

Analysts' Disclosures of Non-Fundamental Information

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Abstract

Existing studies document that analysts' opinions (e.g., recommendations or target prices) are informative on stock returns, even after controlling for accounting forecasts and despite relatively short forecasting horizons. This paper argues that sell-side analysts may acquire incidental information about the order flow that is related to short-term price movements, but unrelated to underlying firm value. We examine the optimal disclosure and pricing of this *non-fundamental* or *demand-based* information. Whereas a risk-neutral agent would never disclose value-relevant (fundamental) information, a risk-neutral analyst will disclose non-fundamental information; the more precise the information, the more widely it is released. The reason for this result is that disclosing information increases competition for the order flow and leads to higher price sensitivity: this in turn increases the value of the non-fundamental information at the expense of the value of the fundamental information. In the limit, a nearly perfectly precise non-fundamental information is released to an arbitrarily large number of investors for an arbitrarily low fee (i.e., almost-public disclosure). Further, analysts' reports are informative on stock movements, even though they do not contain information about long-term cash flows; specifically, we find that, in equilibrium, disclosure by analysts of this non-fundamental information does *not* contribute to greater price efficiency unlike disclosures of fundamental information.

1 Introduction

Sell-side analysts and the market for information have been the subject of an extensive literature. Academic research in accounting has focused on the ability of analysts to accurately forecast earnings and the effects of their reports on market prices. Yet, to the extent that analysts should use their superior ability to predict earnings to make their recommendations (Schipper 1991), the empirical evidence linking analysts' accounting forecasts to the price effect and long-term profitability of their recommendations is mixed.

Existing studies overwhelmingly support the hypothesis that analysts' opinions are informative on stock prices. Specifically, changes in analysts' recommendations or coverage affect stock returns (Walther 1997, Gleason and Lee 2003, Frankel, Kothari and Weber 2006, Ertimur, Sunder and Sunder 2007). Yet, other studies fail to map this information into (long-term) accounting forecasts that would be relevant for constructing a discount cash flow valuation model. Bradshaw (2002, 2004) find that analyst recommendations cannot be easily traced to present value methods - for example, Bradshaw finds that analysts' opinions is mostly explained by forecast of a long-term growth coefficient (essentially another term for an unexplained residual), and not by per-period earnings forecasts. Other studies document that analysts earnings forecasts seem to be imperfect in that they do not use all available information (Lys and Sohn 1990, Keane and Runkle 1998). Mikhail, Walther and Willis (1997) find that analysts' turnover is related to, not only forecast accuracy, but also the profitability of recommendations. Consistent with these ideas, Brav and Lehavy (2003) find that changes in analysts' target price, which in theory should have no additional explanatory power after controlling for earning forecasts, affect stock returns.

The superior ability of analysts to predict the cross-section of stock returns but limited ability to accurately predict long-term earnings is somewhat puzzling. If analysts were to have superior information about the fundamental value of the firm, one should be able to fully explain their informational hedge using their superior earnings forecasts, and thus recommendations and/or target prices should have no additional explanatory power.

This paper provides a rationale that can reconcile these facts, and discusses how much analysts would release information (and at which price) as well as implications for price efficiency. In our model, financial analysts may recommend stocks based on their beliefs or information about price movements that are unrelated to future earnings or cash flows, and that cannot be supported by reasonable fundamental analysis.¹ We argue in this paper that sell-side analysts, due to their position in a brokerage house that receives orders, are very likely to have superior information about short-term demand shocks.² Consistent with this information assumption, Lee (2001) writes “in making security selections. . . investors need to consider *the behavior of noise traders.*” This paper examines the optimal sale and pricing of non-fundamental information, or information on contemporaneous liquidity demand when the seller is risk-neutral.

Certain market participants are particularly likely to have access to demand-based information. For example, traders and sales teams collect orders, brokers provide investment advice to clients that may lead to demand for a security and investment bankers learn about demand for offerings during road shows.³ Research analysts may cull together the information from these groups to determine “market color, market sentiment, supply, prevailing prices or relative value of an issuer’s security.”⁴ Alternatively, analysts may have information which forms the basis for predictions about liquidity trade.⁵ Then, the anticipated liquidity demand is an informative signal, holding aside the news itself. In a market with privately-held value-relevant information, net demand affects the market price of the asset. Because the market maker cannot determine

¹For example, Henry Blodget forecasted that amazon.com would reach \$400 per share. When asked to justify his forecast he said “[the] assumptions are pretty loose and that putting faith in a specific dollar figure is extremely problematic. . . . Just blur your eyes and say I see a big future for these stocks.”

²Using the term of “analysts”, we have in mind here any participant of an investment bank who may distribute information for a fee. This includes security analysts who write analyst reports, but may also include Sales and Traders who distribute such reports selectively as a function of their own information about the market. Given that we model the financial intermediary as a single entity in this model, this distinction is moot in our theoretical framework.

³A well-known example is the failure of Long-term Capital Management (LTCM) in 1998. According to various testimonies collected in Lowenstein (2002), intermediaries trading with LTCM learnt about the fund’s short-term liquidity needs, trading against the fund’s portfolio. As the fund positions worsened, the fund’s managers were forced to release more information as an attempt to match offsetting trades (thus reducing margin calls) and receive a bridge loan or cash infusion.

⁴Remarks before the SIA Compliance and Legal Division Member Luncheon by Annette L. Nazareth, Director, Division of Market Regulation, U.S. Securities and Exchange Commission, New York City, NY, July 19, 2005

⁵For example, if an analyst foresees a firm missing its earnings targets, the analyst can forecast the (over-)response to that news. We thank Gus DeFranco and Stephannie Larocque for helpful discussions about analysts’ information sets.

the source of the demand, *uninformed* demand moves prices in a direction unrelated to the true value of the asset. Non-fundamental information allows the analysts and their clients who possess it to trade in the opposite direction, capturing some of the incorrect price movement created by uninformed trades.

Releasing non-fundamental information leads to greater competition which reduces the value of the signal to each individual in a standard way. However, competition over non-fundamental information has the offsetting effect of increasing the sensitivity of price to order flow, which *increases* the value of the signal. Our paper demonstrates that the optimal amount of distribution is strictly positive. In other words, analysts will always share their (non-fundamental) information with clients, and despite the distribution, the clients can trade on it profitably. The number of clients to whom the analyst sells information is increasing in the precision of the non-fundamental signal, and becomes arbitrarily large (i.e., equivalent to nearly-public disclosure) when the non-fundamental information is perfect.

