Clustered Disclosures by Competing Firms: The Choice of Reporting Periods

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Abstract:

In some industries firms schedule their disclosure at about the same time, usually around the end of the business cycle, whereas in others such disclosures are more dispersed over time. This paper examines a firm's choice of a fiscal year-end (and hence of disclosure timing) relative to the business cycle and to the timing chosen by other firms in the industry. We model a stochastic setting in which the periodic closing of books yields information that is relevant for subsequent managerial decisions. The results show that while it is business seasonality that is the primary determinant of reporting period choice, competitive forces in the form of information transfer effects and proprietary disclosure costs have the ability to make firms' fiscal years deviate from the business cycle. Such deviations are more likely when auto-correlation in firms' annual costs is low, when within-season variations in business conditions are low, when uncertainty is primarily about industry-wide rather than firm-specific factors, and/or when affordable opportunities exist for collecting information that the year-end closing of books typically provides. Further, if incumbent firms are already reporting at the end of the business season, newer firms may have a greater inclination to make a different choice. The results also offer a novel rationale for why the end of the business cycle is an attractive fiscal year-end. The desire to receive information at an opportune time, rather than the ease of collecting information or any other factors, makes the end of business cycle an attractive year-end in our setting.

Keywords: Information Acquisition, Disclosure, Competition, Timing, Fiscal year-end

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1. Introduction

This study investigates the strategic choice of reporting periods (e.g., fiscal year-ends) by competing firms. While the length of the reporting period is often dictated by regulation, firms have discretion over *when* the reporting period will end and, therefore, when information will be disclosed. For instance, US GAAP requires that firms furnish audited financial reports annually but leaves the choice of the fiscal year-end up to the firms. Conventional wisdom holds that this choice is governed by factors such as seasonality, regulation or simply convention.[1] However, if such industry-level factors were the only determinants of this choice, we would observe near-uniformity in financial year-ends within industries. In contrast, evidence based on Compustat firms (Table 1) shows that even though 12/31 is the most popular year-end in all sectors, overall only about seventy percent of the firms choose a December year-end. The degree of fiscal year-end clustering (around 12/31 or other dates) varies widely across industries, suggesting that there may be firm-specific and strategic factors at play as well.

Evidence from firms that change their fiscal year-ends also confirms the presence of strategic concerns in the choice of reporting periods. A review of announcements by nearly a hundred firms that changed their fiscal year between 2003 and 2007 (including prominent firms such as BearingPoint, Tivo and Sears Roebuck) shows that, other than mergers and acquisitions, better alignment with operating cycle and/or with industry peers were the reasons cited most often for the change. For instance, in changing its fiscal year-end from 12/31 to 1/31 TiVo offered that such a change will "help to align the seasonal patterns of demand in TiVo's business with the Company's reporting cycle" and will also "better align the Company's own promotional activities with those of its retail, service and network partners."

[1] For instance, in the retail industry most financial year-ends are in January, when inventory levels are at post-Christmas lows. Education services firms often choose June 30, the end of the school year, as their financial year-end. Firms that have the government as their major customer keep the government's fiscal year is mind in determining their own reporting periods.

Evidence therefore points to business seasonality and the reporting periods of industry peers as being important factors in firms' reporting period choice.

We model a firm's choice of reporting period in the presence of business seasonality and competitive concerns. In contrast to the "herding" behavior explained by Dye and Sridhar [1995] and empirically examined by studies such as Brown, Gordon and Wermers [2006] where the focus is on *ex post* disclosure decisions (i.e., disclosure decisions that are made *after* observing the realized signals), the subject of our analysis is the *ex ante* scheduling of periodic disclosures, and the extent to which such schedules are affected by business seasonality and the choices made by other firms in the industry.

Scheduled periodic disclosures, such as the release of quarterly or annual reports, require extensive collation and summarization of information. This process often yields information that is valuable for internal management purposes as well. For instance, the size of many contingencies, conversions, bonuses, distributions and even many accruals becomes clear only at the end of a reporting period (when books are closed). Thus, the choice of reporting periods determines not just when information is *released* to external parties but also when some managerially relevant information is *updated* for internal use. In this sense the choice of reporting periods is a simultaneous choice about the timing of both information acquisition as well as information disclosure.[2]

In a stochastic setting in which the periodic closing of books yields information necessary for inclusion in external reports and also information that is relevant for subsequent managerial decisions, the analysis first establishes reporting period choice in the absence of competitive concerns. The monopolist's choice is dictated exclusively by managerial need for updated information and serves as a benchmark when we introduce competition in the form of a second firm. The incentives of the second firm that enters the industry are influenced by at least two additional economic forces. First, the report of

[2] Since firms are required to disclose material information in a timely fashion, collecting *but not releasing* material information may not be an option. New Securities & Exchange Commission regulations require firms to file annual reports on Form 10-K within 60 days (reduced from 90 days) after the end of each fiscal year and quarterly reports on Form 10-Q within 35 days (reduced from 45 days) after the end of each fiscal quarter. These new filing rules apply to fiscal years ending after December 15, 2003.

the existing firm offers an additional source of information (an information transfer effect). Second, the relative positioning of the fiscal year, and hence the timing of disclosure, may affect the magnitude of the proprietary costs of disclosing information to a rival. These new forces have the potential to lead the second firm to choose a reporting period different from the one chosen by the monopolist.

The results show that the incentive to choose fiscal years that coincide with the business season are high when serial correlation in the uncertain parameter (e.g., costs) is relatively high. High serial correlation means that knowledge of costs from the prior season is critical for estimating costs in the current season. Firms, therefore, have an incentive to arrange their reporting periods to obtain prior season's information as quickly as possible, and locating their fiscal year-end at the end of the business season accomplishes that best. If all firms in the industry face the same business season, they end up choosing identical reporting periods and we observe clustered year-ends.

A major advantage of choosing a fiscal year that does *not* coincide with the business season is that by doing so firms can close their books and update their information part way through the ongoing season. Firms, therefore, can receive updated information about earlier parts of the ongoing season and this information, if relevant, could be exploited for the remainder of the season.[3] The value of this information depends on how cyclical the business season is. In industries with highly cyclical sales or costs, information from January is of little value in predicting sales or costs in October. As a result of the diminished relevance of early-season information, the incidence of fiscal years that *don't* coincide with the business season may be lower in industries that have more within-season variations in their business.

The results also show that a firm may have an incentive to deviate from the business cycle and from rivals' choices when cross-correlation between the rivals' costs is high. High cross correlation strengthens the information transfer effects. The ability to learn about *own* costs after observing the rival's report is greater when cross-sectional correlation is high. In this case when firms stagger their reporting periods, they have multiple opportunities to update their own information. Information is

[3] For instance, if a firm that operates in an industry with a calendar business cycle chooses a June year-end, in the latter half of the calendar year it will have information about the first six months of the current season that it can exploit in the remaining six months.

sometimes updated by preparing one's own report and sometimes by observing the rivals' reports. Thus, dispersed year-ends are more likely in industries where firms' costs are highly correlated or when rivals' financial reports are informative about trends in industry-wide rather than firm-specific factors. This leads to the seemingly counterintuitive result that *similar* firms (e.g., those whose costs are highly correlated) may be more likely to choose *dispersed* disclosure timing.

If firms can affordably obtain some of the information that the year-end closing of the books yields *before* the fiscal year formally ends, dispersed year-ends become more likely. When there is an alternative source of information besides the financial reporting process, firms can exploit the benefits of a fiscal year that does *not* end with the business season (greater information about more current shocks) without foregoing the benefits of closing with the business season (critical information from the previous season is available earlier in the new season). Given recent innovations in information technology that have made data collection and collation easier and more affordable, managers may no longer have to wait till the end of the fiscal year to obtain certain types of information. This would suggest that, ceteris paribus, dispersed year-ends are more likely in more recent years.

