INTERTEMPORAL TAX DISCONTINUITIES

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ABSTRACT

This paper defines an intertemporal tax discontinuity (ITD) as a circumstance in which different tax rates are applied to gains and losses realized at one point in time versus some other point in time, and studies the effects of ITDs on market behaviors at the time of disclosures of firm performance. The results show that ITDs either depress or amplify trading volume at the time of disclosure, depending upon whether the disclosure is "good news" or "bad news," repectively, and lead to "overreactions" in price changes independent of the "news."

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1 Introduction

In this paper we define an intertemporal tax discontinuity (ITD) as a circumstance in which different tax rates are applied to gains and losses realized at one point in time versus some other point in time. Then we study the effects of ITDs on market behaviors at the time of disclosures of firm performance. The results of our paper show that ITDs either depress or amplify trading volume at the time of disclosure, depending upon whether the disclosure is "good news" or "bad news," respectively, and lead to "overreactions" in price changes independent of the "news". An interesting feature of the latter result is that it provides a tax explanation for seemingly anomalous market behavior (see, for example, the discussion in Kent, Hirshleifer, and Subrahmanyam [1998]).

A significant feature of this paper to the literature in finance and public economics is that there has been debate about whether perfect substitutability among financial assets precludes the possibility of taxes affecting equity prices (Constantinides [1983, 1984], Stiglitz [1983], Klein [1999], among others). Poterba [1987] presents empirical evidence that is inconsistent with perfect substitutability. Scholes and Wolfson [1992] show that in the absence of market frictions and government restrictions, taxpayers can fully avoid taxes; however, they contend that such conditions do not exist. Shackelford [1999] documents that the costs of sophisticated deferral strategies (e.g. shorting-against-the-box and equity swaps) are non-trivial and may overwhelm any benefits of tax deferral.

This paper takes no position concerning the ability of taxpayers to avoid taxes through financial asset substitutability. Instead our contribution to this debate is to suggest that it is a testable hypothesis whether taxes affect equity prices and

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trading volume. Specifically, in this paper we lay out clear results about how ITDs affect the behaviors of price changes and trading volume at the time of disclosures of firm performance (in the absence of perfect substitutability).[1] These results, in turn, suggest straightforward empirical hypotheses to address this issue.

The specific ITD that motivates our study is the differential rate that exists between "long-term" capital gains tax rates and "short-term" capital gains tax rates for individual investors. Long-term capital gains tax rates historically have been less than short-term capital gains tax rates. Under current US tax law, for example, equity held for more than one year is characterized as long-term and taxed at no greater than a 20% statutory tax rate. Short-term capital gains, however, face a 39.6% statutory federal tax rate. Unlike 1970 to 1986, when long-term capital losses provided one-half the deduction of short-term capital losses, long-term and short-term capital losses currently provide the same tax deduction.[2] Complex rules for netting capital gains and losses, however, can effectively create a preference for short-term capital losses. Specifically, initially short-term capital losses are netted against short-term capital gains, and long-term capital losses are netted against long-term capital gains. If net short-term realizations and net long-term realizations are both positive (i.e., gains), then no further nettings are required. In such a case, the short-term capital loss provides a 39.6% tax benefit because it reduces ordinary income, while the long-term capital loss provides only a 20% tax benefit because it reduces favorably taxed long-term capital gains. Thus, although long-term and short-term capital losses currently face similar deductibility, the netting rule can produce differential tax

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[1] Although this paper focuses specifically on price and volume responses to public disclosures about firm performance, its implications apply more generally. For example, Cutler [1988], Lang and Shackelford [1999] and Klein and Macadam [1999], among others, document equity price responses to public disclosures about tax legislation.
[2] Individual investors are currently limited to an annual deduction of $3000 for capital losses in excess of capital gains. Corporations cannot deduct any capital losses in excess of capital gains.

benefits.

Our definition of an ITD is designed to embrace situations other than those that arise from a differential between long and short-term capital gains. For example, an ITD can arise when profits realized early are taxed at a higher rate than profits deferred until some future period, because the future period represents: a time at which the deferred profits are realized and offset against other losses; a time at which deferred profits are passed to the next generation or another organizational form at some reduced tax rate (e.g., step-up in tax basis at death); or a time at which an anticipated rate reduction in the existing tax structure finally occurs. All of these alternative interpretations are compatible with the results of our analysis.

The tax literature has long recognized the potential significance of taxes on asset pricing, but in this context has ignored the role of disclosures of firm performance (e.g., Constantinides [1983,1984], Guenther and Willenborg [1999], Klein [1999], and Ritter [1988]). Alternatively, the disclosure literature has analyzed extensively the effects of disclosures on returns and trading volume, but has ignored taxes (e.g., Kim and Verrecchia [1991a,1991b]). Consequently, an ancillary goal of this paper is to integrate these two literatures.

We do this by introducing an economic analysis of trade in a risky asset over three periods. In period 1 investors hold shares of a risky asset and a risk and tax-free asset in anticipation of a public disclosure about its value in period 2. In period 2 the disclosure occurs and investors trade asset shares to rebalance their portfolio of investments. In period 3 all assets liquidate and all investors consume their asset holdings. For tax purposes, we assume that insufficient time elapses between periods 1 and 2 to allow investors to avail themselves of long-term capital gains treatment. Consequently, profits and losses realized in period 2 are assessed at the short-term

capital gains rate. Alternatively, we assume that sufficient time elapses between periods 2 and 3 to allow investors to avail themselves of long-term capital gains. Consequently, profits and losses realized in period 3 are assessed at the long-term capital gains rate.

The intuition underlying our analysis can be described briefly as follows. Let a circumstance in which there is a positive price change at the time of disclosure be defined as one in which the disclosure in period 2 is "good news," and a circumstance in which there is a negative price change as one in which the disclosure in period 2 is "bad news". Risk-averse investors who are long or overweighted in a risky asset at the time of a "good news" disclosure (i.e., period 2) are inclined to unwind their long positions by selling shares of the asset. Selling ensures a certain profit by eliminating the risk of maintaining an overweighted position in an asset whose future value is uncertain. But the extent to which investors sell off an overweighted position, or whether they even sell at all, is unclear if the sale triggers an income tax. Tax scholars (Balcer and Judd [1987], Klein [1999], Landsman and Shackelford [1995], Scholes and Wolfson [1992], among others) have long recognized that a tax at realization provides incentives for investors to defer the disposition of appreciated property.[3] The greater the appreciation, the greater the realization tax, and the greater the incentive to defer selling. Consequently, at the time of the disclosure, investors must choose between the reduced risk associated with unwinding an overweighted position and the reduced taxes from postponing the sale. This coordination of risk and tax considerations suggests that investors will unwind some, but not all, of their long position at the time of the disclosure. In addition, the amount sold should decrease as the difference between the long-term and short-term capital tax rates increases and/or as investors'

[3] This is commonly referred to in the tax literature as the "lock-in" effect.

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tolerance for risk increases.