Substantial demand-based trading reduces the value of fundamental (hereafter, proprietary) trading. Therefore, while fundamental information sharing would not occur in the absence of non-fundamental trading, a proprietary trader might be willing to provide fundamental information which would create conflicting revenue incentives for the analyst. To maximize profits from the fundamental information, the number of demand-based traders should be as low as possible whereas to maximize profits from non-fundamental information, the number of speculators may be high. The proprietary trader is never willing to give up his monopolist power for free, although the price at which he is willing to sell is decreasing in the analyst's information precision. We find that there is no set of parameters at which the analyst and proprietary trader can find a mutually acceptable sales price for the fundamental information. In fact, when the analyst's information is very precise, he is strictly better-off without access to the fundamental information.

We interpret our findings in the broader context of non-fundamental information circulation and financial services. Following Rule 10b5-1, regulators allow certain corporate insiders to pre-commit and, possibly, disclose in advance trades motivated by liquidity needs (Henderson,

Jagolinzer and Muller 2008). The SEC argued in a recent filing that sharing information about confidential institutional customer order flow allowed traders to take advantage of price movements caused by execution of these orders to the detriment of the institutional customers.⁶ If institutional trades are motivated by private information, front-running can certainly be detrimental to institutional traders. However, our model demonstrates that knowledge of large trades reduces costs for institutional traders transacting for liquidity motives. For example, J.P. Morgan Chase & Co. estimated there would be about \$100 billion in redemption requests for funds of funds in the fourth quarter of 2008. Redemption requests prompt order flow which is unrelated to future value, but which can be incorporated into sell-side analyst's recommendations. The results of our paper point to a complementarity between brokerage and information sales. Sell-side analysts may be in a better position to acquire non-fundamental information *if* they work for a firm that also provides brokerage services. They can, in turn, sell the information to clients who trade on it. Both the brokerage clients and the demand-based traders stand to benefit from the joint provision of services. Whether analysts disclose selectively to privileged clients has also been a source of contention. Information is priced so that demand-based traders are indifferent between receiving it and not receiving it. Our model provides settings in which selective disclosure is inferior to a wide distribution. Finally, our model speaks to issues of information flow within firms. If it is not optimal for the proprietary trading desk to exchange information with analysts in the firm, it is also not in the interest of the firm to require such exchanges to take place.⁷ This indicates that Chinese walls can arise endogenously within an organization.

Literature Review

Our paper is related to literature on the information content of analysts' forecasts. Stickel (1995) and Womack (1996) show that changes in analysts' recommendations are accompanied

⁶www.sec.gov/litigation/admin/33-8673.pdf

⁷For example, Lehman Brothers writes: The Strategic/Proprietary Trading desk leverages the Firm's capital to invest in the global markets. As a buy-side desk within a predominately sell-side Firm, this desk does not directly interact with Lehman Brothers clients. Instead, it relies on other sell-side firms in the market to provide incoming research and facilitate trade executions, acting like an internal hedge fund within the Firm.

by abnormal returns in the direction of the change, both on the announcement date and in the months thereafter. Barber, Lehavy, McNichols, and Trueman (2001) show that a hedge portfolio created using publicly available consensus forecasts leads to an average abnormal gross return of 75 basis points per month. If analysts information is fundamental alone, there should be no prospects for abnormal returns following public disclosure of recommendations. Lee (2001) reminds us that market prices are a product of the interplay between noise traders and rational arbitrageurs. Jegadeesh, Kim, Krische, and Lee (2004) demonstrates a correlation between recommendations and momentum. We take this set of evidence as an invitation to reconsider the basic assumption that analysts' recommendations are based on fundamental analysis alone.

Our approach also contributes to an existing analytical literature that focuses on the endogenous disclosure of information, and its effects on price informativeness. Previous papers in this area focus on voluntary public disclosures and the strategic aspects of non-disclosure (e.g., among others, Dye (1985), Penno (1987), Gigler and Hemmer (2001), Jorgensen and Kirchner (2003)). In a recent paper, Arya and Mittendorf (2007) show that analysts discipline management in providing more forecasts, thus releasing more information to their competitors and increasing overall welfare. Our approach differs from this literature in that we take as endogenous the number of clients to which the information is released (for a fee), while existing papers predominantly focus on public disclosures.

Another set of papers focus on the effect of various forms of disclosures on the trading decisions of informed agents (e.g., Baiman and Verrecchia (1996), Huddart, Hughes and Levine (2003), Bertomeu, Beyer and Dye (2008)). Huddart, Hughes and Brunnermeier (1999) show that exchanges competing to attract the order flow would, in equilibrium, choose regulations that require more disclosure. In a laboratory financial market, Bloomfield and Wilks (2000) find evidence supporting the idea that more information can offset some of the effect of liquidity demand shocks. In these models, the publicly released information can affect the pricing decision of the market maker.

In this paper, we borrow from several of these ideas. As in the endogenous voluntary disclosure literature, we derive the information-sharing decisions endogenously from the objectives of

a profit-maximizing financial intermediary. As in the literature that models the details of trading decisions, we study the effect of such information releases on price efficiency. We present several additional innovations. First, in our model, the intermediary can privately release the information to one or more investors, or publicly release the information (which we model as selling the information for an arbitrarily small fee). We show that the latter can be optimal (in the limit) when the precision of the information is large. Second, we primarily focus on non-fundamental information, while existing papers focus on information about the firm's cash flows.

2 The Model

We lay down the main ingredients and timeline of our model. There is a market for a single security, whose terminal cash flow is initially unknown. A proprietary trader (e.g., an insider or fund manager) receives a noisy signal on this security, and can post a trade. As in Kyle (1985), we assume that liquidity traders also post a trade for liquidity reasons. A financial intermediary (hereafter, “the analyst”) receives a noisy signal on the order flow originating from these liquidity traders. The intermediary publicly announces a fee at which this signal can be purchased. A set of competitive investors (hereafter, “the clients”) decide whether or not to buy the non-fundamental information, and then post a trade conditional on the signal. Finally, a competitive market-maker observes the total order flow (i.e., the sum of the orders of the proprietary trader, the liquidity traders and the clients) and competitively sets a price for the asset. All agents in our model are risk-neutral. By eliminating risk-sharing motives we can highlight other incentives for sharing information.

