# Does Anticipated Information Impose a Cost on Risk-Averse Investors? A Test of the Hirshleifer Effect

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**Abstract**

This paper theoretically and empirically investigates how the risk of future adverse price changes created by the anticipated arrival of information influences risk-averse investors' trading decisions in institutionally imperfect capital markets. Specifically, I examine how the selling activity of individual investors immediately following an earnings announcement is influenced by the trade-off between risk-sharing benefits of immediate trade and explicit transaction costs imposed on such trades. Consistent with my theoretically derived predictions, I find that investors' current trading decisions are less sensitive to the incremental transaction costs created by short-term capital gains taxes on trading profits, as both the *duration* and *intensity* of the risk of future adverse price changes increase. This evidence is consistent with an incremental cost to investors that results from providing precise information, which is commonly referred to as the Hirshleifer Effect (Hirshleifer, 1971; Verrecchia, 1982).

# 1 Introduction

In efficient capital markets, stock prices adjust to reflect the arrival of new information, which leads to stock price volatility (e.g., Fama, 1970; Fama, 1991). Expected price volatility deriving from the *anticipated* arrival of information imposes an incremental welfare cost upon undiversified, risk-averse investors by virtue of their exposure to the risk of adverse price changes (Hirshleifer, 1971; Verrecchia, 1982).[1] In response, risk-averse investors generally desire to trade shares prior to the arrival of information in order to spread the economy's aggregate risk while diversifying their idiosyncratic risks.[2]

In an idealized capital market with frictionless trading, investors can quickly and efficiently balance their portfolios to insure themselves against adverse price changes in the future. However, the existence of costly trading frictions can constrain investors from trading to their desired portfolios, leaving them exposed to incremental welfare costs associated with the risk of adverse price changes from the arrival of new information. This adverse welfare effect of the anticipated arrival of information in the presence of trading restrictions is commonly referred to as the Hirshleifer Effect (Hirshleifer, 1971). While a large body of theoretical research has examined the Hirshleifer Effect, virtually no supporting empirical evidence exists.

In this paper, I identify a novel and powerful capital market setting in which to theoretically motivate and empirically test for evidence consistent with the Hirshleifer Effect. Specifically, I examine the relation between trading volume (a theoretically motivated surrogate for investor welfare) and the risk of adverse price changes in the presence of trading frictions created by the existence of intertemporal tax discontinuities (hereafter ITDs). An ITD results from the incremental capital gains tax rate applied to trading profits on shares held for less than a requisite amount of time.[3] In order to qualify for the lower long-term capital gains tax, investors are re-

[1] *Ceteris paribus*, anticipated price volatility increases with the precision of the anticipated information.

[2] A prominent theoretical model of optimal risk-sharing in financial markets is the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965). In the CAPM, risk-averse investors seek to minimize their exposure to the risk of adverse price changes by holding a diversified portfolio consistent with their individual preferences for risk.

[3] Shackelford and Verrecchia (2002) coined the term *intertemporal tax discontinuity*, which they define it as "a circumstance in which different tax rates are applied to gains realized at one point in time versus some other point

quired to hold assets for a requisite amount of time (typically 12 months) before selling them or else incur the higher short-term capital gains tax on trading profits. Given an ITD, risk-averse investors face an economic tension between trading immediately to an optimal risk-sharing portfolio at the cost of incurring an incremental tax on realized trading profits, versus postponing trade to avoid the incremental tax while facing the risk of interim adverse price changes. This tension embodies the Hirshleifer Effect and is the focus of the paper.

I begin by developing a theoretical framework that employs a two-period model in which risk-averse investors are endowed with a desire to trade for risk-sharing purposes. In period 1, when an ITD cost prevails, investors are presented with an opportunity to trade. Investors can avoid paying the ITD cost by postponing some of their desired trade until period 2 when they will have held shares long enough to avoid paying the incremental ITD cost. However, by delaying trade, they do not achieve their optimal risk-sharing portfolio at period 1. In the interim, investors are exposed to the risk of adverse price changes due to the anticipated arrival of new information signals.[4] Consistent with the Hirshleifer Effect, the model demonstrates that investor's expected utility is decreasing in the precision of the anticipated information and the magnitude of this relation is increasing in the ITD cost facing investors.[5]

While the expected utility results are not directly testable, the model yields empirical implications concerning how the negative relation between trading volume in period 1 and ITD costs vary with the risk of future price changes. *Ceteris paribus*, the model predicts that trading volume is decreasing in aggregate ITD costs among investors (Shackelford and Verrecchia, 2002). However, in making their trading decisions, investors are also concerned about the risk of adverse price changes while waiting to qualify for the lower tax rate. Specifically, as the precision

in time" (pg. 205). In the context of my study, an ITD specifically refers to the difference in tax rates applied to long-term versus short-term capital gains.

[4]In the model, the risk of adverse price changes between the first and second rounds of trading is driven by the precision of the anticipated information signals. In essence, signals of high precision resolve a lot of uncertainty, which (from the ex-ante perspective of period 1) increases the risk of adverse price movements for an investor holding a suboptimal risk-sharing portfolio. If no signals are released in the interim, there is no risk of adverse price changes and no tension exists as all investors wait to trade until the low tax rate is operative in period 2.

[5]That is, the risk of future adverse price changes increases in the precision of anticipated future signals, as high precision signals will cause the future price to be very sensitive to these signals, exposing risk-averse traders to the possibility of large price drops.

of the anticipated information signals increases thereby increasing price volatility and the risk of future adverse price changes, investors place less weight on ITD incentives in making their trading decisions. Bringing these implications to the data, I empirically document that as price volatility increases, traders become more willing to incur the ITD cost involved with trading before satisfying the requisite ITD holding period in order to trade closer to their optimal risk-sharing portfolio and insulate themselves against anticipated price volatility. In essence, higher anticipated price volatility results in the incremental welfare cost of the anticipated arrival of information dominating transaction costs associated with the ITD as investors become more willing to pay explicit transaction costs to shed the adverse welfare effects of anticipated information.

More specifically, I find that in weighing ITD costs against the risk of adverse price movements, investors consider both the *intensity* and the *duration* of the risk of adverse price changes. Intuitively, *intensity* captures the risk of adverse price movements per unit of time, while *duration* captures the amount of time that such risk must be held. For example, a trader may have only a few days left in the requisite ITD holding period, but the risk of adverse price movement is very intense during the short remaining interval, creating incentives for the investor to trade now towards an optimal portfolio to avoid adverse price movements. Likewise, even if intensity is low, an investor with a significant amount of time before qualifying for the favorable long-term tax rate can still have strong incentives to trade today because the low-intensity risk must be held over a long time period.[6]

First, I empirically examine the impact of the *duration* component of risk on the association between trading activity and ITD costs following a quarterly earnings announcement. At a given point in time, investors in a firm's shares have purchased their shares at different times in the past, which means they face a different *duration* of risk as well as a different ITD cost because of

[6] Maydew (2001) poses the following question: If chickens cross the road "because taxes are lower on the other side... why did not *all* the chickens cross the road?" My study argues that some chickens may choose not to cross the road to the lower tax side (i.e., they wait until qualifying for the lower long-term tax rate) because the road is too wide (i.e., high *duration*), too heavily traveled (i.e., high *intensity*), or both, making it too risky to cross to the other side.

the different prices paid for the share. This important variation in the ITD and *duration* of risk trade-off for a given firm's investors at a given point in time (e.g., following a quarterly earnings announcement) is exploited by including separate ITD costs for each holding period relative to qualification for the lower tax rate as separate explanatory variables in a regression explaining trading activity. This makes it possible to test whether the sensitivity of trading activity to ITD costs decreases as the number of days remaining until qualification increases (i.e., *duration* of risk increases). Consistent with the Hirshleifer Effect, I find evidence that investors' trading decisions become less sensitive to ITD costs as the *duration* of the risk they face increases.

Second, using the average daily stock return volatility as a proxy for the *intensity* of risk, I find evidence that the sensitivity of trading activity to ITD costs decreases as the risk of adverse price changes per unit of time increases (i.e., *intensity* increases). In other words, the higher the anticipated price volatility, the less influential ITD incentives are on current trading decisions as investors become more willing to trade now to hedge the more intense risk, despite incurring higher tax costs. Again, this result is consistent with the Hirshleifer Effect.

Why does this paper focus on ITD transaction costs? After all, a number of institutional constraints exist that may inhibit investors' ability to optimally make trades, including incomplete capital markets (Merton, 1987), short sale constraints/prohibitions (Diamond and Verrecchia, 1987), bid-ask spreads (Constantinides, 1986), and taxes (Shackelford and Verrecchia, 2002). While each of these transaction costs is potentially important, I choose to examine the trading friction created by the incremental ITD tax because it offers several important advantages in testing the Hirshleifer Effect relative to other commonly studied transaction costs.

First, and most importantly, an ITD is a perfectly anticipated, time-varying transaction cost with a finite amount of time until expiration. In order to qualify for the lower long-term capital gains tax rate, investors are required to hold assets for a requisite amount of time.[7] This is crucial for empirical tests of the Hirshleifer Effect because it makes it possible to measure the specific time horizon over which investors assess the risk of adverse price changes in determin-

[7] Historically, the requisite holding period has been 6, 9, 12 and 18 months. The ITD holding period of 12 months is the most common.

ing the optimal trade-off between risk and ITD costs. In contrast, most other transaction costs, such as bid-ask spreads and long-term capital gains taxes, do not have an anticipated time variation that allows investors to optimally avoid them.[8] For example, investors can avoid paying long-term capital gains taxes by postponing the sale of their portfolio until death. However, investors' expectations over their life expectancy is unobservable.

Second, an ITD represents a potentially significant trading cost to investors. Currently, the maximum ITD cost imposed on investors, equal to the difference in the maximum statutory capital gains tax rates applied to short-term and long-term gains, is 20% but has historically been as low as 0% (1988 – 1990) and as high as 30% (1982 – 1986). However, I acknowledge that the ITD transaction cost investors consider may differ for a number of reasons. First, some investors may have held shares for the requisite amount of time and qualified for the lower long-term capital gains tax rate. These investors have no ITD incentive to postpone trading. Second, a portion of any short-term capital gains accrued in one security may be partially offset by short-term capital losses from another security in an investor's portfolio, leading to a lower ITD incentive to postpone trades. Third, some investors, such as institutions, may be tax-exempt.[9] The extent to which these mitigating factors are present works against finding any results consistent with the predictions of the model.

Finally, a large body of empirical evidence supports an important role for ITD costs in shaping investor demand and trading volume.[10] For example, Blouin, Raedy and Shackelford (2003) find a negative and statistically significant association between ITD costs and trading volume following quarterly earnings announcements. Reese (1998) finds similar evidence using a sample of IPO firms. The collective evidence in the this literature provides a strong foundation for empirically exploiting the tension created by ITD costs to powerfully isolate and test the Hirshlefer Effect, which is the focus of this paper.

[8]While the magnitude of bid-ask spreads and long-term capital gain tax rates can change over time, the change is not fully anticipated (except in unusual circumstances) and thus does not provide investors with an incentive known in advance of the event.

[9]See Shackelford and Shevlin (2001) and Blouin, Raedy and Shackelford (2003) for a comprehensive review of why capital gains taxes may not matter to investors.

[10]See Shackelford and Shevlin (2001) for a comprehensive review of this literature.

This study contributes to a large body of literature, dating back at least to Hirshleifer (1971), that theoretically examines the welfare implications of anticipated information. Hirshleifer (1971) demonstrates that in a pure exchange economy, risk-averse investors are incrementally worse off (in expectation) if they are not allowed to contract (or trade) prior to the release of anticipated information. Trading spreads investors' risks across the economy and protects investors against the possibility that the anticipated information will adversely change prices. Verrecchia (2001) refers to this as the adverse risk-sharing effect of increased disclosure.[11] The analysis presented in this paper provides a novel and powerful setting in which to directly examine the empirical implications of the incremental costs of providing precise information.

The rest of this paper is organized as follows: section 2 outlines the theoretical framework and empirical implications; section 3 describes the empirical sample and variable definitions; section 4 presents the empirical analysis and results; and section 5 concludes.

# 2 Theoretical Framework

## 2.1 Assumptions

The following analysis employs a stylized model of pure exchange populated by risk-averse investors with homogenous risk preferences. Investors are endowed with shares of a risky asset and a risk-free bond in period 0, trade shares of both in periods 1 and 2, and consume wealth in period 3. One share of the bond (the numeraire commodity) pays one unit of consumption in period 3, while the payoff from a share of the risky asset is a random variable, $\tilde{u}$. The per-capita supply of the risky asset, $x$, is common knowledge among investors and remains fixed across all time periods.

