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TRADING VOLUME with PRIVATE VALUATIONS:

THEORY and EVIDENCE from the EX-DIVIDEND DAY

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First Version

Abstract

We develop and test a theory of the interaction between investors' heterogeneity, risk, transactions costs and trading volume. To test our model we take advantage of the specific nature of trading motives around the distribution of cash dividends namely the costly trading of tax shields. Consistent with the theory, we show that when trades occur because of differential valuation of cash flows an increase in risk or transactions costs reduces volume. It is also shown that the non-systematic risk plays a significant role in determining the volume of trade. Finally, we demonstrate that trading volume is positively related to the degree of heterogeneity and the incentives of the various groups to engage is trading.

I. INTRODUCTION

Price and trading volume are the two most important statistics describing financial markets activity. Financial economists have developed models to understand how different preferences and information are aggregated into a single market price. Hence asset pricing theory can be thought of as a theory of aggregation. By contrast, a theory of market volume must explicitly take agents' heterogeneity into account. While differential liquidity needs or information have been proposed as a source of trading volume, there is no consensus as to their relative importance. Moreover, a theory of volume based on these motives must explain not only the level of volume, but also the timing of the trades.

Constructing a model of trading volume is a non-trivial task. Indeed, in complete markets with multiple agents, no trade takes place after the initial trading day (see for instance Arrow (1953)). Hence heterogenous preferences alone cannot explain trading volume. As a consequence, models of volume based on differential preferences have assumed some degree of market incompleteness (see for instance Dumas (1989) and Campbell *et. al.* (1991)). Similarly, heterogenous information alone does not explain market volume as shown by the rational expectations literature. If, as usually assumed, agents have common priors, i.e. they agree on the prior distribution of uncertainty and disagree only after observing different signals, then unobservable liquidity shocks are needed to generate trading (see for instance Grossman (1981), Tirole (1982), Wang (1993) and Blume *et al.* (1993)). By contrast if agents have different priors, they will trade even in the absence of liquidity shocks (see Harris and Raviv (1992) or Biais and Bossaert (1993)).

In this work, we develop and test a theory of the interaction betweeen investors' heterogeneity, risk, transactions costs and trading volume. For tractability, we consider the case of heterogenous valuation as opposed to heterogenous information.[1] To test our theory, we take advantage of the specific nature of trading motives around the distribution of cash dividends. Trading around this event results neither from differences in information sets nor from differences in opinions but from tax induced differential valuations of dividends. While the present work focuses on dividend distributions, we believe that the insights and the methodology can be applied in other contexts as well.[2]

We analyze trading in the stock market around the ex-dividend day.[3] Because of the differential tax treatment of dividends and capital gains investors do not value \$1 of dividends as equal to \$1 of capital gains (see Elton and Gruber (1970)). For example, if dividend income is taxed at 50% while capital gain income is taxed at 20%, the investor values \$1 of dividend income at \$.625 of capital gain income.[4,5] By contrast, corporate investors who have a higher tax rate on capital gain income (46%) than on dividend income (6.9%) value dividend income more than capital gain income: with these rates, they are indifferent between \$1 of dividend income and \$1.72 of capital gain income.[6] Finally tax exempt investors value \$1 of dividend income at \$1 of capital gain income.

Since the tax code create differences in asset *valuation* as opposed to differences in opinion or information, tax related trading will occur around the ex-day in a fairly predictable manner. For now,

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[1]Models of trading volume based on market incompleteness or heterogenous information generate important insights into the time series relationship between price and volume. However they become untractable in the presence of transactions costs.

[2]See the discussion in the concluding section.

[3]The ex-dividend date is defined as a the first trading date in which the stock trades without the dividend.

[4]Prior to the 1986 Tax Reform Act (TRA), individual investors who held a stock for at least six months paid lower tax on capital gain (20%) than on ordinary dividends (50%). The TRA eliminated all distinction between capital gains and ordinary income. However, it is still possible to defer taxes on capital gains by not realizing the gains.

[5](1-.5)/(1-.2) = .625.

[6]Before the 1986 TRA a corporation who holds the stock of another corporation paid taxes on only 85% of the dividend. Therefore the effective tax rate for dividend income was .15x.46 = .069. After the TRA the corporation income tax rate was reduced to 34% and the fraction of the dividend exempted from taxes was also reduced to 70%. The effective tax rate for dividend income is now .3x.34 = .102.

consider the following stylized example (i) $1 dollar in dividends is paid; (ii) the cum-day price is $100[7] and (iii) the price drop subsequent to the payment of the dividend was known and equal to $.8. In this case, investors who value the dividend for more than $.8 will buy the stock, cash the dividend and sell it later at a $.8 loss. By contrast an investor who values the dividend for less than $.8 follows the opposite trading strategy. With the tax rates as described in the previous paragraph (and ignoring transactions costs and risk for the time being), the after-tax per share profits of the individual investors, tax exempt investors and corporate investors are $.14, $.2 and $.5, respectively.

From our discussion above, it is clear that a greater degree of tax heterogeneity in the economy leads to a higher volume around the ex-day. By contrast, risk and transactions costs reduce volume by making the transfer of dividend paying stocks from investors who do not like dividends to those who do more costly.

First, a tax 'arbitrage' strategy entails a (temporary) deviation from optimal risk sharing since around the ex-day, investors do not hold the market portfolio.[8] For example, a corporate investor buying a stock going ex for tax purposes will be overly exposed to movements of the stock's price. This risk will be large if the minimum holding period necessary to claim the dividend exclusion is large. But even if the stock must only be held overnight, the risk is not trivial. Assuming an overnight risk of about $1 on a $100 stock, which is not unreasonable, one can see that tax related trading should be treated not as a pure arbitrage, but as a risky investment.

Second, transaction costs must be taken into consideration, given that the potential gains are only a fraction of the dividend and are therefore relatively small compared to the stock price. Indeed, the

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[7]The cum-day is the last date that the stock trades with the dividend.

[8]In this paper we refer to a tax-induced trading strategy as a tax 'arbitrage'. Academics usually define as an arbitrage strategy a trading strategy which requires no initial funds and yet provide positive profits. However, a more recent literature recognizes that, in the presence of frictions, 'arbitrage' strategies are often risky investment strategies (see Tuckman and Vila (1992, 1993)).

typical (retail) brokerage costs for common stocks averages 2% on the dollar amount of the trade while the bid-ask spread for actively traded stocks averages around .5% (see Ayiagari and Gertler (1991)). This implies that dividend capture is probably not profitable for small investors who face large transactions costs and that only liquid stocks with a high dividend yield will show a significant amount of tax related trading around the ex-day.

Finally, our model indicates that risk and transactions costs interact in a very interesting way. If transactions costs are negligible, market risk does not affect volume since market risk can be hedged. On the other hand, if market risk is too costly to hedge, then the stock's market risk is as important as its idiosyncratic risk in restricting volume. In the intermediate case, both the market risk and the idiosyncratic risk will affect volume but the effect of the later will be smaller.

To summarize the discussion so far, the main theoretical and empirical points of the paper are that i) investor's heterogeneity in valuation creates volume, ii) transactions costs reduce volume and iii) risk reduces volume. At this stage, only point iii) deserves comment. To our knowledge, the existing empirical evidence shows that on regular trading days, volume and volatility are *positively* correlated (see for instance Gallant, Rossi and Tauchen (1991)). There is no theoretical contradiction however. On regular trading days, investors trade for risk sharing purposes, but because of transactions costs they do not achieve a Pareto optimal risk sharing (see Heaton and Lucas (1992) for instance). When risk increases, the cost of deviating from the Pareto optimal holdings also increases. Therefore volume increases. By contrast, on the ex-day, investors trade *away* from their optimal holdings and hence risk reduces volume.

In our empirical study we consider the *abnormal volume* around the ex day, that is, the volume in excess of regular volume. We find that the abnormal volume is significant and varies both over time and across stocks. In particular, the abnormal volume is much larger for high yield stocks. This is consistent with our theory since tax induced trading in high yield stocks is more profitable than in a low yield stock for the same level of risk and transactions costs. It is also consistent with previous evidence by Lakonishok and Vermaelen (1986).

Next, we document that both the market risk and the idiosyncratic risk negatively affect the level of volume but that the impact of the market risk is lower. These findings indicate that investors do hedge their transactions but only partially because of transactions costs.

