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Accounting comparability and relative performance evaluation by capital markets[☆]

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ABSTRACT

This paper examines how accounting comparability affects the monitoring role and the risk allocation role of capital markets. We develop the statistical and informational properties of accounting reports under varying degrees of comparability. A perfectly comparable accounting information system enables investors to perfectly infer the *difference* between any two firms' future cash flows although investors remain uncertain about either firm's cash flow. Comparability alleviates entrepreneurs' moral hazard problem by strengthening the price response to the relative accounting performance, but can induce excessive price risk as well as residual systematic cash flow risk. Unlike the investors (users) who earn their surplus by bearing the residual systematic risk, the entrepreneurs (preparers) do not find perfect comparability desirable. Hence, a standard setter would mandate higher comparability than preferred by preparers, but not perfect comparability.

1. Introduction

Over the past 40 years, reducing diverse practices and inconsistent guidance is the most frequently cited reason by the Financial Accounting Standards Board (FASB) to take on a project, and more than half of the standards are intended to enhance comparability (Jiang et al., 2018). Despite that, the current standards still allow for diverse practices and inconsistent treatment for similar transactions. FASB board members who are former CFOs or controllers are less likely than those with user backgrounds to dissent because a standard allows for exceptions or gives the management accounting alternatives. As noted by practitioners and researchers, while the users of financial information emphasize on accounting comparability, the preparers often dispute its importance (see, e.g., Van Riper, 1994; De Franco, Kothari and Verdi, 2011; Jiang et al., 2018; Kurt,

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2020). The natural question is: What drives the different attitudes toward comparability by the two major constituents of financial reporting? Why do we still observe diverse practices despite regulatory emphasis on comparability?

One explanation for the existence of diverse accounting practices is that it allows for flexibility and is thus preferred by preparers who may benefit from opportunistic reporting. However, preparers do not always benefit from more discretion when investors rationally correct for the opportunistic reporting on average (see, e.g., Guttman et al., 2006; Gao and Zhang, 2019). In this paper, we show that the information externalities of comparable financial reports can potentially explain why preparers are less enthusiastic about adopting common accounting practices, even in the absence of opportunistic reporting. Indeed, a too-high level of comparability can induce excessive price risk and risk premium borne by the preparers. Thus, we provide a different rationale for diverse accounting practices which is that permitting alternative accounting methods for the same economics phenomenon diminishes *comparability* among reports (FASB, 2018, QC25; IASB, 2018, 2.29).

We first develop the statistical and informational properties of comparability as they are decision-relevant to economic agents. Comparability is viewed as a property of the relationship between the accounting information of at least two firms (FASB, 2018, QC21; IASB, 2018, 2.25). Suppose an accounting information system measures the fundamental value of each firm with errors, we model comparability as the correlation between the measurement errors of any pair of firms under a reporting regime. This proposed measure is theoretically consistent with the notion that adopting a common standard features a larger common measurement error (Dye and Sridhar, 2008; Zhang, 2013), as the correlation between measurement errors is positively associated with the proportion of the common error among reports. On the one hand, higher comparability renders the *difference* between two reports more informative about the *difference* between their reporting firms' fundamentals, and hence improves the users' knowledge about the firm-specific fundamentals relative to other firms. On the other hand, it impairs their knowledge about the average fundamental and thus the aggregate economy due to a larger common measurement error.[1,2]

To study the economic consequences of accounting comparability, we build our model on the overlapping generations setting in Dye (1990), Dye and Sridhar (2007) and Gao (2010), and extend it to multiple firms. Each firm is initially owned and managed by a risk-averse entrepreneur. The cash flow to each firm is jointly determined by an unobservable effort by the entrepreneur, an economy-wide shock common to all firms, and an idiosyncratic shock specific to each firm. After privately exerting the effort, the entrepreneur publicly issues an accounting report which is a noisy signal about the cash flow. Entrepreneurs then sell their firms to risk-averse investors and consume the proceeds due to life-cycle considerations. At the last date, cash flows are realized, and investors consume the cash flows generated by the firms.

In the presence of information externalities, investors efficiently use other firms' reports to price any firm in the market. Their inference about the cash flows given their conjectures of the entrepreneurs' efforts can be decomposed into two tasks. In the first task, the investors infer each firm's idiosyncratic cash flow shock by comparing its report with the other reports. In the second task, the investors learn from all reports to infer the cash flow shock common to all firms. Comparability improves the first inference but impairs the second one. This informational property leads to various efficiency implications.

Comparability alleviates the moral hazard problem arising from the unobservability of the entrepreneurs' efforts. An entrepreneur internalizes the return to his effort to the extent that it affects the firm price through the accounting report. As the investors' inference about the common shock is disciplined by the reports of the other firms, the entrepreneur is incentivized to work hard only to differentiate his report from the others' reports. Due to the noisiness of accounting signals, the rate at which his effort increases the market price is lower than the rate at which it increases the firm value. Higher comparability alleviates this moral hazard problem by strengthening the price response to the relative accounting performance.

Despite its positive effect on the monitoring role of capital markets, perfect comparability is not considered desirable by the entrepreneurs as it induces excessive price risk and risk premium. An undiversified entrepreneur who consumes the proceeds from selling his firm bears the risk associated with the volatility of the firm price. This price risk has both an idiosyncratic and a systematic component. Each component of the price risk is positively associated with the extent to which the investors use the reports to infer its corresponding cash flow shock. Although comparability impairs the investors' inference about the common shock, it can increase the price risk due to the investors' enhanced inference about the idiosyncratic shock when the level of comparability is sufficiently high. The entrepreneurs sell at a lower price due to the risk premium which is determined by the diversified investors' residual uncertainty about the common shock. Higher comparability increases the risk premium by increasing such uncertainty about the aggregate economy.

However, maximizing comparability makes the diversified investors better off because they earn their surplus by bearing the residual systematic risk (Gao, 2010; Bertomeu and Cheynel, 2016). The risk premium equals their marginal cost of bearing the systematic risk which is higher than the average cost, and their surplus increases in the residual systematic risk. The above

[1] The former informational effect manifests itself through the increased price response to a firm's own report. From this perspective, comparability is an *enhancing characteristic* of useful financial information as described by the conceptual frameworks in FASB (2018, QC19) and IASB (2018, 2.23).

[2] We can further illustrate this informational trade-off using an analogy in which students' ability is assessed through exams. The students can be taking the same exam, or assigned to distinct and independent exams. The grades in the former case are more "comparable" because students are evaluated under the same criterion, and hence the ranking of students is more informative of their relative ability. On the other hand, the grades in the latter case are more informative about the average ability of the class because the noisiness induced by independent exams is diversified away in the average grade.

results combined suggest that the preparers prefer a lower level of comparability than the users. As noted by a former FASB member Van Riper (1994):

> "Though its importance is often disputed by preparers of financial information, comparability of financial information has long been a major concern of analysts and legislators."

As lower comparability is associated with diverse accounting practices, our model can potentially explain why preparers are more tolerant of diverse practices relative to users and even tend to lobby for a lower level of standardization (Jiang et al., 2018). If the standard setter incorporates the preferences of both preparers and users of financial reports, the observed standards should reflect both of their preferences (Watts and Zimmerman, 1978). Hence, the standard setter would mandate a higher level of comparability than that would otherwise be chosen by the preparers, but not perfect comparability because of the excessive costs on the preparers. In other words, we should still observe diverse accounting practices despite regulatory emphasis on comparability.[3] The model also predicts that the mandated level of comparability would be higher when the idiosyncratic cash flows are less volatile. That is, we should observe standards allowing for more diverse practices in an economy with highly heterogeneous firms. Moreover, our main results continue to hold qualitatively even when extending our model to allow for firm-wise heterogeneity in the level of comparability.

This paper contributes to the current literature in several aspects. First, it formally defines comparability and investigates the economic consequences of increasing comparability from an informational perspective. Accounting has been intensively studied as an information function (Butterworth, 1972; Liang and Zhang, 2008). Current standard setters follow the conceptual-framework approach to standard setting by first defining desirable qualitative characteristics of financial information and then evaluating alternative standards against them (Bullen and Crook, 2005). However, the common notion of comparability is theoretically ambiguous (Sunder, 2010). A key feature of our theoretical definition is that we disentangle comparability from the informativeness of a stand-alone report which has been studied extensively since Feltham (1972). We examine how comparability affects the usefulness of an accounting report given other firms' reports while controlling for the informativeness of a stand-alone report. Although comparability enhances the usefulness of an accounting report given other firms' reports, we show that the standard that takes into account both constituents would not feature perfect comparability. Nevertheless, we provide a justification for the regulatory emphasis on comparability, as preparers would otherwise choose an even less comparable reporting system than what the standard setter would choose.

Second, this paper is related to the study of the monitoring role of capital markets in addressing agency issues (e.g., Holmstrom and Tirole, 1993; Dye and Sridhar, 2004, 2007). Efficient pricing by the market serves as a disciplinary mechanism for those with control rights. Consequently, how much information is available to the market affects the efficiency of their actions. We extend this line of inquiry by examining the information externalities of financial reports in the sense of Dye (1990) and Dye and Sridhar (2008). Comparability can facilitate the investors' learning of firm value through comparison between firms, thus incentivizing the entrepreneurs to exert efforts to differentiate themselves from the others. This mechanism also formally establishes the intuition in Core et al. (2003) that equity incentives render an *implicit* relative performance evaluation scheme. More recently, Jennings et al. (2020) formally document that a firm's price depends on the relative ranking of its earnings in its peer group.

Finally, this paper addresses the risk allocation effect of disclosure policies (e.g., Dye, 1990; Dye and Sridhar, 2004, 2007; Gao, 2010). Disclosure resolves uncertainty early, increasing the price risk while reducing the residual cash flow risk (Hirshleifer, 1971). In the situation where the current shareholders have to sell to the next generation of shareholders, more precise disclosure is efficient if and only if the new generation is relatively more risk averse than the old generation. Our information structure differs from the standard one in that the level of comparability does not affect the precision of a stand-alone report, but rather affects risk allocation through the information externalities. Due to the investors' diversification of the idiosyncratic risks, only the systematic risk is allocated between the two generations. A higher level of comparability shifts more systematic risk to the investors. Nonetheless, even when the entrepreneurs are relatively more risk averse than the investors, it is not efficient to allocate all the systematic risk to the investors as it also induces excessive idiosyncratic price risk borne by the undiversified entrepreneurs.

The rest of the paper is organized as follows. Section 2 develops the model and discusses the measure of comparability in more details. Section 3 characterizes the equilibrium given an exogenous level of comparability. Section 4 studies the welfare implication of increasing comparability on both constituents of financial reporting. Section 5 discusses the empirical implications. Section 6 extends our main setting and enables firm-wise heterogeneity in the level of comparability. Section 7 concludes.

2. Model

This section describes the basic setting of the economic model and the informational properties of comparability. Since the notion of comparability can only be applied to more than one firm, we model a continuum of firms, with each firm indexed by

[3] There can be many other reasons for users to prefer higher comparability. For example, comparability can perhaps facilitate more efficient information processing by investors. These possible forces not captured by our model do not contradict our results. In practice, there are also many other stakeholders of financial reporting not captured by our analysis. Arguably, preparers and users are among the most important ones.