In the absence of perfect substitutability of financial assets, these risk-tax trade-offs should affect both share price and trading volume at the time of the disclosure. For example, if taxes preclude risk-averse investors from fully unwinding their long positions, the supply of equity will be artificially restricted. To compensate for the tax-motivated restriction in supply, the share price will be bid up. Consequently, price changes at the time of disclosure will appear to "overreact" to "good news" when in fact the overreaction is a temporary seller's strike arising from the realization tax. Another feature of the seller's strike is a reduction in the equity's trading volume.

Similarly, suppose short-term capital losses provide greater deductions than long-term capital losses (as they did from 1970-1986). Then investors who are overweighted in a risky asset at the time of a "bad news" disclosure may sell more of the risky asset than can be justified by simply unwinding their overweighted positions, as a device to expand the benefit of short-term capital losses. This, in turn, expands the supply of the asset and share price will be bid down. In this circumstance price declines at the time of a "bad news" disclosure also will appear to "overreact," that is, fall further than can be justified in a tax-free environment.[4] Another feature of the expanded benefit will be an increase in the equity's trading volume.

The paper unfolds as follows. In section 2 we introduce a model of trade, and discuss the assumptions that underlie it. In section 3 we describe the equilibrium that results in the disclosure period (i.e., period 2). Sections 4 and 5 study the effects of ITDs on trading volume and price changes, respectively. In a final section we discuss prior empirical work whose results relate to our study, and lay out empirical applications of our analysis.

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[4] Under current U.S. tax law, where the deductibility of capital losses does not vary with the holding period, such tax-motivated "overreactions" to public announcements are not expected.

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2 Assumptions Underlying Our Model of Trade

In this section we introduce a model of trade in which two types of investors exchange a risky asset and a risk and tax-free asset (as a numeraire commodity) over three periods. In period 1 investors of both types hold shares of the risky and risk and tax-free asset in anticipation of a public disclosure about the value of risky asset in period 2. In period 2 the disclosure occurs and investors trade asset shares to rebalance their portfolio of investments. In period 3 all assets liquidate and all investors consume their portfolio holdings. For tax purposes, we assume that periods 1 and 2 are sufficiently close in time that any profit or loss associated with investors divesting part or all of their period 1 risky asset investment in period 2 is taxed at the ordinary tax rate of t. Alternatively, we assume that period 3 is sufficiently distant in time that divesting any of their risky asset investment at that time is subject only to a long-term capital gains tax rate that is lower than the ordinary tax rate. To capture the tension arising from an ordinary tax rate on income that is higher than the long-term capital gains tax rate, it is sufficient in our analysis to assume that the ordinary income tax rate is positive (i.e., $t > 0$) and the capital gains tax rate is 0. Consequently, for convenience we employ this convention. Henceforth we refer to the tax differential between the ordinary income tax rate and the capital gains rate as the ITD. Note that the ITD, and the possibility of taxes affecting equity prices in any way, both disappear when either $t = 0$ or the tax rates in both periods are t.

The risk and tax-free investment pays out a return of 1 for each unit of investment (and has no tax implications). Alternatively, when the risky asset liquidates in period 3, it pays out an uncertain liquidating dividend to shareholders that is taxable at the capital gains rate (which is 0). Let $\tilde{u}$ represent the (uncertain) liquidating value of

the risky asset, where the unconditional distribution of $\tilde{u}$ is that it has a normal distribution with mean $E[\tilde{u}]$ and precision (i.e., the reciprocal of variance) of v. In period 3 a value of $\tilde{u}$, $\tilde{u} = u$, is realized. Let $\tilde{y}$ represent the public disclosure in period 2, where $\tilde{y} = \tilde{u} + \tilde{\varepsilon}$, and $\tilde{\varepsilon}$, which is independent of $\tilde{u}$, has a normal distribution with mean 0 and precision n. This characterization of $\tilde{y}$ suggests that in period 2 the public disclosure communicates the true liquidating value of the asset with noise. To ensure that the analysis is as facile as possible, we assume that the disclosure in period 2 has the feature that it subsumes any information investors of either type had about the asset prior to the disclosure. Stated equivalently, we assume that $\tilde{y}$ is a sufficient statistic for any information, either public or private, investors had prior to the disclosure.[5] This implies that in period 2, after the disclosure, the conditional expectation of all investors (regardless of type) about $\tilde{u}$ is that $\tilde{u}$ has a normal distribution with mean $E[\tilde{u}|\tilde{y} = y] = \frac{n}{v+n}y$ and precision $(VAR[\tilde{u}|\tilde{y} = y])^{-1} = v + n$.

We label the two investor types "A" and "B," and assume that investors of each type are identical to all other investors of that type, and types themselves are distinguished only by the amount of the risky asset a type holds in period 1. For example, each investor (regardless of type) is assumed to be risk-averse with a utility for income of w given by $U(w)$, where $U(w)$ is the negative exponential utility function with positive risk tolerance parameter of $r > 0$:

$$U(w) = -\exp[-\frac{w}{r}].$$

Risk aversion on the part of investors is critical assumption in our analysis. Note, however, that investors can be very, very tolerant of risk (i.e., r can be very large),

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[5] Sufficiency is clearly a strong assumption, but it facilitates considerably the analysis and can be defended on the grounds that it captures the intuition of the more general case in which disclosure only partially reduces differences in expectations.

provided no one is explicitly risk neutral.

Let P_1 represent the price of the risky asset in period 1 and let D_1^A and D_1^B represent the amounts of the risky asset held by investor-types A and B, respectively, in that period. Similarly, let P_2 represent the price of the risky asset in period 2, and D_2^A and D_2^B the amounts of the risky asset held by types A and B, respectively, in that period. The relative proportions of type-A investors to type-B investors in the economy are λ and $1 - \lambda$, respectively, where $0 < \lambda < 1$. We assume that the proportion of investors of each type remains fixed over the first two periods that we model. Let x represent the per-capita supply of the risky asset. Note that we do not require that x be of any particular sign, although conventionally the supply of a risky asset is positive. We assume that per-capita supply also does not change over the first two periods.[6] Finally, note that in both periods 1 and 2 investors' per-capita demand for the risky asset must equal the per-capita supply: $\lambda D_1^A + (1 - \lambda) D_1^B = \lambda D_2^A + (1 - \lambda) D_2^B = x$. One straightforward implication of this relation is that if $D_1^A > D_2^A$ then $D_1^B < D_2^B$, and vice versa. Intuitively, this means that if one investor-type divests some of its period 1 holdings of the risky asset in period 2 (e.g., $D_1^A > D_2^A$), then the other investor-type must be simultaneously accumulating, or adding to, its holdings of the risky asset in period 2 (e.g., $D_1^B < D_2^B$).

