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Asymmetric Trading Costs Prior to Earnings Announcements: Implications for Price Discovery and Returns

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ABSTRACT

We show that the cost of trading on negative news, relative to positive news, increases before earnings announcements. Our evidence suggests that this asymmetry is due to financial intermediaries reducing their exposure to announcement risks by providing liquidity asymmetrically. This asymmetry creates a predictable upward bias in prices that increases preannouncement, and subsequently reverses, confounding short-window announcement returns as measures of earnings news and risk premia. These findings provide an alternative explanation for asymmetric return reactions to firms' earnings news, and help explain puzzling prior evidence that announcement risk premia precede the actual announcements. Our study informs methods for research centering on earnings announcements and offers a possible explanation for

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patterns in returns around anticipated periods of heightened inventory risks, including alternative firm-level, industry-level, and macroeconomic information events.

JEL codes: E44; G12; G14; G21; M40; M41

Keywords: earnings announcements; liquidity provision; transaction costs; announcement returns; risk premia; bad news; asymmetric reaction

1. *Introduction*

A vast literature spanning accounting, finance, and economics studies stock returns around firms' earnings announcements. Researchers use stock returns around earnings announcements to understand revisions in investor expectations about firm value, risk premia driven by the release of earnings news, and determinants of the equity market reaction to earnings news, such as the credibility of financial reporting. Similarly, liquidity and trading volumes around earnings announcements are commonly used to gauge the extent of attention or disagreement among investors, information asymmetry, and the news conveyed to investors.

This study provides both theoretical and empirical evidence that returns, liquidity, and trading volume around earnings announcements are asymmetrically influenced by frictions in the financial intermediary sector, which is composed of investment banks, broker-dealers, and market-making firms, among others. Intermediaries provide liquidity by serving as the trade counterparty in response to imbalanced demand between buyers and sellers. In doing so, they are forced to take temporary positions in the security, referred to as inventory, and thus expose themselves to price fluctuations (inventory risk). Due to this exposure, the compensation that intermediaries demand varies with their inventory positions as well as the security's risk profile. We show that these factors create asymmetries in trading costs and, in turn, price discovery surrounding earnings announcements by altering investors' incentives to trade.

Our central hypothesis stems from prior evidence that intermediaries are positively exposed to the market and hold positive average inventory positions, indicating that they are likely exposed to increased risks associated with earnings announcements.[1] As a result of this exposure, we predict that intermediaries demand greater compensation for providing liquidity to sell orders, which would exacerbate their exposure, relative to buy orders, which would shield them from announcement risks by helping them

[1] For example, Brunnermeier and Pedersen [2009] report that broker-dealer firms have median market betas above one. Adrian and Shin [2010] show that financial intermediaries' leverage is highly procyclical and argues that this is because they expand their positions in response to market booms. Similarly, studies using proprietary data on market makers' inventory positions show that they tend to hold positive inventories (Madhavan and Smidt [1993], Comerton-Forde et al. [2010]).

reduce net exposure before the announcement (referred to as "getting flat" in the industry). This asymmetry acts like an endogenous short-sale cost by discouraging selling, which in turn causes an upward bias in preannouncement price discovery and returns that reverses postannouncement. We refer to this hypothesis about the causes and effects of asymmetric trading costs (ATCs) as the ATC hypothesis. We formalize the ATC hypothesis by developing a model of trading before an information event involving a financial intermediary with positive exposure to the announcing firm's equity. Our model predicts the following chain of events: the intermediary sets asymmetric prices for liquidity to reduce its inventory before the announcement, causing a positive bias in preannouncement price discovery, which leads to an upward bias in preannouncement returns that corrects once the news is released. The upward bias may initially seem counterintuitive because, for most agents, the desire to sell would lead to the opposite—a decrease in average prices before announcements. However, when liquidity providers in our model seek to reduce their inventories, they use their pricing power to induce buy demands and ensure that average prices are *above* fundamental value.

Our first set of empirical results supports the cornerstone of the ATC hypothesis, that intermediaries provide liquidity asymmetrically before earnings announcements. Using short-term return reversals as a proxy for the compensation intermediaries demand for this, as in Campbell, Grossman, and Wang [1993], we show that reversals become increasingly asymmetric before announcements. Reversals associated with net selling pressure (i.e., recent losers) increase several days before announcements and peak at more than three times normal levels immediately before announcements, whereas no discernible trend exists for buying pressure. These results are consistent with our model's prediction that intermediaries demand greater compensation for providing liquidity to sellers, relative to buyers, and thus that traders incur higher relative costs of impounding negative news into preannouncement prices.

A natural question is whether the magnitude of an intermediary-based story could explain the magnitude of our findings. We estimate that the asymmetry in liquidity provision in our sample peaks at 54 basis points (bp) on day $t-1$, which is based on the spread in return reversal magnitudes across quintiles of prior day net buying/selling pressure. A basis of comparison for this estimate is the returns of unconditional return-reversal strategies, which peak in our sample at around 100 bp before earnings announcements. Another reasonable benchmark of comparison is the typical magnitude of price pressures due to specialist inventory positions, which Hendershott and Menkveld [2014] estimate is 49 bp, with a half-life of 0.92 days. These comparisons suggest that our results are not only economically meaningful but also comport with plausibility bounds established by research.

Our second set of empirical results provide support for our model's prediction that investors respond to ATCs by trading more aggressively on positive signals before announcements. Specifically, preannouncement abnormal order imbalances (*AOI*s) are strongly positive for good news and insignificantly negative or even slightly positive for bad news, a stark illustration that traders with negative news are deterred from trading before the announcement.

In related tests, we show that preannouncement prices incorporate more good than bad news and that prices adjust following the announcement. Similarly, we also show that preannouncement abnormal trading volume positively predicts firms' earnings news. These results suggest ATCs incentivize investors to more actively trade on positive signals before announcements and that this asymmetry reverses afterward. This asymmetry attenuates after the announcement because the arrival of news reduces the incentives for liquidity providers to get flat.

The third main empirical pattern we find is that firms' average returns are positive beginning an entire week *before* their earnings announcements but become insignificant on announcement dates (t) and significantly negative following the announcements (t+1). This pattern supports our model's prediction that preannouncement price discovery asymmetrically reflects good news, causing an upward bias in preannouncement prices.

The market frictions we highlight yield an important insight for research using earnings announcement returns as measures of risk premia. In our sample, the average three-day market-adjusted return centered on announcement dates is 17 bp (consistent with Cohen et al. [2007]), whereas the average announcement month return is more than three times larger at 55 bp (consistent with Barber et al. [2013]), despite both intending to capture risk premia associated with earnings news. Our model helps explain this discrepancy by showing that, on average, earnings announcement returns reflect two offsetting forces. The first is a positive risk premium driven by the release of earnings news.[2] The second is a negative correction of the preannouncement upward bias in prices as inventory risks subside and trading costs revert to normal levels. These offsetting effects cause abnormal returns to be zero or negative following announcements, despite the positive risk premium. Our paper thus helps explain the timing mismatch between the realization of risk premia (i.e., abnormal returns) and the realization of the underlying risk (i.e., the earnings announcement) documented by Barber et al. [2013]. Absent the ATC hypothesis, this mismatch is puzzling because standard asset pricing models predict that risks and risk premia occur at the same time.

We next empirically validate the central cross-sectional implications of our model, that the preannouncement asymmetries in trading costs, order imbalances, and returns are all concentrated among high uncertainty

[2] Barber et al. [2013] argue that earnings announcement premia reflect compensation for idiosyncratic risks, whereas Savor and Wilson [2016] argue that it stems from exposure to macroeconomic risk.

stocks because these pose greater inventory risk. We also show that uncertainty proxies have a significantly positive relation with firms' preannouncement returns but that the sign of this relation flips and becomes significantly negative on and following earnings announcements. The changing sign of the uncertainty-return relation supports our model's prediction that the upward bias in preannouncement prices and its subsequent reversal are more pronounced when intermediaries face greater inventory risk.

To provide assurance that frictions in the intermediary sector are driving our results, we also address a variety of alternative explanations. One possibility is that our results are driven by asymmetric disclosure, whereby firms are more likely to disclose good news before announcements than bad news. This could explain our evidence that good news is reflected in preannouncement returns, whereas bad news is only reflected on or after the announcement. Another alternative hypothesis is that short-sale costs, rather than asymmetric liquidity provision (*ALP*), make negative news more expensive to impound into preannouncement prices.

We discuss these and other alternative hypothesis in detail and show that, although each can explain some of our findings, each also makes predictions contradicted by other parts of our findings. Explaining all of our findings with a single story is important because a key result in our paper is that preannouncement asymmetries in liquidity provision, *AOI*s, and returns are strongly correlated in both time series and cross-sectional tests. These correlations indicate that our broader results likely stem from a distinct underlying driver and thus are difficult to reconcile with the variety of partial alternative explanations.

We also provide evidence distinguishing our ATC hypothesis from alternatives by linking our findings to changes in the financial intermediary sector. Specifically, we follow Adrian and Shin [2010] by using time series changes in aggregate repurchase agreement (repo) behavior to capture intermediaries' preferences to expand versus contract their net positions and thus their willingness to provide liquidity to buyers versus sellers. We show that our main findings are more pronounced when intermediaries are shrinking their balance sheets, suggesting that our findings stem from their risk- and inventory-management practices.

Because our model's predictions depend on liquidity providers anticipating the arrival of news, we also use unanticipated nonearnings 8-K filing dates as a placebo test. Our ATC hypothesis predicts no asymmetries in trading costs, price discovery, or returns before nonearnings 8-K announcements, while some alternatives (e.g., asymmetric disclosure) predict those asymmetries before nonearnings 8-K announcements. Consistent with the ATC hypothesis, we find no significant changes in these variables before nonearnings 8-Ks.

To summarize, other hypotheses are difficult to reconcile with *ALP* and the upward bias in market prices that rise preannouncement and reverse afterward, as well as the link between our findings and both uncertainty and the financial intermediary sector. However, behavioral biases or omitted frictions may be correlated with those variables as well. We therefore view our main results as being consistent with frictions in the intermediary sector playing an important role and providing a potential (but not exclusive) explanation for the patterns we document.

A central contribution of our paper is in providing a liquidity-provision-based explanation for daily return patterns around earnings announcements, one of the most significant information events for a firm. Prior research uses the asymmetric reaction to earnings announcements to infer asymmetric leakage of news to the market, where insiders opportunistically leak upcoming news when that news is good but withhold it when it is bad. Our findings point to an important alternative possibility. Specifically, liquidity providers' aversion to inventory risk would lead to these systematic return patterns, even in the absence of any asymmetric news leakage, that is, even when the market's ability to anticipate good and bad news at the upcoming announcement is the same.

Our paper also provides a unified framework that links several pervasively studied market outcomes. These outcomes include market prices, returns, trading volumes, order flows, and liquidity—the central constructs of interest in virtually all capital market studies. As a result, our paper provides a conceptual basis and empirical support for understanding several results that likely appear puzzling when viewed outside of our framework. Our model and results therefore may influence the way that researchers understand market outcomes across a variety of settings, particularly outcomes occurring around anticipated periods of heightened inventory risks, including alternative firm-level (e.g., anticipated earnings guidance), industry-level (e.g., trade association meetings), and macroeconomic information events (e.g., Federal Open Market Committee (FOMC) meetings). For example, our ATC hypothesis offers a new explanation for the evidence in Lucca and Moench [2015] that market returns are significantly positive immediately before scheduled FOMC meetings. Like the pre-earnings-announcement return premium discussed above, this pattern is difficult to explain in a frictionless model but can be seen as a natural consequence of *ALP* before information events.

The rest of the paper is organized as follows. Section 2 provides a model of liquidity provision. Section 3 discusses our main findings. Section 4 contains additional analyses. Section 5 distinguishes between our hypothesis and alternatives. Section 6 discusses implications for future research, and Section 7 concludes.

2. *Model*

Our model conveys the intuition for the ATC hypothesis that we advance and test. We hypothesize that frictions in the intermediary sector cause ATCs before information events, causing a positive bias in preannouncement price discovery, which leads to an upward bias in preannouncement returns that corrects when the news is released. The key frictions intermediaries face in the model are an exogenous preference for holding positive positions and an aversion to inventory risk. The former is consistent with the evidence in Brunnermeier and Pedersen [2009] and Adrian and Shin [2010] that broker-dealers' assets are procyclical as well as the evidence in Comerton-Forde et al. [2010] that market makers hold positive inventories 94% of the time, perhaps because it is costly to locate or borrow shares when providing liquidity to buyers. The latter idea is supported by the link between short-term reversals and liquidity provision in Chordia, Roll, and Subrahmanyam [2002] and Nagel [2012], perhaps because intermediaries employ trader-specific risk budgets for agency reasons.

We rely on a broader definition of "intermediary," based on Nagel [2012]. It includes all traders who act as liquidity providers, which is to say they often have orders on both sides of the market and their goal is to profit by temporarily holding shares as they pass from a seller to a buyer. We contrast this sort of intermediary with traders or investors who aim to build a directional position to profit from price movements or hedge risks, which requires demanding liquidity. By this broad definition, intermediaries will mechanically always play an important role in providing liquidity, even as market microstructure evolves with technology and regulation.

Recent microstructure literature provides evidence that there is a speed hierarchy in liquidity provision, with high-frequency traders (HFTs) acting as intraday intermediaries and lower frequency traders absorbing inventory when HFTs reach their risk-bearing capacity. For example, Menkveld [2013] shows that HFTs trade a stock hundreds of times per day, are mostly on the passive (i.e., nonmarketable) side of the order, and typically hold zero inventory overnight. However, as Nagel [2012] points out, unless intraday order imbalances exactly cancel out, someone must provide overnight inventory and will demand compensation in the form of price concessions measurable using daily data. These overnight intermediaries are likely algorithmic traders, quantitative hedge funds, and proprietary trading groups within investment banks. Our model abstracts away from this type of intermediary classification and instead models the behavior of a single intermediary.

2.1 ASSUMPTIONS

We study an asset with payoff $\tilde{v} = \tilde{v}_{-1} + \tilde{v}_0$ at $t = 0$, where $\tilde{v}_{-1} = \{-1, 1\}$ corresponds to a normal period information release and $\tilde{v}_0 = \{-\sigma, \sigma\}$, $\sigma > 1$, corresponds to a high-volatility information release, such as an earnings announcement. We model two trading periods to illustrate that intermediaries behaving optimally will carry an undesirably high inventory from normal periods into the preannouncement period.

The positive innovations $\tilde{v}_{-1} = 1$ and $\tilde{v}_0 = \sigma$ have probabilities z_{-1} and z_0, respectively. However, these innovations are exposed to priced risk, meaning agents value them using risk-neutral probabilities y_{-1} and y_0

instead of z_{-1} and z_0.[3] We assume that the asset has a positive risk premium, so investors price assets using risk-neutral probabilities that underestimate the probability of the good state: $y_{-1} < z_{-1}$ and $y_0 < z_0$. For analytic convenience, we assume that the risk-neutral probabilities are $y_{-1} = y_0 = \frac{1}{2}$ and the risk-free rate is 0.

There are three types of agents in the model: an intermediary M, informed traders I_t, and uninformed traders U_t. To avoid the complexity associated with dynamic trading strategies, we assume that the traders at $t = -1$ are different from those at $t = -2$ and that all traders hold their positions until $t = 0$. The timeline in the model is as follows:

Prior to $t = -2$,	M chooses initial position Q_{-2} and ask and bid prices a_{-2}, b_{-2}.
$t = -2$,	I_{-2} and U_{-2} purchase quantities of shares $x_{I,-2}$ and $x_{U,-2}$, respectively.
Prior to $t = -1$,	$\tilde{v}_{-1}$ is revealed, M chooses ask and bid prices a_{-1}, b_{-1}.
$t = -1$,	I_{-1} and U_{-1} purchase quantities of shares $x_{I,-1}$ and $x_{U,-1}$, respectively.
$t = 0$,	$\tilde{v}_0$ is revealed, all positions are liquidated for $\tilde{v}_{-1} + \tilde{v}_0$.

