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ANNUAL REVIEW OF FINANCIAL ECONOMICS (/content/journals/financial) Volume 9, 2017

<u>(/content/journals/financial/9/1)</u> Information Disclosure in Financial Markets

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value1=Itay+Goldstein&option1=author&noRedirect=true&sortField=prism_publicationDate&sortDescending=true)¹, and Liyan Yang (/search?value1=Liyan+Yang&option1=author&noRedirect=true&sortField=prism_publicationDate&sortDescending=true)² • View Affiliations

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ABSTRACT

Information disclosure is an essential component of regulation in financial markets. In this article, we provide a co hesive analytical framework to review certain key channels through which disclosure in financial markets affects m arket quality, information production, efficiency of real investment decisions, and traders' welfare. We use our fram ework to address four main aspects. First, we demonstrate the conventional wisdom that disclosure improves mar ket quality in an economy with exogenous information. Second, we illustrate that disclosure can crowd out the pro duction of private information and that its overall market-quality implications are subtle and depend on the specifi cation of information-acquisition technology. Third, we review how disclosure affects the efficiency of real investm ent decisions when financial markets are not just a side show, as real decision makers can learn information from t hem to guide their decisions. Last, we discuss how disclosure in financial markets affects investors' welfare throug h changing trading opportunities and through beauty-contest motives. Overall, our review suggests that information n disclosure is an important factor for understanding the functioning of financial markets and that there are severa l trade-offs that should be considered in determining its optimal level.

Keywords

<u>disclosure (/search?option1=pub_keyword&value1="disclosure")</u>, market quality (/search?option1=pub_keyword&value1 ="market quality"), crowding-out effect (/search?option1=pub_keyword&value1="crowding-out effect"), learning from price es (/search?option1=pub_keyword&value1="learning from prices")</u>, real efficiency (/search?option1=pub_keyword&value1 ="real efficiency"), welfare (/search?option1=pub_keyword&value1="welfare")

1. INTRODUCTION

Disclosure of information in financial markets is at the forefront of regulatory efforts to improve financial market q uality and stability. **Greenstone, Oyer & Vissing-Jorgensen (2006**, p. 399) write that "since the passage of the Sec urities Act of 1933 and the Securities Exchange Act of 1934, the federal government has actively regulated US equit y markets. The centerpiece of these efforts is the mandated disclosure of financial information." Recently, these eff orts have been very prominent, with the Sarbanes–Oxley Act of 2002 and the Dodd–Frank Act of 2010 emphasizing various aspects of improved disclosure. For example, the Sarbanes–Oxley Act was passed "to protect investors by i mproving the accuracy and reliability of corporate disclosures made pursuant to the securities laws, and for other purposes" (Pub. L. 107–204, 116 Stat. 745).

Disclosure regulation comes in different forms and affects different activities. Over time, firms have increasingly be en required to disclose information about their operations and financial activities in financial reports to their invest ors. Similarly, investors are required to disclose information about their holdings in firms that might pertain to acti vism, intentions of activism, or acquisitions intentions that could ultimately affect firm value. Moreover, improved quality of public information is also achieved by increasing the reliability of credit ratings and by greater disclosure of macroeconomic and industry-related information. Recently, following the financial crisis of 2008, governments i ncreased the amount of disclosure available about banks by conducting annual stress tests and making their result s publicly available. This has led to significant public debate (**Goldstein & Sapra 2013**).

The academic literature is quite ambiguous about the effects of disclosure and its overall desirability. It is well und erstood that disclosure can potentially promote some important goals: By leveling the playing field in financial mar kets, it can increase market liquidity and market efficiency and can decrease the cost of capital for firms. However, much has been written about potential unintended consequences of disclosure, which occur because of the crowd ing out of private information production, the destruction of risk-sharing opportunities, and the promotion of dest abilizing beauty-contest incentives. Given the flow of new regulations related to disclosure in recent years, researc hers have been delving more and more into the topic, trying to understand the pros and cons and answering key q uestions, such as: What is the optimal level of disclosure in terms of promoting market quality and social welfare? What types of disclosure are most beneficial? In what circumstances is disclosure desirable?

Our goal in this review is to present the main forces that have been put forward in the discussion on the effects of d isclosure in financial markets. As this is a review of theoretical literature, we use a workhorse model that has been used extensively in the literature on information and disclosure in financial markets, and we show how the main fo rces are manifested within this framework. We hope this will be useful to researchers who wish to build on existing theories in developing new ones, testing existing empirical implications, or understanding ongoing policy debates. We do not attempt an all-inclusive survey of the extant disclosure literature (some excellent surveys include those of **Dye 2001**, **Verrecchia 2001**, **Kanodia 2006**, **Leuz & Wysocki 2008**, and **Kanodia & Sapra 2017**). Instead, we aim to organize a few leading forces within a cohesive analytical framework, so that the pros and cons of disclosure can be more easily sorted out and evaluated for different environments.

The structure of this review is as follows. Section 2 presents the basic framework for studying information and discl osure in financial markets, building on the work of **Grossman & Stiglitz (1980)**, **Hellwig (1980)**, and **Verrecchia (1 982a)**. We show basic results demonstrating how increased precision of public information, which is achieved via e nhanced disclosure, improves common measures of market quality. That is, we show that disclosure increases liqu idity and market efficiency and decreases the cost of capital and return volatility. These results capture the usual in tuition that guides regulators in imposing greater disclosure.

In Section 3, we extend the basic framework to endogenize the acquisition of private information by market partici pants, building on work by **Verrecchia (1982b)**, **Diamond (1985)**, and others. We demonstrate the basic argument that increased disclosure leads to crowding out of private-information acquisition. This implies that the effect of di sclosure on market quality is more nuanced once private information is endogenized and that it depends on the a mount of information being disclosed, on the information-acquisition technology, and on the measure of market quality being considered.

Although the analysis in Sections 2 and 3 considers measures of market quality, these measures do not translate ea sily into a clear objective function to tell how much disclosure is desirable. Section 4 extends the framework, revie wing papers that emphasize the role of the financial market in producing information that guides decisions on the real side of the economy. This is in the spirit of the literature on the market feedback effect, which is reviewed by **<u>B</u> ond, Edmans & Goldstein (2012)**. This enables the analysis of optimal disclosure in light of its effect on the efficie ncy of real investment decisions (e.g., **Gao & Liang 2013**; **Han, Tang & Yang 2016**). An interesting dimension reveal ed by papers in this realm of work is that the type of information being disclosed is key in determining whether disc losure is desirable (**Bond & Goldstein 2015**, **Goldstein & Yang 2016**).

Finally, Section 5 considers extensions of the basic framework that allow us to study the effect of disclosure on the welfare of investors in financial markets and, as a result, to pin down optimal disclosure. Whereas the traditional vi ew is that disclosure enhances the welfare of investors, a classic result by **Hirshleifer (1971)** shows that disclosure destroys risk-sharing opportunities and is thus welfare reducing. More recently, **Kurlat & Veldkamp (2015)** suggest ed a reduction in trading opportunities as another way in which disclosure's effects can be negative. Another com mon argument is that disclosure can be harmful because of beauty-contest incentives, leading all investors to want to do the same thing. In such a case, greater precision of public information leads investors to put too much weight on it, thus reducing welfare (**Morris & Shin 2002**).

2. A BASIC MODEL OF INFORMATION AND DISCLOSURE

We introduce a basic framework that enables us to discuss the various effects of disclosure in financial markets in a unified way. We rely on the noisy rational-expectations equilibrium (noisy REE) model, which is a workhorse model that has been used extensively in the literature on information and disclosure in financial markets. The model we d escribe in this section builds on early contributions by <u>Grossman & Stiglitz (1980)</u>, <u>Hellwig (1980)</u>, and <u>Verrecchi</u> <u>a (1982a)</u>. The model has the traditional CARA-normal feature; that is, traders have constant absolute risk aversion (CARA) preferences, and all random variables are normally distributed.

2.1. Setup

There are two dates, t=1 and t=2. At date 1, two assets are traded in a competitive financial market: a risk-free asset and a risky asset. The risky asset is usually thought of as equity issued by a firm, but it can also be a different asset, e.g., a corporate bond. The risk-free asset has a constant value of 1 and is in unlimited supply. The risky asset pays an uncertain cash flow at the final date t=2, denoted by v. We assume that v is normally distributed with a mean of 0 and a precision (reciprocal of variance) of τ_v —that is, $v \sim N(0, \tau_v^{-1})$, with $\tau_v > 0$. $\frac{1}{2}$ The risky asset is traded at an en dogenous price \bar{p} and has a fixed supply $Q \ge 0$.

There are three types of traders in the financial market: informed traders, uninformed traders, and liquidity trader s. The first two types of traders have CARA utility over their wealth at date 2 with a risk aversion coefficient of γ >0. T hey can represent individuals or institutions who trade the risky asset. The total mass of the first two types of trade rs is 1, with a fraction $\mu \in [0, 1]$ being informed traders and a fraction $1-\mu$ being uninformed traders. Prior to tradin g, informed trader *i* observes a private signal \vec{s}_i , which contains information about the fundamental value \vec{v} of the ri sky asset in the following form:

$$\bar{s}_i = \bar{v} + \bar{\varepsilon}_i$$
, with $\bar{\varepsilon}_i \sim N(0, \tau_{\varepsilon}^{-1})$ and $\tau_{\varepsilon} > 0$, **1.**

where $(\bar{v}, \{\bar{\varepsilon}_i\}_{i \in [0,\mu]})$ are mutually independent. For now, we take both μ and τ_{ε} as exogenous. We endogenize them la ter.