$i \in [0,1]$.[4] Each firm is owned and managed by an entrepreneur with the same index as the firm he owns for simplicity. There is also a continuum of investors indexed by $j \in [0,1]$ who buy the firms from entrepreneurs after the release of accounting signals, but before the cash flows are realized.

2.1. Setup

Firm i's cash flow $\widetilde{\theta}_i$ is determined jointly by (i) the effort a_i exerted by its entrepreneur, (ii) the economy-wide shock $\widetilde{\eta}$ common to all firms, and (iii) an idiosyncratic shock $\widetilde{\delta}_i$ specific to each firm. That is, given the effort a_i,

$$\widetilde{\theta}_i = a_i + \widetilde{\eta} + \widetilde{\delta}_i, \text{ with } \widetilde{\eta} \sim \mathcal{N}\left(0, \tau_\eta^{-1}\right), \widetilde{\delta}_i \sim \mathcal{N}\left(0, \tau_\delta^{-1}\right), \tag{1}$$

where $\tau_\eta > 0$ and $\tau_\delta > 0$ are the precisions of the two cash flow shocks, respectively. Both the price and the return of the risk-free asset are normalized to be 1.

The output of the accounting system is a noisy signal about the firm's cash flow. It carries both a common error and an idiosyncratic error. The common error comes from the use of a common set of measurement methods required by the accounting standards, and the idiosyncratic error is due to diverse practices. Formally, conditional on the cash flow, firm i's accounting signal is

$$\widetilde{s}_i = \theta_i + \widetilde{\varepsilon} + \widetilde{\xi}_i, \text{ with } \widetilde{\varepsilon} \sim \mathcal{N}\left(0, \tau_\varepsilon^{-1}\right), \widetilde{\xi}_i \sim \mathcal{N}\left(0, \tau_\xi^{-1}\right), \tag{2}$$

where $\widetilde{\varepsilon}$ and $\widetilde{\xi}_i$ are the common error and the idiosyncratic error, with corresponding precisions $\tau_\varepsilon > 0$ and $\tau_\xi > 0$, respectively. Since the firms are otherwise symmetric, we may also use the economy-wide average signal $\widetilde{\overline{s}} \equiv \int_0^1 \widetilde{s}_i \mathrm{d}i = a + \widetilde{\eta} + \widetilde{\varepsilon}$ as a sufficient statistic of all (other) firms' accounting reports, where $a \equiv \int_0^1 a_i di$ is the average effort. To disentangle comparability from the informativeness of a stand-alone report, we restrict the precision of an individual signal about its reporting firm (hereafter, *reporting precision*) to be a constant τ, with $0 < \tau < \infty$ to ensure usefulness of accounting signals, i.e.,

$$\tau^{-1} \equiv \tau_\varepsilon^{-1} + \tau_\xi^{-1}. \tag{3}$$

In equilibrium, the investors rationally infer the unobservable effort exerted by the entrepreneurs. However, they are unable to perfectly deduce the underlying cash flows of the firms, as the cash flows are subject to the common shock and the idiosyncratic shocks as well. The noisy accounting reports thus help them to imperfectly estimate the extent to which the cash flow shocks have affected the terminal cash flows.

Entrepreneurs and investors are assumed to be risk averse with constant absolute risk aversion (CARA). Entrepreneur i's utility function is given by $u_i(\widetilde{w}_i) = -\frac{1}{\rho_E} e^{-\rho_E \widetilde{w}_i}$, where $\widetilde{w}_i$ denotes his consumption financed by the proceeds from selling his firm. Investor j's utility function is given by $v_j(\widetilde{w}_j) = -\frac{1}{\rho_I} e^{-\rho_I \widetilde{w}_j}$, where $\widetilde{w}_j$ denotes her consumption financed by the cash flows generated by the portfolio she buys from the entrepreneurs.

The timeline of the model consists of four dates, as depicted in Fig. 1. At date $t = 1$, the entrepreneur of each firm $i \in [0,1]$ chooses an effort a_i and personally bears a quadratic cost $\frac{1}{2}a_i^2$. The level of the effort is private information to the entrepreneur who made the choice. At date $t = 2$, the accounting system of each firm produces a public signal about the cash flow that will be generated by the firm. Investors then use all the accounting signals to make portfolio decisions. At date $t = 3$, the trading takes place. Entrepreneurs sell the firms to investors and consume the price of their firms. At the last date $t = 4$, cash flows of all firms are realized, and investors consume the cash flows generated by their portfolios.

All random variables are independent from each other and all parameters are common knowledge unless specified otherwise.

2.2. Measure of comparability

Our theoretical measure of comparability is based on its statistical and informational properties. Wang (2014) defines comparability as the correlation between the measurement processes of two firms' accounting earnings. Because the measurement errors capture the informational properties of the measurement process in our informational framework, the correlation between the measurement processes of the two firms, i and i', is

$$c \equiv \mathrm{Corr}\left(\widetilde{s}_i - \widetilde{\theta}_i, \widetilde{s}_{i'} - \widetilde{\theta}_{i'}\right) = \frac{\mathrm{Cov}\left(\widetilde{\varepsilon} + \widetilde{\xi}_i, \widetilde{\varepsilon} + \widetilde{\xi}_{i'}\right)}{\left[\mathrm{Var}\left(\widetilde{\varepsilon} + \widetilde{\xi}_i\right)\mathrm{Var}\left(\widetilde{\varepsilon} + \widetilde{\xi}_{i'}\right)\right]^{\frac{1}{2}}} = \frac{\tau_\varepsilon^{-1}}{\tau_\varepsilon^{-1} + \tau_\xi^{-1}}. \tag{4}$$

[4] The extent of the information externalities increases in the number of firms in a finite-firm setting (Dye and Sridhar, 2008), so one can view this assumption as a limiting case of the finite-firm setting.

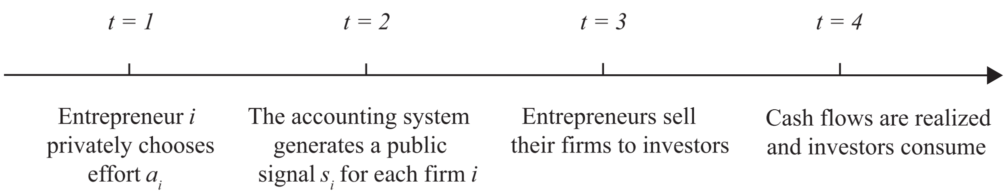


Fig. 1. The timeline of events.

In other words, we measure comparability as the proportion of variance from the common measurement error, $c \in [0,1]$. Thus, controlling for the precision of an individual report as τ, we have

$$\tau_{\varepsilon}^{-1} = c\tau^{-1},\ \tau_{\xi}^{-1} = (1-c)\tau^{-1}. \tag{5}$$

According to the FASB (2018, QC21) and the IASB (2018, 2.25), comparability enables users to identify and understand differences among firms. Taking the difference between the accounting reports of firm i and i' renders a noisy signal of the difference between their fundamentals:

$$\widetilde{s}_i - \widetilde{s}_{i'} = \left(\widetilde{\theta}_i - \widetilde{\theta}_{i'}\right) + \left(\widetilde{\xi}_i - \widetilde{\xi}_{i'}\right). \tag{6}$$

The common measurement error is cancelled out during the comparison, and the variance of the noise is $2\tau_{\xi}^{-1}$ which decreases in c. That is, the amount of information conveyed through the comparison of accounting signals is positively associated with comparability.

This measure is also consistent with the notion that financial reports are more comparable through the application of a common standard because applying a common standard can be associated with a larger common measurement error (Dye and Sridhar, 2008; Zhang, 2013). However, it should be noted that comparability is not equivalent to uniformity. In our setting, comparability not only increases common measurement error, but also reduces the idiosyncratic measurement error so that "like things look alike and different things look different" (FASB, 2018, QC23; IASB, 2018, 2.27).

Limitations of the measure. First, we do not attempt to model how accounting standards map transactions into financial reports. Therefore, the proposed measure of comparability can neither be used to study the frictions in the measurement process nor to provide any operational guidance on evaluating alternative accounting rules (Gao, 2013). Specific accounting rules differ in multiple dimensions in terms of all qualitative characteristics. One qualitative characteristic may have to be diminished to maximize another qualitative characteristic (FASB, 2018, QC34; IASB, 2018, 2.38). Choosing one accounting rule over another may increase comparability but impair other qualitative characteristics, which reduces the informativeness of a report about its reporting firm. In our theoretical inquiry, we hold constant the precision of each stand-alone report in order to focus on the information-externality effects.

Second, our measure does not capture firm-wise heterogeneity in the level of comparability. The level of comparability between any two firms' reports may be affected by their reporting firms' characteristics, including to what extent their transactions are regulated by the standard or if they are in the same industry (De Franco et al., 2011). In other words, c can only be interpreted as a regime-level measure of comparability among all reports. Studying a setting with heterogenous exposures to correlated measurement errors requires carefully specifying the distribution of the exposures, which has nontrivial implications for the way investors use the reports. Nevertheless, in section 6, we simplify the analysis by considering an extension with only two groups of firms, with firms in each group only subject to a group-wide common measurement error besides idiosyncratic errors. Our main results remain qualitatively robust in this extended setting.

Third, our measure of comparability captures the notion that applying a common standard enhances comparability in a reduced-form manner of modelling the common measurement error. It omits other aspects of adopting a common standard. For example, applying a common disclosure regulation to all firms can economize on the information processing costs of users confronted with multiple reports (Gao et al., 2019), reduce the distortion created by lobbying (Friedman and Heinle, 2016), and impose rigidity on financial reporting thus reducing opportunistic reporting (Dye and Sridhar, 2008).

3. Equilibrium analysis

The equilibrium in this model consists of the effort choices simultaneously made by the entrepreneur of each firm and the pricing rules applied by the investors in the capital market. We characterize a perfect Bayesian equilibrium in which all players make optimal decisions that maximize their utility given all their available information as well as their rational expectations regarding the strategic behavior of the other players, utilizing Bayes' rule to make inferences and update their beliefs. Formally, denoting by $\widehat{a}_i$ the conjecture of the players about the effort level a_i^* and $P_i : \mathbb{R}^2 \to \mathbb{R}$ the pricing equation, respectively, any perfect Bayesian equilibrium must satisfy the following conditions for any $i \in [0, 1]$ and for any $s_i, \overline{s} \in \mathbb{R}$:

i. $a_i^* \in \arg\max_{I_i} \mathbb{E}[P_i] - \frac{\rho_E}{2}\mathrm{Var}(P_i) - \frac{1}{2}a_i^2$;

ii. $P_i(s_i, \overline{s}) = \mathbb{E}[\widetilde{\theta}_i | s_i, \overline{s}] - \rho_I \mathrm{Var}(\widetilde{\eta} | s_i, \overline{s})$; and

iii. $\widehat{a}_i = a_i^*$.