Finally, the results also suggest that if there already exist some firms that are reporting at the end of the business season, newer entrants are more likely to choose a fiscal year that does not coincide with the business season. The reports of existing firms may serve as an effective source of information about the previous season, which makes it easier for subsequent firms to deviate from the business season in their reporting period choice.

In summary, the results suggest that fiscal years that don't coincide with the industry business cycle as well as dispersed year-ends for industry firms are more likely when annual costs exhibit low serial correlation or when cyclical fluctuations within the business season are relatively low. They are also more likely in industries where firms' costs are highly correlated or where uncertainty is about industry-wide rather than firm-specific factors. Since recent years have made information collection easier and less costly, dispersed year-ends may also be more likely to be observed in more recent years.

Finally, in an industry where several incumbent firms are already reporting with the business season, newer firms may be more likely to choose a different year-end.

Prior literature offers few explanations for what determines firms' fiscal year choice. While Smith and Pourciau (1988) empirically document differences in the size and risk profile of December and non-December firms, they do not address the question of what may lead to the patterns they observe. Huberman and Kandel (1989) confirm that larger firms are more likely to choose December year-ends. Based on an international dataset, Kamp (2002) examines international diversity in fiscal year-ends and finds that much of continental Europe exceeds the US in terms of the popularity of December as a year-end. In contrast, in countries such as the UK, New Zealand and Australia non-December year-ends are far more popular than they are in the US. These differences are explained mostly by reporting or tax regulation at the national level. Kamp (2002) also provides preliminary evidence that, as compared to other countries in his sample, in the US fiscal year choice is more influenced by business characteristics. The results in this paper provide insights about specific aspects of industry and firm characteristics that may influence fiscal year choice.

Our model explains a firm's disclosure timing relative to the timing chosen by other industry co-members. With the possible exception of Dye and Sridhar [1995], who also provide a potential explanation for disclosures that occur in herds within the same industry, the choice of timing relative to other firms has not been investigated. Since their model looks at *ex post* disclosures (as against disclosures that are scheduled and committed to in advance, as in our model), the herding behavior is prompted by investors' belief revision and increased skepticism about the receipt of information by other firms in the industry after observing disclosure by one firm. Competitive forces are not a part of their model. Similar to our work but also without considering competitive forces, Pae [1999] also examines the amount of costly information to acquire, its discretionary disclosure (*ex post*) and the impact of these decisions on a firm's productive activities.

Competitive forces are incorporated into Hansen and Sankar's [1999] model of information acquisition. However, their model focuses on the timing for information *acquisition*, whereas in our

model firms acquire and then disclose this information publicly. Making the strategically valuable information available to competitors provides an additional rich layer of strategic considerations that influence timing choices in our model. Additionally, while their model looks for the length of the data acquisition cycle, we focus on the timing *within* a particular cycle.[4]

The remainder of the paper proceeds as follows. After setting up the basic model in Section 2 we analyze the reporting period choices of the monopolist and duopolists in Section 3 and 4. The paper concludes with a discussion of the main results in Section 5.

2. The Model

Business Season versus Fiscal Year

All firms in the industry face a common business cycle that spans T operating periods, with the periods indexed from 1 to T, $t \in \{1, \ldots, T\}$. Firms can choose a fiscal year (also assumed to span T operating periods) that coincides with the business season, or a fiscal year that spans a different set of T periods.[5] Consistent with practice, we assume that firms commit to the reporting periods they choose. That is, once chosen, changing fiscal years is prohibitively expensive.

Business seasons and fiscal years are denoted by the superscripts B and F, respectively.[6] A fiscal year that ends any time during (or with) business season B is termed year F, one that ends during business season B+1 is termed year F+1, and so on. (We use the terms business "season" and business "cycle" interchangeably.)

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[4] Other models that incorporate information acquisition in competitive settings include Li, McKelvy, and Page [1986] and Kirby [1993]. The former models acquisition choice in terms of the precision of the signal acquired whereas the latter models it as the number of noisy (and costly) signals to acquire. The focus in these models is on the optimal *amount* of research that the oligopolists individually undertake. In contrast, we assume that research yields perfect information and look for the best *timing* for such research and its disclosure. Raith [1996] provides an excellent summary of the literature on information sharing in oligopolies.

[5] The assumption that reporting periods also span T operating periods effectively means that books are closed (or information is collected) once every season. This assumption is relaxed later to allow for more frequent information collection.

[6] The term "year" generically denotes any scheduled reporting period such as a quarter or a year.

Business cycles are characterized as distinct sets of T operating periods over which cost shocks cumulate as the business cycle progresses. As a result, uncertainty is greater, and the value of information is higher, in operating periods that are closer to the end of the season.[7] A new business cycle starts with a fresh slate. These ideas are made more specific in the following paragraphs.

Industry and Information Structure

Consider a homogenous good industry in which the inverse demand curve in period t is given by $Price_t = A - dQ_t$, where Q is the aggregate output of all firms, and d is a known constant set equal to 1 without loss of generality. Firms work in an uncertain environment with a constant returns to scale technology. In each operating period unit costs are subject to an idiosyncratic and unobservable random shock u_{it}, where $u_{it} \sim N(0, v^2)$.[8] Firms learn the magnitude of these shocks *ex post*, either when books are closed at the end of the fiscal year or when (and if) firms collect additional information prior to the fiscal year end. Further,

$$\text{Cov}(u_{it}, u_{it+n}) = 0$$

$$\text{Cov}(u_{it}, u_{jt}) = r\, v^2$$

$$\text{Cov}(u_{it}, u_{jt+n}) = 0 \qquad (1)$$

The above assumptions imply, respectively, that (a) individual shocks are serially un-correlated, and that (b) cross-sectional correlation exists only for contemporaneous shocks with r as the coefficient of correlation.

Structure of Costs

Firm i's unit costs in the t^{th} operating period of the current business cycle B equal long-term average costs ($\bar{c}_i$), which is a commonly known constant, adjusted for the net impact of all shocks

[7] Results remain unchanged when the model is altered to allow sales to be larger as the business cycle progresses. This is done by assuming that the demand intercept equals tA (rather than A), and therefore increases with t.

[8] Although we label the uncertainty to be about "costs", this is simply a matter of labeling. These shocks could equally well be labeled as shocks to the demand intercept A.

experienced in the prior cycle (ω_i^{B-1}) and the net impact of all the random shocks experienced *to date* in the current cycle (η_{it}^B). That is,

$$C_{it}^B = \bar{c}_i + \delta\, \omega_i^{B-1} + \gamma\, \eta_{it}^B \qquad (2)$$

where $\omega_i^{B-1} = \sum_{k=1}^{T} u_{ik}^{B-1}$, $\eta_{it}^B = \sum_{k=1}^{t} u_{ik}^B$ and u_{it}^B represents cost shock in period t of business cycle B. For expositional ease we refer to ω_i^{B-1} and η_{it}^B as "prior" and "current" components of costs, respectively. Following (1), $\omega_i^{B-1} \sim N(0, Tv^2)$ and $\eta_{it}^B \sim N(0, tv^2)$ and $Cov(\omega_i^{B-1}, \eta_{it}^B) = 0$.

This formulation captures the property that aggregate information from the prior season (ω_i^{B-1}) as well as developments since the start of the current season (η_{it}^B) are relevant for determining costs in the current period. The coefficients δ and γ (both ≥ 0) calibrate the relative importance of the two components. We initially assume that the weight on ω_i^{B-1} is greater than the weight on η_{it}^B (that is, $\delta > \gamma$). This assumption is based on the following reasoning. First, since ω_i^{B-1} averages random shocks over a longer period of time (T periods, as compared to the $t \leq T$ periods over which η_{it}^B is aggregated) it is reasonable to put a greater weight on ω_i^{B-1}. Second, in industries with cyclical business seasons (so that the within-season variation in business conditions is high) information from earlier periods in the current season may not be very informative about conditions in the latter part of the season. This suggests a lesser dependence (a lower γ) on information from earlier parts of the current season and a greater dependence (a higher δ) on last season's complete information when estimating costs in such industries.

