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# Intertemporal Tax Discontinuities

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ABSTRACT

We define an intertemporal tax discontinuity (ITD) as a circumstance in which different tax rates are applied to gains realized at one point in time versus some other point in time. We study the effects of ITDs on market behaviors at the time of disclosures of firm performance, assuming that all investors who trade firm equities are subject to tax. The results of our paper suggest that relative to an economy in which ITDs are absent, ITDs may dampen trading volume and amplify price changes at the time of disclosure.

## 1. *Introduction*

This paper discusses the economic tensions that affect firm equity prices and trading volume around "good news" disclosures of firm performance in a setting in which all investors who trade equities are subject to tax. We highlight the different market behaviors that may arise in economies in which tax considerations play a role, versus ones in which they do not. Specifically, we define an intertemporal tax discontinuity (ITD) as a circumstance in which different tax rates are applied to gains realized at one point in time versus some other point in time (e.g., distinctions between long-term and short-term capital gains tax rates). We then study the effects of ITDs on market behaviors at the time of disclosures of firm performance. The results of our paper suggest that relative to an economy in which ITDs are absent,

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ITDs may dampen trading volume and amplify price changes at the time of disclosure.[1]

We employ a stylized model of trade to analyze ITDs. Stylized trading models are a common device in the accounting literature to study the effects of disclosures on price changes and trading volume (e.g., Lundholm [1988], Kim and Verrecchia [1991a], and Bushman, Gigler, and Indjejikian [1996]). None of the extant models, however, consider the role of taxes. Among a host of justifications for eschewing taxes, one could include: a preponderance of traders, such as pension funds and tax-exempt organizations, who are not subject to taxes; tax planning that mitigates the effect of taxes among traders subject to tax; and perfect substitutability among financial assets that allows potential tax gains to be offset against tax losses.[2] While all of these phenomena mitigate the effects of taxes, as a practical matter another reason why taxes are eschewed in models of trade is that they create complex modeling problems that are difficult to address. The novel feature of our analysis is its attempt to integrate tax considerations into a standard model of trade and grapple with these difficulties.[3]

The operative word here is "grapple." Tax considerations are very difficult to address in general settings; consequently, for pedagogical reasons we predicate our analysis on the polar case of an economy in which *all* investors are subject to the tax implications of ITDs. The benefit of this setting is transparency: in this polar case, the equilibrium is unique and well defined, which makes transparent the effects of ITDs on the behaviors of price changes and trading volume. In the concluding section of this paper, section 4, we explore the general situation in which some investors are subject to ITDs, while others are not. We refer to this setting as a "mixed economy." We discuss a mixed economy to acknowledge that, in general, anything can happen. For example, in a mixed economy there may exist equilibria that comport with economic regimes in which either no investor is subject to ITDs or all investors are subject to ITDs. We postpone a discussion of the general case until the end for pedagogical reasons: before pointing out that in general "anything can happen," we believe that it is useful for the reader to understand first how this may arise by characterizing the general case as

[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], Erickson and Maydew [1998], Guether [2000], Blouin, Raedy, and Shackelford [2002], and Lang and Shackelford [2000], among others, document equity price and volume responses to public disclosures about tax legislation.

[2] For a discussion of these issues, see Miller and Scholes [1982], Stiglitz [1983], Constantinides [1983, 1984], Poterba [1987], Scholes and Wolfson [1992], and Shackelford [2000], among many others.

[3] Tax studies have been similarly remiss by ignoring any trading implications for disclosures. Although long recognizing the potential significance of taxes on asset pricing (e.g., Miller [1977], Poterba and Summers [1984], Balcer and Judd [1987], Fama and French [1998], Reese [1998], Guenther and Willenborg [1999], Harris and Kemsley [1999], Poterba [2001], among many others), to our knowledge no tax study incorporates the impact of disclosure on trading.

a variant of the polar case in which all investors are subject to an identical tax structure.

The intuition underlying our analysis of a setting in which all investors are subject to an ITD can be described briefly as follows. To the extent to which disclosure leads to homogeneous expectations about the (uncertain) value of a risky asset (e.g., a firm), all investors gravitate toward an equilibrium in which the risk associated with holding the risky asset is optimally shared (independent of expectations). Optimal risk sharing in the disclosure period, however, requires that those investors who are overweighted in the risky asset relative to the optimal risk-sharing amount unwind their positions by selling shares of the asset. From the perspective of overweighted investors, selling ensures a certain profit and eliminates 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 sell at all, is unclear if the sale triggers an income tax.[4] The greater the appreciation on the asset sold, the greater the realization tax, and hence the greater the incentive to defer selling. Consequently, at the time of the disclosure, investors must choose between sharing risks optimally and reducing taxes optimally by postponing asset sales in the event that the disclosure is "good news." This coordination of risk and tax suggests that investors who are overweighted will unwind some, but not all, of their position at the time of the disclosure. In addition, the amount sold should decrease as the difference between the expected long-term and short-term capital gains tax rates increases.