Condition (i) pertains to the efforts simultaneously chosen by the entrepreneurs. Each entrepreneur chooses the level of the effort that maximizes his expected utility, given his rational expectations about the other entrepreneurs' efforts and the investors' pricing rule. Condition (ii) describes the pricing rule applied by the investors following firms' issuance of accounting reports.[5] Here, the risk-averse investors are only compensated for bearing nondiversifiable risks, and the risk premium equals their marginal cost of bearing such risk. Condition (iii) ensures that all players have rational expectations regarding each other's behavior.

We derive the interrelated equilibrium outcomes of entrepreneurs' efforts and the capital market prices using backward induction.

Lemma 1. *Each investor holds an identical proportion of the market portfolio and is only compensated for bearing non-diversifiable risks. With conjectured levels of effort $\widehat{a}_i$ and $\widehat{a}$ for firm i and the economy-wide average, respectively, the pricing equation applied by the investors is*:

$$P_i(s_i, \overline{s}) = \widehat{a}_i + \frac{\tau_\xi}{\tau_\delta + \tau_\xi}(s_i - \overline{s}) + \frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}(\overline{s} - \widehat{a}) - \rho_I \frac{1}{\tau_\eta + \tau_\varepsilon}. \tag{7}$$

In equilibrium, investors' conjecture coincides with the actual effort exerted by the entrepreneurs:

$$\widehat{a}_i = a_i^* = \frac{\tau_\xi}{\tau_\delta + \tau_\xi}. \tag{8}$$

In the presence of cash flow uncertainties, investors cannot precisely infer each firm's cash flow despite their rational expectations about the entrepreneurs' efforts. They thus find the accounting reports useful for learning about the two cash flow shocks. When pricing a firm, the inference is decomposed into two tasks. First, they use the relative accounting performance, i.e., the difference between the firm-specific signal and the average signal, to learn about the idiosyncratic shock to the firm. Second, they use the average signal to learn about the common shock to all firms. Essentially, the average report plays two informational roles - it not only is informative about the aggregate economy, but also teases out the common measurement error in the individual firm's report. The latter role is similar to the efficient use of information in relative performance evaluation schemes in Holmstrom (1982).

The equilibrium effort exerted by an entrepreneur is always lower than the efficient level, that is, there is a moral hazard problem.[6] Because the effort is unobservable to the investors, the entrepreneur is incentivized to exert effort only to the extent it increases the firm price through the accounting report. Although the investors cannot distinguish cash flow shocks from the effect of the effort on the firm value, the inference about the common shock is disciplined by the average report. Hence, the entrepreneur can only jam their inference about the idiosyncratic shock. As can be seen from equation (7), the marginal benefit of effort to the entrepreneur is the price coefficient on the relative performance. In other words, the entrepreneur works hard to differentiate his own report from the average report. The economic return of one additional unit of effort in improving future cash flows is 1, but the price coefficient on the relative accounting performance is always lower than 1 due to the imperfection of the accounting signals. This incentive effect of the pricing equation is consistent with the conjecture in Core et al. (2003) that equity incentives of managers render an implicit relative performance evaluation scheme.

Improving comparability has different effects on investors' posterior uncertainty about the two cash flow shocks. An increase in comparability leads to a simultaneous increase of the common error and decrease of the idiosyncratic error in accounting signals (see equations (5)), and thus improves investors' knowledge about the idiosyncratic shock while impairing their knowledge about the common shock. More precisely, the posterior variances of the two shocks are, respectively,

$$\mathrm{Var}(\widetilde{\delta}_i | s_i, \overline{s}) = \mathrm{Var}(\widetilde{\delta}_i | s_i - \overline{s}) = \frac{1}{\tau_\delta + \tau_\xi}, \tag{9}$$

[5] The pricing equation is taken as given in this definition of equilibrium for succinctness. In fact, since there is no asymmetric information among individual investors, it is directly solved by no-arbitrage and market clearing. A similar characterization can be also found in Gao (2019). The complete proof is provided in the appendix.

[6] The efficient level of effort is the one that maximizes the net return of the costly effort. Denote it as a_i^{FB}, then $a_i^{\mathrm{FB}} = \arg\max_{a_i} a_i - \frac{1}{2}a_i^2 = 1$. This efficient outcome can also be achieved if there is no information asymmetry regarding the level of effort.

$$\mathrm{Var}(\widetilde{\eta}|s_i,\overline{s}) = \mathrm{Var}(\widetilde{\eta}|\overline{s}-\widehat{a}) = \frac{1}{\tau_\eta + \tau_\varepsilon}. \tag{10}$$

Higher comparability enables the investors to learn more about a specific firm relative to the other firms, but less about the overall fundamental of the aggregate economy. As a result, firm price depends more on the relative accounting performance and less on the average accounting performance following an increase in comparability. This prediction is consistent with the standard setter's view of relevance being a *fundamental characteristic* and comparability being an *enhancing characteristic* because for the same level of reporting precision of a stand-alone firm, comparability increases the usefulness of the focal firm's report given other firms' reports as reflected by its increased earnings response coefficient.

Proposition 1. *When both constituents are risk neutral, perfect comparability is uniquely Pareto-optimal, i.e.,* $c^*_{rn} = 1$.

In a risk-neutral world, both entrepreneurs and investors would unanimously agree on implementing a perfectly comparable accounting standard. Indeed, in this case, the investors break even on expectation and are indifferent about the level of comparability. The entrepreneurs prefer perfect comparability because it resolves the moral hazard problem. Higher comparability increases the entrepreneurs' perceived marginal benefit from exerting effort through the strengthened price response to the relative accounting performance, and thus encourages the entrepreneur to work harder. Following Holmstrom and Tirole (1993), we refer to this as the *market monitoring effect* of comparability. This incentive effect derives from the market's efficient use of all other firms' reports as comparability does not affect the precision of a stand-alone report. In a risk-averse world, however, the information externalities of the financial reports also have effects on the risk borne by the entrepreneurs and the investors. In the next section, we show that risk aversion is a key driver of our main results that are consistent with the observed different attitudes toward the desirability of comparability by the different constituents of financial reporting.

4. Main results

In equilibrium, the risk premium in firm prices equals the diversified investors' marginal cost of bearing the residual systematic cash flow risk and is higher than the average cost. The gap between the two is the source of the investors' surplus. Thus, the investors' net certainty equivalent from bearing the risk is half of the risk premium. With rational expectations, investors' conjectured levels of effort coincide with the actual ones chosen by the entrepreneurs, which are in turn incorporated into the prices. As a result, an entrepreneur internalizes the net return of his effort in addition to the risk premium. Moreover, the risk-averse entrepreneurs also bear the price risk associated with the volatility of price which contains both an idiosyncratic and a systematic component since they cannot diversify. Formally, the *ex-ante* certainty equivalents of a representative investor and a representative entrepreneur are respectively:

$$\mathrm{CE}_I = \frac{\rho_I}{2}\frac{1}{\tau_\eta + \tau_\varepsilon}, \tag{11}$$

$$\mathrm{CE}_E = \underbrace{\frac{\tau_\xi}{\tau_\delta + \tau_\xi} - \frac{1}{2}\left(\frac{\tau_\xi}{\tau_\delta + \tau_\xi}\right)^2}_{\text{net return of effort}} - \underbrace{\frac{\rho_E}{2}\left(\frac{1}{\tau_\delta}\frac{\tau_\xi}{\tau_\delta + \tau_\xi} + \frac{1}{\tau_\eta}\frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}\right)}_{\text{price risk}} - \underbrace{\rho_I\frac{1}{\tau_\eta + \tau_\varepsilon}}_{\text{risk premium}}. \tag{12}$$

Comparability impairs the investors' knowledge about the common cash flow shock, leading to a higher residual systematic cash flow risk. Since investors earn a higher surplus by bearing more systematic risk, their surplus is maximized with perfect comparability.[7] That is, investors prefer the highest level of comparability, i.e., $c^*_I = 1$.

Entrepreneurs' preference for comparability is jointly determined by its effects on the three terms in equation (12). Despite its positive market monitoring effect on net return of effort, higher comparability results in a less precise inference about the common shock and a higher risk premium, which makes the entrepreneurs worse off. We refer to this as the *risk premium effect*. On the other hand, the *price risk effect* associated with the *ex-ante* volatility of the price can go in either direction. To see this, note that the more responsive the price to information, the more volatile it is *ex-ante*. As comparability strengthens the price response to the relative accounting performance and weakens the price response to the average accounting performance, the price volatility first decreases and then increases in comparability, and is minimized at an intermediate level of comparability. To summarize, the three effects each has a different inclination to the entrepreneurs' preferred level of comparability c^*_E:

i. the market monitoring effect drives c^*_E toward 1;
ii. the price risk effect drives c^*_E toward $\frac{\tau_\delta}{\tau_\eta+\tau_\delta}$; and
iii. the risk premium effect drives c^*_E toward 0.

[7] For a more detailed discussion on risk premium and investors' surplus, see Gao (2010) and Bertomeu and Cheynel (2016).

Proposition 2. *When both constituents are risk averse, the investors prefer perfect comparability, i.e.,* $c_I^* = 1$, *and the entrepreneurs prefer a strictly lower level of comparability, i.e.,* $0 \le c_E^* < 1$.

As comparability has different implications on the idiosyncratic risk and the systematic risk, the two risk-averse constituents desire different levels of comparability. While the investors prefer perfect comparability, the entrepreneurs prefer a strictly lower level of comparability. From the entrepreneurs' perspective, despite its positive effect on the net return of effort, perfect comparability induces excessive price risk as well as risk premium. As shown by Gao (2010), resolving uncertainty allocates risk from investors to entrepreneurs. Although the systematic risk is allocated between the two generations, perfect comparability maximizes the risk premium without minimizing the price risk. Increasing comparability not only allocates more systematic risk to the diversified investors through the increased uncertainty about the common shock and increases the risk premium, but also increases the idiosyncratic risk borne by the undiversified entrepreneurs through the decreased uncertainty about the idiosyncratic shock. Moreover, the entrepreneurs may not desire any comparability at all when the risk premium effect dominates in the presence of sufficiently risk-averse investors.

The different preferences for comparability by the entrepreneurs and the investors coincides with the fact that the importance of comparability is often disputed by the preparers of financial information despite the users' desire for comparability (Van Riper, 1994; Jiang et al., 2018). To capture in a parsimonious way that the standard setter is influenced by both constituents of financial reporting (Watts and Zimmerman, 1978), we assume the standard setter aims to maximize $W \equiv (1 - \omega)CE_E + \omega CE_I$, where $\omega \in (0, 1)$ is the weight placed on the investors' surplus, and denote the optimal level of comparability chosen by the standard setter as c^*.