As in Hendershott and Menkveld [2014], all trades clear through the intermediary exclusively and at the bid or ask price for any quantity the trader chooses. Therefore each trader pays the ask price for any shares bought and receives the bid price for any shares sold.

The $t = -2$ informed trader, I_{-2}, receives a private signal about the realization of $\tilde{v}_{-1}$ but not $\tilde{v}_0$. The signal takes one of two values, $\tilde{s}_{-2} = \{g, b\}$, where $\mathbb{P}(\tilde{v}_{-1} = 1 \mid \tilde{s}_{-2} = g) = \mathbb{P}(\tilde{v}_{-1} = -1 \mid \tilde{s}_{-2} = b) = p > \frac{1}{2}$. Informed traders have mean-variance preferences, where both moments are under the risk-neutral measure,[4] and therefore I_{-2}'s demand satisfies:

$$x_{I,-2}(\tilde{s}_{-2}; a_{-2}, b_{-2}) = \arg\max_x \ \mathbb{E}^y \left(x \left(\tilde{v} - p\left(x \right) \right) \mid \tilde{s}_{-2} \right) \\ - \gamma_T \mathrm{Var}^y \left(x \left(\tilde{v} - p\left(x \right) \right) \mid \tilde{s}_{-2} \right), \quad (1)$$

where γ_T is the traders' risk aversion, and the price function $p(x)$ equals the ask a_{-2} for positive x (i.e., buying) and the bid b_{-2} for negative x (i.e., selling).

The $t = -1$ informed trader I_{-1} observes the public announcement of $\tilde{v}_{-1}$ and receives a private signal about the realization of $\tilde{v}_0$. The signal takes one of two values, $\tilde{s}_{-1} = \{g, b\}$, and has the same precision as $\tilde{s}_{-2}$, meaning $\mathbb{P}(\tilde{v}_0 = \sigma \mid \tilde{s}_{-1} = g) = \mathbb{P}(\tilde{v}_0 = -\sigma \mid \tilde{s}_{-1} = b) = p > \frac{1}{2}$. I_{-1} also has mean-variance preferences and chooses demand $x_{I,-1}(\tilde{s}_{-1}; a_{-1}, b_{-1})$ using an optimization similar to equation (1).

[3] We write $\mathbb{E}^y$ and $\mathbb{E}^z$ for expectations under the risk-neutral measure and physical measure, respectively.

[4] We use the risk-neutral measure to adjust for priced systematic risk and mean-variance preferences to adjust for the additional idiosyncratic risk traders are exposed to by taking concentrated positions.

The uninformed traders in our model are not the usual price-insensitive noise traders. The crux of our story is that the intermediary uses ATCs to attract buyers for the undesired inventory, which necessitates price-sensitive traders. Furthermore, in the presence of a price-insensitive uninformed trader, the intermediary would set enormous bid-ask spreads to profit from uninformed order flow and avoid the informed trader. We therefore model uninformed traders as mean-variance agents who behave as if they are informed. Their signals at times $t = -2$ and $t = -1$ are $\tilde{u}_{-2}$ and $\tilde{u}_{-1}$, respectively. The uninformed traders believe that these signals inform them about $\tilde{v}_{-1}$ and $\tilde{v}_0$, even though in reality they are uninformative. Therefore, uninformed trader demand functions are identical to informed trader demand functions but with false signals $\tilde{u}_{-2}$ and $\tilde{u}_{-1}$ in place of $\tilde{s}_{-2}$ and $\tilde{s}_{-1}$.

The intermediary has mean-variance preferences, where both moments are under the risk-neutral measure, and chooses Q_{-2}, a_{-2}, b_{-2}, a_{-1}, and b_{-1} to maximize its expected utility. The intermediary chooses Q_{-2}, a_{-2}, and b_{-2} prior to trade at $t = -2$ while anticipating how these choices will affect inventory and liquidity provision in period $t = -1$. In the model, we assume that M can costlessly choose whatever Q_{-2} it wants. In reality, the intermediary anticipates the earnings announcement well in advance and shifts prices to induce order flow that pushes the inventory toward Q_{-2}, making Q_{-2} the average initial inventory. Before $t = -1$, it chooses a_{-1} and b_{-1} that are optimal, given the net inventory carried forward after the initial round of trading $Q_{-1} = Q_{-2} - x_{I,-2} - x_{U,-2}$ as well as the realization of $\tilde{v}_{-1}$.

We make two unorthodox assumptions in our model: that the intermediary is a monopolist who chooses bid and ask prices and that the intermediary must be willing to trade any desired quantity at these prices. A more typical approach (e.g., Grossman and Miller [1988], Nagel [2012]) is to model a competitive intermediary sector that is nevertheless averse to idiosyncratic risk and to allow prices to be set using market clearing. In this setting, there is no asymmetry in liquidity provision and therefore no upward pressure on prices. To allow intermediaries to provide liquidity asymmetrically, we instead adopt the assumption from Amihud and Mendelson [1980], Hendershott and Menkveld [2014], and elsewhere that intermediaries have market power.[5] In this case, it is intractable to allow prices to be an arbitrary continuous function of order flow, and so we follow Hendershott and Menkveld [2014] and focus on a discrete pricing mechanism with unlimited quantities at a single bid and ask price.[6]

Expected profits for the intermediary come from trading at advantageous prices: selling at $a > \hat{v}$ and buying at $b < \hat{v}$, where $\hat{v}$ is the conditional

[5] While at odds with the continuous limit order book structure that allows anyone to compete with liquidity providers, this assumption is consistent with evidence that intermediaries' inventories affect prices, implying that the sector as a whole must have some degree of market power (Hendershott and Seasholes [2007], Nagel [2012]).

[6] Our model's qualitative predictions are identical if the intermediary chooses among piecewise-linear pricing schedules.

risk-neutral expected value of $\tilde{v}$. The intermediary also considers two costs associated with inventory levels Q_{-1} and $Q_0 = Q_{-1} - x_{I,-1} - x_{U,-1}$. The first is inventory risk, which affects Q_0 disproportionately because $\tilde{v}_0$ is more volatile than $\tilde{v}_{-1}$. The second is a linear benefit (cost) ρ to holding positive (negative) inventory positions. The linear functional form, as opposed to a linear cost for negative inventories without a benefit for positive inventories, is analytically convenient but also proxies for the fact that positive inventories today are beneficial because they reduce the probability of future negative inventories. All together, the intermediary's objective function is:

$$
\begin{aligned}
&U(Q_2, a_{-2}, b_{-2}, a_{-1}, b_{-1}) \\
&= \overbrace{\mathbb{E}^y\left(\sum_{t=-2}^{t=-1} x_{I,t}(p(x_{I,t}; a_t, b_t) - \hat{v}_t) + x_{U,t}(p(x_{U,t}; a_t, b_t) - \hat{v}_t)\right)}^{\text{Expected trading profit}} \\
&\quad - \gamma_M \underbrace{\left(\mathbb{E}^y\left(Q_{-1}^2\right) + \sigma^2 \mathbb{E}^y\left(Q_0^2\right)\right)}_{\text{Inventory risk}} + \underbrace{\rho\left(\mathbb{E}^y\left(Q_{-1}\right) + \mathbb{E}^y\left(Q_0\right)\right)}_{\text{Cost of negative inventory}}. \qquad (2)
\end{aligned}
$$

2.2 RESULTS AND EMPIRICAL PREDICTIONS

This section presents our equilibrium results and corresponding empirical predictions. We provide a detailed solution of the model and prove our equilibrium results in the appendix. We assume throughout that the intermediary (1) has a benefit of positive inventory positions ($\rho > 0$) and (2) is risk averse ($\gamma_M > 0$). We also assume announcement news creates more volatility than normal news ($\sigma^2 > 1$).

Our results are driven by the decrease in the intermediary's optimal inventory before announcements. The intermediary's choice of initial inventory Q_{-2} is determined by the tradeoff between a preference for positive positions and the risk associated with nonzero inventory. In the preannouncement period $t = -1$, however, the tradeoff changes because inventory risk rises, making the optimal target inventory for $t = -1$ less than Q_{-2}. To reduce inventory toward this optimal target, the intermediary provides liquidity asymmetrically, giving rise to the following equilibrium results. This progression is illustrated by figure 1.

RESULT 1 (Asymmetric Liquidity Provision). *In the preannouncement period, negative price changes overshoot the information revealed by the trade more than positive ones:*

$$\mathbb{E}^z(\tilde{v}|sell) - \mathbb{E}^z(b_{-1}) > \mathbb{E}^z(a_{-1}) - \mathbb{E}^z(\tilde{v}|buy). \qquad (3)$$

EMPIRICAL PREDICTION 1. *The compensation intermediaries demand for providing liquidity, as measured by return reversals, is higher for seller-initiated than buyer-initiated trades.*

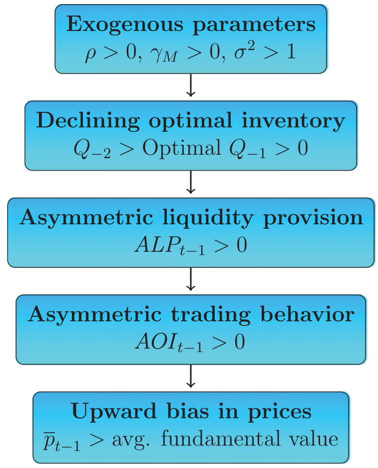

FIG. 1.—Causal chain in our model. This figure presents a schematic of how exogenous parameters cause each of the main equilibrium effects in our model.

The cornerstone of our theory is that intermediaries provide liquidity asymmetrically before announcements in response to inventory risks, which in turn influences investors' incentives to trade. Result 1 establishes that positive price changes overshoot fundamental value to a lesser extent than negative ones, reflecting the fact that the intermediary embeds a smaller liquidity premium into the ask than the bid. Once the information is revealed at $t = 0$, prices converge (on average) to $\mathbb{E}^z(\tilde{v}|\text{buy})$ or $\mathbb{E}^z(\tilde{v}|\text{sell})$, so the differences $a_{-1} - \mathbb{E}^z(\tilde{v}|\text{buy})$ and $\mathbb{E}^z(\tilde{v}|\text{sell}) - b_{-1}$ indicate the extent to which prices overshoot at $t = -1$ and reverse at $t = 0$. Empirical Prediction 1 states that these equilibrium price patterns will result in asymmetric preannouncement return reversals.

RESULT 2 (Asymmetric Trading Intensity). *In the preannouncement period, traders submit larger buy orders in equilibrium than sell orders:*

$$|x_{I,-1}(\tilde{s} = g)| > |x_{I,-1}(\tilde{s} = b)|, \tag{4}$$

$$|x_{U,-1}(\tilde{u} = g)| > |x_{U,-1}(\tilde{u} = b)|. \tag{5}$$

EMPIRICAL PREDICTION 2. *Average order imbalances are abnormally positive before announcements, and price discovery and trading volume are greater for positive news announcements than negative ones.*

Result 2 pertains to price discovery and states that, due to the asymmetric pricing of liquidity described in Result 1, traders optimally choose to place larger orders when receiving good news at $t = -1$. This yields three related empirical predictions: that average preannouncement order imbalances reflect more buys than sells, that preannouncement prices incorporate more earnings news ahead of positive news announcements, and that positive news announcements have greater preannouncement trading volume than negative ones.

To study the implications of ATCs for returns before and after announcements, we first compute the average prices and returns in a "frictionless benchmark," wherein there is no information asymmetry and the asset trades at its risk-neutral expected value in each period. In this case, expected returns (price changes) are:

$$\mathbb{E}^z\left(\tilde{p}_{-1} - p_{-2}\right) = \mathbb{E}^z\left(\tilde{v}_{-1}\right) = 2\left(z_{-1} - \frac{1}{2}\right), \tag{6}$$

$$\mathbb{E}^z\left(\tilde{p}_0 - \tilde{p}_{-1}\right) = \mathbb{E}^z\left(\tilde{v}_0\right) = 2\left(z_0 - \frac{1}{2}\right)\sigma. \tag{7}$$

Expected returns are driven by the risk associated with the news in each period, 1 and σ, and the difference between physical and risk-neutral probabilities (z_t and $y_t = \frac{1}{2}$).

RESULT 3 (Abnormal Returns Around Announcements). *Expected returns computed using average prices under the physical measure satisfy:*

$$\mathbb{E}^z\left(\tilde{p}_{-1} - p_{-2}\right) = \underbrace{2\left(z_{-1} - \frac{1}{2}\right)}_{\textit{Normal risk prem.}} + \underbrace{\rho(\sigma^2 - 1)\left(\frac{2p(1-p) + \frac{\gamma_M}{\gamma_T}}{8p(1-p)(1+\sigma^2) + 2\frac{\gamma_M}{\gamma_T}}\right)}_{\textit{Upward bias}}, \tag{8}$$

$$\mathbb{E}^z\left(\tilde{p}_0 - \tilde{p}_{-1}\right) = \underbrace{2\left(z_0 - \frac{1}{2}\right)\sigma}_{\textit{Announcement risk prem.}} - \underbrace{\rho(\sigma^2 - 1)\left(\frac{2p(1-p) + \frac{\gamma_M}{\gamma_T}}{8p(1-p)(1+\sigma^2) + 2\frac{\gamma_M}{\gamma_T}}\right)}_{\textit{Reversal of bias}}. \tag{9}$$

EMPIRICAL PREDICTION 3. *Average returns are abnormally positive before announcements and less positive or even negative following the announcement. Abnormal preannouncement returns that reverse reflect an upward bias resulting from ATCs, while longer window announcement returns reflect an announcement risk premium.*

Equation (8) quantifies two sources of preannouncement abnormal returns: a risk premium $2(z_{-1} - \frac{1}{2})$, which occurs in the frictionless benchmark as well, and an upward bias caused by the ATCs. The upward bias is proportional to the benefit of positive inventory ρ multiplied by the increase in variance at the announcement $(\sigma^2 - 1)$, both of which are positive by assumption.

It may be initially puzzling that the intermediary's desire to reduce inventory, which leads to lower both ask and bid prices, results in higher average transaction prices. However, the equilibrium response of traders described in Result 2 has an indirect effect on average prices: traders with positive signals use larger quantities, meaning many more trades happen at a_{-1} than b_{-1}. This indirect effect outweighs the direct effect of lower average a_{-1} and b_{-1}, because the intermediary is a net seller on average and uses its market power to capture positive expected trading profits while still reducing their inventory risk.

Similarly, equation (9) quantifies the two sources of excess returns on the announcement date: a risk premium $2(z_0 - \frac{1}{2})\sigma$, which is likely larger than the normal period premium $2(z_{-1} - \frac{1}{2})$, and a reversal of the upward bias in preannouncement prices. Comparing equations (8) and (9) yields two important insights. First, even if there is an abnormally large risk premium at the announcement, returns measured in a narrow window around the announcement will be confounded by the reversal of the preannouncement bias and therefore will understate the risk premium. Second, long-window cumulative returns surrounding the announcement represent the risk premium, while the portion of preannouncement returns that reverse postannouncement reflects the upward bias.

RESULT 4 (Comparative Statics). *Averages of ALP, preannouncement returns, and postannouncement reversals are all increasing in the intermediary's inventory Q_{-1}, risk aversion γ_M, cost of negative positions ρ, and the announcement risk σ.*

EMPIRICAL PREDICTION 4. *Averages of preannouncement ALP, preannouncement returns, and postannouncement reversals are all greater when intermediaries have larger positive inventory positions, less risk-bearing capacity, higher costs of locating and borrowing shares, and/or the earnings announcement risk is higher.*

Our final result shows comparative statics for Results 1 through 3. When the intermediary has a larger inventory, has greater risk aversion, or faces greater announcement risks, all else equal it will be more aggressive in reducing inventory by asymmetrically providing liquidity, thereby increasing the temporary bias in preannouncement prices $\bar{p}_{-1}$.