In period 0, there are two distinct groups of investors, indexed by $i \in \{B, S\} \equiv \{Buyers, Sellers\}$,

[11] Subsequent studies formalize Hirshleifer's argument (e.g., Marshall, 1974; Hakansson, Kunkel and Ohlson, 1982) and develop theoretical models that examine the welfare role of anticipated information using alternative assumptions and settings. See Verrecchia (1982), Diamond (1985), Bushman (1991), Alles and Lundholm (1993), and Campbell (2004), among others. Verrecchia (2001; section 4) provides an extensive review of this literature.

that differ only in their risk-free bond endowment, $E_i$, and risky asset endowment, $D_{0,i}$. Specifically, *Buyers* are endowed with a sufficiently "underweighted" amount of the risky asset (i.e., $D_{0,B} < x$) and therefore wish to buy additional shares. Conversely, *Sellers* are sufficiently "overweighted" (i.e., $D_{0,S} > x$) and therefore wish to sell a portion of their risky asset portfolio.[12] In addition, each investor, $i$, is endowed with a basis, $P_0$, used to compute capital gains. Finally, let $\theta$ and $(1-\theta)$ represent the relative proportions of *Sellers* and *Buyers* in the economy, respectively, which is fixed across time. Therefore, in every period $t$, per-capita demand for the risky asset must equal per-capita supply: $\theta \cdot D_{t,S} + (1-\theta) \cdot D_{t,B} = x$. This identity implies that the aggregate *change* in demand across any number of time periods, $r$, is equal to zero:

$$\theta \left(D_{t+r,S} - D_{t,S}\right) + (1-\theta)\left(D_{t+r,B} - D_{t,B}\right) = 0, \tag{1}$$

where $D_{t,i}$ is investor $i$'s demand for the risky asset in period $t$.

In period 1, all traders observe a disclosure, such as an earnings announcement, about the value of the risky asset. Conditional upon this announcement, investors' expectations about $\tilde{u}$ are that it has a normal distribution with a mean of $\bar{u}$ and a variance normalized to one (without loss of generality).[13] After observing the earnings announcement, investors trade shares of the risky asset and risk-free bond at competitive prices.

Investors' period 1 demand functions are driven by two opposing economic forces. First, following Shackelford and Verrecchia (2002), I assume periods 0 and 1 are sufficiently close in time so that any trading profits from the sale of assets in period 1 are taxed at an unfavorable

[12] The assumption that investors hold less than an optimal risk-sharing amount is made to generate trading volume that triggers capital gains taxes. In this model, there are two situations in which no trade results. First, investors will not trade if they are endowed with an optimal risk-sharing amount of the risky asset, $x$ (Milgrom and Stokey, 1982). Second, even if investors are given suboptimal risk-sharing endowments, they may not trade if their initial allocations are sufficiently close to optimal risk-sharing such that the marginal ITD cost is higher than the marginal risk-sharing benefit of trading the first share. I avoid this uninteresting scenario by assuming that investors are 'sufficiently' overweighted and underweighted in the risky asset. Therefore, my model is intended to shed light on how anticipated information incrementally influences trading volume, *given a desire to trade*, and is not intended to explain *why* trading volume exists.

[13] Following Shackelford and Verrecchia (2002), I interpret this assumption as the earnings announcement subsuming all investors' prior information about $\bar{u}$. That is, any prior information is a forecast of the earnings announcement, which the actual earnings announcement in period 1 subsumes (for example, see Abarbanell, Lanen and Verrecchia, 1995).

short-term capital gains tax rate, $\tau$. Investors can reduce their taxes by postponing their trading activity until period 2, when a second round of trade opens. I assume period 2 is sufficiently distant in time from period 1 so that any realized trading profits in this period qualify for a favorable long-term capital gains tax, which is normalized to zero. Therefore, $\tau$ represents the spread between the short-term and long-term capital gains tax rates and captures the incremental incentive created by an ITD to postpone trading until period 2.

Second, between periods 1 and 2, investors observe an anticipated public signal, $\tilde{y} = \tilde{u} + \tilde{\varepsilon}$, where $\tilde{\varepsilon}$ is independently and normally distributed with a mean of 0 and a precision (inverse of variance) of $s$. The information contained in this signal creates an incentive for risk-averse investors to trade in period 1 to protect themselves from adverse price changes in period 2.

The model concludes in period 3 when investors realize the payoff of the risky asset, pay any capital gains taxes, and consume their remaining wealth. Investors are risk-averse with a utility for wealth characterized by a negative exponential utility function, $U\left(\tilde{W}_i\right) = -\exp\left(-\tilde{W}_i/\gamma\right)$, where $\gamma$ is a risk tolerance parameter common to all investors. $\tilde{W}_i$ is investor $i$'s final wealth that is equal to:

$$\tilde{W}_i = E_i + P_1\left(D_{0,i} - D_{1,i}\right) + P_2\left(D_{1,i} - D_{2,i}\right) + \tilde{u}\cdot D_{2,i} - \tau_i\left(P_1 - P_0\right)\left(D_{0,i} - D_{1,i}\right), \qquad (2)$$

where $P_1$ and $P_2$ are the prices of the risky asset and $D_{1,i}$ and $D_{2,i}$ are investor $i$'s demand for the risky asset in periods 1 and 2, respectively. The final term in equation (2) reflects the total amount of capital gains taxes paid by investor $i$ on realized trading profits in period 1.

## 2.2 Model Equilibrium

The equilibrium price and demand functions in periods 1 and 2 are solved using backward induction. In period 2, trader $i$ maximizes his expected utility with respect to his demand for the risky asset, $D_{2,i}$, conditional upon observing the intermediate public signal, $\tilde{y}$. Because investor $i$'s period 1 tax rate, $\tau_i$, does not affect this optimization problem, it is straightforward to solve for the equilibrium in period 2:

$$\tilde{P}_2 = \frac{\bar{u}+s\tilde{y}}{1+s} - \frac{x}{\gamma(1+s)}, \tag{3}$$

$$D_{2,i} = x, \quad \forall i. \tag{4}$$

Equations (3) and (4) are standard for a model of this type in which all information is public and investors have homogenous risk preferences (e.g., Verrecchia, 1982). Each investor, regardless of type, holds a share of the risky asset equal to the per-capita supply, $x$.[14]

Let a circumstance in which $P_1 > P_0$ be defined as one in which the disclosure (e.g., an earnings announcement) in period 1 is "good news." Given a "good news" disclosure, trader $i$ chooses period 1 demand, $D_{1,i}$, which, given (3) and (4), maximizes his expected utility while anticipating the release of the public signal, $\tilde{y}$, in period 2. As derived in the appendix, the equilibrium price and demand functions are described in the following:

**Lemma 1** *In the presence of an ITD, the (unique) period 1 equilibrium following a "good news" earnings announcement (i.e., $P_1 > P_0$) is one in which Buyers (Sellers) always buy (sell) shares of the risky asset. That is,*

$$P_1 = \frac{\bar{u}-\frac{x}{\gamma}-\theta\tau P_0}{(1-\theta\tau)}, \tag{5}$$

$$x \leq D_{1,S} = x + \frac{\gamma\left(1+s^{-1}\right)(1-\theta)\,\tau\left(\bar{u}-\frac{x}{\gamma}-P_0\right)}{(1-\theta\tau)} \leq D_{0,S}, \tag{6}$$

$$D_{0,B} \leq D_{1,B} = x + \frac{\gamma\left(1+s^{-1}\right)\theta\tau\left(\bar{u}-\frac{x}{\gamma}-\bar{P}_0\right)}{(1-\theta\tau)} \leq x. \tag{7}$$

Equation (5) illustrates that the presence of the ITD increases the stock price as *Sellers* demand compensation for incurring the incremental tax in period 1.[15] In equilibrium, the price reflects

[14]In the presence of an ITD, investors in this two-period model do eventually achieve an optimal risk-sharing portfolio prior to the realization of the risky asset payoff. In contrast, investors in the one-period ITD model of Shackelford and Verrecchia (2002) never reach such an optimal risk-sharing portfolio.

[15]The situation where *Sellers* demand compensation from *Buyers* for the capital gains taxes paid on trades is commonly referred to as the "lock-in" effect (e.g., Landsman and Shackelford, 1995; Klein, 1999; Jin, 2006; Dai et al., 2008).

the average tax rate, $\theta\tau$, among all investors as the total tax cost in the economy is redistributed across all investors. Therefore, while *Buyers* are not explicitly taxed on the purchase of shares in period 1, they are implicity taxed through an increase in the price of the risky asset. It is important to note that in this model, the period 1 price does not depend on the precision of the anticipated public signal, $s$, because this represents idiosyncratic risk for which investors are not compensated.

In contrast to price, the individual demand functions of *Buyers* and *Sellers* given in (6) and (7), respectively, depend on both the precision of the anticipated information, $s$, as well as the ITD transaction cost, $\tau$. In equilibrium, investors' optimal demand falls somewhere in between their initial endowment, $D_{0,i}$, and their optimal risk-sharing allocation, $x$. How closely each investor trades to $x$ reflects the cost of the anticipated signal relative to the ITD transaction cost.

At one extreme, when the anticipated signals provide no additional information (i.e., $s \to 0$), investors know exactly what the price in period 2 will be since there will be no new information to update their beliefs about the underlying value of the risky asset. Consequently, investors will not trade away from their endowment position, $D_{0,i}$, because they can avoid paying the ITD without any risk of adverse price changes. At the other extreme, when the anticipated signals are expected to fully reveal the payoff of the risky asset (i.e., $s \to \infty$), investors trade as close as possible to the optimal risk-sharing allocation, $x$.[16]

## 2.3 Expected Utility and the Hirshleifer Effect

In this section, I demonstrate how individual investor welfare in period 1 is weakly decreasing in the precision, $s$, of the anticipated signal when an ITD transaction cost, $\tau$, is present (i.e., the

[16] By allowing $s$ to go to $\infty$, my model effectively collapses to the one-period model of Shackelford and Verrecchia (2002), because (6) and (7) are identical to the demand functions derived in that paper's model. The intention of the model developed in Shackelford and Verrecchia (2002) is to examine how the existence of an ITD influences price and trading volume, holding the precision of the anticipated information environment constant at $\infty$. In contrast, the intention of my model is to examine the Hirshleifer Effect by documenting how changes in the precision of the anticipated information environment incrementally influences investor welfare when an ITD is present.

Hirshleifer Effect). Investor $i$'s welfare is defined as their expectation over their utility function in period 1:

$$\bar{U}_i = E\left[-\exp(-\tilde{W}_i/\gamma)\right] \tag{8}$$

where $\bar{U}_i$ is investor $i$'s expected utility and $\tilde{W}_i$ is investor $i$'s final wealth as defined in equation (2). Substituting the equilibrium price and demand functions from Lemma 1 results in the following proposition relating changes in expected utility to changes in the precision of the anticipated signal, $s$, and changes in the ITD transaction cost, $\tau$:

**Proposition 1** *In the absence of an ITD (i.e., $\tau = 0$), investor i's expected utility in period 1, $\bar{U}_i$, is not affected the precision of the anticipated signal, $s$. In the presence of an ITD transaction cost (i.e., $\tau > 0$), investor i's expected utility in period 1 is decreasing in the precision of the anticipated signal, $s$. That is,*

$$\left.\frac{\partial \bar{U}_i}{\partial s}\right|_{\tau=0} = 0, \quad \left.\frac{\partial \bar{U}_i}{\partial s}\right|_{\tau>0} < 0, \quad \text{and} \quad \frac{\partial}{\partial \tau}\left(\frac{\partial \bar{U}_i}{\partial s}\right) < 0.$$

The proof is provided in the appendix. The results of Proposition 1 are intuitive and illustrate the Hirshleifer Effect. In the absence of an ITD transaction cost, investors are not constrained from trading in period 1 and, therefore, immediately trade to the optimal risk-sharing portfolio prior to the release of the anticipated signal in period 2. Thus, risk-averse investors diversify away the idiosyncratic risk from the anticipated signal, which makes them insensitive to the precision of the anticipated signal. In contrast, when an ITD is present, investors do not trade to the optimal risk-sharing portfolio (see Lemma 1), which exposes them to idiosyncratic risk related to the anticipated signal. In this case, investors' expected utility is decreasing in the precision of the signal, $s$ (i.e., increasing in the idiosyncratic risk).

Proposition 1 is consistent with the pure exchange model in Hirshleifer (1971) in which investors are not allowed to trade prior to the release of the anticipated public signal. A key difference in my model is that investors are not forbidden from trading prior to the signal, but instead are given a real monetary incentive to postpone trading in order to avoid paying the ITD transaction cost. This feature of the model facilitates an empirical test of the Hirshleifer Effect by examining how variation in the ITD transaction cost changes investors' sensitivity to the risk created by the anticipated arrival of information.

