competition between firms. Instead, inter-firm effects are captured indirectly via the specification of each firm's cash flows. The economic model of this paper describes a more general situation and may escape from the above criticism to some extent.

6. Conclusion

This study investigates how an interrelated firm would change the relation between disclosure quality and cost of capital. Firstly, I model a general production-based economy in which disclosures affect real decisions of two interrelated firms. Secondly, I simplify this general model into two special models by considering two specific economies. I implement a thorough analysis by conducting comparative statics of each special model so that we can have a better understanding of how a firm's disclosure quality affects its share price and cost of capital under different circumstances. It is demonstrated that disclosure quality has both an informational effect and a production effect on a firm's cost of capital. Although an informational effect is the sole effect in a pure exchange economy, both effects exist in a more general production-based economy. An informational effect purely has an impact on investors' perceptions of firms' future cash flows while a production effect changes an interrelated firm's real decisions. Given a positive correlation between two firms, the informational and the production effect invariably affect a disclosing firm's cost of capital in opposite ways. Therefore, there is an implicit endogenous trade-off of disclosure quality. A disclosure threshold may exist to prevent an unambiguous decrease of cost of capital and this existence of threshold highly depends on the degree of firms' correlation and may also be conditional upon a disclosing firm's existing investment level. In a pure exchange economy, improving disclosure quality can invariably benefit the disclosing firm and have a positive externality on its interrelated firm; while in a more dynamic production-based economy, under some circumstances, too much accounting information may be undesirable.

The results may help sort out the inconsistent empirical findings on the relation between accounting information and the cost of capital and reveal possible empirical implications that might be the subject of future work. The results may also provide a theoretical explanation to unsolved disclosure puzzles and add to disclosure regulation debates.

Appendix

Proof of Lemma 1

Consider an economy with two competing firms: firm *i* and firm *j*, and a risk-free bond with expected return of R_f. R_f is assumed to be zero in order to simplify the notation.

At t=3, investors observe an information set $\Phi = \{ y_i, y_j \}$. They then update their assessment of each firm's future cash flow by conjecturing the firm's expanding production level $k_i(\Phi)$ and $k_j(\Phi)$. Together with the knowledge, investors perceive that a firm's cash flow is going to have a mean $E\left[\tilde{V}_n \middle| \left(y, k_n\ (y)\right)\right]$ of and variance $\operatorname{var}\left[\tilde{V}_n \middle| \left(y, k_n\ (y)\right)\right]$ (n=*i*/*j*)

$$E\left[\tilde{V}_n \middle| \left(\Phi, k_n\ (\Phi)\right)\right] = m_n (E\left[\tilde{\pi}_n \middle| \Phi\right] + \pi_{0n}) + k_n (E\left[\tilde{\pi}_n \middle| \Phi\right] + \theta_n) - z_n / 2 \cdot k_n^{\ 2} \tag{A-1}$$

$$\operatorname{var}\left[\tilde{V}_n \middle| \left(\Phi, k_n\ (\Phi)\right)\right] = (m_n + k_n)^2 \operatorname{var}\left[\tilde{\pi}_n \middle| \Phi\right] \tag{A-2}$$

$$\operatorname{cov}\left[\tilde{V}_i, \tilde{V}_j \middle| \left(\Phi, k_i\ (\Phi), k_j\ (\Phi)\right)\right] = (m_i + k_i)(m_j + k_i) \operatorname{cov}\left[\tilde{\pi}_i, \tilde{\pi}_j \middle| \Phi\right] \tag{A-3}$$

Let $U(w_e)$ represents investor e 's utility preference for her wealth w_e. I assume investors all have CARA utility functions with risk tolerance parameter r. Therefore $U(w_e)$ is defined by

$$U(w_e) = -\exp[-\frac{w_e}{\tau}]$$

$$w_e = D_{ei}\left(\tilde{V}_i - P_i\right) + D_{ej}\left(\tilde{V}_j - P_j\right)$$