To allow for the fact that more recent shocks η_{it}^B may be more relevant - even though they span a shorter time series - we relax the ($\delta > \gamma$) assumption in later analysis.

It is also worth noting that although individual shocks u_{it} are independent across time, since unit costs C_{it}^B depend on cumulated shocks, average annual unit costs are serially correlated with $\frac{\delta}{\gamma}$ as an indicator of the degree of autocorrelation in annual costs.

Finally, uncertainty, and therefore the value of information, gets larger as the business season nears its end. This property is captured by the variance of current shocks, η_{it}^{B}, which equals tv^2 and increases with t.

Information in Financial Reports

When books are closed at the end of the fiscal year, which may or may not coincide with the business season, the reporting firm learns perfectly all shocks experienced in the prior fiscal year. Thus, at the beginning of year F (equivalently, at the end of fiscal year F-1) financial report y_i^{F-1} reveals cost shocks incurred in the previous T operating periods. Since the report is publicly disclosed, this information becomes available to competitors as well.[9]

Production Decisions

Given all information available at the beginning of any production period t, $t \in \{1, \ldots, T\}$, and taking as given the reporting schedule, each firm independently chooses output to maximize expected profits in that period. Unless firms collect additional information that is not publicly released (as in Section 4.2), the Cournot game is one of symmetric information.

3. Business Seasonality Only – the Monopolist's Choice

To isolate the impact of business seasonality we first examine the placement of the fiscal year (relative to the business cycle) in the absence of competitive concerns. Suppose monopolist *m* closes the books M periods after the start of the business cycle, where $0 \leq M \leq T$. Assuming no additional information collection, cost estimates in the first M periods of business cycle B will rely on information collected when the books were last closed to prepare fiscal year (F-1) report, y_m^{F-1}. Since this report was prepared

[9] We assume that both the reporting firm as well as the rival observes not just aggregate prior period shocks, ω_i^{F-1}, but also each of the T components of ω_i^{F-1}. Alternatively, we can assume that reporting process reveals the components to the reporting firm, but only the aggregate amount is disclosed in the report. The expected profit expressions for this set-up are large and unwieldy. These results are available as *Mathematica* files from the authors.

at the end of the Mth period in the previous (B-1) business cycle, the monopolist cost estimates in each of the first M periods of the current business cycle B are:

$$E(C_{mt}^{B} \mid y_m^{F-1}) = \bar{c}_m + \delta \left(\sum_{\tau=1}^{M} u_{m\tau}^{B-1} \right) \qquad \text{for } t \in \{1, \ldots, M\} \tag{3}$$

After the Mth period the monopolist closes the books for fiscal year F and learns the remaining T-M components of the previous cycle's shocks (ω_m^{B-1}) as well as the first M components of the current cycle's shocks (η_{mt}^{B}). Cost estimates in each of the latter (T-M) periods in business cycle B therefore are:

$$E(C_{mt}^{B} \mid y_m^{F-1},\ y_m^{F}) = \bar{c}_m + \delta\ \omega_m^{B-1} + \gamma \left(\sum_{\tau=1}^{M} u_{m\tau}^{B} \right) \qquad \text{for } t \in \{M+1, \ldots, T\} \tag{4}$$

Given these cost estimates, optimal expected profits over all T periods of the business cycle are given by:

$$\pi_m^* = \frac{(A - \bar{c}_m)^2 T}{4} + \frac{T^2 \delta^2 v^2}{4} + \frac{\left(\gamma^2 - \delta^2\right) v^2}{4} M(T - M)$$

In the above expression, the first two terms capture expected profits if the monopolist coincides the fiscal year with the business cycle (M = 0 or T), whereas the last term denotes additional profits from staggering the fiscal year-end by M periods relative to the end of the business season. This last term is positive only if $\frac{\delta}{\gamma} \geq 1$ and M > 0. Fiscal period choice is analogous to the choice of an M that maximizes these expected profits. The optimal M is detailed in the following proposition.

Proposition 1*: A monopolist will choose a fiscal year that*

- *coincides with the business cycle (M* = 0) if* $\frac{\delta}{\gamma} \geq 1$
- *ends mid-way through the business cycle (M* =* $\frac{T}{2}$*) if* $\frac{\delta}{\gamma} < 1$

Proof: See Appendix.

When the fiscal year coincides with the business cycle, in every operating period in the current cycle the monopolist has complete knowledge of all shocks incurred in the previous cycle (ω_i^{B-1}) but no knowledge of any shocks incurred in the earlier parts of the current cycle (η_{it}^{B}). In contrast, when the fiscal year begins M periods after start of the business season, for the first M periods of the season the

monopolist works only with partial knowledge of past shocks (ω_i^{B-1}). As such, for the first M periods his expected profits are lower than they would be with a fiscal year that coincided with the business cycle. The tradeoff to this "initial loss" is that in the latter (T-M) periods the monopolist gains not just complete knowledge of past shocks ω_i^{B-1} but also knowledge of the first M shocks in the current cycle. In the latter (T-M) periods, therefore, his profits are greater than they would be with a fiscal year that coincided with the business cycle ("subsequent gain"). The relative magnitude of the "initial loss" and "subsequent gain" determine whether the fiscal year coincides with or staggers with respect to the business season.

When $\delta \geq \gamma$, that is, when the weight on aggregate shocks from the prior cycle (ω_i^{B-1}) is greater than the weight on aggregates shocks from the current cycle, η_{it}^{B}, the benefits from gaining knowledge about η_{it}^{B} ("subsequent gain") is not sufficient to compensate for the initial lack of knowledge of ω_i^{B-1}; delaying the start of the fiscal year (M>0), therefore is not attractive and M* = 0 maximizes profits. As mentioned, the value of γ is likely to be relatively small, and the value of δ is likely to be relatively large, in industries with a cyclical business patterns or strong serial correlations in the uncertain parameter.

Staggering, if chosen, occurs at M* = T/2. This is because for each period that the firm delays the start of its fiscal year beyond the start of the business season, expected profits increase by $\frac{\left(\gamma^2-\delta^2\right)v^2}{4}$ (as long as $\delta < \gamma$). However, delaying also means that these additional profits are obtained for one less period in the season. In other words, a higher M increases expected profits by $\frac{\left(\gamma^2-\delta^2\right)v^2}{4}M$ but these increased profits can only be exploited for the remaining (T-M) periods. These timing tradeoffs yield the mid-point of the business season as the only feasible staggered year-end.

Finally, it is easy to show that if the monopolist can collect additional information such that, independent of when the fiscal year ends, at the start of a new business cycle he has complete knowledge of the previous business cycle's costs ω_i^{B-1}, then fiscal year-end will always be placed mid-way through

the business cycle, M* = $\frac{T}{2}$. In this case there the "initial loss" would be zero, whereas the "subsequent gain" would remain unchanged, making the net impact of staggering strictly positive.

4. Business Seasonality together with Competitive Concerns

In the previous section there were no consequences to disclosing information; the monopolist's choice of a reporting period was driven only by business seasonality and reflected the optimal timing for *acquiring* updated information given that seasonality. Unlike a monopolist, later entrants into the industry must also take into account the reporting schedule of incumbent firms since fiscal reports of these firms may serve as additional sources of information. In addition, because fiscal period choice determines disclosure timing, such choices can also determine the magnitude of the proprietary costs of disclosing information to competitors. In this section we extend the model to include such information transfer effects and proprietary costs of disclosure.

