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The Strategic Timing of Corporate Disclosures

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An important element of a firm's disclosure strategy is the timing of its mandatory public announcements. In this article, two aspects of disclosure timing are examined. The first is the intraday timing of earnings announcements. It is demonstrated here that, under reasonable conditions, market prices reflect better the valuation implications of an earnings announcement when it is made during trading hours rather than after the market has closed. This implies that managers should prefer to release earnings with positive (negative) implications for firm value during (after) trading hours. The second issue examined is the sequencing of multiple corporate disclosures. It is shown that if the announcements have positive (negative) implications for firm value, managers should prefer to make them separately (simultaneously), as market prices better reflect the valuation implications of multiple announcements when they are made at different times.

Corporate managers and academics have become increasingly aware of the potential impact corporate disclosure strategies can have on firm value.[1] One

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[1] See Lev (1992) for a detailed discussion of corporate reporting strategies.

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of the important elements of such strategies is the timing of mandatory corporate announcements. The goal of this article is to examine two aspects of disclosure timing and to provide an understanding of the forces that interact in producing an optimal reporting strategy. This article's analysis is framed in terms of earnings announcements; however, it could equally well be applied to any value-relevant mandatory disclosures.

The first issue that is examined is the intraday timing of corporate earnings announcements. A basic result derived in this context is that the market's reaction to an earnings announcement will depend on the time of day at which the disclosure is made. In particular, the impact of the disclosure is expected to be stronger if it occurs during trading hours rather than after the market has closed.

There are two assumptions underlying this result. The first is that knowledge of the firm's current earnings provides insights into its future profitability. The second is that the firm's manager, along with a subset of traders who closely follow the firm, are better able to make predictions about future profitability from current earnings than are other traders. The extent to which the postannouncement price set by the firm's market-maker reflects the information of these informed traders is determined by the market-maker's ability to discern from the postannouncement order flow the magnitude and direction of informed trading. His ability to do so, however, will be lessened to the extent that the order flow also includes orders from noise traders or from traders who are reacting to other disclosures. Trading that occurs subsequent to an earnings announcement made after the market has closed is more likely to include such orders than is trading subsequent to a release during trading hours. This is because, in the former case, postannouncement trading does not take place until the next market opening; consequently, there is more time for orders from noise traders to accumulate as well as for other announcements having an impact on firm value to occur. As a result, the postannouncement price is less likely to reflect the information of the informed traders if the earnings disclosure is made after the market has closed.

This is shown to imply that, under reasonable conditions, a manager with the objective of maximizing the firm's postannouncement price will have an incentive to disclose the firm's earnings during (after) trading hours if their implications for future profitability are more (less) favorable than is believed by less informed traders.[2] With managers following this strategy, it is predicted that the average price

[2] As should be clear, this means that the timing of the earning announcement itself will also provide a signal (albeit imperfect) to the market-maker of the manager's private information. This aspect is formally incorporated into the analysis in Section 2.

change subsequent to announcements made during trading hours will be more positive than the price change subsequent to disclosures made after the market has closed. Such a result has been documented empirically by Patell and Wolfson (1982) and confirmed by Francis, Pagach, and Stephan (1992). It is also consistent with the empirical finding in Damodaran (1989) that the average price change for firms making earnings announcements is negative on the day after the announcement (which is when the market reacts to the disclosures made after trading hours).[3] As shown below, Patell and Wolfson's finding is also predicted to hold *if the level of reported earnings is held constant.* A related theoretical result appears in Easley and O'Hara (1992), where the timing of trades reveals information to the market-maker.

The explanation provided here for why managers with unfavorable earnings news have an incentive to delay the earnings announcement until after the market close is also appealing because of its consistency with conventional wisdom. It has often been suggested in the popular press that managers delay the announcement of bad news until after trading hours because they believe that the subsequent price reaction will be less extreme. One reason that had been offered for this expectation is that an announcement after the close gives traders more time to evaluate the impact of the earnings report before trading. The analysis here confirms conventional wisdom's expectation of a less extreme price reaction to a disclosure after trading hours. However, the reason is not that traders have more time to digest the news, but rather, that the market-maker is less able to discern the valuation implications from postannouncement trading.

The second issue that is examined here is whether a manager in possession of two pieces of information, one of which is the firm's earnings, would prefer to announce them simultaneously or separately. Such a decision is often faced by a manager at the time of the earnings disclosure because he is likely to also have information about future cash and stock dividends and upcoming stock splits. The factors considered by the manager in making this decision are shown to be similar to those involved in intraday announcement timing. It is demonstrated that the manager would prefer to make the earnings announcement separately from (simultaneously with) the other disclosure if the earnings have more (less) favorable implications for the firm's future probability than is believed by less informed traders.

Previous research on managerial disclosures has, for the most part, focused on the question of whether a manager should voluntarily re-

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[3] Damodaran finds his empirical results to be stronger for announcements made on Fridays. This is not surprising, given the evidence in Patell and Wolfson that a higher proportion of Friday earnings announcements occur after the close (when they are more likely to reflect bad news).

lease information, rather than on the timing of mandatory disclosures.[4] Verrecchia (1983), for example, examines the manager's disclosure decision in the presence of fixed disclosure costs, while Dye (1985) considers this decision in a setting where investors are uncertain whether the manager is in possession of private information. Both Darrough and Stoughton (1990) and Feltham and Xie (1992) examine the disclosure decision when competitors exist in a firm's product market. Finally, Diamond (1985) and Indjejikian (1991) consider optimal disclosure precision in a setting where investors collect their own private information.

The plan of this article is as follows. In Section 1 the economic setting is described. This is followed by an analysis of the share price formation process in Section 2 and the intraday timing decision in Section 3. Equilibrium timing strategies are described in Section 4. In Section 5 the issue of simultaneous versus sequential disclosure of announcements is explored. The article concludes with a summary in Section 6.

1. Economic Setting

Consider a two-period economy in which risk-neutral, perfectly competitive investors trade shares of a risky firm and a riskfree asset.[5] Without loss of generality, the riskfree rate of return is set equal to zero. The return on the risky firm is assumed to come solely in the form of a liquidating dividend, paid at the end of period 2. This dividend is equal to the sum of the firm's earnings over the two periods. As will become clear shortly, it is convenient to separate the earnings of each period t, e_t, into two parts, denoted by f_t and m_t. The component f_t can take one of two possible values, denoted by f_H and f_L, where $f_H > f_L$ and $\Delta f \equiv f_H - f_L$. The component m_t can also assume one of two possible values, denoted by m_H and m_L, where $m_H > m_L$ and $\Delta m \equiv m_H - m_L$. Without loss of generality, the random variables f_t and m_t are assumed to be independent of each other, with ex ante expectations of zero.

At the end of the first period, the manager of the firm learns the value of the firm's first-period earnings, e_1 (along with the components f_1 and m_1). He is required to publicly disclose the value of e_1 in period 2.[6] The manager, however, has some discretion over the timing of the

[4] One exception is Trueman (1990) who considers the timing of earnings announcements across firms.

[5] Allowing for more than one risky firm in the economy would not affect the analysis.

[6] For the subsequent analysis it is not necessary to make any explicit assumption about whether the earnings announcement provides traders enough information to learn the values of f_1 and m_1.