We state next the model in greater details. The market has a single risky security whose underlying (fundamental) value, denoted v , is a normally distributed random variable with mean zero and variance Σ . There are uninformed liquidity traders who have exogenously determined demand u , which is normally distributed with mean zero and variance σ_u^2 .

There are two types of information, fundamental and non-fundamental. Fundamental infor-

mation is a signal about the underlying asset value (v) and non-fundamental information is a signal about contemporaneous liquidity demand (u). We call the market participant who observes the fundamental signal the “proprietary trader” and the market participant who observes the non-fundamental signal the “analyst.” In order to focus on the essential aspects of the model, we make the modeling choice to assume that the analyst does not have fundamental information - which has the benefit of separating the information held by the proprietary trader and that held by the analyst; however the results can be shown to carry over to the alternative environment in which the analyst has fundamental information as well. The analyst can sell its information to a number of clients who then trade on the information. All traders submit market orders for shares and the market maker sets a price equal to the expected value of the asset conditional on the net order flow. All informed traders trade strategically, anticipating the impact of their trades on order flow and consequently on price.

The proprietary trader’s signal on fundamental value is $s = v + \eta$, where $\eta \sim N(0, \sigma^2)$. The analyst’s signal on current period’s liquidity demand is $\tau = u + \epsilon$, where $\epsilon \sim N(0, \sigma_\epsilon^2)$. The non-fundamental signal is an abstract representation of the activities of financial analysts that lead to superior knowledge about the demand for a security (e.g., road-shows, the analysis of various data feeds, relationships with institutional investors, orders over a squawk box, general market data, etc). The analyst charges c for access to the non-fundamental signal; m clients purchase the information, and we assume the clients cannot resell their information.

Each trader submits an order to the market maker who sets price equal to the conditional expected value of the asset. The proprietary trader’s demand function, X , will depend on his information s and the number of clients m ; a representative client’s demand function, Z , will depend his information τ and the total number of other clients of the analyst. Following convention, we denote actual demand of the proprietary trader and client, given realized information sets as $x \equiv X(s, m)$ and $z \equiv Z(\tau, m)$, respectively. The market maker then observes total order flow, $y = x + mz + u$, and the asset is traded according to the price schedule, $P(y)$, where the price is set so that the market maker’s expected profits conditional on y are zero.

The expectation of v given the noisy signal s is $E(v|s) = \Psi s$; the expectation of u given the

noisy signal τ is $E(u|\tau) = \theta\tau$, where

$$\Psi \equiv \Sigma/(\Sigma + \sigma^2) \quad \text{and} \quad \theta \equiv \sigma_u^2/(\sigma_u^2 + \sigma_\epsilon^2).$$

Hereafter, we refer to Ψ and θ as the precision of the fundamental and non-fundamental information, respectively.

Trading profits for all market participants are computed as the difference between price and intrinsic value multiplied by quantity (purchased or sold). A client's net profits are equal to his trading profits less analyst costs (c). The analyst's profits are the sum of all intermediation fees (or, $m \cdot c$). A financial market equilibrium is a set of trading rules that maximize traders' expected profits, given their information sets and the number of other market participants, and a pricing rule so that the market maker breaks even in expectation. To the standard financial market equilibrium, we add two additional conditions to define an information sharing equilibrium.

Definition: *An information sharing equilibrium (ISE) is a fee, an information purchase decision, and demand and pricing schedules such that*

- (A) *Purchase. There are exactly m^* clients willing to purchase at price c^* .*
- (B) *Optimal Sharing. The analyst's revenues are maximized at (c^*, m^*) .*
- (C) *Financial Market Equilibrium (FME). Demand and price schedules satisfy:*
 - (i) *Client profit maximization: For all trading strategies Z ,*

$$Z^* = \operatorname{argmax} E(\Pi_T(X^*, Z, P)|\tau, m),$$
 - (ii) *Proprietary trader profit maximization: For all trading strategies X ,*

$$X^* = \operatorname{argmax} E(\Pi_I(X, Z^*, P)|s, m) \quad \text{and,}$$
 - (iii) *Market efficiency: Price satisfies $P = E(v|y, m)$.*

Parts (A) and (B) together allow the analyst to extract all of the profits from his clients, leaving clients indifferent between purchasing and not purchasing information (i.e., they earn zero expected profits either way).⁸ Part (C) involves the trading decisions of all informed market

⁸Mikhail, Walther, and Willis (1997) find that analysts can produce profitable recommendations, but after accounting for transactions costs, returns are no longer reliably positive.

participants, who can trade against the liquidity demand.

We make several important additional remarks. First, we adopt the convention that the analyst does not trade, which is consistent with the observed separation between sell-side and buy-side analysts. However, for analytical purposes, this assumption is without loss of generality: if the analyst were to trade, then the information would have been sold to a price that would have induced $m^* - 1$ speculators, leaving the predictions of the model unchanged. Second, we assume that the price c at which the information is sold is public; given that the value of c is in a one-to-one mapping with the number of speculators buying the information (by the zero-profit condition), this is equivalent to assuming that the number of clients m is public - thus one can directly condition trading decisions in Part (C) on m . Third, as is common in entry games (here, the clients' purchase decision is analogous to an "entry" decision), we approximate the number of clients m as a continuous variable, although keeping in mind that, in practice, it may be lumpy and set as either the $[m]$ or $[m + 1]$ (where $[m]$ is the integer part) which should not affect our directional predictions.

3 Non-Fundamental Information Sharing

We solve for the optimal information sharing equilibrium by holding fixed the number of clients at arbitrary m and solving for a financial market equilibrium (Part (C) of the definition above). Then, we solve for the analyst's profit maximizing combination of intermediation fee and number of clients, (c^*, m^*) such that the value of information to a client is non-negative.

Financial Market Equilibrium

Suppose the market order of each type of informed trader is a linear function of his information. Then, with the normality of all random variables, the market maker's pricing function can be written as $P(y) = \lambda y$, where y is net order flow and λ represents the sensitivity of price to the order flow. Because the clients are identically informed, we can solve for the optimal linear trading strategy of a single client and scale up by the number of clients. Then, given the trading

strategies of the proprietary trader and demand-based traders, we solve for the market maker's breakeven pricing function.