### 2.4 Trading Volume and Empirical Implications

The results in Proposition 1 cannot be directly tested because investors' expected utility is not observable. Therefore, in this section, I develop testable empirical implications concerning how the negative relation between trading volume and ITD costs varies with the risk created by the anticipated arrival of information, which is consistent with the Hirshleifer Effect. The key construct underlying my model's empirical predictions is the function describing trading volume in period 1. By definition, the per-capita trading volume in period 1 is equal to

$$\begin{aligned} V_1 &= \tfrac{1}{2}\int \left|D_{1,i} - D_{0,i}\right| di \\ &= \tfrac{1}{2}\theta \left|D_{1,S} - D_{0,S}\right| + \tfrac{1}{2}(1-\theta)\left|D_{1,B} - D_{0,B}\right| \\ &= \tfrac{1}{2}\left[\theta\left(D_{0,S} - D_{1,S}\right) + (1-\theta)\left(D_{1,B} - D_{0,B}\right)\right], \end{aligned} \tag{9}$$

where the last step follows from Lemma 1, which states that *Buyers* always buy ($D_{0,B} \leq D_{1,B}$) and *Sellers* always sell ($D_{0,S} \geq D_{1,S}$). Substituting (1) into (9), per-capita trading volume is expressed in terms of *Buyers* demand:

$$V_1 = (1-\theta)\left(D_{1,B} - D_{0,B}\right). \tag{10}$$

Finally, substituting the period 1 demand function of *Buyers* from (7) into (10) leads to the following lemma, which illustrates how trading volume is influenced by the interaction between anticipated information and ITD transaction costs:

**Lemma 2** *In the presence of an ITD, per-capita trading volume, $V_1$, following a "good news" earnings announcement (i.e., $P_1 > P_0$) is*

$$V_1 = V^* - \gamma\theta(1-\theta)\frac{\overbrace{\tau\Delta P_1}^{\substack{\text{ITD incentive to}\\ \text{postpone trade}}}}{\underbrace{Var\left[\tilde{P}_2\right]}_{\substack{\text{risk incentive to}\\ \text{trade immediately}}}}, \tag{11}$$

*where $V^* = (1-\theta)\left(x - D_{0,B}\right)$ is the optimal risk-sharing trading volume in period 1, $Var[\tilde{P}_2] = \frac{s}{(1+s)}$ is the variance of period 2 price, and $\Delta P_1 = P_1 - P_0$ is the capital gain in period 1.*

Equation (11) illustrates the key tension of the model. Actual trading volume, $V_1$, is less than optimal risk-sharing volume, $V^*$, by an amount proportional to the ratio of the aggregate ITD cost to the risk of an adverse price change in period 2. Specifically, as the ITD cost of trading in period 1 increases, investors trade less to avoid paying the explicit transaction cost. That is:

**Corollary 1** *Following a "good news" earnings announcement (i.e., $P_1 > P_0$), per-capita trading is (weakly) decreasing in the ITD incentive among investors, $\frac{\partial V_1}{\partial \tau} \leq 0$.*

Corollary 1 is the main result derived in Shackelford and Verrecchia (2002) and empirically supported by subsequent studies (e.g., Blouin, Raedy and Shackelford, 2003). Therefore, this result merely represents a point of departure for the implications of my model.

The key insight from my model is that investors also consider the cost of being undiversified until they qualify for the lower tax rate when deciding whether to postpone trade in order to minimize taxes. This leads to the following:

**Proposition 2** *Following a "good news" earnings announcement (i.e., $P_1 > P_0$), the negative relation between per-capita trading volume and the ITD incentive among investors is (weakly) increasing (i.e., becoming less negative) in the precision, s of the anticipated information:*

$$\frac{\partial}{\partial s}\left(\frac{\partial V_1}{\partial \tau}\right) = \frac{\partial^2 V_1}{\partial Var[\tilde{P}_2]\partial \tau}\frac{\partial Var[\tilde{P}_2]}{\partial s} = (+)(+) \geq 0. \tag{12}$$

Proposition 2 demonstrates that investors' trading decisions in period 1 become less sensitive to the ITD transaction cost with increases in the cost of being undiversified, captured by the variance of future price. Investors are willing to pay the higher explicit ITD transaction cost to reduce the implicit welfare cost created by anticipated information and the risk of future adverse price movements. In other words, anticipated information imposes a cost on investors (i.e., the Hirshleifer Effect), which is reflected in the comparative statics of Proposition 2.

The precision of the anticipated signal, $s$, and, therefore, the total risk faced by investors in period 1 can be decomposed into a *duration* component and an *intensity* component.[17] Intuitively, *duration* captures the amount of time that the risk must be held until qualification for the lower rate, while *intensity* captures the risk of adverse price movement per unit of time. Both effects, based on the cross-partial derivative of Proposition 2, lead to the two main empirical implications of the model. The first empirical implication relates the *duration* component of risk and is stated as follows:

**Empirical Implication 1** *The negative impact of ITD costs on trading activity following an earnings announcement is mitigated (i.e., is less negative) as the time to qualification increases (i.e., the duration of risk increases).*

As the time to qualification increases, an investor must remain exposed to the risk of adverse price movements over a longer period. Therefore, investors optimally trade more shares today to reduce risk, despite the negative wealth effect of paying the higher short-term tax rate on trading profits.

**Empirical Implication 2** *The negative impact of ITD costs on trading activity following an earnings announcement is mitigated (i.e., less negative) as the intensity of risk per unit of time increases.*

[17] *Intensity* is captured by signal precision, $s$, in the model, as high-precision signals will cause the future price to be very sensitive to these signals, exposing risk-averse traders to the possibility of large price drops. *Duration* refers to the number of signals anticipated prior to period 2

As the intensity of risk per unit of time increases (captured by the precision of a single information signal, $s$, in the interim period), investors are again more willing to trade early, despite the higher taxes, to insulate themselves against the higher implicit costs associated with the risk of adverse price changes. These two empirical implications form the basis around which the empirical analysis is built.

# 3 Empirical Sample and Variable Definitions

## 3.1 Sample Selection

To test the empirical implications of my model, I examine trading activity around quarterly earnings announcements. While quarterly earnings announcements are not an inherent aspect of my model, such a setting does provide at least two benefits. First, quarterly earnings announcements provide a large sample setting associated with trading activity (e.g., Beaver, 1968; Morse, 1981; Bamber, 1986; Landsman and Maydew, 2002). As a result, quarterly earnings announcements are likely to satisfy the theoretical criterion of "given that investors desire to trade" and thus provide a relatively powerful setting to detect whether risk and ITD incentives interact to influence trading volume in a manner predicted by my model.[18]

Second, as described in the theoretical framework, a necessary condition for the existence of a relation between risk and trading activity is that ITD incentives have to influence investors' trading decisions.[19] Consistent with this necessary condition, Blouin, Raedy and Shackelford (2003) and Hurtt and Seida (2004) document evidence of a negative and significant association

[18] If ITD transaction costs matter to investors, then they should affect trading volume on all trading days throughout the year. Therefore, any impact of ITD transaction costs on trading activity around quarterly earnings announcement dates may be understated relative to the actual effect as a result of the distortion in trading volume from the ongoing, unobservable influences of ITD transaction costs prior to the earnings disclosure. This biases against finding any results consistent with the model's predictions.

[19] Absent any transaction costs, such as an ITD, traders will immediately trade to their optimal risk-sharing portfolio to insulate themselves from future adverse price changes. In other words, investors will trade to the same portfolio regardless of the risk of future adverse price changes, implying that there is no relation between trading volume and risk. A necessary condition for such a relationship is the existence of a source of market friction, such as an ITD.

between ITDs and trading volume around quarterly earnings announcements. This supporting evidence provides *prima facie* motivation for examining the role of risk in mitigating the sensitivity of trading to ITD transaction costs around quarterly earnings announcements.

I begin by collecting data on all NYSE–listed firms with an available quarterly earnings announcement date between 1982 and 2002, as found in Compustat. Next, I eliminate observations with a quarterly earnings announcement falling on a date when the requisite ITD holding period is not equal to 12 months.[20] Finally, I require that each observation has the necessary data from Compustat, CRSP, I/B/E/S, Thomson Financial, TAQ and ISSM to compute all variables used in the empirical analysis. The final sample contains 35,222 quarterly earnings announcement observations.

### 3.2 Variable Definitions

The empirical implications developed in section 2 rely upon three important measures: (1) trading volume (the outcome or dependent variable), (2) the ITD incentive to postpone trading, and (3) the risk incentive to trade immediately. The following describes the empirical proxies for each of the three key measures as well as other control variables used in the empirical analysis.

First, the dependent variable employed in multivariate tests is the cumulative three-day abnormal selling activity by individual investors, *AVOL*, around quarterly earnings announcements. Using intra-day trading data from the ISSM and TAQ databases and following Lee and Radhakrishna (2000), I classify trades of less than $10,000 (in 1990-dollars) as made by individual investors and determine the trade direction from the Lee and Ready (1991) algorithm. Examining the selling activity of small trades in this manner increases the likelihood of capturing selling activity by more tax-sensitive individual investors.[21]

[20] This filter excludes announcements made from June 23, 1985 through July 1, 1988 (6-month holding period) and between July 29, 1997 and December 31, 1997 (18-month holding period).

[21] Results are quantitatively similar if cutoff values of less than $5,000 or $20,000 are used to proxy for trades made by individual investors.

I compute a daily selling measure, $S_t$, for individual investors equal to the natural logarithm of one plus the number of trades classified as sell orders by individual investors. Following Hurtt and Seida (2004), expected daily selling activity by individual investors for a given firm during each day of an earnings release period, days $t-1$ to $t+1$, is the average of the daily individual selling metric, $S_t$, for that firm during the 50 days immediately preceding day $t-1$, after excluding prior 3-day earnings announcement windows. *AVOL* is then computed as the mean selling activity by individual investors, $S_t$, less the expected daily selling activity over the 3-day earnings announcement period scaled by the standard deviation of $S_t$ over the 50-day estimation period.[22]

Second, I construct an empirical proxy for the total ITD incentive, *ITD*, aggregated across all investors at the earnings announcement. Recall from the theoretical framework that an individual investor's ITD incentive to postpone trading is a product of the difference between the short-term and long-term capital gains tax rates, $\Delta RATE$, and the change in stock price, $\Delta P_n$, from the time the shares were acquired to the date of the earnings announcement. Consistent with prior ITD studies, I define $\Delta RATE$ as the maximum statutory short-term capital gains tax rate less the maximum statutory long-term capital gains tax rate on day $t$.

The change in stock price at the announcement date, $\Delta P_n$, is defined as the logarithm of the closing stock price on day $t-2$, $\ln(P_{t-2})$, minus the logarithm of the initial purchase price (adjusted for stock splits and stock dividends) on day $t-n$, $\ln(P_{t-n})$, where $n$ is the number of trading days prior to the earnings announcement on which the asset was purchased. Trading activity should reflect the aggregate ITD incentive and, therefore, the aggregate price change among all investors on day $t$. Before aggregating price changes, it is important to note that a change in price with respect to a given day in the past may not induce a strong ITD effect on abnormal trading activity around the earnings announcement if relatively few shares were traded on that particular day. In other words, if very few shares were transacted on day $t-n$,

[22] In an untabulated analysis, I construct an alternative measure of abnormal trading volume around the earnings announcement using the "market" model of Ajinkya and Jain (1989). All inferences reported in the paper are similar using this alternative specification.

then there is a low probability that an investor, trading at the earnings announcement date, purchased shares on $t-n$. The price change computed for this day should receive a lower weight than a trading day with high volume when constructing an aggregate price change measure.[23] Therefore, I compute a volume-weighted average price change $\bar{\Delta}P$ over the 248 trading days (i.e., within the requisite ITD holding period, $n \in [3,4,\ldots,250]$) immediately preceding $t-1$ as follows:

$$\bar{\Delta}P = \sum_{n=3}^{250} \Delta P_n = \frac{1}{248} \sum_{n=3}^{250} w_n \cdot [\ln(P_{t-2}) - \ln(P_{t-n})],$$

where $\Delta P_n$ is the daily volume-weighted change in price from $t-n$ to $t-2$ and $w_n$ is equal to the daily volume on day $t-n$ divided by the firm's cumulative trading volume over the two years immediately preceding the earnings announcement. Weighting price changes with respect to the two–year trading volume implies that the sum of the daily weights applied to days $t-250$ to $t-3$ will be less than one. This is intended to capture the fraction of traders that may have already held shares for more than one year and are no longer subject to an ITD.[24] The aggregate ITD incentive to postpone trading, *ITD*, is estimated as the product of $\Delta RATE$ and $\bar{\Delta}P$.