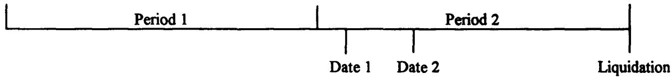

Figure 1
Time line of events
First-period earnings are announced at either date 1 or date 2. An additional disclosure is made at date 2. Trading occurs at both dates 1 and 2, subsequent to any announcements.

earnings release. He is allowed to make the disclosure at either of two dates early in period 2, labeled 1 and 2.[7] Regardless of when the manager announces the firm's earnings, there is an additional information arrival at date 2, originating outside of the firm, which also has valuation implications. Subsequent to any disclosures at each of the two dates, trading takes place in both the firm's shares and the riskless asset. The sequence of events in this economy is depicted in Figure 1.

Given the manager's position as an insider in the firm, he is assumed able to use his knowledge of first-period earnings to make more precise predictions for the earnings of period 2 than are most traders in the market. Specifically, he can perfectly infer the value of f_2. [A manager whose inference is that f_2 equals $f_H(f_L)$ will sometimes be referred to as an H-type (L-type) manager.] Along with the manager, there is a set of N_f informed traders, such as security analysts, whose superior knowledge of the firm also allows them to infer the value of f_2 once the earnings are released. These traders will be referred to below as the f-informed traders. All other traders in the market are only able to use knowledge of e_1 to revise their assessment of the probability that f_2 equals f_H to π_f, where $0 < \pi_f < 1$. (The dependence of π_f on e_1 is suppressed for notational simplicity.) The earnings realization does not provide the manager or any traders with information about m_2.[8]

The second announcement, occurring at date 2, provides information about the component, m_2, of period 2's earnings. Again, given the manager's position in the firm, he is assumed to be able to use this information to perfectly infer the value of m_2. A set of N_m informed traders, distinct from the f-informed traders, are able, like the manager, to precisely infer the value of m_2 from this second announcement.[9]

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[7] It is not necessary for the manager to disclose period 2's earnings since the firm is liquidated at the end of that period.

[8] Given that f_2 can be predicted from current earnings, but m_2 cannot, it is reasonable to interpret $f_2(m_2)$ as the permanent (transitory) component of earnings.

[9] Allowing for some overlap in these two sets of informed investors would not affect the nature of the results to be presented below.

These traders will be referred to below as the m-informed traders. All other traders are only able to use this disclosure to update their assessment of the probability that m_2 equals m_H to π_m, where $0 < \pi_m < 1$. As will become clear from the analysis below, the important feature of this second announcement is that it adds variability to the date 2 order flow that is not present at date 1.

Each of the informed traders begins period 2 owning no shares in the firm and is allowed to place an order at each of dates 1 and 2 to buy or sell one share. However, each informed trader is constrained to hold (or to have a short position of) at most one share at any time.[10,11] In the ensuing analysis, N_f is assumed to be greater than or equal to N_m while Δf is assumed to be at least as large as Δm. Together, these assumptions capture the notion that an earnings announcement is expected, in general, to have a greater impact on informed traders' assessment of future earnings than does another announcement originating outside the firm.[12]

A risk-neutral, perfectly competitive market-maker sets the market price of the firm in trading at each date equal to his expectation of total earnings, $e_1 + e_2$. As shown below, his expectation is a function of the announcements made during the period, the timing of the first-period earnings disclosure, and the order flow at each date.

This order flow consists of the demand (or supply) of shares from both informed traders (as specified above) and liquidity traders. Let $B^i(S^i)$ denote the total volume of orders to buy (sell) shares at date i, $i = 1$ or 2. Further, let the volume of buy orders from liquidity traders at date i of period 2 be denoted by B^i_u and the volume of sell orders be given by S^i_u. B_u and S_u are assumed to be independently and exponentially distributed, and independent of any information or market prices.[13,14] Consequently, the density functions of B^i_u and

[10] This assumption is meant to capture the notion that limits exist on the shareholdings of any informed trader due to risk aversion, institutional constraints, or other considerations.

[11] Allowing an informed trader to buy or sell more than one share opens up the possibility that he will place a larger order at the time of the earnings release if it is made at date 2 rather than at date 1. This is because the date 2 order flow is noisier, due to the presence of the second announcement. However, as long as the informativeness of the postannouncement order flow (and, consequently, of the postannouncement price) remains less for a disclosure at date 2 than for one at date 1, the nature of this article's results will not be affected. Such a result is consistent with Grossman and Stiglitz (1980) who show that, for a fixed number of informed traders, the greater the exogenous level of noise, the less informative the market price.

[12] Dropping the assumption that $N_f \geq N_m$ would not affect the results of this analysis. However, the results do depend on the assumption that Δf is at least as large as Δm. As will be clear below, the relative magnitudes of Δf and Δm are important in determining whether the H-type manager has an incentive to time his firm's earnings release so that the firm's share price better reflects his favorable private information.

[13] Jackson (1991) makes a similar assumption in his work on fully revealing rational expectations equilibria.

[14] It is expected that those liquidity traders who have discretion over the timing of their trades

S_u^i, denoted $g(\cdot)$ and $h(\cdot)$, respectively, take the forms $g(B_u^i) = a \cdot \exp(-aB_u^i)$ and $h(S_u^i) = a \cdot \exp(-aS_u^i)$, where a is a parameter greater than zero. The exponential distribution has the property that larger levels of liquidity demand (or supply) are less likely to occur than are smaller levels. It also has other appealing mathematical properties, as will become apparent in Section 2.[15]

The firm's manager is assumed to be either strategic or nonstrategic. A strategic manager is one who chooses the announcement date for first-period earnings so as to maximize his expectation of the firm's market price at the end of the earnings disclosure window, date 2. Incentives for a manager to focus on the firm's postearnings announcement price, rather than on the liquidating value of the firm, can arise if he expects that the firm will need to issue new shares before the end of period 2 or if he holds some stock options that will expire before the end of the period. (As discussed below, the postannouncement market price prevails until the end of the second period, when the firm's liquidating dividend is revealed. Consequently, this manager could, more generally, be thought of as one who is concerned with the firm's market price at some, unspecified, point prior to liquidation.) Let $\alpha_H(\alpha_L)$ denote the probability that such a manager discloses earnings at date 2 conditional on knowledge that f_2 equals $f_H(f_L)$. As shown below, this probability is endogenously determined by the manager in equilibrium according to the criterion that it maximize his objective function, given the assumption that the market-maker correctly anticipates his choice. In the analysis below $\alpha_H^c(\alpha_L^c)$ will represent the market-maker's conjecture of the probability that an H-type (L-type) strategic manager discloses the firm's earnings at date 2. The probability that the manager is strategic is given by π_s, where $0 < \pi_s < 1$.

would not submit orders at the time of an earnings announcement, since they would be trading with informed traders. The liquidity traders who do trade in this model would, therefore, be thought of as those who do not have such discretion (or who simply do not take timing into consideration). While the density functions for liquidity demand and supply reflect the assumption that the distribution of this nondiscretionary liquidity trading volume is independent of the timing of the earnings announcement, it is reasonable to expect a greater volume subsequent to a date 2 disclosure. As discussed below, such volume represents trading at the beginning of the day and so is more likely to capture the trading decisions of liquidity traders made during the entire period when the market was closed. Allowing for higher volume at date 2 would only serve to strengthen the results of this article.