3. Empirical Tests

3.1 SAMPLE SELECTION

We construct the main data set used in our analyses from three sources. We obtain price and return data from CRSP, firm fundamentals from Compustat, and analysts' forecasts of earnings from IBES. We eliminate firms that have been in the CRSP database for less than six months to ensure that there are sufficient data to calculate historical return volatility and momentum. We also require that firms have coverage in the IBES database to calculate analyst-based earnings surprises and eliminate firms with prices below $1 to mitigate the influence of bid-ask bounce on our calculation of return reversals, as noted in Roll [1984].

Our main analyses examine changes in liquidity and equity prices surrounding the date of firms' quarterly earnings announcements.[7] Because we expect liquidity provision to significantly change once the news is announced, it is important to correctly identify the announcement date to cleanly test our hypotheses. To do so, we follow the procedure from DellaVigna and Pollet [2009] that compares Compustat and IBES announcement dates and assigns the earlier date as being correct.[8] We eliminate observations where the Compustat and IBES announcement dates are more than two trading days apart and also use the IBES time stamp to determine whether the announcement occurred after the market close. When it does, we adjust the announcement date one trading day forward. Using this approach, our final sample consists of 215,754 quarterly earnings announcements from 1993 to 2012.

To show the accuracy of the announcement dates in our sample, figure 2 plots average daily abnormal idiosyncratic volatility in event time in the 21 trading days surrounding firms' announcement dates, t, across three different sources of earnings announcement dates. Specifically, the top panel in figure 2 is plotted against the earnings announcement dates used in this study whereas the middle and bottom panels are plotted against Compustat and IBES announcement dates, respectively. Following Barber et al. [2013], we compute abnormal idiosyncratic volatility on day d by taking the square root of the ratio of the squared residual (from a firm-specific market-model regression with three lags) on day d and the average squared residual from $t - 51$ to $t - 11$, and subtracting one.

Consistent with the findings of DellaVigna and Pollet [2009], the top panel of figure 2 shows that idiosyncratic volatility is concentrated on the announcement dates used in this study, which indicates that the announcement dates in our sample correctly identify the dates of earnings news releases.[9] By contrast, the middle and bottom panels of figure 2 show that idiosyncratic volatility increases on announcement dates proposed by Compustat and IBES but increases further and peaks on the subsequent day, indicating that the announcement dates in these databases are often one day too early. A likely reason for this is that many announcements occur

[7] Lee, Mucklow, and Ready [1993], Krinsky and Lee [1996], and So and Wang [2014] provide evidence that transaction costs increase before announcements due to changes in adverse selection and inventory risks. Whereas these studies focus on the *level* of trading costs, we identify *asymmetries* in trading costs and the implications of these asymmetries for price discovery and returns.

[8] DellaVigna and Pollet [2009] show that their approach yields announcement dates that are more than 95% accurate by comparing their calculated date with newswire time stamps and also more accurate than the dates in Compustat and IBES when either is used in isolation.

[9] Like Barber et al. [2013], we find average abnormal idiosyncratic volatility is slightly negative in the days leading up to and following earnings announcements. This suggests that little new information is delivered in the weeks before and after an earnings announcement.

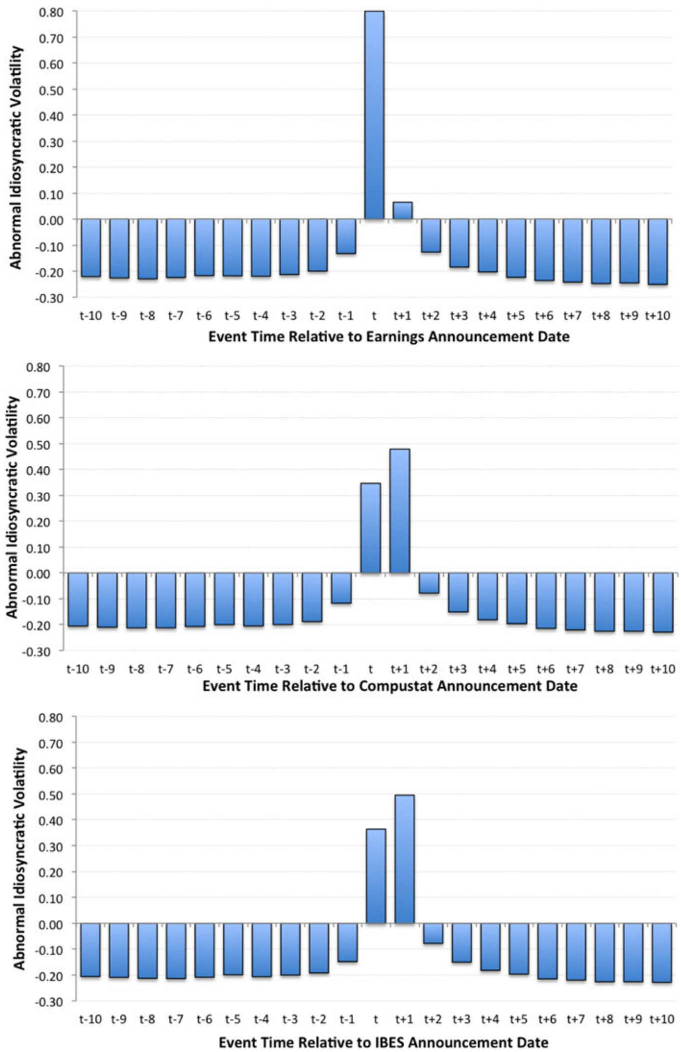

FIG. 2.—Event-time idiosyncratic volatility relative to announcement. This figure plots the time series average of abnormal idiosyncratic volatility in event time in the 21 trading days surrounding firms' earnings announcement date, t. The top panel is plotted against the earnings announcement dates used in this study, the middle panel is plotted against the earnings announcement dates as reported in Compustat, and the bottom panel is plotted against the earnings announcement dates as reported in IBES. We compute abnormal idiosyncratic volatility on day d by taking the square root of the ratio of the squared residual (from a firm-specific market-model regression estimated with three lags) on day d and the average squared residual from $t - 51$ to $t - 11$, and subtracting one. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012.

after markets close, meaning an announcement made today is commonly reflected in tomorrow's close-to-close return.

The findings in figure 2 help explain why we find no excess returns on announcement dates, whereas prior research finds significant excess returns on Compustat announcement dates (e.g., Ball and Kothari [1991] and Frazzini and Lamont [2007]). By using Compustat dates that are frequently one day too early, these studies record the return one day before the actual announcement, which is abnormally positive, as the announcement date return.

3.2 ASYMMETRIC TRADING COSTS

Our first analyses test Empirical Prediction 1, which states that intermediaries set asymmetric prices for providing liquidity before earnings announcements. Because intermediaries in our model demand compensation for providing liquidity in the form of transitory price concessions, we use short-term return reversals as a proxy for the expected returns intermediaries demand for providing liquidity, although, in the online appendix, we also find similar results using alternative proxies for transaction costs.

Panel A of table 1 contains average daily returns for firms within the lowest quintile of returns over the prior day ("losers") and firms within the highest quintile of returns over the prior day ("winners"), in event time for the 21 trading days surrounding firms' announcement dates. Average daily returns of firms in the lowest quintile are generally positive and significant, consistent with intermediaries receiving compensation for providing liquidity in periods of net selling by setting prices below fundamental value. Similarly, the average daily return for firms in the highest quintile are generally negative and significant. Consistent with the findings of Avramov, Chordia, and Goyal [2006], losers exhibit greater reversals than winners throughout the event window, suggesting that intermediaries are generally more averse to providing liquidity to sellers and thus demand asymmetric levels of compensation.

The final column of panel A presents average levels of *ALP* defined as the difference between returns earned from a long position in prior day losers and returns earned from a short position in prior day winners. *ALP* captures differences in reversal magnitudes across losers and winners, and thus higher values of *ALP* indicate that intermediaries demand greater compensation for providing liquidity to sellers relative to buyers. The average level of *ALP* increases beginning several days before the announcement, consistent with intermediaries often taking multiple days to unwind net positions (Madhavan and Smidt [1993]) and thus being averse to taking on additional inventory before high volatility events because doing so increases their risk exposure.

Panel A of table 1 also shows that *ALP* steadily increases until $t-1$, reflecting the contrast between the rapid ascension of reversals associated with the loser portfolio and the flatter trend in reversals associated with the winner portfolio. These results suggest that intermediaries are

TABLE 1
Asymmetric Liquidity Provision

Panel A: Daily returns of prior day losers and winners

	Losers		Winners		*ALP*	
Trading Date	Mean	*t*–Statistic	Mean	*t*–Statistic	Mean	*t*–Statistic
$t-10$	0.325	7.160	−0.168	−3.661	0.157	2.367
$t-9$	0.253	5.737	−0.127	−2.699	0.126	1.866
$t-8$	0.295	7.488	−0.154	−3.666	0.141	2.570
$t-7$	0.300	7.149	−0.167	−3.934	0.133	2.362
$t-6$	0.348	8.636	−0.174	−4.270	0.173	2.857
$t-5$	0.346	8.240	−0.144	−3.151	0.202	3.482
$t-4$	0.345	9.040	−0.111	−2.593	0.234	4.201
$t-3$	0.387	10.444	−0.051	−1.217	0.336	5.685
$t-2$	0.456	10.521	−0.100	−2.369	0.356	5.702
$t-1$	0.589	12.091	−0.048	−1.097	0.541	7.597
t	0.554	8.994	−0.661	−10.496	−0.107	−1.082
$t+1$	−0.286	−6.663	0.169	3.664	−0.117	−1.898
$t+2$	0.053	1.459	−0.011	−0.347	0.042	0.807
$t+3$	0.181	4.255	−0.119	−3.135	0.062	1.054
$t+4$	0.255	7.591	−0.159	−3.885	0.096	1.858
$t+5$	0.339	8.831	−0.183	−4.608	0.155	3.465
$t+6$	0.330	8.169	−0.136	−3.695	0.194	3.804
$t+7$	0.316	9.645	−0.162	−4.588	0.155	3.701
$t+8$	0.365	9.858	−0.198	−5.430	0.167	3.412
$t+9$	0.328	9.047	−0.202	−6.042	0.126	2.791
$t+10$	0.363	9.415	−0.174	−4.952	0.189	4.019

Panel B: Observations and asymmetric liquidity provision by year

		ALP(−4,−2)		*ALP*(−31,−11)		Δ*ALP*	
Year	OBS	Mean	*t*–Statistics	Mean	*t*–Statistics	Mean	*t*–Statistics
1993	6,774	0.404	3.121	0.187	5.427	0.218	1.025
1994	8,026	0.374	4.212	0.143	3.429	0.231	1.970
1995	8,942	0.288	3.512	0.103	2.315	0.185	1.578
1996	9,726	0.461	3.263	−0.038	−0.856	0.499	4.243
1997	10,973	0.364	2.112	0.033	0.941	0.332	1.168
1998	11,212	0.821	4.583	−0.041	−1.029	0.861	2.803
1999	11,361	0.932	5.606	0.287	5.891	0.645	2.205
2000	10,765	0.957	4.501	0.097	1.228	0.860	2.611
2001	10,061	0.894	3.374	0.304	3.226	0.590	1.141
2002	9,894	0.340	2.207	0.131	2.729	0.210	0.730
2003	10,147	0.694	5.818	0.328	9.118	0.366	2.387
2004	10,799	0.160	2.786	0.158	4.970	0.002	0.033
2005	11,450	0.207	5.679	0.012	0.440	0.195	2.105
2006	11,953	0.171	2.333	0.153	5.046	0.017	0.140
2007	12,326	0.043	0.389	0.004	0.203	0.039	0.369
2008	12,246	0.092	0.676	−0.194	−4.191	0.286	2.711
2009	11,903	0.643	2.274	0.442	5.906	0.201	0.572
2010	12,472	0.343	4.170	0.224	6.632	0.119	0.881
2011	12,303	0.085	0.655	0.045	1.439	0.040	0.182

(*Continued*)

TABLE 1—*Continued*

Panel B: Observations and asymmetric liquidity provision by year

		ALP(−4,−2)		*ALP*(−31,−11)		Δ*ALP*	
Year	OBS	Mean	*t*–Statistics	Mean	*t*–Statistics	Mean	*t*–Statistics
2012	12,421	−0.054	−0.766	0.045	1.178	−0.098	−1.282
All	215,754	0.411	7.200	0.121	3.413	0.290	5.345

Panel A presents the average daily return for firms within the lowest quintile of returns over the prior day ("losers") and firms within the highest quintile of returns over the prior day ("winners"). Returns are shown in event time in the 21 trading days surrounding a firm's quarterly announcement date, t. Quintiles are formed each calendar quarter using breakpoints from the prior calendar quarter. The final column presents the difference in reversal patterns across loser and winner portfolios, denoted as *ALP*. The daily *ALP* metric is constructed as the difference between returns earned from buying prior day losers and earned from selling prior day winners. Panel B presents observation counts and the average asymmetry in liquidity provision (*ALP*) for each calendar year. OBS indicates the number of quarterly earnings announcements. t–statistics are based on the time series of quarterly returns. $ALP(X,Y)$ is defined as the average value of *ALP* over days $t + X$ to $t + Y$, where t is the earnings announcement date. ΔALP is the difference between $ALP(-4,-2)$ and $ALP(-31,-11)$. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012. All returns are shown as percentages.

most averse to providing liquidity to sellers when there is the least time to unwind the position before the announcement. Finally, *ALP* changes sign on the announcement date and gradually reverses to normal levels, which is consistent with intermediaries being less averse to taking on inventories once earnings news is announced and inventory risks decline.[10]

Panel B of table 1 contains descriptive statistics for each year of the 1993–2012 sample. The number of firm-quarters gradually increases over time from a low of 6,774 in 1993 to a high of 12,472 in 2010. To assess within-firm changes associated with the announcement, we measure the average preannouncement asymmetry in liquidity provision from $t - 4$ to $t - 2$ and compare it with the average value in nonannouncement periods from $t - 11$ to $t - 31$.[11] We find that the average values of ΔALP, the difference between $ALP(-4,-2)$ and $ALP(-31,-11)$, are generally positive and the pooled mean is significantly positive at the 1% level, indicating that the asymmetry is greater before announcements than in nonannouncement periods. Together, the results in table 1 provide support for the cornerstone of our ATC hypothesis—specifically that intermediaries provide liquidity asymmetrically before earnings announcements.

[10] The change in the sign of the reversal strategy return around the announcement is consistent with the presence of post-earnings announcement drift as well as evidence that appears in Tetlock [2010] that returns on nonnews days tend to reverse whereas returns on news days tend to continue.

[11] We define the preannouncement period from $t - 4$ to $t - 2$ to produce economic magnitudes comparable to the commonly used three-day announcement window from $t - 1$ to $t+1$. However, in the online appendix, we find that our results are qualitatively identical when using a preannouncement window from $t - 6$ to $t - 2$.

3.3 IMPLICATIONS OF ASYMMETRIC TRADING COSTS

Tables 2 and 3 present three tests of Empirical Prediction 2, which states that traders respond to asymmetric liquidity costs by trading more aggressively on good news than bad news. We begin by showing pooled averages of *AOI*s for all earnings announcements in the "All" column of panel A in table 2. Average order imbalances tend to be positive leading up to the announcement and peak on day $t-1$, indicating that investors tend to be net buyers before earnings announcements. By contrast, average order imbalances flip sign and become negative following the announcement, indicating that investors become net sellers once the news is announced and inventory risks decline.