Third, I consider empirical proxies for the total amount of risk each investor considers. The total risk is an increasing function of both the *intensity* and the *duration* of the anticipated price volatility. The *duration* component represents the amount of time over which a given risk *intensity* must be held. It is defined as the number of trading days an investor, who purchased shares on day $t-n$, has remaining until qualification for the lower tax rate. Specifically, *duration, d*, is equal to $250-n$ and is expressed in number of trading days.[25] Consequently, within

[23] The volume traded on a past date will not necessarily be held up to or traded on the earnings announcement date. This makes past daily volumes a noisy proxy for the cross-section of investors trading around the earnings announcement.

[24] For example, consider an earnings announcement observation where the firm's total trading volume over the prior 24 months is 400,000 shares. If only 100,000 shares were traded in the most recent 12 months, then the estimate of $\bar{\Delta}P$ for this observation receives a total weight of 1/4 (or 100,000/400,000). This assumes that 25% of investors trading at the earnings announcement date are potentially subject to an ITD at the earnings announcement. Conversely, if 300,000 of the 400,000 shares were traded in the most recent 12-month period, then the estimate of $\bar{\Delta}P$ for this observation receives a total weight of 3/4, three times the weight of the other observation. Inferences do not change when cumulative three-year and five-year trading volume are used instead.

[25] This definition is a direct result of constraining my sample to time periods with a one-year (or approximately 250 trading days) ITD requisite holding period. For example, an investor who purchased shares 100 trading days before the earnings announcement date will have exactly 150 trading days remaining in their ITD requisite holding

a single observation, $d$ will vary among investors depending on the number of trading days, $n$, prior to the announcement date that each investor purchased shares. The *intensity* component represents the risk of adverse price changes per unit of time (e.g., per trading day). Guided by the predictions of my model, I define *INTENSITY* as the variance of firm-specific daily stock returns in excess of the risk-free rate estimated over the 100 trading days immediately preceding day $t-1$.[26]

In addition, I also control for the influence of several factors that prior empirical research has found to be associated with trading volume around quarterly earnings announcements. The absolute value of unexpected earnings, *AUE*, is intended to control for the information made available at the earnings announcement (Bamber, 1987). *AUE* is equal to the absolute value of actual quarterly earnings per share announced on day $t$ minus the median analyst forecasts reported by IBES over the 60 trading days prior to day $t-1$. In addition, I include the square of unexpected earnings, *NONLINEAR*, to capture any nonlinearities (e.g., Freeman and Tse, 1992; Hurtt and Seida, 2004).

A number of factors reated to the availability of preannouncement information and prior information disclosure are included as control variables. Firm size, *SIZE*, is the logarithm of market value of equity measured at the fiscal quarter-end preceding day $t$ and is a proxy for the level of prior information disclosure (Bamber, 1986; Bamber, 1987; Atiase and Bamber, 1994). *NUM_EST* is the logarithm of the number of analysts issuing a quarterly earnings forecast within 60 days prior to day $t-1$ and is a proxy for the rate of information flow (Hong, Lim and Stein, 2000).

Finally, I include a proxy for the bid-ask spread at the earnings announcement date. The bid-ask spread represents another important transaction cost to investors that may influence their decisions to trade. Atkins and Dyl (1997) provide empirical evidence that annual trading volume is decreasing in the magnitude of the bid-ask spread. Following Atkins and Dyl (1997),

period (i.e., $250-100=150$).

[26]In section 4.4, I also consider a number of other proxies for the *intensity* component of risk, such as idiosyncratic and systematic return volatilities, as well as the skewness of the daily return distribution.

I compute the average bid-ask spread, *BID_ASK*, for each observation as follows:

$$BID\_ASK = \frac{1}{10}\sum_{n=2}^{11}\frac{ASK_{j,t-n} - BID_{j,t-n}}{\left(ASK_{j,t-n} + BID_{j,t-n}\right)/2},$$

where $BID_{j,t-n}$ and $ASK_{j,t-n}$ are the closing bid and ask prices for firm $j$ on day $t-n$.

# 4 Empirical Analysis

The purpose of this section is to test the empirical implications of the model analyzed in section 2. Section 4.1 presents univariate statistics for selected regression variables. In section 4.2, I empirically examine whether ITDs significantly influence the selling activity of individual investors around quarterly earnings announcement dates. Next, I present the fundamental empirical contributions of the paper by testing how risk influences the sensitivity of trading activity to ITDs by decomposing the risk of future adverse price changes into two components: the *duration* and the *intensity* of the risk. In section 4.3, I test whether *duration* (i.e., the length of time that a risk must be borne before an investor meets the ITD holding period requirement) affects trading around quarterly earnings announcements. Finally, in section 4.4, I investigate how the *intensity* of risk interacts with ITD incentives to influence trading.

## 4.1 Descriptive Statistics

Table 1 presents the sample distribution of selected regression variables. Abnormal selling activity by individual investors around quarterly earnings announcements, *AVOL*, has a mean and standard deviation of 1.556 and 1.579, respectively, which are comparable to the values reported in prior studies. The mean $\Delta RATE$ is 0.116 and exhibits considerable variation over the sample period. The mean (median) market value of equity is \$4.681 (\$1.013) billion and the mean (median) number of analysts following each firm is 7.3 (6.0).

## 4.2 ITDs and Trading Activity

Based on the theoretical framework of section 2, a necessary condition for risk to affect trading is that ITDs must have a significant influence on investors' trading decisions. As discussed earlier, Blouin, Raedy and Shackelford (2003) and Hurtt and Seida (2004) document empirical evidence consistent with this necessary condition around quarterly earnings announcement dates, which provides preliminary support and serves as a benchmark for my tests. I test for this effect in my sample and find supporting evidence that corroborates the findings of prior studies. Testing the necessary condition is intended to provide a foundation, and serve as a point of departure, for examining the main empirical implications of my model: how risk influences investors' trading decisions around quarterly earnings announcements given ITD incentives to postpone trade.

I employ the following OLS regression model to test for the necessary condition:

$$AVOL = \beta_0 + \beta_1 \Delta RATE + \beta_2 \bar{\Delta} P + \beta_3 ITD + controls + \epsilon, \tag{13}$$

where a negative sign associated with $\beta_3$ is predicted if ITD transaction costs provide an incentive to investors to postpone trading. Table 2, column 1 presents the parameter estimates for this analysis, which is based on the entire sample. As expected, I find that $\beta_3$ is negative and statistically significant.[27] This result complements similar evidence documented by Blouin, Raedy and Shackelford (2003) and Hurtt and Seida (2004) and provides preliminary evidence that trading activity is decreasing in ITD transaction costs in my sample.

Is this result attributable to ITD effects? Investors are only taxed on realized trading profits (i.e., only if an asset has appreciated in value) but do not receive a direct ITD benefit (in the form of a tax subsidy) from the sale of assets that have depreciated.[28] Therefore, investors' trading decisions when the asset has depreciated in value should be much less sensitive to ITD costs

[27] Standard errors for all specifications account for clustering by the month of the earnings announcement (see Petersen, 2009).

[28] As discussed earlier, investors may receive an indirect ITD benefit if they are able to offset a portion of a realized capital gain in an appreciated asset with a realized capital loss in another asset.

(i.e., the necessary condition may not be satisfied) compared to an asset that has appreciated in value and will generate an ITD tax. The asymmetric nature of tax incentives for appreciated versus depreciated assets provides a discriminating prediction capable of providing additional evidence attributable to an ITD effect. Specifically, I expect *AVOL* to exhibit a negative association with *ITD* when the aggregate price change over the prior holding period is greater than zero. Conversely, I expect to find no such relationship among stocks that have not appreciated over the holding period. Following Blouin, Raedy and Shackelford (2003), I separate the sample into appreciated (i.e., $\bar{\Delta}P > 0$) and depreciated (i.e., $\bar{\Delta}P > 0$) observations and estimate equation (13) for each sample. If the results in column 1 are attributable to ITD incentives to postpone trading, then I expect to find a negative sign on $\beta_3$ for the appreciated sample and an insignificant $\beta_3$ coefficient for the depreciated sample. Table 2, columns 2 and 3 present results for the appreciated and depreciated samples, respectively. Consistent with a tax-related explanation, I find that $\beta_3$ for the appreciated sample is negative and significant (column 2), while $\beta_3$ for the depreciated sample is slightly positive but not statistically significant (column 3).[29]

The empirical results of this section provide evidence that investors' trading decisions around quarterly earnings announcements are sensitive to ITD incentives to postpone trade. The results presented in Table 2 provide evidence that the necessary condition of my model is satisfied and provides a foundation for testing the two main empirical implications of the model.

### 4.3 The Impact of the *Duration* of Risk on ITDs and Trading Activity

This section tests Empirical Implication 1, which states that as *duration* (i.e., the amount of time remaining in the requisite ITD holding period) increases, investors' trading decisions become less sensitive to ITD costs. This occurs because an investor who does not trade now must bear the risk of adverse price changes until the end of the requisite holding period. As this length

[29]At a given point in time, many investors will have already held their shares for longer than the requisite ITD holding period and, therefore, should not be sensitive to ITD transaction costs. In untabulated analyses, I include the stock price appreciation for days $t-249$ to $t-498$ and the interaction with $\Delta RATE$. Both variables are not statistically different from zero in all specifications.

of time increases (i.e., the longer the investor must bear such risk), the more willing they are to incur the ITD cost by prematurely trading to avoid the higher risk of adverse price changes. I refer to this effect as the *duration* of risk.

The results of the previous section indicate a need to consider the ITD incentives of all taxable investors. The average ITD measure, used in the prior tests, equally weights each day's price appreciation across all holding periods. Thus, the $\beta_3$ coefficient in (13) only measures the average ITD incentive among investors and is not capable of discriminating among the different risk-sharing incentives of investors with different amounts of time remaining until qualification.

To empirically test this prediction, I disaggregate the price change, $\bar{\Delta}P$, and *ITD* variables in (13) into the 248 individual holding period components and include each as a separate explanatory variable. In other words, instead of one aggregate ITD variable, I now include 248 ITD variables, one for each day in the requisite holding period. This allows me to estimate a separate ITD coefficient for investors with different *duration* of risk incentives. For example, I include the price change, and corresponding ITD incentive, over the prior 248 days (day $t-250$ to $t-2$) as a separate explanatory variable, which represents an investor that has exactly one day remaining in their ITD requisite holding period. Within the same regression model, I also include the price change and ITD incentive of an investor that purchased shares five days prior to the earnings announcement and has 245 days remaining in their ITD requisite holding period. If investors consider the *duration* of risk when trading, then I expect the ITD incentive of the investor with one day remaining, $ITD_1$, to have a more negative coefficient than the ITD incentive of the investor with 245 days left, $ITD_{245}$. This follows as investors with a longer amount of time remaining in their ITD holding period are more willing to incur the higher ITD costs by prematurely trading in an effort to avoid having to face adverse price risk over a long duration of time.

To test the *duration* of risk effect, I estimate the following regression model:

$$AVOL = \sum_{d=1}^{248} \beta_{\Delta P}(d) \cdot \Delta P_d + \sum_{d=1}^{248} \beta_{ITD}(d) \cdot ITD_d + controls + \epsilon, \tag{14}$$

where $\Delta P_d = \ln(P_{t-2}) - \ln\left(P_{t-(250-d)}\right) \equiv \ln(P_{t-2}) - \ln(P_{t-n})$, $ITD_d = \Delta RATE \cdot \Delta P_d$. The estimated parameters, $\beta_{ITD}(d)$, in the model reflect the sensitivity of trading activity to the ITD transaction cost for an investor with a given duration, $d$, of risk. Based on the empirical predictions of section 2.4, $\beta_{ITD}(d)$ is expected to be an increasing function of the *duration* of risk, $d$ (i.e., $\beta_{ITD}(1) < \beta_{ITD}(2) < \ldots < \beta_{ITD}(247) < \beta_{ITD}(248) < 0$). To test this prediction, I restrict each of the 248 $\beta_{ITD}(d)$ estimates (and their main effects, $\beta_{\Delta P}(d)$) so they follow a linear function of *duration*, $d$. Specifically, the regression in (14) is estimated subject to the following coefficient restrictions:

$$\beta_{\Delta P}(d) = \alpha_0 + \alpha_1 \cdot d, \tag{15}$$

$$\beta_{ITD}(d) = \gamma_0 + \gamma_1 \cdot d, \tag{16}$$

where $\alpha_0$, $\alpha_1$, $\gamma_0$ and $\gamma_1$ are estimated parameters that summarize the coefficient dynamics as a function of duration, $d$.[30] Specifically, $\gamma_0$ is an estimate of the sensitivity of trading activity to the ITD transaction cost for an investor with a very small duration of risk, which is expected to be negative. $\gamma_1$ is an estimate of the change in the sensitivity of trading activity to ITD transaction costs as the duration of risk, $d$, increases. It is expected to be positive, which is consistent with the investors placing less weight on ITD transaction costs (i.e., less negative association) as the duration of risk, $d$, that they must bear increases.[31]

[30] Placing restrictions on the dynamics of the individual coefficients is similar in spirit to traditional distributed lag models (e.g., Gonedes, 1971; Falk and Miller, 1977; Sougiannis, 1994) and mixed data sampling models (e.g., Ghysels, Santa-Clara and Valkanov, 2006; Ghysels, Sinko and Valkanov, 2007)

[31] In addition to succinctly summarizing the dynamics of the coefficient estimates, the restrictions imposed by (15) and (16) reduce two other difficulties associated with a reasonable estimation of (16). First, adding the individual price changes and ITD incentives from the prior year requires the estimation of 496 additional coefficients, which significantly reduces the degrees of freedom. Second, many of the holding period price changes, $\Delta P_d$, are estimated across overlapping time periods, which introduces potential multicollinearity problems among the explanatory variables. For example, the price change of an investor with a duration of one day represents a cumu-

Table 3 presents parameter estimates from (14) subject to (15) and (16). Consistent with my empirical predictions, I find that $\gamma_0$ is negative and statistically significant, and $\gamma_1$ is positive and statistically significant. This implies that the negative relationship between *AVOL* and $ITD_d$ is increasing (i.e., becoming less negative) as the *duration*, $d$, of time investors must bear risk increases. Other control variables have similar signs and magnitudes as those reported in table 2, column 1.