A common way to introduce disclosure into this model is to add a public signal \bar{y} as follows:

$$\bar{y} = \bar{v} + \bar{\eta}$$
, with $\bar{\eta} \sim N(0, \tau_n^{-1})$ and $\tau_\eta \ge 0$ (2.)

(see, e.g., **Diamond 1985**; **Verrecchia 2001**; **Morris & Shin 2002**; **Hughes**, **Liu & Liu 2007**; **Lambert**, **Leuz & Verrec chia 2007**). For example, \bar{y} can be thought of as announcements made by the firm about its future prospects or as e conomic statistics published by government agencies, central banks, or other parties (e.g., credit rating agencies). The precision τ_{η} controls the quality of the public signal \bar{y} , with a high value of τ_{η} signifying that \bar{y} is more informati ve about the asset cash flow \bar{w} (i.e., signifying more disclosure). More disclosure can be achieved by making more fr equent announcements or by releasing more accurate data. (We assume that traders can costlessly interpret the p ublic signal \bar{y} . Some studies have considered settings in which traders can only extract a noisy version of \bar{y} and whe re their public data processing abilities can be different; see, e.g., **Indjejikian 1991**, **Pagano & Volpin 2012**, **Di Mag gio & Pagano 2017**.) Much of our analysis is concerned with how the parameter τ_{η} affects market outcomes. Note t hat we focus on the effect of ex ante disclosure quality, in the sense of an improvement in the precommitted precisi on of public information. We do not address strategic ex post disclosure, where firms choose whether to disclose b ased on their signal, which involves a signaling effect. There is a large literature that addresses these issues (see, e. g., <u>Grossman 1981</u>; <u>Milgrom 1981</u>; <u>Dye 1985</u>; <u>Jung & Kwon 1988</u>; <u>Acharya, DeMarzo & Kremer 2011</u>; <u>Guttman, Kremer & Skrzypacz 2014</u>). Also note that public information in <u>Equation 2</u> represents disclosure about fundame ntal information, so we do not discuss the literature on market transparency, which explores the effect of disclosin g information about trading positions and prices (see, e.g., <u>Madhavan 1995</u>; <u>Pagano & Röell 1996</u>; <u>Bloomfield & O'Hara 1999</u>; <u>Naik, Neuberger & Viswanathan 1999</u>; <u>Huddart, Hughes & Levine 2001</u>; <u>Easley, O'Hara & Yang 20</u> <u>14</u>; for a discussion of the interactions between disclosure of fundamental information and transparency of the tra ding process, see <u>Di Maggio & Pagano 2017</u>).

Liquidity traders, also called noise traders in the literature, demand \bar{x} units of the risky asset, where $\bar{x} \sim N(0, \tau_x^{-1})$, with $\tau_x \in (0, \infty)$, is independent of other shocks in the economy. Noise trading provides the randomness that make s the rational-expectations equilibrium partially revealing, which is crucial to sustaining trading in equilibrium. In t he baseline model, we take the size τ^{-1}_x of noise trading as exogenous. We endogenize it later. Note that there are v arious ways to endogenize noise trading in asymmetric information models, such as endowment shocks (e.g., <u>Dia mond & Verrecchia 1981</u>, <u>Diamond 1985</u>) or private investment opportunities (e.g., <u>Wang 1994</u>; <u>Easley, O'Hara & Yang 2014</u>).

2.2. Equilibrium

The equilibrium requires that (*a*) informed and uninformed traders choose investments in assets to maximize their expected utility conditional on their respective information sets, including the asset price \bar{p} , the public signal \bar{y} , an d (for informed traders) the private signal \bar{s}_i ; (*b*) the markets clear so that the demand for the risky asset equals the exogenous supply *Q*; and (*c*) informed and uninformed traders have rational expectations in the sense that their be liefs about all random variables are consistent with the true underlying distributions and equilibrium behaviors.

Constructing a noisy REE boils down to solving a price function that depends on the public information \bar{y} , informed traders' private information \bar{s}_i , and noise trading \bar{x} . By the law of large numbers, the noise terms \bar{e}_i in the private sig nals \bar{s}_i wash out, and thus we conjecture that the price \bar{p} is a function of $(\bar{y}, \bar{v}, \bar{x})$. The literature focuses on a linear price function of the form

$$\bar{p} = p_0 + p_y \bar{y} + p_v \bar{v} + p_x \bar{x},$$
3.

where the *p*-coefficients are endogenously determined in equilibrium. Here we restrict our attention to this form. Informed trader *i* has an information set $\{\bar{y}, \bar{s}_i, \bar{p}\}$. The CARA-normal setup implies that the demand function of infor med trader *i* is

$$D_{\mathrm{I}}(\bar{y}, \bar{s}_i, \bar{p}) = \frac{E(\bar{v}|\bar{y}, \bar{s}_i, \bar{p}) - \bar{p}}{\gamma \mathrm{Var}(\bar{v}|\bar{y}, \bar{s}_i, \bar{p})}$$

For trader *i*, the information contained in the price is equivalent to the signal \bar{s}_p :

$$\bar{s}_p \equiv \frac{\bar{p} - (p_0 + p_y \bar{y})}{p_v} = \bar{v} + \rho^{-1} \bar{x}, \text{ with } \rho = \frac{p_v}{p_x},$$
(4.)

which is normally distributed, with mean \overline{v} and precision $\rho^2 \tau_x$. Applying Bayes' rule to compute the conditional moments in the demand function, we can obtain

$$D_{\mathrm{I}}(\bar{y}, \bar{s}_i, \bar{p}) = \frac{\tau_{\varepsilon} \bar{s}_i + \tau_{\eta} \bar{y} + \rho^2 \tau_x \bar{s}_p - (\tau_v + \tau_{\varepsilon} + \tau_{\eta} + \rho^2 \tau_x) \bar{p}}{\gamma}.$$
5.

Similarly, an uninformed trader has an information set $\{\bar{y}, \bar{p}\}$, and we can compute this trader's demand function for the risky asset as follows:

$$D_{\rm U}(\bar{y},\bar{p}) = \frac{E(\bar{v}|\bar{y},\bar{p}) - \bar{p}}{\gamma {\rm Var}(\bar{v}|\bar{y},\bar{p})} = \frac{\tau_{\eta}\bar{y} + \rho^2 \tau_x \bar{s}_p - (\tau_v + \tau_{\eta} + \rho^2 \tau_x)\bar{p}}{\gamma}.$$
(6.)

The market-clearing condition is

$$\int_0^\mu D_{\rm I}(\bar{y}, \bar{s}_i, \bar{p}) {\rm d}i + (1-\mu) D_{\rm U}(\bar{y}, \bar{p}) + \bar{x} = Q.$$
7.

To derive the equilibrium price function, we insert **Equations 5 and 6** into **Equation 7** to solve the price in terms of the public signal \bar{y} , the fundamental \bar{v} , and the noise trading \bar{x} , and we then compare with the conjectured price function in **Equation 3** to obtain a system defining the unknown *p*-coefficients.

Solving this system yields the following result: For any $\mu \in [0, 1]$ and $\tau_{\epsilon} \ge 0$, there exists a unique partially revealing noisy REE, with price function of the form in **Equation 3**, where

$$p_{0} = \frac{-\gamma Q}{\mu \tau_{\varepsilon} + \tau_{v} + \tau_{\eta} + \rho^{2} \tau_{x}}, \quad p_{y} = \frac{\tau_{\eta}}{\mu \tau_{\varepsilon} + \tau_{v} + \tau_{\eta} + \rho^{2} \tau_{x}},$$

$$p_{v} = \frac{\mu \tau_{\varepsilon} + \rho^{2} \tau_{x}}{\mu \tau_{\varepsilon} + \tau_{v} + \tau_{\eta} + \rho^{2} \tau_{x}}, \quad p_{x} = \frac{\rho \tau_{x} + \gamma}{\mu \tau_{\varepsilon} + \tau_{v} + \tau_{\eta} + \rho^{2} \tau_{x}},$$

$$(8)$$

with $\rho = \mu \tau_{\epsilon} / \gamma$.

2.3. Market Quality and Disclosure

The effect of disclosure is often understood by examining different measures of market quality. We now define four common measures, explain their origins, and discuss how they are affected by greater disclosure.

2.3.1. Market liquidity.

Market liquidity refers to a market's ability to facilitate the purchase or sale of an asset without drastically affecting the asset's price. The literature has used the coefficient p_X in the price function (**Equation 3**) to inversely measure market liquidity: A smaller p_X means that liquidity trading \bar{x} has a smaller price impact, and thus the market is deep er and more liquid. Formally,

Liquidity
$$\equiv \frac{1}{p_x}$$
. 9.

This measure of market liquidity is often referred to as <u>Kyle's (1985)</u> lambda.

The illiquidity measure p_x can also be linked to another often used measure, the bid-ask spread. Suppose that a liq uidity trader comes to the market with a buying order $\bar{x} = +1$. By **Equation 3**, this trader expects on average to fulfil l this order at an ask price quoted by the market, Ask $\equiv E(\bar{p}|\bar{x} = +1) = p_0 + p_x$. Similarly, if the liquidity trader wants to sell an order $\bar{x} = -1$, then, on average, the trader expects to fulfill the order at a bid price Bid $\equiv E(\bar{p}|\bar{x} = -1) = p_0 - p_x$. As a result, the bid-ask spread is

Bid-ask spread =
$$Ask - Bid = 2p_x$$
.

Thus, p_X is indeed positively associated with the bid-ask spread.