We then turn to the direct relationship between transactions costs and trading volume. Using the bid-ask spread as a measure of transactions costs and dividing stocks in three groups according to their bid-ask spread, we find that abnormal volume is about five times higher for low transactions costs stocks than for high transactions costs stocks. This simple unconditional result extends to a multivariate cross-sectional regression analysis. Using the abnormal volume as the left hand side variable with dividend yield, beta, idiosyncratic risk, and bid ask spread as right hand side variables, the latter is found to have a significant negative coefficient.[9]

To interpret these results, remember that we are talking about *abnormal* volume. While the negative relationship between transactions costs and volume has been documented elsewhere (see for instance Demsetz (1968) and Stoll (1989)), our results indicate that transactions costs inhibit trading proportionally more when agents engage in 'arbitrage' transactions than on normal trading days.

So far we have seen that tax 'arbitrage' strategies subject investors to both risk and transactions costs. Derivative securities, such as options and futures, allow investors to hedge, i.e. reduce risk, at a relatively small cost. We provide both time series and cross-sectional evidence that the presence of

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[9] This negative relationship between transactions costs and abnormal volume can also be detected from time series evidence. In may 1975 brokerage commission schedules were changed from fixed to negotiated, thereby substantially reducing the cost of transacting, especially for large traders. Consistent with Lakonishok and Vermaelen (1986), we find that abnormal volume around the ex day goes up after that date.

options increases abnormal volume. We find that after an option on a particular stock is listed, the abnormal ex-day volume on this particular stock goes up. We also find that stocks with listed options exhibit more abnormal volume than similar stocks without listed options.

Another implication of our model is that, because of transactions costs, the abnormal volume on a stock going ex is lower when many stocks are going ex. This is because each transaction subjects the investor to additional risk while the risk bearing capacity of investors is finite. Our empirical findings are consistent with this implication.

Finally, we provide time series evidence that a greater degree of heterogeneity creates abnormal volume. Our results indicate that heterogeneity has a significant effect on trading volume, especially in stocks where corporate and institutional traders are more dominant. We also show that the volume of trade is significantly higher when corporations have capital gains to offset the tax arbitrage capital losses.

The paper is organized as follows. Section II is devoted to the presentation of the theoretical model and its empirical implications. Section III presents the data set. The empirical results are detailed in section IV while section V contains some concluding remarks.

II. A THEORY OF THE EX-DIVIDEND DAY TRADING VOLUME

We describe the determination of trading volume around the ex-dividend date in an equilibrium model along the lines of Michaely and Vila (1991).[10] Agents in this economy are assumed to be trading in K+1 assets, a risk free bond and K risky dividend paying stocks. These assets are traded on two dates: the cum-day which is the last date where stocks are traded before the dividends are paid and the ex-day which occurs after the dividends are paid. After the ex-day all assets are liquidated.[11]

The stock prices at liquidation are represented by an exogenous random vector $\tilde{v}$. This random vector can be written as

$$\tilde{v} = \bar{v} + \tilde{u}_e + \tilde{u}_l$$

where $\tilde{u}_e$ and $\tilde{u}_l$ denote the information realized at the ex-day and liquidation respectively. We assume that $\tilde{u}_e$ and $\tilde{u}_l$ are mean zero, independent normally distributed random variables with variance-covariance matrices ω_e and ω_l, respectively. The variables p_c and p_e denote the stock price vector at the cum-day and at the ex-day, respectively. In addition, the stocks pay a known dividend d at the ex-day. Finally, the risk-free bond pays a constant interest rate which for the sake of the exposition is set equal to zero.

There are N agents in the economy, n=1..N. Each agent n is initially endowed with $\bar{x}^n$ shares of stocks and b^n bonds. The initial share allocation $(\bar{x}^1,..,\bar{x}^N)$ is Pareto optimal so that no trading of shares would take place where it not for the payment of dividends and the differential tax treatment of dividends and capital gains described below. All agents are subject to proportional taxes on both

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[10]However, unlike Michaely and Vila (1993), agents may trade in more than one risky asset and face transactions costs.

[11]As we shall see, our simple model could be embedded in a infinite horizon model.

dividends and capital gains at rate at rates τ_d^n and τ_g^n, respectively. All taxes are paid at liquidation. In addition, when agent n trades at the cum-day in asset k, he is subject to a proportional transactions cost of c_k^n per share. The vector of transactions costs faced by agent n is denoted by c^n. We make the simplifying assumption that trading at the ex-day is *not* subject to transactions costs. This assumption is not as restrictive as it sounds. Indeed it amounts to assuming that, when doing a round trip transaction, for example buying a share at the cum-day and selling it at the ex-day, transactions costs are paid upfront. We assume that transactions costs can be deducted from taxable capital gain income, i.e. that the IRS taxes capital gains net of transactions costs. Finally, we assume that each agent k maximize his expected utility of after-tax final wealth and that his utility function exhibits constant absolute risk aversion with coefficient ρ^n.

2.1. Equilibrium prices and volume

We first describe agent n's intertemporal budget constraint. Agent n's before-tax wealth is given by

$$W^n_{BT} = b^n + p_c'(\bar{x}^n - x_c^n) - c^{n\prime}\,|x_c^n - \bar{x}^n| + d'x_c^n + p_e'(x_c^n - x_e^n) + \tilde{v}'x_e^n \tag{1}$$

where x_c^n and x_e^n denote agent n's holding at the ex-day and the cum-day respectively.

Agent n's taxes are given by

$$T^n = \tau_g^n\,[\,(p^c - \bar{p}^n)'\bar{x}^n + (p_e - p_c)'x_c^n + (\tilde{v} - p^e)'x_e^n - c^{n\prime}\,|x_c^n - \bar{x}^n|\,] + \tau_d^n\,d'x_c^n \tag{2}$$

where $\bar{p}^n$ is investor n's tax basis for asset k (i.e. the price initially paid for the $\bar{x}_k^n$ shares).

Combining equations (1) and (2), we write agent n's final wealth after taxes, W_{AT}^n as:

$$W_{AT}^n = \{b^n + [p_c - \tau_g(p_c - \bar{p}^n)]'\bar{x}^n\} + (1-\tau_g)\{(p_e - p_c)'x_c^n + (\tilde{v} - p_e)'x_e^n - c^{n\prime}\,|x_c - \bar{x}^n|\} + (1-\tau_d)d'x_c^n. \tag{3}$$

Equation (3) says that after-tax final wealth equals after tax initial wealth plus after tax capital gains net of transactions costs plus after tax dividend income. We denote by W_0^n the after tax initial wealth and by α^n the tax induced preference for dividends vs. capital gains, that is,

$$\alpha^n = \frac{1-\tau_d^n}{1-\tau_g^n} \, . \tag{4}$$

With these notations, agent n's final wealth after taxes can be written as

$$W_{AT}^n = W_0^n + (1-\tau_g^n)\ \{(p_e-p_c+\alpha^n d)'x_c^n - c^{n\prime}\ |x_c^n-\bar{x}^n| + (\tilde{v}-p_e)'x_e^n\} \, . \tag{5}$$

The next step is to describe the equilibrium prices and quantities on the ex-day. Given the normality and constant absolute risk aversion assumptions, standard derivations yield that

$$p_e = \bar{v} + \tilde{u}_e - \frac{1}{\theta}\omega_1\bar{x}$$

and

$$x_e^n = \frac{\theta^n}{\theta}\bar{x} \equiv \bar{x}_n$$

with the following notations:

$$\theta^n = \frac{1}{(1-\tau_g^n)\,\rho^n}$$

is the tax-adjusted risk tolerance of agent n,

$$\theta = \sum_{n=1}^{N} \theta^n$$

is the aggregate risk tolerance and

$$\bar{x} = \sum_{n=1}^{N} \bar{x}^n$$

is the aggregate supply of stocks. As expected, on the ex-day the economy reverts to the initial Pareto optimal risk sharing. Hence our ex-day trading equilibrium can be embedded in an infinite horizon framework where risk sharing is always optimal except around taxable distributions.