In the absence of tax mitigating phenomena, these risk-tax trade-offs should affect both share price and trading volume at the time of the disclosure. For example, if taxes preclude investors from fully unwinding their overweighted positions, the supply of equity will be restricted. To compensate for the tax-motivated restriction in supply, the share price will be bid up. Consequently, price changes at the time of a "good news" disclosure will be greater because of the unwillingness of potential sellers to unwind their positions arising from the realization tax.[5] In addition, the unwillingness of sellers to unwind their positions should result in a reduction in the equity's trading volume.[6]

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

[4] Tax scholars have long recognized that a tax at realization provides incentives for investors to defer the disposition of appreciated property. In the tax literature, this is commonly called the "lock-in" effect (Holt and Shelton [1962]).

[5] Independent of tax considerations, a "good news" disclosure may lead to price increases for other reasons, e.g., a permanent increase in demand for the asset. See, for example, Shleifer's [1986] examination of the price response of firms who join the S&P 500.

[6] See Blouin, Raedy, and Shackelford [2001] for empirical evidence consistent with these claims. They investigate price and volume movements around quarterly earnings announcements and find that price is increasing and volume is declining in the amount of taxes saved by deferring the recognition of a capital gain from short-term to long-term.

rates for individual investors under U.S. tax law.[7] Long-term capital gains tax rates in the U.S. have been less than short-term capital gains tax rates since 1922, except for the period 1988–1990 when rates were equal. Under current law, equity held for more than one year is characterized as long-term and taxed at no greater than a 20% statutory tax rate, while other capital gains face a 39.6% maximum statutory federal tax rate. We ignore capital losses in this analysis because currently these losses provide the same tax deduction regardless of whether they are long or short.[8]

## 2. *Description of the Economy*

### 2.1 GENERAL ASSUMPTIONS

In this section we introduce all the assumptions that underlie our analysis. We begin by assuming 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). In period 1 both investor 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 (potentially) trade asset shares to rebalance their portfolio of investments. In period 3 all assets liquidate and all investors consume their portfolio holdings.

In our analysis we characterize an ITD as follows. We assume that for tax purposes periods 1 and 2 are sufficiently close in time that any profit that arises from 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.

[7] Our definition of an ITD is designed to embrace tax discontinuities that arise from situations other than 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.

[8] This has not always been the case: from 1970 to 1986, long-term capital losses provided one-half the deduction of short-term capital losses. Currently, individual investors are limited to an annual deduction of $ 3,000 for capital losses in excess of capital gains. Corporations cannot deduct any capital losses in excess of capital gains. Complex rules for netting capital gains and losses, however, can create effectively a preference for short-term capital losses.

One caveat to our analysis is that we assume that tax rates in all periods are known and fixed. As we discuss in the introduction, we predicate our analysis on the coordination conflict that arises between risk sharing and tax planning. To the extent to which uncertainty exists about tax rates in the future, this is likely to make tax planning more difficult, and hence less compelling in any risk-sharing-versus-tax-planning trade-off. Consequently, uncertainty about future tax rates likely attenuates our results.

Continuing with a discussion of our model, 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; the realized value of $\tilde{u}$, $\tilde{u} = u$, does not become common knowledge until period 3. Let $\tilde{y}$ represent the public disclosure in period 2. To ensure that the analysis is as facile as possible, we assume that investors' conditional expectations about $\tilde{u}$ in period 2 (i.e., conditional on the disclosure) are that $\tilde{u}$ has a normal distribution with mean $E[\tilde{u} \mid \tilde{y} = y]$ and variance $Var[\tilde{u} \mid \tilde{y} = y]$.[9]

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. Let $j \in (A, B)$ represent a generic investor type. Each investor type is assumed to be risk-averse with a utility for income of $w$ given by $U_j(w)$, where $U_j(w)$ is the negative exponential utility function with positive risk tolerance parameter of $r_j > 0$: $U_j(w) = -\exp[-\frac{w}{r_j}]$. While the assumption of risk aversion on the part of investors plays a critical role in our analysis, it should be emphasized that it is a standard assumption in models of trade. In addition, note that investors can be very, very tolerant of risk (i.e., $r_j$ can be very large), provided no one is explicitly risk neutral. Finally, let $\pi_A$ and $\pi_B$ represent the relative proportions of type-A and type-B investors in the economy, respectively, where $\pi_A + \pi_B = 1$. We assume that the proportion of investors of each type remains fixed over the first two periods that we model.