From **Equation 8**, we know that disclosure improves market liquidity; that is, ∂ Liquidity/ $\partial \tau_{\eta}$ >0. Intuitively, more pr ecise public information implies that there is less uncertainty about the asset value, so rational traders trade more aggressively against liquidity traders. As a result, changes in liquidity trading are absorbed with a smaller price change.

2.3.2. Market efficiency.

Market efficiency, also called price efficiency or informational efficiency, concerns how informative the prevailing market prices are about the future values of the traded assets. An underlying reason for promoting market efficienc y is that it is believed to be a good proxy for real efficiency, by which more information in prices about underlying v alues improves real investment decisions.²_In Section 4, we refine this statement. In the literature (e.g., <u>Vives 2008</u>, <u>Peress 2010</u>, <u>Ozsoylev & Walden 2011</u>), researchers measure market efficiency using the precision of the posterio r about an asset fundamental conditional on its price, ³_that is,

Market efficiency
$$\equiv \frac{1}{\operatorname{Var}(\bar{v}|\bar{p})}$$
. **10.**

Given that \bar{v} and \bar{p} are normally distributed, $1/Var(\bar{v}|\bar{p})$ is positively related to the correlation coefficient $Corr(\bar{v}, \bar{p})$ bet ween \bar{v} and \bar{p} , that is,

$$\frac{1}{\operatorname{Var}(\bar{v}|\bar{p})} = \frac{\tau_v}{1 - [\operatorname{Corr}(\bar{v}, \bar{p})]^2}$$

For this reason, one can also use $Corr(\bar{v}, \bar{p})$ to measure market efficiency (e.g., **Goldstein & Yang 2014**).

Using **Equation 8**, we can show that disclosure improves market efficiency, that is, $\partial [1/Var(\bar{v}|\bar{p})]/\partial \tau_{\eta} > 0$. Intuitively, more public information before the price is formed directly injects more fundamental information into the price thr ough updating traders' forecasts about the asset payoff. This implies that the price tracks fundamental value more closely.

2.3.3. Cost of capital.

In this one-period model, the return on the risky asset is $\bar{v} - \bar{p}$, as at date 2, the uncertainty is resolved and the asse t price is its fundamental value \bar{v} . The expected return $E(\bar{v} - \bar{p})$ is often interpreted as the cost of capital on the risky asset (e.g., **Easley & O'Hara 2004**; **Hughes, Liu & Liu 2007**; **Lambert, Leuz & Verrecchia 2007**). A lower cost of cap ital benefits the issuer of the security, as it enables the issuer to sell the security at a higher price.

From **Equation 8**, we have

$$E(\bar{v} - \bar{p}) = \frac{\gamma Q}{\mu \tau_{\varepsilon} + \tau_{v} + \tau_{\eta} + \left(\frac{\mu \tau_{\varepsilon}}{v}\right)^{2} \tau_{x}}.$$
11.

Thus, the cost of capital $E(\bar{v} - \bar{p})$ is positively affected by risk aversion γ and asset supply Q in the numerator. This is because traders are willing to pay a lower price when they are more risk averse and have to hold more of the asset on average, so the risk they have to bear is higher. The expression in the denominator is equal to

$$\frac{\mu}{\operatorname{Var}(\bar{v}|\bar{y},\bar{s}_i,\bar{p})} + \frac{1-\mu}{\operatorname{Var}(\bar{v}|\bar{y},\bar{p})},$$

which is inversely related to the average risk perceived by traders per unit of the security. When the perceived risk g oes up, the cost of capital also increases. Disclosure affects the cost of capital only through affecting the perceived r isk: A higher level of disclosure lowers the cost of capital by lowering traders' average risk; that is, $\partial E(\bar{v} - \bar{p})/\partial \tau_{\eta} < 0$

2.3.4. Return volatility.

Return volatility $\sigma(\bar{v} - \bar{p}) = \sqrt{\operatorname{Var}(\bar{v} - \bar{p})}$ is another measure that attracts attention from academics and regulators. U sing **Equation 8**, we can show that disclosure lowers return volatility; that is, $\partial \sigma(\bar{v} - \bar{p})/\partial \tau_{\eta} < 0$. This is because mor e public information improves market efficiency, which thus brings the asset price \bar{p} closer to the fundamental \bar{v} .

2.3.5. Summary.

To summarize the results discussed thus far, we can see that for a given fraction μ of informed traders and a given p recision of their information τ_ε, disclosure improves all typical measures of market quality. It increases market liqui dity and market efficiency and decreases the cost of capital and return volatility. This is the conventional wisdom t hat is often put forward to argue for greater disclosure with the intent of improving the functioning of the financial market. This is consistent with many academic papers (e.g., **Diamond & Verrecchia 1991**; **Verrecchia 2001**; **Easley & O'Hara 2004**; **Hughes, Liu & Liu 2007**; **Lambert, Leuz & Verrecchia 2007**; **Gao 2008**) and with the logic behind r ecent regulatory acts, such as the Sarbanes–Oxley Act of 2002 and the Dodd–Frank Act of 2010. ⁴

3. INFORMATION ACQUISITION AND CROWDING-OUT EFFECT

In Section 2, both the fraction μ of informed traders and the precision τ_{ϵ} of informed traders' private information w ere exogenous. In this setup, disclosure was shown to improve various measures of market quality, as it enabled m ore information to get into prices, improving market liquidity, market efficiency, etc. However, a natural question i s: How do changes in disclosure affect private-information production, which is central to financial markets? Begin ning to think about the effects of disclosure more broadly, various researchers have endogenized the variables μ an d τ_{ϵ} that capture the amount of private information in the market (e.g., <u>Verrecchia 1982b</u>; <u>Diamond 1985</u>; <u>Kim & V</u> errecchia 1994; Gao & Liang 2013; Colombo, Femminis & Pavan 2014). One key finding in their studies is that mo re public information can weaken the incentives of traders to become informed and/or to acquire more precise info rmation. In other words, public information crowds out the production of private information. This can weaken an d potentially reverse the direct effect of disclosure on some market-quality variables. In this section, we augment t he baseline model in Section 2 with information acquisition to illustrate the crowding-out effect.

3.1. Setup

We add an information-acquisition date, t=0, to the baseline model in Section 2. The information-acquisition techn ology closely follows **Grossman & Stiglitz (1980)** and **Verrecchia (1982a)**. At date 0, there exists a unit mass of ide ntical CARA traders. Trader *i* can become informed by paying a cost to acquire a private signal \bar{s}_i in the form of **Equa tion 1**, which has a trader-specific precision $\tau_{\varepsilon i}$. The information-acquisition cost $C(\tau_{\varepsilon i})$ has two parts \underline{s}_{\cdot} : a fixed cos t $c_F \ge 0$ and a variable cost $c_V(\tau_{\varepsilon i})$, where $c_V(\cdot)$ is an increasing, smooth, and convex function satisfying $c_V(0)=0$. Fo r instance, we can think of traders as financial institutions, and their information-acquisition activities typically inv olve both a fixed cost (such as the overhead cost of establishing a research department) and a variable cost (such a s the cost of hiring analysts to produce financial reports). In equilibrium, an endogenous fraction μ of traders decid e to acquire private information, and these traders become the informed traders in the financial market at date 1. We can show that the informed traders choose the same precision level τ_{ε} in equilibrium, and thus the economies at dates 1 and 2 are the same as in the baseline model.

The equilibrium in this extended economy consists of an information-acquisition equilibrium at date 0 and a noisy REE at date 1. The noisy REE at date 1 is still characterized by **Equations 3 and 8**. The information-acquisition equil ibrium at date 0 is characterized by (*a*) an intensive margin, τ^*_{ϵ} —how precise is the information that informed trade rs acquire?—and (*b*) an extensive margin, μ^* —how many traders decide to become informed? In the literature, rese archers have either fixed $\mu^*=1$ and considered the crowding-out effect of disclosure on τ^*_{ϵ} (e.g., **Verrecchia 1982b**) or fixed the value of τ^*_{ϵ} and considered the crowding-out effect on μ^* (e.g., **Diamond 1985**). As we show below, bot h settings can naturally emerge endogenously in our setup and may have different implications.

Let us consider a particular trader *i*. Suppose that a fraction μ of traders are informed and acquire signals with prec ision τ_{ϵ} . When trader *i* stays uninformed, we use $CE_U(\tau_{\epsilon}, \mu)$ to denote this trader's ex ante expected utility (certainty equivalent) at the trading stage. When trader *i* decides to become informed and acquire a private signal with precisi on $\tau_{\epsilon i}$, we use $CE_I(\tau_{\epsilon i}; \tau_{\epsilon}, \mu)$ to denote this trader's ex ante expected utility. Note that in $CE_I(\tau_{\epsilon i}; \tau_{\epsilon}, \mu)$, trader *i* can o nly choose $\tau_{\epsilon i}$ and will take (τ_{ϵ}, μ) as given. Following an argument similar to that of **Grossman & Stiglitz (1980)**, w e can compute $CE_U(\tau_{\epsilon}, \mu)$ and $CE_I(\tau_{\epsilon i}; \tau_{\epsilon}, \mu)$ and analyze equilibrium outcomes.