Finally, we derive the demand for stocks on the cum-day and the equilibrium prices and volume. We denote by $\bar{p}_e$ the expected ex-day price i.e.

$$\bar{p}_e = \bar{v} - \frac{1}{\theta}\,\omega_1\bar{x} \, .$$

Given the assumptions of normality and constant absolute risk aversion, and equation (5), agent n's problem consists of maximizing

$$(\bar{p}_e - p_c)' x_c^n + \alpha^n d' x_c^n - (c^n)' |x_c^n - \bar{x}^n| - \frac{1}{2\theta^n} (x_c^n)' \omega_e x_c^n. \tag{6}$$

The first order condition is

$$\bar{p}_e - p_c + \alpha^n d - c^n \otimes \epsilon^n - \frac{1}{\theta^n} \omega_e x_c^n = 0$$

where the vector ϵ^n is defined as

$$\epsilon_k^n = 1 \qquad \text{if} \qquad x_{ck}^n > \bar{x}_k^n$$

$$\epsilon_k^n = -1 \qquad \text{if} \qquad x_{ck}^n < \bar{x}_k^n$$

$$-1 \leq \epsilon_k^n \leq 1 \qquad \text{if} \qquad x_{ck}^n = \bar{x}_k^n$$

and the vector $c^n \otimes \epsilon^n$ as

$$(c^n \otimes \epsilon^n)_k = c_k^n \epsilon_k^n.$$

From the first order condition, the equilibrium price satisfies

$$p_c = [\, \bar{p}_e + \bar{\alpha} d - \frac{1}{\theta} \omega_e \bar{x} \,] - \sum_{n=1}^{N} \delta^n c^n \otimes \epsilon^n \tag{7}$$

where δ^n is the share of agent n in the economy, as measured by his risk tolerance, that is

$$\delta^n = \frac{\theta^n}{\theta}$$

and $\bar{\alpha}$ is the average preference for dividends vs. capital gains i.e.

$$\bar{\alpha} = \sum_{n=1}^{N} \delta^n \alpha^n .$$

Equation (7) decomposes the cum-day price into two components. The first component (within brackets) is the cum-day price in the absence of transactions costs. It is equal to the expected (risk adjusted) ex-day price plus the after-tax market value of the dividend vector, $\bar{\alpha}d$. The second component measures the impact of transactions costs on the ex-day price. Its sign is ambiguous: If buyers face larger (lower) transactions costs than sellers, then the cum-day price will be lower (higher) than in the absence of transactions costs.

Plugging (7) into the first order condition yields the equilibrium holdings

$$x_c^n = [\,\bar{x}^n + \theta^n(\alpha^n-\bar{\alpha})\omega_c^{-1\prime}d\,] + \theta^n\omega_c^{-1\prime}[\sum_{m=1}^{N}\delta^m c^m\otimes\epsilon^m - c^n\otimes\epsilon^n] \tag{8}$$

The first term in equation (8) represents the investor's optimal trading strategy in the absence of transactions costs. The interpretation is very simple. If the tax differential between dividend income and capital gain income of agent n is greater than the market average, he will hold more of the dividend paying assets than he usually would have held during non-dividend paying periods. The second term represents the adjustment of his strategy due to the fact that i) the equilibrium price will be different because other traders face transactions costs and ii) he himself faces transactions costs. The difficulty with equations (7) and (8) is that the variables ϵ_k^n are endogenous since they depend upon the sign of individual trades. Hence in general it is impossible to solve for ϵ_k^n.

In what follows we will analyze the properties of the equilibrium in a simple one factor model.

2.2. The zero transactions costs case

We first consider the case where all transactions costs are zero, i.e. $c_k^n \equiv 0$. In this case, the price and volume vectors on the cum day, p_c^* and V_c^* are given by

$$p_c^* = \bar{p}_c + \bar{\alpha}d - \frac{1}{\theta}\omega_c\bar{x} \tag{9}$$

and

$$V_c^* = \frac{\theta}{2}[\sum_{n=1}^{N}|\delta^n(\alpha^n-\bar{\alpha})|]\,|\omega_c^{-1}d|\,. \tag{10}$$

Given the normality assumption, the tax-adjusted CAPM holds so that stock prices depend only upon market risks and not upon idiosyncratic risks. By contrast, the trading volume on any given stock is not affected by the stock's market risk. To see this point in the simplest possible manner, we consider a symmetric one factor case where:

(i) the information shock on the ex day $\tilde{u}_{et}$ can be written

$$\tilde{u}_{et} = \tilde{\delta} + \tilde{\eta}_t$$

with $\tilde{\delta}$ independent of the $\tilde{\eta}_t$'s with variance σ_M^2, and the $\tilde{\eta}_t$'s identically and independently distributed with variance σ^2, (ii) the supply of all stocks is the same (normalized to one), so that the market portfolio comprises the same dollar amount of each stock and, (iii) a fraction s=S/K of all the stocks pays the same dividend d, while the other stocks do not pay any dividend.

In this case the matrices ω_e and ω_e^{-1} can be written

$$\omega_e = \sigma^2 \begin{pmatrix} 1+\tau & \tau & . & . & \tau \\ \tau & 1+\tau & \tau & . & . \\ . & \tau & 1+\tau & \tau & . \\ . & . & \tau & 1+\tau & \tau \\ \tau & . & . & \tau & 1+\tau \end{pmatrix} \quad \text{and} \quad \omega_e^{-1} = \frac{1}{\sigma^2} \begin{pmatrix} 1-\phi & -\phi & . & . & -\phi \\ -\phi & 1-\phi & -\phi & . & . \\ . & -\phi & 1-\phi & -\phi & . \\ . & . & -\phi & 1-\phi & -\phi \\ -\phi & . & . & -\phi & 1-\phi \end{pmatrix}$$

with

$$\tau = \frac{\sigma_M^2}{\sigma^2} \quad \text{and} \quad \phi = \frac{\tau}{1+K\tau}.$$

From equation (8) with $c_t^n \equiv 0$, and K large (i.e. $K\phi = 1$), investor n's net trade on the cum day equals

$$\frac{1}{\sigma^2}\theta^n(\alpha^n - \bar{\alpha})(1-s)\,d \quad \text{on each stock which pays a dividend and} \qquad (11.a)$$

$$-\frac{1}{\sigma^2}\theta^n(\alpha^n - \bar{\alpha})\,s\,d \quad \text{on stocks which do not pay dividend.} \qquad (11.b)$$

Investor n's trading strategy can be easily described. If investor n likes dividends more than the average investor, i.e. if $\alpha^n > \bar{\alpha}$, then the investor will buy dividend paying stocks and hedge by selling non- dividend paying stock. As can be seen from equation (11), the volume does not depend upon the market risk σ_M^2.

In addition, if s is small compared to one, i.e. when the portfolio of stocks going ex is a small fraction of the market, the volume on each individual stock going ex does not depend upon how many stocks are going ex.

To summarize, when transactions costs are zero our model yields the following testable implications:

Implication 1: The trading volume is an increasing function of the degree of tax heterogeneity in the economy.

The intuition behind this proposition is quite clear. As the differences in valuations widens, i.e. as the tax heterogeneity increases, the gains from trade increase. Hence trading volume goes up.

Implication 2: The trading volume is an increasing function of the dividend yield.

Keeping all other variable constant, as the dividend yield increases the gains from transfering the dividend from high tax investors to low tax investors also increases.

Implication 3: The trading volume is a decreasing function of the idiosyncratic risk σ^2.

Investors buying (selling) dividend paying stocks find themselves over- (under-) invested in these stocks. As a result they are exposed to the idiosyncratic risk of these stocks.

Implication 4: The trading volume does not depend on the market risk component of the stock risk σ_M^2.

In the absence of transactions costs, the market risk can be costlessly hedged and hence does not inhibit trading. Implications 3 and 4 combined with equation (9) show that risk affects prices and volume differently. Market risk affects prices and not trading volume while idiosyncratic risk affects trading volume and not prices.

Implication 5: If only a small fraction of stocks are going ex, the trading volume on any stock going ex does not depend upon the number of stocks going ex.

Since hedging the market risk is costless, the additional risk in the ex-day 'arbitrage' is independent across stocks. Hence the trading activity on one stock is not affected by the trading activity on another stock.

2.3. The role of transactions costs

Transactions costs limit investors' tax related trading. To see that the effect of transactions costs is likely to be significant, consider a \$100 stock which pays a \$1 quarterly dividend and assume that $\bar{\alpha}=.8$.[12] With these numbers, a corporate investor ($\alpha^n=1.72$) makes \$.92 per share. Hence the return on this strategy is about .92% which is comparable to transactions costs. A tax exempt investor ($\alpha^n=1$) makes .2% which is well below the range of transactions costs for most investors. Given the casual remarks above, we expect transactions costs to be a significant factor in the ex-day trading activity.

With transactions costs, the equilibrium prices and quantities are much harder to calculate. Transactions costs limit the number of investors who participate in the ex-day trading as well as the trading activity of those who do participate. The effect on volume is clear: volume is reduced. On the other hand, since transactions costs limit the trading of both buyers ($\alpha^n>\bar{\alpha}$) and sellers ($\alpha^n<\bar{\alpha}$) the resulting effect on prices is somewhat ambiguous.[13]

To see that, we construct a symmetric example along the lines of the one presented in section 2.2. In addition to the assumptions in section 2.2., we assume that the distribution of investors' tax preference parameter α^n (with probability δ^n) is symmetric around $\bar{\alpha}$ and that all investors face the

[12] This value is consistent with Elton and Gruber (1970), Michaely (1991) and our results in section (3).