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. 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 a conventional assumption is that the supply of a risky asset is positive. One assumption we do require, however, is that the per-capita supply also does not change over the first two periods. This implies that investors' per-capita demand for the risky asset in both periods 1 and 2 must equal the per-capita supply: $\pi_A D_1^A + \pi_B D_1^B = \pi_A D_2^A + \pi_B D_2^B = x$. One

[9] A conventional, institutional interpretation of the assumption that $\tilde{y}$ subsumes all prior information about $\tilde{u}$ is that any prior information is a forecast of $\tilde{y}$, which the actual disclosure of $\tilde{y}$ in period 2 subsumes: see, for example, Abarbanell, et al. [1995].

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., $D_1^A > D_2^A$), the other investor-type must be simultaneously accumulating, or adding to, its holdings of the risky asset in period 2 (e.g., $D_1^B < D_2^B$), and vice versa.

### 2.2 THE ABSENCE OF AN ITD

Note that in the stylized economy we describe above, there are at least two reasons why ITDs may be absent. As alluded to in the introduction, the first reason is that taxes in general play no role. This could result from: a preponderance of traders who are not subject to taxes; tax planning strategies that mitigate the effect of taxes among investors subject to tax; and financial assets that are perfect substitutes, thereby allowing any potential tax gains to be offset against tax losses. In the context of our analysis, this is tantamount to suggesting that $t = 0$. The second reason is that the ordinary income tax rate and the capital gains tax rate are identical. In the context of our analysis, this is tantamount to suggesting that the long-term capital gains tax rate is $t$: that is, the same as the ordinary income tax rate. Because both these cases yield equivalent results, for convenience we characterize the absence of an ITD as a situation in which $t = 0$.

In the absence of an ITD, it is a straightforward exercise to show that the unique, Pareto efficient equilibrium in period 2 is:

$$D_2^A = \frac{r_A}{\pi_A r_A + \pi_B r_B} x;$$

$$D_2^B = \frac{r_B}{\pi_A r_A + \pi_B r_B} x;$$

$$P_2 = E[\tilde{u} \mid \tilde{y} = y] - \frac{1}{\pi_A r_A + \pi_B r_B} Var[\tilde{u} \mid \tilde{y} = y] x.$$

See, for example, Wilson [1968]. This equilibrium can be explained by the fact that in period 2 all investors (regardless of type) have homogeneous expectations about the value of the risky asset conditional on the disclosure; hence, they hold per-capita amounts of the risky asset in relation to their risk tolerance profiles (i.e., the $r_j$ s) and their proportional representation (i.e., the $\pi_j$ s). For example, if both investor types have the same tolerance for risk (i.e., $r_A = r_B$), the Pareto efficient equilibrium is for each investor type to hold the per-capita amount as its share of the risky asset (independent of type): that is, $D_2^A = D_2^B = x$.

For convenience, we refer to an investor type as being "overweighted" in the risky asset if, in period 1, the type holds more than the Pareto efficient amount described above, and "underweighted" if the type holds less. For example, type-A investors are overweighted if $D_1^A > \frac{r_A}{\pi_A r_A + \pi_B r_B} x$, and underweighted if $D_1^A < \frac{r_A}{\pi_A r_A + \pi_B r_B} x$. Note that if one investor-type is overweighted, then the other type must be underweighted. In addition, note that "underweighted" does not imply necessarily a short-sale position: when

$x$ is positive, an investor-type can be underweighted and still hold a positive amount of the risky asset. To facilitate the discussion, in this paper we ignore tax issues that arise from investors executing short-sales, and price change and trading volume effects that arise from restrictions and/or prohibitions on short-sales.

Let a circumstance in which $P_2 - P_1 > 0$ be defined as one in which the disclosure in period 2 is "good news." In the subsequent analysis we focus on the "good news" case and determine endogenously values for $P_2$, $D_2^A$ and $D_2^B$ in the presence of an ITD (i.e., $t > 0$); then we contrast these values to those that arise in the absence of an ITD (i.e., $t = 0$). Alternatively, all of $P_1$, $D_1^A$ and $D_1^B$ are treated as exogenous. The reason for this is twofold. First, determining $P_1$, $D_1^A$ and $D_1^B$ endogenously complicates the analysis without further enhancing 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 the economic characteristics of the investor type that is overweighted in the risky asset in period 1. The actual values of $D_1^A$ and $D_1^B$, however, play no role.