A second implication of Empirical Prediction 2 is that informed traders place larger orders when they receive positive signals. To establish this pattern empirically, panel A of table 2 contains daily *AOI*s around announcements in which firms report "good" news, defined as earnings at or above the consensus earnings forecast, and those where firms report "bad" news, defined as earnings below the consensus. Panel A shows that there is a large spike in directional trading before good news announcements and no spike for bad news. In fact, *AOI*s are *positive* the day before bad news announcements. Panel A of table 2 also shows that postannouncement order imbalances follow the opposite pattern: negative news tends to be followed by a longer trend of net selling, whereas no such trend exists for positive news. These patterns are consistent with the idea that investors are deterred from expressing negative news before earnings announcements and instead trade on negative news afterward.

In panel B of table 2, we test the third implication of Empirical Prediction 2, that asymmetric order flow results in biased price discovery before earnings announcements. We show that, for good news announcements, average returns are consistently positive leading up to the announcement. They then increase as the announcement approaches and remain statistically significant throughout.[12] By contrast, for bad news announcements, average returns are slightly negative several days before the announcement but attenuate over time, becoming statistically insignificant in the days immediately before the announcement.

Starting on the announcement day, the pattern in price discovery immediately reverses, with prices strongly incorporating negative news but reacting less to good news, which preannouncement prices already reflected to a greater degree. Panel B of table 2 also provides average returns in the four trading days before the announcement and the four trading days on and after it. These tests illustrate the preannouncement bias toward

[12] We do not estimate *ALP* in good and bad news subsamples because our model predicts that *ALP* is determined by intermediary inventory and preferences and is not affected by the sign of earnings news.

TABLE 2

Asymmetric Order Flow and Price Discovery

Panel A: Abnormal order imbalances across good and bad news announcements

	All		Good		Bad	
Trading Date	Mean	t–Statistic	Mean	t–Statistic	Mean	t–Statistic
$t-10$	−0.003	−0.667	−0.002	−0.349	−0.007	−1.158
$t-9$	0.001	0.279	0.004	0.630	−0.006	−0.866
$t-8$	−0.004	−0.828	0.000	−0.056	−0.014	−1.994
$t-7$	−0.005	−0.982	0.000	0.076	−0.019	−2.937
$t-6$	−0.003	−0.458	0.001	0.095	−0.013	−1.863
$t-5$	0.000	−0.034	0.002	0.342	−0.006	−0.825
$t-4$	−0.001	−0.158	0.002	0.341	−0.009	−1.351
$t-3$	0.007	1.206	0.012	1.990	−0.004	−0.565
$t-2$	0.012	2.023	0.019	2.947	−0.003	−0.457
$t-1$	0.046	7.473	0.057	9.009	0.022	2.831
t	0.023	3.968	0.044	6.304	−0.023	−2.701
$t+1$	0.004	0.644	0.013	2.204	−0.019	−2.538
$t+2$	−0.013	−2.171	−0.012	−1.844	−0.015	−2.220
$t+3$	−0.014	−2.274	−0.009	−1.506	−0.024	−3.234
$t+4$	−0.011	−1.828	−0.001	−0.186	−0.029	−4.407
$t+5$	−0.003	−0.444	0.005	0.741	−0.020	−2.582
$t+6$	−0.003	−0.479	0.007	1.005	−0.026	−3.364
$t+7$	−0.010	−1.470	0.000	−0.062	−0.031	−4.084
$t+8$	−0.010	−1.560	−0.002	−0.339	−0.027	−3.607
$t+9$	−0.009	−1.441	0.001	0.160	−0.033	−4.603
$t+10$	−0.003	−0.422	0.004	0.621	−0.016	−1.977
Mean$(t-4, t-1)$	0.015	2.778	0.021	3.806	0.000	0.056
Mean$(t, t+3)$	−0.001	−0.114	0.009	1.589	−0.022	−3.583

Panel B: Returns across good and bad news

	Good		Bad	
	Mean	t–Statistic	Mean	t–Statistic
$t-10$	0.055	3.025	−0.066	−3.133
$t-9$	0.065	3.914	−0.105	−4.311
$t-8$	0.060	3.629	−0.071	−3.581
$t-7$	0.073	4.479	−0.071	−3.004
$t-6$	0.083	4.974	−0.042	−1.769
$t-5$	0.093	5.371	−0.047	−2.186
$t-4$	0.095	5.673	−0.041	−1.969
$t-3$	0.135	7.368	0.000	0.008
$t-2$	0.165	7.919	−0.043	−1.905
$t-1$	0.280	11.364	−0.028	−0.910
t	1.059	16.730	−2.012	−20.815
$t+1$	0.190	7.840	−0.511	−16.925
$t+2$	0.014	0.832	−0.111	−4.774
$t+3$	0.007	0.369	−0.040	−1.783
$t+4$	0.035	2.073	−0.050	−2.362
$t+5$	0.038	2.569	0.002	0.107
$t+6$	0.040	2.718	0.004	0.174

(*Continued*)

TABLE 2—*Continued*

Panel B: Returns across good and bad news

	Good		Bad	
	Mean	t–Statistic	Mean	t–Statistic
$t+7$	0.042	3.213	−0.006	−0.377
$t+8$	0.044	3.012	0.011	0.519
$t+9$	0.037	2.737	0.004	0.184
$t+10$	0.033	2.365	0.027	1.431
Mean$(t-4,\ t-1)$	0.639	9.494	−0.144	−1.997
Mean$(t,\ t+3)$	1.281	14.298	−2.649	−24.391

Panel A contains daily abnormal order imbalances. Order imbalances equal the difference between buyer- and seller-initiated trading volume, calculated from intraday trade and quote data using the Lee-Ready algorithm. We calculate a firm's daily abnormal order imbalances by standardizing the order imbalance using the mean and standard deviation of the firm's order imbalances from $t-51$ to $t-11$. Panel B contains daily market-adjusted percentage returns in event time in the 21 trading days surrounding a firm's quarterly announcement date, t, partitioned across good and bad news announcements. An announcement is "good" ("bad") news when the firm's reported earnings are equal to or exceed (less than) the last consensus forecast reported in IBES immediately before the announcement. We calculate the average return to each event-day within each quarter and report the time series average across quarters. The table also reports t–statistics based on the time series of average order imbalances and returns. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012.

positive price discovery and subsequent reversal, in which markets appear to catch up to negative news once the announcement is made and liquidity provision returns to normal.

To further illustrate the pattern in price discovery, the top panel of figure 3 plots the percentage of cumulative returns in the 21 days surrounding announcements. The figure contrasts with the expression of good and bad earnings news in prices before the announcement. Preannouncement prices continuously incorporate positive news but stop incorporating negative news in the days immediately before the announcement and instead incorporate the news on the announcement date. Similarly, the bottom panel of figure 3 plots average cumulative returns in the 21 days surrounding announcements and shows that the majority of negative returns in the month of a bad news earnings announcement are earned once the news is released.

Our model also predicts that traders use larger orders for positive signals and therefore that preannouncement trading volume foreshadows positive earnings surprises. Table 3 establishes this empirically by regressing earnings news proxies and preannouncement returns on preannouncement abnormal turnover, ΔTO, defined as average daily share turnover from $t-4$ to $t-2$ minus the corresponding average from $t-51$ to $t-11$. We use two proxies for earnings announcement news: *SURP*, defined as firms' actual earnings per share (EPS) minus the consensus analyst forecast and scaled by beginning-of-quarter price, and *SUE*, standardized unexplained earnings, defined as the realized EPS minus EPS from four quarters prior, divided by the standard deviation of this difference over the prior eight quarters. The results in table 3 confirm that abnormal preannouncement

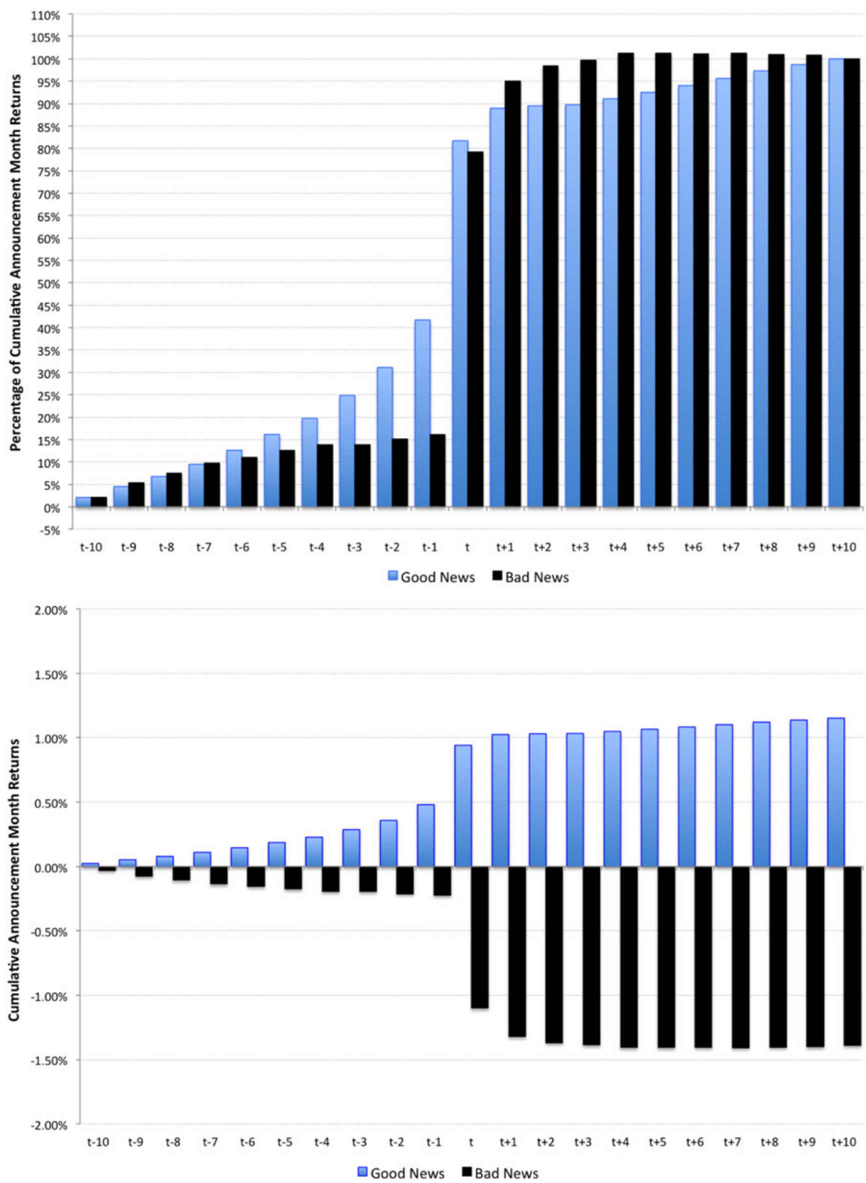

FIG. 3.—Returns for good and bad news announcements. The top panel in this figure plots the average percentage of cumulative returns in the 21 days surrounding an earnings announcement, where day *t* corresponds to the earnings announcement date, for good and bad news announcements. An announcement is labeled as "good" ("bad") if the corresponding analyst-based earnings surprise, *SURPRISE*, is greater or equal to (less than) zero. *SURPRISE* equals the actual earnings per share (EPS) number reported in IBES minus the last consensus forecast available immediately before the announcement and scaled by beginning-of-quarter price. The bottom panel plots the average cumulative returns in the 21 days surrounding an earnings announcement. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012.

TABLE 3
Preannouncement Turnover and Earnings News

	RET(−4,−2)		*SURP*		*SUE*	
	1	2	3	4	5	6
ΔTO	1.213***	1.241***	0.066***	0.037**	0.150***	0.147***
	(9.01)	(8.82)	(3.58)	(2.32)	(6.49)	(7.46)
SIZE	–	−0.398***	–	0.468***	–	0.089***
	–	(−4.09)	–	(11.18)	–	(3.67)
LBM	–	−0.210***	–	−0.427***	–	−0.668***
	–	(−3.56)	–	(−9.59)	–	(−13.07)
MOMEN	–	−0.216***	–	0.300***	–	0.359***
	–	(−5.32)	–	(5.35)	–	(9.98)
R^2 (%)	0.596	0.672	0.012	1.852	0.077	2.451

This table contains results from regressing preannouncement returns and earnings news proxies on preannouncement abnormal turnover. We measure preannouncement turnover as average daily volume scaled by total shares outstanding from $t-4$ to $t-2$, where t is the firm's earnings announcement date. To measure abnormal turnover, ΔTO, we subtract the average level of turnover in nonannouncement periods from $t-51$ to $t-11$. *RET*(−4,−2) is the preannouncement market-adjusted return from $t-4$ to $t-2$ in percentage terms. *SURP* equals the actual earnings per share (EPS) number reported in IBES minus the last consensus forecast available immediately before the announcement and scaled by beginning-of-quarter price. *SUE* is the standardized unexplained earnings, defined as the realized EPS minus EPS from four quarters prior, divided by the standard deviation of this difference over the prior eight quarters. All independent variables are assigned to quintiles each calendar quarter, where the highest (lowest) values are assigned a value of 1 (0) using distributional breakpoints from the prior calendar quarter. $t-$statistics, shown in parentheses, are based on standard errors clustered by firm and industry. Year fixed effects are included throughout. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012.

turnover has a significant positive relation with contemporaneous returns and positively predicts both measures of earnings news, which may be puzzling because trading volume is a commonly used measure of investor disagreement and models involving short-sale costs typically predict that disagreement foreshadows underperformance. However, this result is consistent with Empirical Prediction 2 that informed agents respond to *ALP* by trading more aggressively on positive signals.

3.4 AVERAGE RETURNS AROUND EARNINGS ANNOUNCEMENTS

In table 4, we test Empirical Prediction 3, which states that asymmetries in trading costs elicit an upward bias in preannouncement returns. Panel A presents time series average returns in event-time in the month (21 trading days) centered on firms' quarterly earnings announcement dates. Our primary measure, *RET*, denotes daily market-adjusted returns. As a second measure of excess returns, *AP* denotes the announcement premium, defined as the firm's daily return minus the contemporaneous average return of all nonannouncing firms in our sample. Additionally, to mitigate the influence of static risk characteristics on returns, we also use within-firm variation in returns around announcements, relative to nonannouncement periods, following Cohen et al. [2007]. Specifically, *AR* is a firm's raw return on the specified date minus the average of its raw return from $t-51$ to $t-11$.