In what follows, we will initially assume that $\delta \geq \gamma$ so that, if it weren't for competitive concerns, as per Proposition 1 firms would choose to coincide their fiscal years with the business cycle. Section 4.3 relaxes this assumption and provides an overview of the results when $\delta < \gamma$.

4.1 No Additional Information

With $\delta \geq \gamma$, as per Proposition 1 the first entrant in the industry (firm 1) will choose a fiscal year that coincides with the business cycle. Suppose a later entrant (firm 2) chooses a fiscal year that begins M periods after the start of a new business cycle, where $0 \leq M \leq T$. With this choice firm 2's information environment changes over the business cycle in the following way. When a new business cycle starts, the latest financial reports available to firm 2 are its own latest report y_2^{F-1} (released T-M periods before the start of the current business cycle) and the rival's latest report y_1^{F-1} (released at the start of this business

cycle). Figure 1 provides a graphical illustration of the relative placement of the fiscal years.[10] Firm 2's own report y_2^{F-1} reveals ω_2^{F-1}, where

$$\omega_2^{F-1} = \sum_{t=M+1}^{T} u_{2t}^{B-2} + \sum_{t=1}^{M} u_{2t}^{B-1} \tag{5}$$

That is, firm 2's report y_2^{F-1} reflects shocks from the two separate business cycles, (B-2) and (B-1), that the fiscal year (F-1) spans. The last term in (5) represents the first M shocks in ω_2^{B-1} and is the only part of the report that is relevant for estimating costs in business cycle B. Therefore, for the first M periods of business cycle B, firm 2 knows the first M components of ω_2^{B-1} $(=\sum_{t=1}^{M} u_{2t}^{B-1})$ from its own reporting process. It estimates the remaining T-M components of ω_2^{B-1} from the publicly available rival's report y_1^{F-1} which covers all periods of the previous business cycle. Neither of the reports available in the first M periods contains any information about η_{it}^{B}. Cost estimates in each of the first M periods in the business cycle therefore are:

$$\mathrm{E}(C_{2t}^{B} \mid y_1^{F-1},\ y_2^{F-1}) = \bar{c}_2 + \delta\left(\sum_{\tau=1}^{M} u_{2\tau}^{B-1} + r * \sum_{\tau=M+1}^{T} u_{1\tau}^{B-1}\right) \qquad \text{for t} \in \{1, \ldots, \mathrm{M}\} \tag{6}$$

These estimates are maintained for the first M periods of the season. At the end of the Mth period firm 2 closes the books for its fiscal year F and perfectly learns the remaining T-M components of the previous cycle's costs (ω_i^{B-1}) as well as the first M components of the current cycle's shocks (η_{2t}^{B}). Cost estimates in each of the last (T-M) periods in the business cycle therefore are:

[10] For instance, in Figure 1 when business cycle B starts, for the first four periods firm 2 knows only the initial four shocks (u_{21}^{B-1}- u_{24}^{B-1}) from the B-1 cycle. At the end of the fourth period firm 2 closes its books again and, from that point onwards, knows all the shocks from the B-1 cycle (u_{21}^{B-1}- u_{28}^{B-1}) as well as the initial four shocks from the current cycle (u_{21}^{B}- u_{28}^{B}). As another example, suppose firm 2's business cycle coincides with the calendar year, but a firm chooses a March year-end. When the 2008 business cycle begins, the firm's books were last closed at the end of March 2007 so that only information up to that point (three months of data) is known. Till March 2008, firm 2 will work with these three months of data. At the end of March 2008 when it closes its books again it will finally have all information about 2007, as well as information for the first three months of the current 2008 cycle.

$$E(C_{2t}^{B} \mid y_1^{F-1},\ y_2^{F}) = \bar{c}_2 + \delta\ \omega_2^{B-1} + \gamma\left(\sum_{\tau=1}^{M} u_{2\tau}^{B}\right) \qquad \text{for } t \in \{M+1, \ldots, T\} \tag{7}$$

Firm 1's cost estimates are analogously determined and are detailed in the Appendix. With cost estimates as described above, expected profits over the business cycle (spanning T periods) are:

$$\pi_2^{*} = \frac{(A - 2\bar{c}_2 + \bar{c}_1)^2 T}{9} + \delta^2\,\frac{(5-4r)v^2T^2}{9} + \frac{\left(\gamma^2(2-r)^2 - 4\delta^2(1-r^2)\right)v^2}{9} M(T-M) \tag{8}$$

The first two terms together reflect expected profits if the fiscal years of the two firms coincided with each other (and also with the business cycle), whereas the last term reflects incremental profits if firm 2's fiscal year were staggered by M periods (and firm 1 continued to report at the end of the business cycle. This last term is positive if and only if $\frac{\delta^2}{\gamma^2} < \frac{(2-r)^2}{4(1-r^2)}$ and M >0. Firm 2's choice of a reporting period is equivalent to choosing an optimal M that maximizes these expected profits.

Proposition 2 *If* $\frac{\delta}{\gamma}$ *so that firm 1 chooses to coincide its fiscal year with the business cycle, the second entrant, firm 2, will choose a fiscal year that*

- *coincides with the business cycle (and with firm 1's fiscal year) if* $\frac{\delta^2}{\gamma^2} \geq \frac{(2-r)^2}{4(1-r^2)}$.
- *ends mid-way through the business cycle (*$M^{*}=\frac{T}{2}$*) if* $\frac{\delta^2}{\gamma^2} < \frac{(2-r)^2}{4(1-r^2)}$

Proof: See Appendix.

When firm 2 coincides its fiscal year with the business cycle, in every period in the business season firm 2 always has perfect knowledge of all T components of the prior season's shocks ω_2^{B-1} (but no knowledge of shocks from earlier in the current, η_{2t}^{B}). In contrast, when firm 2 begins its fiscal year M periods after the start of the business season, in the first M periods it has perfect knowledge only of the first M components and only partial knowledge (inferred from the rival's report) of the last (T-M) components of prior season's shocks, as shown in (6). As a result of the more limited information, staggering with respect to the business cycle yields lower expected profits in the first M periods ("initial loss"). To compensate, though, in the last (T-M) periods of the business cycle firm 2 gains not just

complete knowledge of last periods shocks, ω_2^{B-1}, but also knowledge about the initial M shocks from earlier in the current season, as shown in (7). As a result, expected profits in the last (T-M) periods of the business season are greater ("subsequent gain") when fiscal years are staggered versus when they coincide with the business cycle. The relative magnitude of the "initial loss" and the "subsequent gain" determines the final outcome.[11]

When $\frac{\delta^2}{\gamma^2} \leq \frac{(2-r)^2}{4(1-r^2)}$, the "subsequent gain" is larger than the "initial loss", making the net impact of staggering - the last term in (8) - positive. Firm 2 then maximizes expected profits by staggering its year-end with respect to the rival. Further, when staggering it chooses a fiscal year that ends at the mid-point of the business cycle, M* = $\frac{T}{2}$.

Coincident fiscal years for the two firms are the outcome only if $\frac{\delta^2}{\gamma^2} \geq \frac{(2-r)^2}{4(1-r^2)}$. In this section by assumption (to be relaxed later) $\delta \geq \gamma$, so that the $\frac{\delta^2}{\gamma^2} \geq 1$. The right hand side of the above condition is always less than 1 if r < 0.8. It follows therefore that this condition is met (so that firm 2 will coincide its fiscal year with the business cycle, and therefore with firm 1's) when $\delta \geq \gamma$ and r < 0.8. Coincident fiscal years may also result for some values of r ≥ 0.8 as long as the above condition is satisfied. In general, coincident fiscal years are more likely with larger values of $\frac{\delta}{\gamma}$ and smaller values of r.