While the actual values of $D_1^A$ and $D_1^B$ play no role, for convenience we assume that in period 1 investors are not in the period 2 Pareto efficient equilibrium: That is, $D_1^A \neq \frac{r_A}{\pi_A r_A + \pi_B r_B} x$ and $D_1^B \neq \frac{r_B}{\pi_A r_A + \pi_B r_B} x$. While there are many rationales for why this may not be the case, the one most commonly cited in the extant literature is that in period 1 different investor types have heterogeneous expectations of heterogeneous quality about either the value of the risky asset or the forthcoming disclosure in period 2 (or both).[10] These heterogeneous expectations likely arise from different priors and/or different private information. While in principle there is no harm in assuming the alternative that $D_1^A = \frac{r_A}{\pi_A r_A + \pi_B r_B} x$ and $D_1^B = \frac{r_B}{\pi_A r_A + \pi_B r_B} x$, it precludes the possibility of trade in period 2.[11] No trade is an uninteresting case from the perspective of this paper because it results in no difference in market behaviors in ITD-free versus ITD economies, and it characterizes a situation that does not appear to be descriptive of real market settings around disclosure events. Consequently, we ignore this case.

## 3. *An ITD Economy*

### 3.1 EQUILIBRIA IN THE PRESENCE OF ITDs

In this section we assume that both investor types (in effect, everyone in the economy) face an identical tax structure characterized by the existence

[10] See, for example, the discussions in Kim and Verrecchia [1991a,1991b] and Abarbanell, et al. [1995].

[11] See Milgrom and Stokey [1982] and Verrecchia [2001] for more discussion of why no trade occurs for this circumstance in an economy of the type we employ.

of an ITD. That is, we assume that the *reduction* of any investor type's risky asset position from period 1 to period 2 in the presence of "good news" implies paying tax on the profit 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 a profit net of tax on that transaction of $(P_2 - P_1)(D_1^A - D_2^A)(1 - t)$. Alternatively, we assume that the *increase* in any investor type's risky asset position from period 1 to period 2 implies no taxable profit at the ordinary income tax rate of $t$. For example, if $D_1^A \leq D_2^A$, 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.

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 in the presence of ITDs. Then we establish that despite two candidates, there is in fact a unique equilibrium with the following feature. The investors among the type that is overweighted in the risky asset in period 1 always reduce their risky asset position in period 2. Similarly, investors among the type that is underweighted in the risky asset in period 1 always increase their risky asset position in period 2. This implies that investors who are overweighted in period 1 have their profits taxed at a rate $t$. 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, note that when a "good news" disclosure occurs in period 2, type-A investors face one of two optimization problems. If $D_1^A - D_2^A > 0$, type-A investors divest themselves of part of the risky asset position they established in period 1. Consequently, here a type-A investor solves:

$$\max_{D_2^A} E\left[-\exp\left[-\frac{1}{r_A}\{(\tilde{u} - P_1)D_2^A + (P_2 - P_1)\left(D_1^A - D_2^A\right)(1 - t)\} \mid \tilde{y} = y\right]\right].$$

For example, in this characterization, a type-A investor's risky asset position in period 1 is $D_1^A$. Type-A investors pay capital gains tax on that part of $D_1^A$ that they *retain* through to period 3, which is $D_2^A$. Note, however, that in our characterization the capital gains tax is zero, and hence their profit for this part is $(\tilde{u} - P_1)D_2^A$. They pay ordinary income tax of $t$ on that part of $D_1^A$ that they *sell* in period 2, which is $D_1^A - D_2^A$. Here, their 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, $D_1^A - D_2^A \leq 0$, here type-A investors (weakly) *increase* their holdings of the risky asset in period 2. Hence, here they pay capital gains tax (which is 0) on their profit in period 3 of $\tilde{u}D_2^A - P_2(D_2^A - D_1^A) - P_1 D_1^A$, which, one can show, equals $(\tilde{u} - P_1)D_2^A + (P_2 - P_1)(D_1^A - D_2^A)$. Consequently, here they solve:

$$\max_{D_2^A} E\left[-\exp\left[-\frac{1}{r_A}\left\{(\tilde{u}-P_1)D_2^A+(P_2-P_1)\left(D_1^A-D_2^A\right)\right\} \mid \tilde{y}=y\right]\right].$$

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:

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

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

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

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

$$D_2^A = r_A \cdot \frac{E[\tilde{u}\mid\tilde{y}=y]-(1-t)\,P_2-tP_1}{Var[\tilde{u}\mid\tilde{y}=y]};$$

the other occurs at

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

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., $D_2^B < D_1^B$).

While in principle there exist multiple equilibria, the first result of the paper demonstrates that the period 2 equilibrium is actually unique.[12] (The proof to this result is in the appendix.)