At **t=3**, investor e chose her demand D_{ei} of firm *i*'s shares and D_{ej} of firm *j*'s shares to maximize her expected utility by solving:

$$\max_{D_e} E\left[U\left(w_e \middle| \Phi, k_i(\Phi)\right)\right] = E\left[\exp\left[-\tfrac{1}{\tau}\left(D_{ei}\left(\tilde{V}_i - P_i\right) + D_{ej}\left(\tilde{V}_j - P_j\right)\right)\right]\left(\Phi, k_i(\Phi), k_j(\Phi)\right)\right]$$

$$= -\exp\left\{\begin{array}{l} -\tfrac{1}{\tau} *(E\left[\left[D_{ei}\left(\tilde{V}_i - P_i\right) + D_{ej}\left(\tilde{V}_j - P_j\right)\right]\left(\Phi, k_i(\Phi), k_j(\Phi)\right)\right] \\ -\tfrac{1}{2\tau}\left[\begin{array}{l} D_{ei}^{\ 2} \operatorname{var}\left(\tilde{V}_i \middle| \left(\Phi, k_i(\Phi), k_j(\Phi)\right)\right) + D_{ej}^{\ 2} \operatorname{var}\left(\tilde{V}_j \middle| \left(\Phi, k_i(\Phi), k_j(\Phi)\right)\right) \\ + 2D_{ei}D_{ej} \operatorname{cov}\left(\tilde{V}_i, \tilde{V}_j \middle| \left(\Phi, k_i(\Phi), k_j(\Phi)\right)\right) \end{array}\right] \end{array}\right\}$$

The first-order condition with respect to the demand D_{ei} and D_{ej} yields:

$$\begin{cases} E\left[\tilde{V}_i \middle| \Phi\right] - P_i - \tfrac{1}{2\tau} \cdot \left[2D_{ei}^{\ *} \operatorname{var}(\tilde{V}_i | \Phi) + 2D_{ej}^{\ *} \operatorname{cov}(\tilde{V}_i, \tilde{V}_j | \Phi)\right] = 0 \\ E\left[\tilde{V}_j \middle| \Phi\right] - P_j - \tfrac{1}{2\tau} \cdot \left[2D_{ej}^{\ *} \operatorname{var}(\tilde{V}_j | \Phi) + 2D_{ei}^{\ *} \operatorname{cov}(\tilde{V}_i, \tilde{V}_j | \Phi)\right] = 0 \end{cases} \tag{A-4}$$

The second-order condition with respect to the demand D_{ei} / D_{ej} is <0, guaranteeing that $D_{ei}^{\ *} / D_{ej}^{\ *}$ is the maximum solution.

Normalize the per capital supply of shares of each firm to be one unit, then market clearing requires:

$$Suppy^* = 1 = D_{ei}^{\ *} = D_{ej}^{\ *}$$

Therefore the equilibrium share price for firm i $P_i^*(\Phi)$ at t=3 is:

$$P_i^*(\Phi) = E\left[\tilde{V}_i \middle| \Phi\right] - \tfrac{1}{\tau}\left[\operatorname{var}(\tilde{V}_i|\Phi) + \operatorname{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)\right] \tag{A-5}$$

Set $\mu_i = E[\tilde{\pi}_i|\Phi]$; $\mu_j = E[\tilde{\pi}_i|\Phi]$; $s_{ij} = \operatorname{cov}\left[\tilde{\pi}_i, \tilde{\pi}_j|\Phi\right]$; $s_i = \operatorname{var}\left[\tilde{\pi}_i|\Phi\right]$; $s_j = \operatorname{var}\left[\tilde{\pi}_j|\Phi\right]$

Then $\operatorname{cov}(\tilde{V}_i, \tilde{V}_j|\Phi) = (\ m_i + k_i)(\ m_j + k_j)\, s_{ij}$ (A-6)

In the absence of agency problem, assume that the manager's object is to maximize the current share price when deciding the expanding production level of $k_i(\Phi)$:

$$\max_{k_i(\Phi)} P_i^*(\Phi) = E\left[\tilde{V}_i \middle| \Phi\right] - \tfrac{1}{\tau}\left[\operatorname{var}(\tilde{V}_i|\Phi) + \operatorname{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)\right]$$

$$= (\ m_i + k_i)\cdot \mu_i + m_i \cdot \pi_0 + k_i \cdot \theta_i - z_i / 2 \cdot k_i^{\ 2} - \tfrac{1}{\tau}\cdot[(m_i + k_i)^2 \cdot s_i + (m_i + k_i)(m_j + k_j)s_{ij}]$$

The first-order condition with respect to $k_i(\Phi)$ yields the optimal expanding investment is:

$$k_i^*(\Phi) = \frac{\theta_i + \mu_{\text{i}} - \frac{2}{\tau} m_i s_i - \frac{1}{\tau}(m_j + k_j)s_{ij}}{z_i + \frac{2}{\tau} s_i} \tag{A-7}$$

The second-order condition is <0, guaranteeing that $k_i^*(\Phi)$ is the maximum solution.