Proposition 2 also suggests that when $\frac{\delta}{\gamma} \geq 1$, firm 2 is *less* likely (than a monopolist) to choose a fiscal year end that coincides with the business season. To see this note that when $\frac{\delta}{\gamma} \geq 1$, the monopolist coincides with business season for all values of r. In contrast, when $\frac{\delta}{\gamma} \geq 1$ the condition for firm 2 to

[11] From the last term in (8), $\frac{-4\delta^2(1-r^2)v^2}{9} M(T-M)$ reflects the "initial loss" whereas $\frac{\gamma^2(2-r)^2v^2}{9} M(T-M)$ is the "subsequent gain."

coincide, $\frac{\delta^2}{\gamma^2} \geq \frac{(2-r)^2}{4(1-r^2)}$, is met for all r ≤ 0.8 but only for certain values of r ≥ 0.8. The existence of an incumbent firm that already reports with the business cycle means that a later entrant has a (albeit noisy) source of information about the prior cycle's costs. This serves to reduce the "initial loss" and makes deviation from the business cycle more likely.[12]

4.2 Additional Information Collection

The prior section assumed that unless firm 2's fiscal year coincided with the business cycle, for the first M periods of the new business cycle it did not have a complete estimate of the prior cycle's shocks, ω_2^{B-1} . We now assume that at the end of each business cycle firms collect additional information such that when the new business cycle starts, they always have complete knowledge of prior season's shocks, ω_i^{B-1} . For firm 2, when it starts its fiscal year M periods after the start of the new business season, the additional information pertains to the last (T-M) shocks in ω_2^{B-1} . Note specially that this privately collected information is *not* disclosed to the rival. With this assumption, cost estimates in each of the first M periods are

$$E(C_{2t}^B \mid y_1^{F-1},\ y_2^{F-1}) = \bar{c}_2 + \delta\ \omega_2^{B-1} \tag{9}$$

Cost estimates in the remaining T-M periods remain unchanged and are as described in (7). Optimal expected profits over the T periods of the business cycle are:

$$\pi_2^* = \frac{(A - 2\bar{c}_2 + \bar{c}_1)^2 T}{9} + \delta^2 \frac{(5-4r)v^2T^2}{9} + \frac{\left(4\gamma^2(2-r)^2 - 7\delta^2(1-r^2)\right)v^2}{36} M(T-M) \tag{10}$$

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[12] A comparison of the optimal expected profit functions of the two firms shows that, assuming $\bar{c}_1 = \bar{c}_2$, the difference in equilibrium expected profits equals $(\pi_1^* - \pi_2^*) = \frac{r(5r-4)v^2\gamma^2}{12}(T-M)$
When fiscal years coincide (for r < 0.8), M = T and expected profits for the two firms are equal. However, if r ≥ 0.8 firm 2 may have an incentive to stagger so that M < T. In that case firm 1's equilibrium profits are greater. This suggests that the first movers' profits are always at least as large as firm 2's.

Proposition 3 *If firm 2 collects additional information such that it is fully informed about the previous business cycle when a new cycle begins, firm 2 will choose a fiscal year that*

- *coincides with the business cycle (and with firm 1's fiscal year) if* $\frac{\delta^2}{\gamma^2} \geq \frac{4(2-r)^2}{7(1-r^2)}$
- *ends mid-way through the business cycle (M* =* $\frac{T}{2}$*) if* $\frac{\delta^2}{\gamma^2} < \frac{4(2-r)^2}{7(1-r^2)}$.

Proof: See Appendix.

That is, the ability to collect information earlier than the end of the reporting period increases the likelihood of staggered year-ends. To see this note that, comparing expected profit expressions in (10) and (8), collecting additional information about the previous business cycle lowers the "initial loss" while keeping the "subsequent gain" unaltered.[13] As a result, additional information collection improves the probability of staggered year-ends. Further, and consistent with results in prior literature on information sharing, it can be shown that firm 2 may have incentives to disclose the additional information that it collects privately.[14] If the privately collected information is disclosed, the "initial loss" reduces to zero and firm 2 always prefers to stagger.

Finally, a comparison of (10) and (8) also reveals that information about an additional (T-M) components of ω_2^{B-1} increases expected profits by $\frac{(1-r^2)v^2\delta^2}{4}M(T-M)$. Therefore, as long as the cost of collecting the additional information is less than this amount, it will be in firm 2's interest to gather the additional information.

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[13] With additional information about ω_2^{B-1} the initial loss goes down from $-\frac{4}{9}\delta^2(1-r^2)v^2$M(T-M) to $-\frac{7}{36}\delta^2(1-r^2)v^2$M(T-M). Although both firms are now perfectly informed about ω_i^{B-1} the initial loss does not reduce to zero because, as compared to coincident fiscal years, in this case the rival remains uninformed about some components of firm 2's costs and, as prior research shows, the informed firm's profits are lower when the rival is ignorant about the informed firm's costs. (Proposition 2 and 4i in Fried [1984], Proposition 4.4 in Raith [1996], Proposition 1 in GalOr [1988]).

[14] In Cournot oligopolies allowing the rival to become better informed about the disclosing firm's costs improves the expected profits of the informed firm. (Proposition 2 in Fried [1984], Proposition 4.4 in Raith [1996], Proposition 1 in GalOr [1988]).

4.3 When $\delta < \gamma$

In our model the degree of year-over-year serial correlation in unit costs is an increasing function of $\frac{\delta}{\gamma}$. When $\delta < \gamma$, information about shocks from the current (rather than the prior) business cycle is relatively more valuable in estimating costs. The reporting process will yield information about cost shocks from earlier in the current cycle only if the reporting period ends part way through the current cycle. Consistent with this thought Proposition 1 showed that when $\delta < \gamma$ the monopolist will choose a fiscal year that ends at T/2.

A subsequent entrant into the industry must decide whether to coincide its fiscal year with the business cycle or with the incumbent firm's or to place it spanning a completely different set of T periods. If the incumbent firm is reporting at T/2, as a new season begins firm 2 cannot depend on the incumbent firm's reports for information related to all T periods of the prior season. As a result the "initial cost" to not coinciding with the business cycle is greater in this setting but is mitigated somewhat by the relatively smaller magnitude of δ. Additionally, the "subsequent gain" from not coinciding with the business cycle (which came in the form of information about the current season) is also weaker since firm 2 already has an opportunity to learn (albeit imperfectly) about the current season after firm 1 releases its report at T/2. The net effect of these forces is detailed in Proposition 4.

Proposition 4 *When $\delta < \gamma$ and the incumbent firm reports at T/2, firm 2 will choose a fiscal year that*

- *ends between the end of the business season and firm 1's fiscal year-end, $0 < M^* < T/2$, if $r \geq 0.8$*
- *ends with the business season, $M^* = 0$, if $r < 0.8$.*

Proof: See Appendix.

Two aspects of this result are worth highlighting.[15] First, in this setting there is never any reason for firm 2 to cluster with firm 1. If firm 2 chooses to deviate from the business cycle, it can always do better by locating its fiscal year-end between the end of the business cycle and firm 1's fiscal year-end.

[15] There exists another equilibrium that is symmetric to the equilibrium described in Proposition 4. This equilibrium occurs at M** = T-M*, and the equilibrium profits at M* and M** are equal for the two firms. As a result, firm 2 will be indifferent between M* and M**.