Figure 1 presents a plot of $\beta_{ITD}(d)$ as a function of the *duration* of risk, $d$, and illustrates how the sensitivity of investors' trading decisions to ITD costs changes with *duration*. Specifically, the sensitivity of investors' trading decisions to ITD costs is increasing (i.e., becoming less negative) in *duration*. This is consistent with the notion that, all else being equal, when investors face more uncertainty in the future (i.e., have a longer time to wait), postponing trade becomes more costly from a risk perspective, and thus the ITD incentive to postpone trading becomes relatively less important than risk-related incentive to trade immediately.

## 4.4 The Impact of the *Intensity* of Risk on ITDs and Trading Activity

This section tests Empirical Implication 2, which states that as the *intensity* of price fluctuations per unit of time increases, investors' trading decisions become less sensitive to ITD costs. Holding *duration* of risk and the ITD incentive to postpone trading constant, stocks with a higher expected daily return volatility pose a greater risk of adverse future price changes than do lower volatility stocks. I refer to this effect as the *intensity* of risk.

To test this prediction, I estimate the regression specified in (14) but alter the coefficient

lative 248-day price change. Similarly, within the same observation, an investor with a duration of two days has a 247-day price change. Both price changes share 247 daily price changes, which means they will be highly correlated. When severe multicollinearity exists, it becomes very difficult to precisely identify the separate effects among the explanatory variables. As a consequence, coefficient estimates will exhibit large sampling variances (see Judge et al., 1985). This problem is further compounded by the inclusion of the remaining 246 price change variables, as well as 248 highly correlated $ITD_d$ variables. Restricting the individual coefficients to a small-dimension parameter space, as in (15) and (16), injects additional information into the regression through the parameterizing function, which imposes a large number of coefficient constraints. This reduces the sampling variability of coefficient estimates and counteracts increased variability from multicollinearity (see Judge et al., 1985; Kennedy, 2003).

restrictions, (15) and (16), as follows:

$$\beta_{\Delta P}(d) = \alpha_0 + \alpha_1 \cdot d + \alpha_{int} \cdot INTENSITY, \quad (17)$$

$$\beta_{ITD}(d) = \gamma_0 + \gamma_1 \cdot d + \gamma_{int} \cdot INTENSITY, \quad (18)$$

where a positive $\gamma_{int}$ is consistent with Empirical Implication 2 and *INTENSITY* is expressed as a sample rank.[32]

Table 4 presents the parameter estimates from (14), subject to (17) and (18). Consistent with my empirical predictions, I find that the coefficient $\gamma_{int}$ is positive and statistically significant, which signifies that the function describing $\beta_{ITD}(d)$ (as in Figure 1) shifts upward as *INTENSITY* increases. This implies that investors' trading decisions become less sensitive to ITD costs as postponing trade becomes more costly from a risk perspective. Therefore, investors are more likely to pay the higher ITD cost to shed the risk of intense price movements, holding *duration* constant. In addition, the coefficients $\gamma_0$ and $\gamma_1$ associated with *duration* are similar to the values reported in table 3. All other control variables exhibit similar values to those reported in previous specifications.

Recall from the analysis in section 4.2 that investors have asymmetric ITD incentives depending on whether the price has appreciated or depreciated over the prior holding period. The previous specifications do not account for such differences in appreciated and depreciated prices and, therefore, in differences in ITD incentives to postpone trading. A potential solution is to partition the sample based on whether the stock has an average appreciation or an average depreciation over the prior holding period (see section 4.2 and results in table 2, columns 2 and 3). However, even if the average investor holding a stock has an appreciated basis, some investors holding the same stock will have a depreciated basis (as purchase prices vary over

[32]In my model, trading volume is a function of the variance, and not of the standard deviation, of anticipated stock prices. However, this is an artifact of the stylized nature of the model's assumptions and there is no reason to believe that investors do not consider the standard deviation instead of the variance. In order to avoid any non-linear differences between the two measures, I use sample percentile ranks because both the standard deviation and variance will have exactly the same rank order. All other measures of *INTENSITY* I consider in the section are expressed as a sample percentile rank.

the prior holding period) and, therefore, different ITD incentives than an investor with an appreciated basis. Classifying observations based on the average amount of price appreciation destroys information about asymmetric ITD costs across different holding periods within the same observation. I allow appreciated holding periods to follow different functions describing $\beta_{\Delta P}(d)$ and $\beta_{ITD}(d)$ from those of depreciated holding periods. Specifically, (17) and (18) are adjusted as follows:

$$\begin{aligned}
\beta_{\Delta P}(\theta) &= APP_d \cdot \left(\alpha_0^A + \alpha_1^A \cdot d + \alpha_{int}^A \cdot INTENSITY\right) \\
&\quad + DEP_d \cdot \left(\alpha_0^D + \alpha_1^D \cdot d + \alpha_{int}^D \cdot INTENSITY\right), \qquad (19) \\
\beta_{ITD}(\theta) &= APP_d \cdot \left(\gamma_0^A + \gamma_1^A \cdot d + \gamma_{int}^A \cdot INTENSITY\right) \\
&\quad + DEP_d \cdot \left(\gamma_0^D + \gamma_1^D \cdot d + \gamma_{int}^D \cdot INTENSITY\right), \qquad (20)
\end{aligned}$$

where $\theta \in \{d, INTENSITY, APP_d, DEP_d\}$. $APP_d$ is an indicator variable equal to one if the change in stock price for an investor with duration $d$ is positive (i.e., $\Delta P_d > 0$), and equal to zero otherwise. $DEP_d$ is an indicator variable equal to one if the change in stock price for an investor with duration $d$ is not positive (i.e., $\Delta P_d \leq 0$) and equal to zero otherwise. If investors have asymmetric ITD incentives with respect to appreciated and depreciated holding periods, then I expect the previous results for $\beta_{ITD}(\theta)$ to reflect the influence of appreciated days (i.e., $\gamma_\theta^A$ coefficients are statistically significant with the predicted sign) rather than the influence of depreciated days (i.e., $\gamma_\theta^D$ coefficients are not statistically significant).

Table 5 presents the parameter estimates associated with $\beta_{ITD}(\theta)$ from (14), subject to (19) and (20). Consistent with an asymmetric ITD incentive between appreciated and depreciated price changes, I find that the coefficient estimates associated with appreciated holding periods (i.e., $\gamma_\theta^A$) have the predicted sign and are statistically significant. In particular, the coefficient $\gamma_{int}^A$ is positive and statistically significant with a higher magnitude than the value reported in table 4. By contrast, the estimates associated with depreciated holding periods (i.e., $\gamma_\theta^D$) do not consistently have the predicted sign and are not statistically significant.

In addition to variance of the daily stock return distribution, I also consider three other proxies for the *intensity* component of risk: (1) the idiosyncratic variance of daily returns, (2) the systematic (market and 2-digit industry) variance of daily returns, and (3) the coefficient of skewness of the daily return distribution. First, I examine whether the *INTENSITY* results in tables 4 and 5 are driven by idiosyncratic risk, systematic risk or both, by decomposing the total return variance, *INTENSITY*, into the idiosyncratic variance, *IDIO*, and the systematic variance, *SYST*. Specifically, *IDIO* and *SYST* are equal to the variance of the residual and predicted values (expressed as a sample percentile rank), respectively, from a regression of firm-specific returns on the CRSP value-weighted market return and the 2-digit industry return (for example, see Roll, 1988), estimated over the 100 trading days immediately preceding day $t-1$, where $t$ is the quarterly earnings announcement date. Results for this specification are presented in table 6, column 1. I find that $\gamma^A_{idio}$ is positive and statistically significant, while $\gamma^A_{syst}$ is positive but not statistically significant. These results indicate that if investors attempt to hedge their risks (e.g., by short-selling similar assets), it may be difficult to find a substitute asset to hedge the idiosyncratic risk of adverse price changes while waiting for the ITD holding period to expire. Conversely, systematic risk does not significantly influence the sensitivity of investors' trading decisions to ITD costs.

Second, I examine the degree to which a firm's stock is "crash prone" by examining the degree of left-skewness in the daily return distribution. Specifically, I define *SKEW* as the negative coefficient of skewness (expressed as a sample rank) of the firm-specific daily price change distribution, estimated over the 100 trading days immediately preceding day $t-1$. Following Chen, Hong and Stein (2001), I compute *SKEW* as follows:

$$SKEW = -\frac{100 \cdot 99^{3/2} \cdot \sum_{n=2}^{101} R^3_{t-n}}{99 \cdot 98 \cdot \left(\sum_{n=2}^{101} R^2_{t-n}\right)^{3/2}},$$

where $R_{t-n}$ is the logarithm of the daily change in stock price on day $t-n$. Placing a minus sign on the coefficient of skewness adopts the convention that a higher value of *SKEW* corresponds to a higher risk of a stock price "crash." Table 6, column 2 presents results for the MIDAS specification in which *INTENSITY* is replaced with *SKEW*. Consistent with the *INTENSITY* results from table 5, I find that $\gamma^A_{skew}$ is positive and statistically significant, which is consistent with a decrease in the sensitivity of investors' trading decisions to ITD costs as the probability of a large stock price "crash" (i.e., high *SKEW*) increases.

Finally, prior research documents a positive correlation between stock price volatility and the degree of institutional ownership in a firm (e.g., Potter, 1992; Sias, 1996). Many institutions are exempt from paying capital gains taxes, leaving them with no ITD incentive to postpone trading. Because *INTENSITY* is based on the stock price volatility, it may simply serve as a proxy for the degree of institutional ownership and, therefore, capture the average tax status among traders at the quarterly earnings announcement date, rather than the risk of adverse price changes that investors, subject to an ITD, may consider. I examine this possibility by computing the fraction of a firm's stock owned by institutional investors to see if it eliminates the statistical significance or changes the sign of $\gamma^A_{idio}$ in table 6, column 1. Specifically, I include the percentage of shares held by 13-F filing institutions, *INST* (expressed as a sample rank), computed at the end of the calendar quarter immediately preceding the earnings announcement date. The results in table 6, column 3 show that $\gamma^A_{idio}$ remains positive and statistically significant, while $\gamma^A_{inst}$ is negative and not statistically significant. The lack of significance associated with $\gamma^A_{inst}$ is consistent with the empirical evidence in Blouin, Raedy and Shackelford (2003) illustrating that the degree of institutional ownership does not provide a discriminating ITD result for their sample. This indicates that *INST* may be a poor proxy for the true (unobservable) tax-status of traders around an earnings announcement. Consequently, I cannot rule out the possibility that *INTENSITY* is simply a proxy for the fraction of investors that are subject to an ITD cost.

# 5 Conclusions

This paper theoretically and empirically investigates how the risk of future adverse price changes created by the anticipated arrival of information influences risk-averse investors' trading decisions in institutionally imperfect capital markets, which is commonly referred to as the Hirshleifer Effect (Hirshleifer, 1971). I examine the relation between trading activity and the risk of adverse price changes, as measured by stock price volatility, in the presence of trading frictions created by the existence of intertemporal tax discontinuities (ITDs). An ITD refers to the incremental capital gains tax rate applied to trading profits on shares held for less than a requisite amount of time. Specifically, I examine how trading activity is influenced by the trade-off between the risk-sharing benefits of immediate trade to mitigate exposure to future adverse price changes, and explicit transaction costs imposed upon such trades by the existence of an ITD.