For convenience, we refer to an investor type as being overweighted in the risky asset if the type holds more than the per-capita supply of the risky asset in period 1, and underweighted if the type holds less. For example, type-A investors are over-weighted if $D_1^A > x$, and underweighted if $D_1^A < x$. Note that if one investor-type is

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[6] As discussed above, we assume that periods 1 and 2 are sufficiently close in time so as to require short-term capital gains treatment. Hence, the further assumption that that the supply of the risky asset does not change during this window should not be controversial. If the supply were to change (for example, through secondary offerings), this could vitiate our results.

overweighted, then the other type must be underweighted.[7]

The focus of the subsequent analysis is to determine endogenously values for P_2, D_2^A and D_2^B. Alternatively, all of P_1, D_1^A and D_1^B are treated as exogenous. The reason for the latter is twofold. First, determining P_1, D_1^A and D_1^B endogenously makes the analysis very complex without enhancing further the paper's contribution, which is to understand the behavior of price and volume in period 2, at the time of a disclosure. Second, and perhaps more salient, there is no need to determine endogenously values for P_1, D_1^A and D_1^B because the results of our analysis do not depend on these values. Specifically, as discussed in more detail below, the equilibria we describe depends exclusively on whether A-type investors are overweighted in the risky asset in period 1 (which implies that B-type investors are underweighted), or A-type investors are underweighted in the risky asset in period 1 (which implies that B-type investors are overweighted). The actual values of D_1^A and D_1^B, however, play no role.

This does raise the question, however, of whether one would expect A-type investors to hold amounts of the risky asset in period 1 that are different from amount held by B-type investors in real institutional settings. As a practical matter, we would expect *some* investors to take different positions in the risky asset in period 1 based on different expectations about the disclosure in period 2. These different expectations could result from: different prior beliefs, different private information, and/or, perhaps, different heuristic behaviors involving the use of information. In addition, D_1^A and D_1^B could be different simply because different investor types are endowed with different levels of the risky asset in period 1. Consequently, we assume

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[7] In addition, note that underweighted does not imply necessarily a short-sale: when x is positive, an investor-type can be underweighted relative to per-capita supply and still hold a positive amount. To facilitate the discussion, in this paper we ignore tax issues that arise from investors executing short-sales.

$D_1^A \neq D_1^B$.[8]

Finally, we assume that any investor's *reduction* in her risky asset position from period 1 to period 2 implies either a profit or loss at the ordinary income tax rate of t. For example, if $D_1^A > D_2^A$, then type-A investors reduce their holdings in the risky asset by an amount $D_1^A - D_2^A > 0$, and register either a profit or a loss on that transaction of $(P_2 - P_1)(D_1^A - D_2^A)(1 - t)$. Alternatively, we assume that any investor's *increase* in her risky asset position from period 1 to period 2 implies no taxable profit or loss at the ordinary income tax rate of t. For example, if $D_1^A \leq D_2^A$, then there are no tax implications to the behavior of type-A investors in period 2.

In effect, we treat profits realized in period 2 as tax disadvantaged because insufficient time elapses between periods 1 and 2 to allow investors to avail themselves of the favorable long-term capital gains tax rate. Conversely, we treat losses realized in period 2 as *tax advantaged* because presumably this amount can be applied against any other income currently being taxed at the ordinary income tax rate (e.g., salary, taxable benefits, income from other investments). Note, however, that we do not model these incomes, but instead treat them as exogenous.

Under current US tax law, capital losses realized in periods 2 and 3 face identical tax treatment (except for certain cases involving the netting of capital gains and losses). Despite the current irrelevance of ITDs for capital losses, the analysis of losses in this paper appropriately characterizes many other settings, including the reduced benefits from future deductions when tax rates are declining. More generally, because tax accounts are maintained using nominal dollars, the tax benefit of a loss position is maximized by accelerating recognition, during periods of declining or stable tax rates.

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[8] There is no harm in also allowing for the case of $D_1^A = D_1^B = x$, except for the fact that it results in no trade at the time of the disclosure. No trade occurs when $D_1^A = D_1^B = x$ because investors of either type would then be identical in all regards and have homogeneous expectations conditional on a disclosure in period 2, which implies $D_2^A = D_2^B = x$.

Loss acceleration and rapid tax basis recovery motivate accelerated depreciation and are a fundamental component of many tax shelters.

In any event, adapting our model to be consistent with capital losses in periods 2 and 3 facing identical tax treatments is a straightforward exercise. Therefore, we present the more general analysis in which profits (losses) realized in period 2 are tax disadvantaged (advantaged) at the ordinary income tax rate of t, and alert the reader to the implications of proscribing tax advantaged losses when we discuss the results of our analysis.

3 Equilibria in Our Model of Trade

In this section we characterize the equilibria that result from our model of trade. To briefly sketch the results of this section, first we introduce and discuss the two potential equilibria in period 2 that result from investors' actions. Then we establish that despite two candidates, there is in fact a unique equilibrium, and it has the following feature. An investor among the type that is overweighted in the risky asset in period 1 always reduces her risky asset position in period 2. Similarly, an investor among the type that is underweighted in the risky asset in period 1 always increases her risky asset position in period 2. This implies that an investor who is overweighted in period 1 either has her profits taxed at a rate t, or her losses shielded by a rate t, depending upon whether the disclosure in period 2 is "good news" or "bad news". Consequently, tax effects on prices and trading volume in our model arise exclusively through the behavior of investors who are overweighted in the risky asset in period 1.

To start, we consider the behavior of type-A investors. When the disclosure occurs in period 2, type-A investors face one of two optimization problems. If $D_1^A - D_2^A >$

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0, then type-A investors divest themselves of part of the risky asset position they established in period 1. Consequently, here a type-A investor solves:

$$E[-\exp[-\frac{1}{r}\{(\tilde{u} - P_1)D_2^A + (P_2 - P_1)(D_1^A - D_2^A)(1 - t)\}|\tilde{y} = y].$$

For example, in this characterization, a type-A investor's risky asset position in period 1 is D_1^A. A type-A investor pays capital gains tax on that part of D_1^A that she *retains* through to period 3, which is D_2^A. Note, however, that in our characterization the capital gains tax is zero, and hence her profit (or loss) for this part is $(\tilde{u} - P_1)D_2^A$. She pays ordinary income tax of t on that part of D_1^A that she *sells* in period 2, which is $D_1^A - D_2^A$. Here, her profit (or loss) on this part net of the ordinary income tax is $(P_2 - P_1)(D_1^A - D_2^A)(1 - t)$.