PROPOSITION 1. *In an economy in which all investors face an identical tax structure characterized by an ITD, the (unique) equilibrium that occurs in period* 2 *in conjunction with a "good news" disclosure (i.e.,* $P_2 - P_1 > 0$*) is the one in which 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 investors of type* $j$ *are overweighted in the risky asset in period* 1, *where* $j \in (A, B)$ *and* $k$ *is its complement, the equilibrium in period* 2 *is characterized by:*

$$D_2^j = r_j \cdot \frac{\pi_k r_k t}{\pi_j r_j (1-t) + \pi_k r_k}\left(\frac{E[\tilde{u} \mid y] - P_1}{Var[\tilde{u} \mid y]}\right) + \frac{r_j (1-t)}{\pi_j r_j (1-t) + \pi_k r_k} x$$

$$D_2^k = r_k \cdot \frac{-\pi_j r_j t}{\pi_j r_j (1-t) + \pi_k r_k}\left(\frac{E[\tilde{u} \mid y] - P_1}{Var[\tilde{u} \mid y]}\right) + \frac{r_k}{\pi_j r_j (1-t) + \pi_k r_k} x; \quad (1)$$

$$P_2 = \frac{(\pi_j r_j + \pi_k r_k) E[\tilde{u} \mid y] - \pi_j r_j t P_1 - Var[\tilde{u} \mid y] x}{\pi_j r_j (1-t) + \pi_k r_k}.$$

To understand better proposition 1, it is useful to compare its results to those in the absence of an ITD (i.e., $t = 0$). Henceforth we use the expression "fully unwind" to describe a situation in which investors among the type that is overweighted in the risky asset in period 1 reduce their position down to the amount that is implied by the Pareto efficient equilibrium described in section 2.2: that is, $D_2^A = \frac{r_A}{\pi_A r_A + \pi_B r_B} x$ and $D_2^B = \frac{r_B}{\pi_A r_A + \pi_B r_B} x$. In the absence of an ITD, investors always fully unwind their positions in period 2 because disclosure results in homogeneous expectations for both investor-types about the value of the risky asset. Consequently, absent an ITD, Pareto efficiency dictates that investors of either type hold amounts of the per-capita supply of the risky asset in relation to their tolerance for risk and proportional representation. The Pareto efficient equilibrium may not result in the presence of an ITD, however, because the incentive to share risk optimally through trade may militate against the incentive to avoid tax.

To elaborate on this, 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 equilibrium has negative tax consequences for type-A investors in that they net only $1 - t$

[12] Recall that we ignore capital losses in this analysis because currently these losses provide the same tax deduction regardless of whether they are long or short. Consequently, in the context of our analysis a (weakly) "bad news" disclosure, i.e., $P_2 - P_1 \leq 0$, has no tax implications, and results in a unique equilibrium that is identical to the ITD-free equilibrium characterized in section 2.2.

of any profits realized in period 2, but it has the advantage that it improves risk sharing. 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"). This, however, would force type-B investors to (weakly) divest. The problem with this second equilibrium 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.

It is useful for the subsequent analysis to expand on this intuition more formally. For example, we know from the proof of proposition 1 in the appendix (see eqn. [A4]) that in the presence of "good news," the demand for the risky asset of the investor-type that divests in period 2, say type-A, can be represented as follows:

$$D_2^A = r_A \frac{\pi_B r_B t}{Var[\tilde{u} \mid y]} \left( \frac{P_2 - P_1}{(\pi_A r_A + \pi_B r_B)} \right) + \frac{r_A}{\pi_A r_A + \pi_B r_B} x. \qquad (2)$$

Note, however, that "good news" is defined by $P_2 - P_1 > 0$, and hence the first term on the right-hand-side of equation (2) is positive. This implies that in the presence of an ITD, type-A investors do not fully unwind their overweighted positions to hold the optimal risk-sharing amount: that is, $D_2^A > \frac{r_A}{\pi_A r_A + \pi_B r_B} x$. 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 $t$, the size of the ITD increases. In short, an ITD yields an equilibrium in which the investor-type that is overweighted in the risky asset sells *less* aggressively in the presence of a "good news" disclosure vis à vis the case in which ITDs are absent because realized profits are tax disadvantaged.[13]

### 3.2 TRADING VOLUME IN THE PRESENCE OF ITDs

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

$$\frac{1}{2}\pi_A \left| D_2^A - D_1^A \right| + \frac{1}{2}\pi_B \left| D_2^B - D_1^B \right|.$$

[13] Note that the amount $D_2^A - \frac{r_A}{\pi_A r_A + \pi_B r_B} x$ 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 equation (2) 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 $t$, because 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.