Proposition 3. *The optimal comparability* c^* *is strictly higher than the one that would otherwise be chosen by the entrepreneurs whenever it is non-zero, i.e.,* $c^* > c_E^*$ *if* $c_E^* \in (0, 1)$. *Moreover, there exists a threshold* $\widehat{\omega} \in \left(\frac{2}{3}, 1\right)$ *such that* c^* *is strictly lower than the perfect level, i.e.,* $c^* < 1$, *if and only if* $\omega < \widehat{\omega}$. *The interior* c^* *increases (decreases) in the weight the standard setter places on the investors (entrepreneurs).*

The optimal level of comparability chosen by the standard setter is greater than that desired by the entrepreneurs because the standard setter caters for the investors' preference for perfect comparability. In addition, as long as the standard setter places a sufficient weight on the entrepreneurs, the optimal policy would not feature perfect comparability as it induces excessive price risk as well as residual systematic cash flow risk. Indeed, the relative weight placed on the two constituents determines not only the relative importance but also the direction of the effect of the residual systematic risk on the optimal comparability. Since the investors' net certainty equivalent from bearing the risk is half of the risk premium (see equations (11) and (12)), the effect of the residual systematic risk drives the optimal comparability toward the minimum level 0 when $\omega < \frac{2}{3}$, but toward the maximum level 1 when $\omega > \frac{2}{3}$. In other words, the standard setter's inclination on the risk premium is more aligned with the entrepreneurs (investors) in the former (latter) case. Moreover, even when the effect of the residual systematic risk vanishes at $\omega = \frac{2}{3}$, the price risk effect will still render the optimal comparability lower than 1. Thus, the threshold $\widehat{\omega}$ above which the optimal comparability is perfect has to be strictly higher than $\frac{2}{3}$.

Taken together, the above results potentially explain why we still observe diverse accounting practices despite regulatory emphasis on comparability. Without the regulatory intervention, the level of comparability implemented by the preparers would likely not internalize the users' preference for perfect comparability and hence be lower than the optimal level from the standard setter's perspective. To better understand the role played by different agents' risk attitudes in generating our results, we consider the following two special cases.

Corollary 1. *When either constituent is risk neutral, we have*

i. $\rho_E > \rho_I = 0$: *investors are indifferent, and* $c_E^* = c^* \in (0, 1)$; *and*
ii. $\rho_I > \rho_E = 0$: $c_E^* < c^* < c_I^* = 1$ *when* $c_E^* > 0$ *and* ω *is sufficiently low.*

When the investors are risk neutral, they are not compensated for bearing risks. As a result, the break-even investors are indifferent to the level of comparability, and the standard setter's optimal policy coincides with the one preferred by the risk-averse entrepreneurs. Since the existence of the price risk effect diminishes the desirability of perfect comparability, the standard setter would mandate an interior level of comparability. On the other hand, when the investors are risk averse, they prefer perfect comparability because it maximizes their surplus gained by bearing the residual systematic cash flow risk. However, the risk-neutral entrepreneurs prefer a lower level of comparability even without the price risk effect because they sell at a lower price due to the risk premium. The standard setter's optimal policy is thus determined by trading off both constituents' preferences. When the entrepreneurs prefer some level of comparability and the standard setter places a sufficient weight on the entrepreneurs, the optimal comparability admits an interior solution and is higher than that would otherwise be chosen by the entrepreneurs.

To summarize, investors' risk aversion is necessary for our model to speak to their preference for the level of comparability. In particular, to generate the joint empirical regularity that (i) preparers of financial information prefer a lower level of comparability than users, and (ii) perfect comparability is not an observed policy, the assumption that the investors are risk averse is indispensable. In other words, the higher risk premium due to the higher systematic risk left in the market by a higher level of comparability is the key friction that prevents the observed policy from featuring perfect comparability when the standard setter places sufficient weights on both constituents.

Next, we explore how the primitive variables of the model affect the optimal policy that would be chosen by the standard setter.

Corollary 2. *The optimal level of comparability c^*, whenever it admits an interior solution,*

(i) *decreases in investors' degree of risk aversion ρ_I, i.e., $\frac{dc^*}{d\rho_I} < 0$ if and only if $\omega < \frac{2}{3}$;*
(ii) *increases in entrepreneurs' risk aversion ρ_E, i.e., $\frac{dc^*}{d\rho_E} > 0$, if and only if $\omega < \frac{2}{3}$, $\rho_I > 2\frac{1-\omega}{2-3\omega}\frac{\tau_\eta \tau_\delta^2}{\tau_\eta \tau_\delta + \tau(\tau_\eta + \tau_\delta)}$ and $\rho_E > \frac{\tau_\delta^2(2\tau_\eta - \tau)}{\tau_\eta \tau_\delta + \tau(\tau_\eta + \tau_\delta)}$;*
(iii) *increases in the common cash flow volatility τ_η^{-1} i.e., $\frac{dc^*}{d\tau_\eta} < 0$ if and only if $\rho_E > \frac{2-3\omega}{1-\omega}\rho_I$;*
(iv) *decreases in the idiosyncratic cash flow volatility τ_δ^{-1}, i.e., $\frac{dc^*}{d\tau_\delta} > 0$; and*
(v) *decreases in the reporting precision τ, i.e., $\frac{dc^*}{d\tau} < 0$, if $\omega < \frac{2}{3}$ and $\rho_E > \frac{2-3\omega}{1-\omega}\rho_I$.*

Recall that the relative weight placed on the two constituents determines to which direction the residual systematic risk drives the optimal comparability. Generally, investors' risk aversion tends to decrease the optimal level of comparability because the associated risk premium effect drives the optimal comparability closer to the minimum level. However, when the weight placed on the investors is excessively high, i.e., $\omega > \frac{2}{3}$, investors' surplus takes precedence, making the effect of the residual systematic risk drive the optimal comparability closer to the maximum level instead. Hence, the optimal comparability increases in the investors' risk aversion in this case.

The effect of entrepreneurs' risk aversion depends on the original level of comparability. Recall that the price risk borne by the entrepreneurs is minimized at $c = \frac{\tau_\delta}{\tau_\eta + \tau_\delta}$. When the weight placed on the investors is not excessively high and both constituents are relatively risk averse, the market monitoring effect is dominated by the price risk effect and risk premium effect, leading the optimal comparability to lie in $\left(0, \frac{\tau_\delta}{\tau_\eta + \tau_\delta}\right)$. As the entrepreneurs become more risk averse, it increases the optimal comparability toward its upper bound $\frac{\tau_\delta}{\tau_\eta + \tau_\delta}$. Otherwise, when the optimal level of comparability lies in $\left(\frac{\tau_\delta}{\tau_\eta + \tau_\delta}, 1\right)$, the optimal comparability moves closer toward its lower bound $\frac{\tau_\delta}{\tau_\eta + \tau_\delta}$ as the entrepreneurs become more risk averse.

As discussed earlier, a higher level of comparability allocates more systematic risk to the investors. When the investors are relatively more risk tolerant than the entrepreneurs, they are efficiently allocated more risks. Hence, in this case, an increase in the common cash flow volatility τ_η^{-1} leads to an increase in the optimal level of comparability. Similarly, when the entrepreneurs are relatively more risk tolerant than the investors, they are efficiently allocated more risk with a decreased level of comparability.

Observe from equations (11) and (12) that the idiosyncratic volatility affects the optimal comparability only through the net return of effort and the idiosyncratic component of the price risk. As the idiosyncratic shock becomes more volatile, that is, as τ_δ^{-1} increases, firm price is more responsive to the relative accounting performance, which results in higher effort by the entrepreneurs but also more price risk. Hence, the optimal policy leans more toward reducing the idiosyncratic component of the price risk than resolving the moral hazard problem by introducing more idiosyncratic measurement error with a lower level of comparability.

As for the effect of an improvement in the reporting precision on the optimal comparability, we first consider the special case in which the two constituents have the same risk attitude and are equally weighted by the standard setter. In this case, the standard setter's optimal choice of comparability is independent of both the common cash flow shock and the common measurement error due to the risk allocation role of comparability. Consequently, when the reporting quality improves, the optimal allocation of the reporting precision to the idiosyncratic measurement error stays the same and it is more efficient to devote all the efforts to reducing the common measurement error. Generally, when the weight placed on the investors is not excessively high, increasing the relative risk aversion of the entrepreneurs will only strengthen the idiosyncratic part of the price risk effect. As a result, the negative effect of an improved reporting precision on the optimal level of comparability will even be more salient.

5. Empirical implications

Besides rationalizing the existence of diverse accounting practices despite regulatory emphasis on comparability, our analysis generates various additional empirical implications. The pricing equation (7) suggests that firms are priced relatively to other firms given their relative accounting performance. More recently, Jennings et al. (2020) document that a firm's price responds positively to an improvement in the relative ranking of its earnings among its peers. Our theory thus predicts that such price response to the relative accounting performance is more pronounced in regimes with a higher level of standardization.

Rewriting the pricing equation in Lemma 1, we have

$$P_i(s_i, \bar{s}) = \hat{a}_i + \alpha s_i + \beta \bar{s} - \frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}\hat{a} - \rho_I \frac{1}{\tau_\eta + \tau_\varepsilon}, \text{ where}$$
$$\alpha = \frac{\tau_\xi}{\tau_\delta + \tau_\xi}, \ \beta = \frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon} - \frac{\tau_\xi}{\tau_\delta + \tau_\xi}. \tag{13}$$

The price coefficient α captures the extent to which a firm's price relies on its own accounting signal, and is henceforth referred to as the direct earnings response coefficient (the direct ERC), whereas the price coefficient β captures the extent to which a firm's price relies on the average accounting signal (or, equivalently, the peer firms' accounting signals), and is henceforth referred to as the cross earnings response coefficient (the cross ERC).

Corollary 3. *The direct ERC increases in comparability and the cross ERC decreases in comparability. Moreover, the cross ERC is positive (negative) if comparability is lower (higher) than* $\frac{\tau_\delta}{\tau_\eta+\tau_\delta}$.

Higher comparability increases the direct ERC due to the increased informativeness of the relative accounting performance. It enables the market to learn more about the idiosyncratic characteristic of each firm relative to the average firm (market portfolio). As a result, the price of the firm responds more aggressively to the firm's report when the reports are more comparable. On the other hand, achieving higher comparability impairs investors' knowledge of the common shock by introducing more common error. For example, a high average report can stem from either a favorable common shock or too much false positive due to the common measurement error. When there is more common error, the average report is used relatively more in correcting for the common error than in updating about the common shock. The cross ERC thus decreases in comparability and can even be negative when comparability is sufficiently high.