Lemma 1 *With m demand-based traders and a single proprietary trader, there is a unique linear financial market equilibrium. Let $r_m = (m(m+2)(1-\theta)+1)/(m+1)^2$ and define constants β_m , γ_m and λ_m by $\beta_m = (\Psi r_m \sigma_u^2 / \Sigma)^{1/2}$, $\gamma_m = -\theta / (m+1)$, and $\lambda_m = (\Sigma \Psi / (4r_m \sigma_u^2))^{1/2}$. Then, equilibrium demand and price schedules are*

$$X_m^* = \beta_m s \quad Z_m^* = \gamma_m \tau \quad P_m^* = \lambda_m (x + mz + u)$$

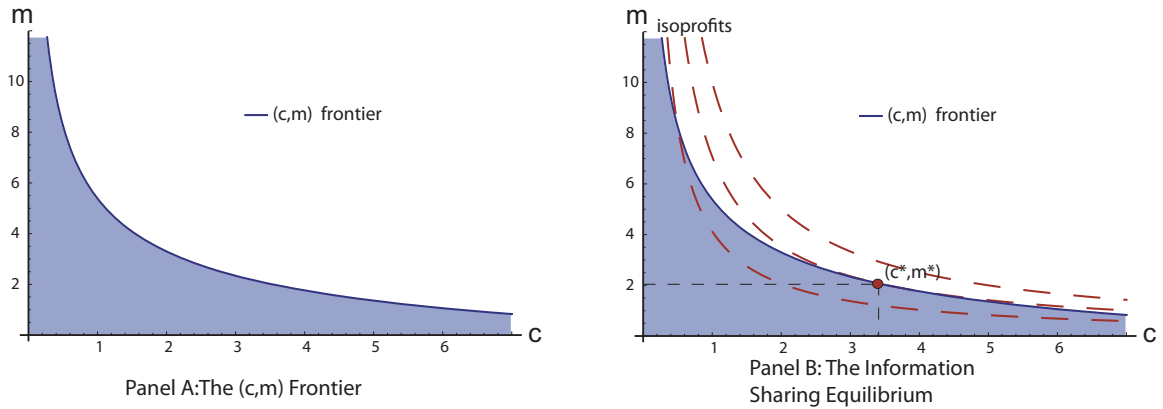
The analyst's clients each trade against the liquidity demand as one of an m -trader oligopoly. The sensitivity of the client's demand to the non-fundamental signal (τ) depends only on its accuracy, θ . The effect of demand-based trading is to reduce the liquidity available for the proprietary trader to exploit, and leads to a higher price sensitivity parameter, λ_m . To see this, consider the impact of m clients observing τ . Initially, the liquidity traders provide an order imbalance of u . Then, the clients trade $m\gamma\tau$ shares, driving order flow (in expectation) back towards zero. The residual liquidity variance, when there are m clients, is the variance of the net non-fundamental trades, calculated as

$$\text{Var}(u + m\gamma\tau) = \left(\frac{m(m+2)(1-\theta)+1}{(m+1)^2} \right) \sigma_u^2 \equiv r_m \sigma_u^2$$

and $r_m \leq 1$ for all $m \geq 1$. Since the market maker incorporates all of the sources (proprietary, demand-based, and liquidity traders) of order flow in calculating his conditional expectation, break-even prices are more sensitive to the order imbalance than they would be in the absence of speculation.

Price sensitivity is increasing in the precision of both fundamental and non-fundamental information and the number of informed clients. The proprietary desk's trading intensity on its signal (β_m) has the same relation to the exogenous parameters that it would in a model without demand-based trading, but original liquidity variance is replaced by *ex-post* variance. A large liquidity realization moves the price along the linear pricing function, but demand-based

Figure 1: Optimal Non-Fundamental Information Sales



trading reverses the move through trades in the opposite direction of the liquidity demand. The proprietary desk trades based on the remaining disguise (i.e., after netting liquidity and “anti-liquidity” trades). Consequently, total information content of prices does *not* increase with demand-based trading (i.e., more fundamental information is not revealed through trades), where information content is the inverse of the conditional variance of v , given price.

Observation 1: An analyst releasing non-fundamental information does not contribute to market price efficiency. Specifically, the information content of prices $Var(v|P) = \Sigma (1 - \frac{\phi}{2})$ does not depend on the number of clients m or the precision of the non-fundamental information.

Optimal Information Sales and Purchases

The larger the number of clients, the more each individual client must moderate his individual demand, reducing individual profits. However, there is a novel offsetting benefit to disclosure of non-fundamental information. Increasing the number of demand-based traders leads to an endogenous increase in price sensitivity that increases per unit non-fundamental trading profits.

The shaded region in Panel A of Figure 1 shows feasible combinations of fees and number of clients. At each combination (c, m) in that region, m clients would be willing to purchase the

information at fee c , using the financial market equilibrium price sensitivity for the particular number of clients. The solid boundary line is the (c, m) -frontier representing the largest fee the analyst can charge such that m clients are willing to purchase.⁹ The analyst chooses the fee along the frontier that maximizes its revenues. The profit maximizing fee, c^* , is on the analyst's iso-profit curve tangent to the (c, m) frontier (depicted in Panel B of Figure 1). The optimal fee is unique and the complete information sharing equilibrium is presented in Proposition 1.

Proposition 1

i. For $\theta \in (0, 1)$, there exists a unique information sharing equilibrium (ISE) where

$$0 = m^* (1 - m^* - m^{*2}) (1 - \theta) + 1$$

$$c^* = \frac{\theta (\Sigma \Psi r_{m^*} \sigma_u^2)^{\frac{1}{2}}}{2 (m^* (m^* + 2) (1 - \theta) + 1)}$$

and trading strategies and prices follow Lemma 1 at m^ .*

ii. The analyst always discloses his information, or $m^ > 1$.*

iii. The number of clients is increasing in the precision of the non-fundamental signal; if $\theta \rightarrow 1$, m^ is arbitrary large.*

Non-fundamental information is always shared whether or not the analyst trades directly on it.¹⁰ The analyst extracts the full non-fundamental trading surplus from all demand-based trading. The sale of non-fundamental information occurs without risk-sharing motives and without a reduction in the precision of the seller's information. Higher precision leads to greater distribution and higher expected profits; therefore an analyst has no incentives to add noise to the signal. Contrast this with the results on *fundamental* information-sharing. Admati and Pfleiderer (1988) show that a risk-neutral analyst would release its information to only one client, because additional sales would generate competition among clients which would always decrease surplus. Incorporating risk-aversion by the analysts, they show that information-sharing

⁹Equivalently, the frontier can be interpreted as the maximum number of clients m willing to purchase information at every given price c .