If, alternatively, $D_1^A - D_2^A \leq 0$, then here a type-A investor (weakly) *increases* her holdings of the risky asset in period 2. Hence, here she pays capital gains tax (which is 0) on her profit (or loss) in period 3 of $\tilde{u}D_2^A - P_2\left(D_2^A - D_1^A\right) - P_1 D_1^A$, which, one can show, equals $(\tilde{u} - P_1)D_2^A + (P_2 - P_1)(D_1^A - D_2^A)$. Consequently, here she solves:

$$E[-\exp[-\frac{1}{r}\{(\tilde{u} - P_1)D_2^A + (P_2 - P_1)(D_1^A - D_2^A)\}|\tilde{y} = y].$$

Well known properties of the moment generating function for the normally distributed uncertain liquidating value of the risky asset (i.e., $\tilde{u}$) imply that a type-A investor's optimization problem with regard to choosing D_2^A can be summarized as follows (ignoring irrelevant proportionality factors). Type-A investors choose D_2^A to maximize $f(D_2^A)$, where $f(D_2^A)$ is defined by:

$$f\left(D_2^A\right) = -\exp[-\frac{1}{r}(E[\tilde{u}|\tilde{y} = y] - P_1)D_2^A + \frac{1}{2r^2}VAR[\tilde{u}|\tilde{y} = y](D_2^A)^2 - \frac{1}{r}(P_2 - P_1)(D_1^A - D_2^A)(1 - t)]$$

when $D_2^A < D_1^A$, and

$$f\left(D_2^A\right) = -\exp[-\frac{1}{r}(E[\tilde{u}|\tilde{y} = y] - P_1)D_2^A + \frac{1}{2r^2}VAR[\tilde{u}|\tilde{y} = y](D_2^A)^2 - \frac{1}{r}(P_2 - P_1)(D_1^A - D_2^A)]$$

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when $D_2^A \geq D_1^A$. Note that $f(\cdot)$ is continuous and has, potentially, two local optima (i.e., points at which the first derivative of $f(\cdot)$ equals 0). One local optimum occurs at

$$D_2^A = r \cdot \frac{E[\tilde{u}|\tilde{y} = y] - (1 - t) P_2 - t P_1}{Var[\tilde{u}|\tilde{y} = y]};$$

the other occurs at

$$D_2^A = r \cdot \frac{E[\tilde{u}|\tilde{y} = y] - P_2}{Var[\tilde{u}|\tilde{y} = y]}.$$

Furthermore, both these optima are local maxima because at these points the second derivative of $f(\cdot)$ is negative. The existence of two local maxima implies the existence of two potential equilibria. These equilibria can be characterized as follows.

1) An equilibrium in which type-A investors in period 2 divest themselves of some of their holdings of the risky asset acquired in period 1 (i.e., $D_2^A < D_1^A$), which, in turn, implies that type-B investors accumulate more of the risky asset (i.e., $D_2^B \geq D_1^B$) because the total supply of the risky asset is fixed at x; and

2) An equilibrium in which type-A investors in period 2 accumulate more of their holdings of the risky asset from period 1 (i.e., $D_2^A \geq D_1^A$), which, in turn, implies that type-B investors divest themselves of some of their holdings of the risky asset (i.e., $D_2^B < D_1^B$).

Our next step is to analyze these two equilibria. When that task is completed, we establish that there exists a unique equilibrium that is characterized as follows. That investor-type that is overweighted in the risky asset always sells in period 2, and that investor-type that is underweighted in the risky asset always accumulates in period 2.

To analyze the two equilibria, first note that type-B investors have two local maxima that are equivalent to those of type-A investors:

$$D_2^B = r \cdot \frac{E[\tilde{u}|\tilde{y}=y] - (1-t)P_2 - tP_1}{Var[\tilde{u}|\tilde{y}=y]},$$

and

$$D_2^B = r \cdot \frac{E[\tilde{u}|\tilde{y}=y] - P_2}{Var[\tilde{u}|\tilde{y}=y]}.$$

Furthermore, recall that if $D_2^A < D_1^A$ then $D_2^B > D_1^B$, and vice versa. Consequently, the requirement that $\lambda D_2^A + (1-\lambda)D_2^B = x$ implies that the price of the risky asset in period 2 can be characterized as either:

$$P_2 = \frac{E[\tilde{u}|y] - \lambda t P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{\lambda(1-t) + (1-\lambda)} \tag{1}$$

if $D_2^A < D_1^A$ (and hence $D_2^B > D_1^B$); or

$$P_2 = \frac{E[\tilde{u}|y] - (1-\lambda)t P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{\lambda + (1-\lambda)(1-t)} \tag{2}$$

if $D_2^A > D_1^A$ (and hence $D_2^B < D_1^B$).

Note that eqns. (1) and (2), in turn, imply the following refinements for the demand of the risky asset in period 2 on the part of type-A and type-B investors. If $D_2^A < D_1^A$ (and hence $D_2^B > D_1^B$), then

$$D_2^A = r \cdot \frac{t(1-\lambda)}{\lambda(1-t) + (1-\lambda)}\left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]}\right) + \frac{1-t}{\lambda(1-t) + (1-\lambda)}x \tag{3}$$

and

$$D_2^B = r \cdot \frac{-t\lambda}{\lambda(1-t) + (1-\lambda)}\left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]}\right) + \frac{1}{\lambda(1-t) + (1-\lambda)}x;$$

while if $D_2^A > D_1^A$ (and hence $D_2^B < D_1^B$), then

$$D_2^A = r \cdot \frac{-t(1-\lambda)}{\lambda + (1-\lambda)(1-t)}\left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]}\right) + \frac{1}{\lambda + (1-\lambda)(1-t)}x$$

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and

$$D_2^B = r \cdot \frac{t\lambda}{\lambda + (1 - \lambda)(1 - t)} \left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]} \right) + \frac{1 - t}{\lambda + (1 - \lambda)(1 - t)} x.$$

The discussion so far has alluded to the possibility of two equilibria: one in which type-A investors divest (and type-B accumulate), and one in which type-A investors accumulate (and type-B investors divest). Nonetheless, the first result of the paper demonstrates that the period 2 equilibrium is actually unique. (The proof to this result is in the appendix.)

Proposition 1. The period 2 equilibrium is unique and can be characterized as follows. The investor-type that is overweighted in the risky asset in period 1 always divests in period 2, and the investor-type that is underweighted in the risky asset in period 1 always accumulates in period 2. For example, if $D_1^A > x$, which implies $D_1^B < x$, then the equilibrium in period 2 is characterized by:

$$D_2^A = r \cdot \frac{t(1 - \lambda)}{\lambda(1 - t) + (1 - \lambda)} \left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]} \right) + \frac{1 - t}{\lambda(1 - t) + (1 - \lambda)} x;$$

$$D_2^B = r \cdot \frac{-t\lambda}{\lambda(1 - t) + (1 - \lambda)} \left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]} \right) + \frac{1}{\lambda(1 - t) + (1 - \lambda)} x;$$

$$P_2 = \frac{E[\tilde{u}|y] - \lambda t P_1 - \frac{1}{r} Var[\tilde{u}|y] x}{\lambda(1 - t) + (1 - \lambda)}.$$

Alternatively, if $D_1^A < x$, which implies $D_1^B > x$, then the equilibrium in period 2 is characterized by:

$$D_2^A = r \cdot \frac{-t(1 - \lambda)}{\lambda + (1 - \lambda)(1 - t)} \left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]} \right) + \frac{1}{\lambda + (1 - \lambda)(1 - t)} x;$$

$$D_2^B = r \cdot \frac{t\lambda}{\lambda + (1 - \lambda)(1 - t)} \left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]} \right) + \frac{1 - t}{\lambda + (1 - \lambda)(1 - t)} x;$$

$$P_2 = \frac{E[\tilde{u}|y] - (1 - \lambda) t P_1 - \frac{1}{r} Var[\tilde{u}|y] x}{\lambda + (1 - \lambda)(1 - t)}.$$

To understand better proposition 1, it is useful to compare its results to those in the absence of an ITD (e.g., $t = 0$). Henceforth we use the expression "fully unwind"

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to describe a situation in which an investor among the type that is overweighted in the risky asset in period 1 reduces her position down to the per-capita supply in period 2, and an investor among the type that is underweighted accumulates up to the per-capita supply: that is, $D_2^A = D_2^B = x$. In the absence of an ITD, investors always fully unwind their positions in period 2. The rationale for this result is that disclosure results in identical expectations for both investor-types (and both types are identical in utility preferences). Consequently, optimal risk sharing dictates that both investor types end up holding the per-capita supply of the asset in period 2 (absent an ITD). Period 2 equilibria may not yield $D_2^A = D_2^B = x$ in the presence of an ITD, however, because the incentive to share risk optimally through trade may either militate against, or be reinforced by, tax incentives.