Get symmetric result for firm j's optimal expanding investment at t=3:

$$k_j^*(\Phi) = \frac{\theta_j + \mu_{\text{j}} - \frac{2}{\tau} m_j s_j - \frac{1}{\tau}(m_i + k_i)s_{ij}}{z_j + \frac{2}{\tau} s_j} \tag{A-8}$$

Solve equations (A-6) and (A-7) and get the equilibrium:

$$k_i^*(\Phi) = \frac{(\theta_i + \mu_i)}{(z_i + \frac{2}{\tau}s_i) - \frac{(\frac{1}{\tau}s_{ij})^2}{(z_j + \frac{2}{\tau}s_j)}} - \frac{\frac{2}{\tau}s_i - \frac{(\frac{1}{\tau}s_{ij})^2}{(z_j + \frac{2}{\upsilon}s_j)}}{(z_i + \frac{2}{\tau}s_i) - \frac{(\frac{1}{\tau}s_{ij})^2}{(z_j + \frac{2}{\tau}s_j)}}\cdot m_i - \frac{(\frac{1}{\tau}s_{ij})\cdot(\theta_j + \mu_j + z_j m_j)}{(z_i + \frac{2}{\tau}s_i)\cdot(z_j + \frac{2}{\tau}s_j) - (\frac{1}{\tau}s_{ij})^2} \tag{A-9}$$

Alternatively, it can be written as:

$$k_i^*(\Phi) = \frac{(\theta_i + \mu_i) - \frac{2}{\tau}s_i m_i}{z_i + \frac{2}{\tau}s_i} + \frac{1}{(z_i + \frac{2}{\tau}s_i)(z_j + \frac{2}{\tau}s_j) - (\frac{1}{\tau}s_{ij})^2}\cdot\left[(\tfrac{1}{\tau}s_{ij})^2\cdot\left(\frac{\theta_i + \mu_i + z_i m_i}{z_i + \frac{2}{\tau}s_i}\right) - (\tfrac{1}{\tau}s_{ij})\cdot(\theta_j + \mu_j + z_j m_j)\right] \tag{A-9(a)}$$

If s_{ij}=0 ($\operatorname{cov}\left[\tilde{\pi}_i, \tilde{\pi}_j\right]$=0), two firms are fully independent. $k_i^*(\Phi) = \dfrac{(\theta_i + \mu_i) - \frac{2}{\tau}s_i m_i}{z_i + \frac{2}{\tau}s_i}$ as if it is in a single firm setting.

Proof of Lemma 2

According to Lemma 1, the equilibrium share price for firm i $P_i^*(\Phi)$ at t=3 is:

$$P_i^*(\Phi) = E\left[\tilde{V}_i \middle| \Phi\right] - \tfrac{1}{\tau}\left[\operatorname{var}(\tilde{V}_i|\Phi) + \operatorname{cov}(\tilde{V}_i, \tilde{V}_j|\Phi)\right] \tag{A-5(a)}$$

In a mixed economy:

$$\mathrm{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)= m_i m_j s_{ij} \tag{A-6(a)}$$

Thus $\underset{pe}{P_i^*}(\Phi)=m_i(\mu_i+\pi_i)-\frac{1}{\tau}m_i(m_i s_i+m_j s_{ij})$ (A-11)

Proof of Lemma 3

According to Lemma1, the equilibrium share price for firm j $P_j^*(\Phi)$ at t=3 is:

$$P_j^*(\Phi)=E\left[\tilde{V}_j|\Phi\right]-\tfrac{1}{\tau}\left[\mathrm{var}(\tilde{V}_j|\Phi)+\mathrm{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)\right] \tag{A-5(b)}$$

In a mixed economy:

$$\mathrm{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)= m_i k_j s_{ij} \tag{A-6(b)}$$