Three types of information-acquisition equilibriums arise. First, when c_F , the fixed cost of information acquisition, i s sufficiently small, all traders become informed, that is, $\mu^*=1$; this case mimics the one studied by **Verrecchia (198** <u>**2b**</u>). Here, $CE_U(\tau^*_{\epsilon}, 1) \leq CE_I(\tau^*_{\epsilon}; \tau^*_{\epsilon}, 1)$, so traders choose to become informed when all others are informed, and the precision of information τ^*_{ϵ} is pinned down by the first-order condition: $\partial CE_I(\tau^*_{\epsilon}; \tau^*_{\epsilon}, 1)/\partial \tau_{\epsilon i}=0$. Second, when $c_F t$ akes an intermediate value, an intermediate proportion of traders choose to become informed: $\mu^* \in (0, 1)$. The equi librium is pinned down by a condition that makes traders indifferent between producing the equilibrium amount o f information and remaining uninformed, $CE_U(\tau^*_{\epsilon}, \mu^*)=CE_I(\tau^*_{\epsilon}; \tau^*_{\epsilon}, \mu^*)$, and by a first-order condition that guarante es that the level of precision is chosen optimally, $\partial CE_I(\tau^*_{\epsilon}; \tau^*_{\epsilon}, \mu)/\partial \tau_{\epsilon i}=0$. It turns out that in equilibrium, the precisi on of information produced τ^*_{ϵ} is independent of disclosure quality τ_{η} , and thus this case mimics the one studied by **Diamond (1985)**. Finally, when c_F is sufficiently large, no trader chooses to become informed, which is guarant eed by the condition $CE_U(0, 0) \ge \max_{\tau_{ij}} CE_I(\tau_{\epsilon i}; 0, 0)$.

Figure 1 graphically illustrates these equilibrium outcomes. For this illustration, we assume that the variable cost f unction takes a quadratic form, $c_V(\tau_{\epsilon i})=(k/2)\tau^2_{\epsilon i}$, and that the parameter values are $\tau_v = \tau_x = \gamma = Q = 1$ and k=0.1. The figure plots the regimes of equilibrium types in the parameter space of (c_F, τ_η) . Generally speaking, as c_F and τ_η be come larger, an equilibrium with a lower μ^* is more likely to prevail. This feature is a reflection of the crowding-out effect, which we explain in more detail in Section 3.2.1.

Figure 1

Equilibrium types in the economy with endogenous information acquisition. This figure plots the equilibrium types in the space of (τ_{η}, c_{F}) , where parameter τ_{η} controls the disclosure quality and parameter c_{F} denotes the fixed cost of information acquisition. The variable cost of information a cquisition takes a quadratic form, $c_{V}(\tau_{\varepsilon i})=(k/2)\tau^{2}_{\varepsilon i}$. The parameter values are $\tau_{V}=\tau_{X}=\gamma=Q=1$ and k=0.1.





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3.2. The Effect of Disclosure

We now reexamine the effect of disclosure when private information is endogenous.

3.2.1. The crowding-out effect on private information.

The results below follow directly from the equilibrium analysis in Section 3.1 and demonstrate the crowding-out eff ect. First, when all traders are informed, so that $\mu^*=1$, the equilibrium precision of information τ^*_{ϵ} decreases with i ncreasing quality of public information τ_{η} . Second, when an intermediate fraction of traders choose to become inf ormed, so that $\mu^* \in (0, 1)$, this fraction decreases with increasing quality of public information τ_{η} (in this case the pr ecision τ^*_{ϵ} is unaffected). These two results reproduce the crowding-out effects studied by <u>Verrecchia (1982b)</u> and <u>Diamond (1985)</u>, respectively. Intuitively, when both public information and private information are about the sa me random variable \bar{v} , they are substitute, and thus additional public information motivates traders to cut back on their costly private acquisition activities either in the form of producing less-precise private information or in the for m of becoming uninformed.

In **Figure 1**, we can see how an increase in disclosure makes it more likely that we should move to an equilibrium with a smaller fraction of informed traders. **Figure 2** continues this example with the same parameters, illustrating the crowding-out effect more directly. We now also set $c_F=0.07$. We plot the equilibrium fraction μ^* of informed traders and the equilibrium precision τ^*_{ϵ} of private information as functions of the precision τ_{η} of public information. We see that globally, both μ^* and τ^*_{ϵ} weakly decrease with τ_{η} . Starting from low disclosure, all traders choose to be come informed traders starts decreasing as disclosure continues to improve, eventually drying up all the inform ation produced privately in the market. Hence, public disclosure clearly crowds out private information. We now ex amine the effect that this has on the measures of market quality studied in Section 2.3.

Figure 2

The crowding-out effect. This figure plots (*a*) the equilibrium fraction μ^* of informed traders and (*b*) the equilibrium precision τ^*_{ε} of informed trade rs' private information against the disclosure quality τ_{η} . The variable cost of information acquisition takes a quadratic form, $c_V(\tau_{\varepsilon i})=(k/2)\tau^2_{\varepsilon i}$. The parameter values are $\tau_V = \tau_X = \gamma = Q = 1$, $c_F = 0.07$, and k = 0.1.



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3.2.2. Effect on market quality.

In Section 2, disclosure had an unambiguous effect on four measures of market quality—market liquidity, market e fficiency, cost of capital, and return volatility—increasing the first two and decreasing the other two. However, thin gs ought to be more complicated once we consider the crowding-out effect on private information. We use **Figure 3** to demonstrate the overall effect of disclosure on these measures once private information adjusts endogenously on the basis of the analysis above. **Figure 3** uses the same parameter values as does **Figure 2**. It turns out that the effect of disclosure is often nonmonotonic and that the results depend on whether crowding out happens in the ext ensive margin (as in **Diamond 1985**) or the intensive margin (as in **Verrecchia 1982b**) and on which measure of ma rket quality we inspect.

Figure 3

The effect of disclosure on an economy with endogenous information acquisition. This figure plots (*a*) the cost of capital $E(\bar{v} - \bar{p})$, (*b*) return vola tility $\sigma(\bar{v} - \bar{p})$, (*c*) market efficiency $1/\text{Var}(\bar{v}|\bar{p})$, and (*d*) market liquidity $1/p_x$ as functions of disclosure quality τ_{η} . The variable cost of informati on acquisition takes a quadratic form, $c_V(\tau_{\epsilon i}) = (k/2)\tau^2_{\epsilon i}$. The parameter values are $\tau_v = \tau_x = \gamma = Q = 1$, $c_F = 0.07$, and k = 0.1.



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Let us consider the effect of disclosure τ_{η} on the cost of capital $E(\bar{v} - \bar{p})$. Recall that without considering private inf ormation to be endogenous, disclosure has a direct negative effect on the cost of capital. **Figure 3** shows that, in th e presence of endogenous private information, there are three different regimes. First, when τ_{η} is small, $E(\bar{v} - \bar{p})$ de creases as τ_{η} increases. In this regime, μ^* is fixed at 1 and τ^*_{ϵ} decreases with increasing τ_{η} , which corresponds to th e work of <u>Verrecchia (1982b</u>). Here, the crowding out of private information happens in the intensive margin. The decrease in private information following an increase in disclosure increases the risk faced by traders, pushing to a n average increase in the cost of capital, but this is not strong enough to overcome the direct reducing effect that di sclosure has on the cost of capital. Second, when τ_{η} takes intermediate values, $E(\bar{v} - \bar{p})$ starts to increase with τ_{η} . H ere, $\mu^* \in (0, 1)$ decreases with τ_{η} and τ^*_{ϵ} is fixed, which corresponds to the work of <u>Diamond (1985)</u>, where the cro wding out happens in the extensive margin. Now the decrease in private information as a result of increased disclo sure is sufficiently strong that the cost of capital increases with disclosure, in opposition to the direct effect. Hence, the indirect effect of crowding out on the extensive margin is more powerful in this regime. Third, when τ_{η} is high, $E(\bar{v} - \bar{p})$ decreases with increasing τ_{η} again. Here, $\mu^*=0$, so disclosure no longer affects private information, and onl y the direct reducing effect of disclosure on the cost of capital is present. $\frac{6}{2}$. Overall, we see that the crowding out of private information by public information implies that disclosure no longer has a uniformly negative effect on the c ost of capital, so the total effect must be evaluated more carefully and depends on the exact information structure i n place.

Considering the effect of disclosure on market efficiency and return volatility, we can see effects very similar to tho se described above for the cost of capital. The exception is the measure of liquidity, which is monotonically increasi ng in disclosure. Here, the crowding-out effect of private information does not interfere with the positive direct effe ct that disclosure has on liquidity. This is because the crowding-out effect partly benefits market liquidity, as it wea kens adverse selection induced by private information.

4. DISCLOSURE AND REAL EFFICIENCY

The above analysis has shown the effect that disclosure has on four commonly mentioned variables that capture di fferent dimensions of market quality. We first showed how disclosure unambiguously improves these measures wh en we consider only its direct effect, but then showed that disclosure tends to crowd out private-information produ ction and, as a result, has a more nuanced effect on the different measures. One issue with the above analysis is th at these measures do not translate easily into a clear objective function that will help us tell when disclosure is desi rable and when it is not.

In this section we address this issue and extend our basic framework, reviewing papers that have attempted to pin down optimal disclosure policy with a clear objective function in mind. The papers reviewed here emphasize the ro le of the financial market in producing information and in guiding the decisions on the real side of the economy, e. g., investment decisions made by firm managers. This idea goes back to <u>Hayek (1945)</u>, who argued that prices are an important source of information because they aggregate information from many market participants. There is a vast recent literature exploring the implications of this market feedback effect; a recent survey is provided by <u>Bon</u> <u>d, Edmans & Goldstein (2012)</u>. The papers reviewed here explore optimal disclosure policy, taking into account h ow disclosure affects the information provided by the market and the efficiency of the investment decisions that ar e guided by the market. This, of course, is related to the concept of market efficiency discussed in Section 2. Howev er, as should be clear from the analysis here, market efficiency and real efficiency are not always aligned. The latter refers to the efficiency of the market in revealing information needed for decisions on the real side of the economy. Real efficiency is what the models here feature, based on an objective function developed from first principles. For a broader discussion, see **Bond, Edmans & Goldstein (2012)** and the distinction they make between forecasting pr ice efficiency and revelatory price efficiency.