To understand this issue, it is useful to distinguish between two cases: "good news" and "bad news". For example, let a circumstance in which $P_2 - P_1 > 0$ be defined as one in which the disclosure in period 2 is "good news," and a circumstance in which $P_2 - P_1 < 0$ as one in which the disclosure in period 2 is "bad news". The reason for distinguishing between "good" and "bad news" is that in the case of the latter investors' risk and tax incentives are aligned, whereas in the case of the former they are not. For example, suppose that type-A investors are overweighted in the risky asset in period 1 and type-B investors are underweighted, and the disclosure in period 2 is "good news". There are always two potential equilibria. Type-A investors could divest themselves of shares of the risky asset in period 2 and type-B investors could accumulate. This is one potential equilibrium. With taxes, however, type-A investors net only $1 - t$ of any profits realized in period 2. Consequently, as an alternative to absorbing the deadweight tax loss of t on their realized profits, type-A investors could instead (weakly) accumulate more shares in period 2 (i.e., accumulate

more shares or "stand pat"), and type-B investors could (weakly) divest. This is the second potential equilibrium. The problem with this equilibrium, however, is that divesting has negative tax consequences for type-B investors *and* exacerbates risk-sharing for both investor types. Consequently, investors gravitate toward the equilibrium in which type-A investors divest and type-B investors accumulate.

Now consider the "bad news" case. Here, as well, type-A investors could divest and type-B investors could accumulate. Alternatively, type-A investors could accumulate more shares in period 2 and type-B investors could divest. In the presence of an ITD and "bad news," however, type-A investors' losses in period 2 are shielded by a factor of t. Consequently, the advantage to type-A investors of divesting and type-B investors of accumulating is that it has positive tax consequences for type-A investors *and* yields risk-sharing benefits to both investor types. Consequently, this becomes the equilibrium.

It is useful for the subsequent analysis to expand on this intuition more formally. For example, eqn. (1) implies that "good news" yields in the following inequality:

$$
\begin{aligned}
P_2 - P_1 &= \frac{E[\tilde{u}|y] - \lambda t P_1 - \frac{1}{r} Var[\tilde{u}|y] x}{\lambda(1-t) + (1-\lambda)} - P_1 \\
&= \frac{E[\tilde{u}|y] - P_1 - \frac{1}{r} Var[\tilde{u}|y] x}{\lambda(1-t) + (1-\lambda)} > 0.
\end{aligned}
$$

This, in turn, implies that

$$
\begin{aligned}
D_2^A - x &= r \cdot \frac{t(1-\lambda)}{\lambda(1-t) + (1-\lambda)} \left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]} \right) + \frac{1-t}{\lambda(1-t) + (1-\lambda)} x - x \\
&= r \cdot \frac{t(1-\lambda)}{\lambda(1-t) + (1-\lambda)} \left(\frac{E[\tilde{u}|y] - P_1 - \frac{1}{r} Var[\tilde{u}|y] x}{Var[\tilde{u}|y]} \right) > 0. \quad (4)
\end{aligned}
$$

In words, eqn. (4) implies that in the presence of an ITD, type-A investors do not fully unwind their overweighted positions in period 2 to hold the per-capita supply (i.e., $D_2^A - x > 0$). Instead, type-A investors hold back from the market some of

their overweighted position established in period 1 because their realized profits are net of a tax of t, whereas they face no tax for divesting in period 3. Note, also, that the amount that they hold back increases as either t, the size of the ITD, or r, investors' risk tolerance, increases. In effect, type-A investors do not fully unwind their positions because realized profits are tax disadvantaged.

To digress briefly, the amount $D_2^A - x$ can be interpreted as the tax deferred portion of a type-A investor's holdings of the risky asset after trade in period 2. In should be clear from eqn. (4) that this deferral is zero if $t = 0$. The deferral is also zero, however, if there is a tax on realized profits in period 3, and the period 3 tax equals the period 2 tax of t. The reason for this is that if the tax is the same in both periods, there is no reason to defer the realization of profits. This result may seem at odds with Klein [1999], who suggests a model of intertemporal asset pricing in which deferrals are positive despite the existence of a *single* tax rate. In Klein [1999], however, deferrals are introduced exogenously. By demonstrating that positive deferrals arise endogenously through ITDs, our results strengthen Klein's claims about the role of deferrals on asset pricing.

In the presence of "bad news," the following inequalities result:

$$
\begin{aligned}
P_2 - P_1 &= \frac{E[\tilde{u}|y] - \lambda t P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{\lambda(1 - t) + (1 - \lambda)} - P_1 \\
&= \frac{E[\tilde{u}|y] - P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{\lambda(1 - t) + (1 - \lambda)} < 0,
\end{aligned}
$$

and

$$
\begin{aligned}
D_2^A - x &= r \cdot \frac{t(1 - \lambda)}{\lambda(1 - t) + (1 - \lambda)}\left(\frac{E[\tilde{u}|y] - P_1}{Var[\tilde{u}|y]}\right) + \frac{1 - t}{\lambda(1 - t) + (1 - \lambda)}x - x \\
&= r \cdot \frac{t(1 - \lambda)}{\lambda(1 - t) + (1 - \lambda)}\left(\frac{E[\tilde{u}|y] - P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{Var[\tilde{u}|y]}\right) < 0. \quad (5)
\end{aligned}
$$

Eqn. (5) implies that in the presence of "bad news" and an ITD, type-A investors

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more than fully unwind their overweighted positions in period 2 to hold *less than* the per-capita supply (i.e., $D_2^A - x < 0$). The rationale for this is that their losses from selling a overweighted position in the face of "bad news" are *ameliorated,* or reduced, by the ordinary income tax rate of t, whereas there is no tax shield associated with divesting in period 3. Once again, note that the expansion of their selling increases as either t, the size of the ITD, or r, investors' risk tolerance, increases. In effect, type-A investors more than fully unwind their positions because realized losses are tax advantaged.

In short, an ITD yields the following characterization of an equilibrium at the time of disclosure. An investor among the type that is overweighted in the risky asset sells *less* aggressively in the presence of a "good news" disclosure vis à vis the no-ITD case, while she sells *more* aggressively in the presence of a "bad news" disclosure.