TABLE 4

Daily Returns in Event Time

Panel A: Equal-weighted daily returns in event-time

	RET	*t*–Statistics	*AP*	*t*–Statistics	*AR*	*t*–Statistics
$t-10$	0.017	0.970	−0.003	−0.337	0.055	1.286
$t-9$	0.009	0.527	−0.017	−1.607	0.058	1.636
$t-8$	0.016	1.033	0.006	0.675	0.063	1.964
$t-7$	0.025	1.562	0.009	0.818	0.064	2.028
$t-6$	0.042	2.399	0.029	2.486	0.084	2.387
$t-5$	0.049	2.841	0.035	3.208	0.109	2.897
$t-4$	0.050	3.049	0.020	2.020	0.082	2.133
$t-3$	0.091	4.982	0.069	5.013	0.110	2.981
$t-2$	0.096	4.900	0.087	6.124	0.128	3.596
$t-1$	0.180	7.732	0.180	9.168	0.222	5.237
t	0.042	1.422	0.035	1.382	0.087	1.741
$t+1$	−0.039	−1.968	−0.067	−4.821	−0.010	−0.255
$t+2$	−0.026	−1.624	−0.053	−4.428	0.000	−0.002
$t+3$	−0.010	−0.550	−0.019	−1.888	0.021	0.678
$t+4$	0.007	0.414	0.006	0.601	0.040	1.283
$t+5$	0.028	1.919	0.016	1.589	0.066	2.158
$t+6$	0.029	1.866	0.001	0.128	0.064	1.864
$t+7$	0.027	2.135	0.002	0.243	0.060	1.863
$t+8$	0.033	2.160	0.021	2.580	0.070	2.274
$t+9$	0.026	2.052	0.016	1.966	0.045	1.303
$t+10$	0.031	2.317	0.011	1.228	0.050	1.610
Mean	0.034	1.911	0.018	1.245	0.070	1.936
(−1,+1)	0.175	3.051	0.131	3.383	0.285	2.350
(−4, −2)	0.219	4.674	0.157	5.442	0.292	2.830

Panel B: Average returns across subsamples

	RET		*AP*		*AR*	
	(−4,−2)	(−1,+1)	(−4,−2)	(−1,+1)	(−4,−2)	(−1,+1)
1993–1999	0.138	0.143	0.467	0.476	0.263	0.168
	(3.66)	(2.97)	(2.88)	(2.71)	(3.58)	(2.16)
2000–2006	0.073	0.128	0.299	0.317	0.232	0.118
	(2.17)	(2.07)	(1.81)	(1.69)	(3.40)	(1.14)
2007–2012	0.002	0.099	0.080	0.026	0.028	0.071
	(0.04)	(1.76)	(0.38)	(0.10)	(0.33)	(0.64)

This table presents time series average returns in event time in the 21 trading days surrounding firms' quarterly earnings announcement date, t. *RET* equals the daily market-adjusted return. *AP* equals the firm's daily return minus the contemporaneous average return of all nonannouncing firms. *AR* equals the firm's raw return minus its average raw return during nonannouncement periods. The nonannouncement period is from $t-51$ to $t-11$. A firm is deemed a nonannouncer on day d if it did not announce earnings within the 21 trading days centered on day d. We calculate the average return to each event-day within each quarter and report the time series average across quarters. The table also reports t–statistics based on the time series of average returns. Panel B presents average preannouncement and announcement-window returns and corresponding t–statistics in parentheses, across three subsamples based on periods. The notation (X,Y) indicates average returns during the days between $t+X$ and $t+Y$. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012. All returns are shown as percentages.

Panel A of table 4 presents one of our main results. Specifically, the table shows that, on average, firms begin earning significantly positive returns an entire week *before* their earnings announcements starting on $t-6$. Preannouncement returns grow in magnitude and significance when approaching the announcement, peaking on day $t-1$.

The evidence in table 4 is generally consistent with the findings of Barber et al. [2013] that the bulk of the monthly earnings *AP* is earned before announcements. However, our evidence also contrasts with the finding of Barber et al. [2013] that the largest abnormal return occurs on the announcement date, t. To our knowledge, by precisely measuring the earnings announcement date, our study is the first to show that returns are only reliably positive *before*, but not during, the arrival of earnings news.[13]

As shown in section 2, in the presence of an announcement risk premium but no market frictions, prices should be low preannouncement, rise during the announcement in proportion to the realization of priced risk, and stabilize postannouncement. By contrast, our evidence shows that prices predictably increase preannouncement, do not significantly change during the announcement, and decrease postannouncement. Our model and empirical results help to reconcile these findings by highlighting the influence of ATCs.

The bottom rows of table 4 quantify the relative magnitudes of preannouncement returns from $t-4$ to $t-2$ and announcement returns from $t-1$ to $t+1$. Across all three return metrics, the mean and t-statistic of returns from $t-4$ to $t-2$ are just as large, if not larger, than those corresponding to $t-1$ to $t+1$. Table 4 also shows that cumulative returns from $t-1$ to $t+1$ are only significantly positive because of large positive returns the day immediately before the announcement on $t-1$, rather than the returns on the announcement day t.

Additionally, the cumulative returns from $t-10$ to $t+10$ highlight the puzzling discrepancy between the estimated magnitudes of short- and longer window announcement risk premia. Specifically, consistent with the magnitudes shown by prior research, the average three-day market-adjusted announcement return is approximately 17 bp, whereas average announcement month return is approximately three times as large at 55 bp, despite both measures intending to capture risk premia associated with earnings news. Our paper helps to explain this discrepancy by identifying market frictions that elicit a downward bias in short-window announcement returns because, while the returns reflect risk premia, they also reflect a reversal of the upward bias in preannouncement prices.

Thus our return-based results help solve the puzzle from Barber et al. [2013] that a significant portion of the monthly earnings *AP* is earned

[13] Similarly, whereas So and Wang [2014] and Levi and Zhang [2015] show that announcement returns are positive, conditional upon extreme negative preannouncement returns, our unconditional tests show that average announcement day returns are insignificantly different from zero.

before announcement dates. We show that, even in the presence of a risk premium associated with an information event, researchers are likely to observe abnormal returns beforehand due to predictable asymmetries in trading costs.

The evidence of significant preannouncement returns in table 4 is unlikely to be driven by an idiosyncratic risk premium, considering the evidence in figure 2 that idiosyncratic volatility is concentrated on the announcement date. In standard asset pricing models, risk premia should be earned at the same time as the realization of the priced risk. However, we show that excess returns precede idiosyncratic volatility at the announcement by an entire week and provide a friction-based explanation for this phenomenon.

More generally, positive preannouncement returns are unlikely to purely reflect compensation for an unspecified form of risk, for example caused by peer firms announcing their earnings, because of the postannouncement reversal. Excess returns due to risk premia do not reverse because, if they did, they would not compensate long-term investors for bearing the risk. Instead, the postannouncement reversal of preannouncement excess returns is consistent with a friction-based, transitory bias in preannouncement prices. Due to this upward bias, prices must adjust further in response to the release of negative earnings news, suggesting that evidence of an asymmetric reaction to negative news announcements shown in prior research is at least partially driven by greater preannouncement costs of selling rather than selective disclosures.

Our ATC hypothesis predicts that preannouncement biases vary with how intermediaries provide liquidity, which is likely influenced by the continued evolution of market microstructure and changes to the composition and market power of liquidity providers, as discussed in section 2. To illuminate this issue, panel B of table 4 reports average preannouncement- and announcement-window returns across three subsamples partitioned by time. The results show both measures of returns decrease over time, particularly the preannouncement return, consistent with changes in the financial intermediary sector gradually alleviating the frictions that lead to predictable upward biases in preannouncement prices.

4. *Additional Analyses*

4.1 CROSS-SECTIONAL IMPLICATIONS

Our model predicts that market prices incorporate more good news before announcements and less during, and vice versa for bad news. Together, these predictions suggest that estimated earnings response coefficients (ERCs) are more likely to be sensitive to the chosen return window for announcements with positive earnings surprises. To test this prediction empirically, we estimate ERCs using the same sample but three different announcement windows from $t-1$ to $t+1$, $t-5$ to $t+5$, and t to $t+1$.

TABLE 5
Earnings Response Coefficients

	Good News (N=145,349)			Bad News (N=70,405)		
	(−1,+1)	(−5,+5)	(0,+1)	(−1,+1)	(−5,+5)	(0,+1)
RET:	(1)	(2)	(3)	(4)	(5)	(6)
SURP	1.456***	2.005***	1.278***	0.140***	0.155***	0.150***
	(8.32)	(7.97)	(8.17)	(3.28)	(3.27)	(3.98)
SIZE	−0.104***	−0.147***	−0.059	0.156**	0.195***	0.173**
	(−2.79)	(−4.63)	(−1.62)	(2.08)	(2.88)	(2.26)
LBM	0.126	0.605	0.254	1.082***	1.684***	0.978***
	(0.42)	(1.57)	(0.97)	(4.09)	(5.08)	(4.12)
MOMEN	−0.007**	−0.016***	−0.007***	−0.003	−0.014***	−0.001
	(−2.44)	(−3.03)	(−2.80)	(−1.41)	(−3.31)	(−0.57)
R^2 (%)	1.608	1.683	1.375	0.430	0.432	0.524

This table presents regressions of announcement-window returns on analyst-based earnings surprises, across subsamples partitioned by the sign of the earnings surprise. Returns are measured over three windows—t−1 to t+1, t−5 to t+5, and t to t+1—where t is the earnings announcement date. *SURP* equals the actual EPS number reported in IBES minus the last consensus forecast available immediately before the announcement and scaled by beginning-of-quarter price. *LBM* and *SIZE* are the log of one plus the book-to-market ratio and log of market capitalization, respectively. *MOMEN* equals the firm's market-adjusted return from t−51 to t−11. Columns (1) through (3) correspond to positive surprise announcements ($SURP \geq 0$), and columns (4) through (6) correspond to negative news announcements ($SURP < 0$). t–statistics, shown in parentheses, are based on standard errors clustered by firm and industry. Year fixed effects are included throughout. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012.

Because we use the same sample of announcements for each regression, any differences in ERCs must be attributable to variation in the return-window. In table 5, columns 1 through 3 correspond to positive surprise announcements (i.e., $SURP \geq 0$), and columns 4 through 6 correspond to those with negative surprises (i.e., $SURP < 0$). Focusing first on positive surprises, columns 1 and 2 show that there is a large discrepancy between ERCs when returns are measured from $t-1$ to t+1 versus $t-5$ to t+5. Specifically, ERCs increase by 37% (=(2.005−1.456)/1.456). Moreover, column 3 shows that the difference in ERCs is even more dramatic for good news announcements when we measure returns from t to t+1, consistent with preannouncement prices incorporating an increasing share of good news leading up to the release of earnings news.

By contrast, columns 4, 5, and 6 of table 5 show that ERCs are relatively insensitive to the announcement window chosen among bad news announcements, consistent with bad news not being reflected in prices until the announcement.[14] Together, these findings demonstrate that regressions using short-window announcement returns are more likely to understate ERCs among positive news announcements. Thus, when researchers interact earnings news with a signal to estimate its impact on the ERC, the

[14] ERCs for bad news announcements are significantly smaller than those for good news announcements because analyst surprises have a larger standard deviation among negative news announcements. In untabulated tests, our inferences are unchanged when standardizing the distribution of surprises for each subsample.

estimates are potentially confounded by any correlation between the signal and the nature of the firm's earnings news.

Our next cross-sectional tests explore Empirical Prediction 4, which states that the extent to which intermediaries provide liquidity asymmetrically increases with σ, the volatility associated with the announcement. We test this prediction in panel A of table 6 using three proxies for uncertainty: *EVOL*, the firm's earnings volatility, defined as the standard deviation of quarterly earnings scaled by total assets over the prior eight quarters; *VLTY*, the firm's return volatility, defined as the standard deviation of daily market-adjusted returns from $t-51$ to $t-11$; and *AGE*, the log of the number of months since the firm first appeared in CRSP. We expect that higher values of *EVOL* and *VLTY* and lower values of *AGE* indicate greater uncertainty about firms' earnings and thus higher *ALP*. Consistent with changes in *ALP* stemming from inventory risks, panel A of table 6 shows that the preannouncement increase in *ALP* is pronounced among higher uncertainty stocks across all three proxies.

Our model also predicts that the preannouncement upward bias in order flow and returns, as well as the subsequent reversal, are pronounced among higher uncertainty stocks, due to greater asymmetries in preannouncement trading costs. Consistent with our prediction, panel B of table 6 shows that preannouncement *AOI*s and returns are strongest among high uncertainty stocks.

Although panels A and B of table 6 show the link between uncertainty and preannouncement returns, we also predict a sharp reversal in the link between uncertainty and returns once earnings news is announced and inventory risks decline. Consistent with this prediction, panel C of table 6 shows that the uncertainty-return relation is strongly positive on day $t-1$, where uncertainty proxies have the most robust positive relation with preannouncement returns. However, panel C also shows that the sign of the uncertainty-return relation flips on day t, becoming significantly negative on and following the announcement.

The knife-edge change in returns shown in table 6 provides clear evidence of a predictable upward bias in preannouncement prices that reverses postannouncement. Moreover, the preannouncement bias and subsequent reversal are economically large, with the day $t-1$ difference across volatility quintiles in average returns annualizing to 127.6% and the day t difference annualizing to -79.8%.

Panel D of table 6 illustrates an important implication of our findings. Specifically, we study three common definitions of announcement-window returns and show that the choice over alternative windows significantly impacts the size and significance of the relation between uncertainty proxies and announcement returns. For example, using the earnings volatility proxy, we show that measuring returns from $t-1$ to t results in an insignificant spread in announcement returns across high and low uncertainty firms (17 bp, p-value $= 0.12$), whereas the uncertainty spread jumps more than fourfold to 71 bp and becomes highly statistically significant (p-value $=$

TABLE 6

Cross-Sectional Implications

Panel A: Asymmetric liquidity provision sorted by uncertainty proxies

Proxy:	*VLTY*			*EVOL*			*AGE*		
ALP:	(−4, −2)	(−31, −11)	Δ*ALP*	(−4, −2)	(−31, −11)	Δ*ALP*	(−4, −2)	(−31, −11)	Δ*ALP*
Q1 (Low)	0.119	0.116	0.003	0.026	0.030	−0.004	0.623	0.112	0.511
Q2	0.259	0.093	0.166	0.200	0.070	0.130	0.435	0.138	0.297
Q3	0.356	0.086	0.270	0.267	0.073	0.194	0.342	0.136	0.206
Q4	0.470	0.101	0.369	0.413	0.102	0.312	0.346	0.133	0.213
Q5 (High)	0.639	0.189	0.450	0.708	0.237	0.470	0.218	0.069	0.149
High−Low	0.520	0.074	0.447	0.682	0.207	0.474	−0.405	−0.043	−0.361
p-Value	0.000	0.269	0.000	0.000	0.018	0.002	0.000	0.424	0.002

Panel B: Abnormal order imbalances and returns sorted by uncertainty proxies

	VLTY		*EVOL*		*AGE*	
	AOI(−4, −2)	*RET*(−4, −2)	*AOI*(−4, −2)	*RET*(−4, −2)	*AOI*(−4, −2)	*RET*(−4, −2)
Q1 (Low)	−0.007	0.019	−0.008	0.036	0.009	0.369
Q2	0.000	0.062	0.000	0.141	0.009	0.309
Q3	0.002	0.123	0.009	0.162	0.012	0.210
Q4	0.010	0.289	0.012	0.332	0.003	0.171
Q5 (High)	0.014	0.569	0.013	0.412	−0.007	0.066
High−Low	0.021	0.550	0.021	0.376	−0.016	−0.303
p-Value	0.019	0.000	0.006	0.001	0.051	0.003

Panel C: Announcement returns sorted by uncertainty proxies

	VLTY			*EVOL*			*AGE*		
	t−1	*t*	*t*+1	*t*−1	*t*	*t*+1	*t*−1	*t*	*t*+1
Q1 (Low)	0.054	0.140	0.032	0.061	0.176	0.069	0.278	−0.217	−0.152
Q2	0.080	0.245	0.077	0.148	0.186	0.024	0.195	0.002	−0.060
Q3	0.160	0.219	0.055	0.168	0.113	0.029	0.172	0.108	−0.012
Q4	0.237	0.091	−0.084	0.209	−0.053	−0.070	0.180	0.124	0.006
Q5 (High)	0.381	−0.492	−0.308	0.307	−0.217	−0.250	0.091	0.185	0.018
High−Low	0.327	−0.633	−0.341	0.246	−0.393	−0.319	−0.187	0.401	0.170
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Panel D: Alternative announcement return metrics sorted by uncertainty proxies

	VLTY			*EVOL*			*AGE*		
	(−1,0)	(−1,+1)	(0,+1)	(−1,0)	(−1,+1)	(0,+1)	(−1,0)	(−1,+1)	(0,+1)
Q1 (Low)	0.193	0.228	0.178	0.226	0.297	0.253	0.026	−0.108	−0.366
Q2	0.316	0.402	0.329	0.320	0.351	0.210	0.173	0.123	−0.051
Q3	0.372	0.437	0.285	0.266	0.305	0.154	0.261	0.262	0.109
Q4	0.313	0.242	0.020	0.137	0.080	−0.108	0.292	0.302	0.148
Q5 (High)	−0.169	−0.463	−0.793	0.057	−0.173	−0.457	0.272	0.297	0.209
High−Low	−0.362	−0.692	−0.971	−0.169	−0.471	−0.711	0.246	0.405	0.574
p-Value	0.003	0.000	0.000	0.121	0.001	0.000	0.010	0.002	0.000

This table presents average values of asymmetry in liquidity provision (*ALP*), abnormal order imbalances (*AOI*), and market-adjusted returns (*RET*) across sample partitions based on quintiles of a given uncertainty proxy. *p*-values are based on the time series of quarterly returns. The (X,Y) column headings indicate that the variable is measured over days $t+X$ to $t+Y$, where t is the earnings announcement date. The $t+X$ column headings indicate that the variable is measured on day $t+X$. ΔALP is defined as the difference between $ALP(-4,-2)$ and $ALP(-31,-11)$. *EVOL* is the firm's earnings volatility, defined as the standard deviation of quarterly earnings scaled by total assets over the prior eight quarters. *VLTY* is the standard deviation of daily market-adjusted returns from $t-51$ to $t-11$. *AGE* is the log of the number of months since the firm first appeared in CRSP. Observations are assigned to quintiles each calendar quarter, where the highest (lowest) values are assigned to quintile Q5 (Q1) using distributional breakpoints from the prior calendar quarter. The sample for this analysis consists of 215,754 quarterly earnings announcements spanning 1993 through 2012. *ALP* and returns are shown as a percentages.