[15] The economic setting of this article clearly differs significantly from that commonly employed in noisy rational expectations models, where signals and order flows are assumed to be normally distributed random variables. The need to depart from such a setting arises because of the fact that disclosure timing provides information that is used by the market-maker to value the firm. As a consequence, the market-maker's posterior distribution for firm value would deviate from normality, making an analysis in the traditional setting mathematically intractable.

With probability $(1 - \pi_s)$ the manager does not strategically time the earnings announcement. Nonstrategic behavior will arise under (at least) two sets of circumstances. One is if the manager strictly adheres to the requirement of the stock exchanges and NASDAQ that information be released in a timely manner. In such a case he will disclose his firm's earnings report as soon as it is prepared, regardless of whether it results in a disclosure during or after trading hours. Alternatively, nonstrategic behavior will arise if the manager's objective is to maximize the firm's earnings, or equivalently, its liquidating value, rather than its market price at some intermediate point during the second period.[16] A nonstrategic manager reports earnings at date 2 with an exogenous probability of α_{ns}, where $0 < \alpha_{ns} < 1$.[17] Investors are assumed not to know whether the manager is strategic.

Before proceeding with the formal analysis, it is useful to note that the manager's decision over whether to release earnings at date 1 or date 2 can be interpreted as a decision over whether to make the announcement during or after trading hours. The distinguishing feature of an earnings announcement made after the close is that informed traders cannot react to it until the opening of the following day's trading. Because of this, postannouncement trading activity subsequent to such a disclosure is more likely to include trades that are motivated by other events, unrelated to the earnings release, than is a disclosure during trading hours.[18] Consequently, in this setting an announcement of earnings at date 1 (when there are no other disclosures) can be thought of as representing a release during trading hours, while an earnings announcement at date 2 (which is accompanied by another informative disclosure) would be analogous to a release while the market is closed.

2. Price Formation

As mentioned previously, the risk-neutral market-maker sets the firm's market price at date i of period 2, $i = 1$ or 2, equal to his expectation at that time of the firm's liquidating dividend, taking into account the total volume of buy and sell orders and the timing of the earnings

[16] The determination of the firm's earnings, however, is exogenous to the analysis of this article.

[17] The effect of dropping the assumption that some managers are nonstrategic is discussed in Section 4.1.

[18] Consistent with this statement, Jain and Joh (1988) report that the standard deviation of trading volume on the NYSE is significantly higher during the first hour of trading than during any other hour of the trading day.

announcement.[19,20] Denote the market price set by the market-maker at date i, given that he observes B^i and S^i and given that the earnings are disclosed at date 1 (date 2) by $P^i(1, B^i, S^i)[P^i(2, B^i, S^i)]$.[21] In order to derive these prices, the trading rule of the informed traders must first be specified. Informed traders are assumed to submit market orders. These traders being risk-neutral and perfectly competitive, will each place an order to buy (sell) one share at date i if his expectation for the liquidating dividend, conditional on his information, is greater (less) than his expectation for the price to be set by the market-maker at that date.[22] It is straightforward to show that this trading strategy implies that an f-informed trader will purchase (sell) one share at the time of the earnings announcement if he observes that f_2 is equal to $f_H(f_L)$ while an m-informed trader will purchase (sell) one share at date 2, after the second disclosure, if he observes that m_2 is equal to $m_H(m_L)$.[23] By doing so, the informed trader makes a positive expected profit on his trade.[24]

2.1 Earnings disclosure at date 1

Consider, first, the prices set by the market-maker if the manager discloses earnings at date 1. In this case, N_f informed traders learn the value of f_2 prior to trading at date 1. As was discussed above, if f_2 equals $f_H(f_L)$, then the total demand for (supply of) shares by the f-informed traders at date 1 equals N_f. Aware that the informed traders are acting in this manner, the market-maker can infer that f_2 equals f_H if the total volume of sell orders at date 1, S^1, is less than N_f, since such an order flow can only arise if the informed traders placed buy orders. Similarly, if the total volume of buy orders at date 1, B^1, is less than N_f, the market-maker can infer that f_2 equals f_L.

If both B^1 and S^1 are greater than or equal to N_f, however, the

[19] The assumption that the market-maker observes only the aggregate demand for and supply of shares is similar to that employed by Kyle (1985). Making the alternative assumption that the market-maker observes individual orders, as in Glosten and Milgrom (1985), renders the analysis more complicated but does not affect the results.

[20] Note that the market-maker learns the timing of the earnings announcement at date 1 even if there is no disclosure at that date. This is because the absence of a disclosure implies that the earnings announcement will occur at date 2 with certainty.

[21] While suppressed for the sake of simplicity, the date 2 market price also depends on the order flow at date 1.

[22] This trading rule is subject to the constraint that each informed trader hold (or sell short) at most one share.

[23] If an f-informed trader were allowed to hold (have a short position of) more than one share, then, conditional on a date 1 earnings announcement and the observation that $f_2 = f_H(f_L)$, he might desire to purchase (sell) shares at both dates 1 and 2.

[24] This can be verified by comparing the equilibrium prices set by the market-maker at each date, specified below, with each informed trader's expectation of the firm's liquidating dividend.

market-maker cannot infer the value of f_2 with certainty from the order flow. Using Bayes' rule, the market-maker's assessment of the probability that f_2 equals f_H is calculated as follows:

$$\begin{aligned}
&\text{prob}(f_H|\text{earnings disclosure at date 1}, B^1, S^1 \geq N_f) \\
&= \frac{\text{prob}(B^1, S^1 \geq N_f | f_2 = f_H)\pi_f^1}{\text{prob}(B^1, S^1 \geq N_f | f_2 = f_H)\pi_f^1 + \text{prob}(B^1, S^1 \geq N_f | f_2 = f_L)(1 - \pi_f^1)} \quad (1) \\
&= \frac{\text{prob}(B_u^1 \geq 0;\ S_u^1 \geq N_f)\pi_f^1}{\text{prob}(B_u^1 \geq 0;\ S_u^1 \geq N_f)\pi_f^1 + \text{prob}(B_u^1 \geq N_f;\ S_u^1 \geq 0)(1 - \pi_f^1)}, \quad (2)
\end{aligned}$$

where π_f^i denotes the market-maker's posterior assessment of the probability that f_2 equals f_H, based solely on his observation of an earnings announcement at date i, $i = 1$ or 2.[25,26] It is straightforward to show that $\text{prob}(B_u^1 \geq 0;\ S_u^1 \geq N_f) = \text{prob}(B_u^1 \geq N_f;\ S_u^1 \geq 0)$, so that Equation (2) reduces to π_f^1. When both total demand and total supply are greater than or equal to N_f and liquidity demand and supply are exponentially distributed with the same value for the parameter a, the order flow does not provide the market-maker with any additional information with which to revise his assessment of the probability that f_2 equals f_H. It remains equal to π_f^1. This is an appealing property of the exponential distribution, as it significantly simplifies the analysis.