[13] See Vayanos and Vila (1993) for a discussion of the relationship between transactions costs and prices.

same transactions costs $c_t^n \equiv c$ on every asset.

The symmetry assumption makes the model tractable which is unusual for multi-assets models with transactions costs.[14] In particular, prices are not affected by transactions costs and the tax-adjusted CAPM holds. This allows for a simple description of trading strategies and therefore market volume (the details of the derivation can be found in appendix A). Agents can be divided in five endogenous groups characterized by two constants $0<t<h$ which depend among other things on the level of transactions costs and in the dividend amount:

(i) $|\alpha^n-\bar{\alpha}| \leq t$: The investor's valuation of a dollar of dividend is close to the market price of a dollar of dividend. Trading is too costly compared to the benefits.

(iia) $t < \alpha^n-\bar{\alpha} \leq h$: The investor buys dividend paying stocks but does not hedge because hedging is too costly. In this case, dividend arbitrage subjects the investor to the total risk of the *portfolio* of stocks going ex.[15]

(iib) $-h \leq \alpha^n-\bar{\alpha} < -t$: Similarly, the investor sells dividend paying stocks and does not hedge.

(iiia) $h < \alpha^n-\bar{\alpha}$: The investor's private valuation of dividends is quite different from the market's. Therefore he takes a large position in dividend paying stocks and hedges a portion of the market risk that he undertakes. The optimal hedging strategy (derived in appendix A) equates the marginal cost of hedging, i.e. the transactions cost, to the marginal benefit i.e. the marginal cost of the market risk. In addition, the optimal arbitrage decision equates the marginal profit net of transactions costs to the marginal cost of the additional risk. Since the marginal cost of the additional risk equals the marginal cost of the idiosyncratic risk plus the

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[14]See also Fremault (1992) for another example.

[15]Since transaction costs are proportional diversification is not costly: The investor prefers to buy *all* dividend paying assets than just a subset. In the presence of fixed transactions costs, the investor will trade only a subset of the dividend paying stocks (see Fremault (1992) for a similar result).

marginal cost of the market risk, we obtain the first order condition: marginal profit of arbitrage equals marginal cost of the idiosyncratic risk plus marginal cost of hedging. It follows that the investor's trade is independent of the level of the market risk and a decreasing function of the idiosyncratic risk.

(iiib) $\alpha^n - \bar{\alpha} < -h$: The investor sells dividend paying stocks and hedges the market risk.

Given this relatively simple classification of investors, we can derive the following testable implications (see appendix A for details):

Implication 6: The trading volume is lowered by the presence of transactions costs.

In the presence of transactions costs such as brokerage commissions and bid-ask spreads, investors trade less and hedge less. As a result, transactions costs make tax 'arbitrage' not only more costly but also more risky.

Implication 4': The trading volume is a decreasing function of *both* the market risk component of the stock risk and the idiosyncratic risk. The effect of idiosyncratic risk is stronger.

The intuition for implication 4' follows from our previous discussion of the trading strategies of the different groups. The trading of all active agents is affected by the idiosyncratic risk while the market risk affects only the trading described in (iia) and (iib).

Implication 5': The trading volume on each individual stock is a decreasing function of the number of stocks going ex.

This may look counterintuitive since when a large number of stocks are going ex, the dividend paying portfolio contains less idiosyncratic risk. Hence there will be more *aggregate* dividend arbitrage trading. But the trading volume per stock will be lower since agents' willingness to assume a non-optimal amount of market risk is limited.[16]

Finally, in the presence of transactions costs agents take smaller positions. This is true in particular for agents who do not hedge. As a result, the idiosyncratic risk is less a factor in the determination of the trading volume.

Implication 7: In the presence of transactions costs, the trading volume is less sensitive to the idiosyncratic risk.

The model presented in this section relies on several specific assumptions that were useful if not necessary for analytical tractability. Two assumptions in particular deserve comment.

First, we have assumed that the initial allocation was Pareto optimal. As a result, tax heterogeneity is the only source of abnormal volume. We also assumed that transactions costs are paid up front so that all investors revert to their initial position at the ex-day. For example, long term investors sell dividend paying stocks at the cum-day and buy them back at the ex-day. In the traditional literature on the ex-day (Elton and Gruber (1970)), long term investors trade around the dividend payment for precisely liquidity reasons. Sellers trade at the cum while buyers trade at the ex. Since there is no *a-priori* reason to believe that there are more long term sellers than long term buyers, *as a group*, long term investors behave as in our model.[17]

Second, in order to obtain a closed form solution for trading volume in the presence of transactions costs we have considered a simple symmetric model. While a more general model with a non-

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[16]An analogous situation occurs in portfolio theory: A constant absolute risk aversion investor having access to two positively correlated assets will invest less in each of them than he would if he had access to only one of them. However the total amount invested will be higher.

[17]If transactions costs are zero, assuming non Pareto-optimal initial allocations (which allows for long term traders as in Elton and Gruber (1970)) is a minor modification (see Michaely and Vila (1991)).

symmetrical distribution of tax rates, cross sectional variation of factor loading and transactions cost might yield new insights, we believe that our empirical implications are robust to these specifications. In appendix B, we show that our results hold in a model with non unit beta and differential transactions costs.

III. DATA

Data on dividend distributions, ex-dividend dates, and daily trading volume are compiled from the CRSP 1991 daily master tapes. Stocks are included in the sample if they are listed on the NYSE or AMEX between January 1963 and December 1991 and pay a taxable cash dividend (distribution types 1212 through 1292 on the CRSP tapes). Ex-dividend day events are included in the sample if:

(1) there are at least 40 daily volume observations in the estimation period (days -45 to -6, and days +6 to +45), to estimate the expected daily trading volume and,

(2) the trading volume is positive in at least one of the 11 days around the ex-day.

The final sample consists of 155,302 taxable cash dividend distributions.[18] Dividend yields are calculated as the dividend amount over the cum-dividend day price. We use the average of market value of equity in the 80 day estimation period as a proxy for the firm's market capitalization around the event. Our invsetigation also requires estimates of bid-ask spreads. We use data from the 1988-1990 ISSM transaction files to calculate the average bid-ask spread.

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[18] We have repeated the entire experiment for only ordinary quarterly dividends. The results are practically the same as reported in the paper. This is not surprising given that over 91% of the dividends in our sample are quarterly dividends (2.30% are monthly, 2.38% are categorized as unspecified, 1.2% are semi-annual, 1.68% are special, and no other category has more than 0.3% of the observations.) Also the inclusion of events with zero trading volume on the ex-day, does not affect any of our conclusions. Finally, to ensure that our results are not due to 'spillover' of abnormal volume from the announcement date, we included only events in which the announcement date was at least four days prior to the ex-dividend day. The sample contains 138,142 ex-day observations (about 89% of the original sample). The cumulative abnormal volume for this sample is 94.7% (t = 23.46) compared with a CAV of 100.6% for the entire sample and the ex-dividend day abnormal volume is 14.00% (t = 16.71) compared with an AV of 14.7% for the entire sample. We repeated several of the experiments described below with this subsample. None of our conclusions changed.

IV. EMPIRICAL RESULTS

4.1. Summary statistics and variable definitions.

Table I contains summary statistics on the abnormal volume (AV), the cumulative abnormal volume (CAV), in the eleven days centered around the ex-dividend day, and the cumulative abnormal volume weighted by the market capitalization of the firms going ex, (WCAV). To compute these variables, we first calculated the mean volume in the estimation period for each event. The mean volume for event i is defined as the mean daily turnover for days -45 to -6 and +6 to +45:

$$ATO_i = \frac{\sum_{t \in [-45,-6] \cup [+6,+45]} TO_{it}}{T}$$

where TO_{it} is the daily turnover (shares traded relative to shares outstanding) for security i in day t and T is the number of days with valid volume observations in the estimation period.

Then, for each day in the event period we calculated the abnormal volume as

$$AV_{it} = \frac{TO_{it}}{ATO_i} - 1, \qquad t \in -5,\ldots,+5.$$

The mean daily abnormal turnover for the entire sample is calculated as

$$AV_t = \frac{\sum_{i=1}^{N} AV_{it}}{N}, \qquad t \in -5,\ldots,+5$$

where N is the number of events with valid observations in day t.