0.00) when announcement-window returns are measured from t to $t+1$. The striking contrast in these estimates reflects our knife-edge results, where uncertainty proxies relate positively to preannouncement returns $(t-1)$ but negatively to postannouncement returns $(t+1)$.[15]

4.2 INTERNAL VALIDITY: TIME SERIES AND CROSS-SECTIONAL TESTS

In this section, we further validate our hypothesis that asymmetries in preannouncement trading costs, order imbalances, and returns are all driven by the inventory management decisions of intermediaries. To do so, we first show that these three patterns are correlated *across quarters* in time series tests and *across firms* in cross-sectional tests, indicating that our findings stem from the same underlying phenomenon. Next, we show that our effects are stronger when financial intermediaries are contracting their balance sheets, consistent with our hypothesis.

For our time series tests, we calculate three pairwise correlations among the quarterly average values of *ALP*, *AOI*, and *RET*, denoted as $\rho(ALP, AOI)$, $\rho(ALP, RET)$, and $\rho(AOI, RET)$, for each event-day from $t-10$ to $t+10$. Panel A of table 7 shows that the time series correlations between *ALP*, *AOI*, and *RET* are positive and economically large, with the average correlation exceeding 50%. Moreover, the bottom two rows of panel A show that these correlations tend to be stronger in the preannouncement period from $t-4$ to $t-2$, relative to the pooled 21-day event-window, consistent with preannouncement inventory risks being a central driver of the link between *ALP*, *AOI*, and *RET*.

In panel B of table 7, we also show that *ALP*, *AOI*, and *RET* tend to be concentrated among the same types of firms. Specifically, we compute within-quarter averages of *ALP*, *AOI*, and *RET* for decile portfolios sorted by each of our uncertainty proxies and then calculate correlations in the cross-section of these portfolios.[16] We calculate these correlations within each quarter and present time series average correlations as well as corresponding *t*-statistics in a fashion similar to Fama-MacBeth tests.

Panel B shows that the preannouncement patterns in returns, *AOI*, and *ALP* are all concentrated among the same types of firms within a given quarter, which generates positive cross-portfolio correlations across all three metrics.[17] An important caveat to these results is that they do not establish causality in support of our ATC hypothesis. Instead, they are consistent with

[15] Similarly, table 6 shows that, on average, high uncertainty firms underperform low uncertainty firms during their announcements. Such a conclusion would be puzzling because investors appear to earn lower returns when investing in higher risk stocks and vice versa. However, our results indicate that this is likely the reversal of an upward bias in preannouncement prices concentrated among high uncertainty firms.

[16] We rely on portfolios for these tests, rather than individual firms, because we need multiple firms to implement the *ALP* estimates used throughout our main analyses.

[17] In the online appendix, we find similarly positive cross-sectional correlations when calculating firm-specific versions of our main outcome variables.

TABLE 7

Correlations Among ALP, AOI, and Returns

Panel A: Across-quarter correlations in event-time

	$\rho(AOI, RET)$	$\rho(AOI, ALP)$	$\rho(ALP, RET)$	Average ρ
$t-10$	0.340	0.349	0.687	0.459
$t-9$	0.484	0.492	0.670	0.549
$t-8$	0.373	0.417	0.611	0.467
$t-7$	0.335	0.427	0.627	0.463
$t-6$	0.470	0.382	0.728	0.527
$t-5$	0.411	0.523	0.669	0.534
$t-4$	0.615	0.522	0.588	0.575
$t-3$	0.505	0.490	0.770	0.588
$t-2$	0.488	0.432	0.630	0.517
$t-1$	0.555	0.415	0.587	0.519
t	0.264	0.269	0.296	0.276
$t+1$	0.385	0.546	0.692	0.541
$t+2$	0.527	0.411	0.551	0.496
$t+3$	0.385	0.511	0.641	0.512
$t+4$	0.514	0.614	0.595	0.574
$t+5$	0.517	0.449	0.597	0.521
$t+6$	0.417	0.522	0.543	0.494
$t+7$	0.463	0.416	0.690	0.523
$t+8$	0.416	0.483	0.592	0.497
$t+9$	0.500	0.458	0.480	0.480
$t+10$	0.391	0.419	0.527	0.446
Mean	0.446	0.455	0.608	0.503
Mean$(t-4, t-2)$	0.536	0.481	0.663	0.560

Panel B: Average cross-sectional portfolio correlations

	$\rho(AOI, RET)$	$\rho(AOI, ALP)$	$\rho(ALP, RET)$
VLTY Portfolios	0.178	0.032	0.107
	(11.42)	(2.62)	(6.47)
EVOL Portfolios	0.179	0.041	0.103
	(12.01)	(4.13)	(7.33)
AGE Portfolios	0.174	0.034	0.042
	(12.28)	(3.90)	(3.41)

Panel A presents across-quarter correlations among the average values of *ALP*, *AOI*, and *RET* for each of the 21 days surrounding firms' announcements. For each event-day within the $t-10$ through $t+10$ window, we calculate three pairwise correlations among the quarterly average values of *ALP*, *AOI*, and *RET*, denoted as $\rho(ALP, AOI)$, $\rho(ALP, RET)$, and $\rho(AOI, RET)$. Panel B contains time series averages of quarterly cross-sectional correlations between portfolio-level values of *ALP*, *AOI*, and *RET* using portfolios sorted by deciles of our three main uncertainty proxies. *EVOL* is the firm's earnings volatility, defined as the standard deviation of quarterly earnings scaled by total assets over the prior eight quarters. *VLTY* is the standard deviation of daily market-adjusted returns from $t-51$ to $t-11$. *AGE* is the log of the number of months since the firm first appeared in CRSP. Observations are assigned to quintiles each calendar quarter using distributional breakpoints from the prior calendar quarter. The sample for this analysis consists of 215,754 earnings announcements spanning 1993 through 2009.

our three preannouncement patterns having the same underlying driver, which our frictions-based model is uniquely able to explain, whereas alternative explanations require multiple simultaneous drivers.

Table 8 further supports our ATC hypothesis by linking our findings to changes in the financial intermediary sector. These tests explore the time

TABLE 8

The Roles of Investor Sentiment and Financial Intermediary Growth

Panel A: Monthly correlations

	$SENT$	$RET(-2,-4)_M$	$AOI(-2,-4)_M$	$\Delta ALP(-2,-4)_M$	$\overline{FIG}_M$
$SENT$		−0.037	−0.025	0.012	0.067
$RET(-2,-4)_M$	−0.037		0.421	0.555	−0.043
$AOI(-2,-4)_M$	−0.025	0.421		0.364	−0.147
$\Delta ALP(-2,-4)_M$	0.012	0.555	0.364		−0.164
$\overline{FIG}_M$	0.067	−0.043	−0.147	−0.164	

Panel B: Time series regressions with monthly intermediary data

	$RET(-4,-2)_M$		$AOI(-4,-2)_M$		$\Delta ALP(-4,-2)_M$	
	(1)	(2)	(3)	(4)	(5)	(6)
$SENT$	−0.348*	−0.299	−0.022	−0.020	−0.472*	−0.374
	(−1.81)	(−1.38)	(−1.08)	(−0.95)	(−1.94)	(−1.39)
$\overline{FIG}_M$	–	−2.222	–	−0.656**	–	−7.875*
	–	(−0.63)	–	(−2.26)	–	(−1.87)
N	216	155	215	155	216	155
R^2 (%)	1.672	1.770	0.441	3.109	1.941	4.380

Panel C: Panel regressions with weekly intermediary data

	$RET(-4,-2)$		$RET(-1,+1)$		$RET(+2,+4)$	
	(1)	(2)	(3)	(4)	(5)	(6)
FIG	−1.797***	−1.792***	−0.087	−0.088	1.109***	1.107***
	(−3.34)	(−3.53)	(−0.11)	(−0.12)	(2.82)	(2.96)
$FIG{*}IU$	–	−3.745***	–	0.661	–	2.172**
	–	(−3.07)	–	(0.80)	–	(2.55)
IU	0.221***	0.249***	−0.545***	−0.550***	−0.198***	−0.214***
	(4.45)	−4.55	(−4.35)	(−4.37)	(−2.83)	(−3.03)
R^2 (%)	0.341	0.367	6.808	6.808	0.261	0.269

Panel A presents correlations of the monthly investor sentiment index from Baker and Wurgler [2006] and monthly averages of three preannouncement measures: (1) market-adjusted returns, denoted $RET(-2,-4)_M$; (2) abnormal buy-sell order imbalances, denoted $AOI(-4,-2)_M$; and (3) abnormal asymmetric liquidity provision, denoted $\Delta ALP(-2,-4)_M$. The sample for this analysis consists of 216 calendar months spanning 1993 through 2010, during which the investor sentiment index is available. Panel B presents time series regressions of the monthly averages of our outcome variables on *SENT* as well as the monthly average of aggregate financial intermediary balance sheet growth, denoted $\overline{FIG}_M$. Aggregate balance sheet information is obtained from the Federal Reserve Bank of New York, where growth for a given week is defined as the weekly change in total repurchase agreements (standard repos plus reverse repos), relative to the prior calendar week. In panel B, year-fixed effects are included throughout. The sample ranges from 216 to 155 monthly observations, depending on the availability of $\overline{FIG}_M$, which became available in 1998. Panel C presents results from panel regressions of firms' returns surrounding earnings announcements on weekly aggregate financial intermediary balance sheet growth, *FIG*, and *LBM*, *SIZE*, *MOMEN*, and *SURP*. We measure *FIG* in the week before firms' earnings announcements. $RET(X,Y)$ is the cumulative market-adjusted return from $t+X$ to $t+Y$ in percentage terms, where t is the firm's earnings announcement date. *IU* is a composite uncertainty proxy calculated as the sum of volatility (*VLTY*), earnings volatility (*EVOL*), and minus 1 times firm age (*AGE*), where all three measures are standardized each quarter to have a zero mean and unit standard deviation. The coefficients for *LBM*, *SIZE*, *MOMEN*, and *SURP* are omitted for brevity. In panel C, year fixed effects are included throughout, and t–statistics, shown in parentheses, are based on standard errors clustered by firm and industry. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The sample for panel C consists of 169,700 earnings announcements spanning 1998 through 2012.

series implications of Empirical Prediction 4 that our findings should be most pronounced when intermediaries prefer to reduce their net positions. Adrian and Shin [2010] use weekly aggregate repurchase agreement transactions to measure adjustments to the scale of financial intermediaries' balance sheets. We use the average of this measure over each calendar month, denoted as $\overline{FIG_M}$. We adopt this measure, assuming it is correlated with intermediaries' willingness to provide liquidity to buyers, which would reduce their net balance sheet position, versus sellers, which would have the opposite effect. The negative correlations between $\overline{FIG_M}$ and *AOI*, *ALP*, and *RET* in panel A indicate that the asymmetries we study are stronger when intermediaries are contracting their balance sheets and are therefore less willing to take on new inventory positions, as we predict.

Panel B of table 8 provides complimentary evidence using time series regressions, with fixed effects, of our main outcome variables on investor sentiment and intermediary balance-sheet growth. The regression evidence is consistent with panel A, where sentiment relates insignificantly or negatively to *RET*, *AOI*, and ΔALP. $\overline{FIG_M}$, by contrast, relates negatively to all three outcome variables and significantly so for *AOI* and ΔALP.

Finally, in panel C of table 8, we extend the monthly time series analysis in panels A and B by examining the link between returns surrounding firms' announcements and *weekly* changes in the intermediary sector. These tests combine both time series and cross-sectional implications within a panel data setting. We measure weekly aggregate intermediary balance-sheet growth in the week before firms' earnings announcements, denoted *FIG*, and predict that it relates negatively to the preannouncement upward bias in prices and positively to the subsequent reversal. These tests also include a composite uncertainty proxy, *IU*, calculated as the sum of the three uncertainty proxies from table 6 (*VLTY*, *EVOL*, and $-1*AGE$), where all three measures are standardized each quarter.

Columns 1, 3, and 5 of panel C corroborate our central hypotheses by showing that both the preannouncement upward bias in returns and the subsequent reversal are most pronounced when intermediaries are scaling down their balance sheet positions. The symmetry in results across preversus postannouncement returns is consistent with intermediaries inducing a short-term upward bias in preannouncement prices that subsequently reverses.

Finally, columns 2, 4, and 6 combine our cross-sectional and time series tests by interacting *FIG* with uncertainty proxies. Using an interaction term between *FIG* and our uncertainty proxy, *IU*, we confirm our prediction that the relation between intermediary balance sheet growth and returns is more pronounced among high uncertainty stocks because their announcements engender greater risks.

4.3 EXTERNAL VALIDITY: EXTENSION TO FRIDAY EFFECTS

In the online appendix, we provide a validity test in a seemingly unrelated setting—and contribute directly to the literature—by demonstrating how our theory can help explain well-known Friday effects in prior research. The main intuition for our analysis of Friday effects is that weekends, like earnings announcements, pose heightened inventory risks because markets are closed longer and prices move more, compared to typical overnight periods (French [1980]). Given this mechanism, our theory predicts that intermediaries' risk and inventory management concerns influence market outcomes in much the same way as earnings announcements.

Echoing our earnings announcement results, we show in the online appendix that *ALP*, *AOI*s, and average returns, respectively, all increase throughout the week and reverse at the beginning of the subsequent week. We also show that these predictable patterns are concentrated among high volatility firms and are positively correlated in the cross-section. These findings suggest that the intraweek patterns we document stem from the risk and inventory management practices of intermediaries.

The evidence on intraweek patterns contributes to the literature by providing a novel explanation for the well-documented Friday effect that stock returns are abnormally positive on Fridays (e.g., French [1980], Lakonishok and Levi [1982], Keim and Stambaugh [1984]). Prior literature has argued that the effects stem from investor behavior, whereas we argue that it derives, at least in part, from intermediaries' inventory management decisions throughout the week.

5. *Alternative Hypotheses*

As noted in section 1, there are multiple alternative explanations for our findings. The first is that they stem from firms selectively disclosing positive earnings news before their announcements, as suggested by Roychowdhury and Sletten [2012]. Under this explanation, firms are more likely to withhold bad news and disclose good news, resulting in an upward bias in preannouncement price discovery. While this would explain the observed return patterns conditional on the sign of earnings news, in a fully rational pricing model, selective disclosure alone would not cause average preannouncement returns to be *unconditionally* positive because rational investors should interpret the lack of preannouncement disclosure as bad news and adjust prices accordingly. If investors do not rationally interpret no news as bad news or underreact specifically to bad news, selective disclosure could also explain the unconditional return pattern we document empirically (a possibility raised by Giglio and Shue [2014]).