4 Trading Volume in the Presence of ITDs

Now we extend the intuition so far developed to address how ITDs affect trading volume. Note that per-capita trading volume in period 2 is characterized in our model by the expression:

$$\frac{1}{2}\lambda|D_2^A - D_1^A| + \frac{1}{2}(1 - \lambda)|D_2^B - D_1^B|.$$

Recall that in the absence of an ITD, both investor-types would hold the per-capita supply of the risky asset in period 2: $D_2^A = D_2^B = x$. This implies that in the absence of an ITD, per-capita trading volume is:

$$\frac{1}{2}\lambda|x - D_1^A| + \frac{1}{2}(1 - \lambda)|x - D_1^B|.$$

As discussed above, however, if type-A investors are overweighted in the risky asset and type-B investors underweighted, a "good news" disclosure results in $D_1^A > D_2^A >$

x and $D_1^B < D_2^B < x$ (as opposed to $D_1^A > D_2^A = x$ and $D_1^B < D_2^B = x$ in the absence of an ITD). But this, in turn, implies that

$$
\begin{aligned}
\frac{1}{2}\lambda|D_2^A - D_1^A| + \frac{1}{2}(1 - \lambda)|D_2^B - D_1^B| &= \frac{1}{2}\lambda(D_1^A - D_2^A) + \frac{1}{2}(1 - \lambda)(D_2^B - D_1^B) \\
&< \frac{1}{2}\lambda(D_1^A - x) + \frac{1}{2}(1 - \lambda)(x - D_1^B) \\
&= \frac{1}{2}\lambda|x - D_1^A| + \frac{1}{2}(1 - \lambda)|x - D_1^B|.
\end{aligned}
$$

In other words, a "good news" disclosure results in less trading volume in the presence of an ITD because an investor who is overweighted in the risky asset does not fully unwind her position. Similarly, if type-A investors are overweighted in the risky asset and type-B investors underweighted, a "bad news" disclosure results in $D_1^A > x > D_2^A$ and $D_1^B < x < D_2^B$. But this implies that

$$
\begin{aligned}
\frac{1}{2}\lambda|D_2^A - D_1^A| + \frac{1}{2}(1 - \lambda)|D_2^B - D_1^B| &= \frac{1}{2}\lambda(D_1^A - D_2^A) + \frac{1}{2}(1 - \lambda)(D_2^B - D_1^B) \\
&> \frac{1}{2}\lambda(D_1^A - x) + \frac{1}{2}(1 - \lambda)(x - D_1^B) \\
&= \frac{1}{2}\lambda|x - D_1^A| + \frac{1}{2}(1 - \lambda)|x - D_1^B|.
\end{aligned}
$$

In other words, a "bad news" disclosure results in more trading volume in the presence of an ITD because an investor who is overweighted in the risky asset more than fully unwinds her position. These results are summarized in the following proposition.

Proposition 2. Trading volume is lower in the disclosure period (i.e., period 2) when the disclosure is "good news," and higher when the disclosure is "bad news," relative to a an economy with no ITD.

One addendum to proposition 2 is that if losses in period 2 are not tax advantaged, taxes will not affect trading volume in the presence of "bad news".

It should be clear from our discussion in the previous section that the extent to which disclosure either depresses or amplifies trading volume increases as either t, the size of the ITD, or r, investors' risk tolerance, increases. Consequently, we state these as corollaries to proposition 2, the proofs to which are left to the interested reader.

Corollary 1. The extent to which disclosure either depresses or amplifies trading volume increases as the size of the ITD increases (i.e., as t increases).

Corollary 2. The extent to which disclosure either depresses or amplifies trading volume increases as investors' risk tolerance increases (i.e., as r increases).

In the next section we extend the discussion to consider the change in price in period 2.

5 Price Changes in the Presence of ITDs

With regard to the price of the risky asset in period 2, note that in the absence of an ITD (i.e., $t = 0$), the price is

$$P_2 = E[\tilde{u}|y] - \frac{1}{r}Var[\tilde{u}|y]x.$$

The usefulness of this benchmark is that it suggests that in the absence of an ITD, price in period 2 is simply investors' expectations of the (uncertain) value of the asset conditional on their knowledge at that time (i.e., the public disclosure y), adjusted for the total supply of the risky asset, x, times their risk tolerance (i.e., r) and their uncertainty associated with their conditional valuation of the asset (i.e., $Var[\tilde{u}|y]$). Note that this is a very standard formulation of price in a competitive, rational expectations model of trade when investors have homogeneous expectations. For example, as investors' tolerance for risk becomes unbounded (i.e., $r \to \infty$), the price

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of asset in period 2 becomes simply $E[\tilde{u}|y]$: that is, investors' expectations of the asset's value conditional on the disclosure. Note that this benchmark also implies that in the absence of tax effects, the change in price in period 2 is

$$P_2 - P_1 = E[\tilde{u}|y] - \frac{1}{r}Var[\tilde{u}|y]x - P_1.$$

Now consider price change in period 2 in the presence of an ITD. If we exclude from consideration the uninteresting case of no trade in period 2 (which results from both investor types holding the per-capita supply of the risky asset in period 1), then there are only two possible characterizations of the change in price in period 2. If $D_1^A > x$, then

$$
\begin{aligned}
P_2 - P_1 &= \frac{E[\tilde{u}|y] - \lambda t P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{\lambda(1-t) + (1-\lambda)} - P_1 \\
&= \frac{E[\tilde{u}|y] - \frac{1}{r}Var[\tilde{u}|y]x - P_1}{\lambda(1-t) + (1-\lambda)} \\
&= \frac{1}{\lambda(1-t) + (1-\lambda)}\left(E[\tilde{u}|y] - \frac{1}{r}Var[\tilde{u}|y]x - P_1\right).
\end{aligned}
$$

Alternatively, if $D_1^A < x$, then

$$P_2 - P_1 = \frac{1}{\lambda + (1-\lambda)(1-t)}\left(E[\tilde{u}|y] - \frac{1}{r}Var[\tilde{u}|y]x - P_1\right).$$

What do these characterizations of price change suggest? Recall that the change in price in period 2 absent an ITD was $E[\tilde{u}|y] - \frac{1}{r}Var[\tilde{u}|y]x - P_1$. Note that because $0 < \lambda < 1$, when $t > 0$ both $\frac{1}{\lambda(1-t)+(1-\lambda)} > 1$ and $\frac{1}{\lambda+(1-\lambda)(1-t)} > 1$. Consequently, the change in price in period 2 in the presence of an ITD is always greater than in the absence of an ITD by a factor of either $\frac{1}{\lambda(1-t)+(1-\lambda)}$ or $\frac{1}{\lambda+(1-\lambda)(1-t)}$ (holding the disclosure itself constant). In effect, this means that in the presence of an ITD, price changes appear to be "overreacting" to news vis à vis the no-ITD case. As discussed

above, the reason for this "overreaction" is that the ITD distorts the incentives for investor-types to hold the per-capita supply of the risky asset in period 2.

This leads to the major result of the paper.