4.1. Crowding-Out Effect and Optimal Disclosure Policy

The crowding-out effect reviewed in Section 3 suggests that disclosure can reduce the amount of private informati on in the price. Thus, if a firm manager tries to learn information from the price, the crowding-out effect tends to ha rm the manager's learning quality. However, as we reviewed in Section 2, disclosure can benefit the firm by lowerin g the cost of capital when information is exogenous. <u>Gao & Liang (2013)</u> study the resulting trade-off to examine th e optimal disclosure policy of a firm. We now present an extension of our CARA-normal setup that captures their tra de-off.

We extend the model in Section 3 to include another active player (the firm) and an intermediate date ($t = 1\frac{1}{2}$). We interpret the traded risky asset as the asset-in-place of a firm. The firm is endowed with information $\bar{s}_F = \bar{v} + \bar{\epsilon}_F$, wit $h \bar{\epsilon}_F \sim N(0, \tau_F^{-1})$ and $\tau_F > 0$. At the beginning of date 0, the firm chooses a disclosure policy that commits it to disclose a noisy version of \bar{s}_F to the financial market at date 1 in the following form:

$$\bar{y} = \bar{s}_F + \bar{\delta}$$
, with $\bar{\delta} \sim N(0, \tau_{\delta}^{-1})$ and $\tau_{\delta} \in [0, \infty]$. (12.)

All of the underlying random variables $(\bar{v}, \bar{\varepsilon}_F, \bar{\delta}, \{\bar{\varepsilon}_i\}_i, \bar{x})$ are mutually independent. We can rewrite \bar{y} in **Equation 12** in the form defined in **Equation 2** by defining $\bar{\eta} \equiv \bar{\varepsilon}_F + \bar{\delta}$, where $\bar{\eta} \sim N(0, \tau_{\eta}^{-1})$ with $\tau_{\eta} = (\tau^{-1} F^+ \tau^{-1} \delta)^{-1} \in [0, \tau_F]$. The parameter τ_{η} still controls the disclosure quality. In particular, when $\tau_{\eta}=0$, the firm does not disclose any information, and when $\tau_{\eta}=\tau_F$, the firm discloses its information \bar{s}_F without error.

The firm also has a growth opportunity whose productivity is related to \bar{v} . The firm invests in the growth opportuni ty at $t = 1\frac{1}{2}$, so it can look into the asset price \bar{p} to extract information about \bar{v} . The growth opportunity's cash flow \bar{G} is realized at date 2, and it takes the following form:

$$\bar{G} = \sqrt{\Phi}\bar{v}I - \frac{I^2}{2},$$

where *i* is the investment made by the firm at $t = 1\frac{1}{2}$ and the parameter $\Phi>0$ captures the size of the growth option. As in the work of **Subrahmanyam & Titman (1999)** and **Foucault & Gehrig (2008)**, we assume that the growth op portunity is separate from the asset-in-place and is nontradable, to keep the model tractable. In this extended econ omy, the firm makes two decisions: a disclosure-policy decision at *t*=0 and a real-investment decision at $t = 1\frac{1}{2}$. We assume that the firm is risk-neutral and cares about both the asset-in-place and the growth opportunity. To simplif y things relative to Section 3, we assume that private information acquisition does not incur a fixed cost and that o nly the variable cost function remains, for instance, $c_V(\tau_{\epsilon i})=(k/2)\tau^2_{\epsilon i}$, with k>0. All the other features of the model are the same.

The noisy REE in the financial market at date 1 is still characterized as in Section 2, and the information-acquisition equilibrium at date 0 is still characterized as in Section 3. We now examine the two decisions of the firm. At $t = 1\frac{1}{2}$, t he firm has an information set $\{\bar{s}_{\rm F}, \bar{p}, \bar{y}\} = \{\bar{s}_{\rm F}, \bar{s}_{p}\}$, where \bar{s}_{p} is the market signal given by **Equation 4**. The firm's opti mal investment policy maximizes the expected value of the growth opportunity in **Equation 13** given the informati on available, implying that $I(\bar{s}_{\rm F}, \bar{s}_{p}) = \sqrt{\Phi}E(\bar{v}|\bar{s}_{\rm F}, \bar{s}_{p})$. Inserting $I(\bar{s}_{\rm F}, \bar{s}_{p})$ back into the growth opportunity and taking t he unconditional expectation yields the expected growth value:

$$E(\bar{G}) = \frac{\Phi}{2} \left(\frac{1}{\tau_v} - \frac{1}{\tau_v + \tau_F + (\tau_\varepsilon/\gamma)^2 \tau_x} \right).$$
 14.

We can see that the expected growth value increases with the precision $(\tau_{\epsilon}/\gamma)^2 \tau_x$ of the price signal \bar{s}_p . This is a result of the feedback effect. The firm benefits from having more precise information in the price about the fundamental \bar{v} because then it can make a more efficient investment decision. By the crowding-out effect, additional disclosure lowers the precision τ_{ϵ} of private information produced and so makes the price signal \bar{s}_p less accurate. As a result, disclosure can harm the firm by reducing the value of the growth option.

At t=0, the firm chooses an optimal disclosure policy τ_{η} . Following Langberg & Sivaramakrishnan (2010), we assu me that the firm's objective at date 0 is a weighted average of the expected price of the asset-in-place and its expec ted growth opportunity value, $\alpha E(\bar{p}) + (1 - \alpha)E(\bar{G})$, with $\alpha \in (0, 1)$. (For instance, the firm is balancing the interests o f its short-term shareholders, who sell the shares at a price \bar{p} , and its long-term shareholders, who care about the fi rm's terminal cash flows $\bar{v} + \bar{G}$.) Here, the expected price $E(\bar{p})$ of the asset-in-place is derived from Equations 3 and 8, and the expected value of the growth option $E(\bar{G})$ is given by Equation 14. Then the optimal disclosure policy τ^{op} τ_{η} balances two forces. On the one hand, greater disclosure increases $E(\bar{p})$ by reducing the uncertainty faced by fin ancial-market traders, thus reducing the cost of capital they impose on the firm. $\underline{\mathcal{I}}$ On the other hand, greater disclos sure crowds out private information production and so deprives the firm of valuable information, thereby reducing the efficiency of its investment decision and the value of its growth option. As a result, one can show that when Φ/Q is relatively high, that is, when the firm's growth opportunity is large relative to its asset-in-place, the negative eff ect of disclosure dominates, and thus the firm chooses to disclose less. This model therefore implies that growth fir ms are endogenously more opaque than value firms.

4.2. Liquidity-Chasing Noise Trading

Another negative effect of disclosure on real efficiency is studied by <u>Han, Tang & Yang (2016)</u>. They follow the appr oach of modeling discretionary liquidity traders in the market microstructure literature (e.g., <u>Admati & Pfleiderer</u> <u>1988</u>, <u>Foster & Viswanathan 1990</u>) and show that greater disclosure attracts more noise trading. We now modify t he model presented in Section 4.1 to illustrate this mechanism. We shut down the information-acquisition activities of the CARA traders at date 0 and endow each of them with a p rivate signal \bar{s}_i with precision τ_{ϵ} . There is also a large mass of discretionary liquidity traders who are risk-neutral, un informed, and ex ante identical.⁸ These traders are discretionary in the sense that at date 0, each chooses whether to participate in the market at date 1 by optimally balancing the expected loss from trading against informed CARA traders versus an exogenous liquidity benefit *B* of market participation. If discretionary liquidity trader *l* decides to trade, this trader has to trade \bar{u} units of risky asset, where $\bar{u} \sim N(0, 1)$ and is perfectly correlated across liquidity trad ers. The equilibrium mass L^* of liquidity traders participating in the market determines the noise trading active in t he market: $\bar{x} \equiv L^*\bar{u}$ and $\tau^{-1}_{\ x} = L^{*2}$. All other features of the model in Section 4.1 are unchanged.

We now characterize the market participation equilibrium of discretionary liquidity traders at date 0. At that point, discretionary liquidity trader / faces the following trade-off. First, trading generates an exogenous benefit *B*>0, whic h represents the exogenous liquidity needs. Second, because liquidity traders are trading against informed CARA tr aders, they will incur endogenous trading losses on average. Then the expected utility of participating in the marke t for discretionary liquidity trader / is

$$W(L;\tau_{\eta}) = B + E[\bar{u} \cdot (\bar{v} - \bar{p})] = \underbrace{B}_{\text{liquidity benefit}} - \underbrace{p_x(L;\tau_{\eta}) \times L}_{\text{trading cost}}.$$
15.

Here, *l* is the mass of liquidity traders choosing to participate in the market and $p_X(L; \tau_\eta)$ is given by **Equation 8**, wit h $\tau^{-1}_{X} = L^2$. Note that, given market liquidity, expected trading losses are increasing in *l* because when more liquidit y traders participate, they exert stronger price pressure, given that they trade in the same direction. In equilibrium, an endogenous mass L^* of liquidity traders choose to participate in the market, while the rest choose not to. Henc e, L^* is determined by the indifference condition: $W(L^*; \tau_\eta)=0$.