Using these results, the price set by the market-maker at date 1 is given by the following expressions:

$$\begin{aligned}
P^1(1, B^1, S^1) &= e_1 + f_L + \pi_f^1 \Delta f, && \text{if } B^1, S^1 \geq N_f, && (3) \\
&= e_1 + f_H, && \text{if } S^1 < N_f, && (4) \\
&= e_1 + f_L, && \text{if } B^1 < N_f. && (5)
\end{aligned}$$

As reflected in Equations (3) through (5), the price at date 1 is equal to the sum of period 1's earnings plus the earnings for period 2. The expected value of e_2, in turn, is just equal to the market-maker's revised expectation for f_2. (The market-maker's expectation for m_2

[25] Using Bayes' rule, the expression for π_f^i is given by

$$\frac{\text{prob}\,(\text{disclose at } i|f_2 = f_H)\pi_f}{\text{prob}\,(\text{disclose at } i|f_2 = f_H)\pi_f + \text{prob}\,(\text{disclose at } i|f_2 = f_L)(1 - \pi_f)}.$$

[26] The market-maker cannot use the timing of the earnings announcement to update his expectation for the value of m_2 since the manager's timing decision is made before the manager learns the value of m_2.

remains equal to zero since he does not update his beliefs about m_2 at date 1.)

Proceeding in an analogous fashion, the market price at date 2 is derived. It is given by the following expressions:

$$P^2(1, B^2, S^2) = P^1(1, B^1, S^1) + m_L + \pi_m \Delta m, \qquad \text{if } B^2, S^2 \geq N_m, \quad (6)$$
$$P^2(1, B^2, S^2) = P^1(1, B^1, S^1) + m_H, \qquad \text{if } S^2 < N_m, \quad (7)$$
$$P^2(1, B^2, S^2) = P^1(1, B^1, S^1) + m_L, \qquad \text{if } B^2 < N_m. \quad (8)$$

(Note that the f-informed traders have already traded on their information at date 1 and, since they are not privately informed about m_2, do not trade again at date 2.)

2.2 Earnings disclosure at date 2

Consider, now, the price set by the market-maker if the manager discloses the firm's earnings at date 2. Since there is no disclosure at date 1, the order flow at that time does not include informed demand or supply and so does not provide the market-maker with information about next period's earnings. However, the date 2 order flow does give the market-maker information. In this case, though, the market-maker's inference problem is more complicated because the order flow reflects the demand and supply of both the f-informed as well as the m-informed traders.

To understand the price-setting process at date 2, refer to Figure 2, which divides the feasible combinations of total demand, B^2, and total supply, S^2, into ten regions.

It is straightforward to derive the date 2 market price for an order flow that falls within cells 1, 3, 6, or 10 because, in such cases, the market-maker perfectly infers the values of f_2 and m_2. To illustrate how the price is determined in each of the other regions, consider cell 5. Given that liquidity demand is exponentially distributed, it is easy to show, using Bayes' rule, that the probability of f_2 equalling f_H and that of m_2 equalling m_L is $\pi_f^2(1-\pi_m)/[\pi_f^2(1-\pi_m)+(1-\pi_f^2)\pi_m]$. This is equal to the probability of f_H and m_L occurring, conditional only on knowledge that either f_H, m_L or f_L, m_H will occur. This implies that the specific values for B^2 and S^2 within the cell do not provide any additional information to the market-maker. It is straightforward to show that this is true for all regions in which the order flow does not perfectly reveal the values of f_2 and m_2. With this insight, it is simple to calculate the date 2 market price for each region i, denoted

S^2 \ B^2	0	N_m	N_f	N_m+N_f
0	NA	NA	NA	f_H, m_H 10
N_m	NA	NA	f_H, m_L 6	f_H, m_H or f_H, m_L 9
N_f	NA	f_L, m_H 3	f_L, m_H or f_H, m_L 5	not f_L, m_L 8
N_m+N_f	f_L, m_L 1	f_L, m_H or f_L, m_L 2	not f_H, m_H 4	any combination 7

Figure 2
Possible values for the components of second-period earnings as a function of the order flow
Total demand at date 2, B^2, increases from left to right; total supply at date 2, S^2, increases from top to bottom. The letters NA inside a cell indicate that the range of demand and supply in that cell cannot occur. The number in the lower right-hand corner of each of the other cells is an identifying number for that cell. Also inside each of those cells the combinations of values for f_2 and m_2 that are consistent with that cell's demand and supply region are listed. Each cell is inclusive of its left and top borders but is exclusive of its right and bottom borders.

by P_i^2. They are given as follows:

$$P_1^2 = e_1 + f_L + m_L,$$

$$P_2^2 = e_1 + f_L + m_L + \pi_m \Delta m,$$

$$P_3^2 = e_1 + f_L + m_H,$$

$$P_4^2 = e_1 + \frac{\begin{array}{c}\pi_f^2(1-\pi_m)(f_H + m_L) + (1-\pi_f^2)\pi_m(f_L + m_H) \\ +(1-\pi_f^2)(1-\pi_m)(f_L + m_L)\end{array}}{\pi_f^2(1-\pi_m) + (1-\pi_f^2)\pi_m + (1-\pi_f^2)(1-\pi_m)},$$

$$P_5^2 = e_1 + \frac{(1-\pi_f^2)\pi_m(f_L + m_H) + \pi_f^2(1-\pi_m)(f_H + m_L)}{(1-\pi_f^2)\pi_m + \pi_f^2(1-\pi_m)},$$

$$P_6^2 = e_1 + f_H + m_L,$$

$$P_7^2 = e_1 + f_L + \pi_f^2 \Delta f + m_L + \pi_m \Delta m,$$

$$P_8^2 = e_1 + \frac{\begin{array}{c}\pi_f^2\pi_m(f_H + m_H) + \pi_f^2(1-\pi_m)(f_H + m_L) \\ +(1-\pi_f^2)\pi_m(f_L + m_H)\end{array}}{\pi_f^2\pi_m + \pi_f^2(1-\pi_m) + (1-\pi_f^2)\pi_m},$$

$$P_9^2 = e_1 + f_H + m_L + \pi_m \Delta m,$$

$$P_{10}^2 = e_1 + f_H + m_H.$$

3. The Earnings Announcement Timing Decision

In this section the earnings announcement timing decision of a strategic manager is analyzed. Recall that his objective is to maximize his expectation of the date 2 market value of the firm. His decision is made at date 1, after learning the value of the firm's first-period earnings, and the value of f_2, but before any trading. The manager's expectation is taken over all possible realizations of total demand and supply at dates 1 and 2 and over the possible realizations of m_2.