Employing a stylized model, I demonstrate that current trading decisions depend upon two aspects of risk: the *intensity* of expected future price fluctuations per unit of time and the *duration* of time that risk must be borne. Tension in the model is created by introducing an incremental capital gains tax rate applied to trading profits on shares held for less than a requisite amount of time. Thus, risk-averse investors face an economic tension between trading immediately to an optimal risk-sharing portfolio at the cost of incurring an incremental tax on realized trading profits, versus postponing trade to avoid the incremental tax while facing the risk of interim, adverse price changes. Specifically, I find that the total amount of risk that each investor considers is an increasing function of both the *intensity* and the *duration* of the risk of adverse price changes. Intuitively, intensity captures the risk of adverse price movements per unit of time, while duration captures the amount of time that such risk must be held. The fact that investors can reduce tax costs by postponing the sale of shares until a known future point in time creates a unique opportunity to empirically test the Hirshleifer Effect.

I empirically examine whether the *duration* and *intensity* components of risk affect the sensitivity of abnormal trading activity by individual investors around quarterly earnings announcements to ITD transaction costs. Consistent with the model's predictions, I document evidence that as the number of days left to avoid the incremental tax increases (i.e., *duration* of the risk increases), abnormal trading activity becomes less sensitive to the incremental transaction costs created by an ITD. Similarly, I find evidence that as the expected volatility of future stock price increases (i.e., *intensity* of the risk increases), abnormal trading activity becomes less sensitive to ITD transaction costs. These results suggest that investors are more willing to incur explicit tax costs in order to insulate themselves against increases in the risk of price fluctuations driven by increases in the *duration* and *intensity* components of the risk. Overall, my analysis provides a novel and powerful setting in which to directly examine empirical implications of the adverse risk-sharing effect of anticipated information (i.e., the Hirshleifer Effect).

# Appendix

**Derivation of Lemma 1**

Consider investor $i$'s optimization problem in period 1, which is to maximize expected utility, $\bar{U}_i$::

$$\underset{D_{1,i}}{\text{Max}} \ \bar{U}_i = E_{\tilde{u},\tilde{P}_2}\left[-\exp\left(-\tilde{W}_i/\gamma\right)\right],$$

where $\tilde{W}_i = E_i + P_1\left(D_{0,i} - D_{1,i}\right) + \tilde{P}_2\left(D_{1,i} - D_{2,i}\right) + \tilde{u}\cdot D_{2,i} - \tau_i\left(P_1 - P_0\right)\left(D_{0,i} - D_{1,i}\right)$. Substituting the relation $D_{2,i} = x$ (from equation 4) and using the moment-generating function for the normal random variables $\tilde{P}_2$ and $\tilde{u}$, investor $i$'s problem becomes:

$$\underset{D_{1,i}}{\text{Max}} \ \bar{U}_i = -\exp\Big\{-\tfrac{1}{\gamma}\Big[E_i + \left(P_1\left(1-\tau_i\right) + P_0\tau_i\right)\cdot D_{0,i} + \left(E\left[\tilde{P}_2\right] - P_1\left(1-\tau_i\right) - P_0\tau_i\right)\cdot D_{1,i}$$

$$+\left(\bar{u} - E\left[\tilde{P}_2\right]\right)\cdot x\Big] + \tfrac{1}{2\gamma^2}\left(D_{1,i}^2 - x^2\right)\text{Var}\left[\tilde{P}_2\right]\Big\}. \tag{A1}$$

Differentiating this expression with respect to $D_{1,i}$, setting it equal to zero, and solving for $D_{1,i}$ yields:

$$D_{1,i} = \frac{E\left[\tilde{P}_2\right] - P_1\left(1-\tau_i\right) - P_0\tau_i}{\frac{1}{\gamma}\text{Var}\left[\tilde{P}_2\right]}. \tag{A2}$$

At this point, there are two potential equilibria in period 1: (1) *Sellers* dispose of shares and *Buyers* acquire shares (i.e., all investors trade toward optimal risk-sharing) and (2) *Sellers* acquire shares and *Buyers* dispose of shares (i.e., all investors trade away from optimal risk-sharing).

Consider the first potential equilibrium. If *Sellers* sell shares in period 1, then they will incur a tax, $\tau_S = \tau$, on any trading profits. Conversely, *Buyers* will not pay taxes, $\tau_B = 0$, on any shares they purchase in period 1. Consequently, the demand functions of *Buyers* and *Sellers* can be expressed, respectively, as

$$D_{1,B} = \frac{E\left[\tilde{P}_2\right] - P_1}{\frac{1}{\gamma}Var[\tilde{P}_2]}, \tag{A3}$$

$$D_{1,S} = \frac{E\left[\tilde{P}_2\right] - P_1\left(1-\tau\right) - \tau P_0}{\frac{1}{\gamma}\text{Var}\left[\tilde{P}_2\right]}. \tag{A4}$$

Applying the market clearing condition and substituting (A3) and (A4):

$$\begin{aligned} x &= \int D_{1,i}\, di \\ &= \theta D_{1,S} + \left(1-\theta\right) D_{1,B} \\ &= \frac{E\left[\tilde{P}_2\right] - P_1\left(1-\theta\tau\right) - \theta\tau P_0}{\frac{1}{\gamma}\text{Var}\left[\tilde{P}_2\right]}. \end{aligned} \tag{A5}$$

The unconditional expectation and variance of $\tilde{P}_2$ (from equation 3) are given by:

$$E\left[\tilde{P}_2\right] = \bar{u} - \frac{x}{\gamma\left(1+s\right)}, \tag{A6}$$

$$\text{Var}\left[\tilde{P}_2\right] = \frac{s}{\left(1+s\right)}. \tag{A7}$$

Substituting (A6) and (A7) into (A5) and solving for $P_1$ yields:

$$P_1 = \frac{\bar{u} - \frac{x}{\gamma} - \theta\tau P_0}{1 - \theta\tau}, \tag{A8}$$

which is identical to (5). Substituting (A6)–(A7) into (A3)–(A4) and simplifying each expression gives:

$$D_{1,S} = x + \frac{\gamma\left(1 + \frac{1}{s}\right)\tau(1-\theta)\left(\bar{u} - \frac{x}{\gamma} - P_0\right)}{(1-\theta\tau)}, \tag{A9}$$

$$D_{1,B} = x - \frac{\gamma\left(1 + \frac{1}{s}\right)\theta\tau\left(\bar{u} - \frac{x}{\gamma} - P_0\right)}{(1-\theta\tau)}, \tag{A10}$$

which are identical to (6) and (7), respectively.

Note that *Buyers* demand function, given by (A10), can be rewritten as follows:

$$D_{1,B} = x - \frac{\theta\tau(P_1 - P_0)}{\frac{1}{\gamma}Var[\tilde{P}_2]}. \tag{A11}$$

Recall that a "good news" announcement assumes $P_1 > P_0$. It directly follows from (A11) that *Buyers* demand in period 1, $D_{1,B}$, must be less than the optimal risk-sharing allocation, $x$. Therefore, if *Buyers* purchase shares, they buy less than an optimal risk-sharing amount. Similar manipulations of (A9) lead to the result that *Sellers* period 1 demand is always greater than the optimal risk-sharing amount, $x$.

Next, consider the second potential equilibrium where *Sellers* acquire shares and *Buyers* dispose of shares (i.e., all investors trade away from optimal risk-sharing). If *Sellers* buy shares in period 1, then they do not incur a tax, $\tau_S = 0$, on any trading profits. Conversely, *Buyers* do pay taxes, $\tau_B = \tau$, on the sale of shares in period 1. In this scenario, *Buyers* and *Sellers* swap their tax status and, therefore, swap their demand functions. Therefore, *Buyers* take on the demand function of *Sellers* derived in the first equilibrium, which implies that they desire to hold an amount greater than the optimal risk-sharing amount, $x$. Given that *Buyers*, by definition, initially hold an "underweighted" amount, $D_{0,B} < x$, the only way they can trade to an amount greater than $x$ is to purchase additional shares. This is inconsistent with the initial conjecture that *Buyers* sell shares and demonstrates that the second potential equilibrium does not exist. Therefore, the unique period 1 equilibrium is one in which *Buyers* (*Sellers*) always buy (sell) shares of the risky asset (i.e., $D_{1,B} \geq D_{0,B}$ and $D_{1,S} \leq D_{0,S}$. ■

**Derivation of Proposition 1**

Substituting the equilibrium relations from (A2) and (A7) into (A1) and rearranging terms, gives investor $i$'s expected utility:

$$\bar{U}_i = -\exp\left\{-\tfrac{1}{\gamma}\left[E_i + \left(P_1\left(1-\tau_i\right) + P_0\tau_i\right)\cdot D_{0,i}\right] - \tfrac{1}{2\gamma^2}\left(D_{1,i}^2 + x^2\right)\operatorname{Var}\left[\tilde{P}_2\right] - \tfrac{x^2}{\gamma(1+s)}\right\}. \tag{A12}$$

Differentiating (A12) with respect to $s$ gives:

$$\begin{aligned}
\frac{\partial \bar{U}_i}{\partial s} &= -\exp\{\bullet\}\cdot\left[-\frac{\operatorname{Var}\left[\tilde{P}_2\right]\cdot D_{1,i}}{\gamma^2}\cdot\frac{\partial D_{1,i}}{\partial s} - \frac{\left(D_{1,i}^2 + x^2\right)}{2\gamma^2}\cdot\frac{\partial \operatorname{Var}\left[\tilde{P}_2\right]}{\partial s} + \frac{x^2}{\gamma^2\left(1+s\right)^2}\right] \\
&= -\exp\{\bullet\}\cdot\left[-\frac{\operatorname{Var}\left[\tilde{P}_2\right]\cdot D_{1,i}}{\gamma^2}\cdot\frac{\left(x - D_{1,i}\right)}{(1+s)^2\operatorname{Var}\left[\tilde{P}_2\right]} - \frac{\left(D_{1,i}^2 + x^2\right)}{2\gamma^2}\cdot\frac{1}{(1+s)^2} + \frac{x^2}{\gamma^2\left(1+s\right)^2}\right] \\
&= -\frac{\exp\{\bullet\}}{2\gamma^2\left(1+s\right)^2}\cdot\left(D_{1,i} - x\right)^2 \le 0.
\end{aligned} \tag{A13}$$

If $\tau = 0$, then $D_{1,i} = x$ (from Lemma 1), which gives $\frac{\partial \bar{U}_i}{\partial s}|_{\tau=0} = 0$ from the above expression. If $\tau > 0$, then $D_{1,i} \neq x$, which gives $\frac{\partial \bar{U}_i}{\partial s}|_{\tau>0} < 0$. ■

**Derivation of Proposition 2**

Substituting (A11) into (10) and simplifying the expression gives:

$$\begin{aligned}
V_1 &= (1-\theta)\left(D_{1,B} - D_{0,B}\right) \\
&= (1-\theta)\left[x - D_{0,B} - \frac{\theta\tau\left(P_1 - P_0\right)}{\frac{1}{\gamma}\operatorname{Var}\left[\tilde{P}_2\right]}\right] \\
&= V^* - (1-\theta)\frac{\theta\tau\Delta P_1}{\frac{1}{\gamma}\operatorname{Var}\left[\tilde{P}_2\right]}
\end{aligned}$$

where $V^* = (1-\theta)\left(x - D_{0,B}\right)$, $\operatorname{Var}\left[\tilde{P}_2\right] = \frac{s}{1+s}$, and $\Delta P_1 = P_1 - P_0$. ■

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**Table 1**

Sample Distribution

| Variable | Mean | Std. Dev. | $1^{st}$ | $25^{th}$ | Median | $75^{th}$ | $99^{th}$ |
|---|---|---|---|---|---|---|---|
| *AVOL* | 1.556 | 1.579 | −1.107 | −0.240 | 1.287 | 2.802 | 5.508 |
| $\Delta RATE$ | 0.124 | 0.079 | 0.000 | 0.030 | 0.116 | 0.196 | 0.300 |
| $\bar{\Delta}P$ | 0.014 | 0.109 | −0.323 | −0.043 | 0.017 | 0.074 | 0.328 |
| *ITD* | 0.002 | 0.017 | −0.056 | −0.003 | 0.000 | 0.008 | 0.053 |
| *INTENSITY* | 0.063 | 0.064 | 0.008 | 0.025 | 0.043 | 0.077 | 0.315 |
| *UE* | −0.091 | 0.977 | −4.800 | −0.171 | 0.000 | 0.124 | 3.401 |
| *BID_ASK* | 0.026 | 0.031 | 0.004 | 0.010 | 0.015 | 0.027 | 0.171 |
| *SIZE* | 4.681 | 15.628 | 0.055 | 0.380 | 1.013 | 3.059 | 68.801 |
| *NUM_EST* | 7.293 | 5.402 | 1.000 | 3.000 | 6.000 | 10.000 | 24.000 |