Alternatively, one may argue that more weight should be given to larger stocks since a higher turnover in those stocks implies much higher abnormal dollar volume than the same turnover for smaller stocks. Hence we also computed the average daily turnover, weighted by the stock's market capitalization

$$WAV_t = \frac{\sum_{i=1}^{N} AV_{it} \cdot \bar{C}_i}{\sum_{i=1}^{N} \bar{C}_i}, \quad t \in -5,\ldots,+5$$

where $\bar{C}_i$ is the stock's market capitalization calculated as

$$\frac{\sum_{t \in [-45,-6] \cup [+6,+45]} P_{it} \cdot S_{it}}{T} .$$

and P_{it} and S_{it} are the stock price and number of shares outstanding for event i in day t, respectively.

The cumulative abnormal volume is the sum of the daily abnormal volume for the eleven days around the event that is

$$CAV_i = \sum_{t=-5}^{+5} AV_{it} .$$

The average cumulative abnormal volume (CAV), and the weighted average cumulative abnormal volume (WCAV), are defined in the same way as AV and WAV for abnormal volume. T-statistics for the volume behavior around the ex-dividend day are calculated using the cross-sectional estimates of the variance of abnormal volume.[19]

For the entire sample, the ex-dividend day volume is 14.7% higher than average, and in the eleven day period, the cumulative abnormal volume is more than 100% higher than regular trading volume, both are significant with a t-statistics of 24.62 and 33.07 respectively. The average dividend yield in the sample is 1.001%. Also reported in the table are the volume statistics when the sample is partitioned by dividend yield. Observations are sorted into three groups according to their yield, and means are calculated within each yield group. The dividend yields for the high, medium, and low yield groups are 1.70%, 0.89% and 0.41% respectively. Both the ex-day abnormal volume and the

[19]Korajczyk, Lucas and McDonald (1991) use this procedure to examine price behavior around seasoned equity issue announcements (see also Collins and Dent (1984).)

cumulative abnormal volume increase monotonically with yield. A significant difference however is observed only between the medium and high yield groups: 6.17% vs. 33.14% abnormal volume. In fact, for the high yield group, the CAV is almost 200%, and is about three times higher than for the medium yield group. The size-weighted cumulative abnormal trading volume is higher than the unweighted CAV. For example, for the high yield group, WCAV is 449%, more than double the CAV (196.3%). As discussed later, the higher size-weighted volume may be related to the negative association between size and transaction costs.

The finding of positive association between dividend yield and abnormal volume is consistent with the model's implication (implication 2), as well as with several prior findings. Using a sample of 1200 ex-dividend days, Grundy (1985) finds that the trading volume for the group with dividend yield greater than 1.2%, is higher than for the group with dividend yield less than 1.2% (no significance test is reported). Similarly, Lakonishok and Vermaelen (1986) report a higher increase in abnormal trading in the three days preceding the ex-day of high yield stocks.

From Table I we can see that trading due to the upcoming dividend does not occur only on the cum-day and on the ex-day, but starts several days before the ex-day. Therefore in subsequent analyses, we report the results using the cumulative abnormal trading volume in the eleven days around the ex-day.

The second part of Table I contains information about the bid-ask spreads of the stocks in our sample. The bid-ask spread is used as one of our proxies for cross sectional differences in transactions costs. There are several reasons why it is considered as a good proxy. First, for many of the traders that are involved in ex-day trading, such as corporations and institutional investors, the bid-ask spread is the major component of their transactions costs. Second, as Stoll and Whaley (1983) and Amihud and Mendelson (1986) show, the correlation between total transactions costs and the bid-ask spread is very high. Finally, using a sample of NASDAQ firms, Karpoff and Walkling (1990) show that the ex-day excess return is positively correlated with the bid-ask spread, consistent with the effect of transactions costs on ex-day returns in the presence of 'arbitrageurs'.

The ISSM data includes intra-day bid-ask spreads, which were used to estimate the average bid-ask spread for each event in our 1988-1990 sample. For each day in the estimation period, we use the opening, mid-day, and closing bid-ask spread to calculate a daily spread. The mean spread for event i is defined as the average daily spread over the estimation period:

$$BAS_i = \frac{1}{T_i} \sum_{t=-45}^{-6} \frac{1}{3} \sum_{j=1}^{3} \frac{Ask_{tji} - Bid_{tji}}{\frac{1}{2}\,(Ask_{tji} + Bid_{tji})} \tag{12}$$

where j = open, mid-day, or close transaction, t is the day relative to the ex-dividend day and T_i is the number of days in the estimation period with valid observations.

Table I contains some statistics on the bid-ask spread, using a sample of 15,900 ex-dividend day events in the period 1988 to 1990. The mean and median spread are 1.53% and 1.32% respectively, and the standard deviation of the mean spread is 0.96%. It should be noted however that the actual bid-ask spread is likely to be lower than what is described in Table I. First, since the ex-dividend is a non information event and many of the trades are not motivated by private information but rather by private valuation, the adverse selection component of the bid-ask spread is lower than in 'regular' days. Indeed Koski (1991) show that the average relative bid ask spread on the cum and ex-day is around 0.65%, compared with a regular day bid-ask spread of 1.53% in our sample.[20] Lee (1993) estimates that over 62% of the transactions on the NYSE are executed between the bid and ask quotes, and therefore argues that the quoted bid-ask spread overstates the actual spread. In addition,

[20]Supporting evidence to this claim can also be found in Madhavan and Smidt (1991) and Castanias, Chung and Johnson (1988). Madhavan and Smidt (1991) find that the informativeness of the trade significantly affect specialist behavior. Castanias, Chung and Johnson (1988) report that the bid-ask spread for informationless trades in options are much smaller than for normal trades.

Koski (1991) brings direct evidence from the ex-day activity, that some large traders are able to substantially reduce the actual bid-ask spread through bilateral bargaining. However, as long as the cross-sectional differences in the observed bid-ask spreads reflects the actual cross-sectional differences in transactions costs, our conclusions are not altered.

4.2. Risk, Transactions Costs and Trading Volume Around The Ex-Dividend Day

As has been theoretically established in the previous section, the volume of trade depends, among other things on the risk and the amount of transactions costs involved in the trading. The effect of these two variables on the trading volume, however, are interrelated. First, the model predicts that ex-dividend days associated with more risk will experience lower trading volume. This relation varies, however,depending on whether the risk is idiosyncratic or systematic (Implications 3 and 4). These predictions are tested empirically in section 4.2.1. Second, a change in transactions costs has a direct effect on the volume of trade when investors have differential valuations of cash flows. Implication 6 states that as the level of transactions costs increases, the abnormal trading volume will decrease.

The direct relation between transactions costs and trading volume is examined in section 4.2.2. The third, and perhaps the most interesting conclusion of the model concerns the interplay between risk and transactions costs and their effect on trading volume. The model implies that systematic risk will have no effect on trading volume if there are no transactions costs, but will have a negative impact in the presence of transactions costs. On the other hand, the model implies that the idiosyncratic risk will have a negative effect on trading volume with or without transactions costs. In addition, the interaction between those risk factors and transactions costs results in an opposite prediction about their effect on trading volume: the higher the level of transactions costs, the lower will be the impact of the idiosyncratic risk on trading volume and the higher will be the impact of the systematic risk. The intuition behind the result that idiosyncratic risk has a lesser role when transactions costs are high is that agents will tend to hedge less, and consequently assume significantly smaller positions. These implications are tested in section 4.2.3.

4.2.1 The direct effect of risk on trading volume.

Implications 3, 4 and 4' state that both the idiosyncratic risk and the systematic risk have a non positive effect on the level of abnormal trading volume. In the presence of transactions costs, Implication 4 states that both risk factors have a negative effect on trading volume and that the effect of the idiosyncratic risk is stronger. We examine the effect of these two types of risk using a regression analysis, reported in Table II. The dependent variable is the cumulative abnormal volume in the eleven days around the ex-day. The independent variables are the stock's dividend yield, the idiosyncratic risk, normalized by the market risk at the same time period, and the systematic risk, beta. The latter two variables are calculated during the estimation period from daily return observations.

As predicted by the model, both the idiosyncratic risk coefficient and the beta coefficient are negative with values of -0.49 and -0.33 respectively. Both coefficients are significantly different from zero with a t-statistics of 18.65 and 7.82 respectively. The idiosyncratic risk coefficient is about 50% higher (in absolute value) than the beta risk coefficient. The difference is significant with a t-statistics of 3.17. Finally, consistent with prior analysis, the yield coefficient is positive and highly significant with a t-statistics of 8.51.