Part A of the Appendix contains the derivation of this expectation for an i-type manager, conditional both on an earnings disclosure at date 1, denoted by $E_i[P^2(1,\cdot,\cdot)]$, and on a disclosure at date 2, denoted by $E_i[P^2(2,\cdot,\cdot)]$. The difference between $E_i[P^2(1,\cdot,\cdot)]$ and $E_i[P^2(2,\cdot,\cdot)]$, denoted by ΔP_i and representing the expected increase in the date 2 price resulting from an earnings release at date 1 rather than at date 2, is given as follows:

$$\begin{aligned}\Delta P_H &= (\pi_f^1 - \pi_f^2)\exp(-aN_f)\Delta f + \exp(-aN_f)\\ &\quad\times[1-\exp(-aN_m)]\cdot\{\Delta f\cdot A_H + \Delta m\cdot B_H\},\end{aligned} \tag{9}$$

and

$$\begin{aligned}\Delta P_L &= (\pi_f^1 - \pi_f^2)\exp(-aN_f)\Delta f + \exp(-aN_f)\\ &\quad\times[1-\exp(-aN_m)]\cdot\{\Delta f\cdot A_L + \Delta m\cdot B_L\},\end{aligned} \tag{10}$$

where

$$\begin{aligned}A_H &\equiv (1-\pi_m)\exp(aN_m) + \pi_f^2 - \frac{\pi_f^2(1-\pi_m)^2}{\pi_f^2(1-\pi_m)+1-\pi_f^2}\\ &\quad - \frac{\pi_f^2(1-\pi_m)^2[\exp(aN_m)-1]}{\pi_f^2(1-\pi_m)+\pi_m(1-\pi_f^2)} - \frac{\pi_f^2}{\pi_f^2+\pi_m(1-\pi_f^2)},\\ B_H &\equiv \pi_m - \frac{(1-\pi_f^2)\pi_m(1-\pi_m)}{\pi_m(1-\pi_f^2)+1-\pi_m}\\ &\quad - \frac{(1-\pi_f^2)\pi_m(1-\pi_m)[\exp(aN_m)-1]}{\pi_m(1-\pi_f^2)+(1-\pi_m)\pi_f^2} - \frac{\pi_m}{\pi_m+\pi_f^2(1-\pi_m)},\\ A_L &\equiv \pi_f^2 - \frac{\pi_f^2(1-\pi_m)}{\pi_f^2(1-\pi_m)+1-\pi_f^2} - \frac{\pi_f^2\pi_m(1-\pi_m)[\exp(aN_m)-1]}{\pi_f^2(1-\pi_m)+\pi_m(1-\pi_f^2)}\\ &\quad - \frac{\pi_f^2\pi_m}{\pi_f^2+\pi_m(1-\pi_f^2)},\end{aligned}$$

and

$$B_L \equiv \pi_m + \pi_m \exp(aN_m) - \frac{(1-\pi_f^2)\pi_m}{\pi_m(1-\pi_f^2)+1-\pi_m} - \frac{(1-\pi_f^2)\pi_m^2[\exp(aN_m)-1]}{\pi_m(1-\pi_f^2)+(1-\pi_m)\pi_f^2} - \frac{\pi_m^2}{\pi_m+\pi_f^2(1-\pi_m)}.$$

Note that all of the terms in Equations (9) and (10) are multiplied by either Δf or Δm. The terms in Δf represent the expected increase in the market-maker's assessment of the probability that f_2 equals f_H if the manager releases earnings at date 1 rather than at date 2. Similarly, the terms in Δm represent the expected increase in the market-maker's assessment of the probability that m_2 equals m_H if earnings are released at date 1 rather than at date 2. Taken as a whole, Equations (9) and (10) then reflect the change in the market-maker's expectation for $e_2 \equiv f_2 + m_2$ if the manager discloses earnings at date 1 instead of at date 2.

Further insight into these expressions is gained by abstracting from the impact that the earnings release date itself has on the market-maker's expectation for f_2. This is accomplished by setting α_H^c equal to α_L^c, so that $\pi_f^1 = \pi_f^2$. In this case, the first term in both Equation (9) and Equation (10) drops out. It is a straightforward matter to show that the sum of the remaining terms multiplying Δf in Equation (9) are positive and the sum of the terms in Δm are negative. The opposite is true in Equation (10). This means that, from the viewpoint of an H-type (L-type) manager, an earnings release at date 1 is expected to increase (decrease) the market-maker's assessment of the probability that f_2 equals f_H and decrease (increase) his assessment of the probability that m_2 equals m_H.

To understand the reason for this, note that an earnings release at date 1 rather than at date 2 makes it easier for the market-maker to infer the value of f_2. This is because the m-informed traders are not submitting any (potentially confounding) orders at date 1. Consequently, from the viewpoint of an H-type (L-type) manager, a release at date 1 is expected to raise (lower) the market-maker's assessment of the probability that f_2 equals f_H. On the other hand, if the H-type manager does delay the release of earnings until date 2, he causes an increase in the total demand observed by the market-maker at that time. Since the market-maker is not able to infer the source of the demand perfectly, his assessment of the probability that m_2 equals m_H is expected to increase over what it would have been if the earnings were released at date 1. In contrast, if the L-type manager delays the earnings disclosure until date 2, he causes an increase in the total supply at that time. This is expected to decrease the market-maker's assessment of the probability that m_2 equals m_H.

4. Equilibrium

The following proposition establishes the existence of an equilibrium disclosure strategy in this economy and characterizes its properties:

Proposition 1. *An equilibrium exists in which the market-maker's conjectures about the manager's earnings disclosure strategy are fulfilled by the manager's actions. Equilibrium is characterized by*
(i) $0 \leq \alpha_H = \alpha_L \leq 1$, *which occurs if* $\Delta P_H = \Delta P_L = 0$ *when* $\alpha_H^c = \alpha_L^c$;
(ii) $\alpha_H = 0$ *and* $0 < \alpha_L \leq 1$, *which occurs if* $\Delta P_H > 0$ *and* $\Delta P_L < 0$ *when* $\alpha_H^c = \alpha_L^c$;
(iii) $\alpha_H = 1$ *and* $0 \leq \alpha_L < 1$, *which occurs if* $\Delta P_H < 0$ *and* $\Delta P_L > 0$ *when* $\alpha_H^c = \alpha_L^c$.
In cases (ii) and (iii), the equilibrium is unique.

Proof. See Part B of the Appendix.

4.1 The case where the m-informed traders are noise traders: $\Delta m = 0$

To gain further insight into the nature of equilibrium, it is useful to consider a setting where $m_H = m_L$ so that $\Delta m = 0$. In this setting, the orders placed at date 2 by the m-informed traders can be thought of as noise trading. Those traders have no real information, but demand (supply) N_m shares probability π_m $(1-\pi_m)$. In this case the following can be shown:

Proposition 2. *When* $\Delta m = 0$, *equilibrium is characterized by the H-type manager disclosing earnings at date 1 and the L-type manager disclosing them at date 2 with positive probability.*

Proof. To verify this, it is sufficient to show that $\Delta P_H > 0$ and $\Delta P_L < 0$ when $\alpha_H^c = \alpha_L^c$. (Refer back to Proposition 1.) Under these conjectures, the first term in Equations (9) and (10) drops out. Further, when $\Delta m = 0$, the only remaining terms are those multiplying Δf. As noted previously, these terms sum to a positive number in Equation (9) and to a negative number in Equation (10). ■

To better understand the intuition behind Proposition 2, note that when $\Delta m = 0$ the only difference between dates 1 and 2 is the extent of noise trading. Consequently, the manager's timing decision can be thought of as a choice over the level of noise trading that will accompany the release of the firm's earnings. The decision is simpler than in the case where $\Delta m > 0$, since the timing of the earnings announcement only affects the market-maker's expectation for f_2; it cannot affect his expectation for m_2. Since the H-type manager has favorable information about his firm, he prefers to release earnings at date 1, when there is less noise, so that the market-maker can better infer the value of f_2 from the order flow. In contrast, the L-type manager has an incentive to disclose the firm's earnings with positive probability at date 2, since it is more difficult for the market-maker to infer the value of f_2 from the order flow at that time. It should be recognized that the L-type manager gains by this action only because, from the market-maker's viewpoint, there is a positive probability that the manager is nonstrategic and so is not deliberately timing the disclosure of earnings. If this probability were zero, then the market-maker would be able to perfectly infer from a disclosure at date 2 that f_2 equals f_L, eliminating any incentive the L-type manager would have to delay the announcement.