¹⁰The continuous approximation for m is important here, yet it is conceptually indicative that the model suggests some disclosure to be optimal. In practice, when m is set to be discrete, there may be small values of the precision such that $m^* = 1$ is preferred to $m^* = 2$.

is used to diversify away liquidity risk - an aspect that is very different in our model. Information disclosures caused by risk-aversion have also different implications. In the Admati-Pfeiderer framework, Garcia and Sangiorgi (2007) show that information owners add noise when selling to many clients (e.g., “newsletter” distribution) or sell to only a few clients precisely.¹¹

An increase in the precision of fundamental information (Ψ) is beneficial to both the proprietary desk and the analyst. Although the number of clients is independent of the fundamental information precision, the fee the analyst charges increases in Ψ . An increase in the precision of the non-fundamental signal (θ) increases the analyst’s profits at the expense of the proprietary desk. Although a proprietary desk acting as a monopolist in both fundamental and non-fundamental information would prefer perfect (to noisy) non-fundamental information, the opposite holds when the non-fundamental information is in the hands of an analyst who can share it. As non-fundamental precision increases, the number of clients gets large and the profits of the proprietary desk are driven down. In the limit, the number of clients would be infinite and the proprietary desk’s profits would be zero. If fundamental is held (and traded on) by a corporate insider, our results suggest that laws that prohibit insider trading become less essential when analysts provide non-fundamental information to a large set of clients. Under optimal non-fundamental sharing, the expected losses of liquidity traders are lower than they would be in a market without demand-based trading.¹²

4 Fundamental Information Exchange

When non-fundamental information is very precise, the resulting wide distribution of information will significantly reduce the proprietary desk’s profits. If the proprietary desk could find a

¹¹Further, risk-aversion motives fit only imperfectly the problem faced by most security analysts and fund managers. First, most sell-side analysts work for large firms, which are unlikely to be influenced by risk-sharing motives at the individual stock analyst level. In fact, we are not aware of any empirical study that relates the risk-sharing motives of a bank or its clients to the number and size of funds to which the analyst distributes information. Second, the risk due to a liquidity shock should be almost entirely diversifiable, and thus risk-aversion by investment funds is in direct contradiction with the basic asset pricing model and widely-used models of fund management (Huddart (1999), Berk and Green (2004)). Third, most large funds have their own buy-side analysts, but do not give access to the output of their analysts. If (their own) risk-aversion were to cause some benefits to sharing information, they should also sell their own research output.

¹²This is the endogenous m analog to the result in Taub and Bernhardt (2007).

way to change the analyst's incentives to distribute information, would it wish to do so? That is, suppose the proprietary desk shares fundamental information with the analyst. By doing so, it creates conflicting interests for the analyst. As before, the analyst wishes to profit on the non-fundamental information, but doing so has spillover effects on his ability to profit from the (newly acquired) fundamental information.

Lemma 2 *With m clients and two fundamentally informed traders (the proprietary desk and analyst), there is a unique linear financial market equilibrium. Defining constants $\hat{\beta}_m$, $\hat{\gamma}_m$ and $\hat{\lambda}_m$ by $\hat{\beta}_m = (\Psi r_m \sigma_u^2 / (2\Sigma))^{1/2}$, $\hat{\gamma}_m = -\theta / (m+1)$, and $\hat{\lambda}_m = (2\Sigma\Psi / (9r_m \sigma_u^2))^{1/2}$, equilibrium demand (for each trader with each type of information) and price schedules are*

$$\hat{X}_m = \hat{\beta}_m s \quad \hat{Z}_m = \hat{\gamma}_m \tau \quad \hat{P}_m = \hat{\lambda}_m (2x + mz + u), \quad (1)$$

In the financial market equilibrium, the proprietary desk and analyst act as duopolists in the fundamental information; the demand-based clients' demands are unaffected by the number of fundamentally informed traders. However, because prices are more sensitive to trades with increased competition in fundamental trading, the non-fundamental signal becomes more valuable.

Proposition 2

i. For $\theta \in (0, 1)$, there exists a unique information sharing equilibrium (ISE) where

$$\begin{aligned} 0 &= 1 - \hat{m}^2(3 + 2\hat{m})(1 - \theta) \\ \hat{c} &= \frac{\sqrt{2}\theta}{3} \frac{(\Sigma\Psi r_{\hat{m}} \sigma_u^2)^{\frac{1}{2}}}{(\hat{m}(\hat{m} + 2)(1 - \theta) + 1)} \end{aligned}$$

and trading strategies and prices follow Lemma 2 at \hat{m} .

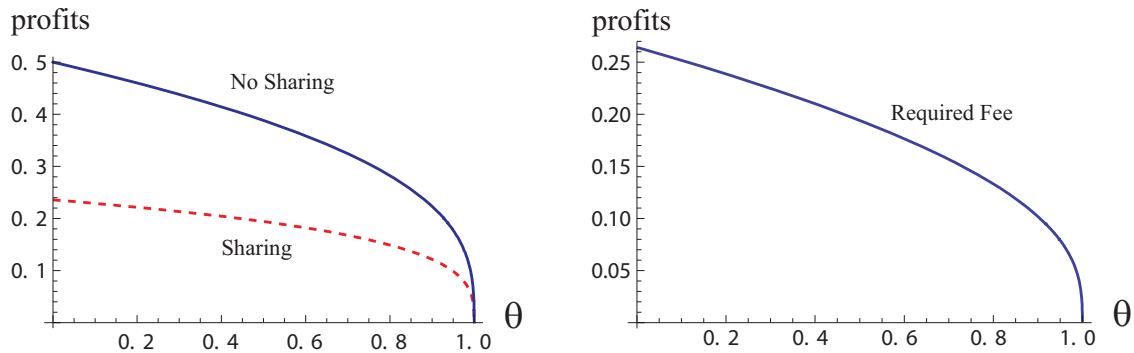
ii. Holding exogenous parameters constant, non-fundamental information is less widely sold when the analyst also has access to the fundamental signal ($\hat{m} \leq m^$).*

Possession of fundamental information indeed reduces the extent of distribution, and for imprecise non-fundamental information, the optimal number of clients may be less than one (i.e., no sharing). Although possessing the fundamental information induces the analyst to reduce the degree of distribution, the cost to the proprietary desk of the increased competition on the fundamental signal is too great, giving Corollary 1 below.