Firm j's object is to maximize its current share price when deciding the expanding production level of $k_j(\Phi)$:

$$\max_{k_j(\Phi)} P_j^*(\Phi)=E\left[\tilde{V}_j|\Phi\right]-\tfrac{1}{\tau}\left[\mathrm{var}(\tilde{V}_j|\Phi)+\mathrm{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)\right]$$

$$=k_j\cdot(\mu_j+\theta_j)-z_j/2\cdot k_j^{\,2}-\tfrac{1}{\tau}\cdot[k_j^{\,2}\cdot s_i+m_i k_j s_{ij}]$$

The first-order condition with respect to $k_j(\Phi)$ yields the optimal expanding investment is:

$$\underset{new}{k_j^*}(\Phi)=\frac{\theta_j+\mu_j-\frac{1}{\tau}m_i s_{ij}}{z_j+\frac{2}{\tau}s_j} \tag{A-10}$$

The equilibrium share price for firm i $P_i^*(\Phi)$ at t=3 is:

$$P_i^*(\Phi)=E\left[\tilde{V}_i|\Phi\right]-\tfrac{1}{\tau}\left[\mathrm{var}(\tilde{V}_i|\Phi)+\mathrm{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)\right] \tag{A-4(b)}$$

Rewrite (A-5(a)) in terms of (A-9) and rewrite (A-4(b)) in terms of (A-1), (A-2) and (A-5(a)), the equilibrium price for firm i $P_i^*(\Phi)$ at t=3 is:

$$\underset{c}{P_i^*}(\Phi)=m_i(\mu_i+\pi_{0i})-\tfrac{1}{\tau}m_i(m_i s_i+\underset{new}{k_j^*}s_{ij}) \tag{A-12}$$

Proof of Proposition 1

Cost of capital of firm i is defined as :

$$E(R_i)=\frac{1}{\tau\cdot H_i-1}\,where H_i=\frac{E[E[\tilde{V}_i\mid\Phi]]}{E[\mathrm{var}[\tilde{V}_i\mid\Phi]]+E[\mathrm{cov}[\tilde{V}_i,\tilde{V}_j\mid\Phi]]} \tag{A-13}$$

In a pure exchange economy, by equations (A-5(a)) and (A-11):

$$E(R_i)=\frac{1}{\frac{\tau\cdot\pi_{i0}}{m_i s_i+m_j s_{ij}}-1}=\frac{1}{\tau\cdot\underset{pe(conditional)}{H_i}-1} \tag{A-14}$$

$$s_i=\frac{1}{\alpha_i+\beta_i};s_{ij}=\frac{\alpha_i}{h(\alpha_i+\beta_i)};\ \partial(s_i)/\partial(\beta_i)>0;\partial(s_{ij})/\partial(\beta_i)>0$$

Thus $\partial(E(R_i))/\partial(\beta_i) < 0, always$

Proof of Proposition 2

$$\frac{\partial(E[\text{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)])}{\partial(\beta_i)} = \frac{\alpha_i}{h}\frac{\partial(k_j^* \cdot s_i)}{\partial(\beta_i)} = \frac{\alpha_i}{h}[(\alpha_i+\beta_i)\cdot Y]^{(-2)}\left(A\beta_i^2 + B\beta_i + C\right) \qquad \text{(A-15)}$$

Where $Y = (\alpha_i+\beta_i)(x - y\beta_i)$; $x = h^2(z_j\alpha_j\tau + 2)$; $y = \alpha_j\alpha_i$

$A = -\left(\theta_j\alpha_j h^2\tau\right)\cdot x$ *, always <0*

$B = -2\alpha_i\left(\theta_j\alpha_j h^2\tau\right)\cdot x + 2m_i h\tau\cdot xy + \left(\theta_j h^2\tau\right)\cdot y^2$ *, either >0 or <0*

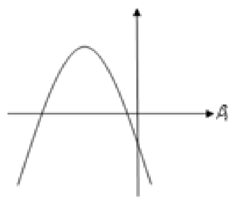
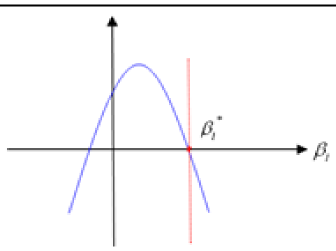
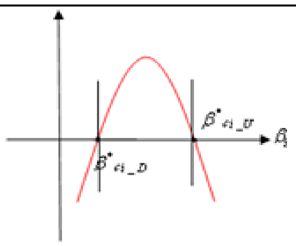
$C = -\alpha_i\left(\theta_j h^2\tau\right)\cdot xy + 2m_i h\tau\cdot xy + \alpha_i xy^2 + \alpha_i m_i h\cdot y^2$ *either <0 or <0*