4.2.2. The role of transactions costs.

As the cost of trading increases, fewer investors will find it profitable to trade around the ex-day, and those who find it profitable to trade will trade for lesser amounts, (Implication 6). The cross-sectional implication of this proposition is that stocks with lower transactions costs will exhibit higher abnormal trading volume around the ex-dividend day.[21] To this end, we first divide the sample into three subgroups according to the cost of trading, estimated by the security's bid-ask spread, [see equation (12)]. Indeed as reported in the last row of Table III, Panel A, as transactions costs increase, the abnormal volume decreases. For the low transactions costs group, the cumulative trading volume is 519.68% higher than the average trading volume, and is only 108.2% higher for the group with the highest transactions costs. For all groups, however, the CAV is significantly greater than zero.

However, as has been established before (implication 2 and Table 1) the incentive to trade increases with dividend yield as well. In order to distinguish between the yield effect and the cost of trading effect, we divided the sample into 9 categories. Each event is categorized by its dividend yield and average bid-ask spread. The mean dividend yield for the three categories are 0.387%, 0.805% and 2.08% for the high- medium- and low-dividend yield groups respectively. Each dividend yield group contains 5300 observations. We sub-divided each of the three subsamples by the cost of transacting, estimated by the bid-ask spread around the ex-day, and measure the abnormal volume for each of those 9 groups.[22] Our model predicts that the volume of trade should increase within each yield group as transactions costs decrease. Moreover, if there is more 'arbitrage' and dividend capture in the high yield stocks, then the increase in the abnormal volume should be more pronounced in those stocks than in the lower yield stocks.

The results indicate that the group with the highest yield and the lowest cost of transactions experience the highest volume of trade around the ex-day: more than 15.5 times the normal trading volume. For the high yield group (third column), an increase in transactions cost has the biggest

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[21] Lakonishok and Vermaelen (1986) show that reduction in transaction costs increases the overall trading volume on the ex-dividend day.

[22] Because of data limitation on bib-ask spread, our sample contains events from 1988-1990 only.

(negative) effect on abnormal volume. The trading volume for the high yield/high transactions cost group is only 2.3 times the regular trading volume. Consistent with the concentration of short term traders and corporations in the high yield stocks, we see that while the trading volume in the low and medium yield stock are not affected by increases in transactions costs to the same extent as the high yield stocks.

In order to use a longer period in our analysis, we construct an additional measure of transactions costs, namely the market capitalization of the firms that are going ex. The use of market capitalization as a proxy for the cost of transacting is largely motivated by the empirical findings of negative correlation between the bid-ask spread and market capitalization. For the events in the period 1988 through 1990 we find that the correlation coefficient is -.298.[23] Indeed the results in Table III, Panel B shows a similar pattern to what has been described in Panel A: The abnormal volume of trade increases as the cost of transacting is reduced, and this increase is more pronounced for the high yield group than for the low yield group. As with the case of the bid-ask spread, the group that is associated with the lowest transactions costs and highest dividend yield exhibit the largest abnormal trading volume: almost 5 times more trading than in regular days. Also, for the largest firms (i.e., lowest cost of trading), abnormal volume increases monotonically with yield. For the medium and low size group, however, there is no much difference between the trading volume for the medium and low yield stocks.

Our long sample period enables us to observe a profound structural change in transactions costs and to test its effect on the incentives to trade around the ex-day. The May 1975 change in commission schedules, from fixed to negotiated, substantially reduced the cost of transacting, especially for large

[23]We are not the first to use market capitalization as a proxy for transactions costs in this context. Lakonishok and Vermaelen (1986) and Karpoff and Walkling(1988) use a similar measure.

traders. Therefore, one would expect an increase in the abnormal volume of trade after 1975. Indeed, as reported in Table IV there is a marked increase in the abnormal trading volume around the ex-dividend day in the period 1976-1991, compared to the first period of 1962-1975. Consistent with the cross sectional analysis reported in Table II, the increase is more pronounced for the high yield stocks than for the medium or low dividend yield stocks.[24]

Of more interest is the combined effect of transactions costs, the idiosyncratic risk and the systematic risk on the ex-day trading volume. Using a multivariate regression analysis, where the dependent variable is the cumulative abnormal volume, we examine these relationship for the entire sample and for the three dividend yield samples. The results are reported in Table V. Because of the inclusion of the bid-ask spread variable, the sample in Panel A is restricted to the 1988-1990 time period. The spread coefficient is negative and highly significant for the entire sample as well as for the high dividend yield group, with a t-statistics of -5.72 and -8.76 respectively. The spread coefficient is negative but statistically insignificant for the medium and low yield groups. The idiosyncratic risk coefficient is negative and significant for the entire sample and for each subgroup, and the beta coefficient has the right sign, and significant for the entire sample. A similar pattern emerges when size is used as the transactions costs proxy (Panel B): it is positive and significant for the entire sample and for the high yield group, negative and insignificant for the medium yield group, and negative (and significant) for the high yield group. Note that using size as a proxy for the cross-sectional variation in transactions costs enables us to utilize the entire 1963-1991 period.

Overall, the results are consistent with the model's predictions: securities with higher transactions costs experience lower abnormal trading volume, even after controlling for the level of risk associated

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[24]These results are consistent with what has been reported by Lakonishok and Vermaelen (1986).

with the trade. It is also found that for high dividend yield stocks, where the incentives to trade are higher, the effect of transactions costs on trading volume is more pronounced.

4.2.3 The interaction between risk and transactions costs.

Thus far we have examined the direct effect of risk and transactions costs on trading volume. As the model implies, however, the effect of the idiosyncratic risk and beta on the ex-day volume of trade will vary depending on the cost of transacting. First, comparing the effect of the market risk on volume (Implications 4 and 4'), reveals that as transactions costs increase the effect (negative) of the market risk on trading volume increases. The effect of the idiosyncratic risk component on trading volume is predicted to be the opposite: as transactions cost increase the effect of the idiosyncratic risk on trading volume decreases, (Implication 7). The intuition behind these results is that the systematic risk can be hedged away at no cost in the absence of transactions costs, As transactions costs become higher, investors choose to hedge less, and consequently, the systematic risk affects their trading decision. Even without trading costs, however, investors bear the idiosyncratic risk. As trading costs increase, investors hedge less, trade less and hence the idiosyncratic risk becomes less important.

We test these predictions using a regression analysis. The dependent variable is the cumulative abnormal volume (CAV) around the dividend distribution. The independent variables are the dividend yield, the idiosyncratic risk, the security's beta, and a size variable. In addition we define Q_i to be zero if the ex-dividend day occurred before January 1976, and one if the ex-day occurred between January 1st 1976 and December 31st 1991. Both risk component are multiplied by these dummy variable. According to the model, the idiosyncratic risk component's coefficient should be lower prior to 1976 since the transactions costs level were higher during this time period and there were fewer hedging instruments around (such as futures or options contracts). The beta coefficient is predicted to be higher before 1976. The results are presented in Table VI. In the first row, where all ex-dividend day observations are included, the dummy slope coefficient for the idiosyncratic risk is negative and significant indicating that the idiosyncratic risk had bigger (in absolute value) effect on trading volume after the transition from fix to negotiated commission schedule. The beta coefficient has a much larger coefficient prior to 1976, consistent with the assertion that as transactions costs got lower, and more hedging vehicles became available, the beta risk had a smaller effect on trading volume. In the second row of the table we present the results for the high dividend yield group (top 1/3 yield). Consistent with prior analysis, the effect of both risk component is more negative on this yield group than for the entire sample. The change in transactions costs has also a bigger effect on both the beta and the idiosyncratic risk coefficients. The beta coefficient is less negative after the reduction in transactions costs, and the idiosyncratic risk coefficient is more negative. Finally the results reported in the last row show that while the risk components negatively affect the trading volume for the bottom 2/3 of the sample (in term of their yield), the change in transactions costs had no significant effect on these coefficients.

Overall, the results of this section demonstrate the importance of transactions costs and risk on trading volume. As the model predicts, when trade occurs because of the differential valuations of cash flows, an increase in risk (either systematic or nonsystematic), reduces trading volume. The effect of the nonsystematic risk component is than the effect of the systematic risk. Also, the data confirms the assertion that trading volume and transactions costs are negatively correlated. The model's predictions about the interaction between transactions costs and risk, and their effects on trading volume is supported by the data: The effect of the systematic risk on volume is more pronounced at times when trading costs are high, and the idiosyncratic risk has a larger effect on abnormal volume when trading costs are low. The evidence is also consistent with the assertion that most investors who trade around the ex-day, do so in stocks with large dividend yield. These stocks therefore will be affected the most by change in transactions costs or by the availability of hedging instruments; both through the direct effect of transactions costs, and the indirect effect through the idiosyncratic and the systematic risk of the stock.