Since firm 2 locates its year-end at M* = 0 or M* < T/2, and the incumbent firm locates at T/2, when $\delta < \gamma$ dispersed year-ends for these two firms are always the outcome. Second, and on a related note, it follows that year-ends that don't coincide with the business cycle are more likely when costs exhibit low auto-correlation (as indicated in our model by low values of $\frac{\delta}{\gamma}$). Results in the previous sections showed that when $\frac{\delta}{\gamma} > 1$, both firm 1 and firm 2 choose to end their fiscal year with the business season as long as $r < 0.8$; firm 2 deviates from this only for some (but not all) values of $r \geq 0.8$. In contrast, when $\frac{\delta}{\gamma} < 1$, firm 1 always chooses a fiscal year different from the business season whereas firm 2 makes that choice for *all* values of $r \geq 0.8$

5. Discussion and Conclusion

In many industries a majority of the firms choose fiscal years that coincide with the business cycle. For instance, many retail firms choose end of January, after the post-Christmas rush, while firms catering to the education market often choose the school year as their fiscal year. On the other hand, there are closely competing firms such as Adobe, Apple and Microsoft, all major players in the software publishing industry and all catering to somewhat similar customers, that choose to end their fiscal years at vastly different times - in November, September and June, respectively - even though December is the most popular year-end in their industry. Casual empiricism also shows that when changing fiscal years firms often consider the fiscal years of peer firms. For instance, when the software firm Versata Inc. changed its fiscal year from 12/31 to 10/30 in 2002, it offered a bevy of strategic reasons:

> "Versata has noted that several successful software companies have made a similar change and have announced benefits from having a non-traditional fiscal year. Moving to a year-end cycle that is different than the traditional calendar yearend is intended to put Versata in an improved position to close more direct business during the last month of each new fiscal quarter when there may be less external and internal competition for customer time and resources. Additionally, an important part of Versata's strategy continues to be selling through channel partners. Since a majority of Versata's channel partners have a calendar year fiscal quarter, Versata now has the potential to support channel partners during the last month of their quarter."

While there are numerous industry-specific factors that influence the reporting period choice, these factors by themselves are not sufficient to explain the within-industry variation in reporting periods that evidence in Table 1 reveals. To explain the factors that determine whether fiscal year-ends within an industry will be clustered or dispersed, this paper develops a model of reporting period choice that incorporates both competitive forces and business seasonality. The main results from the analysis are summarized in Table 2 and yield the following insights.

The results show that higher values of $\frac{\delta}{\gamma}$ are more likely to result in fiscal years that coincide with the business cycle. Since δ and γ are weights on information from the prior and current year, respectively, higher values of $\frac{\delta}{\gamma}$ are likely to be observed in industries with strong auto-correlation in uncertain parameters (so that the significance of past information, as captured by δ, is high) and/or in industries where the business season is highly cyclical such that earlier parts of the season have little bearing on the later parts (γ is low). This suggests that fiscal year-ends that coincide with the business cycle are more likely for firms with relatively high serial correlations in their costs and/or for firms that operate in industries with more within-season variations in their business.

Even though higher values of $\frac{\delta}{\gamma}$ provide strong incentives for firms to coincide their fiscal year with the business season, firms may still deviate from this choice and stagger their year-ends when information transfer effects are strong. One benefit of staggered year-ends is the ability to update *own* information part way through one's own fiscal year by observing rivals' reports. This ability is more pronounced when cross-sectional correlation is high or when financial reports are informative about industry-wide rather than firm-specific factors. Since the possibility of learning from rivals' reports is higher when firms are similar, we obtain the seemingly counterintuitive result that *similar* firms are more likely to choose *dispersed* disclosure timing.

The results show that when $\frac{\delta}{\gamma} > 1$ staggering occurs only for relatively large values of r, where r is the cross-sectional correlation in firms' uncertain parameter (costs). In our model, when $\frac{\delta}{\gamma} > 1$ staggered year-ends occur only for some (not all) values of r that exceed 0.8. This suggests that staggered year-ends are relatively infrequent and this suggestion is consistent with empirical evidence. Table 1 shows that of the 8,006 Compustat firms registered in the U.S. in 2005, about 73% cluster their year-end at the most popular month in their respective industry group and only 27% deviate from this cluster. Disaggregating this data further, of the 27% that deviate 16% choose year-ends such that even if the annual year-ends don't match, the quarters still match up with the popular December year-end group. Thus, only about 11% of the firms choose year-ends that result in both the annual and quarterly periods being truly staggered with respect to the most popular fiscal period in their industry.[16]

If it is possible for firms to collect some of the information that fiscal reports provide earlier than at the end of the fiscal year, Proposition 3 shows that staggered year-ends become more likely. The primary benefit of closing the books at the end of the business cycle is that information from the previous cycle is available early in the next cycle. If there is an alternative source of information regarding the previous cycle, then firms can exploit the benefits of staggering (greater information about more recent shocks) without foregoing the benefits of coinciding with the business cycle.

It is also worth noting that in our model there is no incentive for firms to cluster at any point other than the end of the business cycle. Proposition 4 shows that when the first firm chooses a fiscal year that does not coincide with the business cycle, the second firm, ceteris paribus, never chooses to cluster with firm 1. Clustering year-ends around each other *per se* provides no benefits to firms, but ending the fiscal year with the business cycle does.[17] In other words, although the appearance may be one of herding, firms do not necessarily move towards *each other* but towards a common business cycle.

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[16] These ratios change only slightly when we leave out the 288 Retail sector firms (2-dgit NAICS 44-45).

[17] There may be reasons other than business seasonality that prompt firms to choose the same year-end. These reasons include convention, business cycles of customers and/or suppliers, capital market

Finally, if information from the previous business cycle is important and if there already exist some firms that are reporting with the business cycle, it makes it easier for subsequent entrants to the industry to deviate from the business cycle in their reporting period choice. This is evident from the fact that the condition for the first firm in the industry to stagger with respect to the fiscal year is $\frac{\delta}{\gamma} < 1$ (Proposition 1), whereas the condition for the second firm that enters the industry (firm 2) to stagger - provided the first firm is reporting with the business cycle - is $\frac{\delta^2}{\gamma^2} < \frac{(2-r)^2}{4(1-r^2)}$ (Proposition 2). When $\frac{\delta}{\gamma} < 1$ the monopolist's condition is met for all values of r, whereas the second firm's condition is met only for certain (not all) values of r that exceed 0.8.

Conclusion

In order to understand the factors that determine whether fiscal year-ends within an industry will be clustered or dispersed, and whether fiscal years will end with the business season, this paper develops a model of reporting period choice that incorporates both competitive forces and business seasonality. Overall, our results show that while it is business seasonality that is the primary determinant of reporting period choice, competitive forces in the form of information transfer effects and proprietary disclosure costs have the ability to make firms' fiscal years deviate from the business cycle. Such deviation is more likely when auto-correlation in firms' annual costs is low, when within-season variations in business conditions are low, when cross-sectional correlation between costs of industry peers is high and/or when affordable opportunities exist for collecting information that the year-end closing of books typically provides. Further, if incumbent firms are already reporting at the end of the business season, newer firms may have a greater inclination to make a different choice. The results also offer a novel rationale for why the end of the business cycle is an attractive fiscal year-end. Firms receive valuable managerial information when books are closed at the end of reporting periods. The motivation to receive this

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incentives related to improving comparability with peers, the convenience of matching the fiscal year with the tax year, etc.

information at an opportune time, rather than the ease of collecting information or any other factors, makes the end of business cycle an attractive year-end in our setting.

Like all models our model is somewhat stylized and captures only some of the economic forces that bear on the reporting choice. However, this relatively simple model allows us to isolate and explain the impact of the key economic forces clearly. The overall insights provided by the model are robust and generalizable to broader settings.