It is important to note that the actions of the strategic manager result in a higher expected share price, not only in postannouncement trading, but also for the remainder of the second period. This is because both the f-informed and the m-informed traders attain their optimal shareholding position (subject to the constraint on their total holdings) by trading at dates 1 and 2 and, with no additional information revealed during the period, do not trade again. Consequently, the market-maker does not change his assessment of the firm's value during the remainder of the period.

An interesting empirical prediction that arises in this setting involves the relation between the expected price reaction to an earnings announcement at date 1 and the reaction to an announcement at date 2. Recall that the expected share price conditional solely on an announcement at date 1 is given by $e_1 + f_L + \pi_f^1 \Delta f$, while the expected price conditional solely on a date 2 disclosure is equal to $e_1 + f_L + \pi_f^2 \Delta f$. Each of these expected prices is also equal to the expected change in price from the beginning of period 2 through postannouncement trading, since the ex ante price of the firm is assumed equal to zero. Given that $\alpha_H < \alpha_L$ in equilibrium (or alternatively stated, given that the probability of f_2 equalling f_H is higher for an announcement at date 1), it is a simple matter to verify that $\pi_f^1 > \pi_f^2$. This immediately leads to the following:

Proposition 3. *When $\Delta m = 0$, the expected change in the firm's* *share price in response to an earnings announcement is greater if that announcement is made at date 1 rather than at date 2.*

As discussed in Section 1, a release at date 1 can be thought of as one that takes place during trading hours, while a release at date 2 is one that is made after the market has closed for the day. Interpreted in this way, the following corollary to Proposition 3 results:

Corollary 1. *When $\Delta m = 0$, the expected change in the firm's share price in response to an earnings announcement is greater if that announcement is made during trading hours rather than after the market has closed.*[27]

This result has been documented empirically by Patell and Wolfson (1982). It is not clear from their work, however, whether the greater price response they find to announcements made during trading hours is driven by the disclosure of more favorable reported earnings at that time or is due, at least in part, to other factors, such as that suggested here. As implied by Proposition 3 and Corollary 1, even if earnings surprise (reported earnings minus the market's prior expectation of earnings) is held constant, the average price response should be greater for announcements made while the market is open. Results of a more recent study by Francis, Pagach, and Stephan (1992) are consistent with this prediction. While confirming Patell and Wolfson's primary result, they find no significant difference in their sample between the average earnings surprise of firms announcing earnings after the market close and a control group of firms releasing earnings during trading hours.

Also consistent with Corollary 1, Damodaran (1989) finds that the average price change for firms making earnings announcements is negative on the day after the announcement. While Damodaran does not distinguish between firms disclosing earnings during and after trading hours, the analysis of this section predicts a negative average price change *only* for firms announcing earnings after the close (which is the day when the market reacts to such disclosures). The next-day price reaction should be zero for firms disclosing earnings during

[27] As before, the price change is measured from the beginning of period 2 through postannouncement trading. It should be noted that if the price change for an after-trading hours announcement were, instead, measured from date 1 to date 2, it would have an expected value of zero. This is because in trading at date 1 the market-maker adjusts the price of the firm given his knowledge that no earnings announcement was made at that time. This result, however, is driven solely by the assumption that the absence of a disclosure during the day implies that the announcement will be made that night. If, instead, there was a positive probability that the release would occur during trading hours on a subsequent day, the average price change between dates 1 and 2 would again be negative for a disclosure after the market close.

trading hours (since the market should react to those announcements on the day of their release).

In line with the expectation of a greater price reaction to earnings released during trading hours, a higher level of future earnings is also predicted for such announcements, as compared to those made after the close. This follows immediately from the fact that $\pi_f^1 > \pi_f^2$. Such a prediction provides an additional empirical test of this model.

It is conjectured that extending this analysis to allow for trading at the time of the second-period earnings announcement would show there to be more price volatility at that time if period 1 earnings are disclosed after the close rather than during trading hours. This is because, in the case of an announcement after the close, the postannouncement price would incorporate less information about period 2 earnings; consequently, there would be a greater price impact at the time of the subsequent earnings release.

A final point to note is that the documented empirical findings to date are expected to be weaker for those firms whose shares are cross-listed on one or more foreign exchanges. This is because such firms' shares may trade during part of the time that the U.S. exchanges are closed. Consequently, an announcement made after the close in the United States may actually be one that is made during trading hours on some foreign exchange. Not taking this into account will confound any comparison between earnings announcements made while the market is open in the United States and those made after trading hours.

4.2 The case where $\Delta m > 0$

As discussed in Section 3, when $\Delta m > 0$ the manager's disclosure decision affects not only the market-maker's assessment of f_2, but also that of m_2. Specifically, an H-type (L-type) manager increases (decreases) the market-maker's expectation of the value of m_2 by releasing earnings at date 2. Because of this additional effect, the equilibrium that arises when $\Delta m > 0$ may differ from that when $\Delta m = 0$. However, with ΔP_H and ΔP_L continuous in Δm, the nature of equilibrium will be the same if Δf is great enough relative to Δm. This is stated in the following corollary to Proposition 2.

Corollary 2. *For Δf sufficiently greater than Δm, equilibrium is characterized by the H-type manager disclosing at date 1 and the L-type manager disclosing at date 2 with positive probability.*

Proof. To prove the corollary, it is sufficient to show that for Δf sufficiently greater than Δm, $\Delta P_H > 0$ and $\Delta P_L < 0$ when $\alpha_H^c = \alpha_L^c$. This follows immediately given that the terms multiplying $\Delta f(\Delta m)$

in Equation (9) sum to a positive (negative) number and sum to a negative (positive) number in Equation (10) when $\alpha_H^c = \alpha_L^c$. ■

As long as the potential impact of current earnings on informed traders' assessment of future earnings (Δf) is expected to be large relative to the impact of other announcements released at date 2 (Δm), then an H-type manager would again be more likely to disclose the firm's earnings at date 1 than would an L-type manager. As a result, Proposition 3 and Corollary 1 would still hold.

A similar conclusion is drawn if the number of informed traders is sufficiently large. This is reflected in the following proposition.

Proposition 4. *For N_m (and N_f) sufficiently large, equilibrium is characterized by the H-type manager disclosing at date 1 and the L-type manager disclosing at date 2 with positive probability.*

Proof. To prove the proposition, it is sufficient to show that for N_m (and N_f) large enough, $\Delta P_H > 0$ and $\Delta P_L < 0$ when $\alpha_H^c = \alpha_L^c$. This follows immediately given that (i) as N_m becomes large, the only significant terms in Equations (9) and (10) are those involving $\exp(aN_m)$ and (ii) Δf is assumed to be greater than Δm. ■

When N_m and N_f are large, liquidity trading is negligible by comparison. If the manager discloses at date 1, then f_2 will almost certainly be revealed to the market-maker through the order flow. This gives the H-type manager the incentive to disclose earnings at date 1. In contrast, it gives the L-type manager an incentive to delay the earnings disclosure until date 2, when the market-maker may be unable to infer that f_2 is equal to f_L due to the presence of orders from the m-informed traders.