$\Delta = B^2 - 4AC = 8\theta_j h^3\tau^2 xy^3\cdot m_i + 4(m_i h\tau xy)^2 + \alpha_i^4\theta_j^2 h^4\tau\cdot y^2$ *, always >0*

$$\beta^*_{ci\_U} = \frac{-B+\sqrt{\Delta}}{2A} \; and \; \beta^*_{ci\_D} = \frac{-B-\sqrt{\Delta}}{2A} \; ;$$

Table 1 summarises all sufficient and necessary conditions for $\frac{\partial(E[\text{cov}(\tilde{V}_i,\tilde{V}_j|\Phi)])}{\partial(\beta_i)} > 0$

Table A-1

Sufficient and Necessary Conditions	$f(\beta_i) = A\beta_i^2 + B\beta_i + C$	**Threshold of Disclosure Quality on Interrelated Firm Effect**
$\left.\begin{matrix} m_i < m^*_{i1} \\ (1/h)^2 > \dfrac{2(z_j\alpha_j\tau+2)}{(\sqrt{3}-1)(\alpha_i\alpha_j)} \end{matrix}\right\} \Leftrightarrow \begin{cases} B<0 \\ C<0 \end{cases}$		No disclosure threshold
$\left.\begin{matrix} m_i < m^*_{i2} \\ 0 < (1/h)^2 < \dfrac{2(z_j\alpha_j\tau+2)}{(\sqrt{3}-1)(\alpha_i\alpha_j)} \end{matrix}\right\} \Leftrightarrow \begin{cases} B<0 \\ C<0 \end{cases}$		
$m_i > m^*_{i2} \Leftrightarrow C > 0$		One disclosure threshold : $\beta^*_{ci\_U} = \dfrac{-B+\sqrt{\Delta}}{2A}$
$\left.\begin{matrix} m^*_{i1} < m_i < m^*_{i2} \\ (1/h)^2 > \dfrac{2(z_j\alpha_j\tau+2)}{(\sqrt{3}-1)(\alpha_i\alpha_j)} \end{matrix}\right\} \Leftrightarrow \begin{cases} B>0 \\ C<0 \end{cases}$		Two disclosure thresholds: $\beta^*_{ci\_D} = \dfrac{-B-\sqrt{\Delta}}{2A}$; $\beta^*_{ci\_U} = \dfrac{-B+\sqrt{\Delta}}{2A}$
$m^*_{i1} = \theta_j h\tau/(1-\frac{1}{2}\cdot\frac{x}{y})$ and $m^*_{i2} = \theta_j h\tau/(2+3y/(x-y))$; $x = h^2(z_j\alpha_j\tau+2)$; $y = \alpha_j\alpha_i$		

Proof of Proposition 3

$$\frac{\partial(E[R_i])}{\partial(\beta_i)} = [(\alpha_i+\beta_i)\cdot Y]^{(-2)}(\overline{A}\beta_i^2+\overline{B}\beta_i+\overline{C}) \qquad \text{(A-16)}$$

Where Y= $(\alpha_i+\beta_i)(x-y\beta_i)$; $x=h^2(z_j\alpha_j\tau+2)$; $y=\alpha_j\alpha_i$

$\overline{A}=-\theta_j h\tau\cdot xy-(x-y)^2\cdot m_i$, *always <0*

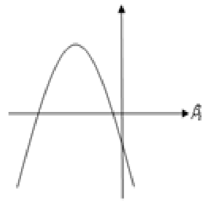
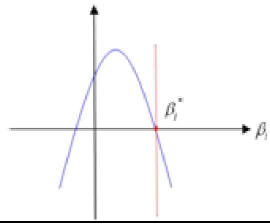
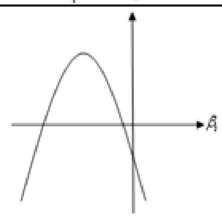
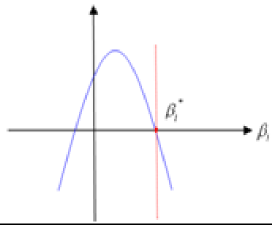
$\overline{B}=\alpha_i\{2x(2y-x)\cdot m_i-\theta_j h\tau\cdot y(2x-y)\}$, *either >/<0*