Proposition 3. Assuming that investor-types hold different amounts of the risky asset in period 1, the existence of an ITD will increase price changes at the time of a disclosure (vis à vis no ITD) by a factor of either $\frac{1}{\lambda(1-t)+(1-\lambda)}$ or $\frac{1}{\lambda+(1-\lambda)(1-t)}$. That is, price changes will appear to be "overreacting" at the time of a disclosure relative to the no-ITD case.

As should be clear, note that if losses in period 2 are not tax advantaged, price changes resulting from "bad news" will manifest no "overreaction" because tax considerations play no role in how investor-types unwind their positions.

An interesting feature of proposition 3 is that it provides a tax explanation for seemingly anomalous market behavior (absent controlling for tax effects). This issue is a tangential contribution of this paper, however, and the reader interested in pursuing this link to market anomalies should consult Kent, *et al.* [1998].

Because the extent of "overreaction" is either $\frac{1}{\lambda(1-t)+(1-\lambda)}$ or $\frac{1}{\lambda+(1-\lambda)(1-t)}$, proposition 3 yields two immediate corollaries, the proofs to which are left to the interested reader.

Corollary 3. The extent of "overreaction" increases as the ITD increases (i.e., as t increases).

Corollary 4. The extent of "overreaction" increases as the relative proportion of investors who are overweighted increases. For example, "overreaction" increases as λ increases if type-A investors are overweighted in the risky asset in period 1, and as $1 - \lambda$ increases if type-B investors are overweighted in the risky asset in period 1.

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In effect, corollaries 3 and 4 suggest that the extent of "overreaction" is greatest at times where the ITD is greatest, and at times where the relative proportion of the overweighted investor-type is greatest.

To digress briefly, note that we assume that both investor types are subject to an ITD. Suppose, however, that the economy is populated exclusively by type-A investors, who are subject to the ITD, and type-C investors, who are tax-exempt organizations (in the same proportion as the original A and B types, namely λ and $1-\lambda$). Then it should be clear that here price changes only "overreact" in the absence of controlling for an ITD when type-A investors are overweighted in the risky asset in period 1 (i.e., $D_1^A > x$). For example, here

$$P_2 - P_1 = \frac{1}{\lambda(1-t) + (1-\lambda)} \left(E[\tilde{u}|y] - \frac{1}{r} Var[\tilde{u}|y]x - P_1 \right).$$

When type-C investors are overweighted in period 1 (i.e., $D_1^C > x$), there is no "overreaction" because tax considerations play no role in the decision of type-C investors to unwind their positions: specifically, here

$$P_2 - P_1 = E[\tilde{u}|y] - \frac{1}{r} Var[\tilde{u}|y]x - P_1.$$

In other words, the extent of "overreaction" is governed exclusively by the tax status of those investors or organizations who are overweighted in the risky asset as they enter the disclosure period.

6   Empirical Considerations

To summarize our analysis in the context of current US tax law where realized profits alone are impacted by ITDs, this paper predicts that ITDs exaggerate the effect of "good news" disclosures on equity prices, and depress the effect of "good news"

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disclosures on trading volume. In addition, the equity price exaggeration and volume depression should be increasing in the size of the ITD. Both price and volume effects, however, are temporary. Although we do not analyze events beyond the disclosure period in this paper, presumably investors will unwind their overweighted positions gradually over time as their holding periods convert gains from short-term tax treatment to long-term treatment. This, in turn, suggests that in ensuing periods prices will adjust downward and volume will exceed the level that would be expected in the absence of taxes.

Reese [1998], for example, examines equity prices and trading volume for IPO stocks around the date that original investors qualify for long-term capital treatment. He finds that from 1975 to 1986, prices fell and trading volume increased following long-term qualification for shares that appreciated. No such patterns are detected for IPOs from 1989 to 1995, a period when the spread between capital gains tax rates and ordinary tax rates was smaller. Reese [1998] concludes that IPO investors defer the sale of appreciated shares to garner long-term capital gains tax treatment if the spread between capital and ordinary rates is sufficiently large.

Reese's [1998] findings are consistent with this paper's prediction that sellers unwind their appreciated positions after long-term capital gains treatment is assured, driving prices down and volume up. His tests, however, are disconnected from any examination of the factors that create equity appreciation, and ignore investor reactions to public disclosures.

Similarly, Poterba and Weisbenner [1998] show that from 1970-1976, the prices of equities that had declined during the previous six months (the long-term holding period at that time) rebounded following year-end, consistent with price reversion following a tax-induced sell-off. Recall that during these years, long-term capital

These anecdotes are consistent with the theory in this paper. If investors unwind appreciated positions once the tax-favored capital gains tax rate applies to their investments, a reduction in the holding period would cause an unusually large number of equities to shift immediately from ordinary to capital gains tax treatment. Instead of the steady trickle of a small percentage of a firm's shares from ordinary to capital gains treatment, a shortening of the holding period would create a deluge of shares that could be sold immediately at favorable tax rates. This paper predicts that such a shift in holding periods would depress prices and increase volume.

These extant empirical studies and anecdotes, however, are silent on the price and volume effects around public disclosures. Each case involves the reversion of prices and volume following an assumed event. None identifies the event that alters prices and volume originally. For example, Reese [1998] investigates IPOs where equity prices have increased. His empirical design assumes that a seller's strike caused prices to rise and volume to fall before the holding period for long-term capital gains treatment was completed. He provides no direct empirical evidence of such overreactions, which are the primary interest of this paper.

We propose a more direct test of the predictions advanced in this study about the effects of taxes on prices and volume around the time of disclosure. Although the theory generalizes to any disclosure about firm performance, the finance and accounting literature provides extensive documentation of the price response to a specific public disclosure, quarterly earnings announcements. To the extent investors accurately forecast future "good news" earnings announcements, risk considerations should compel them to sell their overweighted positions when the announcement occurs.

It should be emphasized that in real institutional settings, individual investors are

the only equity holders who enjoy preferential treatment of long-term capital gains. Consequently, individuals who have not held the investments for the requisite period might choose to defer selling until the tax-favored long-term capital gains tax rate applies. If so, share prices should rise and volume fall more around the disclosure than would be anticipated in the absence of taxes. Furthermore, "overreactions" in prices should be increasing in the percentage of shares held by individual investors, in the size of the ITD, and in the magnitude of the "good news."

To test the price effects, we propose the following empirical design:

$$UR_{ik} = \alpha + \beta * UE_{ik}(1 + \Delta\tau_k[1 + indiv_{ik}]) + \gamma * controls + \varepsilon_{ik},$$

where

UR_{ik} = unexpected returns for firm i in quarter k;

UE_{ik} = unexpected earnings for firm i in quarter k;

$\Delta\tau_k$ = the maximum personal short-term capital gains rate

less the maximum personal long-term capital gains tax rate in quarter k;

$indiv_{ik}$ = percentage of firm i's outstanding shares held by individual investors in quarter k.