The sample includes 35,222 observations of quarterly earnings announcements from 1982 to 2002. Let $t$ denote the quarterly earnings announcement date identified by Compustat. *AVOL* is the average of daily actual less daily expected selling activity by individual investors scaled by the standard deviation of selling activity, computed over days $t-1$ to $t+1$. Actual selling activity by individual investors is the natural logarithm of one plus the number of trades classified as sell orders by individual investors and the expectation and standard deviation of selling activity is the average and standard deviation, respectively, of the same selling metric over the 50 trading dates immediately preceding day $t-1$ (after excluding prior 3-day earnings announcement windows). $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. $\bar{\Delta}P$ is the volume-weighted, average price change over the prior 248 trading days immediately preceding day $t-2$ (within the requisite ITD holding period), $\frac{1}{248}\sum_{n=3}^{250} w_n \cdot \Delta P_{t-n}$, where $\Delta P_{t-n}$ is the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ and $w_n$ is the equal to the daily volume on day $t-n$ divided by the firm's cumulative trading volume over the two years immediately preceding the earnings announcement. *ITD* is equal to the product of $\Delta RATE$ and $\bar{\Delta}P$. *INTENSITY* is 100 times the variance of daily changes in the logarithm of stock price estimated over the 100 trading days immediately preceding day $t-1$. *UE* is 100 the times the difference between announced quarterly earnings on day $t$ and the median analyst forecast within the 60 days preceding day $t-1$. *BID_ASK* is the average percentage bid-ask spread over the 10 trading days immediately preceding day $t-1$. *SIZE* is the market value of equity (in billions) at the end of the fiscal quarter preceding day $t$. *NUM_EST* is the number of analysts issuing a quarterly earnings forecast within 60 days prior to day $t-1$.

**Table 2**

Determinants of Selling Activity by Individual Investors
Around Quarterly Earnings Announcements

| | | Dependent Variable: *AVOL* | | | | | |
|---|---|---|---|---|---|---|---|
| | | Full Sample | | Appreciated $(\bar{\Delta}P > 0)$ | | Depreciated $(\bar{\Delta}P \leq 0)$ | |
| Variable | Pred. | Coeff. | ($t$-stat) | Coeff. | ($t$-stat) | Coeff. | ($t$-stat) |
| $\Delta RATE$ | | −0.828 | (−5.17) | 0.423 | (2.00) | −0.926 | (−5.07) |
| $\bar{\Delta}P^a$ | | 2.182 | (6.94) | 2.396 | (11.86) | 0.512 | (1.15) |
| $ITD^a$ | (–) | −4.414 | (−3.60) | −5.709 | (−3.35) | −0.655 | (−0.75) |
| $AUE^b$ | | 0.238 | (8.05) | 0.337 | (10.10) | 0.148 | (6.35) |
| $NONLINEAR^b$ | | −0.027 | (−3.65) | −0.039 | (−4.36) | −0.015 | (−5.52) |
| $BID\_ASK^a$ | | −1.864 | (−1.89) | −2.389 | (−4.20) | 1.493 | (1.02) |
| *SIZE* | | 0.112 | (3.22) | 0.064 | (4.29) | 0.164 | (6.34) |
| *NUM_EST* | | 0.019 | (2.60) | 0.020 | (2.50) | 0.016 | (2.29) |
| Adj. $R^2$ | | 0.4058 | | 0.4388 | | 0.4303 | |
| Num. Obs. | | 35,222 | | 22,360 | | 12,862 | |

[a] Variable winsorized at the 1% and 99% levels.; [b] Variable winsorized at the 99% level.

Let $t$ denote the quarterly earnings announcement date identified by Compustat. The dependent variable is the three-day abnormal selling activity by individual investors, *AVOL*, around quarterly earnings announcements from 1982 to 2002. Specifically, *AVOL* is the average of daily actual less daily expected selling activity by individual investors scaled by the standard deviation of selling activity, computed over days $t-1$ to $t+1$. Actual selling activity by individual investors is the natural logarithm of one plus the number of trades classified as sell orders by individual investors and the expectation and standard deviation of selling activity is the average and standard deviation, respectively, of the same selling metric over the 50 trading dates immediately preceding day $t-1$ (after excluding prior 3-day earnings announcement windows). $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. $\bar{\Delta}P$ is the volume-weighted, average price change over the prior 248 trading days immediately preceding day $t-2$ (within the requisite ITD holding period), $\frac{1}{248}\sum_{n=3}^{250} w_n \cdot \Delta P_{t-n}$, where $\Delta P_{t-n}$ is the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ and $w_n$ is the equal to the daily volume on day $t-n$ divided by the firm's cumulative trading volume over the two years immediately preceding the earnings announcement. *ITD* is equal to the product of $\Delta RATE$ and $\bar{\Delta}P$. *AUE* is 100 the times absolute value of the difference between announced quarterly earnings on day $t$ and the median analyst forecast within the 60 days preceding day $t-1$. *NONLINEAR* is equal to the square of *AUE*. *BID_ASK* is the average percentage bid-ask spread over the 10 trading days immediately preceding day $t-1$. *SIZE* is the logarithm of the market value of equity at the end of the fiscal quarter preceding day $t$. *NUM_EST* is the logarithm of the number of analysts issuing a quarterly earnings forecast within 60 days prior to day $t-1$. Firm fixed-effects are included and coefficient $t$-statistics are based on standard errors clustered by the month of the earnings announcement.

## Table 3

Regression Examining the *Duration* of Risk and Selling Activity by Individual Investors Around Quarterly Earnings Announcements

| Dependent Variable: *AVOL* | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameters | | Pred. | Coeff. | ($t$-stat) | Parameters | Coeff. | ($t$-stat) |
| $ITD_d$ | $\gamma_0$ | (–) | −12.895 | (−4.19) | $\Delta RATE$ | −0.815 | (−4.97) |
| | $\gamma_1$ | (+) | 0.057 | (3.07) | $AUE^b$ | 0.231 | (8.24) |
| | | | | | $NONLINEAR^b$ | −0.027 | (−3.17) |
| $\Delta P_d$ | $\alpha_0$ | | −1.726 | (−2.75) | $BID\_ASK^a$ | −1.187 | (−1.83) |
| | $\alpha_1$ | | 0.040 | (6.04) | *SIZE* | 0.118 | (3.54) |
| | | | | | *NUM_EST* | 0.018 | (2.70) |

Adj. $R^2 = 0.4088$
normalsizeNum. Obs. = 35,222

[a] Variable winsorized at the 1% and 99% levels.; [b] Variable winsorized at the 99% level.

This table presents parameter estimates from the following regression model:

$$AVOL = \sum_{d=1}^{248} \beta_{\Delta P}(d) \cdot \Delta P_d + \sum_{d=1}^{248} \beta_{ITD}(d) \cdot ITD_d + controls + \epsilon,$$

$$\text{subject to:} \quad \beta_{\Delta P}(d) = \alpha_0 + \alpha_1 \cdot d, \qquad \beta_{ITD}(d) = \gamma_0 + \gamma_1 \cdot d.$$

Let $t$ denote the quarterly earnings announcement date identified by Compustat. The dependent variable is the three-day abnormal selling activity by individual investors, *AVOL*, around 35,222 quarterly earnings announcements from 1982 to 2002. Specifically, *AVOL* is the average of daily actual less daily expected selling activity by individual investors scaled by the standard deviation of selling activity, computed over days $t-1$ to $t+1$. Actual selling activity by individual investors is the natural logarithm of one plus the number of trades classified as sell orders by individual investors and the expectation and standard deviation of selling activity is the average and standard deviation, respectively, of the same selling metric over the 50 trading dates immediately preceding day $t-1$ (after excluding prior 3-day earnings announcement windows). $\Delta P_{t-n}$ is equal to the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ scaled by 248 and weighted by the ratio of the firm's daily volume on day $t-n$ to the total trading volume over the two years immediately preceding the earnings announcement. $ITD_d$ is equal to the product of $\Delta RATE$ and $\Delta P_d$, where $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. Duration, $d$, is the number of trading days from the quarterly earnings announcement date, $t$, that an investor, which purchased shares on day $t-n$, must hold the stock to meet the requisite ITD holding period of 250 trading days. Other *controls* (defined in section 3.2) include *AUE*, *NONLINEAR*, *SIZE*, and *NUM_EST*. Firm fixed-effects are included and coefficient $t$-statistics are based on standard errors clustered by the month of the earnings announcement.

## Table 4

Regression Examining the *Intensity* of Risk and Selling Activity by Individual Investors Around Quarterly Earnings Announcements

Dependent Variable: *AVOL*

| Parameters | | Pred. | Coeff. | ($t$-stat) | Parameters | Coeff. | ($t$-stat) |
|---|---|---|---|---|---|---|---|
| $ITD_d$ | $\gamma_0$ | (–) | −11.048 | (−2.55) | $\Delta RATE$ | −0.987 | (−5.46) |
| | $\gamma_1$ | (+) | 0.039 | (4.14) | $AUE^b$ | 0.246 | (8.54) |
| | $\gamma_{int}$ | | 2.848 | (2.03) | $NONLINEAR^b$ | −0.028 | (−3.38) |
| | | | | | $BID\_ASK^a$ | −2.190 | (−2.15) |
| $\Delta P_d$ | $\alpha_0$ | | −1.971 | (−3.03) | $SIZE$ | 0.126 | (3.85) |
| | $\alpha_1$ | | 0.044 | (6.50) | $NUM\_EST$ | 0.019 | (2.85) |
| | $\alpha_{int}$ | | −0.371 | (−1.85) | $INTENSITY$ | −0.328 | (−3.32) |

Adj. $R^2$ = 0.4120
Num. Obs. = 35,222

[a] Variable winsorized at the 1% and 99% levels.; [b] Variable winsorized at the 99% level.

This table presents parameter estimates from the following regression:

$$AVOL = \sum_{d=1}^{248} \beta_{\Delta P}(\theta)\cdot \Delta P_d + \sum_{d=1}^{248} \beta_{ITD}(\theta)\cdot ITD_d + controls + \epsilon,$$

$$\text{subject to:} \quad \beta_{\Delta P}(\theta) = \alpha_0 + \alpha_1 \cdot d + \alpha_{int}\cdot INTENSITY,$$

$$\beta_{ITD}(\theta) = \gamma_0 + \gamma_1 \cdot d + \gamma_{int}\cdot INTENSITY,$$

where $\theta \in \{d, INTENSITY\}$. Let $t$ denote the quarterly earnings announcement date identified by Compustat. The dependent variable is the three-day abnormal selling activity by individual investors, *AVOL*, around 35,222 quarterly earnings announcements from 1982 to 2002. Specifically, *AVOL* is the average of daily actual less daily expected selling activity by individual investors scaled by the standard deviation of selling activity, computed over days $t-1$ to $t+1$. Actual selling activity by individual investors is the natural logarithm of one plus the number of trades classified as sell orders by individual investors and the expectation and standard deviation of selling activity is the average and standard deviation, respectively, of the same selling metric over the 50 trading dates immediately preceding day $t-1$ (after excluding prior 3-day earnings announcement windows). $\Delta P_{t-n}$ is equal to the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ scaled by 248 and weighted by the ratio of the firm's daily volume on day $t-n$ to the total trading volume over the two years immediately preceding the earnings announcement. $ITD_d$ is equal to the product of $\Delta RATE$ and $\Delta P_d$, where $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. Duration, $d$, is the number of trading days from the quarterly earnings announcement date, $t$, that an investor, which purchased shares on day $t-n$, must hold the stock to meet the requisite ITD holding period of 250 trading days. *INTENSITY* is the the variance of daily changes in the logarithm of stock price estimated over the 100 trading days immediately preceding day $t-1$ expressed as a fractional rank within the sample (high fractional rank corresponds to high variance). Other *controls* (defined in section 3.2) include *AUE*, *NONLINEAR*, *SIZE*, and *NUM_EST*. Firm fixed-effects are included and coefficient $t$-statistics are based on standard errors clustered by the month of the earnings announcement.