We can exploit the above feature of the pricing equation to construct a regime-level empirical proxy for comparability. The cross ERC estimated using a cross section of firms is negatively associated with the level of comparability. A limitation of this proxy is that it does not allow for firm-wise variations as in De Franco et al. (2011) and Fang et al. (2022). However, an advantage is that it does not require time-series data assuming that comparability is time-invariant. Hence, this proxy can be used to compare comparability across regimes at a particular time, or to study time-series variations of comparability in a particular regime over time, for example, around policy changes. In addition, this proxy can be adopted to test some of the predictions in Corollary 2. For example, the model predicts that the optimal level of comparability decreases in the idiosyncratic cash flow volatility, implying that markets with more heterogeneous firms tend to feature more diverse accounting practices.[8]

6. Extension

In this section we extend the baseline model to allow for firm-wise heterogeneity in reporting comparability. For example, financial reports of firms in the same industry may be more comparable than those in different industries. To simplify the analysis, we assume there are two groups of firms and firms in each group are subject to a group-specific common measurement error in addition to firm-specific idiosyncratic measurement errors. Indeed, we restrict the cross-group comparability to be zero while allowing the within-group comparability levels to vary across the two groups. We obtain the results corroborating the robustness of the analysis in the baseline setting, and discuss the potential of testing our predictions using firm-level empirical measures of comparability such as the ones constructed by De Franco et al. (2011) and Fang et al. (2022).[9]

Specifically, in this extended setting, the future cash flow of firm i in group $k \in \{1, 2\}$ is

$$\widetilde{\theta}_{k,i} = a_{k,i} + \widetilde{\eta} + \widetilde{\eta}_k + \widetilde{\delta}_{k,i}, \tag{14}$$

where $a_{k,i}$ is the effort chosen by the entrepreneur, $\widetilde{\eta} \sim \mathcal{N}(0, \tau_\eta^{-1})$ is the economy-wide common cash flow shock, $\widetilde{\eta}_k \sim \mathcal{N}(0, \tau_{\eta_k}^{-1})$ is the within-group common cash flow shock, and $\widetilde{\delta}_{k,i} \sim \mathcal{N}(0, \tau_{\delta_k}^{-1})$ is the firm-specific idiosyncratic shock. Conditional on the cash flow, firm i's accounting signal is

$$\widetilde{s}_{k,i} = \widetilde{\theta}_{k,i} + \widetilde{\varepsilon}_k + \widetilde{\xi}_{k,i}, \tag{15}$$

where $\widetilde{\varepsilon}_k \sim \mathcal{N}(0, \tau_{\varepsilon_k}^{-1})$ is the within-group common error and $\widetilde{\xi}_{k,i} \sim \mathcal{N}(0, \tau_{\xi_k}^{-1})$ is the firm-specific idiosyncratic error. As in the baseline model, controlling for the reporting precision, i.e., $\tau_k^{-1} \equiv \tau_{\varepsilon_k}^{-1} + \tau_{\xi_k}^{-1}$, we measure within-group comparability as $c_k = \frac{\tau_{\varepsilon_k}^{-1}}{\tau_{\varepsilon_k}^{-1} + \tau_{\xi_k}^{-1}}$. Without loss of generality, we assume that each group is of a half measure.

Lemma 2. *With conjectured levels of effort* $\widehat{a}_{k,i}$ *and* $\widehat{a}_k$ *for firm i and group-k average, respectively, the pricing equation applied by the investors is:*

$$P_{k,i}(s_{k,i}, \bar{s}_k, \bar{s}_{k'}) = \widehat{a}_{k,i} + \frac{\tau_{\xi_k}}{\tau_{\delta_k} + \tau_{\xi_k}}(s_{k,i} - \bar{s}_k) + b_{kk}(\bar{s}_k - \widehat{a}_k) + b_{kk'}(\bar{s}_{k'} - \widehat{a}_{k'}) - \rho_I \mathbf{m}^\top \boldsymbol{\Sigma}_{\eta|s} \mathbf{m}, \tag{16}$$

where b_{kk}, $b_{kk'}$, $\boldsymbol{\Sigma}_{\eta|s}$, *and* $\boldsymbol{m}$ *are constants given in the appendix.*

In equilibrium, investors' conjecture coincides with the actual effort exerted by the entrepreneurs:

8 Dye and Sridhar (2008) make a similar prediction that when the level of heterogeneity is high, a flexible regime with opportunistic reporting and no common measurement error dominates a rigid regime with a common measurement error but no opportunistic reporting. We abstract from the reporting discretion issue but compare regimes with a spectrum of proportions of the common error with respect to the total reporting noise.

9 Those firm-level empirical measures of comparability are constructed for each firm-year against the other firms in an identified peer group.

$$\hat{a}_{k,i} = a^*_{k,i} = \frac{\tau_{\xi_k}}{\tau_{\delta_k} + \tau_{\xi_k}}. \tag{17}$$

When inferring the future cash flow of firm i in group k, investors first use the difference between the firm-specific signal and the group average signal $s_{k,i} - \bar{s}_k$ to infer about the firm's idiosyncratic shock $\tilde{\delta}_{k,i}$, and then use the average signal of each group $\bar{s}_k$ and $\bar{s}_{k'}$ to learn about the common shocks $\tilde{\eta} + \tilde{\eta}_k$. Both group average signals are useful in the second task because of the economy-wide correlation induced by the common cash flow shock $\tilde{\eta}$. Lastly, the risk premium is determined by the investors' residual uncertainties about the undiversifiable common shocks $\{\tilde{\eta}+\tilde{\eta}_1, \tilde{\eta}+\tilde{\eta}_2\}$, $\boldsymbol{\Sigma}_{\eta|s}$, and the mass of each group in the market portfolio $\mathbf{m}$.

Rewriting the pricing equation (16) following equation (13), the direct ERC and cross ERC for firms in group k are respectively:

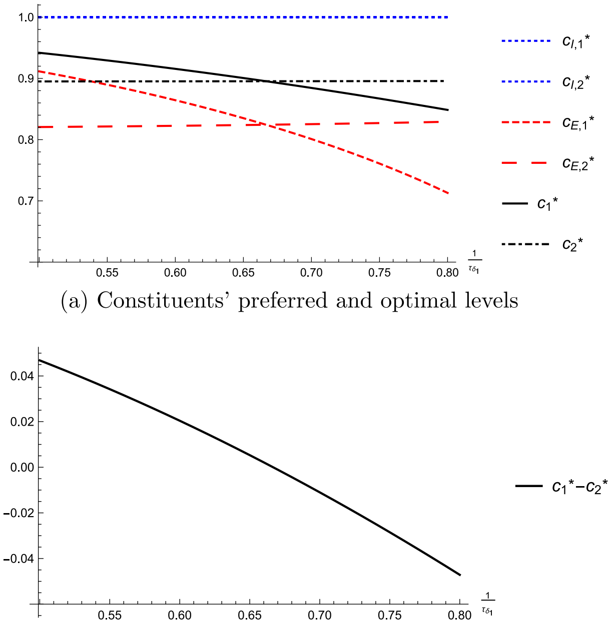
$$\alpha_k = \frac{\tau_{\xi_k}}{\tau_{\delta_k} + \tau_{\xi_k}}, \; \beta_k = b_{kk} - \frac{\tau_{\xi_k}}{\tau_{\delta_k} + \tau_{\xi_k}}. \tag{18}$$

Since the average signal of the other group $\bar{s}_{k'}$ also affects the price of a firm in group k, from an econometrics point of view, the reports of other groups also need to be controlled in order to have unbiased estimates of the direct ERC and cross ERC. Moreover, the direct ERC α_k increases in comparability c_k and the cross ERC β_k decreases in comparability c_k. At the same time, however, the cross ERC of firms in the other group $\beta_{k'}$ increases in comparability c_k. In other words, the difference $\alpha_k - \alpha_{k'}$ monotonically increases in $c_k - c_{k'}$, and the difference $\beta_k - \beta_{k'}$ monotonically decreases in $c_k - c_{k'}$. Hence, the predictions in Corollary 3 can be tested using firm-level empirical measures of comparability. For example, Chen et al. (2020) show that the empirical measure constructed by De Franco et al. (2011) is positively associated with the direct ERC.[10]

The certainty equivalents of a representative investor and a representative entrepreneur of each group are respectively:

$$\mathrm{CE}_I = \frac{\rho_I}{2}\mathbf{m}^\top \boldsymbol{\Sigma}_{\eta|s}\mathbf{m}, \tag{19}$$

$$\mathrm{CE}_{E,k} = a^*_k - \frac{1}{2}(a^*_k)^2 - \frac{\rho_E}{2}\left(\frac{1}{\tau_{\delta_k}}a^*_k + \left(\boldsymbol{\Sigma}_\eta - \boldsymbol{\Sigma}_{\eta|s}\right)_{k,k}\right) - \rho_I \mathbf{m}^\top \boldsymbol{\Sigma}_{\eta|s}\mathbf{m}, \tag{20}$$



(a) Constituents' preferred and optimal levels

(b) Cross-sectional difference in optimal levels

Fig. 2. The Effects of Idiosyncratic Cash Flow Volatility on Comparability.

Note: Fig. 2(a) plots the effects of the group-1 idiosyncratic cash flow shock volatility, i.e., $\tau_{\delta_1}^{-1}$, on different constituents' preferred and the optimal levels of comparability, holding constant the group-2 idiosyncratic cash flow shock volatility. Fig. 2(b) plots the effect on the cross-sectional difference in the two groups' optimal levels of comparability. Other parameter values are $\omega = 0.5$, $\rho_E = \rho_I = 0.5$, $\tau_\eta = \tau_{\eta_1} = \tau_{\eta_2} = 1$, $\tau_{\delta_2} = 1.5$, and $\tau_1 = \tau_2 = 1$.

[10] Variations in the firm-level empirical measures are mostly cross-sectional. Hence, we need to show that the cross-sectional difference $c_k - c_{k'}$ affects the cross-sectional differences $\alpha_k - \alpha_{k'}$ and $\beta_k - \beta_{k'}$ in the same manner as c affects α and β in Corollary 3.

where Σ_η denotes the prior uncertainty about the common shocks $\{\tilde{\eta}+\tilde{\eta}_1, \tilde{\eta}+\tilde{\eta}_2\}$. Assuming that the standard setter aims to maximize $W\equiv\frac{1}{2}(1-\omega)(\text{CE}_{E,1}+\text{CE}_{E,2})+\omega\text{CE}_I$, let $\{c^*_{I,1}, c^*_{I,2}\}$, $\{c^*_{E,1}, c^*_{E,2}\}$, and $\{c^*_1, c^*_2\}$ be the pair of comparability that respectively maximizes CE_I, $\text{CE}_{\text{E},1}+\text{CE}_{\text{E},2}$, and W.[11] Consistent with our main results in Propositions 2 − 3, the investors always prefer perfect comparability for both groups of firms, whereas the entrepreneurs prefer a strictly lower level of comparability. Consequently, the optimal levels of comparability chosen by the standard setter lie in between.

We also illustrate the robustness of our results in this extension using numerical examples as presented in Fig. 2 due to computational complexity. We focus on the effect of idiosyncratic cash flow volatility because it is the only unambiguous and monotone comparative statics in Corollary 2. As can be seen from Fig. 2(a), although group-1 idiosyncratic cash flow volatility affects the entrepreneurs' preferred comparability $c^*_{E,k}$ and the optimal policy c^*_k for both groups, its effects on group-1's tend to be in the opposite direction than those on group-2's and also much more significant in magnitude. Combining it with the observation from Fig. 2(b), both the group-1 optimal comparability c^*_1 and the cross-group difference in the optimal comparability $c^*_1-c^*_2$ decrease in group-1 idiosyncratic cash flow volatility $\tau^{-1}_{\delta_1}$. Indeed, the same holds symmetrically for group-2 idiosyncratic cash flow volatility. Hence, the empirical predictions provided by Corollary 2(iv) can potentially be tested using firm-level empirical measures of comparability as well.