A selective disclosure story, whether it features rational or irrational investors, does not explain our evidence of *ALP*. Any public disclosures will be available to both intermediaries and investors and thus will not create asymmetric private information. As a result, without the frictions we describe, intermediaries have no reason to asymmetrically provide liquidity. Furthermore, alternative hypotheses based on asymmetric disclosure do not explain why order imbalances are positive, even before bad news announcements, or why our findings are significantly related to changes in the intermediary sector.

In the online appendix, we also provide empirical evidence of informed trading in options markets before negative news announcements, indicating that some traders are aware of the news before its announcement. Specifically, we show that preannouncement values of the implied-volatility spread measure from Cremers and Weinbaum [2010] are positively related to subsequent earnings news in the subsample of announcements with negative news. This test mitigates the concern that selective disclosures prevent traders from being informed about negative earnings information.

A second alternative hypothesis is that there is an asymmetry in information acquisition and therefore directional trading, rather than an asymmetry in liquidity provision. For example, Cieslak, Morse, and Vissing-Jorgensen [2016] suggest that the on average positive returns before FOMC announcements shown by Lucca and Moench [2015] are driven by insider information. This bias could explain our results on *AOI*s and average returns before announcements. However, asymmetrically positive information acquisition would make the adverse selection faced by intermediaries worse for buy orders than sell orders. As a result, there would be larger liquidity costs for buy orders than sell orders, the opposite of what we find. If information acquisition were asymmetrically negative instead, this alternative hypothesis would explain the observed asymmetry in trading costs but not the preannouncement patterns in order imbalances or price discovery.[18] The following summarizes the predictions of the two possible asymmetric adverse selection alternatives, where the crossed-out text indicates predictions that are inconsistent with what we observe empirically:

Preannouncement	Good News Asymmetry	Bad News Asymmetry	Empirical Results
Price discovery greater for:	Good news	~~Bad news~~	Good news
Liquidity more expensive for:	~~Buys~~	Sells	Sells
Abn. order imbalances for:	Buys	~~Sells~~	Buys

A third alternative hypotheses is that our evidence of positive preannouncement abnormal returns stems from exposure to priced risk, as argued by Savor and Wilson [2016]. In our model, exposure to systematic risk explains the presence of return premia. However, our frictions-based story is uniquely able to explain the *timing* of the premia. Specifically, our

[18] In the online appendix, we also find no association between preannouncement order imbalances and the multimarket measure of information asymmetry (MIA) from Johnson and So [2016], suggesting that our results are not driven by an asymmetry in the direction of private information.

findings show that, while abnormal volatility is concentrated only on the announcement date, returns are abnormally positive before announcements, insignificant on the announcement day, and negative afterward. This pattern occurs in our model but is inconsistent with a purely risk-based story, which predicts positive excess returns on the announcement day and no runup in preannouncement prices or subsequent reversal.

A fourth alternative hypothesis is that short-sale costs cause prices to rise due to greater speculative demand from optimists than pessimists, as suggested by Miller [1977]. Berkman et al. [2009] argue that this pattern intensifies before earnings announcements and that announcements correct prices downward by resolving speculative disagreement about firm value. Consistent with this hypothesis, Trueman, Wong, and Zhang [2003] find abnormally positive preannouncement returns and order imbalances for Internet stocks during the 1998–2000 tech bubble. Our findings identify *ALP* as an alternative sell-oriented friction, similar to short-sale constraints, that rises preannouncement in proportion to the uncertainty underlying the announcement. Our evidence of preannouncement asymmetries in liquidity provision also casts doubt on the short-sale cost explanation because increased speculative demand from optimists should give rise to greater short-term reversals in response to buying pressure because nonfundamental price changes tend to reverse. In contrast, our findings in table 1 show the opposite. In the online appendix, we also examine the role of short-sale constraints by using exogenous variation created by the Securities and Exchange Commission (SEC's) Reg SHO experiment as discussed by Diether, Lee, and Werner [2009]. The results show no significant effect of the regulation on the patterns we document.

To further investigate this and other alternatives based on market-wide sentiment, we examine the correlation between the investor-sentiment index from Baker and Wurgler [2006] and monthly averages of our main outcome variables: (1) market-adjusted returns, denoted $RET(-2,-4)_M$; (2) *AOI*s, denoted $AOI(-4,-2)_M$; and (3) abnormal *ALP*, denoted $\Delta ALP(-2,-4)_M$. Stambaugh, Yu, and Yuan [2012] take a similar approach to study anomalies and show that overvaluation is concentrated in periods of high investor sentiment. Similarly, Lee, Shleifer, and Thaler [1991] argue that investor sentiment explains the overvaluation of close-end funds.

Thus, to the extent that pervasive investor irrationality drives our results, our findings should be positively correlated with market-level investor sentiment, which increased during the tech-boom of the late 1990s (Baker and Wurgler [2006]). An important caveat is that variations in sentiment do not necessarily capture all types of micro-level sentiment that might explain our findings.

Table 8 shows that the correlations between market-wide sentiment, denoted *SENT*, and our main outcome variables are all economically small, less than 5% in magnitude. Moreover, the correlations between sentiment and both returns and *AOI*s are *negative*. The small or negative correlations between sentiment and our main outcome variables indicate that our results are, if anything, weaker during periods of high sentiment, suggesting that our findings are unlikely to be driven by investor irrationality alone.

A distinguishing feature of our hypothesis is that it only applies to information events with anticipated timing, whereas the selective disclosure, asymmetric adverse selection, and some behavioral alternatives could apply to unanticipated events as well. As a placebo test, we therefore further distinguish our ATC hypothesis from alternatives using nonearnings 8-K filings, which are less likely to be anticipated. In the online appendix, we find no significant evidence of abnormal preannouncement *ALP*, *AOI*, or average returns before nonearnings 8-K filings. This nonresult is consistent with our frictions-based story, which requires foreknowledge of the announcement date by intermediaries, and generally inconsistent with alternative stories, such as selective disclosure, that do not depend on public foreknowledge.[19]

To the best of our knowledge, the ATC hypothesis is uniquely able to provide a unified explanation for all of our collective evidence on a variety of market outcomes. Moreover, alternative explanations are difficult to reconcile with the preannouncement rise and postannouncement reversal of *ALP* and biased market prices as well as the cross-sectional correlations among our findings and the links to uncertainty and changes in the intermediary sector. However, our results do not rule out the possibility that these alternative hypotheses play a role in driving some of our results. We therefore view our main results as being consistent with *ALP* playing an important role in driving market outcomes and providing a potential (but not exclusive) explanation for the predictable patterns in returns, liquidity, and trading volume around earnings announcements.

6. *Implications for Future Research*

Taken together, our findings raise at least three important methodological issues that stem from ATCs. These issues, along with our recommendations for how researchers can mitigate, utilize them, or both are as follows:

1) Earnings announcement returns: We predict that a significant portion of the returns associated with earnings announcements (e.g., news, risk premia, or both) is concentrated beforehand. To mitigate measurement error associated with preannouncement upward biases and subsequent reversals, we recommend that future research on scheduled events use monthly returns or a longer daily return window while attempting to control for other sources of news in multivariate tests.

[19] In the online appendix, we also provide corroboratory evidence by showing that our effects are stronger among verified versus unverified earnings announcements, where verified announcements are more likely to have anticipated timing because the firm states in advance when its earnings will be announced.

2) Inventory risks as an omitted variable: We argue that inventory risks relate positively to returns before the announcement (reflecting an upward bias) but also negatively to returns immediately following the announcement (reflecting the reversal of the bias). This pattern gives rise to a classic omitted variable problem, which can confound short-window returns as a proxy for announcement news, particularly when the construct of interest (e.g., reporting quality) is correlated with inventory risks (e.g., via uncertainty over earnings news). To mitigate this bias, researchers studying short-window announcement returns should directly control for firm-level inventory risk proxies (e.g., return volatility) within multivariate tests, employ long-window announcement returns if they prefer univariate tests, or both.
3) Good versus bad news announcements: An implication of our model is that there is more price discovery before good news announcements, causing narrow-window returns to miss a substantial portion of price discovery and underestimate ERCs. Thus, when researchers interact earnings news with a signal, the resulting ERCs are potentially confounded by a correlation between the signal and the nature of the firm's earnings news. We therefore recommend that researchers gauge the sensitivity of their findings to the use of long-window announcement returns, estimate ERCs across subsamples of positive versus negative news, or both.

The second and third points above also relate to studies that examine trading volume (e.g., Bamber [1987], Garfinkel and Sokobin [2006]). Our findings show that announcement trading volume is more likely to reflect negative news because ATCs create an incentive for investors to delay trading on negative signals until after news is released, which can confound trading volumes as proxies for disagreement, earnings news, or both.

Our main analysis pertains to earnings announcement dates, which are important dates for the disclosure of information beyond recent financial performance. Dividend or share repurchase announcements, management forecasts, analyst forecasts, conference calls with investors, and a variety of other disclosures are clustered on or near earnings announcements. Our results therefore imply that returns around these event days will also be subject to the biases we document to the extent that their timing is clustered on earnings announcement dates.

7. *Conclusion*

In this study, we advance and test the ATC hypothesis, rooted in the incentives of financial intermediaries who provide liquidity by serving as the trade counterparty in response to imbalanced demand between buyers and sellers. In doing so, they tend to hold positive average inventory positions, indicating likely exposure to increased inventory risks associated with earnings announcements. Our ATC hypothesis predicts that, due to this exposure, intermediaries reduce their exposure to announcement risks by providing liquidity asymmetrically, which increases the cost of trading on negative news before earnings announcements.

Our model and empirical findings provide support for our hypothesis. Specifically, we show that ATCs create a predictable upward bias in prices that increases preannouncement and subsequently reverses, confounding short-window announcement returns as measures of earnings news and risk premia. More broadly, we provide a unified framework that links several pervasively studied market outcomes. These outcomes include market prices, returns, trading volumes, order flows, and liquidity, which matter centrally in virtually all capital market research.

An important contribution of our paper is that it provides a liquidity-provision-based explanation for daily return patterns around the earnings announcement, one of the most significant information events for a firm. A natural reason that one would observe systematically positive returns leading up to good news at earnings announcements while not observing a similar pattern for bad news is that there is asymmetric news leakage to the market. This raises the possibility that insiders opportunistically leak information about an upcoming public news event when the news is good but withhold news when it is bad. Our findings point to an important alternative possibility. Specifically, liquidity providers' aversion to inventory risk could lead to these systematic return patterns even in the absence of any asymmetric news leakage.

Our paper also provides a conceptual basis and empirical support for understanding several results that likely appear puzzling when viewed outside of our framework. An example of our paper's conceptual contribution is in explaining why earnings announcement risk premia occur before the actual announcement (Barber et al. [2013]). In the absence of our framework, this separation is puzzling because standard asset pricing models predict that risks and risk premia should occur at the same time. Our results indicate that this pattern arises due to ATCs. As a result, our model and evidence have the potential to influence the way that researchers understand market outcomes across a variety of settings, particularly those that study market outcomes in close proximity to firm-level, industry-level, and macroeconomic information events.

APPENDIX

Model Solution and Proofs

A.1 DETAILED MODEL SOLUTION

We solve the model by working backward, beginning with the trading game at $t = -1$. The intermediary has initial inventory Q_{-1} that is determined by its choice of Q_{-2} and the trading game at $t = -2$, but at $t = -1$, inventory is no longer a choice variable. Given realization $\tilde{v}_{-1} = v_{-1}$, the two possible asset values are $\{v_{-1} - \sigma, v_{-1} + \sigma\}$. The intermediary's problem in the subgame is therefore:

$$a_{-1}, b_{-1} = \arg\max_{a,b} \; U\left(a, b \mid Q_{-1}, v_{-1}\right). \tag{A.1}$$

$$\begin{aligned} &U\left(a, b \mid Q_{-1}, v_{-1}\right) \\ &= \overbrace{\mathbb{E}^{y}\left(x_{I,-1}(p(x_{I,-1}; a, b) - \hat{v}_{-1}) + x_{U,-1}(p(x_{U,-1}; a, b) - \hat{v}_{-1})\right)}^{\text{Expected trading profit}} \\ &\quad - \gamma_M \sigma^2 \underbrace{\mathbb{E}^{y}\left(Q_{-1} - x_{I,-1} - x_{U,-1}\right)^2}_{\text{Inventory risk}} + \rho \underbrace{\mathbb{E}^{y}\left(Q_{-1} - x_{I,-1} - x_{U,-1}\right)}_{\text{Cost of negative inventory}}. \end{aligned} \tag{A.2}$$

Our assumptions imply that the informed trader's demand function at $t = -1$ satisfies:

$$\begin{aligned} x_{I,-1}(\tilde{s}_{-1}; a_{-1}, b_{-1}) = \arg\max_{x} \; &\mathbb{E}^{y}\left(x\left(\tilde{v} - p(x)\right) \mid \tilde{s}_{-1}\right) \\ &- \gamma_T \mathrm{Var}^{y}\left(x\left(\tilde{v} - p(x)\right) \mid \tilde{s}_{-1}\right), \end{aligned} \tag{A.3}$$

where

$$p(x) = \begin{cases} a_{-1} & \text{if } x \geq 0 \\ b_{-1} & \text{if } x < 0 \end{cases}. \tag{A.4}$$

This implies:

$$x_{I,-1}(\tilde{s}_{-1}; a_{-1}, b_{-1}) = \begin{cases} \frac{v_{-1} + (2p-1)\sigma - a_{-1}}{8\gamma_T p(1-p)\sigma^2} & \text{if } \tilde{s}_{-1} = g \\ \frac{v_{-1} - (2p-1)\sigma - b_{-1}}{8\gamma_T p(1-p)\sigma^2} & \text{if } \tilde{s}_{-1} = b. \end{cases} \tag{A.5}$$

Similarly, for uninformed traders, we have:

$$x_{U,-1}(\tilde{u}_{-1}; a_{-1}, b_{-1}) = \begin{cases} \frac{v_{-1} + (2p-1)\sigma - a_{-1}}{8\gamma_T p(1-p)\sigma^2} & \text{if } \tilde{u}_{-1} = g \\ \frac{v_{-1} - (2p-1)\sigma - b_{-1}}{8\gamma_T p(1-p)\sigma^2} & \text{if } \tilde{u}_{-1} = b. \end{cases} \tag{A.6}$$

We substitute demand functions from (A.5) and (A.6) into each of the three components of intermediary utility, relying on the following notation:

$$A_{0,d} \equiv \frac{(2p-1)}{8\gamma_T p(1-p)\sigma.} \tag{A.7}$$

$$A_{1,d} \equiv \frac{1}{8\gamma_T p(1-p)\sigma^2.} \tag{A.8}$$

$$\alpha \equiv a - v_{-1.} \tag{A.9}$$

$$\beta \equiv b - v_{-1.} \tag{A.10}$$

The expected trading profit term satisfies:

$$\begin{aligned}
\mathbb{E}^y\left(\text{trading profit}\right) &= \mathbb{E}^y\left[x_i(\tilde{s}_{-1})\left(p\left(x_i(\tilde{s}_{-1};a,b)\right)-\hat{v}\right)\right.\\
&\quad \left.+\, x_u(\tilde{u}_{-1};a,b)\left(p\left(x_u(\tilde{u}_{-1})\right)-\hat{v}\right)\right]\\
&= \frac{1}{4}[2(A_{0,d}-A_{1,d}\alpha)(\alpha-\sigma(2p-1))\\
&\quad + 2(A_{0,d}-A_{1,d}\alpha)\alpha + 2(-A_{0,d}-A_{1,d}\beta)\beta\\
&\quad + 2(-A_{0,d}-A_{1,d}\beta)(\beta-\sigma(1-2p))]\\
&= -A_{0,d}\sigma(2p-1) + \frac{3}{2}A_{0,d}(\alpha-\beta) - A_{1,d}(\alpha^2+\beta^2).
\end{aligned} \tag{A.11}$$