Equation 15 shows that discretionary liquidity traders have incentives to chase market liquidity. That is, if a chang e in the trading environment improves market liquidity (i.e., p_X decreases), then, other things being equal, expecte d trading losses decrease and discretionary liquidity traders are more likely to participate in the market. As disclos ure promotes market liquidity, releasing public information induces more discretionary liquidity traders to choose to participate in the market; that is, $\partial L^*/\partial \tau_n > 0$.

Disclosure also affects real efficiency through affecting the firm's learning from the price. By observing the price \bar{p} , the firm obtains a signal \bar{s}_p with a precision (τ_{ϵ}/γ)² τ_x . Recall that in this economy, the precision of noise trading is g iven by $\tau_x = 1/L^{*2}$, which implies that the precision of the information in the price decreases as the level of disclosur e increases: $\partial[\tau_{\epsilon}/(\gamma L^*)]^2/\partial \tau_{\eta} < 0$. That is, more public information attracts additional liquidity trading and, as a resul t, the price reveals less fundamental information, thereby reducing real efficiency.

4.3. Multiple Dimensions of Disclosure

The models discussed in Sections 4.1 and 4.2 highlight the negative real-efficiency effects of disclosure. Two recent papers, by **Bond & Goldstein (2015)** and **Goldstein & Yang (2016)**, point out that in the presence of multiple dime nsions of information, the real-efficiency implications of disclosure might be different depending on what dimensi on of information is disclosed.

Bond & Goldstein (2015) show that a decision maker on the real side of the economy should disclose information about issues on which he or she knows more than the market and keep silent about issues on which he or she want s to learn from the market. Bond & Goldstein cast their idea in a trading model where the decision maker is the gov ernment, which makes an intervention decision. We now extend the baseline model in Section 2 to illustrate the m echanism. Suppose that the firm's cash flow \bar{v} at date 2 is given by $\bar{v} = T + \bar{v}_B$, where $\bar{v}_B \sim N(0, \tau_B^{-1})$ with $\tau_B > 0$. The c omponent *T* is the result of endogenous government intervention based on its private information and the asset pri ce \bar{p} . For example, one can think of the government bailouts of AIG and Citigroup in the recent financial crisis. Spec ifically, we add an additional date, $t = 1\frac{1}{2}$, at which the government chooses *T* to maximize

$$E\left[-\frac{(T-\bar{v}_A)^2}{2}+cT\,\big|\,\mathcal{I}_{\rm G}\right],$$

where $\bar{v}_A \sim N(0, \tau_A^{-1})$ (with $\tau_A > 0$), c > 0 is a constant, and \mathcal{I}_G is the government's information set. As discussed by **Bon <u>d & Goldstein (2015)</u>**, this objective function qualitatively captures many government motives, such as promoting social surplus and maintaining stability in the financial sector.

Note that in this setting, the asset cash flow \bar{v} is ultimately driven by two underlying random variables, \bar{v}_A and \bar{v}_B . We e assume that the government wants to learn from the market more about element \bar{v}_A than about element \bar{v}_B . For example, \bar{v}_A determines the benefit from intervention, as it reflects the spillover effect from an individual bank's fail ure, and this is something the government needs to learn about from the market. In contrast, \bar{v}_B is information about the bank's expected direct cash flows, which is information that the government has direct access to. For simplic ity, suppose that the government knows \bar{v}_B perfectly and only receives a private signal \bar{s}_G on \bar{v}_A , where $\bar{s}_G = \bar{v}_A + \bar{e}_G$ with $\bar{e}_G \sim N(0, \tau_G^{-1})$ and $\tau_G > 0$. Traders have private information on \bar{v}_A in the form of **Equation 1** but know nothing ab out \bar{v}_B . That is, trader *i* receives a signal $\bar{s}_i = \bar{v}_A + \bar{e}_i$ with $\bar{e}_i \sim N(0, \tau_e^{-1})$ and $\tau_E > 0$. So the asset price \bar{p} will aggregate private signals \bar{s}_i and convey information on \bar{v}_A . The government can use disclosure to affect the information-aggrega tion process of the price. Specifically, at date 1 before the financial market opens, the government discloses two pu blic signals, $\bar{y}_A = \bar{s}_G + \bar{\eta}_A$ and $\bar{y}_B = \bar{v}_B + \bar{\eta}_B$, where $\bar{\eta}_A \sim N(0, \tau_{\eta A}^{-1})$ (with $\tau_{\eta A} \in [0, \infty]$) and $\bar{\eta}_B \sim N(0, \tau_{\eta B}^{-1})$ (with $\tau_{\eta B} \in [0, \infty]$). All the underlying random variables ($\bar{v}_A, \bar{v}_B, \bar{e}_G, \bar{\eta}_A, \bar{\eta}_B, \{\bar{e}_I\}_I$) are mutually independent.

The price function in the financial market at date 1 takes the form $\bar{p} = p_0 + p_{yA}\bar{y}_A + p_{yB}\bar{y}_B + p_v\bar{v}_A + p_x\bar{x}$, where the p-coefficients are endogenous. At $t = 1\frac{1}{2}$, the government has an information set . To the government, the price is still equivalent to the signal \bar{s}_p as in **Equation 4**, i.e.,

$$\bar{s}_p = \frac{\bar{p} - p_0 - p_{yA}\bar{y}_A - p_{yB}\bar{y}_B}{p_v} = \bar{v}_A + \rho^{-1}\bar{x}, \text{ with } \rho = \frac{p_v}{p_x}.$$

Thus, the government's intervention policy is

$$T(\bar{s}_{G}, \bar{s}_{p}) = \arg \max_{T} E\left[-\frac{(T - \bar{v}_{A})^{2}}{2} + cT \left| \bar{s}_{G}, \bar{y}_{A}, \bar{y}_{B}, \bar{v}_{B}, \bar{p} \right] \right]$$

= $E(\bar{v}_{A} | \bar{s}_{G}, \bar{s}_{p}) + c = \frac{\tau_{G}}{\tau_{A} + \tau_{G} + \rho^{2}\tau_{x}} \bar{s}_{G} + \frac{\rho^{2}\tau_{x}}{\tau_{A} + \tau_{G} + \rho^{2}\tau_{x}} \bar{s}_{p} + c.$ (16)

The precision $\rho^2 \tau_X$ of signal \bar{s}_p still captures the extra information that the government learns from the market. As in Section 4.1, in equilibrium, the government's utility increases with precision $\rho^2 \tau_X$, as a higher $\rho^2 \tau_X$ means that the government is making a more informed intervention decision. In this sense, $\rho^2 \tau_X$ is a measure of real efficiency. Financial trader *i* has an information set { \bar{s}_i , \bar{y}_A , \bar{y}_B , \bar{p} }, which is equivalent to { \bar{s}_i , \bar{y}_A , \bar{y}_B , \bar{s}_p }. The CARA-normal setup i

mplies that trader is demand for the risky asset is

$$D(\bar{s}_i, \bar{y}_A, \bar{y}_B, \bar{p}) = \frac{E[T(\bar{s}_G, \bar{s}_p) + \bar{v}_B | \bar{s}_i, \bar{y}_A, \bar{y}_B, \bar{s}_p] - \bar{p}}{\gamma \operatorname{Var}[T(\bar{s}_G, \bar{s}_p) + \bar{v}_B | \bar{s}_i, \bar{y}_A, \bar{y}_B, \bar{s}_p]}.$$
17.

Using the expression for $T(\bar{s}_G, \bar{s}_p)$ in **Equation 16** and the market-clearing condition, $\int_0^1 D(\bar{s}_i, \bar{y}_A, \bar{y}_B, \bar{p}) di + \bar{x} = Q$, we can solve for \bar{p} in terms of $(\bar{y}_A, \bar{y}_B, \bar{v}_A, \bar{x})$. Comparing this solved price with the conjectured price function, we then for m a system in terms of the *p*-coefficients that characterizes the noisy REE in the financial market.

The key results can be summarized as follows: Disclosing information about \bar{v}_A harms the government through imp airing its learning quality from the price, whereas disclosing information about \bar{v}_B benefits the government. Intuitiv ely, consider the extreme cases where the government fully discloses one of the signals. (For intermediate cases, th e intuition is similar but more difficult to convey.) First, if the government fully discloses its signal on \bar{v}_A so that $\bar{y}_A = \bar{s}_G$ and $\tau_{\eta A} = \infty$, then $T(\bar{s}_G, \bar{s}_P)$ is perfectly known by financial traders, so they will no longer put any weight on th eir own private signals \bar{s}_i . As a result, the price does not aggregate \bar{s}_i anymore and the government learns nothing fr om the price. Effectively, there is a crowding-out effect, whereby disclosing information about something the trade rs know makes them trade less on this information and reduces the ability of the government to learn from their inf ormation. Interestingly, this crowding out does not operate through the incentives to produce information, as we s aw previously in this review, but through the ability to trade on existing information. It is captured by the numerato r of traders' demand function (**Equation 17**), as the availability of public information reduces the speculative value of their private information and causes them to trade less aggressively. Second, suppose that the government fully discloses its information on \bar{v}_B so that $\bar{y}_B = \bar{v}_B$ and $\tau_{\eta B} = \infty$. Then financial traders no longer need to forecast, which lowers the risk they face, making traders trade more aggressively on . This effect of reducing uncertainty, originati ng from the fact that traders are risk averse, is reflected by the denominator of their demand function (Equation 17), as the reduction in risk incentivizes them to trade more on their information. In consequence, the price will aggre gate more of traders' private information, benefiting the government's learning from the price.