7. Conclusion

This paper proposes a theoretical framework that highlights the information externalities of comparable accounting reports and the resulting trade-off in learning about similarities and differences between firms. Such an informational trade-off leads to subsequent economic trade-offs and implies different preferences for accounting comparability by different agents, depending on whether they are the users or the preparers of financial information. As a result, although preferred by the users, perfect comparability is not what standard setters should attempt to achieve because it imposes excessive costs on the preparers. The model thus explains why we still observe diverse accounting practices despite regulatory emphasis on comparability. As accounting policies are influenced by constituents with different interests, the analysis of the "optimal level of comparability", which internalizes the interests of both entrepreneurs (preparers) and investors (users) in the model, provides empirical predictions about the determinants of accounting policies from a positive perspective (Watts and Zimmerman, 1978).

In addition, the pricing equation that reflects the efficient use of accounting information suggests a *structural* approach to construct a regime-level empirical proxy for comparability. Our model predicts that, controlling for a firm's own report, the firm's price response to the average report in a reporting regime decreases in the level of comparability and can even become negative with sufficiently high comparability. This property of the pricing equation allows the price coefficient on the average report estimated with a cross section of firms to proxy for the level of comparability in this reporting regime. Intuitively, higher comparability renders the firm price more responsive to the relative accounting performance, thus resulting in the other firms' positive reports being used more as bad news when pricing a firm. This empirical proxy can be used to compare comparability across regimes at a particular time, or to study the time-series variations of comparability in a particular regime over time, for example, around policy changes.[12]

Our study is subject to some caveats. We work with comparability as an informational property while assuming away a more practical problem: how standards should be set to achieve this property. Analytical research can potentially add to understanding this practical problem. For example, most accounting measurement methods are discrete in the sense that continuous accounting inputs are truncated at a recognition threshold (Gao and Jiang, 2020). It is thus an open question whether using the same threshold for all firms (uniformity) enhances or undermines comparability. We also assume away opportunistic reporting by the preparers, although the lack of comparability can be endogenously caused by opportunistic reporting. Dye and Sridhar (2008) compare two polar cases: one with common measurement error but without reporting discretion (the rigid regime) versus one without common measurement error but with reporting discretion (the flexible regime). Future research can extend the analysis to examine how more flexibility and opportunistic reporting cause lower correlation of measurement errors and lower comparability. Moreover, we assume a stylized economy in which firms do not have strategic interactions with others. In reality, firms could be substitutes because they are competitors, or complements because of technology and demand spillovers.

Appendix

Proof of the Pricing Equation. The price of each firm given all available information $\mathcal{I}\equiv\{s_i\}_{i\in[0,1]}$ follows a strict factor structure. As shown by Al-Najjar (1998), strict factor structure and no-arbitrage imply that for almost every asset (or a portfolio of assets) i with payoff $\tilde{\theta}_i$,

[11] Here, the entrepreneurs' preferred pair of comparability is defined as the one that maximizes their total surpluses rather than the Nash-equilibrium outcome because we consider the entrepreneurs as a single political constituent who influences the standard setter as a coalition. Nevertheless, solving for the pair of comparability as a Nash-equilibrium outcome yields qualitatively similar results.

[12] We thank Frank Zhou for pointing it out at the 2019 Junior Accounting Theory Conference.

$$\mathbb{E}[\widetilde{\theta}_i|\mathcal{I}] = P_i + F$$

where P_i is the price of asset i, the constant F is the factor price, and by assumption, the loading on the factor F is 1 for all assets in our setting. Given the above relationship between price and return, the payoff of holding any portfolio is a (weakly) mean preserving spread of the payoff to the market portfolio.[13] The price of market portfolio P_m must clear the market such that

$$\frac{a + \mathbb{E}[\widetilde{\eta}|\mathcal{I}] - P_m}{\rho_I \mathrm{Var}(\widetilde{\eta}|\mathcal{I})} = 1,$$

which gives the risk factor $F = \rho_I Var(\widetilde{\eta}|\mathcal{I})$. Hence, the risk-averse investors are only compensated for bearing non-diversifiable risks, and the price of firm i is

$$P_i = \mathbb{E}[\widetilde{\theta}_i|\mathcal{I}] - F = \mathbb{E}[\widetilde{\theta}_i|\mathcal{I}] - \rho_I \mathrm{Var}(\widetilde{\eta}|\mathcal{I}).$$

Proof of Lemma 1. Given investors' conjectured levels of effort $\widehat{a}_i$ and $\widehat{a}$ for firm i and the economy-wide average, respectively,

$$\begin{aligned} P_i(s_i, \overline{s}) &= \mathbb{E}[\widetilde{\theta}_i|\mathcal{I}] - \rho_I \mathrm{Var}(\widetilde{\eta}|\mathcal{I}) \\ &= \widehat{a}_i + \mathbb{E}[\widetilde{\delta}_i|s_i - \overline{s}] + \mathbb{E}[\widetilde{\eta}|\overline{s} - \widehat{a}] - \rho_I \mathrm{Var}(\widetilde{\eta}|\overline{s} - a) \\ &= \widehat{a}_i + \frac{\tau_\xi}{\tau_\delta + \tau_\xi}(s_i - \overline{a}) + \frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}(\overline{a} - \widehat{a}) - \rho_I \frac{1}{\tau_\eta + \tau_\varepsilon}. \end{aligned}$$

In equilibrium, $\widehat{a}_i = a_i^*$ for all firms, where

$$\begin{aligned} a_i^* &= \arg\max_{a_i} \mathbb{E}[P_i] - \frac{\rho_E}{2}\mathrm{Var}(P_i) - \frac{1}{2}a_i^2 \\ &= \widehat{a}_i + \frac{\tau_\xi}{\tau_\delta + \tau_\xi}(a_i - \overline{a}) - \rho_I \frac{1}{\tau_\eta + \tau_\varepsilon} - \frac{\rho_E}{2}\left(\frac{1}{\tau_\eta}\frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon} + \frac{1}{\tau_\delta}\frac{\tau_\xi}{\tau_\delta + \tau_\xi}\right) - \frac{1}{2}a_i^2 \\ &= \frac{\tau_\xi}{\tau_\delta + \tau_\xi}. \end{aligned}$$

□

Proof of Proposition 1. The proof follows immediately after plugging in $\rho_I = \rho_E = 0$ to equations (11) and (12). □

Proof of Proposition 2. From equations (11) and (12), we have

$$\frac{\mathrm{dCE}_I}{\mathrm{d}c} = \frac{1}{\tau}\frac{\rho_I}{2}\left(\frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}\right)^2 > 0, \tag{A1}$$

$$\begin{aligned} \frac{\mathrm{dCE}_E}{\mathrm{d}c} &= \frac{\partial \mathrm{CE}_E}{\partial \tau_\xi}\frac{\mathrm{d}\tau_\varepsilon}{\mathrm{d}c} + \frac{\partial \mathrm{CE}_E}{\partial \tau_\varepsilon}\frac{\mathrm{d}\tau_\xi}{\mathrm{d}c} \\ &= \frac{1}{\tau}\left\{ \underbrace{\frac{\tau_\delta^2 \tau_\xi^2}{(\tau_\delta + \tau_\xi)^3}}_{\text{market monitoring effect}} - \underbrace{\frac{\rho_E}{2}\left[\left(\frac{\tau_\xi}{\tau_\delta + \tau_\xi}\right)^2 - \left(\frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}\right)^2\right]}_{\text{price risk effect}} - \underbrace{\rho_I\left(\frac{\tau_\varepsilon}{\tau_\eta + \tau_\varepsilon}\right)^2}_{\text{risk premium effect}} \right\}, \end{aligned} \tag{A2}$$

where $\tau_\varepsilon = \tau_\varepsilon(c)$ and $\tau_\xi = \tau_\xi(c)$ are defined in equation (5). It follows that $\mathrm{sgn}\left(\frac{\mathrm{dCE}_E}{\mathrm{d}c}\right) = \mathrm{sgn}(\Phi(c))$ where

$$\Phi(c) \equiv 2\frac{(1-c)\tau_\delta^2}{(1-c)\tau_\delta + \tau} - \rho_E - (2\rho_I - \rho_E)\left[\frac{(1-c)\tau_\delta + \tau}{c\tau_\eta + \tau}\right]^2.$$

Let $\Phi_1(c) \equiv 2\frac{(1-c)\tau_\delta^2}{(1-c)\tau_\delta + \tau} - \rho_E$ and $\Phi_2(c) \equiv (2\rho_I - \rho_E)\left[\frac{(1-c)\tau_\delta + \tau}{c\tau_\eta + \tau}\right]^2$, then

[13] The argument resembles the two-fund separation theorem in Ross (1978) and Connor (1984).

$$\lim_{c\to 0}\Phi_1 = \frac{2\tau_\delta^2}{\tau_\delta+\tau} - \rho_E \qquad \lim_{c\to 0}\Phi_2 = (2\rho_I - \rho_E)\left(\frac{\tau_\delta+\tau}{\tau}\right)^2$$

$$\lim_{c\to 1}\Phi_1 = -\rho_E \qquad \lim_{c\to 1}\Phi_2 = (2\rho_I - \rho_E)\left(\frac{\tau}{\tau_\eta+\tau}\right)^2.$$

As a result, we have $\lim_{c\to 0}\Phi_1 > \lim_{c\to 0}\Phi_2$ if and only if $\rho_E > \frac{2(\tau_\delta+\tau)^3\rho_I - 2\tau^2\tau_\delta^2}{\tau_\delta(\tau_\delta+\tau)(\tau_\delta+2\tau)}$, and $\lim_{c\to 1}\Phi_1 < \lim_{c\to 1}\Phi_2$ for any $\rho_E, \rho_I > 0$. Hence, $c = 1$ is not desirable for the entrepreneurs. Next, we characterize the conditions when the entrepreneurs prefer an interior level of comparability. Observe that

$$\frac{\partial\Phi_1}{\partial c} = -2\frac{\tau\tau_\delta^2}{[(1-c)\tau_\delta+\tau]^2} < 0,$$

$$\frac{\partial^2\Phi_1}{\partial c^2} = -4\frac{c\tau_\delta^3}{[(1-c)\tau_\delta+\tau]^3} < 0;$$

$$\frac{\partial\Phi_2}{\partial c} = 2(\rho_E - 2\rho_I)\frac{(1-c)\tau_\delta+\tau}{(c\tau_\eta+\tau)^3}[\tau_\eta\tau_\delta + \tau(\tau_\eta+\tau_\delta)] \Rightarrow \text{sgn}\left(\frac{\partial\Phi_2}{\partial c}\right) = \text{sgn}(\rho_E - 2\rho_I),$$

$$\frac{\partial^2\Phi_2}{\partial c^2} = 2(2\rho_I - \rho_E)\frac{\tau_\delta(c\tau_\eta+\tau) + 3\tau_\eta[(1-c)\tau_\delta+\tau]}{(c\tau_\eta+\tau)^4}[\tau_\eta\tau_\delta + \tau(\tau_\eta+\tau_\delta)] \Rightarrow \text{sgn}\left(\frac{\partial^2\Phi_2}{\partial c^2}\right) = \text{sgn}(2\rho_I - \rho_E).$$