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Figure 1 Business Cycle and Fiscal Years

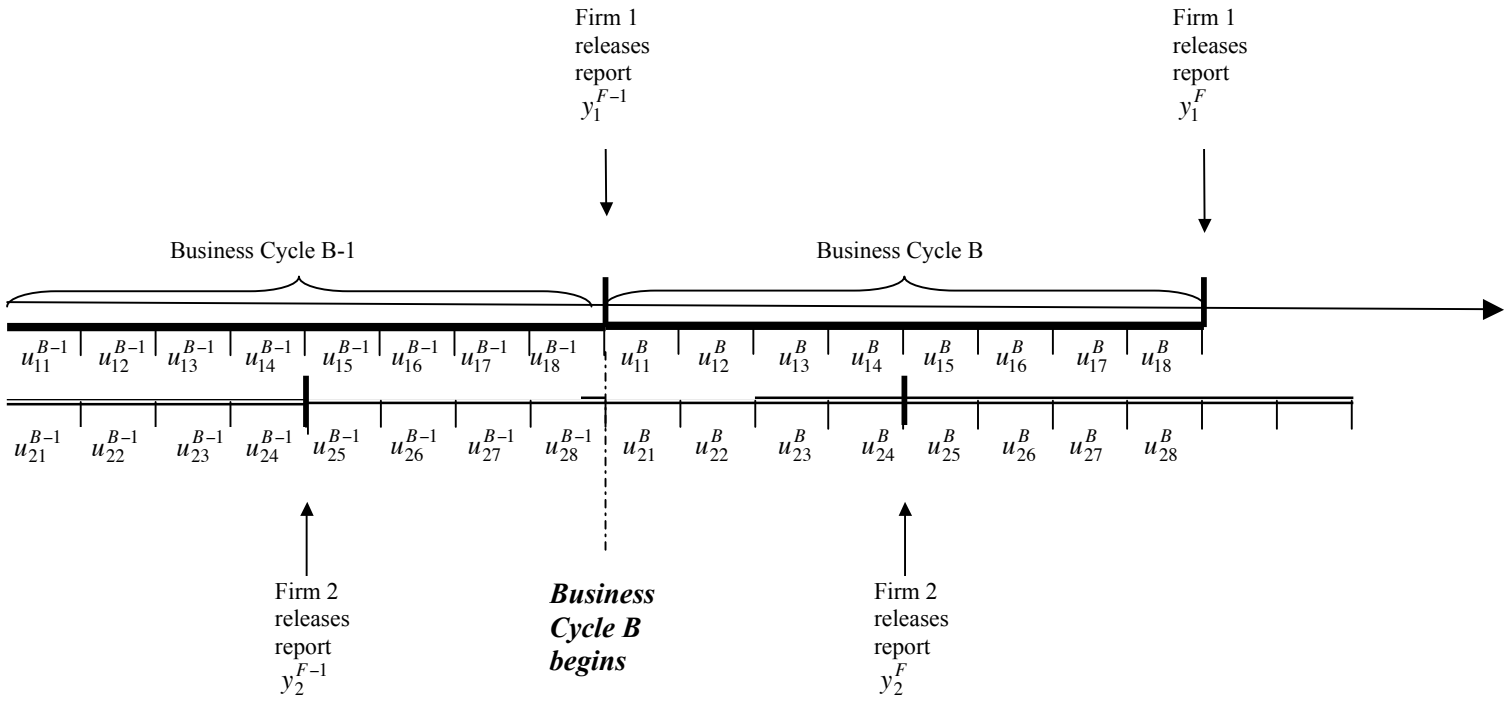

Figure 1 shows the arrangement of fiscal years for firms 1 and 2 when each business cycle (and fiscal year) spans eight operating periods. When business cycle B begins, firm 1 knows all shocks from businceess cycle B-1 (u_{11}^{B-1} to u_{18}^{B-1}) whereas firm 2 knows only the shocks u_{21}^{B-1} to u_{24}^{B-1}.

Legend:

u_{it}^{B} Shock to firm i's costs in period t of business cycle B

Firm 1's fiscal year coincides with the business cycle.

Firm 2's fiscal year.
Firm 2's fiscal year starts M (=4) periods after the start of a new business

Table 1 Clustering of Fiscal Year-ends in each of the firms

Distribution of fiscal year-ends in 2005 for firms incorporated in the U.S. for which year-ends and NAICS were available on the 2007 COMPUSTAT tapes.

	FYE➔	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*
Industry Sector*	#Firms												
11	23	0%	0%	0%	0%	4%	9%	0%	9%	0%	9%	4%	65%
21	455	2%	0%	2%	2%	0%	5%	1%	1%	4%	1%	0%	80%
22	277	0%	0%	2%	0%	0%	1%	0%	0%	6%	0%	0%	89%
23	93	0%	0%	3%	2%	1%	8%	1%	0%	5%	2%	4%	73%
31-33	2,968	2%	1%	6%	2%	2%	8%	1%	1%	6%	2%	1%	67%
42	217	3%	3%	9%	1%	3%	8%	3%	2%	6%	0%	1%	60%
44-45	288	35%	4%	4%	1%	0%	3%	2%	2%	7%	1%	0%	40%
48-49	222	0%	0%	4%	0%	1%	3%	0%	1%	2%	0%	2%	86%
51	915	2%	1%	6%	1%	1%	6%	2%	1%	5%	2%	1%	72%
52	1,501	0%	0%	2%	0%	0%	4%	0%	0%	4%	1%	0%	88%
53	152	2%	0%	2%	1%	1%	7%	2%	0%	5%	1%	1%	80%
54	370	3%	0%	5%	1%	1%	7%	1%	1%	7%	1%	1%	70%
56	152	1%	2%	2%	2%	1%	5%	1%	1%	7%	2%	1%	74%
61	25	0%	0%	0%	0%	4%	20%	4%	4%	8%	0%	0%	60%
62	132	0%	0%	2%	0%	1%	6%	2%	2%	8%	2%	0%	80%
71	57	2%	4%	0%	2%	2%	7%	4%	0%	4%	0%	2%	75%
72	131	2%	1%	2%	2%	2%	6%	2%	2%	9%	2%	1%	69%
81	28	4%	0%	11%	4%	0%	11%	0%	0%	7%	4%	0%	61%
99	23	0%	0%	0%	0%	4%	9%	0%	9%	0%	9%	4%	65%
	8006	3%	1%	5%	1%	1%	6%	1%	1%	5%	2%	1%	73%

** These sector classifications are based on U.S. Census Bureau's 1997 NAICS definitions. This classification system is more current and more refined than the SIC classifications. For instance, it separately identifies an Information Sector (#51) which the SIC system does not.

Sector Names

11 Agriculture, Forestry, Fishing
21 Mining
22 Utilities
23 Construction
31-33 Manufacturing
42 Wholesale
44-45 Retail
48-49 Transportation &Warehousing
51 Information
52 Finance a & Insurance
53 Real Estate
54 Professional, Scientific and Technical Services
56 Administrative Support and Waste Management
61 Educational Services
62 Health Care and Social Assistance
71 Arts, Entertainment and Recreation
72 Accommodation and Food Services
81 Other Services

Table 2 Summary of Main Results

	Firm 1's choice	**Firm 2's choice**
$\frac{\delta}{\gamma} > 1$ (high serial correlation; more seasonal business)	Firm 1's reporting period coincides with business cycle.	*Firm 2's reporting period coincides with the business cycle (and with Firm 1's) only if* ▪ $r < 0.8$ ▪ $r \geq 0.8$ *and* $\frac{\delta^2}{\gamma^2} \geq \frac{(2-r)^2}{4(1-r^2)}$
$\frac{\delta}{\gamma} < 1$	Firm 1 reports at T/2	Firm 2 never reports at T/2. ▪ *Firm 2's reporting period coincides with the business cycle only if* $r < 0.8$ ▪ *Firm 2's reporting period ends between the end of the business season and the end of Firm1's reporting period* when $r \geq 0.8$.

Firm 1 is the incumbent firm and firm 2 is the subsequent entrant into the industry.
The table shows the main results from Propositions 2 and 4.

- When $\frac{\delta}{\gamma} > 1$, dispersed year-ends occur only for some (not all) values of $r \geq 0.8$.
- When $\frac{\delta}{\gamma} < 1$, dispersed year-ends occur for *all* values of r.