Recall that in the absence of an ITD, type-A investors would hold $\frac{r_A}{\pi_A r_A + \pi_B r_B} x$ and type-B investors would hold $\frac{r_B}{\pi_A r_A + \pi_B r_B} x$. This implies that absent an ITD, per-capita trading volume is:

$$\frac{1}{2}\pi_A\left|\frac{r_A}{\pi_A r_A + \pi_B r_B} x - D_1^A\right| + \frac{1}{2}\pi_B\left|\frac{r_B}{\pi_A r_A + \pi_B r_B} x - D_1^B\right|.$$

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 $D_1^A > D_2^A > \frac{r_A}{\pi_A r_A + \pi_B r_B} x$ and $D_1^B < D_2^B < \frac{r_B}{\pi_A r_A + \pi_B r_B} x$. But this, in turn, implies that

$$\begin{aligned}
&\frac{1}{2}\pi_A\left|D_2^A - D_1^A\right| + \frac{1}{2}\pi_B\left|D_2^B - D_1^B\right| \\
&= \frac{1}{2}\pi_A\left(D_1^A - D_2^A\right) + \frac{1}{2}\pi_B\left(D_2^B - D_1^B\right) \\
&< \frac{1}{2}\pi_A\left(D_1^A - \frac{r_A}{\pi_A r_A + \pi_B r_B} x\right) + \frac{1}{2}\pi_B\left(\frac{r_B}{\pi_A r_A + \pi_B r_B} x - D_1^B\right) \\
&= \frac{1}{2}\pi_A\left|\frac{r_A}{\pi_A r_A + \pi_B r_B} x - D_1^A\right| + \frac{1}{2}\pi_B\left|\frac{r_B}{\pi_A r_A + \pi_B r_B} x - D_1^B\right|.
\end{aligned}$$

In other words, a "good news" disclosure results in less trading volume in the presence of an ITD because investors who are overweighted in the risky asset do not fully unwind their positions.

COROLLARY 1. *In the presence of a "good news" disclosure and relative to the absence of an ITD, trading volume is lower in the disclosure period (i.e., period* 2*); the extent to which it is lower increases as the size of the ITD increases (i.e., as t increases).*

### 3.3 PRICE CHANGES IN THE PRESENCE OF ITDs

With regard to the price of the risky asset in period 2, recall from the discussion in section 2.2 that absent an ITD (i.e., $t = 0$), the price of the risky asset in period 2 is $P_2 = E[\tilde{u} \mid y] - \frac{1}{\pi_A r_A + \pi_B r_B} Var[\tilde{u} \mid y]x$, and hence the change in price is

$$P_2 - P_1 = E[\tilde{u} \mid y] - \frac{1}{\pi_A r_A + \pi_B r_B} Var[\tilde{u} \mid y]x - P_1.$$

Now consider price change in period 2 in the presence of an ITD. If we exclude from consideration the no trade case discussed in section 2.2, price change in period 2 can be characterized as:

$$\begin{aligned}
P_2 - P_1 &= \frac{(\pi_j r_j + \pi_k r_k)E[\tilde{u} \mid y] - \pi_j r_j t P_1 - Var[\tilde{u} \mid y]x}{\pi_j r_j (1-t) + \pi_k r_k} - P_1 \\
&= \frac{\pi_j r_j + \pi_k r_k}{\pi_j r_j (1-t) + \pi_k r_k}\left(E[\tilde{u} \mid y] - \frac{1}{\pi_j r_j + \pi_k r_k} Var[\tilde{u} \mid y]x - P_1\right),
\end{aligned}$$

where the $j$th subscript, $j \in (A, B)$, describes the investor type that is overweighted in the risky asset, and the $k$th subscript describes its complement.

This characterization suggests that holding the disclosure itself constant, the change in price in the presence of an ITD is always greater than in the absence of an ITD by a factor of $\frac{\pi_j r_j + \pi_k r_k}{\pi_j r_j (1-t) + \pi_k r_k}$; this expression is greater than 1 because $t > 0$. In effect, in the presence of a "good news" disclosure and an ITD, price changes are greater *vis à vis* the no-ITD case. The economic intuition underlying this result is that the realization tax makes investors who are overweighted in the risky asset unwilling to fully unwind their (overweighted) positions.

COROLLARY 2. *In the presence of a "good news" disclosure and relative to the absence of an ITD, price changes are greater by a factor of* $\frac{\pi_j r_j + \pi_k r_k}{\pi_j r_j (1-t) + \pi_k r_k}$; *the extent to which they are greater increases as either the ITD increases (i.e., as* $t$ *increases), the proportion of investors who are overweighted increases (i.e., as* $\pi_j$ *increases), or the risk tolerance of the proportion of investors who are overweighted increases (i.e., as* $r_j$ *increases).*

## 4. Caveats and Conclusion

As a caveat to our results, in this concluding section we discuss the role of the assumption employed in section 3 that all investors in the economy are subject to an ITD. Assuming identical tax treatments for all investors is clearly an abstraction from real market settings in which both taxable and tax-free investors participate.[14] We refer to an economy in which both tax and tax-free investors participate as "mixed." The problem with analyzing mixed economies is that trading volume and price change behaviors are governed by the tax characteristics of those investors who are overweighted in the risky asset. In the absence of specific knowledge about those characteristics, definitive statements and results about how ITDs affect market behaviors are elusive.