## Table 5

Regression Examining the *Intensity* of Risk and Selling Activity by Individual Investors Around Quarterly Earnings Announcements for Appreciated and Depreciated Holding Periods

| Dependent Variable: *AVOL* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | | Pred. | Coeff. | ($t$-stat) | Parameters | | Coeff. | ($t$-stat) |
| $ITD_d \cdot APP_d$ | $\gamma_0^A$ | (–) | −18.965 | (−2.29) | $ITD_d \cdot DEP_d$ | $\gamma_0^D$ | 1.305 | (0.59) |
| | $\gamma_1^A$ | (+) | 0.062 | (3.61) | | $\gamma_1^D$ | 0.014 | (0.73) |
| | $\alpha_{int}^A$ | (+) | 7.543 | (3.18) | | $\gamma_{int}^D$ | 1.583 | (0.12) |

Adjusted $R^2$ = 0.4235
Num. Obs. = 35,222

This table presents selected parameter estimates from the following regression:

$$AVOL = \sum_{d=1}^{248} \beta_{\Delta P}(\theta) \cdot \Delta P_d + \sum_{d=1}^{248} \beta_{ITD}(\theta) \cdot ITD_d + controls + \epsilon,$$

$$\text{subject to:} \quad \beta_{\Delta P}(\theta) = APP_d \cdot \left(\alpha_0^A + \alpha_1^A \cdot d + \alpha_{int}^A \cdot INTENSITY\right) + DEP_d \cdot \left(\alpha_0^D + \alpha_1^D \cdot d + \alpha_{int}^D \cdot INTENSITY\right),$$

$$\beta_{ITD}(\theta) = APP_d \cdot \left(\gamma_0^A + \gamma_1^A \cdot d + \gamma_{int}^A \cdot INTENSITY\right) + DEP_d \cdot \left(\gamma_0^D + \gamma_1^D \cdot d + \gamma_{int}^D \cdot INTENSITY\right)$$

where $\theta \in \{d, INTENSITY, APP_d, DEP_d\}$. The dependent variable is the three-day abnormal selling activity by individual investors, *AVOL* (defined in section 3.2), around 35,222 quarterly earnings announcements from 1982 to 2002. $\Delta P_{t-n}$ is equal to the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ scaled by 248 and weighted by the ratio of the firm's daily volume on day $t-n$ to the total trading volume over the two years immediately preceding the earnings announcement. $ITD_d$ is equal to the product of $\Delta RATE$ and $\Delta P_d$, where $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. Duration, $d$, is the number of trading days from the quarterly earnings announcement date, $t$, that an investor, which purchased shares on day $t-n$, must hold the stock to meet the requisite ITD holding period of 250 trading days. *INTENSITY* is the the variance of daily changes in the logarithm of stock price estimated over the 100 trading days immediately preceding day $t-1$ expressed as a fractional rank within the sample (high fractional rank corresponds to high variance). $APP_d$ is an indicator variable equal to one if the change in stock price for an investor with duration, $d$, is positive (i.e. $\Delta P_d > 0$) and equal to zero otherwise. $DEP_d$ is an indicator variable equal to one if the change in stock price for an investor with duration, $d$, is not positive (i.e. $\Delta P_d \leq 0$) and equal to zero otherwise. Other *controls* (defined in section 3.2) include *AUE*, *NONLINEAR*, *SIZE*, and *NUM_EST*. Firm fixed-effects are included and coefficient $t$-statistics are based on standard errors clustered by the month of the earnings announcement.

## Table 6

Regression Examining Alternative Measures of Risk and Selling Activity by Individual Investors Around Quarterly Earnings Announcements

| | | Dependent Variable: *AVOL* | | | | | |
|---|---|---|---|---|---|---|---|
| | | (1) | | (2) | | (3) | |
| Parameters | | Coeff. | ($t$-stat) | Coeff. | ($t$-stat) | Coeff. | ($t$-stat) |
| $ITD_d \cdot APP_d$ | $\gamma_0^A$ | −17.415 | (−2.88) | −18.287 | (−2.41) | −17.299 | (−2.25) |
| | $\gamma_1^A$ | 0.058 | (3.71) | 0.057 | (3.14) | 0.058 | (3.37) |
| | $\gamma_{idio}^A$ | 8.365 | (3.17) | | | 7.314 | (3.08) |
| | $\gamma_{syst}^A$ | 1.024 | (0.27) | | | −0.271 | (−0.89) |
| | $\gamma_{skew}^A$ | | | 5.886 | (3.64) | | |
| | $\gamma_{inst}^A$ | | | | | −0.122 | (−0.40) |

This table presents selected parameter estimates from the following regression:

$$AVOL = \sum_{d=1}^{248} \beta_{\Delta P}(\theta) \cdot \Delta P_d + \sum_{d=1}^{248} \beta_{ITD}(\theta) \cdot ITD_d + controls + \epsilon,$$

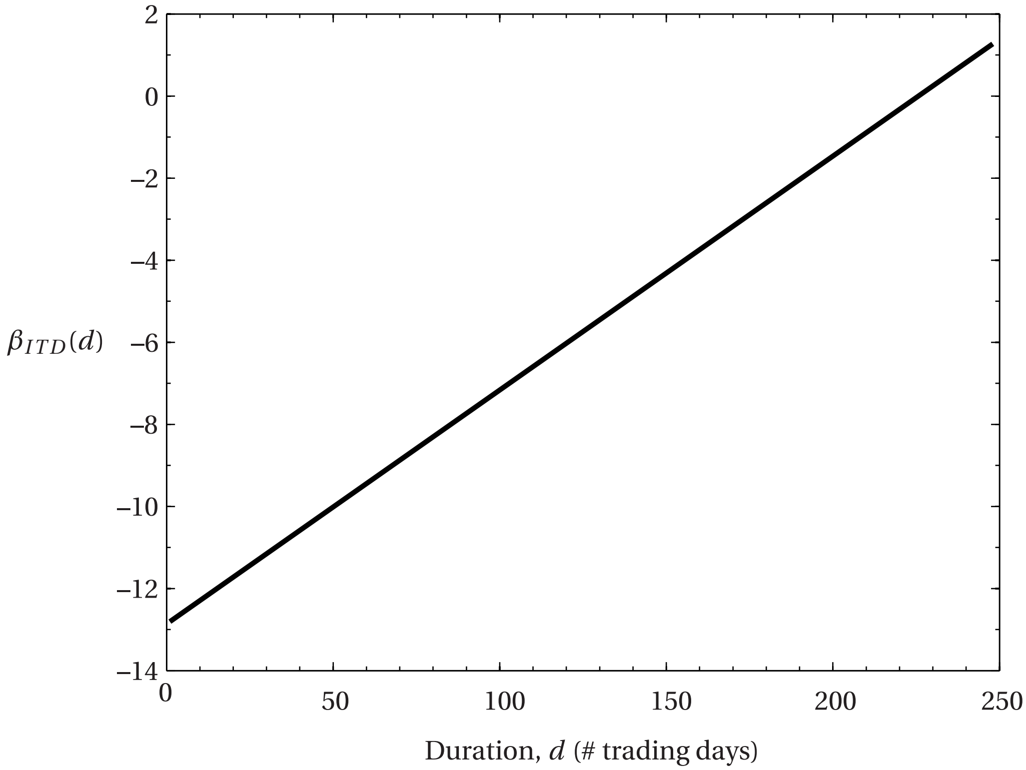
subject to:

$$\begin{aligned}
\beta_{\Delta P}(\theta) &= APP_d \cdot (\alpha_0^A + \alpha_1^A \cdot d + \alpha_{idio}^A \cdot IDIO + \alpha_{syst}^A \cdot SYST + \alpha_{skew}^A \cdot SKEW + \alpha_{inst}^A \cdot INST) \\
&\quad + DEP_d \cdot (\alpha_0^D + \alpha_1^D \cdot d + \alpha_{idio}^D \cdot IDIO + \alpha_{syst}^D \cdot SYST + \alpha_{skew}^D \cdot SKEW + \alpha_{inst}^D \cdot INST), \\
\beta_{ITD}(\theta) &= APP_d \cdot (\gamma_0^A + \gamma_1^A \cdot d + \gamma_{idio}^A \cdot IDIO + \gamma_{syst}^A \cdot SYST + \gamma_{skew}^A \cdot SKEW + \gamma_{inst}^A \cdot INST) \\
&\quad + DEP_d \cdot (\gamma_0^D + \gamma_1^D \cdot d + \gamma_{idio}^D \cdot IDIO + \gamma_{syst}^D \cdot SYST + \gamma_{skew}^D \cdot SKEW + \gamma_{inst}^D \cdot INST),
\end{aligned}$$

where $\theta \in \{d, IDIO, SYST, SKEW, INST, APP_d, DEP_d\}$. The dependent variable is the three-day abnormal selling activity by individual investors, *AVOL* (defined in section 3.2), around 35,222 quarterly earnings announcements from 1982 to 2002. $\Delta P_{t-n}$ is equal to the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ scaled by 248 and weighted by the ratio of the firm's daily volume on day $t-n$ to the total trading volume over the two years immediately preceding the earnings announcement. $ITD_d$ is equal to the product of $\Delta RATE$ and $\Delta P_d$, where $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. Duration, $d$, is the number of trading days from the quarterly earnings announcement date, $t$, that an investor, which purchased shares on day $t-n$, must hold the stock to meet the requisite ITD holding period of 250 trading days. *INTENSITY* is the the variance of daily changes in the logarithm of stock price estimated over the 100 trading days immediately preceding day $t-1$ expressed as a fractional rank within the sample (high fractional rank corresponds to high variance). *IDIO* (*SYST*) is the residual (predicted) variance, expressed as a fractional rank, from a regression of firm-specific excess returns on the excess market return and the excess 2-digit industry return estimated over the 100 trading days immediately preceding day $t-1$. *SKEW*, expressed as a fractional rank, is the negative coefficient of skewness of the firm-specific daily return distribution estimated over the 100 trading days immediately preceding day $t-1$. *INST*, expressed as a fractional rank, is the percentage of shares held by a 13-F filing institution at the end of the calendar quarter immediately preceding the earnings announcement date, $t$. $APP_d$ is an indicator variable equal to one if the change in stock price for an investor with duration, $d$, is positive (i.e. $\Delta P_d > 0$) and equal to zero otherwise. $DEP_d$ is an indicator variable equal to one if the change in stock price for an investor with duration, $d$, is not positive (i.e. $\Delta P_d \leq 0$) and equal to zero otherwise. Other *controls* (defined in section 3.2) include *AUE*, *NONLINEAR*, *SIZE*, and *NUM_EST*. Firm fixed-effects are included and coefficient $t$-statistics are based on standard errors clustered by the month of the earnings announcement.

## Figure 1

Sensitivity of Selling Activity by Individual Investors
Around Quarterly Earnings Announcements to
ITD Incentives as a Function of the *Duration* of Risk, $d$




This figure plots the $\beta_{ITD}(d)$ coefficient as a function of the *duration* of risk, $d$, and is estimated from the following regression:

$$AVOL = \sum_{d=1}^{248} \beta_{\Delta P}(d) \cdot \Delta P_d + \sum_{d=1}^{248} \beta_{ITD}(d) \cdot ITD_d + controls + \epsilon,$$

$$\text{subject to:} \qquad \beta_{\Delta P}(d) = \alpha_0 + \alpha_1 \cdot d,$$

$$\beta_{ITD}(d) = \gamma_0 + \gamma_1 \cdot d.$$

Let $t$ denote the quarterly earnings announcement date identified by Compustat. The dependent variable is the three-day abnormal selling activity by individual investors, *AVOL*, around quarterly earnings announcements from 1982 to 2002. Specifically, *AVOL* is the average of daily actual less daily expected selling activity by individual investors scaled by the standard deviation of selling activity, computed over days $t-1$ to $t+1$. Actual selling activity by individual investors is the natural logarithm of one plus the number of trades classified as sell orders by individual investors and the expectation and standard deviation of selling activity is the average and standard deviation, respectively, of the same selling metric over the 50 trading dates immediately preceding day $t-1$ (after excluding prior 3-day earnings announcement windows). $\Delta P_{t-n}$ is equal to the logarithm of the stock price on day $t-2$ (adjusted for stock splits and stock dividends) minus the logarithm of the stock price on day $t-n$ scaled by 248 and weighted by the ratio of the firm's daily volume on day $t-n$ to the total trading volume over the two years immediately preceding the earnings announcement. $ITD_d$ is equal to the product of $\Delta RATE$ and $\Delta P_d$, where $\Delta RATE$ is the maximum statutory short-term capital gains tax rate minus the maximum statutory long-term capital gains tax rate on day $t$. Duration, $d$, is the number of trading days from the quarterly earnings announcement date, $t$, that an investor, which purchased shares on day $t-n$, must hold the stock to meet the requisite ITD holding period of 250 trading days. Other *controls* (defined in section 3.2) include *AUE*, *NONLINEAR*, *SIZE*, and *NUM_EST*.