4.3 The role of derivative assets.

The evidence presented in the last section shows that risk and transactions costs significantly affect investors' trading decisions when their private valuation differs from the market's valuation. It is likely therefore, that the introduction of instruments that enables investors to reduce the ex-day trading risk, will result in a higher trading volume. More specifically, derivative securities, such as options, can be used to reduce the risk exposure of the underlying transaction, or alternatively, reduce the cost of an hedging strategy that is already in place. In both cases, the predicted effect is clear: We would expect more trading since the risk exposure is lower, and the effective cost of the entire transactions is lower.

A potential way to investigate the effect of the availability of hedging instruments on trading volume is to examine the effect of the introduction of a stock index future contract, such as the Major Market Index (MMI) in July 1984. However, such a test may be problematic since several other events may have occurred around the same time period, for example the 1984 TRA which increased the required holding period for corporations from 16 to 46 days.

This type of problem is much less severe around the introduction of stock options. First, stock options were introduced gradually and do not concentrate in a particular time period. Second, since a stock option is most likely to be used as a hedge against trades in the underlying stock, other stocks in the same time period are less likely to be affected, and therefore can be used as a control sample. To this end, we collected a comprehensive sample of all stocks with a traded option. Our initial sample consists of all options listed on the CBOE, NYSE, AMEX, Pacific Stock Exchange and Philadelphia Stock Exchange from 1973 through 1987, with an underlying asset that is traded on the NYSE or AMEX. A firm is included in the sample if return data was available for ten years centered around the option inception and it has at least four ex-dividend dates in the three years prior to the option listing and at least four ex-dividend dates in the three years after the option listing. The final sample contains 448 stocks.

Table VII presents some summary statistics for this sample. First we calculated the average dividend yield for the pre- and post-listing periods. For each firm in the pre-listing (post-listing) sample we calculated the dividend yield as the average yield over all the ex-dividend days in the five year period. The sample average yield was then calculated as the average firm's dividend yield.[25] The same procedure was followed for the calculation of both the average dollar amount of dividend paid and the average price. The sample's average standard deviation of returns was calculated using daily returns in the year before (after) the option listings. The average amount of dividend paid was $0.298 and $0.312 before and after the option listing, and the average dividend yield changed from an average of 0.834% to an average of 0.9%. Both differences are statistically insignificant. The average post-listing price is $36.7, which is 3.72 dollar lower than the average prelisting price. The standard deviation of daily returns is somewhat lower after the listing: 2.153 compared with 2.257 before, but the difference is insignificant. Lastly, as alluded to before, Panel B presents the distribution of the inception of options in our sample by year.

We compare the trading volume activity before and after the option listing day in the following manner. We calculate the cumulative abnormal volume for each event using the procedure described

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[25] This procedure is followed so that firms with larger number of ex-day events will not receive a greater weight in calculating the sample average.

in Section 4.1. Then, in order to give each stock in the sample the same weight, regardless of the number of ex-dividend days it had, we compute the average CAV for each stock in our sample both in the period before and the period after the option listing. The mean cumulative abnormal volume, reported in Table VIII, is the cross-sectional mean of CAV_i. The t-statistic is calculated using the cross-sectional variation of the cumulative abnormal volume. In the first column of the table we report the CAV for the entire sample of 448 firms, and in the second we report the results for only those stocks that had a dividend greater than 12.5 cents. The third column contain the CAV of the top third stocks in term of their yield. The results indicate that the volume of trade significantly increase after the option listing: The cumulative abnormal volume is 32.8% compared with 118.6% for the pre-listing period and the post-listing period, respectively. This difference is significant at the 1% level (t=5.88). The same results emerges from the sample of the higher yield stocks or only stocks with dividend yield greater than 12.5 cents: The level of abnormal volume is significantly higher after the option listing than before. Consistent with our prior findings, the absolute level of abnormal trading volume is higher both before and after the option listing for the high yield groups, compared with the entire sample.

It is possible that the upward trend in the ex-day abnormal trading volume through time may have contributed to our findings of higher abnormal volume in the three years after the option listing than in the three years prior to the option listings. To control for this potential confounding effect we use an alternative procedure. For each firm with a listed option we find a matched firm without a listed option, and compare their abnormal volume of trade around the ex-day. In order to find the matched sample we screen the CRSP tapes for stocks without options traded in the same time period (in the first three years after the option listings). We then choose a subsample of stocks that have a dividend yield that is in the 20% range of the yield of the stock with option. From this group we select all stocks with market value of equity in the 50% range of the stock with option, and then we select the stock that is closest in price. This procedure is repeated for every stock with an underlying option. Using this criteria we are able to find 368 matched pairs of stocks with and without options.

The sample characteristics are described in Table IX. The dividend yield, market value of equity and the daily standard deviation in returns are insignificantly different from each other between the two samples. The average price of the stocks with options is about $2.5 higher than the stocks without options.

When comparing the cumulative abnormal return of the two samples (first column of Table X), we find that the difference in the volume of trade is significantly higher for the stocks with options than for the stocks without options, 130.4% and 99.4% respectively. It is worth noting however, that when comparing the mean CAV in the period before and after the option listing we find that the mean CAV is about four times higher after the listings (32.8% compared with 118.6%, as reported in Table VIII), the differences are much lower (though still significant), when the comparison is done on a cross sectional basis instead of on a time series basis: We find only a 30% difference between stocks with and without options when keeping the time variable constant. This seems to imply that at least part of the increase in the trading volume after the option listing is related to some other trends in the market and not directly related to the option listing *per se*. As reported in the last two columns of Table X, we find significant difference in trading volume around the ex-dividend day even after we eliminate stocks with dividends smaller than 12.5 cents, (second column), or included only the high yield securities in the sample (third column).

4.5. Portfolio effects

Without transactions costs the systematic risk can be easily hedged, and the only constraint to the volume of trade is the idiosyncratic risk. Since the idiosyncratic risks are independent across stocks, the model implies that the amount invested in each stock going ex is independent of the number of stocks going ex. When investors incur transactions costs, however, not all of the systematic risk can be hedged, and therefore the trading volume on each individual stock will be a decreasing function of the number of stocks going ex, (Implication 5'), though the total volume on the ex-day portfolio will be higher the higher the number of stocks going ex. We test this implication by examining the effect of the number of stocks that go ex in a given day on the trading volume in each stock.

Table XI contains some summary statistics regarding the number of stocks that have the same ex-dividend day. The mean (median) number of stock that go ex in the same day is 20.63 (13) with a standard deviation of 20.56.[26] As can be seen from the last three columns of the table, the high-, medium-, and low-yield groups have the same average number of stocks that go ex at a given day. There is no clustering of ex-days by yield. It is evident, however, that the number of ex-dividend days are not uniformly distributed across days. For the entire ex-day sample, the maximum ex-dividend days in one day is 153 and the minimum is zero.

The effect of the number of stocks that have the same ex-dividend day is examined In Table XII. Using regression analysis where the dependent variable is the cumulative abnormal volume and the independent variables are the dividend yield, the two risk variables and the number of stocks that go ex in the same day (ND). In the first row we report the results for the entire sample, and in the second and third rows the results are reported for the high yield group and for the low and medium yield groups combined. First, consistent with implication 5', the ND coefficient is negative and significant for the entire sample and for each sub-sample. It seems, however, that the number of

[26]It is worth noting that the distribution of ex-dividend days across the day of the week is not even. There are twice the number of ex-day on Monday than in any other day of the week. We have also calculated summary statistics regarding the number of stocks that have an ex-dividend day in the same month. An average of 431.8 stocks have an ex-dividend day in a given month, with a maximum and a minimum of 805 and 16.

stocks that go ex, has a much greater impact on the high yield group than on the rest of the sample. The ND coefficient is about 10 times larger for that group of stocks.

4.6. Tax heterogeneity and trading volume

One of the major implication of the model is that the higher the dispersion in investors' private valuation, the stronger the incentives to trade, and consequently, the larger the volume of trade. As to the ex-dividend day trading, it implies that as the tax heterogeneity among investors increases there are more gains from trade, (Implication 1). Given the changes the US tax code, and the changes in the relative importance of the various trading groups in the economy, it is clear that the tax heterogeneity variable varies through time. In principle, if clientele groups could be precisely identified, one could construct a firm specific tax heterogeneity variable.[27] However, to the best of our knowledge, there is no reliable data on the cross sectional variation in tax rates (and in absolute risk aversion), across holders of different stocks.