The mechanism in the work of <u>Goldstein & Yang (2016)</u> is different and does not rely on risk aversion, as they stud y an environment in which all players are risk neutral. In their model, what matters for determining which informati on will be reflected by prices is the relative intensity at which agents trade on different pieces of information. Assu ming again two dimensions of information, which in the context of a regular firm could represent the demand for t he firm's products and the quality of its production technology, and assuming that agents have access to signals on both, Goldstein & Yang show that revealing more precise information on the dimension about which the firm alrea dy knows will cause traders to trade more aggressively on the dimension about which the firm wants to learn and will enable the firm to learn more from the price. The opposite will be true if more precise public information is rev ealed on what the firm is trying to learn; this will crowd out valuable private information from being incorporated i nto the price, reducing the firm's ability to learn from the price.

There is another important distinction in the work of **Goldstein & Yang (2016)** relative to the literature. In most mo dels discussed above, such as those of **Gao & Liang (2013)** and Bond & Goldstein (2016), public information is discl osed by the real decision maker, so the decision maker does not directly learn from the disclosed information. In so me scenarios, this may not be the case. For example, a firm manager can benefit directly from public information d isclosed by the government or by other agencies. In these scenarios, disclosure has both a direct effect of providing new information to the decision maker and an indirect effect of affecting price informativeness. The analysis of **Gol dstein & Yang (2016)** considers both effects. Paradoxically, for the reason discussed above, more disclosure about the variable that the real decision maker wants to learn can backfire, as it interferes with the ability of the market t o reveal this type of information, attenuating the positive direct effect of better disclosure. In cases where the mark et is very effective at processing information, the indirect effect can be stronger than the direct effect, implying that better disclosure can reduce the overall quality of information available to the decision maker and can harm real e fficiency, even though the decision maker directly learns from the public information.⁹

The analysis of multiple dimensions of information can be linked to the debate on the optimal disclosure of stress-t est results (for a survey, see **Goldstein & Sapra 2013**). Stress-test results are useful for regulators to make intervent ion decisions and for creditors to determine whether to roll over their debt or extend more credit to financial instit utions. However, one must keep in mind that disclosure of these results will crowd out information from the financi al market. Based on the papers described here, disclosure is undoubtedly beneficial when the stress-test result is a bout issues in which the regulator or creditors have a relative informational advantage over the financial market. H owever, when the stress-test result is about something that the regulator or creditors know relatively less than the f inancial market, disclosing such information makes market prices less informative, which can lead to negative effic iency outcomes.

5. INVESTORS' WELFARE

The previous section described the various effects of disclosure on the efficiency of real investment decisions. Anot her important issue that has to be considered in evaluating the effects of disclosure is the implications for the welfa re of traders in the financial market. As mentioned in Section 2, the usual argument invoked in favor of disclosure is that it improves market quality, which is perceived to have positive effects for investors in financial markets. Howe ver, as we discuss in this section, several models in the literature have shown that disclosure can have negative effe cts on investors' welfare. Hence, it is not always warranted to implement "investor protection" regulations that imp rove disclosure. In the next two subsections, we discuss two families of models that develop ideas along these line s.

5.1. Destruction of Trading Opportunities

The well-known <u>Hirshleifer (1971)</u> effect is a powerful argument against public disclosure of information. The idea is that when traders face idiosyncratic risks arising from, say, heterogeneous endowment shocks, public disclosure decreases welfare by reducing the risk-sharing opportunities available to traders. More recently, <u>Kurlat & Veldkam</u> <u>**p**(2015)</u> studied a related channel through which disclosure harms investors. In their setting, investors benefit wh en they have access to assets with a higher risk and a higher return, and these opportunities are eliminated by publ ic disclosure of information. The common theme of both channels is that disclosure harms investors through destr oying trading opportunities. We now extend the baseline model in Section 2 to illustrate these channels.

For the Hirshleifer effect to arise, we assume that traders trade to share risks rather than to speculate on private inf ormation. Specifically, we assume that at date 2, trader *i* receives an endowment of labor income, $\bar{q}_i \bar{v}$, where $\bar{q}_i \sim N(0, \sigma_q^2)$ with $\sigma_q \ge 0$, and \bar{q}_i is independent of \bar{v} and also independent across traders. When trading at date 1, tra der *i* knows his or her exposure \bar{q}_i to the risky asset but has no private information about the asset value . To simplif y things further, we assume that there are no noise traders in the model. The other features of the model are uncha nged, and, in particular, the public signal is still given by **Equation 2**. In this economy, trader *i*'s demand for the ris ky asset is

$$D_i(\bar{y}, \bar{p}) = \frac{E(\bar{v}|\bar{y}, \bar{p}) - \bar{p}}{\gamma \operatorname{Var}(\bar{v}|\bar{y}, \bar{p})} - \bar{q}_i.$$
18.

In **Equation 18**, the first term is the demand of a CARA trader without endowment shocks, who is attempting to ma ke a profit on the deviations of prices from the expected fundamental value, and the second term is the hedging ter m capturing trader *i*'s attempt to reduce the endowment risk. Combining **Equation 18** with the market-clearing co ndition, we can compute the asset price \vec{p} as

$$\bar{p} = E(\bar{v}|\bar{y}) - \gamma \operatorname{Var}(\bar{v}|\bar{y})Q.$$
19.

As there is no private information or noise trading, the price depends only on the public signal .

Inserting **Equation 18** into trader *i*'s objective function yields the indirect utility at the trading stage as follows:

$$U_i(\bar{y}, \bar{p}, \bar{q}_i) = -\exp\left(-\underbrace{\frac{[E(\bar{v}|\bar{y}) - \bar{p}]^2}{2\operatorname{Var}(\bar{v}|\bar{y})}}_{\text{trading gains}} - \gamma \underbrace{\bar{p}\bar{q}_i}_{\text{wealth}}\right).$$
20.

In **Equation 20**, the term $p\bar{q}_i$ captures the fact that each unit of labor income increases trader *i*'s wealth by the price \bar{p} of the risky asset, as it has the same cash flow as the risky asset. The term represents the benefit from trading the risky asset given the trading behavior in **Equation 18**. This term essentially captures the effect highlighted by **Kurla t & Veldkamp (2015)**.

We can use the certainty equivalent $CE \equiv -(1/\gamma) \log(-E[U_i(\bar{y}, \bar{p}, \bar{q}_i)])$ to study the ex ante utility of trader *i*. To formall y see the effect shown by **Kurlat & Veldkamp (2015)**, let us turn off the Hirshleifer effect by dropping traders' idios yncratic endowments and assuming that they simply trade the quantity put on the market by the issuer, that is, σ_q =0 and *Q*>0. Using **Equation 19**, the first term in the utility function in **Equation 20** can be expressed as

$$\frac{[E(\bar{v}|\bar{y}) - \bar{p}]^2}{2\text{Var}(\bar{v}|\bar{y})} = \frac{\gamma^2 Q^2}{2} \text{Var}(\bar{v}|\bar{y}) = \frac{\gamma^2 Q^2}{2} \frac{1}{\tau_v + \tau_\eta}.$$
21.

Then

$$CE = \frac{\gamma Q^2}{2} \frac{1}{\tau_v + \tau_\eta},$$

which decreases as disclosure quality τ_{η} increases. The intuition is as follows: Greater disclosure brings the asset pr ice closer to its fundamental, so traders cannot enjoy the benefit of trading a risky asset. In the limit, if \bar{y} perfectly re veals \bar{v} , then the risky asset becomes riskless, and traders lose all access to risk in their portfolio. The argument is v ery simple: If traders trade the risky asset in equilibrium, then we can infer that they derive utility from it, and this u tility is lost if we shut down risk by revealing the information publicly. Note that this model takes the perspective of the investors by pointing out that they could be made worse off by greater disclosure quality. One should remembe r that the issuer could be made better off by disclosure, for several reasons. For example, if the issuer is risk neutral and cares about the average selling price of the security, then, as discussed in Section 2.3.3, disclosure leads to a lo wer cost of capital, which in turn benefits the issuer. As the model is not a zero-sum game, in general the welfare lo ss of the investors and the welfare gain of the issuer do not cancel out.

Now let us turn off the effect of <u>Kurlat & Veldkamp (2015)</u> and demonstrate the Hirshleifer effect; that is, suppose that $\sigma_q > 0$ and Q=0. In this case, the asset is no longer provided by the issuer and traders trade among themselves t o hedge against their endowment shocks. We can compute

which again decreases with increasing τ_{η} . Intuitively, as traders are risk averse, they benefit from trading risk-shari ng contracts that insure against their exposure to idiosyncratic shocks. Disclosure reduces risk-sharing opportuniti es, as once the asset value is known, it is no longer possible to insure against its realization. The Hirshleifer effect suggests that disclosure is unambiguously bad. This is true when there is enough capital in ris k-sharing markets to allow them to work. However, this is not always the case. Consider, for example, the interbank market, which is used to share risk among banks. During the recent financial crisis, when aggregate conditions wer e bleak, this market was not able to function, as too many banks suffered shortages. This arguably led to market br eakdown. **Goldstein & Leitner (2015)** study a model to consider a trade-off between the negative Hirshleifer effect and a positive effect of disclosure to prevent market breakdown. They find that, in good times, disclosure is undesi rable because of the Hirshleifer effect. In bad times, however, some disclosure is necessary to get the risk-sharing market to work. They characterize optimal disclosure schemes in the spirit of the Bayesian persuasion literature fol lowing **Kamenica & Gentzkow (2011)**. Importantly, full disclosure is not desirable, and optimal disclosure is just e nough to restart the risk-sharing market by separating traders into different groups and excluding some of them fro m risk-sharing arrangements.