Appendix

Proof of Proposition 1:

In each period t the monopolist maximizes expected profits $E\pi^B_{mt} = (A - EC^B_{mt} - q^B_{mt})q^B_{mt}$, where EC^B_{mt} are expected costs based on available information at the start of period t. Profit-maximizing output is:

$$q^{B\bullet}_{mt} = \frac{1}{2}(A - \bar{c} - \delta\, EC^B_{mt}) \qquad \text{(A1)}$$

In the first M periods of the business season, EC^B_{mt} is as detailed in equation (3). Plugging these cost estimates in (A1), then using the resulting $q^{B\bullet}_{mt}$ in the realized profit function $\Pi^B_{mt} = (A - C^B_{mt} - q^B_{mt})q^B_{mt}$ and taking expectation (before any of the random variables are realized) yields expected profits in the first M periods. Profits in each of the last (T-M) periods are calculated using cost estimates in equation (4) and following similar steps.

Summing the profits over the T periods in the business cycle yields the expected profit expression in (5). The expected profit function is maximized with respect to M to yield the result in Proposition 1. The second order condition for M* =T/2 to be a maxima is:

$$-\frac{1}{2}v^2(\gamma^2 - \delta^2) < 0$$

and is satisfied when $\gamma > \delta$.

Proof of Proposition 2:

In each period t firm i chooses output to maximize expected profits $E\pi^B_{it} = (A - EC^B_{it} - Q^B_t)q^B_{it}$, where Q^B_t is the aggregate output in the industry.

In each of the first M periods of the business cycle firm 2's expected costs EC^B_{2t} are as given in equation (6). Because firm 1's fiscal year coincides with the business cycle, firm 1's cost estimates in each of the first M operating periods are:

$$\mathrm{E}(C^B_{1t} \mid y^{F-1}_1,\ y^{F-1}_2) = \bar{c}_1 + \delta\, \omega^{B-1}_1 \qquad \text{for t} \in \{1, \ldots, \mathrm{M}\}$$

Firm i's reaction function takes the form $q^B_{it} = \frac{1}{2}(A - EC^B_{it} - \hat{q}^B_{jt})$ so that optimal output is given by $q^{B*}_{it} = \frac{1}{3}(A - 2EC^B_{it} + EC^B_{jt})$. Expected costs are plugged into q^{B*}_{it} and the resulting expression for optimal output is used to calculate the period t realized optimal profits $\Pi^B_{it} = (A - C^B_{it} - Q^{B*}_t)q^{B*}_{it}$, where t $\in$ {1, …, M}.

In the last (T-M) periods, after the release of firm 2's report y_2^F at end of period M, firm 2's costs are as described in equation (7). Firm 1 learns about the first M components of η_{1t}^B from y_2^F and therefore estimates costs as:

$$E(C_{1t}^B \mid y_1^{F-1},\ y_2^F) = \bar{c}_1 + \delta\ \omega_{1t}^{B-1} + \gamma\left(r^* \sum_{\tau=1}^{M} u_{2\tau}^B\right) \qquad \text{for } t \in \{M+1, \ldots, T\}$$

With these expected costs, optimal profits in each of the last (T-M) periods are calculated as described above. Summing optimal profits over all T periods of the business season and taking expectations before any random variables are realized (using the covariance structure specified in equation (1)) yields the expected profit function in (8). The second order condition for M* =T/2 to be a maxima is given by:

$$-\frac{2\left(\gamma^2(2-r)^2 - 4\delta^2(1-r^2)\right)v^2}{9} < 0$$

and is met iff $\frac{\delta^2}{\gamma^2} < \frac{(2-r)^2}{4(1-r^2)}$.

Proof of Proposition 3:

When firm 2 collects additional information and keeps it private, firm 1's cost estimates remain unchanged and are as described in the proof for Proposition 2. Firm 2's cost estimates are described in the text. Optimal expected profits are calculated using these cost estimates and following steps similar to those described in the proof of Proposition 2. (If firm 2 does not disclose its private information, the Cournot game becomes one of asymmetric information; conjectures that optimal output is linear in the private information are used to solve this game.) The second order condition for M* =T/2 to be a maxima is given by:

$$-\frac{\left(4\gamma^2(2-r)^2 - 7\delta^2(1-r^2)\right)v^2}{36} < 0$$

and is met iff $\frac{\delta^2}{\gamma^2} < \frac{4(2-r)^2}{7(1-r^2)}$.

Proof of Proposition 4:

With $\delta < \gamma$, according to Proposition 1 firm 1 places its fiscal year mid-way through the business season, at T/2. Firm 2 can place its year-end before, with or after firm 1's.

Case 1: $0 \le M \le T/2$

Suppose firm 2 ends its fiscal year after the first M periods of the business season, where $0 \le M \le T/2$. Then, the information environment in the industry will change over the business season in the following way. In the first M periods of fiscal year F, the latest reports available in the industry will be y_1^{F-1} (covering up to the first T/2 periods of the previous business cycle) and y_2^{F-1} (covering up to the first M periods, where $M \le T/2$, of the previous business cycle). At the end of the Mth period in fiscal year F firm 2 will release its new report. Therefore, in periods M+1 to T/2, the latest reports will be y_1^{F-1} (as before) and y_2^F (covering up to the first M periods of the *current* business cycle). Finally, at the end of the period $\frac{T}{2}$ firm 1 will release its report so that from periods (T/2 + 1) onwards the latest publicly available reports will be y_2^F (as before) and y_1^F (covering up to the first T/2 periods of the *current* business cycle). Firm 2's expected profits for the T periods during the business cycle are given by

$$\pi_2^* = \frac{(A - 2\bar{c}_2 + \bar{c}_1)^2 T}{9} + \delta^2 \frac{(5-4r)v^2}{9}\left(M^2 - M\frac{T}{2} + \frac{3T^2}{4}\right) + \gamma^2 \frac{(5-4r)v^2}{9} M\frac{T}{2}$$
$$- \frac{(2-r)^2 v^2}{36}(2M - T)(2M\gamma^2 + T\delta^2) - \frac{(1-2r)^2 v^2}{36}(2M - T)(2M\delta^2 + T\gamma^2)$$

The optimal M is given by:

$$M^* = \frac{T}{2} * \frac{\left((5-4r) + 3(1-r^2)\right)(\gamma^2 - \delta^2)}{2\left(\gamma^2(2-r)^2 - 4\delta^2(1-r^2)\right)}$$

To be consistent with the starting assumption that $0 \le M \le T/2$, it must be that M* lies between 0 and T/2; it is easy to show that this is true only for $r \ge 0.8$. Thus, M* is an equilibrium only if $r \ge 0.8$.

The second order condition for M* to be a maxima is given by:

$$-\frac{2\left(\gamma^2(2-r)^2 - 4\delta^2(1-r^2)\right)v^2}{9} < 0$$

and is met iff $\frac{\delta^2}{\gamma^2} < \frac{(2-r)^2}{4(1-r^2)}$. With $\delta \le \gamma$, the LHS is ≤ 1 and when $r \ge 0.8$, $\frac{(2-r)^2}{4(1-r^2)}$ is ≥ 1. Therefore, when ($\delta \le \gamma$) and $r \ge 0.8$ firm 2 will always choose to place its fiscal year-end at M*, where $0 \le M^* \le T/2$. For lower values of r, firm 2 will coincide its fiscal year with the business season (M*=0). (For r <0.8, coinciding with the business season always yields higher expected profits than coinciding with firm 1's fiscal year.)

Case 2: $T/2 < M \le T$

Finally, if we start with the assumption that firm 2 chooses an M such that $T/2 \le M \le T$, there exists an equilibrium at M** in which M** = T-M*. Other properties of this equilibrium are similar to the ones described above. Expected profits at M* and at M** are identical.