$\overline{C}=\ \alpha_i^2\{(2y^2-(x-y)^2)\cdot m_i-\theta_j h\tau\cdot y(x-y)\}$, *either >/<0*

$\overline{\Delta}=\overline{B}^2-4\overline{A}\overline{C}=\alpha_i^6\alpha_j{}^4(\theta_j h\tau+2m_i)^2$, *always* >0

Table 2 summarises all sufficient and necessary conditions for $\dfrac{\partial(E[\mathrm{cov}(\widetilde{V}_i,\widetilde{V}_j|\Phi)])}{\partial(\beta_i)}>0$

Table A-2

Correlation	Existing Investment	Sufficient and Necessary Condition	$f(\beta_i)=\overline{A}\beta_i^2+\overline{B}\beta_i+\overline{C}$	Threshold of Disclosure Quality on Cost of Capital
$0<(1/h)<h_d^*$ $(0<y<\frac{1}{1+\sqrt{2}}x)$	Independent on m_i	$0<(1/h)<h_d^* \Leftrightarrow \begin{cases}\overline{B}<0\\ \overline{C}<0\end{cases}$		No disclosure threshold
$(1/h)>h_u^*$ $(y>x)$	Independent on m_i	$(1/h)>h_u^* \Leftrightarrow C>0$		One disclosure threshold β_i^* $\beta_i^*=\dfrac{-\overline{B}+\sqrt{\Delta}}{2\overline{A}}$
$h_u^*<(1/h)<h_d^*$ $(\frac{1}{1+\sqrt{2}}x<y<x)$	$m_i\in(0,m_{Ri}{}^*)$	$\left.\begin{matrix}h_u^*<(1/h)<h_d^*\\ m_i\in(0,m_{Ri}{}^*)\end{matrix}\right\}\Leftrightarrow\begin{cases}\overline{B}<0\\ \overline{C}<0\end{cases}$		No disclosure threshold
	$m_i\in(m_{Ri}{}^*,+\infty)$	$\left.\begin{matrix}h_u^*<(1/h)<h_d^*\\ m_i\in(m_{Ri}{}^*,+\infty)\end{matrix}\right\}\Leftrightarrow\begin{cases}\overline{B}<0\\ \overline{C}>0\end{cases}$		One disclosure threshold β_i^* $\beta_i^*=\dfrac{-\overline{B}+\sqrt{\Delta}}{2\overline{A}}$
$h_d^*=(\frac{1}{1+\sqrt{2}}\cdot\dfrac{(z_j\alpha_j\tau+2)}{\alpha_i\alpha_j})^{0.5}$; $h_u^*=(\dfrac{(z_j\alpha_j\tau+2)}{\alpha_i\alpha_j})^{0.5}$; $m_{Ri}{}^*=\dfrac{\theta_j h\tau\cdot y(x-y)}{2x(2y-x)}$; $x=h^2(z_j\alpha_j\tau+2)$; $y=\alpha_j\alpha_i$				

$$E(R_j) = \frac{1}{\tau \cdot H_j - 1} \, where H_j = \frac{\theta_j - \frac{z_j}{2} E(k_j{}^*)}{E(k_j{}^*) s_j + m_i s_{ij}} \tag{A-17}$$

$$\frac{\partial(H_j)}{\partial(\beta_i)} = \Theta \cdot (A_j \beta_i{}^2 + B_j \beta_i + C_j)$$

$$Where \;\; X = \tfrac{1}{2} z_j + \tfrac{1}{\tau}\left[\frac{1}{\alpha_j} - (\frac{\alpha_i}{h})\right]; Y = z_j + \frac{1}{\alpha_j} \cdot (1 + \tfrac{2}{\tau})$$

$$\Theta = \left\{ m_i \cdot (\frac{\alpha_i}{h}) \cdot \left[\left(\alpha_i + \beta_i\right)\left(\alpha_j^{(-1)} + z_j + \tfrac{2}{\tau}\alpha_j^{(-1)}\right) - (\frac{\alpha_i}{h}) \cdot \beta_i \cdot (1 + \tfrac{2}{\tau}) \right] \right\}^{(-2)}, \textit{ always} > 0$$