5.2. Coordination and Beauty Contests

Keynes (1936) argues that stock markets share the essence of a beauty contest because the actions of traders are governed not only by their expectations about the true value of traded assets, but also by their expectations about what other traders believe. There are many other environments, such as currency attacks or bank runs, in which ag ents have not only fundamental concerns but also strategic concerns. In these contexts, public disclosure provides more than just information about fundamentals, as it plays a coordination role of informing agents of what other a gents know and so helping each agent to predict the actions of others. This coordination role can be detrimental to efficiency and welfare in the sense that agents place too much weight on the public signal relative to weights that would be used by a social planner. In an example described by **Scharfstein & Stein (1990)**, investors' coordination that ot hers are following—but ends up harming the quality of investment and monitoring decisions.

The coordination mechanism and its general implications are best demonstrated by **Morris & Shin (2002)**. We now review their model. To keep consistency, we adopt similar notations as in our baseline model in Section 2. The und erlying state is given by , which is drawn from an improper uniform prior over the real line (i.e., $\tau_v = 0$). There is a continuum [0, 1] of agents. Agent *i* chooses action D_i , and we use **D** to denote the action profile over all agents. Agent *i* has access to both a private signal and a public signal \bar{y} , given by **Equations 1 and 2**, respectively.

In the work of **Morris & Shin (2002)**, the beauty-contest motive is directly built into agents' preferences. Specificall y, the utility for agent *i* is given by

$$u_i(\bar{v}, D) = -(1-b)(D_i - \bar{v})^2 - b(L_i - \bar{L}),$$

22.

where $b \in (0, 1)$ is a constant, $L_i = \int_0^1 (D_j - D_i)^2 dj$, and $\bar{L} = \int_0^1 L_j dj$. Hence, the agent has an incentive (with weight 1– b) to take an action close to the fundamentals (e.g., buy more of the asset when the fundamentals are high) and an incentive (with weight b) to take an action close to others' actions (e.g., buy when others are buying). Then the acti on taken by agent *i* is given by

$$D(\bar{s}_i, \bar{y}) = \arg\max_{D_i} E[u_i(\bar{v}, D) \mid \bar{s}_i, \bar{y}] = (1-b)E(\bar{v}|\bar{y}, \bar{s}_i) + bE(\bar{D}|\bar{y}, \bar{s}_i),$$
23.

where \bar{D} is the average action in the population, i.e., $\bar{D} = \int_0^1 D(\bar{s}_i, \bar{y}) di$. Hence, the agent makes a decision based on the expected level of the fundamental \bar{v} and the expectation of what other agents will do. Parameter *B* controls the intensity of the beauty-contest motive.

We consider an equilibrium in which each agent follows a linear strategy of the form $D(\bar{s}_i, \bar{y}) = \kappa_s \bar{s}_i + \kappa_y \bar{y}$, where $\kappa_s a$ nd κ_y are endogenous coefficients. Inserting this conjectured strategy into **Equation 23**, we can find the expression for $D(\bar{s}_i, \bar{y})$. We then compare coefficients in this computed expression with those in the conjectured linear strategy to compute κ_s and κ_y as follows:

$$\kappa_s = \frac{\tau_{\varepsilon}(1-b)}{\tau_{\varepsilon}(1-b) + \tau_{\eta}} \quad \text{and} \quad \kappa_y = \frac{\tau_{\eta}}{\tau_{\varepsilon}(1-b) + \tau_{\eta}}.$$
24.

When there is no beauty-contest motive (i.e., when b=0), the weight κ_y that is put on the public signal is based on t he precision of the two signals, as in Bayesian updating. When the beauty-contest motive arises and strengthens (i. e., when B>0 and increases), the weight κ_y on the public signal increases. The reason is that whereas both signals p rovide information about the fundamental, the public signal carries additional weight, given that it also provides in formation about what other agents know, and hence it helps in predicting their actions.

In the work of **Morris & Shin (2002)**, the excessive weight on the public signal harms social welfare, which is define d as the (normalized) average of individual utilities. By **Equation 22**, social welfare is

$$W(\bar{v}, \mathbf{D}) \equiv \frac{1}{1-b} \int_0^1 u_i(\bar{v}, \mathbf{D}) di = -\int_0^1 (D_i - \bar{v})^2 di.$$
 (25.)

A social planner would seek to keep all agents' actions close to \mathbf{v} . This is because the beauty-contest motive cancel s out across individuals and so does not affect social welfare. Thus, if the social planner can specify the weight that each agent puts on the public signal \mathbf{v} , that weight would be $\kappa^{opt}_{y} = \tau_{\eta}/(\tau_{\varepsilon} + \tau_{\eta})$, which is lower than the equilibrium weight κ_{y} on \mathbf{v} . Thus, the coordination role of public information is welfare reducing.

The implication is that greater disclosure might harm agents' welfare. Formally, using **Equations 24 and 25**, we can compute the expected welfare in equilibrium as

$$E[W(\vec{v}, \mathbf{D})|\vec{v}] = -\frac{\tau_{\eta} + \tau_{\varepsilon}(1-b)^2}{[\tau_{\eta} + \tau_{\varepsilon}(1-b)]^2}.$$

Direct computation shows that $E[W(\bar{v}, D)|\bar{v}]$ is U-shaped in the precision τ_{η} of public information. Intuitively, releasi ng public information has two effects on welfare. The positive effect stems from the informational role; that is, mor e public information helps agents to predict the state more accurately. The negative effect stems from the coordina tion role; that is, agents put too much weight on public information, and this is exacerbated when the public infor mation is more precise. The overall result is that when the public information is sufficiently coarse, the negative eff ect dominates, whereas when the public information is sufficiently accurate, the positive effect dominates. Hence, i ncreasing the precision of disclosure is desirable when disclosure is already quite precise.

We point out that the negative welfare effect of coordination is not general. It follows here because the beauty-cont est element in individual utility is of zero-sum nature. <u>Angeletos & Pavan (2007)</u> show that, in other settings, coor dination is socially valuable, so welfare necessarily increases with the precision of public information. One such ex ample is investment complementarity, in which the production of one firm positively depends on the aggregate pr oduction of all firms in the same industry. <u>Colombo, Femminis & Pavan (2014)</u> extend the work of <u>Angeletos & Pa</u> <u>van (2007)</u> to allow for endogenous acquisition of private information.

Although **Morris & Shin (2002)** take the beauty-contest motive as given, it is important to ask where this motive mi ght come from. After all, most traditional models of financial markets, built from first principles, do not necessarily predict that traders would like to do what other traders do. **Allen, Morris & Shin (2006)** and **Cespa & Vives (2015)** endogenize the beauty-contest motive using short horizons of financial traders. A short-horizon trader has to close his or her investment positions in an asset before its fundamental value is realized, so this trader's payoff depends on how much other traders would like to pay, rather than on how much he or she expects the fundamental value of the asset will be. As in the work of **Morris & Shin (2002)**, public information again plays two roles in affecting tradi ng: an informational role, because it conveys information about the unknown fundamental value, and a coordinati on role, because it is common to the information sets of all traders and helps a short-horizon trader to predict the f uture liquidation value when he or she closes positions.

Gao (2008) uses the setting of **Allen, Morris & Shin (2006)** to examine the implications of disclosure for market efficiency. The setting is an extension of our baseline model in Section 2, with one more date (*t*=0) and hence with two trading periods (*t*=0 and *t*=1). The risky asset still pays off at date 2. Traders' short horizons are characterized by an overlapping-generations assumption. **Gao (2008)** focuses his analysis on the implication of disclosure for market e fficiency at date 0. He shows that greater disclosure always drives stock prices closer to the fundamental value and hence improves market efficiency. The reason lies in an endogenous link between the two roles of public informati on in affecting the trading of date-0 traders. The coordination role occurs because short-horizon traders correctly b elieve in the first place that future traders will use public information because of its information value. When the inf ormation value becomes less, traders at date 0 overuse it less because they (again, correctly) believe that others will be using it less. Thus, the coordination role is always secondary to the informational role in terms of market efficiency in the setting of **Gao (2008)**. Note that this result does not directly speak to traders' welfare because, as we dis cuss in Section 5.1, a more informative price may actually harm traders.

<u>Goldstein, Ozdenoren & Yuan (2011)</u> endogenize the beauty-contest motive using a model in which the aggregate trading of currency speculators reveals new information to a central bank and affects its policy decision. The beaut y-contest motive arises in their setting because speculators know that a large speculative currency attack has the p

otential to convince the central bank that the fundamentals are weak, so each speculator would like to second-gue ss other speculators' actions to better coordinate. As a result, speculators put excessive weight on signals that are c orrelated with other speculators' information. In this setting, the central bank may inadvertently strengthen the co ordination motive by releasing more information that becomes common to speculators, which backfires by reduci ng the informational content that the central bank learns from the attack, leading the bank to make more policy mi stakes.

6. CONCLUSION

The analysis provided in this article demonstrates key insights from the literature on how information disclosure in financial markets affects market quality, information production, real efficiency, and traders' welfare. As the analys is shows, there are many aspects to consider when evaluating the effects of disclosure and the optimal regulation o f the level and form of disclosure. We have showed here how many of these effects can be manifested in a cohesive analytical framework that has proven useful in understanding trading and information in financial markets. As disc losure is being used more and more as a tool by regulators to increase market quality, it is important to consider its different implications. We hope that our review will be useful for researchers interested in advancing the theoretica l and empirical work in the area and for policy analysis as regulations of market disclosure continue to evolve.

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