Corollary 1 *The proprietary desk's expected profits are lower with fundamental information sharing than without sharing for all combinations of exogenous parameters.*

Figure 2 graphs Corollary 1. The profit function for the proprietary desk labeled 'no sharing' is calculated using the optimal number of clients when the analyst does not possess fundamental information (m^*), and the profit function labeled 'sharing' is calculated using the optimal number of clients when the analyst has fundamental information (\hat{m}). The 'no sharing' profit curve is everywhere above the 'sharing' profit curve for all values of exogenous parameters. The required fee is increasing in the variance of underlying value and the precision of fundamental information.

Figure 2: Proprietary desk's profits: Shared Fundamental Information vs. No Sharing



If the proprietary desk could extract a portion of the analyst's fundamental trading profits in exchange for sharing his fundamental information, might it then be optimal to share?¹³ The

¹³An alternative way to think about the resource transfer from the analyst to the proprietary desk would be for the analyst to commit to sell to a smaller number of clients than is optimal in exchange for the information. Whether such commitments are feasible may be debatable, however we can imagine an unmodeled repeated relationship between the proprietary desk and analyst where a failure to stick to the agreed upon distribution would lead to no sharing in all subsequent periods.

difference between the ‘shared information’ and ‘no sharing’ curves determines the “required” fee, or the minimum transfer payment the proprietary desk would demand from the analyst in exchange for information, which we plot on the right hand side of Figure 2

Figure 3: Analyst’s profits: Shared Fundamental Information vs. No Sharing

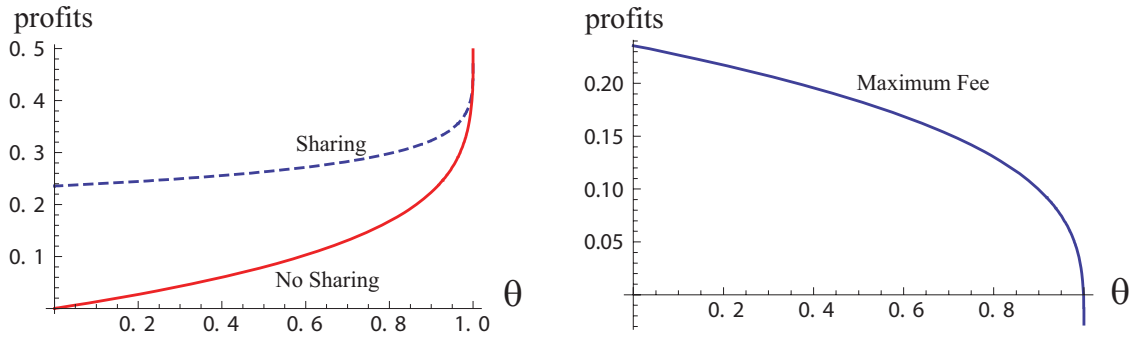
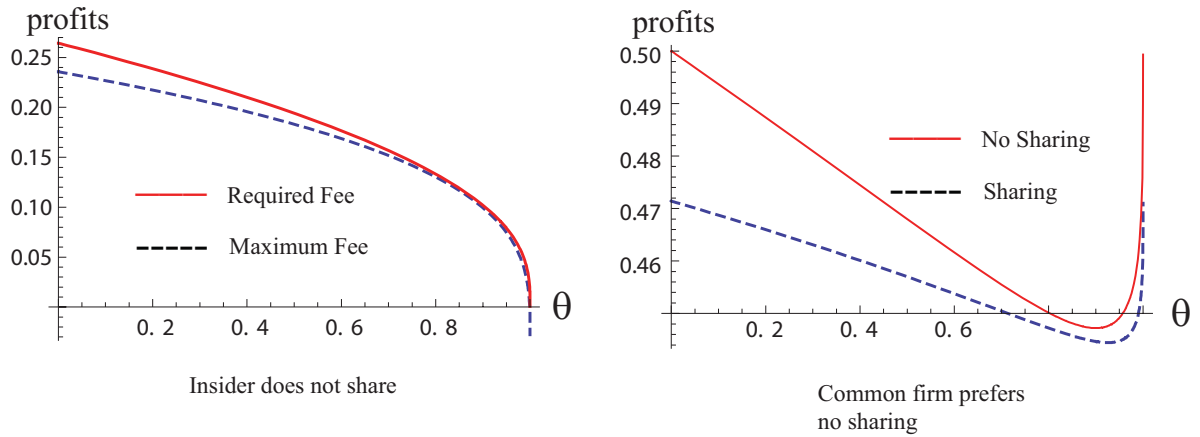


Figure 3 graphs the analyst’s profits under ‘no sharing’ and ‘sharing’ of *fundamental* information, assuming the proprietary desk provides the information for free. In possession of fundamental information, the analyst generates profits from both fundamental trading and the sale of non-fundamental information. Without fundamental information, the analyst’s profits are exclusively from the sale of non-fundamental information. We assume the analyst cannot resell fundamental information to other clients. The analyst’s profits with the fundamental information are actually lower than without it for high values of θ . Rather than pay for the information in these cases, the analyst would have to be paid to accept it. The difference between the two curves determines the analyst’s maximum willingness to pay for fundamental information, plotted on the right hand side of Figure 3.

The proprietary desk’s minimum willingness to sell price is everywhere above the analyst’s maximum willingness to pay (solid vs. dashed line, respectively on the left hand side of Figure 4). Therefore, the proprietary desk will never provide the analyst access to his private signal (part (a) of Proposition 3). Since the analyst and proprietary desk do not share fundamental information voluntarily, does this extend to information sharing within a firm? Suppose there is an integrated financial services firm that provides financial analysis, advisory services, investment banking, brokerage, etc. A common criticism of providing all of these services under one

Figure 4: Impossibility of Fundamental Sharing Equilibrium



roof is that it creates a conflict of interest: departments interact (e.g., share information) to benefit some clients at the expense of others. Suppose the integrated firm could force information sharing to either benefit the analyst (when θ is low) or the proprietary desk (when θ is high). Part (b) of Proposition 3 shows that the integrated firm will never encourage sharing among groups.