When $\rho_E \geq 2\rho_I$, $c_E^* \in (0,1)$ if $\rho_E > \frac{2(\tau_\delta+\tau)^3\rho_I - 2\tau^2\tau_\delta^2}{\tau_\delta(\tau_\delta+\tau)(\tau_\delta+2\tau)}$; otherwise $c_E^* = 0$.
When $\rho_E < 2\rho_I$.

i. If $\rho_E > \frac{2(\tau_\delta+\tau)^3\rho_I - 2\tau^2\tau_\delta^2}{\tau_\delta(\tau_\delta+\tau)(\tau_\delta+2\tau)}$: then $c_E^* \in (0,1)$; and

ii. If $\rho_E \leq \frac{2(\tau_\delta+\tau)^3\rho_I - 2\tau^2\tau_\delta^2}{\tau_\delta(\tau_\delta+\tau)(\tau_\delta+2\tau)}$: if $\Phi_1(c) \leq \Phi_2(c)\ \forall c \in [0,1]$, then $c_E^* = 0$; and if $\Phi_1(c) = \Phi_2(c)$ has two interior solutions $0 < c_E^1 < c_E^2 < 1$ where c_E^1 is the local minimum and c_E^2 is the local maximum, then $c_E^* = 0$ or c_E^2. □

Proof of Proposition 3. Given the standard setter's objective function, let

$$\Lambda(c) \equiv \frac{dW}{dc} = (1-\omega)\frac{d\text{CE}_E}{dc} + \omega\frac{d\text{CE}_I}{dc}. \tag{A3}$$

Whenever c_E^* is interior, evaluating the first-order derivative at $c = c_E^*$ yields

$$\Lambda(c_E^*) = \omega\frac{d\text{CE}_I}{dc}\bigg|_{c=c_E^*} > 0,$$

implying $c^* > c_E^*$ since CE_I is monotonically increasing in c.

Next we derive the condition under which c^* admits an interior solution. Rewriting the certainty equivalents of the two constituents as functions of c, suppose to the contrary that $c^* = 1$, then for any $c \in (c_E^*, 1)$, we have

$$(1-\omega)\text{CE}_E(1) + \omega\text{CE}_I(1) > (1-\omega)\text{CE}_E(c) + \omega\text{CE}_I(c)$$

$$\Leftrightarrow\ \omega > \frac{\text{CE}_E(c) - \text{CE}_E(1)}{\text{CE}_E(c) - \text{CE}_E(1) + \text{CE}_I(1) - \text{CE}_I(c)}$$

$$\Leftrightarrow\ \omega \geq \widehat{\omega} \equiv \sup_{c\in(c_E^*,1)} \frac{\text{CE}_E(c) - \text{CE}_E(1)}{\text{CE}_E(c) - \text{CE}_E(1) + \text{CE}_I(1) - \text{CE}_I(c)}$$

since $\text{CE}_E(c) - \text{CE}_E(1) > 0$ and $\text{CE}_I(1) - \text{CE}_I(c) > 0$ by the proof of Proposition 2.

Further note that by L'Hôpital's rule, we have

$$\lim_{c\to 1^-}\frac{\text{CE}_E(c) - \text{CE}_E(1)}{\text{CE}_E(c) - \text{CE}_E(1) + \text{CE}_I(1) - \text{CE}_I(c)} = \lim_{c\to 1^-}\frac{\text{CE}_E'(c)}{\text{CE}_E'(c) - \text{CE}_I'(c)} = \frac{\text{CE}_E'(1)}{\text{CE}_E'(1) - \text{CE}_I'(1)}.$$

Since $\text{CE}_E'(1) < 0$ and $\text{CE}_I'(1) > 0$, we conclude that $\widehat{\omega} \in (0,1)$.

To see that $\widehat{\omega} > \frac{2}{3}$, we plug in $\omega = \frac{2}{3}$ and evaluate $\Lambda(1)$, which yields $\Lambda(1)|_{\omega=\frac{2}{3}} < 0$.

Now we proceed to examine how the interior c^* changes with respect to ω. When $c^* \in (0,1)$, we have

$$\frac{\partial\Lambda}{\partial\omega}\bigg|_{c=c^*} = \frac{\mathrm{dCE}_I}{\mathrm{d}c}\bigg|_{c=c^*} - \frac{\mathrm{dCE}_E}{\mathrm{d}c}\bigg|_{c=c^*} > 0$$

since $\frac{\mathrm{dCE}_I}{\mathrm{d}c}\big|_{c=c^*} > 0$ and $\frac{\mathrm{dCE}_E}{\mathrm{d}c}\big|_{c=c^*} < 0$. Further note that $\frac{\partial\Lambda}{\partial c}\big|_{c=c^*} < 0$ by local concavity. Therefore, by implicit function theorem,

$$\frac{\mathrm{d}c^*}{\mathrm{d}\omega} = -\frac{\frac{\partial\Lambda}{\partial\omega}}{\frac{\partial\Lambda}{\partial c}}\Bigg|_{c=c^*} > 0. \qquad \square$$

Proof of Corollary 1. The proof follows immediately from the proofs of *Propositions 2* and *3*. □

Proof of Corollary 2. Plugging in equations (11) and (12) to the standard setter's objective function, we have

$$W = (1-\omega)\left\{\frac{\tau_\xi}{\tau_\delta+\tau_\xi} - \frac{1}{2}\left(\frac{\tau_\xi}{\tau_\delta+\tau_\xi}\right)^2 - \frac{\rho_E}{2}\left(\frac{1}{\tau_\delta}\frac{\tau_\xi}{\tau_\delta+\tau_\xi} + \frac{1}{\tau_\eta}\frac{\tau_\varepsilon}{\tau_\eta+\tau_\varepsilon}\right) - \frac{2-3\omega}{2(1-\omega)}\rho_I\frac{1}{\tau_\eta+\tau_\varepsilon}\right\}.$$

Comparing to expression (12) and following the proof of Proposition 2, we have $\mathrm{sgn}\left(\frac{\mathrm{d}W}{\mathrm{d}c}\right) = \mathrm{sgn}(\Gamma(c))$, where

$$\Gamma(c) \equiv 2\frac{(1-c)\tau_\delta^2}{(1-c)\tau_\delta+\tau} - \rho_E - \left(\frac{2-3\omega}{1-\omega}\rho_I - \rho_E\right)\left[\frac{(1-c)\tau_\delta+\tau}{c\tau_\eta+\tau}\right]^2,$$

and that when $c^* \in (0,1)$, if $\rho_E \geq \frac{2-3\omega}{1-\omega}\rho_I$, then c^* is the only critical point; otherwise, c^* is the only critical point or $c^* = c_2$ where $0 < c_1 < c_2 < 1$ are the two critical points. By implicit function theorem,

$$\frac{\mathrm{d}c^*}{\mathrm{d}x} = -\frac{\frac{\partial\Gamma}{\partial x}}{\frac{\partial\Gamma}{\partial c}}\Bigg|_{c=c^*} \Rightarrow \mathrm{sgn}\left(\frac{\mathrm{d}c^*}{\mathrm{d}x}\right) = \mathrm{sgn}\left(\frac{\partial\Gamma}{\partial x}\bigg|_{c=c^*}\right) \text{ for } x\in\{\rho_I,\rho_E,\tau_\eta,\tau_\delta,\tau\},$$

since $\frac{\partial\Gamma}{\partial c}\big|_{c=c^*} < 0$ by local concavity. In particular,

$$\frac{\partial\Gamma}{\partial\rho_I}\bigg|_{c=c^*} = -\frac{2-3\omega}{1-\omega}\left[\frac{(1-c^*)\tau_\delta+\tau}{c^*\tau_\eta+\tau}\right]^2 \Rightarrow \mathrm{sgn}\left(\frac{\mathrm{d}c^*}{\mathrm{d}\rho_I}\right) = \mathrm{sgn}\left(\omega-\frac{2}{3}\right);$$

$$\frac{\partial\Gamma}{\partial\rho_E}\bigg|_{c=c^*} = \frac{\tau_\eta+\tau_\delta}{c^*\tau_\eta+\tau}\left(\frac{\tau_\delta}{\tau_\eta+\tau_\delta} - c^*\right)\left[\frac{(1-c^*)\tau_\delta+\tau}{c^*\tau_\eta+\tau}+1\right].$$

Note that $\mathrm{sgn}\left(\Gamma(c^*) - \Gamma\left(\frac{\tau_\delta}{\tau_\eta+\tau_\delta}\right)\right) = \mathrm{sgn}\left(\frac{2-3\omega}{1-\omega}\rho_I - 2\frac{\tau_\eta\tau_\delta^2}{\tau_\eta\tau_\delta+\tau(\tau_\eta+\tau_\delta)}\right)$, then.

i. If $\omega \geq \frac{2}{3}$, then $c^* > \frac{\tau_\delta}{\tau_\eta+\tau_\delta}$;

ii. If $\omega < \frac{2}{3}$, then when $\rho_I < \frac{2(1-\omega)}{2-3\omega}\frac{\tau_\eta\tau_\delta^2}{\tau_\eta\tau_\delta+\tau(\tau_\eta+\tau_\delta)}$, we have $c^* > \frac{\tau_\delta}{\tau_\eta+\tau_\delta}$. Otherwise, plugging in $\rho_I = \frac{2(1-\omega)}{2-3\omega}\frac{\tau_\eta\tau_\delta^2}{\tau_\eta\tau_\delta+\tau(\tau_\eta+\tau_\delta)}$, we have $\frac{\partial\Gamma}{\partial c}\big|_{c=\frac{\tau_\delta}{\tau_\eta+\tau_\delta}} = -\frac{\tau(\tau_\eta+\tau_\delta)^4\left((\tau(\tau_\eta+\tau_\delta)+\tau_\eta\tau_\delta)\rho_E+\tau_\delta^2(\tau-2\tau_\eta)\right)}{(\tau(\tau_\eta+\tau_\delta)+\tau_\eta\tau_\delta)^4}$, implying $\mathrm{sgn}\left(\frac{\tau_\delta}{\tau_\eta+\tau_\delta} - c^*\right) = -\,\mathrm{sgn}\left(\frac{\partial\Gamma}{\partial c}\big|_{c=\frac{\tau_\delta}{\tau_\eta+\tau_\delta}}\right) = \mathrm{sgn}\left(\rho_E - \frac{\tau_\delta^2(2\tau_\eta-\tau)}{\tau(\tau_\eta+\tau_\delta)+\tau_\eta\tau_\delta}\right)$.