5. The Case of Two Disclosures by the Firm

In the setting of the previous sections, the firm's manager was assumed to possess only one piece of information, the firm's first-period earnings, and was faced with the decision of when to release them. In the setting of this section, in contrast, the manager holds two pieces of information, one of which is the firm's first-period earnings, and must decide whether to disclose them at the same time. This decision problem is expected to arise with some frequency since managers often possess information about an upcoming dividend or stock split around the time of an earnings announcement. With minor changes, it is possible to explore the manager's decision within the framework of the preceding analysis.

Assume, as before, that the firm's first-period earnings, when released, provide a set of N_f informed traders with perfect information as to the value of the component, f_2, of the second period's earnings. A second announcement now gives a set of N_y other traders (where $N_y \leq N_f$) imperfect information about f_2.[28] Specifically, it provides the N_y traders with a signal, y, which takes on one of two values, y_H or y_L. When f_2 equals $f_H(f_L)$, y takes on the value $y_H(y_L)$ with probability $1/2 \leq \pi < 1$ and the value $y_L(y_H)$ with probability $1-\pi$. Given this information structure, the greater is π, the more accurately can the N_y informed traders infer the value of f_2 from the second announcement. In the analysis below these traders will be referred to as y-informed traders. In contrast to these traders, the market-maker's inferences about the value of f_2 are unaffected by the second announcement.

This setting reflects the notion that there are some traders who are not sufficiently knowledgeable as to be able to infer the value of f_2 from the first-period's earnings; however, they can make some inferences about it from the second announcement. That their inferences are imperfect is consistent with the second disclosure being either a dividend or stock split announcement, one which is expected to be a relatively noisy indicator of future profitability.

A strategy of disclosing the two pieces of information at separate times (at the same time) is modeled here as the manager releasing the earnings report at date 1 (date 2) while making the second announcement at date 2.[29] In order to simplify the analysis and focus on this timing decision, it is assumed that no disclosure pertaining to the component m_2 of second-period earnings is made at date 2.

Since the analysis of the manager's timing decision is similar to that of the previous sections it will not be repeated here; for details see Gennotte and Trueman (1994). As the following proposition states, there exists a unique equilibrium in this setting.

Proposition 5. *A unique equilibrium exists in which the market-maker's conjectures about the manager's earnings disclosure strategy are fulfilled by the manager's actions. In equilibrium an H-type manager releases his firm's earnings report separately from the second announcement while an L-type manager makes the announcements at the same time with positive probability.*

[28] The results of this analysis would be unaffected if it were assumed that $N_f < N_y$.

[29] A third choice for the manager could be to release the firm's earnings after the other announcement. Allowing for this additional possibility, however, significantly complicates the analysis.

Proof. See Gennotte and Trueman (1994).

To understand the intuition behind this result, note that, from the market-maker's perspective, the second announcement adds noise to the date 2 order flow since the y-informed traders cannot perfectly infer from it the value of f_2 (unless $\pi = 1$). Consequently, there is some probability that they will trade inappropriately. The H-type manager prefers to make his earnings disclosure at date 1, when no such noise exists, so that there is a greater probability that the market-maker will be able to infer f_2 from the order flow and price the firm's shares appropriately. In contrast, the L-type manager has an incentive to disclose earnings with positive probability at date 2 since it is more difficult for the market-maker to infer the value of f_2 from the order flow at that time. Note that this equilibrium, and the forces driving it, are exactly the same as in Section 4.1, where the manager had only one announcement to make and where the sole effect of the second announcement was to add noise to the date 2 order flow.[30]

Given that the H-type manager is more likely than the L-type manager to disclose earnings separately from the second announcement, the following empirical implication immediately results:

Proposition 6. *The change in the firm's share price in response to an earnings announcement is expected to be greater if that announcement is made separately from, rather than at the same time as, another announcement by the firm.*

Not only is the price reaction to an earnings announcement affected by the time of day it is made, but as stated in Proposition 6, it is also affected by whether the earnings are released at the same time as other disclosures made by the firm. As mentioned earlier, upcoming dividends or stock splits are commonly announced around the same time that earnings are disclosed each quarter. Proposition 6 suggests that the price reaction to the earnings report will be more positive if it is made separately from the dividend or stock split announcement.

[30] A natural extension of this analysis would be to allow the manager to make each of his disclosures either during or after trading hours. It is expected that in such a setting the H-type manager would prefer (for Δf sufficiently greater than Δm or N_m and N_f sufficiently large) to make the announcements separately, during trading hours, while the L-type manager would prefer, with positive probability, to make announcements simultaneously, after the market has closed.

6. Summary and Conclusions

It has been shown here that a manager whose goal is to maximize the postearnings announcement price of his firm's shares may have a preference over the time of day that the earnings report is released. This is because the price reaction varies with the time of the announcement. This dependence arises because the market-maker's ability to infer from current earnings the implications for the firm's future profitability is, in general, greater for an earnings announcement made during trading hours than for one made after the market has closed. Under reasonable conditions, this makes the manager more (less) likely to release his firm's earnings during trading hours when those earnings have more (less) favorable implications for the firm's future profitability than is believed by less informed traders. Given these conditions, the average price reaction to an announcement made while the market is open will be higher than the reaction to one made after the market has closed, consistent with prior empirical findings. This result is expected to hold even if reported earnings are held constant. In line with the expectation of a greater price reaction for earnings releases during trading hours, a higher level of future earnings is also predicted for such announcements, as compared to those made after the close. This prediction, which has not previously been empirically examined, provides a means of testing the model's validity.

This analysis was extended to consider the question of whether a manager who is in possession of two pieces of information (one of which is the firm's earnings) should disclose them simultaneously or separately from each other. The decision was shown to be similar to that of intraday earnings announcement timing. In this setting it was demonstrated that a manager would prefer to make the announcements separately (simultaneously) as long as they have more positive (negative) implications for firm value than is believed by less informed traders. It follows from this result that the price reaction to an earnings report is expected to be more positive if it is released by itself, rather than in conjunction with another announcement by the firm.

Appendix A

Derivation of the expected date 2 prices for a single firm disclosure

In order to derive the expected date 2 prices, the probabilities of the relevant order flows must first be calculated. From the perspective of an H-type manager, conditional on a disclosure at date 1:

$$\begin{aligned}
\text{prob}(B^1, S^1 \geq N_f|\text{H-type}) &= \text{prob}(B_u^1 \geq 0, S_u^1 \geq N_f) \\
&= \exp(-aN_f), \\
\text{prob}(S^1 < N_f|\text{H-type}) &= \text{prob}(S_u^1 < N_f) \\
&= 1 - \exp(-aN_f), \\
\text{prob}(B^1 < N_f|\text{H-type}) &= \text{prob}(B_u^1 < 0) \\
&= 0.
\end{aligned}$$

Using Equations (3) through (5), the H-type manager's expectation of the date 1 price, $E_H[P^1(1, \cdot, \cdot)]$, given a disclosure at that time is

$$\begin{aligned}
E_H[P^1(1, \cdot, \cdot)] = {} & e_1 + (f_L + \pi_f^1 \Delta f) \\
& \times \exp(-aN_f) + f_H[1 - \exp(-aN_f)]. \qquad \text{(A1)}
\end{aligned}$$

Following along similar lines, it is easy to show that the L-type manager's expectation of the date 1 price, conditional on a disclosure at that time, $E_L[P^1(1, \cdot, \cdot)]$, is

$$E_L[P^1(1, \cdot, \cdot)] = e_1 + (f_L + \pi_f^1 \Delta f) \cdot \exp(-aN_f) + f_L[1 - \exp(-aN_f)]. \qquad \text{(A2)}$$

It should be clear that the manager's expectation of the price at date 2, conditional on a date 1 earnings disclosure, denoted by $E_H[P^2(1, \cdot, \cdot)]$ ($E_L[P^2(1, \cdot, \cdot)]$) for an H-type (L-type) manager, is equal to his expectation of the date 1 price. This is because the difference between the realized prices at the two dates is due solely to the market-maker's inference of the value of m_2, after observing the date 2 order flow. Since the manager has no private information about m_2 at date 1, and given that its ex ante expectation is equal to zero, the manager's expectation for the market-maker's inference of m_2 is also equal to zero.