Proposition 3

- i. *If the price sensitivity is consistent with the number of fundamentally informed traders, there is no fee at which both the proprietary desk is willing to sell his fundamental information and the analyst is willing to buy it.*
- ii. *If the analyst and proprietary desk work for separate divisions in a common firm, overall firm profits cannot be enhanced by sharing fundamental information.*

To see this, Figure 4 plots the sum of the analyst and proprietary desk's profits with (solid line) and without (dashed line) sharing. Notice that the profits of the overall firm are higher without sharing. This suggests a natural division among groups in the firm. Without spending the time and energy associated with erecting a Chinese wall, this is a setting where one would, *de facto*, arise endogenously. However, the market maker must believe in the efficiency of the Chinese wall (i.e., information flows can genuinely be avoided when it is beneficial for the firm).

If the absence of a formal Chinese wall was taken as prima facie evidence that information leakage (sharing) would occur, it would be self fulfilling; the proprietary desk would indeed share its information as long as $\theta > 0.502$. Therefore, to ensure the preferred equilibrium, explicit Chinese walls may be arise even in the absence of regulation requiring them.

5 Conclusion

This paper analyzes the sale of non-fundamental information by a single analyst to clients who can trade on that information in a Kyle (1985) market. The analysis highlights the differences between fundamental and non-fundamental information. While a single, risk neutral agent with fundamental information always prefers to be a monopolist, an individual with non-fundamental information increases the information's value by sharing it. The demand-based traders issue orders in the opposite direction of noise traders, driving expected order flow towards zero and reducing the variance of the disguise for proprietary trading. Order imbalances are more likely to come from the proprietary desk possessing fundamental information, leading to an increase in price sensitivity. With more sensitive prices, demand-based traders can better capitalize on incorrect price swings stemming from liquidity trades.

In our model, the analyst, who possesses non-fundamental information, extracts the total surplus from his clients. With this feature, the optimal number of clients is always greater than one. The more precise the non-fundamental information, the more widely it is sold. The analyst has no incentives to add noise or distort his signals, as lower precision reduces clients' willingness to purchase.

Proprietary desks in our model are strictly worse off with an analyst who possesses and optimally sells his information to clients than in a market absent demand-based trading. Despite the costs of demand-based trading, the proprietary desk will not offer analysts its fundamental information in order to limit the analyst's desire to sell non-fundamental information. The reduction in the number of clients the analyst is willing to offer is insufficient to compensate the proprietary desk for competition on the fundamental signal.

Our results suggest complementarities between services in a financial services firm despite often heard criticism that they lead to conflicts of interest. By offering brokerage services, analysts gain access to non-fundamental information, which can be subsequently sold to potential clients. While this may reduce the value of proprietary desk trading, such a reduction would occur as long as there is demand-based trading (i.e., regardless of if it occurs within the firm itself). Because a firm with divisions producing (or gaining access to) both fundamental and non-fundamental will not increase its overall value by sharing within the firm, naturally arising limits to intra-firm information flow are possible.

Proof of Lemma 1: Suppose for constants β_m, γ_m and λ_m , linear functions X, Z and P are given by

$$X_m = \beta_m s \quad Z_m = \gamma_m \tau \quad P_m = \lambda_m y$$

Given the linear rules, the proprietary desk and a single informed client choose X_m and Z_m to maximize profits, that can be written as

$$\begin{aligned} E\{(v - P_m)X_m|s, m\} &= E(\beta s(v - \lambda(\beta s + m\gamma\tau + u))|s) = E(\beta v^2 - \lambda\beta^2 s^2) \\ E\{(v - P_m)Z_m|\tau, m\} &= E(\gamma\tau(v - \lambda(\beta s + \gamma\tau + (m-1)\bar{\gamma}\tau + u))|\tau) \\ &= E(-\lambda\gamma^2\tau^2 - \lambda\bar{\gamma}\gamma\tau^2 - \lambda\gamma u^2) \end{aligned}$$

where $\bar{\gamma}$ is the trading strategy of each of the other $m-1$ clients. Taking first order conditions and replacing $\bar{\gamma}$ with γ since all clients are identical, we have

$$\beta_m = \frac{\Psi}{2\lambda_m} \quad \text{and} \quad \gamma_m = -\frac{\theta}{m+1}. \quad (\text{A-1})$$

$P = \lambda_m y = E\{v|y\}$ implies

$$\lambda_m = \frac{\beta_m \Sigma}{\beta_m^2 \Sigma / \Psi + \sigma_u^2 \left(\frac{m^2 \gamma_m^2}{\theta} + 2m\gamma_m + 1 \right)}. \quad (\text{A-2})$$

Solving Equations A-1 and A-2 subject to the second order condition $\lambda_m > 0$ gives the equilibrium.

□

Proof of Proposition 1: The *ex-ante* profit of an individual client in a market with a total of m clients, $\pi_{S,NF}$ is:

$$\pi_{S,NF} = \frac{\gamma_m \left(-\gamma_m \lambda - \left(\frac{(m-1)\gamma_m}{\theta} + 1 \right) \theta \lambda \right) \sigma_u^2}{\theta} \quad (\text{A-3})$$

Replacing the expression of γ_m and simplifying

$$\pi_{S,NF} = \frac{\theta \lambda \sigma_u^2}{(m+1)^2} \quad (\text{A-4})$$

An informed client is indifferent between buying and not buying information at c :

$$c = \frac{\theta \lambda \sigma_u^2}{(m+1)^2} \quad (\text{A-5})$$

Replacing λ by λ_m , we get

$$c_m = \frac{\theta}{2(m+1)} \left(\frac{\Sigma \Psi \sigma_u^2}{m(m+2)(1-\theta) + 1} \right)^{\frac{1}{2}} \quad (\text{A-6})$$