The expected inventory risk term satisfies:

$$\begin{aligned}
\sigma^2\mathbb{E}^y\left(\left(Q_{-1}-x_{I,-1}-x_{U,-1}\right)^2\right) &= \frac{\sigma^2}{4}[(Q_{-1}-2A_{0,d}+2A_{1,d}\alpha)^2+2(Q_{-1}\\
&\quad + A_{1,d}(\alpha+\beta))^2 + (Q_{-1}+2A_{0,d}\\
&\quad + 2A_{1,d}\beta)^2] = A_{0,v}+A_{1,v}\alpha+B_{1,v}\beta\\
&\quad + A_{2,v}(\alpha^2+\beta^2)+C_{2,v}\alpha\beta,
\end{aligned} \tag{A.12}$$

where

$$A_{0,v} \equiv \sigma^2\left(2A_{0,d}^2+Q_{-1}^2\right). \tag{A.13}$$

$$A_{1,v} \equiv 2\sigma^2 A_{1,d}(Q_{-1}-A_{0,d}). \tag{A.14}$$

$$B_{1,v} \equiv 2\sigma^2 A_{1,d}(Q_{-1}+A_{0,d}). \tag{A.15}$$

$$A_{2,v} \equiv \tfrac{3}{2}\sigma^2 A_{1,d}^2. \tag{A.16}$$

$$C_{2,v} \equiv \sigma^2 A_{1,d}^2. \tag{A.17}$$

Finally, the expected cost of negative inventory term satisfies:

$$\rho\,\mathbb{E}^y\left(Q_{-1}-x_{I,-1}-x_{U,-1}\right) = \rho\left(Q_{-1}+A_{1,d}\left(\alpha+\beta\right)\right). \tag{A.18}$$

Putting the pieces together, the marker maker's full objective function satisfies:

$$U\left(a,b \mid Q_{-1}\right) = A_{0,m}+A_{1,m}\alpha+B_{1,m}\beta+A_{2,m}(\alpha^2+\beta^2)+C_{2,m}\alpha\beta, \tag{A.19}$$

where

$$A_{0,m} \equiv -A_{0,d}\sigma(2p-1)-\gamma_M\sigma^2\left(2A_{0,d}^2+Q_{-1}^2\right)+\rho Q_{-1}. \tag{A.20}$$

$$A_{1,m} \equiv \tfrac{3}{2}A_{0,d}-2\gamma_M\sigma^2 A_{1,d}(Q_{-1}-A_{0,d})+\rho A_{1,d}. \tag{A.21}$$

$$B_{1,m} \equiv -\tfrac{3}{2}A_{0,d} - 2\gamma_M\sigma^2 A_{1,d}(Q_{-1} + A_{0,d}) + \rho A_{1,d.} \tag{A.22}$$

$$A_{2,m} \equiv -A_{1,d} - \tfrac{3}{2}\gamma_M\sigma^2 A_{1,d.}^2 \tag{A.23}$$

$$C_{2,m} \equiv -\gamma_M\sigma^2 A_{1,d}^2. \tag{A.24}$$

We solve the first-order conditions with respect to a and b and find the following prices:

$$a_{-1} = M_{-1} + \tfrac{1}{2}S_{-1,} \tag{A.25}$$

$$b_{-1} = M_{-1} - \tfrac{1}{2}S_{-1}, \tag{A.26}$$

where

$$M_{-1} \equiv v_{-1} - \tfrac{4p(1-p)\gamma_M}{4p(1-p)+\frac{\gamma_M}{\gamma_T}}\sigma^2\left(Q_{-1} - \tfrac{\rho}{2\gamma_M\sigma^2}\right), \tag{A.27}$$

$$S_{-1} \equiv \tfrac{12p(1-p)+2\frac{\gamma_M}{\gamma_T}}{8p(1-p)+\frac{\gamma_M}{\gamma_T}}(2p-1)\sigma. \tag{A.28}$$

Substituting a_{-1} and b_{-1} from (A.25) and (A.26) into the intermediary's utility function in equation (A.1), we have the following subgame expected utility as a function of Q_{-1}:

$$U_{-1}(Q_{-1}) = C - \frac{4p(1-p)\gamma_M\sigma^2}{4p(1-p)+\frac{\gamma_M}{\gamma_T}}\left(Q_{-1} - \frac{\rho}{2\gamma_M\sigma^2}\right)^2, \tag{A.29}$$

where C is a constant that does not depend on inventory Q_{-1}. Note that expected subgame utility is maximized when excess inventory $Q_{-1} - \frac{\rho}{2\gamma_M\sigma^2}$ is zero, leading to the interpretation of $\frac{\rho}{2\gamma_M\sigma^2}$ as the target or optimal inventory for the announcement period.

Using the subgame equilibrium characterization, we solve for the intermediary's $t = -2$ optimal choice of Q_{-2}, a_{-2}, and b_{-2}:

$$\begin{aligned}
&U(Q_{-2}, a_{-2}, b_{-2}) \\
&= \overbrace{\mathbb{E}^y\left(x_{I,-2}(p(x_{I,-2}; a_{-2}, b_{-2}) - \hat{v}_{-2}) + x_{U,-1}(p(x_{U,-2}; a_{-2}, b_{-2}) - \hat{v}_{-2})\right)}^{\text{Expected trading profit}} \\
&\quad - \gamma_M \underbrace{\mathbb{E}^y\left(Q_{-2} - x_{I,-2} - x_{U,-2}\right)^2}_{\text{Inventory risk}} + \rho \underbrace{\mathbb{E}^y\left(Q_{-2} - x_{I,-2} - x_{U,-2}\right)}_{\text{Cost of negative inventory}} \\
&\quad + \underbrace{C - \frac{4p(1-p)\gamma_M\sigma^2}{4p(1-p)+\frac{\gamma_M}{\gamma_T}}\mathbb{E}^y\left(Q_{-2} - x_{I,-2} - x_{U,-2} - \frac{\rho}{2\gamma_M\sigma^2}\right)^2}_{\text{Expected } t=-2 \text{ utility}}.
\end{aligned} \tag{A.30}$$

Solving first-order conditions with respect to Q_{-2}, a_{-2}, and b_{-2} using a process similar to the one used for $t = -1$ yields the following solution:

$$Q_{-2} = \frac{\rho}{2\gamma_M}\left(\frac{8p(1-p) + \frac{\gamma_M}{\gamma_T}}{4p(1-p)(1+\sigma^2) + \frac{\gamma_M}{\gamma_T}}\right). \tag{A.31}$$

$$a_{-2} = \frac{1}{2}S_{-2}. \tag{A.32}$$

$$b_{-2} = -\frac{1}{2}S_{-2}. \tag{A.33}$$

$$S_{-2} \equiv \frac{3(4p(1-p)+\sigma^2)+2\frac{\gamma_M}{\gamma_T}K}{2(4p(1-p)+\sigma^2)+\frac{\gamma_M}{\gamma_T}K}(2p-1). \tag{A.34}$$

$$K \equiv \frac{4p(1-p)(1+\sigma^2)+\frac{\gamma_M}{\gamma_T}}{4p(1-p)+\frac{\gamma_M}{\gamma_T}}. \tag{A.35}$$

A.2 PROOFS OF EQUILIBRIUM RESULTS

RESULT A.1 (Asymmetric Liquidity Provision). *In the preannouncement period, negative price changes overshoot the information revealed by the trade more than positive ones:*

$$\mathbb{E}^z(\tilde{v}|\mathit{sell}) - \mathbb{E}^z(b_{-1}) > \mathbb{E}^z(a_{-1}) - \mathbb{E}^z\left(\tilde{v}|\mathit{buy}\right). \tag{A.36}$$

Proof. Equations (A.27) and (A.28) imply that:

$$\begin{aligned}\mathbb{E}^z(a_{-1} + b_{-1} - 2v_{-1}) &= 2\mathbb{E}^z(M_{-1} - v_{-1}) \\ &= -\frac{8p(1-p)\gamma_M}{4p(1-p) + \frac{\gamma_M}{\gamma_T}}\sigma^2\left(\mathbb{E}^z(Q_{-1}) - \frac{\rho}{2\gamma_M\sigma^2}\right).\end{aligned} \tag{A.37}$$

Since liquidity provision at $t = -2$ is symmetric, we have that:

$$\mathbb{E}^z(Q_{-1}) = Q_{-2} = \frac{\rho}{2\gamma_M}\left(\frac{8p(1-p) + \frac{\gamma_M}{\gamma_T}}{4p(1-p)(1+\sigma^2) + \frac{\gamma_M}{\gamma_T}}\right) > \frac{\rho}{2\gamma_M\sigma^2}. \tag{A.38}$$

In words, before the preannouncement trading period, expected market market inventory is above the optimal Q_0, which necessitates *ALP*:

$$\begin{aligned}\mathbb{E}^z(Q_{-1}) > \frac{\rho}{2\gamma_M\sigma^2} &\Rightarrow \mathbb{E}^z(a_{-1} + b_{-1} - 2v_{-1}) < 0 \\ &\Rightarrow \mathbb{E}^z(a_{-1} - v_{-1}) < \mathbb{E}^z(v_{-1} - b_{-1}).\end{aligned} \tag{A.39}$$

Furthermore, since:

$$\mathbb{E}^z(\tilde{v}|\text{buy}) = v_{-1} + \frac{1}{2}(2p-1)\sigma + 2\left(z_0 - \frac{1}{2}\right)\sigma, \tag{A.40}$$

$$\mathbb{E}^z(\tilde{v}|\text{sell}) = v_{-1} - \frac{1}{2}(2p-1)\sigma + 2\left(z_0 - \frac{1}{2}\right)\sigma, \tag{A.41}$$

we have:

$$\mathbb{E}^z(a_{-1}) - \mathbb{E}^z\left(\tilde{v}|\text{buy}\right) = \mathbb{E}^z\left(a_{-1} - v_{-1} - \tfrac{1}{2}(2p-1)\sigma - 2\left(z_0 - \tfrac{1}{2}\right)\sigma\right) \tag{A.42}$$

$$< \mathbb{E}^z\left(v_{-1} - b_{-1} - \tfrac{1}{2}(2p-1)\sigma + 2\left(z_0 - \tfrac{1}{2}\right)\sigma\right) \tag{A.43}$$

$$= \mathbb{E}^z(\tilde{v}|\text{sell}) - \mathbb{E}^z(b_{-1}). \tag{A.44}$$

■

RESULT A.2 (Asymmetric Trading Intensity). *In the preannouncement period, traders submit larger buy orders in equilibrium than sell orders:*

$$|x_{I,-1}(\tilde{s}=g)| > |x_{I,-1}(\tilde{s}=b)|. \tag{A.45}$$

$$|x_{U,-1}(\tilde{u}=g)| > |x_{U,-1}(\tilde{u}=b)|. \tag{A.46}$$

Proof. Follows from Result A.1 and the demand functions in equations (A.5) and (A.6). ■

RESULT A.3 (Abnormal Returns Around Announcements). *Expected returns computed using average prices under the physical measure satisfy:*

$$\mathbb{E}^z(\tilde{p}_{-1} - p_{-2}) = \underbrace{2\left(z_{-1} - \frac{1}{2}\right)}_{\textit{Normal risk prem.}} + \underbrace{\rho(\sigma^2-1)\left(\frac{2p(1-p) + \frac{\gamma_M}{\gamma_T}}{8p(1-p)(1+\sigma^2) + 2\frac{\gamma_M}{\gamma_T}}\right)}_{\textit{Upward bias}} \tag{A.47}$$

$$\mathbb{E}^z(\tilde{p}_0 - \tilde{p}_{-1}) = \underbrace{2\left(z_0 - \frac{1}{2}\right)\sigma}_{\textit{Announcement risk prem.}} - \underbrace{\rho(\sigma^2-1)\left(\frac{2p(1-p) + \frac{\gamma_M}{\gamma_T}}{8p(1-p)(1+\sigma^2) + 2\frac{\gamma_M}{\gamma_T}}\right)}_{\textit{Reversal of bias}} \tag{A.48}$$

Proof. Since liquidity provision is symmetric at $t = -2$, the average price $\overline{p}_{-2}$ equals the frictionless benchmark $E^y(\tilde{v}) = 0$.

For a given inventory Q_{-1}, we define the average price at $t = -1$, $\overline{p}(Q_{-1})$, as the average across the four different demand combinations of the volume-weighted average price given that demand combination.[20] This average satisfies:

$$\overline{p}(Q_{-1}) = \mathbb{E}^z(\text{vwap}) = M_{-1} + S_{-1}\frac{v_{-1} - M_{-1}}{4(2p-1)\sigma - S_{-1}.} \tag{A.49}$$

We can therefore substitute equations (A.27) and (A.28) into (A.49) and simplify to:

$$\overline{p}(Q_{-1}) = v_{-1} + \frac{2p(1-p) + \frac{\gamma_M}{\gamma_T}}{4p(1-p) + \frac{\gamma_M}{\gamma_T}}\left(Q_{-1} - \frac{\rho}{2\gamma_M\sigma^2}\right)\gamma_M\sigma^2. \tag{A.50}$$

We now take the expectation over possible Q_{-1} and use equation (A.38) for $\mathbb{E}^z(Q_{-1})$. Since $\mathbb{E}^z(Q_{-1}) > \frac{\rho}{2\gamma_M\sigma^2}$, average excess inventory is positive, resulting in *ALP* and, as a consequence, an upward bias in prices:

$$\overline{p}_{-1} \equiv \mathbb{E}^z\left(\overline{p}(Q_{-1})\right) = 2\left(z_{-1} - \tfrac{1}{2}\right) + \rho(\sigma^2 - 1)\left(\frac{2p(1-p)+\frac{\gamma_M}{\gamma_T}}{8p(1-p)(1+\sigma^2)+2\frac{\gamma_M}{\gamma_T}}\right). \tag{A.51}$$

The asset liquidates at $t = 0$ for $\tilde{v}$, making the average price $\overline{p}_0$ equal the frictionless benchmark $2(z_{-1} - \frac{1}{2}) + 2(z_0 - \frac{1}{2})\sigma$. Combining the equations for $\overline{p}_{-2}$, $\overline{p}_{-1}$, and $\overline{p}_0$ yields the expected returns in (A.47) and (A.48). ■

RESULT A.4 (Comparative Statics). *Average asymmetry in liquidity provision, preannouncement returns, and postannouncement reversals are all increasing in the intermediary's inventory Q_{-1}, risk aversion γ_M, cost of negative positions ρ, and the announcement risk σ.*

Proof. From equation (A.50), it is clear that the average preannouncement price conditional on Q_{-1} is increasing in Q_{-1}. Furthermore, after some algebra, the average preannouncement price in equation (A.51) is increasing in γ_M, ρ, and σ. Finally, the asymmetry in liquidity provision, as measured by the difference:

$$\mathbb{E}^z\left(v_{-1} - b_{-1}\right) - \mathbb{E}^z\left(a_{-1} - v_{-1}\right) = -2\mathbb{E}^z\left(M_{-1} - v_{-1}\right) \tag{A.52}$$

$$= \frac{8p(1-p)\gamma_M}{4p(1-p)+\frac{\gamma_M}{\gamma_T}}\sigma^2\left(\mathbb{E}^z(Q_{-1}) - \frac{\rho}{2\gamma_M\sigma^2}\right) \tag{A.53}$$

$$= \frac{4p(1-p)\gamma_M}{4p(1-p)(1+\sigma^2)+\frac{\gamma_M}{\gamma_T}}\rho(\sigma^2 - 1), \tag{A.54}$$

is also an increasing function of γ_M, ρ, and σ. ■

[20] Other possible average prices in this setting exhibit the pattern in Result A.3 even more strongly.

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