It is feasible, however, to estimate the time series variations in tax heterogeneity. Using the IRS Individuals Statistics of Income, Corporations Statistics of Income, and the Federal Reserve Flow of Funds publications for the years 1963 through 1989, we calculate the yearly mean and variance of α^n as explained below. The IRS publications provide information regarding the amount of dividend income received by individuals in each tax bracket as well as the amount of dividend received by corporations. The Federal Reserve publications contain information about the amount of dividends received by pension funds and insurance companies (institutional investors). From this data, and the marginal tax bracket of each group, we are able to construct the yearly mean and variance of the

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[27] Several studies, such as Auerbach(1985) and Mackie-Mason (1988) have attempted to use firm specific tax clientele variable to analyze corporate financial policy. This variable can be viewed as the mean of the tax distribution, while our interest is in the variance of this distribution. Even though the former is easier to measure, these studies do not seem to have great success in explaining corporate dividend policy using this variable.

relative tax preference variable α^n. The weights on each α^n are set to the relative amount of dividend received by this group of investors.[28]

Another factor that may affect the level of abnormal trading volume through the tax heterogeneity, is the incentives of the various groups to trade. In particular, corporate investors' incentives to trade, and their effects on the ex-day trading are measured using three additional variables: the level of $\bar{\alpha}$, the return on the overall market in the current year and the return on the market in the prior year. The first variable capture the increase weight of the corporate traders in the market place as it manifest itself through $\bar{\alpha}$. The second and third variables capture the corporate traders' incentives to trade through a proxy of their capital gains. Since the capital losses from dividend capture activity can be deducted only against capital gains, prior and current year changes in the level of the market are used as proxies for corporate capital gains. As their level of capital gains increases, the incentives to trade around the ex-day increases as well. In other words, the higher the level of corporate profits from capital gains, the higher the incentives to trade around the ex-day.

Given the nature of out test, we constructed a monthly abnormal volume variable. The mean cumulative abnormal volume for each month is calculated as the average of the cumulative abnormal volume for all securities with an ex-dividend day in that month, weighted by the market capitalization of the firm's equity. We then estimate the effect of differential valuation on the monthly abnormal volume:

$$CAV_t = a_0 + a_1\left(\frac{D}{P}\right)_t + a_2 RM_t + a_3 RM_{t-1} + a_4\bar{\alpha}_t + a_5 Var_1(\alpha_t^n) + a_6 Var_2(\alpha_t^n) + a_7\sigma^2_{mt} + a_8 Log(t) + \epsilon_t.$$

[28]It should be noted that our construction of the distribution of α^n is only a proxy. First, the weights are proportional to the dividend received and not to the absolute risk tolerance. This can be justified by noting that the share of dividend received is a reasonnable proxy for risk bearing capacity. Second, our measure of tax heterogeneity is available on a yearly basis only, which implies that we actually measure discrete, year-end, changes in tax heterogeneity. Since most tax changes occurs at year-end (though not changes in the weights of the various trading groups), this empirical approximation may be appropriate. It is comforting to note that Poterba (1987) arrives at a very similar estimate of the mean of α by using a slightly different data source.

(13)

The results of estimating equation (13) using monthly data for the years 1963-1985 are reported in Table XIII.[29] In addition to the explanatory variables described above, the estimating equation includes a monthly dividend yield variable, calculated as the average dividend yield of all stocks with an ex-dividend day on that month, weighted by their market capitalization; the monthly market variance σ^2_{mt}, calculated as the daily return variance of the equally weighted index in the 60 days prior to month t; and a log time variable (in years) that captures the overall upward trend in trading volume through the years, Log(t). Finally, it is possible, and quite likely, that individual investors will not engage in the ex-day trading to a large extent because of transactions costs. In that case, the variability in the tax rates (and weights) of this investor group may not affect the ex-dividend day volume, and in fact may not even be the appropriate measure of the cross sectional variance of α^n. We therefore calculate an alternative measure of the variance of α^n [labeled as $Var_2(\alpha^n)$], which include the weights and relative tax rates of corporations and institutions alone. We account for the serial correlation present in the data using a maximum likelihood procedure as in Beach and Mackinnan (1978).

In the first and second rows of Table XIII the regressions are estimated for all ex-dividend days events in the sample period. In the second regression, however, we use the cross-sectional variance of α^n that accounts for the variation in the relative tax rates and weights of only corporate and institutional investors ($Var_2(\alpha^n)$). For most parts, the results using either variables are quite similar: the yield coefficient is positive and significant, indicating that the time series variation in ex-dividend day abnormal trading volume is positively related to the amount of dividend paid in a particular month. Also, as the risk level in the market increases (measure by the market's variance), the trading

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[29] A potential complication is the activities of the Japanese insurance companies in the mid- and late 80s. Their dividend related trades are regulatory rather than tax motivated. While this type of incentive can be easily incorporated into the model, it is not capture in the tax heterogeneity variable. As shown in Koski(1992), these trades had a substantial effect on the volume of trade, especially in 1988. We therefore limit out time series to the period 1963 through 1985.

volume decreases. It seems that the effect of dividend yield and risk on time series behavior of abnormal volume is in the same direction they affected the cross-sectional behavior of ex-day abnormal volume. The measures of the corporate traders to engage in the ex-day trading are all in the right direction, but significant only for the second regression. That is, as α increases, which indicate greater presence of corporate traders, the abnormal volume increases as well, and is significant when the heterogeneity variable accounts for the activity of institutional and corporate traders. Likewise, the level of the market is positive, and significant at the 10% level, indicating that higher level of capital gains increases the incentive to trade and consequently increases volume. Perhaps most importantly, as the degree of tax heterogeneity between institutional and corporate traders increases, the volume of trade increases in a significant way.

In the third row of the table we analyze the effect of these variables on a subsample where the corporate and institutional trading is the most pronounced, namely on the high dividend yield stocks. Indeed, the current level of the market as well as $\bar{\alpha}$ and the tax heterogeneity variable are positive and highly significant, and the market risk proxy is negative and significant. Comparing the level of the coefficients between regressions (2) and (3) indicate that all these variable plays a more important role in determining the volume of trade for the high yield stocks than for the entire sample. A similar picture emerges from the last regression in the table (fourth row). When only the bottom two third of the sample (in term of yield) is included, non of the variables is statistically significant. These results are not surprising if individual investors faces higher transactions costs than large institutional and corporate trades, which prevents them from actively participate in the ex-dividend day tradings.[30]

Overall, the results indicate that heterogeneity has a significant effect on trading volume, especially

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[30] It is still possible that delay and acceleration of trades by individual investors may occur (see Grundy 1985). Michaely and Vila (1993) document evidence around the 1986 TRA which is consistent with this assertion.

in stocks where corporate and institutional traders are more dominant. It is also shown that the higher the incentives to engage in these trades (proxied by level of capital gains and dividend yield), the volume of trade is significantly higher. The amount of risk involved in those trades, on the other hand, reduces the trading volume.

V. CONCLUSION

In this paper we consider the impact of investors' heterogeneity, risk and transactions costs on trading volume. We focus our empirical analysis on trading volume around ex-dividend days. These events represent an almost ideal environment for our experiment since the dominant motive of trade around these events is the differential valuation of cash flows (dividends relative to capital gains) across investors. In a relatively simple framework, the model indicates that transactions costs reduce trading volume. This result is not surprising and is common to many models of trading volume. Models of trading volume that are based on portfolio rebalancing towards optimal holdings, however, predict that higher risk will be associated with higher trading volume as the cost associated with non-Pareto holdings increases with risk. As the present model reveals, when investors' trading motives are based on heterogeneous valuation, risk reduces the incentives to trade, an consequently the trading volume. Perhaps more interestingly, the systematic risk and the idiosyncratic risk have different effects on the trading volume. Unlike prices, the trading volume is always affected by the idiosyncratic risk involved in the trade. The effect of the idiosyncratic risk is bigger the lower the transactions costs are. By contrast, the systematic risk can be fully hedged in the absence of transactions costs. As the level of transactions costs increases and hedging becomes more costly, investors choose to expose themselves to some level of systematic risk. At the same time they also reduce their level of trade, which also results in a lesser role for the idiosyncratic risk in determining trading volume.

The empirical evidence that we find is consistent with the model's implications: (1) Stocks with higher bid-ask spreads experience lower abnormal trading volume; (2) Stocks with higher idiosyncratic risk experience lower trading volume; (3) Stocks with lower beta exhibit higher volume; (4) The reduction in transactions costs in May 1975 resulted in an overall higher ex-day trading volume; (5) The non-systematic variance coefficient is found to be lower before 1976, and the beta coefficient to be higher. Also, stocks with underlying options, where hedging is cheaper, experience higher ex-day trading volume than otherwise identical securities.

It is also shown that the time series variations in the abnormal trading volume around the ex-dividend day is positively related to the degree of tax heterogeneity and the incentives of the various trading groups to engage in those trades. