RESEARCH PROGRAM IN FINANCE AT THE
WALTER A. HAAS SCHOOL OF BUSINESS,
UNIVERSITY OF CALIFORNIA, BERKELEY

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The Strategic Timing of Corporate Disclosures

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November 1992

Finance Working Paper #224

We would like to thank Nils Hakansson, Hua He, Baruch Lev, Hayne Leland, Toshi Shibano, Matt Spiegel, and participants in seminars at the University of California at Berkeley for their helpful comments. All remaining errors are our own.
Abstract

Corporate managers and academics have become increasingly aware of the potential impact which corporate disclosure strategies can have on firm value. One of the important elements of such strategies is the timing of corporate announcements. In this paper, two aspects of disclosure timing are examined in order to provide an understanding of the forces that interact in producing an optimal reporting strategy. The first issue analyzed is the intraday timing of corporate earnings announcements. It is demonstrated here that, under reasonable conditions, the impact of the disclosure is stronger 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, the manager should prefer to make them separately (simultaneously).
THE STRATEGIC TIMING OF CORPORATE DISCLOSURES

INTRODUCTION

Corporate managers and academics have become increasingly aware of the potential impact which corporate disclosure strategies can have on firm value. One of the important elements of such strategies is the timing of corporate announcements. The goal of this paper is to examine two aspects of disclosure timing and to provide an understanding of the forces that interact in producing an optimal reporting strategy. The paper's analysis is framed in terms of earnings announcements; however, it could equally well be applied to any value-relevant 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 post-announcement price set by the firm's market-maker reflects the information of these informed traders is determined by

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1See Lev (1992) for a detailed discussion of corporate reporting strategies.
the market-maker's ability to discern from the post-announcement 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 which 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, post-announcement 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 post-announcement 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 post-announcement 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. With managers following this strategy, it is predicted that the average price 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). 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). As shown below, Patell and Wolfson's finding is also predicted to hold if the level of reported earnings is held constant. That the price reaction to the earnings announcement depends on the timing of the disclosure, itself, and not just on its content, has not previously been examined empirically, and provides a means for testing the validity of this analysis. A related theoretical results 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 post-announcement

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2Damodaran finds his empirical results to be stronger for announcements made on Fridays. This is not surprising, given that the amount of time between an after-hours earnings disclosure and post-announcement trading is greater for Friday announcements than for those made on any other day of the week. The greater span of time makes it less likely that the market-maker will be able to infer the implications of the earnings announcement from the post-announcement order flow. This gives an added incentive for managers whose earnings have unfavorable implications to release them after the close on Fridays.
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 will 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 profitability than is believed by less informed traders.

The plan of the paper is as follows. In Section I the economic setting is described. This is followed by an analysis of the share price formation process in Section II and the intraday timing decision in Section III. Equilibrium timing strategies are described in Section IV. In Section V the issue of simultaneous versus sequential disclosure of announcements is explored. The paper concludes with a summary in Section VI.

I. ECONOMIC SETTING

Consider a two period economy in which risk-neutral, perfectly competitive investors trade shares of a risky firm and a riskfree asset.\(^3\) Without loss of generality, the riskfree rate of return is set equal to

\(^3\)Allowing for more than one risky firm in the economy would not affect the analysis.
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, less the firm's initial investment, which, for simplicity, is set equal to zero. As will become clear shortly, it is convenient to separate the earnings of each period \( i \), \( e_i \), into two parts, denoted by \( f_i \) and \( m_i \). \( f_i \) can take one of two possible values, denoted by \( f_H \) and \( f_L \), where \( f_H > f_L \) and \( \Delta f = f_H - f_L \). \( m_i \) can also assume one of two possible values, denoted by \( m_H \) and \( m_L \), where \( m_H > m_L \) and \( \Delta m = m_H - m_L \). Without loss of generality, the random variables \( f_i \) and \( m_i \) 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. The manager, however, has some discretion over the timing of the earnings release. He is allowed to make the disclosure at either of two dates early in period 2, labelled 1 and 2.\(^4\) 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 the following timeline:

\(^4\)It is not necessary for the manager to disclose period 2's earnings since the firm is liquidated at the end of that period.
Date 1 - possible earnings announcement, followed by trading.
Date 2 - possible earnings announcement, along with additional disclosure, followed by trading.

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 \( f_2 = f_B \) (\( f_L \)) will sometimes be referred to as an H-type (L-type) manager.) Along with the manager, there is a set of \( N_r \) 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 \( f_2 = f_B \) to \( \pi_f \), where \( 0 < \pi_f < 1 \). (The dependence of \( \pi_f \) on \( e_1 \) is suppressed for notational simplicity.) The earnings realization does not provide the manager or any traders with information about \( m_2 \).^5

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

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^5Given 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.
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.\(^5\) 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 $m_m$ to $\pi_m$, where $0 < \pi_m < 1$. As will become clear from 
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. 

In the ensuing analysis, $N_f$ is assumed to be greater than or equal to $N_m$ while $\Delta f$ is assumed to be at least as large as $\Delta m$. 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.\(^7\)

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 and liquidity traders. Let $B_1$ ($S_1$) denote the total volume 
of orders to buy (sell) shares at date 1. Each of the informed traders 
begins period 2 owning no shares in the firm and is allowed to place an

\(^6\)Allowing for some overlap in these two sets of informed investors would 
not affect the nature of the results to be presented below.

\(^7\)Dropping the assumption that $N_f$ is greater than or equal to $N_m$ would not 
affect the results of this analysis. However, the results do depend on the 
assumption that $\Delta f$ is at least as large as $\Delta m$. 

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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.\(^6\)

The volume of buy orders from liquidity traders at date \(i\) of period 2,
\(i = 1\) or \(2\), is denoted by \(B^i\) while the volume of sell orders is given by \(S^i\).
They are assumed to be independently and exponentially distributed, and
independent of any information or market prices.\(^9\) Consequently, the
density functions of \(B^i\) and \(S^i\), denoted \(f(\cdot)\) and \(g(\cdot)\), respectively, have
the following forms:

\[ f(B^i) = a \cdot \exp(-aB^i) \]  
(1)

and:

\[ g(S^i) = a \cdot \exp(-aS^i) \]  
(2)

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 II.\(^10\)

\(^6\)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.

\(^9\)Jackson (1991) makes a similar assumption in his work on fully revealing
rational expectation equilibria.

\(^10\)The economic setting of this paper 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.
There are two possible managerial types. With probability $\pi_s < 1$ the manager has a short-term horizon, choosing 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. (As discussed below, this post-announcement market price prevails until the end of the second period, when the firm's liquidating dividend is revealed. Consequently, the short-horizon 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.) Incentives for a manager to focus on the firm's short-term price 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. 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. With probability $1-\pi_s < 1$ the manager has a long-term horizon, with an objective of maximizing the liquidating value of the firm, instead of maximizing its market price at some intermediate point during the second period. (A long-horizon manager can alternatively be thought of as one who strictly adheres to the Securities and Exchange Commission's requirement that an earnings report be released as soon as it is prepared, regardless of whether it results in a disclosure during or after trading hours.) Since the timing of the earnings announcement does not affect total earnings over the two periods, it does not affect the value of the firm at the end of period 2. Consequently, a manager with a long-
term horizon finds disclosure timing to be a matter of indifference. He reports earnings at date 2 with an exogenous probability of $\alpha_{ns}$, where $0 < \alpha_{ns} < 1$. Investors are assumed to be unaware of the manager's type.

The following table summarizes what each of the market participants learns at dates 1 and 2 and their subsequent actions.

\footnote{The effect of dropping the assumption that some managers have long-horizons is discussed in Section IV.A.}
If Earnings are Disclosed at Date 1

At date 1:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Learns</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>f-informed trader</td>
<td>$f_2$</td>
<td>places order in market</td>
</tr>
<tr>
<td>m-informed trader</td>
<td>$\text{prob}(f_2=f_2^m)=\pi_1^m$</td>
<td>none</td>
</tr>
<tr>
<td>liquidity trader</td>
<td></td>
<td>places order in market</td>
</tr>
<tr>
<td>market-maker</td>
<td>$\text{prob}(f_2=f_2^m)=\pi_1^m$; $B^1, S^1$</td>
<td>clears market</td>
</tr>
</tbody>
</table>

At date 2:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Learns</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>f-informed trader</td>
<td>$\text{prob}(m_2=m_2^m)=\pi_m$</td>
<td>none</td>
</tr>
<tr>
<td>m-informed trader</td>
<td>$m_2$</td>
<td>places order in market</td>
</tr>
<tr>
<td>liquidity trader</td>
<td></td>
<td>places order in market</td>
</tr>
<tr>
<td>market-maker</td>
<td>$\text{prob}(m_2=m_2^m)=\pi_m$; $B^2, S^2$</td>
<td>clears market</td>
</tr>
</tbody>
</table>

If Earnings are Disclosed at Date 2

At date 1:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Learns</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>f-informed trader</td>
<td>nothing</td>
<td>none</td>
</tr>
<tr>
<td>m-informed trader</td>
<td>nothing</td>
<td>none</td>
</tr>
<tr>
<td>liquidity trader</td>
<td>$B^1, S^1$</td>
<td>places order in market</td>
</tr>
<tr>
<td>market-maker</td>
<td></td>
<td>clears market</td>
</tr>
</tbody>
</table>

At date 2:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Learns</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>f-informed trader</td>
<td>$f_2$, $\text{prob}(m_2=m_2^m)=\pi_2^m$</td>
<td>places order in market</td>
</tr>
<tr>
<td>m-informed trader</td>
<td>$m_2$, $\text{prob}(f_2=f_2^m)=\pi_2^m$</td>
<td>places order in market</td>
</tr>
<tr>
<td>liquidity trader</td>
<td></td>
<td>places order in market</td>
</tr>
<tr>
<td>market-maker</td>
<td>$\text{prob}(f_2=f_2^m)=\pi_2^m$; $\text{prob}(m_2=m_2^m)=\pi_m$; $B^2, S^2$</td>
<td>clears market</td>
</tr>
</tbody>
</table>
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, post-announcement 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.\textsuperscript{12} 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.

II. 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 announcement.\textsuperscript{13,14} Denote the market price set by the market-maker at

\textsuperscript{12}Consistent with this statement, Jain and Joh (1988) report that the standard deviation of trading volume on the New York Stock Exchange is significantly higher during the first hour of trading than during any other hour of the trading day.

\textsuperscript{13}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
date i, given that he observes $B^i$ and $S^i$ and given that the earnings are disclosed at date 1 (date 2) by $P^i(1,B^i,S^i)$ [$P^i(2,B^i,S^i)$]. 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. 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 $m_H$ ($m_L$). By doing so, the informed trader makes a positive expected profit on his trade.

As a prelude to deriving the firm's market price at each date, note that, based solely on his observation of an earnings announcement at date i, the market-maker's posterior assessment of the probability that $f_2$ equals

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14 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.

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

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

17 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.
\[ f_B, \text{ denoted by } \pi_1, \text{ is given by:} \]

\[ \pi_1 = \frac{\text{prob(disclose at } i \text{ if } f_2 = f_B) \pi_f}{\text{prob(disclose at } i \text{ if } f_2 = f_B) \pi_f + \text{prob(disclose at } i \text{ if } f_2 = f_L) (1-\pi_f)} \]  \hspace{1cm} (3)

Expression (3) yields:

\[ \pi_2 = \frac{[(1-\alpha_B^H)\pi_s + (1-\alpha_{ns})(1-\pi_s)]\pi_f}{[(1-\alpha_B^H)\pi_s + (1-\alpha_{ns})(1-\pi_s)]\pi_f + [(1-\alpha_B^L)\pi_s + (1-\alpha_{ns})(1-\pi_s)](1-\pi_f)} \]  \hspace{1cm} (4)

and:

\[ \pi_2 = \frac{[\alpha_B^H\pi_s + \alpha_{ns}(1-\pi_s)]\pi_f}{[\alpha_B^H\pi_s + \alpha_{ns}(1-\pi_s)]\pi_f + [\alpha_B^L\pi_s + \alpha_{ns}(1-\pi_s)](1-\pi_f)} \]  \hspace{1cm} (5)

where \( \alpha_B^H (\alpha_B^L) \) is the market-maker's conjecture of the probability that an H-type (L-type) manager discloses the firm's earnings at date 2.\(^{18}\)

A. 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 \( f_B \) (\( f_L \)), 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 \( f_B \) if the total volume of sell orders at date 1, \( S^1 \), is less than \( N_f \), since such an

\(^{18}\)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 \( m_2 \).
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 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 \( f_R \) is calculated as follows:

\[
\text{prob}(f_R | \text{earnings disclosure at date 1, } B^1, S^1 \geq N_f) = \\
\frac{\text{prob}(B^1, S^1 \geq N_f | f_2 = f_R) \pi_2^1}{\text{prob}(B^1, S^1 \geq N_f | f_2 = f_R) \pi_2^1 + \text{prob}(B^1, S^1 \geq N_f | f_2 = f_L)(1 - \pi_2^1)}
\]

(6)

\[
\frac{\text{prob}(B_0^1 \geq 0; S_0^1 \geq N_f) \pi_2^1}{\text{prob}(B_0^1 \geq 0; S_0^1 \geq N_f) \pi_2^1 + \text{prob}(B_0^1 \geq N_f; S_0^1 \geq 0)(1 - \pi_2^1)}
\]

(7)

It is straightforward to show that \( \text{prob}(B_0^1 \geq 0; S_0^1 \geq N_f) = \text{prob}(B_0^1 \geq N_f; S_0^1 \geq 0) \), so that (7) reduces to \( \pi_2^1 \). 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 \( f_R \). It remains equal to \( \pi_2^1 \). This is an appealing property of the exponential distribution because it significantly simplifies the analysis.

Using these results, the price set by the market-maker at date 1 is given by the following expressions:
\[ P^1(1, B^1, S^1) = e_1 + f_L + \pi^1_2 \Delta f \quad \text{if } B^1, S^1 \geq N_f \quad (8) \]

\[ = e_1 + f_H \quad \text{if } S^1 < N_f \quad (9) \]

\[ = e_1 + f_L \quad \text{if } B^1 < N_f \quad (10) \]

As reflected in expressions (8) - (10), the price at date 1 is equal to the sum of period 1's earnings plus the expected 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 \( m_2 \) remains equal to zero since he does not update his beliefs about \( m_2 \) at date 1.)

The market price at date 2 is derived in an analogous fashion. If the total demand for (supply of) shares at date 2, \( B^2 (S^2) \), is less than \( N_m \), then the \( m \)-informed traders must be selling (buying) shares; consequently, \( m_2 \) must equal \( m_L \) (\( m_H \)). (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.) If \( B_2 \) and \( S_2 \) are both greater than or equal to \( N_m \), then the market-maker learns nothing about \( m_2 \) from the date 2 order flow. His assessment of the probability that \( m_2 \) equals \( m_H \) remains equal to \( \pi_m \). Consequently:

\[ P^2(1, B^2, S^2) = P^1(1, B^1, S^1) + m_L + \pi_m \Delta m \quad \text{if } B^2, S^2 \geq N_m \quad (11) \]

\[ P^2(1, B^2, S^2) = P^1(1, B^1, S^1) + m_H \quad \text{if } S^2 < N_m \quad (12) \]

\[ P^2(1, B^2, S^2) = P^1(1, B^1, S^1) + m_L \quad \text{if } B^2 < N_m \quad (13) \]
B. 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.

Specifically, an order to buy (sell) $N_f$ shares is placed by the $f$-informed traders at date 2 if $f_2$ equals $f_B$ ($f_L$), while an additional order to buy (sell) $N_m$ shares is placed by the $m$-informed traders if $m_2$ equals $m_B$ ($m_L$).

To understand the price-setting process at date 2, refer to the table below, which divides the feasible combinations of total demand, $D^2$, and total supply, $S^2$, into ten regions.
Along the horizontal axis total demand increases from left to right, while along the vertical axis total supply increases from top to bottom. The letters NA inside of a cell indicates that the range of demand and supply in that cell cannot occur. For example, demand and supply cannot both be less than $N_m$ since the $m$-informed traders must be either buying or selling shares. In the lower right-hand corner of each of the other cells is an identifying number for the 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. For example, when total demand is greater than or equal to $N_m + N_f$ and total supply is less than $N_m$ (cell 10), $f_2$ must equal $f_H$ and $m_2$ must equal $m_H$. This is because total supply is sufficiently small that neither set of informed traders could be selling.

\[ \begin{array}{|c|c|c|c|}
\hline
& N_m & N_f & N_m + N_f \\
\hline
0 & NA & NA & f_H, m_H \\
\hline
N_m & NA & f_H, m_L & f_H, m_H or f_H, m_L \\
\hline
S^2 & f_L, m_H & f_L, m_H or f_H, m_L & not f_L, m_L \\
\hline
N_f & 3 & 6 & 9 \\
\hline
N_m + N_f & f_L, m_L & f_L, m_H or f_L, m_L & not f_H, m_H & any combination \\
\hline
& 1 & 2 & 4 & 7 \\
\hline
\end{array} \]

\[ B^2 \]
shares at date 2.

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 \( m_2 \). The market price is thus equal to \( e_1 + e_2 \). To illustrate how the price is determined in each of the other regions, consider cell 5. Given the order flow, the probability that \( f_2 \) equals \( f_H \) and \( m_2 \) equals \( m_L \) is calculated as follows:

\[
\text{prob}(f_H, m_L | \text{earnings disclosed at date 2, } N_f \leq B^2, S^2 < N_m + N_f) = \frac{\text{prob}(N_f \leq B^2, S^2 < N_m + N_f | f_H, m_L) \pi_f^2(1-\pi_m)}{\text{prob}(N_f \leq B^2, S^2 < N_m + N_f | f_H, m_L) \pi_f^2(1-\pi_m) + \text{prob}(N_f \leq B^2, S^2 < N_m + N_f | f_L, m_H) (1-\pi_f)^2 \pi_m}.
\]

(14)

\[
\text{prob}(0 \leq B_0^2 < N_m; N_f - B_f \leq S_0^2 < N_f) \pi_f^2(1-\pi_m) = \frac{\text{prob}(0 \leq B_0^2 < N_m; N_f - B_f \leq S_0^2 < N_f) \pi_f^2(1-\pi_m) + \text{prob}(N_f - N_m \leq B^2_0 < N_f; 0 \leq S^2_0 < N_m) (1-\pi_f)^2 \pi_m}{\text{prob}(N_f - N_m \leq B^2_0 < N_f; 0 \leq S^2_0 < N_m) (1-\pi_f)^2 \pi_m}.
\]

(15)

With liquidity demand exponentially distributed, it is easy to show that \( \text{prob}(0 \leq B_0^2 < N_m; N_f - B_f \leq S_0^2 < N_f) = \text{prob}(N_f - N_m \leq B_0^2 < N_f; 0 \leq S_0^2 < N_m) \), so that expression (15) simplifies to \( \pi_f^2(1-\pi_m)/[\pi_f^2(1-\pi_m) + (1-\pi_f)^2 \pi_m] \). 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 a simple matter to calculate the date 2 market price for each region \( i \), denoted by \( P_i^2 \). They are given in Observation 1.
Observation 1: Conditional on the firm's manager disclosing period 1 earnings at date 2, the share price set by the market-maker if the date 2 order flow falls in region i, i = 1, ..., 10, is:

\[ P_i^1 = e_1 + f_L + m_L \]
\[ P_i^2 = e_1 + f_L + m_L + \pi_m \Delta m \]
\[ P_i^3 = e_1 + f_L + m_H \]
\[ P_i^4 = e_1 + \frac{\pi_L^2 (1-\pi_m)(f_H+m_L) + (1-\pi_L^2)\pi_m(f_L+m_H) + (1-\pi_L^2)(1-\pi_m)(f_L+m_L)}{\pi_L^2 (1-\pi_m) + (1-\pi_L^2)\pi_m + (1-\pi_L^2)(1-\pi_m)} \]
\[ P_i^5 = e_1 + \frac{(1-\pi_L^2)\pi_m(f_L+m_H) + \pi_L^2(1-\pi_m)(f_H+m_L)}{(1-\pi_L^2)\pi_m + \pi_L^2(1-\pi_m)} \]
\[ P_i^6 = e_1 + f_H + m_L \]
\[ P_i^7 = e_1 + f_L + \pi_L^2 \Delta f + m_L + \pi_m \Delta m \]
\[ P_i^8 = e_1 + \frac{\pi_L^2 \pi_m(f_H+m_H) + \pi_L^2(1-\pi_m)(f_H+m_L) + (1-\pi_L^2)\pi_m(f_L+m_H)}{\pi_L^2 \pi_m + \pi_L^2(1-\pi_m) + (1-\pi_L^2)\pi_m} \]
\[ P_i^9 = e_1 + f_H + m_L + \pi_m \Delta m \]
\[ P_i^{10} = e_1 + f_H + m_H \]

III. THE EARNINGS ANNOUNCEMENT TIMING DECISION

In this section the earnings announcement timing decision of a manager with a short-term horizon 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 \( m_2 \).

Appendix A contains the derivation of this expectation for an i-type manager, conditional both on an earnings disclosure at date 1, denoted by \( E_1[P^2(1,\cdot,\cdot)] \), and on a disclosure at date 2, denoted by \( E_1[P^2(2,\cdot,\cdot)] \). The difference between \( E_1[P^2(1,\cdot,\cdot)] \) and \( E_1[P^2(2,\cdot,\cdot)] \), denoted by \( \Delta P_1 \) and representing the expected increase in the date 2 price resulting from an earnings release at date 1 rather than at date 2, appears as Observation 2.

Observation 2:

\[
\Delta P_1 = (\pi_1^2 - \pi_2^2) \exp(-aN_2)\Delta f + \exp(-aN_2)[1 - \exp(-aN_m)] \cdot (\Delta f \cdot A_H + \Delta m \cdot B_H)
\]  

(16)

and:

\[
\Delta P_L = (\pi_1^2 - \pi_2^2) \exp(-aN_2)\Delta f + \exp(-aN_2)[1 - \exp(-aN_m)] \cdot (\Delta f \cdot A_L + \Delta m \cdot B_L)
\]  

(17)

where:

\[
A_H = (1 - \pi_m)\exp(aN_m) + \pi_2^2 - \frac{\pi_2^2(1 - \pi_m)^2}{\pi_2^2(1 - \pi_m) + 1 - \pi_2^2} - \frac{\pi_2^2(1 - \pi_m)^2[\exp(aN_m) - 1]}{\pi_2^2(1 - \pi_m) + \pi_m(1 - \pi_2^2)} - \frac{\pi_2^2}{\pi_2^2 + \pi_m(1 - \pi_2^2)}
\]

\[
B_H = \pi_m - \frac{(1 - \pi_2^2)\pi_m(1 - \pi_m)}{\pi_m(1 - \pi_2^2) + 1 - \pi_m} - \frac{(1 - \pi_2^2)\pi_m(1 - \pi_m)[\exp(aN_m) - 1]}{\pi_m(1 - \pi_2^2) + (1 - \pi_m)\pi_2^2} - \frac{\pi_m}{\pi_m + \pi_2^2(1 - \pi_m)}
\]

\[
A_L = \pi_2^2 - \frac{\pi_2^2(1 - \pi_m)}{\pi_2^2(1 - \pi_m) + 1 - \pi_2^2} - \frac{\pi_2^2\pi_m(1 - \pi_m)[\exp(aN_m) - 1]}{\pi_2^2(1 - \pi_m) + \pi_m(1 - \pi_2^2)} - \frac{\pi_2^2\pi_m}{\pi_2^2 + \pi_m(1 - \pi_2^2)}
\]

and:

21
\[ B_L = \pi_m + \pi_m \exp(aN_m) - \frac{(1-\pi_m^2)\pi_m}{\pi_m(1-\pi_m^2) + 1-\pi_m} - \frac{(1-\pi_m^2)\pi_m^2[\exp(aN_m) - 1]}{\pi_m(1-\pi_m^2) + (1-\pi_m)\pi_m^2} - \frac{\pi_m^2}{\pi_m + \pi_m(1-\pi_m)} \]

Note that all of the terms in expressions (16) and (17) are multiplied by either $\Delta f$ or $\Delta m$. The terms in $\Delta f$ represent the expected increase in the market-maker's assessment of the probability that $f_2$ equals $f_B$ if the manager releases earnings at date 1 rather than at date 2. Similarly, the terms in $\Delta m$ represent the expected increase in the market-maker's assessment of the probability that $m_2$ equals $m_B$ if earnings are released at date 1 rather than at date 2. Taken as a whole, expressions (16) and (17) then reflect the change in the market-maker's expectation for $e_2 = f_2 + m_2$ 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 $\sigma^2$ equal to $\sigma^2_1$, so that $\pi_1 = \pi_2$. In this case, the first term in both (16) and (17) drops out. It is a straightforward matter to show that the sum of the remaining terms multiplying $\Delta f$ in (16) are positive and the sum of the terms in $\Delta m$ are negative. The opposite is true in expression (17). 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 $f_B$ and decrease (increase) his assessment of the probability that $m_2$ equals $m_B$.

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 $f_B$. 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 $m_B$ 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 $m_H$.

Additional insight into expressions (16) and (17) comes from the following observation:

**Observation 3**: $\Delta P_B$ and $\Delta P_L$ both increase as either $\alpha_H$ decreases or $\alpha_L$ increases.

**Proof**: A decrease in $\alpha_H$ or an increase in $\alpha_L$ both act to increase $\pi_1^H$ and decrease $\pi_2^H$. It is easy to see that $\Delta P_B$ and $\Delta P_L$ increase with $\pi_1^H$. Tidious, but straightforward, differentiation of $\Delta P_B$ and $\Delta P_L$ also reveals that they increase as $\pi_2^H$ decreases.

Q.E.D.

This is an intuitive result. The greater the conjectured probability that an H-type manager discloses earnings at date 1 (or the lower the
probability that an L-type manager discloses them at that time), the greater (lower) is the market-maker's assessment of the probability that \( f_2 \) equals \( f_2 \) if he observes a date 1 (date 2) disclosure. This increases the expected difference between the market value of the firm conditional on an earnings announcement at date 1 and conditional on an announcement at date 2.

IV. 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 either:

a. \( 0 \leq \alpha_H - \alpha_L \leq 1 \), which occurs if \( \Delta P_H = \Delta P_L = 0 \) when \( \alpha_H = \alpha_L \);

b. \( \alpha_H = 0 \) and \( 0 < \alpha_L \leq 1 \), which occurs if \( \Delta P_H > 0 \) and \( \Delta P_L < 0 \) when \( \alpha_H = \alpha_L \);

c. \( \alpha_H = 1 \) and \( 0 \leq \alpha_L < 1 \), which occurs if \( \Delta P_H < 0 \) and \( \Delta P_L > 0 \) when \( \alpha_H = \alpha_L \).

In cases (b) and (c), the equilibrium is unique.

**Proof**: See Appendix B.

As reflected in the proposition, the keys to determining the nature of the equilibrium reporting strategies are the signs of \( \Delta P_H \) and \( \Delta P_L \) when both manager types are conjectured to report at date 2 with equal probability.

If both \( \Delta P_H \) and \( \Delta P_L \) equal zero under these conjectures, then the equilibrium strategy is for both types to disclose earnings at date 2 with the same probability. In this case any value of \( \alpha_H = \alpha_L \) between zero and one is
fulfilled by the manager’s actions in equilibrium. If $\Delta P_H > 0$ and $\Delta P_L < 0$ when $\alpha_H = \alpha_L$, then the unique equilibrium is where the H-type manager discloses earnings at date 1 while the L-type manager reports them at date 2 with positive probability. If $\Delta P_H < 0$ and $\Delta P_L > 0$ when $\alpha_H = \alpha_L$, then the unique equilibrium is where the H-type manager reports earnings at date 2 while the L-type manager discloses them at date 1 with positive probability.

A. THE CASE WHERE $\Delta m = 0$

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 with probability $\pi_m (1 - \pi_m)$. 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 $\alpha_H = \alpha_L$. (Refer back to Proposition 1.) Under these conjectures, the first term in expressions (16) and (17) drops out. Further, when $\Delta m = 0$, the only remaining terms are those multiplying $\Delta f$. As noted previously, these terms sum to a positive number in expression (16) and a negative number in expression (17).

Q.E.D.

25
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 has a long-term horizon 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 short-horizon manager result in a higher expected share price, not only in post-announcement 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 \( e_1 + f_L + \pi_L^1 \Delta f \), while the expected price conditional solely on a date 2 disclosure is equal to \( e_1 + f_L + \pi_L^2 \Delta f \). Each of these expected prices is also equal to the expected change in price from the beginning of period 2 through post-announcement trading, since the ex-ante price of the firm is assumed equal to zero. Given that \( \alpha_L < \alpha_H \) 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 \( \pi_L^1 > \pi_L^2 \). This immediately leads to the following proposition:

**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 I, a release at date 1 can be thought of as one which takes place during trading hours, while a release at date 2 is one which is made after the market has closed for the day. Interpreted in this way, the following corollary to Proposition 3 results:
Corollary 1: 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. 20

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 those suggested here. Proposition 3 and Corollary 1 imply that, even if reported earnings are held constant, the average price response should be greater for announcements made while the market is open.

B. THE CASE WHERE Δm > 0

As discussed in Section III, when Δm > 0 the manager's disclosure decision affects not only the market-maker's assessment of f2, but also that of m2. Specifically, an H-type (L-type) manager increases (decreases) the market-maker's expectation of the value of m2 by releasing earnings at date 2. Because of this additional effect, the equilibrium which arises when Δm > 0 may differ from that when Δm = 0. However, with ΔP_H and ΔP_L continuous

20As before, the price change is measured from the beginning of period 2 through post-announcement 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.
in $\Delta m$, the nature of equilibrium will be the same if $\Delta f$ is great enough relative to $\Delta m$. This is stated in the following corollary to Proposition 2.

**Corollary 2:** For $\Delta f$ sufficiently greater than $\Delta m$, 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 $\Delta f$ sufficiently greater than $\Delta m$, $\Delta P_H > 0$ and $\Delta P_L < 0$ when $a_H^g = a_F^g$. This follows immediately given that the terms multiplying $\Delta f$ ($\Delta m$) in expression (16) sum to a positive (negative) number and a negative (positive) number in expression (17) when $a_H^g = a_F^g$.

Q.E.D.

As long as the potential impact of current earnings on informed traders' assessment of future earnings ($\Delta f$) is expected to be large relative to the impact of other announcements released at date 2 ($\Delta m$), 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 $N_r$) 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, \( \Delta P_B > 0 \) and \( \Delta P_L < 0 \) when \( \alpha^B = \alpha^L \). This follows immediately given that (a) as \( N_m \) becomes large, the only significant terms in (16) and (17) are those involving \( \exp(aN_m) \) and (b) \( \Delta f \) is assumed to be greater than \( \Delta m \).

Q.E.D.

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.

V. 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, provides a set of \( N_z \) 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 \( N_y \leq N_z \)) imperfect information about \( f_2 \).\(^{21,22}\) Specifically, it provides the \( N_y \) traders with a signal, \( y \), which takes on one of two values, \( y_b \) or \( y_l \). When \( f_2 \) equals \( f_b \) (\( f_l \)), \( y \) takes on the value \( y_b \) (\( y_l \)) with probability \( 1/2 \leq \pi < 1 \) and the value \( y_l \) (\( y_b \)) with probability \( 1-\pi \). Given this information structure, the greater is \( \pi \), 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 modelled here as the manager releasing the earnings report at date 1 (date 2) while making the second announcement at

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\(^{21}\)The effect of allowing the second announcement to give perfect information to the \( N_y \) traders about \( f_2 \) is discussed later in this section.

\(^{22}\)The results of this analysis would be unaffected if it were assumed that \( N_z < N_y \).
date 2. 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.

The analysis proceeds along lines similar to that of the previous sections. As a prelude, note that, based on his observation that earnings are announced at date 1 (date 2) and his conjecture of the probability that an i-type manager releases earnings at date 2, \( \alpha_f \), the market-maker's posterior assessment of the probability that \( f_2 \) equals \( f_8 \), is again given by expression (4) [(5)], above.

Consider the prices set by the market-maker if the manager releases earnings at date 1. Using a line of reasoning identical to that of Section II, the price at date 1 is given by:

\[
P^1(1,B^1,S^1) = e_1 + f_L + \pi_1 \Delta f \quad \text{if } B^1, S^1 \geq N_f
\]

\[
= e_1 + f_8 \quad \text{if } S^1 < N_f
\]

\[
= e_1 + f_L \quad \text{if } B^1 < N_f
\]

The market price at date 2 can differ from that at date 1 only if the date 1 order flow does not reveal \( f_2 \). (If \( f_2 \) is revealed at date 1, the second announcement provides no additional information about future earnings.) This happens only if \( B^1 \) and \( S^1 \) are both at least as large as \( N_f \). In this case, the y-informed traders place a total order to buy (sell)

---

23A 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.
N_y shares if they observe the signal y_R (y_L) from the second announcement. If the total supply of shares at date 2 is less than N_y, then the market-maker infers that the y-informed traders have purchased shares and must have observed the signal y_R. Knowing this, the market-maker revises his assessment of the probability that f_2 is equal to f_R to:

\[ \text{prob}(f_R | \text{earnings release at date 1, } y_R) = \frac{\pi \pi^2_y}{\pi \pi^2_y + (1-\pi)(1-\pi^2_y)} \]  

(21)

In contrast, if the total demand for shares at date 2 is less than N_y, then the market-maker infers that the y-informed traders have sold shares and must have observed the signal y_L. In this case, the market-maker's revised assessment of the probability that f_2 is equal to f_R is:

\[ \text{prob}(f_R | \text{earnings release at date 1, } y_L) = \frac{(1-\pi)\pi^2_y}{(1-\pi)\pi^2_y + \pi(1-\pi^2_y)} \]  

(22)

As before, if the total demand and supply are both greater than or equal to N_y, the market-maker cannot make any inferences from the order flow about the value of f_2. His assessment of the probability that f_2 equals f_R remains at \pi^2_y.

Employing these results, the price set by the market-maker at date 2 in the case where the date 1 order flow does not reveal f_2 is given by the following set of expressions:

\[ P^2(1,B^2,S^2) = e_1 + f_L + \frac{1}{2} \Delta f \]  

if \( B^2, S^2 > N_y \)  

(23)
\[
P^2(1, B^2, S^2) = e_1 + f_L + \frac{\pi \pi_1^1}{\pi \pi_1^1 + (1-\pi)(1-\pi_1^1)} \cdot \Delta f \quad \text{if } S^2 < N_y \tag{24}
\]

\[
P^2(1, B^2, S^2) = e_1 + f_L + \frac{(1-\pi) \pi_1^1}{(1-\pi)(1-\pi_1^1) + \pi(1-\pi_1^1)} \cdot \Delta f \quad \text{if } B^2 < N_y \tag{25}
\]

Consider, now, the case where the manager discloses the firm’s earnings simultaneously with the second announcement, at date 2. Since there is no disclosure at date 1, the order flow at that time does not provide the market-maker with information about \(f_2\). However, the date 2 order flow does yield information to the market-maker. As before, total demand and supply at date 2 fall into one of ten possible regions, as summarized in the following table:

<table>
<thead>
<tr>
<th>(B^2)</th>
<th>0</th>
<th>(N_y)</th>
<th>(N_r)</th>
<th>(N_y+N_r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>(f_L, y_B)</td>
<td>10</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
<td>(f_L, y_L)</td>
<td>(f_B, y_B) or (f_B, y_L)</td>
<td>9</td>
</tr>
<tr>
<td>(N_r)</td>
<td>(f_L, y_B)</td>
<td>(f_L, y_B) or (f_B, y_L)</td>
<td>not (f_L, y_L)</td>
<td>5</td>
</tr>
<tr>
<td>(S^2)</td>
<td>(f_L, y_L)</td>
<td>(f_L, y_B) or (f_L, y_L)</td>
<td>not (f_B, y_B)</td>
<td>any combination</td>
</tr>
<tr>
<td>(N_y+N_r)</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Recall that the letters NA inside of a cell indicates that the range of
demand and supply in that cell cannot occur. Inside the other cells of the table are the combinations of values for $f_2$ and $y_2$ that are consistent with that cell's demand and supply region. In the lower right-hand corner of each cell is an identifying number for that cell.

Following along the lines of the analysis in Section II, the market price for each cell $i$, $P_i^2$, can be calculated and are stated in the following observation.

Observation 4: Conditional on the firm's manager disclosing period 1 earnings at date 2, the share price set by the market-maker if the date 2 order flow falls in cell $i$, $i = 1, \ldots, 10$, is as follows:

\begin{align*}
P_1^2 &= e_1 + f_L \\
P_2^2 &= e_1 + f_L \\
P_3^2 &= e_1 + f_L \\
P_i^2 &= e_1 + f_L + \frac{(1-\pi)\pi_2^2}{(1-\pi)\pi_2^2 + 1-\pi_2^2} \cdot \Delta f \\
P_4^2 &= e_1 + f_L + \pi_2^2 \Delta f \\
P_5^2 &= e_1 + f_H \\
P_7^2 &= e_1 + f_L + \pi_2^2 \Delta f \\
P_8^2 &= e_1 + f_L + \frac{\pi_2^2}{\pi_2^2 + (1-\pi)(1-\pi_2^2)} \cdot \Delta f \\
P_9^2 &= e_1 + f_H \\
P_{10}^2 &= e_1 + f_H
\end{align*}

Appendix C contains the derivation of the $i$-type manager's expectation.
for the date 2 price of the firm, conditional both on an earnings disclosure
at date 1, $E_1[P^2(1,\cdot,\cdot)]$, and on a disclosure at date 2, $E_1[P^2(2,\cdot,\cdot)]$. The
difference between $E_1[P^2(1,\cdot,\cdot)]$ and $E_1[P^2(2,\cdot,\cdot)]$, denoted by $\Delta P_4$ and
representing the expected increase in the date 2 price resulting from an
earnings disclosure made separately from the second announcement, rather
than at the same time, appears as Observation 5.

Observation 5:

\[
\Delta P_a = (\pi_1^1 - \pi_2^2)\exp[-a(N_r + N_y)]\Delta f + (1-\pi)[\exp(aN_y) - 1]\exp(-aN_r)\Delta f \\
+ \exp(-aN_r)[1 - \exp(-aN_y)](A\pi + B(1-\pi) - C(1-\pi) - D - \pi_2^2(1-\pi)[\exp(aN_y) - 1])\Delta f
\]

(26)

and:

\[
\Delta P_L = (\pi_1^1 - \pi_2^2)\exp[-a(N_r + N_y)]\Delta f \\
+ \exp(-aN_r)[1 - \exp(-aN_y)](A(1-\pi) + B\pi - C - D(1-\pi) - \pi_2^2(1-\pi)[\exp(aN_y) - 1])\Delta f
\]

(27)

where:

\[
A = \frac{\pi_1^1}{\pi_1^1 + (1-\pi)(1-\pi_1^1)}
\]

\[
B = \frac{(1-\pi)\pi_1^1}{(1-\pi)\pi_1^1 + \pi(1-\pi_1^1)}
\]
\[ C = \frac{(1-\pi)\pi_2^2}{(1-\pi)\pi_2^2 + 1-\pi_2} \]

and:

\[ D = \frac{\pi_2^2}{\pi_2^2 + (1-\pi)(1-\pi_2)} \]

The following proposition establishes the existence of a unique equilibrium disclosure strategy in this setting and characterizes its properties:

**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 \( \alpha_H = 0 \) and \( 0 < \alpha_L \leq 1 \).

**Proof:** The proof is identical to that of Proposition 1. Further, in this case the difference \( \Delta P = \Delta P_H - \Delta P_L \) can be shown to be decreasing in \( \pi \) and equal to zero when \( \pi = 1 \). Given the assumption that \( \pi < 1 \), \( \Delta P \) is positive and, therefore, case (b) of Proposition 1 obtains: \( \alpha_H = 0 \) and \( 0 < \alpha_L \leq 1 \).

Q.E.D.

As stated in the proposition, an \( H \)-type manager has an incentive to release his firm's earnings report separately from the second announcement while an \( L \)-type manager has an incentive to make the announcements at the same time with positive probability. 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 IV.A, 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.

It is interesting to note that when the y-informed traders' information is perfect (that is, when $\pi = 1$), $\Delta P_H = \Delta P_L$. This implies that both types of managers will choose the same disclosure strategy, so that $\alpha_H = \alpha_L$. In such a case $\pi_H^1 = \pi_L^1$, which makes the equilibrium value of both $\Delta P_H$ and $\Delta P_L$ equal to zero. Consequently, both types of managers will be indifferent between disclosing earnings at date 1 or at date 2. This result arises because in this framework the expected price set by the market-maker is the same whether there are $N_z$ perfectly informed traders at date 1 and $N_y$ perfectly informed traders at date 2 or whether there are no informed traders at date 1 but $N_z + N_y$ perfectly informed traders at date 2.

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.

VI. SUMMARY AND CONCLUSIONS

It has been shown here that a manager whose goal is to maximize the post-earnings 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. 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 Price
In the Case of 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:

\[
\text{prob}(B^1, S^1 \geq N_f | \text{H-type}) = \text{prob}(B^1_{\geq 0}, S^1_{\geq N_f}) \\
= \exp(-aN_f)
\]

\[
\text{prob}(S^1 < N_f | \text{H-type}) = \text{prob}(S^1 < N_f) \\
= 1 - \exp(-aN_f)
\]

\[
\text{prob}(B^1 < N_f | \text{H-type}) = \text{prob}(B^1_{< 0}) \\
= 0
\]

Using expressions (8) - (10), 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 then given by:

\[
E_h[P^1(1, \cdot, \cdot)] = e_1 + (f_L + \pi_1 \Delta f) \cdot \exp(-aN_f) + f_H[1 - \exp(-aN_f)] \quad (Al)
\]

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:
\[ E_L[P^1(1,\cdot,\cdot)] = e_1 + (f_L + \pi_2^L \Delta f) \cdot \exp(-aN_T) + f_L[1-\exp(-aN_T)] \]  \hspace{1cm} (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 \( E_L[P^2(1,\cdot,\cdot)] \) (or \( E_L[P^2(1,\cdot,\cdot)] \)) 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 marker-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 marker-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 ten 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 \( m_1 \), so that the \( m \)-informed traders will be submitting sell orders. (If they, instead, observed \( m_1 \), 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 \( m_1 \), the order flow falls into cell 5 if and only if \( 0 \leq S^2_d < N_M \) and \( N_F - N_M \leq S^2_d < N_F \). The probability of this is given by \( [1-\exp(-aN_m)][\exp(-a(N_F-N_m))-\exp(-aN_T)] \). Multiplying this by 1-\( \pi_m \) and rearranging gives \( \pi_{AB} \) below. 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 \( m_B \). Conditional on this event, an order flow realization within region 5 requires that \( N_f-N_m \leq B^2 < N_f \) and \( 0 \leq S^2 < N_m \). 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 \( \pi_m \) and rearranging gives \( \pi_{5L} \) below.

Following along these lines for all ten regions, the assessment by a j-type manager of the probability that region i will occur, denoted \( \pi_{i,j} \), is given by:

\[
\begin{align*}
\pi_{1H} &= 0 \\
\pi_{1L} &= (1-\pi_m)[1-\exp(-aN_m)] \\
\pi_{2H} &= 0 \\
\pi_{2L} &= \exp(-aN_m) - \exp(-aN_f) \\
\pi_{3H} &= 0 \\
\pi_{3L} &= \pi_m[1-\exp(-a(N_f-N_m))][1-\exp(-aN_m)] \\
\pi_{4H} &= (1-\pi_m)\exp(-aN_f)[1-\exp(-aN_m)] \\
\pi_{4L} &= \exp(-aN_f)[1-\exp(-aN_m)] \\
\pi_{5H} &= (1-\pi_m)[\exp(aN_m)-1]\exp(-aN_f)[1-\exp(-aN_m)] \\
\pi_{5L} &= \pi_m[\exp(aN_m)-1]\exp(-aN_f)[1-\exp(-aN_m)] \\
\pi_{6H} &= (1-\pi_m)[1-\exp(-aN_m)][1-\exp(-a(N_f-N_m))] \\
\pi_{6L} &= 0 \\
\pi_{7H} &= \exp(-a(N_f+N_m)) \\
\pi_{7L} &= \exp(-a(N_f+N_m)) \\
\pi_{8H} &= \exp(-aN_f)[1-\exp(-aN_m)] \\
\pi_{8L} &= \pi_m\exp(-aN_f)[1-\exp(-aN_m)] \\
\pi_{9H} &= \exp(-aN_m) - \exp(-aN_f)
\end{align*}
\]
\[ \pi_{SL} = 0 \]
\[ \pi_{10B} = \pi_B[1 - \exp(-\alpha N_B)] \]
\[ \pi_{10L} = 0 \]

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 \( \Sigma_i P_i^2 \pi_{1B} \) (\( \Sigma_i P_i^2 \pi_{1L} \)). 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 Observation 2.
APPENDIX B

Proof of Proposition 1

The following lemma is useful in proving Proposition 1:

**Lemma:** Expressed in terms of \( \Delta P = \Delta P_H - \Delta P_L, \Delta P_H \) and \( \Delta P_L \) are given by:

\[
\Delta P_H = (\pi_1 - \pi_2) \cdot (\Delta f - E_H[P^2(1, \cdot, \cdot)] - E_L[P^2(1, \cdot, \cdot)]) + (1 - \pi_2) \cdot \Delta P
\]

\[
\Delta P_L = (\pi_1 - \pi_2) \cdot (\Delta f - E_H[P^2(1, \cdot, \cdot)] - E_L[P^2(1, \cdot, \cdot)]) - \pi_2 \cdot \Delta P
\]

**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:

\[
\pi_1 \cdot E_H[P^2(1, \cdot, \cdot)] + (1 - \pi_1) \cdot E_L[P^2(1, \cdot, \cdot)] = f_L + \pi_1 \Delta f
\]

\[
\pi_2 \cdot E_H[P^2(2, \cdot, \cdot)] + (1 - \pi_2) \cdot E_L[P^2(2, \cdot, \cdot)] = f_L + \pi_2 \Delta f.
\]

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

Q.E.D.

Proof of Proposition 1:

As a first step in the proof, note that when \( \alpha_H = \alpha_L \), \( \pi_1 = \pi_2 = \pi_2 \). In this case \( \Delta P_H \) and \( \Delta P_L \) do not depend on the specific values taken by \( \alpha_H \) and \( \alpha_L \). Further, using the expressions in the lemma, it is straightforward to verify that when \( \alpha_H = \alpha_L \) and one of the two price differences, \( \Delta P_H \) or \( \Delta P_L \), is equal to zero, then \( \Delta P \) is also equal to zero. This implies that the other price difference must also be zero. This rules out any combination of \( \Delta P_H \).
and $\Delta P_L$ not covered in the proposition.

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

Part (b). To prove part (b), suppose that $\Delta P_H > 0$ and $\Delta P_L < 0$ when $\alpha_H = \alpha_L$. Consider a pair $(\alpha_H^*, \alpha_L^*)$ such that $\alpha_H^* > \alpha_L^*$. From Observation 3, $\Delta P_L$ is increasing in $\alpha_L^*$; hence the value of $\Delta P_L$ at $(\alpha_H^*, \alpha_L^*)$ is less than its value at $(\alpha_H^*, \alpha_H^*)$ and so is negative. With $\Delta P_L$ negative, the L-type manager would prefer to increase $\alpha_L$, implying that $\alpha_L$ cannot be less than $\alpha_H$ in equilibrium. For all possible conjectures such that $\alpha_L^* \geq \alpha_H^*$, the value of $\Delta P_H$ is larger than its value at $(\alpha_H^*, \alpha_H^*)$ (from Observation 3) and is, therefore, positive. Consequently, the equilibrium strategy of the H-type manager must be at a corner: $\alpha_H = 0$. Since $\Delta P_L$ increases in $\alpha_L^*$, an interior equilibrium for $\alpha_L$ obtains if there exists an $\alpha_L^* \leq 1$ where $\Delta P_L$ is zero (when $\alpha_H^* = 0$). Otherwise, $\alpha_L = 1$. Finally, note that $\alpha_L$ must be strictly greater than zero because $\Delta P_L$ is negative at $(0,0)$.