$$A_j = 2\theta_j m_i \cdot (\frac{\alpha_i}{h}) X (Y - (1 + \tfrac{2}{\tau}) \cdot (\frac{\alpha_i}{h})), \textit{ either} > / < 0,$$

$$B_j = 4\theta_j m_i \cdot (\frac{\alpha_i{}^2}{h}) XY, \textit{ either} > / < 0$$

$$C_j = m_i \cdot (\frac{\alpha_i{}^2}{h}) \left\{ \theta_j \alpha_i \left[z_j (\frac{\alpha_i}{h}) + \tfrac{2}{\tau} \cdot \alpha_j^{(-1)} + (z_j + \tfrac{2}{\tau} \cdot \alpha_j^{(-1)})^2 + z_j \alpha_j^{(-1)} \right] - \tfrac{1}{2} \cdot z_j (1 + \tfrac{2}{\tau}) \cdot (\frac{\alpha_i}{h})^2 m_i) \right\},$$

either >/<0

$$\Delta_j = B_j^2 - 4A_j \cdot C_j, \textit{ either} > / < 0$$

	t=1	t=2	t=3	t=4
Firm i:	$\mathbf{m_i}$ units of existing production level	has an expanding investment opportunity observe a signal of the marginal profitability ($\tilde{y}_i$) and disclose it to the market	chose the optimal expanding production level of $\mathbf{k_i^*}$ units to maximize its current share price	both firms' cash flows realize
Firm j: $j \neq i$ *(Interrelated)*	$\mathbf{m_j}$ units of existing production level	also have an expanding opportunity observes the signal ($\tilde{y}_j$) and disclosed it to the market	chose the optimal expanding production level of $\mathbf{k_j^*}$ units to maximize its current share price	
Investors:	rational expect the expanding investment opportunity and disclosure effects on both firms	observe the signal set $\Phi = \{ \tilde{y}_i , \tilde{y}_j \}$ update their assessment of both firms' future cash flow	submitting their optimal demands of firms' shares and market is cleared	collect their proceeds

Figure 1
The timeline of events of a general economy

	t=1	t=2	t=3	t=4
Firm i:	**m_i** units of existing production level	observe a signal of the marginal profitability ($\tilde{y}_i$) and disclose it to the market	No action	cash flow realizes
Firm j: $j \neq i$ *(interrelated)*	**m_j** units of existing expanding production level	also observes the signal ($\tilde{y}_j$) and disclosed it to the market	No action	cash flow realizes
Investors:		observe the signal set $\Phi = \{ \tilde{y}_i , \tilde{y}_j \}$ update their assessment of both firms' future cash flow	submitting their optimal demands of firms' shares and market is cleared	collect their proceeds

Figure 2
The timeline of events of a pure exchange economy

	t=1	t=2	t=3	t=4
Firm i:	$\mathbf{m_i}$ units of existing production level	observe a signal of the marginal profitability ($\tilde{y}_i$) and disclose it to the market	No action	
Firm j: *$j \neq i$* *(Interrelated)*	**No** existing production level	also have an expanding opportunity observes the signal ($\tilde{y}_j$) and disclosed it to the market	chose the optimal expanding production level of $\mathbf{k_j}$***** units to maximize its current share price	both firms' cash flows realize
Investors:	rational expect the expanding investment opportunity and disclosure effects on both firms	observe the signal set $\Phi = \{ \tilde{y}_i , \tilde{y}_j \}$ update their assessment of both firms' future cash flow	submitting their optimal demands of firms' shares and market is cleared	collect their proceeds

Figure 3
The timeline of events of a mixed economy

References

Clinch, G., and N Sinclair., 1987. Intra-industry information releases: A recursive systems approach *Journal of Accounting and Economics* 9: 89-106.

Darrough, M., 1993. Disclosure policy and competition: Cournot vs. Bertrand. *The Accounting Review* 68, 534–562.

Darrough, M. N., and N. M. Stoughton. 1990. Financial disclosure policy in an entry game. *Journal of Accounting S- Economics* 12: 219-244.

Diamond, D., Verrecchia, R., 1991. Disclosure, liquidity, and the cost of capital. *The Journal of Finance* 66, 1325–1355.