To conclude, if $\omega \geq \frac{2}{3}$, then $\frac{\mathrm{d}c^*}{\mathrm{d}\rho_E} < 0$; if $\omega < \frac{2}{3}$, then when $\rho_I < \frac{2(1-\omega)}{2-3\omega}\frac{\tau_\eta\tau_\delta^2}{\tau_\eta\tau_\delta+\tau(\tau_\eta+\tau_\delta)}$, $\frac{\mathrm{d}c^*}{\mathrm{d}\rho_E} < 0$; when $\rho_I > \frac{2(1-\omega)}{2-3\omega}\frac{\tau_\eta\tau_\delta^2}{\tau_\eta\tau_\delta+\tau(\tau_\eta+\tau_\delta)}$, $\frac{\mathrm{d}c^*}{\mathrm{d}\rho_E} < 0$ for $\rho_E < \frac{\tau_\delta^2(2\tau_\eta-\tau)}{\tau(\tau_\eta+\tau_\delta)+\tau_\eta\tau_\delta}$ and $\frac{\mathrm{d}c^*}{\mathrm{d}\rho_E} > 0$ for $\rho_E > \frac{\tau_\delta^2(2\tau_\eta-\tau)}{\tau(\tau_\eta+\tau_\delta)+\tau_\eta\tau_\delta}$.

$$\frac{\partial\Gamma}{\partial\tau_\eta}\bigg|_{c=c^*} = 2\left(\frac{2-3\omega}{1-\omega}\rho_I - \rho_E\right)\left[\frac{(1-c^*)\tau_\delta+\tau}{c^*\tau_\eta+\tau}\right]^2\frac{c^*}{c^*\tau_\eta+\tau} \Rightarrow \mathrm{sgn}\left(\frac{\mathrm{d}c^*}{\mathrm{d}\tau_\eta}\right) = \mathrm{sgn}\left(\frac{2-3\omega}{1-\omega}\rho_I - \rho_E\right),$$

$$\frac{\partial\Gamma}{\partial\tau_\delta}\bigg|_{c=c^*} = 2(1-c^*)\left\{\tau_\delta\frac{(1-c^*)\tau_\delta+2\tau}{[(1-c^*)\tau_\delta+\tau]^2} + \left(\rho_E - \frac{2-3\omega}{1-\omega}\rho_I\right)\frac{(1-c^*)\tau_\delta+\tau}{(c^*\tau_\eta+\tau)^2}\right\} \Rightarrow \frac{\mathrm{d}c^*}{\mathrm{d}\tau_\delta} > 0 \quad \text{when } \rho_E \geq \frac{2-3\omega}{1-\omega}\rho_I.$$

When $\rho_E < \frac{2-3\omega}{1-\omega}\rho_I$, $\mathrm{sgn}\left(\frac{\mathrm{d}c^*}{\mathrm{d}\tau_\delta}\right) = \mathrm{sgn}\left(\frac{\partial}{\partial\tau_\delta}\frac{\mathrm{d}W}{\mathrm{d}c}\bigg|_{c=c^*}\right)$ since $\frac{\partial}{\partial c}\frac{\mathrm{d}W}{\mathrm{d}c}\bigg|_{c=c^*} < 0$.

$$\frac{\partial}{\partial c}\frac{\mathrm{d}W}{\mathrm{d}c}\bigg|_{c=c^*}=(1-\omega)\tau\left\{\frac{\tau_\delta^2[2(1-c^*)\tau_\delta-\tau]}{[(1-c^*)\tau_\delta+\tau]^4}-\rho_E\left[\frac{\tau_\delta}{[(1-c^*)\tau_\delta+\tau]^3}+\frac{\tau_\eta}{(c^*\tau_\eta+\tau)^3}\right]+\frac{2-3\omega}{1-\omega}\rho_I\frac{\tau_\eta}{(c^*\tau_\eta+\tau)^3}\right\}<0$$

$$\Rightarrow\ \rho_E>\frac{\frac{2-3\omega}{1-\omega}\rho_I\frac{\tau_\eta}{(c^*\tau_\eta+\tau)^3}+\frac{\tau_\delta^2[2(1-c^*)\tau_\delta-\tau]}{[(1-c^*)\tau_\delta+\tau]^4}}{\frac{\tau_\delta}{[(1-c^*)\tau_\delta+\tau]^3}+\frac{\tau_\eta}{(c^*\tau_\eta+\tau)^3}}>\frac{\rho_E\frac{\tau_\eta}{(c^*\tau_\eta+\tau)^3}+\frac{\tau_\delta^2[2(1-c^*)\tau_\delta-\tau]}{[(1-c^*)\tau_\delta+\tau]^4}}{\frac{\tau_\delta}{[(1-c^*)\tau_\delta+\tau]^3}+\frac{\tau_\eta}{(c^*\tau_\eta+\tau)^3}}$$

$$\Rightarrow\ \rho_E>\tau_\delta\frac{2(1-c^*)\tau_\delta-\tau}{(1-c^*)\tau_\delta+\tau}$$

$$\frac{\partial}{\partial\tau_\delta}\frac{\mathrm{d}W}{\mathrm{d}c}\bigg|_{c=c^*}=(1-\omega)\frac{\tau(1-c^*)}{[(1-c^*)\tau_\delta+\tau]^4}([[(1-c^*)\tau_\delta+\tau]\rho_E-\tau_\delta[(1-c^*)\tau_\delta-2\tau])>(1-\omega)\frac{\tau\tau_\delta(1-c^*)}{[(1-c^*)\tau_\delta+\tau]^3}>0$$

$$\Rightarrow\ \frac{\mathrm{d}c^*}{\mathrm{d}\tau_\delta}>0\quad\text{when } \rho_E<\frac{2-3\omega}{1-\omega}\rho_I.$$

$$\frac{\partial\Gamma}{\partial\tau}\bigg|_{c=c^*}=2\left(\rho_E-\frac{2-3\omega}{1-\omega}\rho_I\right)\frac{(1-c^*)\tau_\delta+\tau}{(c^*\tau_\eta+\tau)^3}[c^*(\tau_\eta+\tau_\delta)-\tau_\delta]-2\frac{(1-c^*)\tau_\delta^2}{[(1-c^*)\tau_\delta+\tau]^2}$$

$$\underset{=}{\text{FOC}}\ \frac{\left(\rho_E-\frac{2-3\omega}{1-\omega}\rho_I\right)\left[\frac{(1-c^*)\tau_\delta+\tau}{c^*\tau_\eta+\tau}\right]^2\left[2\frac{c^*(\tau_\eta+\tau_\delta)-\tau_\delta}{c^*\tau_\eta+\tau}+1\right]-\rho_E}{(1-c^*)\tau_\delta+\tau}.$$

Note that $\left[\frac{(1-c)\tau_\delta+\tau}{c\tau_\eta+\tau}\right]^2\left[2\frac{c(\tau_\eta+\tau_\delta)-\tau_\delta}{c\tau_\eta+\tau}+1\right]\le 1$ with the upper bound achieved at $c=\frac{\tau_\delta}{\tau_\eta+\tau_\delta}$. Hence, $\frac{\mathrm{d}c^*}{\mathrm{d}\tau}<0$ if $\omega<\frac{2}{3}$ and $\rho_E>\frac{2-3\omega}{1-\omega}\rho_I$. □

Proof of Corollary 3. The proof follows immediately after plugging in equation (5). □

Proof of Lemma 2. Recall that the price of each firm given all available information $\mathcal{I}\equiv\{s_{k,i}\}_{i\in[0,\frac{1}{2}],k\in\{1,2\}}$ follows a strict factor structure. The risk premium is determined by the non-diversifiable risk of market portfolio, $\widetilde{\eta}+\frac{1}{2}(\widetilde{\eta}_1+\widetilde{\eta}_2)$. Denote $\boldsymbol{\Sigma}_\eta$ and $\boldsymbol{\Sigma}_s$ as the 2×2 variance-covariance matrix of $\{\widetilde{\eta}+\widetilde{\eta}_1,\widetilde{\eta}+\widetilde{\eta}_2\}$ and $\{\widetilde{\bar{s}}_1,\widetilde{\bar{s}}_2\}$, respectively, and $\boldsymbol{\Sigma}_{\eta s}$ as the 2×2 covariance matrix of the two sets of variables. Then given investors' conjectured levels of effort $\widehat{a}_{k,i}$ and $\widehat{a}_k$ for firm i and the group k average, respectively,

$$\begin{aligned}P_{k,i}(s_{k,i},\bar{s}_k,\bar{s}_{k'})&=\mathbb{E}\left[\widetilde{\theta}_{k,i}\middle|\mathcal{I}\right]-\rho_I\mathrm{Var}\left(\widetilde{\eta}+\frac{1}{2}(\widetilde{\eta}_1+\widetilde{\eta}_2)\middle|\mathcal{I}\right)\\&=\widehat{a}_{k,i}+\frac{\tau_{\xi_k}}{\tau_{\delta_k}+\tau_{\xi_k}}(s_{k,i}-\bar{s}_k)+b_{kk}(\bar{s}_k-\widehat{a}_k)+b_{kk'}(\bar{s}_{k'}-\widehat{a}_{k'})-\rho_I\mathbf{m}^\top\boldsymbol{\Sigma}_{\eta|s}\mathbf{m},\end{aligned}$$

where $\mathbf{m}$ is a 2×1 vector with $\frac{1}{2}$ in each element that denotes the mass of each group, and the coefficients on the average signals and the residual uncertainties about the undiversifiable common shocks $\{\widetilde{\eta}+\widetilde{\eta}_1,\widetilde{\eta}+\widetilde{\eta}_2\}$ are:

$$(b_{ij})_{2\times2}\equiv\boldsymbol{\Sigma}_{\eta s}\boldsymbol{\Sigma}_s^{-1}=\frac{1}{B}\begin{pmatrix}\tau_{\varepsilon_1}((\tau_\eta+\tau_{\eta_1})(\tau_{\eta_2}+\tau_{\varepsilon_2})+\tau_{\eta_2}\tau_{\varepsilon_2}) & \tau_{\eta_1}\tau_{\eta_2}\tau_{\varepsilon_2}\\ \tau_{\eta_1}\tau_{\eta_2}\tau_{\varepsilon_1} & \tau_{\varepsilon_2}((\tau_\eta+\tau_{\eta_2})(\tau_{\eta_1}+\tau_{\varepsilon_1})+\tau_{\eta_1}\tau_{\varepsilon_1})\end{pmatrix},$$

$$\boldsymbol{\Sigma}_{\eta|s}\equiv\boldsymbol{\Sigma}_\eta-\boldsymbol{\Sigma}_{\eta s}\boldsymbol{\Sigma}_s^{-1}\boldsymbol{\Sigma}_{\eta s}^\top=\frac{1}{B}\begin{pmatrix}(\tau_\eta+\tau_{\eta_1})(\tau_{\eta_2}+\tau_{\varepsilon_2})+\tau_{\eta_2}\tau_{\varepsilon_2} & \tau_{\eta_1}\tau_{\eta_2}\\ \tau_{\eta_1}\tau_{\eta_2} & (\tau_\eta+\tau_{\eta_2})(\tau_{\eta_1}+\tau_{\varepsilon_1})+\tau_{\eta_1}\tau_{\varepsilon_1}\end{pmatrix},$$

where $B=(\tau_\eta+\tau_{\eta_1}+\tau_{\eta_2})\tau_{\varepsilon_1}\tau_{\varepsilon_2}+\tau_{\eta_1}\tau_{\eta_2}(\tau_{\varepsilon_1}+\tau_{\varepsilon_2})+\tau_\eta(\tau_{\eta_1}\tau_{\eta_2}+\tau_{\eta_1}\tau_{\varepsilon_2}+\tau_{\eta_2}\tau_{\varepsilon_1})$.

The rest of the proof follows in a similar way to the proof of Lemma 1 and is hence omitted.

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