To elaborate further on this issue, recall from the discussion in section 3.1 that the disclosure period equilibrium is characterized by investors who are overweighted in the risky asset divesting and investors who are underweighted in the risky asset accumulating. Suppose, however, that either type-A investors are tax-free institutions while type-B investors are subject to ITDs, or type-A investors are subject to ITDs while type-B are tax-free institutions. Both scenarios comport with a mixed economy. In the case of the former, the equilibrium that results is identical to an ITD-free equilibrium described in section 2.2, because as tax-free institutions divesting

[14] For example, in the case of the latter, distinctions between short-term and long-term capital gains and losses matter only for sales that are reported on individuals' tax returns (e.g., sales of investments held in personal accounts, street-name, trusts, mutual funds, partnerships, S corporations, limited liability corporations, and other entities that pass-through taxable gains and losses from investments). Short-term and long-term distinctions are irrelevant for sales of investments held in C corporations, tax-exempt organizations, estates, foreign investors, and individuals investing through individual retirement accounts, 401(k) retirement accounts, and other defined contribution plans.

investors (i.e., type-A investors) are not subject to tax. Hence, this equilibrium results in market behaviors at the time of disclosure that are indistinguishable from the ITD-free regime. Alternatively, if type-A investors are subject to ITDs and type-B investors are tax-free institutions, the equilibrium that results is identical to the ITD equilibrium outlined in proposition 1 because in this situation divesting investors (i.e., type-A investors) are subject to tax on their short-term capital gains. In short, in a mixed economy in which some investors are subject to tax considerations while others are not, some equilibria may have features indistinguishable from an ITD-free regime, while other equilibria are indistinguishable from an ITD regime. In other words, all manner of behavior may result. This limits any claims about how ITDs affect market behaviors in mixed economies in the absence of specific knowledge of the tax characteristics of investors who actively participate in the buying and selling of equities at the time of firm disclosures.

While we acknowledge this limitation, our contribution is to make clear the economic tension that arises from investors who are subject to an ITD choosing between optimal risk sharing considerations associated with unwinding an overweighted position and optimal tax planning considerations associated with postponing the sale of firm equities. In the case of "good news," this coordination of risk and tax suggests that investors who are overweighted will unwind less of their position at the time of the disclosure than is implied by optimal risk sharing. We point out that in the absence of tax mitigating phenomena, these risk-tax trade-offs should affect both share price and trading volume behaviors at the time of disclosures of firm performance.

## APPENDIX

PROOF OF PROPOSITION 1. Recall that type-A investors have two local maxima:

$$D_2^A = r_A \cdot \frac{E[\tilde{u} \mid \tilde{y} = y] - (1-t)\,P_2 - tP_1}{Var[\tilde{u} \mid \tilde{y} = y]}, \quad \text{and}$$

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

Similarly type-B investors have two local maxima that are equivalent to those of type-A investors:

$$D_2^B = r_B \cdot \frac{E[\tilde{u} \mid \tilde{y} = y] - (1-t)\,P_2 - tP_1}{Var[\tilde{u} \mid \tilde{y} = y]}, \quad \text{and}$$

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

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., $D_2^B < D_1^B$).

First we analyze these two equilibria. Then 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.

Recall that if $D_2^A < D_1^A$ then $D_2^B > D_1^B$, and vice versa. Consequently, the requirement that $\pi_A D_2^A + \pi_B D_2^B = x$ implies that the price of the risky asset in period 2 can be characterized as either:

$$P_2 = \frac{(\pi_A r_A + \pi_B r_B)\, E[\tilde{u} \mid y] - \pi_A r_A t P_1 - Var[\tilde{u} \mid y]\, x}{\pi_A r_A (1-t) + \pi_B r_B} \tag{A1}$$

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

$$P_2 = \frac{(\pi_A r_A + \pi_B r_B)\, E[\tilde{u} \mid y] - \pi_B r_B t P_1 - Var[\tilde{u} \mid y]\, x}{\pi_A r_A + \pi_B r_B (1-t)} \tag{A2}$$

if $D_2^A > D_1^A$ (and hence $D_2^B < D_1^B$). Equations (A1) and (A2), 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

$$D_2^A = r_A \cdot \frac{\pi_B r_B t}{\pi_A r_A (1-t) + \pi_B r_B} \left( \frac{E[\tilde{u} \mid y] - P_1}{Var[\tilde{u} \mid y]} \right) + \frac{r_A (1-t)}{\pi_A r_A (1-t) + \pi_B r_B} x \tag{A3}$$

and

$$D_2^B = r_B \cdot \frac{-\pi_A r_A t}{\pi_A r_A (1-t) + \pi_B r_B} \left( \frac{E[\tilde{u} \mid y] - P_1}{Var[\tilde{u} \mid y]} \right) + \frac{r_B}{\pi_A r_A (1-t) + \pi_B r_B} x;$$