Dye, R. A., 1985. Disclosure of nonproprietary information. *Journal of Accounting Research* 23:123-145

Dye, R. A., 1988. Earnings Management in an Overlapping Generations Model. *Journal of Accounting Research* 26(2): 195-235.

Dye, R. A., 1990. Mandatory versus Voluntary Disclosures: The Cases of Financial and Real Externalities. *Accounting Review* 65(1): 1-24.

Dye, R. A., 2001. An evaluation of "essays on disclosure" and the disclosure literature in accounting. *Journal of Accounting and Economics* 32(1-3): 181-235

Dye, R. A. and S. S. Sridhar., 2002. Resource Allocation Effects of Prices Reactions to Disclosures. *Contemporary Accounting Research* 19(3): 385-410.

Easley, D. and M. O'Hara ., 2004. Information and the cost of capital. *The Journal of Finance* 59,1553-1583.

Feltham, G. A., and J. Z. Xie. 1992. Voluntary financial disclosure in an entry game with continua of types. *Contemporary Accounting Research* 9 (Fall): 46-80.

Firth ,M. The impact of earnings announcements on the share price behaviour of similar type firms. *The Economic Journal* 86 (1976): 296–306

Foster, G. 1981. Intra-industry Information Transfers Associated With Earnings Releases. *Journal of Accounting & Economics* 3: 201–32.

Francis, J. R., Khurana I. K.,and Pereira., 2005. Disclosure Incentives and Effects on Cost of Capital around the World. *The Accounting Review* 80(4): 1125-1162

Gao. P.Y., 2010. Disclosure Quality, Cost of Capital and Investors .*The Accounting Review* 85(1): 1-29

Gigler, F., 1994. Self-enforcing voluntary disclosures. *Journal of Accounting Research* 32: 224–241.

Gleason, C., N. Jenkins and W. Johnson, 2008. The contagion effects of accounting restatements. *The Accounting Review* 83: 83−110.

Healy, P. M. and K. G. Palepu ., 2001. Information asymmetry, corporate disclosure, and the capital markets: A review of the empirical disclosure literature. *Journal of Accounting and Economics* 31(1-3): 405-440.

Kanodia, C. 1980. Effects of shareholder information on corporate decisions and capital market equilibrium. *Econometrica* 48 (4): 923–953.

Kim, O., Verrecchia, R., 1994. Market liquidity and volume around earnings announcements. *Journal of Accounting and Economics* 17, 41–68.

Kim,Y.,Lacina, M. and Pak. M.S.,2008. Positive and Negative Information Transfers from management forecasts. *The Journal of Accounting Research* 46(4):885-908

Kyle, A. S. 1985. Continuous auctions and insider trading. *Econometrica* 53 (6): 1315–1335.

Lambert, R., C. Leuz, and R. E. Verrecchia. 2007. Accounting information, disclosure, and the cost of capital. *Journal of Accounting Research* 45 (2): 385–420.

Lang L.and R. M. Stulz, 1992. Contagion and competitive intra-industry effects of bankruptcy announcements, *Journal of Financial Economics* 32, 45–60.

LEVITT, A. 1988. The Importance of High Quality Accounting Standards. *Accounting Horizons* 12: 79–82.

Marshall, J., 1974. Private incentives and public information. *American Economic Review* 64: 373–390.

Ng, D., 1975. Information accuracy and social welfare under homogenous beliefs. *Journal of Financial Economics* 2, 53–70.

Ohison, J.A. and A. G. Buckman. 1981. Toward a Theory of Financial Accounting: Welfare and Public Information. *Journal of Accounting Research* 19: 399-433.

Ohlson, J. A. 1984. The Structure of Asset Prices and Socially Useless-Useful Information. *Journal of Finance* 39(5): 1417-1435.

Samuelson, P. A. 1958. An Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money. *Journal of Political Economy*, University of Chicago Press, vol. 66: 467-482.

Tobin, J. On the Efficiency of the Financial System. *Lloyd's Banking Review* 153 (1982): 1–15.

Verrecchia, R., 1983. Discretionary disclosure. *Journal of Accounting & Economics* 5: 179–194.

Verrecchia, R., 2001. Essays on disclosure. *Journal of Accounting & Economics* 32: 97–180

Wilson, R., 1968. Theory of syndicates. *Econometrica* 36:119–132.