The analyst's profits are equal to $\pi_{B,NF} = mc_m$. To maximize its profits we endogenize the

number of clients. We take the FOC of $\pi_{B,NF}$ in m :

$$\frac{(m(1-m-m^2)(1-\theta)+1)\theta\sqrt{\Sigma\Psi\sigma_u^2}}{2(m+1)^2(m(m+2)(1-\theta)+1)^{3/2}} = 0 \quad (\text{A-7})$$

Therefore m^* and c^* are implicitly defined by the following equations:

$$0 = m^* (1 - m^* - m^{*2}) (1 - \theta) + 1 \quad (\text{A-8})$$

$$c^* = \frac{\theta}{2(m^* + 1)} \left(\frac{\Sigma\Psi\sigma_u^2}{r_{m^*}} \right)^{\frac{1}{2}} \quad (\text{A-9})$$

Write equation (A-8) as $\Gamma(\theta, m^*) = 0$ where

$$\Gamma(\theta, m) = m(1 - m - m^2)(1 - \theta) + 1.$$

$\Gamma(\theta, m)$ is a polynomial expression of degree three with domain $m \in [0, +\infty)$ and ranges from 1 to $-\infty$. Therefore there exists a unique real solution to $\Gamma(\theta, m^*) = 0$. Thus there exists a unique function $\Delta(\theta)$ such that $m^* = \Delta(\theta)$.

- $\Delta(0)$ solves $\Gamma(0, \Delta(0)) = 0$ or $(1 - \Delta(0))(\Delta(0) + 1)^2 = 0$, which gives $\Delta(0) = 1$.
- $\forall m, \lim_{\theta \rightarrow 1} \pi_{B,NF} = \frac{m}{2(m+1)} (\Sigma\Psi\sigma_u^2)^{\frac{1}{2}}$, which is increasing in m ; thus the profit is maximized at $m \rightarrow \infty$.

Applying the implicit function theorem,

$$\begin{aligned} \Delta'(\theta) &= -\frac{\partial\Gamma}{\partial\theta}(\theta, m) / \frac{\partial\Gamma}{\partial m}(\theta, m) \\ &= \frac{m(-m^2 - m + 1)}{(-3m^2 - 2m + 1)(1 - \theta)} \end{aligned}$$

Given equation (A-8), $(-m^2 - m + 1) < 0$ and also $(-3m^2 - 2m + 1) < 0$. Therefore $\Delta'(\theta)$ is positive and m^* is increasing in θ .

□

Proof of Proposition 2: From Lemma 2, the price sensitivity with two fundamentally informed traders and m clients is equal to

$$\lambda_m = \frac{\sqrt{2}(m+1)}{3} \left(\frac{\Sigma\Psi}{(m(m+2)(1-\theta)+1)\sigma_u^2} \right)^{\frac{1}{2}}$$

As before, to make an informed client indifferent between buying the information and not having it, we set

$$\begin{aligned} c &= \frac{\theta\lambda\sigma_u^2}{(m+1)^2} \\ &= \frac{\sqrt{2}\theta}{3(m+1)} \left(\frac{\Sigma\Psi\sigma_u^2}{m(m+2)(1-\theta)+1} \right)^{\frac{1}{2}} \end{aligned}$$

Taking the FOC of the analyst's non-fundamental profits, mc_m , with respect to m :

$$\frac{(1-m^2(2m+3)(1-\theta))\theta\Sigma\sigma_u\Psi}{3\sqrt{2}((m+1)^3-m(m+1)(m+2)\theta)^2 \sqrt{\frac{\Sigma\Psi}{m(m+2)(1-\theta)+1}}} = 0 \quad (\text{A-10})$$

Therefore the optimal number of clients, \hat{m} , and fees, \hat{c} , are implicitly defined by the following equation:

$$0 = \hat{m}(-\hat{m}-\hat{m}^2+1)(1-\theta)+1-\hat{m}(\hat{m}+1)^2(1-\theta) \quad (\text{A-11})$$

$$\hat{c} = \frac{\sqrt{2}\theta}{3(\hat{m}+1)} \left(\frac{\Sigma\Psi\sigma_u^2}{\hat{m}(\hat{m}+2)(1-\theta)+1} \right)^{\frac{1}{2}} \quad (\text{A-12})$$

Write equation (A-11) as $\hat{\Gamma}(\theta, \hat{m}) = 0$ where

$$\hat{\Gamma}(\theta, m) = m(1-m-m^2)(1-\theta)+1-m(m+1)^2(1-\theta).$$

$\hat{\Gamma}(\theta, m)$ is a polynomial of degree three decreasing with domain $m \in (0, +\infty)$ and ranges from 1 to $-\infty$. Thus, there is a unique real solution given by A-11 such that $\hat{m} = \hat{\Delta}(\theta)$.

- $\hat{\Delta}(0)$ solves $\hat{\Gamma}(0, \hat{\Delta}(0)) = 0$ or $1 - \hat{\Delta}(0)^2(2\hat{\Delta}(0) + 3) = 0$, which gives $\hat{\Delta}(0) = 1/2$.
- $\forall m, \lim_{\theta \rightarrow 1} \pi_{B,NF} = \frac{(2m+1)}{3\sqrt{2}(m+1)} (\Sigma\Psi\sigma_u^2)^{\frac{1}{2}}$, which is increasing in m ; the optimal m is infinite.

$\hat{\Gamma}(\theta, m)$ is decreasing in m . At $m = m^*$, $\hat{\Gamma}(\theta, m^*) = -m^*(m^*+1)^2(1-\theta) < 0$ and at $m = \hat{m}$, $\hat{\Gamma}(\theta, \hat{m}) = 0$ respectively by equations (A-8) and (A-11). Thus $\hat{\Gamma}(\theta, m^*) < \hat{\Gamma}(\theta, \hat{m})$ and $\hat{m} \leq m^*$.

□

Proof of Proposition 3: The maximum fee the proprietary desk can extract from the analyst is

$$\bar{f} = \pi_{B,NF}(\hat{m}) + \pi_{I,F}(\hat{m}) - \pi_{B,NF}(m^*).$$

Simple comparison shows $\pi_{I,F}(m^*) > \pi_{I,F}(\hat{m}) + \bar{f}$.

Since $\pi_{B,NF}(m^*) + \pi_{I,F}(m^*) > \pi_{B,NF}(\hat{m}) + 2\pi_{I,F}(\hat{m})$, interdivisional sharing cannot increase overall profits.

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