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

$$D_2^A = r_A \cdot \frac{-\pi_B r_B t}{\pi_A r_A + \pi_B r_B (1-t)} \left( \frac{E[\tilde{u} \mid y] - P_1}{Var[\tilde{u} \mid y]} \right) + \frac{r_A}{\pi_A r_A + \pi_B r_B (1-t)} x$$

and

$$D_2^B = r_B \cdot \frac{\pi_A r_A t}{\pi_A r_A + \pi_B r_B (1-t)} \left( \frac{E[\tilde{u} \mid y] - P_1}{Var[\tilde{u} \mid y]} \right) + \frac{r_B (1-t)}{\pi_A r_A + \pi_B r_B (1-t)} x.$$

To establish the existence of a unique equilibrium, 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. We prove proposition 1 by showing that WGN in combination with the assumptions that A-type investors are underweighted in the risky asset and divest themselves of some of the risky asset in period 2 leads to a contradiction. This implies that in the presence of WGN, investors among the type that is underweighted must accumulate more of the risky asset in period 2; correspondingly, investors among the type that is overweighted must divest. To begin, assume type-A investors are underweighted in the risky asset (i.e., $D_1^A < \frac{r_A}{\pi_A r_A + \pi_B r_B} x$), divest some of the risky asset in period 2, and the disclosure in period 2 is WGN. First, note that equation (A1) can be rearranged to yield:

$$\begin{aligned} E[\tilde{u} \mid y] &= \frac{(\pi_A r_A (1-t) + \pi_B r_B)\, P_2 + \pi_A r_A t P_1 + Var[\tilde{u} \mid y]\, x}{(\pi_A r_A + \pi_B r_B)} \\ &= (\pi_A r_A (1-t) + \pi_B r_B) \\ &\quad \times \frac{P_2 + \frac{\pi_A r_A t}{(\pi_A r_A (1-t) + \pi_B r_B)} P_1 + \frac{1}{(\pi_A r_A (1-t) + \pi_B r_B)} Var[\tilde{u} \mid y]\, x}{(\pi_A r_A + \pi_B r_B)}. \end{aligned}$$

Substituting this expression for $E[\tilde{u} \mid y]$ into equation (A3) implies the following demand:

$$\begin{aligned} D_2^A &= \frac{\pi_B r_A r_B t}{Var[\tilde{u} \mid y]} \\ &\times \left( \frac{P_2 + \frac{\pi_A r_A t}{(\pi_A r_A (1-t) + \pi_B r_B)} P_1 + \frac{1}{(\pi_A r_A (1-t) + \pi_B r_B)} Var[\tilde{u} \mid y]\, x - \frac{(\pi_A r_A + \pi_B r_B)}{(\pi_A r_A (1-t) + \pi_B r_B)} P_1}{(\pi_A r_A + \pi_B r_B)} \right) \\ &\quad + \frac{r_A (1-t)}{\pi_A r_A (1-t) + \pi_B r_B} x \\ &= \frac{\pi_B r_A r_B t}{Var[\tilde{u} \mid y]} \left( \frac{P_2 + \frac{\pi_A r_A t}{(\pi_A r_A (1-t) + \pi_B r_B)} P_1 - \frac{(\pi_A r_A + \pi_B r_B)}{(\pi_A r_A (1-t) + \pi_B r_B)} P_1}{(\pi_A r_A + \pi_B r_B)} \right) \\ &\quad + \frac{\frac{r_A r_B \pi_B t}{(\pi_A r_A + \pi_B r_B)} + r_A (1-t)}{\pi_A r_A (1-t) + \pi_B r_B} x \\ &= \frac{\pi_B r_A r_B t}{Var[\tilde{u} \mid y]} \left( \frac{P_2 - P_1}{(\pi_A r_A + \pi_B r_B)} \right) + \frac{r_A}{\pi_A r_A + \pi_B r_B} x. \end{aligned} \tag{A4}$$

But equation (A4), in turn, implies that if the disclosure is WGN (i.e., $P_2 - P_1 \geq 0$), $D_2^A \geq \frac{r_A}{\pi_A r_A + \pi_B r_B} x$. But this contradicts the assumption that type-A investors are underweighted in the risky asset and divest because *divesting* shares in period 2 requires $D_1^A > D_2^A \geq \frac{r_A}{\pi_A r_A + \pi_B r_B} x$, and by assumption $D_1^A < \frac{r_A}{\pi_A r_A + \pi_B r_B} x$. ■

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