If taxes affect investor decisions around the disclosure date, we anticipate the signs of the coefficients on the interactive terms ($UE_{ik} * \Delta\tau_k$ and $UE_{ik} * \Delta\tau_k * indiv_{ik}$) will be positive, conditional on controlling for other documented return determinants. A positive coefficient on $UE_{ik} * \Delta\tau_k$ is consistent with earnings response coefficients increasing in the spread between ordinary and capital gain tax rates. A positive coefficient on $UE_{ik} * \Delta\tau_k * indiv_{ik}$ is consistent with the tax-induced variation in earnings response coefficients increasing with the percentage of stock potentially subject to the favorable capital gains treatment.

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A similar test could be constructed to assess the effect of taxes on trading volume around the disclosure date. Substituting abnormal volume for unexpected returns and using the same regressors, the theory in this paper predicts the signs of the coefficients on the interaction terms would be negative. Earnings announcements should affect volume more as the spread between ordinary and long-term capital gains tax rates widens, and more to the extent to which shareholders are individuals subject to differential capital gains taxation.

Appendix A

Proof of Proposition 1. Let a circumstance in which $P_2 - P_1 \geq 0$ be defined as one in which the disclosure in period 2 is "weakly good news," henceforth WGN, and a circumstance in which $P_2 - P_1 < 0$ as one in which the disclosure in period 2 is "strictly bad news," henceforth SBN. We prove proposition 1 by showing that in each of the WGN and SBN cases taken separately, the assumption that A-type investors are underweighted in the risky asset, in combination with the supposition that they divest themselves of some of the risky asset in period 2, leads to a contradiction. This implies that if an investor is among the type that is underweighted, then she must accumulate more of the risky asset in period 2, and, correspondingly, an investor among the type that is overweighted must divest.

To begin, assume type-A investors are underweighted in the risky asset (i.e., $D_1^A < x$) and the disclosure in period 2 is WGN. Suppose further that type-A investors divest some of the risky asset in period 2. From eqn. (3), a A-type investor who divests in period 2 has the following demand:

$$
\begin{aligned}
D_2^A &= r \cdot \frac{t\,(1-\lambda)}{\lambda(1-t)+(1-\lambda)}\Big(\frac{E[\tilde{u}|y]-P_1}{Var[\tilde{u}|y]}\Big) + \frac{1-t}{\lambda(1-t)+(1-\lambda)}x \\
&= r \cdot \frac{t\,(1-\lambda)}{\lambda(1-t)+(1-\lambda)}\Big(\frac{E[\tilde{u}|y]-\frac{Var[\tilde{u}|y]}{r}x-P_1}{Var[\tilde{u}|y]}\Big) + \frac{1-t\lambda}{\lambda(1-t)+(1-\lambda)}x \\
&= rt\,(1-\lambda)\,(P_2 - P_1) + x, \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad (A1)
\end{aligned}
$$

where the first expression on the right-hand-side of eqn. (A1) results from eqn. (1) and the fact that

$$
\begin{aligned}
\frac{1}{\lambda(1-t)+(1-\lambda)}\Big(\frac{E[\tilde{u}|y]-\frac{Var[\tilde{u}|y]}{r}x-P_1}{Var[\tilde{u}|y]}\Big) &= \frac{E[\tilde{u}|y]-\lambda t P_1 - \frac{1}{r}Var[\tilde{u}|y]x}{\lambda(1-t)+(1-\lambda)} - P_1 \\
&= P_2 - P_1,
\end{aligned}
$$

and the second expression from the fact that $\frac{1-t\lambda}{\lambda(1-t)+(1-\lambda)} = 1$. But eqn. (A1), in turn, implies that if the disclosure is WGN (i.e., $P_2 - P_1 \geq 0$), then $D_2^A \geq x$. But this contradicts the assumption that type-A investors are underweighted in the risky asset because *divesting* shares in period 2 requires $D_1^A > D_2^A \geq x$ and by assumption $D_1^A < x$.

Now assume that the disclosure in period 2 is SBN. Once again, also assume that type-A investors are underweighted in the risky asset (which implies that B-type investors are overweighted). Suppose that in period 2 type-A investors divest some of the risky asset (which implies that B-type investors accumulate). Recall that at the local maximum when type-A investors divest is represented by $D_2^A = r \cdot \frac{E[\tilde{u}|\tilde{y}=y]-(1-t)P_2-tP_1}{Var[\tilde{u}|\tilde{y}=y]}$, and the expected utility of type-A investors at this maximum is:

$$-\exp[-\frac{1}{2}\frac{(E[\tilde{u}|\tilde{y}=y]-P_2+t(P_2-P_1))^2}{VAR[\tilde{u}|\tilde{y}=y]} - \frac{1}{r}(P_2-P_1)(1-t)D_1^A]. \qquad (A2)$$

Alternatively, the local maximum when type-A investors accumulate is represented by $D_2^A = r \cdot \frac{E[\tilde{u}|\tilde{y}=y]-P_2}{Var[\tilde{u}|\tilde{y}=y]}$, and the expected utility of type-A investors at this maximum is:

$$-\exp[-\frac{1}{2}\frac{(E[\tilde{u}|\tilde{y}=y]-P_2)^2}{VAR[\tilde{u}|\tilde{y}=y]} - \frac{1}{r}(P_2-P_1)D_1^A]. \qquad (A3)$$

If the local maximum in which type-A investors divest is also a global maximum, then it must be that the argument in the exponential in eqn. (A2) is lower than the argument in eqn. (A3), or

$$-\frac{1}{2}\frac{(E[\tilde{u}|\tilde{y}=y]-P_2+t(P_2-P_1))^2}{VAR[\tilde{u}|\tilde{y}=y]} - \frac{1}{r}(P_2-P_1)(1-t)D_1^A$$
$$< -\frac{1}{2}\frac{(E[\tilde{u}|\tilde{y}=y]-P_2)^2}{VAR[\tilde{u}|\tilde{y}=y]} - \frac{1}{r}(P_2-P_1)D_1^A.$$

But this, in turn, implies

$$\frac{1}{r}(P_2 - P_1)tD_1^A < \frac{1}{2}\frac{2t\left(E[\tilde{u}|\tilde{y} = y] - P_2\right)(P_2 - P_1) + t^2(P_2 - P_1)^2}{VAR[\tilde{u}|\tilde{y} = y]}. \qquad (A4)$$

Note, however, that in the presence of SBN (i.e., $P_2 - P_1 < 0$), eqn. (A4) implies

$$D_1^A > r\frac{E[\tilde{u}|\tilde{y} = y] - P_2 + \frac{1}{2}t(P_2 - P_1)}{VAR[\tilde{u}|\tilde{y} = y]}. \qquad (A5)$$

But using an equivalent argument, it must be that type-B investors who accumulate in period 2 exhibit the following relation

$$D_1^B < r\frac{E[\tilde{u}|\tilde{y} = y] - P_2 + \frac{1}{2}t(P_2 - P_1)}{VAR[\tilde{u}|\tilde{y} = y]}. \qquad (A6)$$

Because the right-hand-side of eqns. (A5) and (A6) are the same, taken together these eqns. imply that $D_1^A > D_1^B$. But this contradicts the assumption that type-A investors are underweighted in the risky asset.

Q.E.D.

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