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

Q.E.D.
APPENDIX C

Derivation of the Expected Date 2 Price

In the Case of Two Disclosures By the Firm

When the manager discloses the firm's earnings at date 1:

\[
\text{prob}(B^1, S^1 \geq N_f; B^2, S^2 \geq N_y | \text{H-type}) = \text{prob}(B^1_{N_f} \geq 0, S^1_{N_f} \geq N_f) \pi \cdot \text{prob}(B^2_{N_y} \geq 0, S^2_{N_y} \geq N_y) + (1-\pi) \cdot \text{prob}(B^2_{N_y} \geq N_y, S^2_{N_y} \geq 0))
\]

\[
= \exp[-a(N_f+N_y)]
\]

\[
\text{prob}(B^1, S^1 \geq N_f; S^2 < N_y | \text{H-type}) = \text{prob}(B^1_{N_f} \geq 0, S^1_{N_f} \geq N_f) \pi \cdot \text{prob}(S^2 < N_y)
\]

\[
= \pi \cdot \exp(-aN_f) \left[1 - \exp(-aN_y)\right]
\]

\[
\text{prob}(B^1, S^1 \geq N_f; B^2 < N_y | \text{H-type}) = \text{prob}(B^1_{N_f} \geq 0, S^1_{N_f} \geq N_f) \cdot (1-\pi) \cdot \text{prob}(B^2_{N_y} < N_y)
\]

\[
= (1-\pi) \cdot \exp(-aN_f) \left[1 - \exp(-aN_y)\right]
\]

\[
\text{prob}(S^1 < N_f | \text{H-type}) = \text{prob}(S^1_{N_f} < N_f)
\]

\[
= 1 - \exp(-aN_f)
\]

\[
\text{prob}(B^1 < N_f | \text{H-type}) = \text{prob}(B^1_{N_f} < 0)
\]

\[
= 0
\]

\[
\text{prob}(B^1, S^1 \geq N_f; B^2, S^2 \geq N_y | \text{L-type}) = \text{prob}(B^1_{N_f} \geq N_f, S^1_{N_f} \geq 0) \pi \cdot \text{prob}(B^2_{N_y} \geq N_y, S^2_{N_y} \geq 0) + (1-\pi) \cdot \text{prob}(B^2_{N_y} \geq 0, S^2_{N_y} \geq N_y))
\]

\[
= \exp[-a(N_f+N_y)]
\]

47
\[
\text{prob}(B^1, S^1 \geq N_x; S^2 < N_y | \text{L-type}) = \text{prob}(B^1 \geq N_x, S^1 \geq 0) \cdot (1 - \pi) \cdot \text{prob}(S^2 < N_y) \\
= (1 - \pi) \cdot \exp(-aN_x) [1 - \exp(-aN_y)]
\]

\[
\text{prob}(B^1, S^1 \geq N_x; B^2 < N_y | \text{L-type}) = \text{prob}(B^1 \geq N_x, S^1 \geq 0) \cdot \pi \cdot \text{prob}(B^2 < N_y) \\
= \pi \cdot \exp(-aN_x) [1 - \exp(-aN_y)]
\]

\[
\text{prob}(S^1 < N_x | \text{L-type}) = \text{prob}(S^1_0 < 0) \\
= 0
\]

\[
\text{prob}(B^1 < N_x | \text{L-type}) = \text{prob}(B^1_0 < N_x) \\
= 1 - \exp(-aN_x)
\]

Combining these probabilities with expressions (18) - (20) and (23) - (25) yields the i-type manager's expectation of the date 2 market price of the firm conditional on an earnings disclosure at date 1, \( E_i[P^2(1,\cdot,\cdot)] \):

\[
E_i[P^2(1,\cdot,\cdot)] = e_i + f_L + \Delta f(\pi \exp[-a(N_x+N_y)] + A_i \exp(-aN_x) [1 - \exp(-aN_y)] + 1 - \exp(-aN_x))
\]

\[\text{C1}\]

and:

\[
E_i[P^2(1,\cdot,\cdot)] = e_i + f_L + \Delta f(\pi \exp[-a(N_x+N_y)] + A_i \exp(-aN_x) [1 - \exp(-aN_y)])
\]

\[\text{C2}\]

where:
\[ A_{H} = \frac{\pi^{2}\pi^{\frac{1}{2}}}{\pi \pi^{\frac{1}{2}} + (1-\pi)(1-\pi^{\frac{1}{2}})} + \frac{(1-\pi)^{2}\pi^{\frac{1}{2}}}{(1-\pi)\pi^{\frac{1}{2}} + \pi(1-\pi^{\frac{1}{2}})} \]

and:

\[ A_{L} = \frac{\pi(1-\pi)\pi^{\frac{1}{2}}}{\pi \pi^{\frac{1}{2}} + (1-\pi)(1-\pi^{\frac{1}{2}})} + \frac{\pi(1-\pi)\pi^{\frac{1}{2}}}{(1-\pi)\pi^{\frac{1}{2}} + \pi(1-\pi^{\frac{1}{2}})} \]

To derive the manager's expectation of the date 2 price conditional on an earnings disclosure at that time, it is first necessary to calculate the manager's assessment of the probability of occurrence of each of the ten order flow regions. Proceeding along lines similar to that in Appendix A yields:

\[ \pi_{1H} = 0 \]
\[ \pi_{1L} = \pi[1-\exp(-aN_y)] \]
\[ \pi_{2H} = 0 \]
\[ \pi_{2L} = \exp(-aN_y) - \exp(-aN_z) \]
\[ \pi_{3H} = 0 \]
\[ \pi_{3L} = (1-\pi)[1-\exp(-a(N_z-N_y))][1-\exp(-aN_y)] \]
\[ \pi_{4H} = (1-\pi)\exp(-aN_z)[1-\exp(-aN_y)] \]
\[ \pi_{4L} = \exp(-aN_z)[1-\exp(-aN_y)] \]
\[ \pi_{5H} = (1-\pi)[\exp(aN_y)-1]\exp(-aN_z)[1-\exp(-aN_y)] \]
\[ \pi_{5L} = (1-\pi)[\exp(aN_y)-1]\exp(-aN_z)[1-\exp(-aN_y)] \]
\[ \pi_{6H} = (1-\pi)[1-\exp(-aN_y)][1-\exp(-a(N_z-N_y))] \]
\[ \pi_{6L} = 0 \]
\[ \pi_{7B} = \exp(-a(N_x+N_y)) \]
\[ \pi_{7L} = \exp(-a(N_x+N_y)) \]
\[ \pi_{8B} = \exp(-aN_x)[1-\exp(-aN_y)] \]
\[ \pi_{8L} = (1-\pi)\exp(-aN_x)[1-\exp(-aN_y)] \]
\[ \pi_{9B} = \exp(-aN_y) - \exp(-aN_x) \]
\[ \pi_{9L} = 0 \]
\[ \pi_{10B} = \pi[1-\exp(-aN_x)] \]
\[ \pi_{10L} = 0 \]

As before, the H-type (L-type) manager's expectation for the date 2 market price conditional on an earnings release at date 2 is equal to \( \Sigma_i P_i^2 \pi_{iB} \) (\( \Sigma_i P_i^2 \pi_{iL} \)). Subtracting this expectation from that conditional on an earnings announcement at date 1 gives the expected increase in the date 2 price of the firm if the manager makes the two announcements separately, rather than simultaneously. This difference is given in Observation 5.
REFERENCES