Consider next the manager's expectation for the date 2 price of the firm conditional on an earnings disclosure at that date. In order to derive this expectation, it is necessary to first calculate the manager's assessment of the probability of occurrence of each of the 10 order flow regions. As an example of how these are calculated, consider region 5. From the perspective of an H-type manager, who knows that N_f informed traders will be purchasing shares at date 2, this region can occur only if m_2 is equal to m_L, so that the m-informed traders will be submitting sell orders. (If they, instead, observed m_H, the total demand for shares at date 2 would be at least equal to $N_f + N_m$, which is outside of region 5.) The probability of this event is $1 - \pi_m$. Conditional on m_2 equalling m_L, the order flow falls into cell 5 if and only if $0 \leq B_u^2 < N_m$ and $N_f - N_m \leq S_u^2 < N_f$. The probability of this is given by $[1-\exp(-aN_m)][\exp(-a(N_f-N_m))-\exp(-aN_f)]$. Multiplying this by $1-\pi_m$ gives π_{5H}, the assessment of an H-type manager of the probability that region 5 will occur. From the perspective of an L-type manager, who knows that N_f informed traders will be selling shares at date 2, region 5 can occur only if m_2 is equal to m_H. Conditional on this event, an order flow realization within region 5 requires that $N_f - N_m \leq B_u^2 < N_f$ and $0 \leq S_u^2 < N_m$. The probability of this joint event is given by $[\exp(-a(N_f - N_m)) - \exp(-aN_f)][1 - \exp(-aN_m)]$. Multiplying this by π_m gives π_{5L}, the assessment of an L-type manager of the probability that region 5 will occur.

Following along these lines for all 10 regions gives the assessment by a j-type manager of the probability that region i will occur, denoted by π_{ij}. [See Gennotte and Trueman (1994) for the specification of each of these probabilities.] The H-type (L-type) manager's expectation for the date 2 market price conditional on an earnings release at date 2 is then equal to $\Sigma_i P_i^2 \pi_{iH} (\Sigma_i P_i^2 \pi_{iL})$. Subtracting this expectation from that conditional on an earnings release at date 1 gives the expected increase in the firm's date 2 price if the manager announces earnings at date 1 rather than at date 2. This difference appears as Equations (9) and (10).

Appendix B

Proof of proposition 1

The following lemma is useful in proving Proposition 1:

Lemma 1. *Expressed in terms of* $\Delta P \equiv \Delta P_H - \Delta P_L$, ΔP_H *and* ΔP_L *are given by*

$$\begin{aligned}\Delta P_H &= (\pi_f^1 - \pi_f^2) \cdot \{\Delta f - (E_H[P^2(1,\cdot,\cdot)] - E_L[P^2(1,\cdot,\cdot)])\} \\ &\quad +(1 - \pi_f^2) \cdot \Delta P, \\ \Delta P_L &= (\pi_f^1 - \pi_f^2) \cdot \{\Delta f - (E_H[P^2(1,\cdot,\cdot)] - E_L[P^2(1,\cdot,\cdot)])\} - \pi_f^2 \cdot \Delta P.\end{aligned}$$

Proof. The law of iterated expectations implies that a weighted average of the two managers' expectations [where the weight on the expectation for the H-type (L-type) manager is equal to the probability that f_2 equals $f_H(f_L)$] equals the market-maker's expectation of the firm's value, conditional solely on the time of the earnings announcement. Consequently,

$$\begin{aligned}\pi_f^1 \cdot E_H[P^2(1,\cdot,\cdot)] + (1 - \pi_f^1) \cdot E_L[P^2(1,\cdot,\cdot)] &= f_L + \pi_f^1 \Delta f, \\ \pi_f^2 \cdot E_H[P^2(2,\cdot,\cdot)] + (1 - \pi_f^2) \cdot E_L[P^2(2,\cdot,\cdot)] &= f_L + \pi_f^2 \Delta f.\end{aligned}$$

This system of equations is equivalent to that of the lemma.

Proof of Proposition 1. As a first step in the proof, note that when $\alpha_H^c = \alpha_L^c, \pi_f^1 = \pi_f^2 = \pi_f$. In this case ΔP_H and ΔP_L do not depend on the specific values taken by α_H^c and α_L^c. Further, using the expressions in the lemma, it is straightforward to verify that when $\alpha_H^c = \alpha_L^c$ and one of the two price differences, ΔP_H or ΔP_L, is equal to zero, then ΔP is also equal to zero. This implies that the other price difference must also be zero. This rules out any combination of ΔP_H and ΔP_L not covered in the proposition.

To prove part (i) of the proposition, note that the term in curly brackets in the lemma is positive. (It would equal zero if the earnings announcement timing fully revealed the manager's information. However, this possibility is ruled out by assumption.) Given this, the equilibrium values of α_H and α_L are interior (implying that $\Delta P_H = \Delta P_L = \Delta P = 0$) only if $\pi_f^1 = \pi_f^2$, which is equivalent to the condition that $\alpha_H^c = \alpha_L^c$.

To prove part (ii), suppose that $\Delta P_H > 0$ and $\Delta P_L < 0$ when $\alpha_H^c = \alpha_L^c$. Consider a pair (α_H^c, α_L^c) such that $\alpha_H^c > \alpha_L^c$. It is straightforward to show that ΔP_L is increasing in α_L^c; hence the value of ΔP_L at (α_H^c, α_L^c) is less than its value at (α_H^c, α_H^c) and so is negative. With ΔP_L negative, the L-type manager would prefer to increase α_L, implying that α_L cannot be less than α_H in equilibrium. For all possible conjectures such that $\alpha_L^c \geq \alpha_H^c$, the value of ΔP_H is larger than its value at (α_H^c, α_H^c) and is, therefore, positive. Consequently, the equilibrium strategy of the H-type manager must be at a corner: $\alpha_H = 0$. Since ΔP_L increases in α_L^c, an interior equilibrium for α_L obtains if there exists an $\alpha_L^c \leq 1$ where ΔP_L is zero (when $\alpha_H^c = 0$). Otherwise, $\alpha_L = 1$. Finally, note that α_L must be strictly greater than zero because ΔP_L is negative at (0,0).

The proof for part (iii) follows along the same lines as that of part (ii). In this case α_L must be less than α_H. Specifically, $\alpha_H = 1$ and $\alpha_L < 1$ in equilibrium.

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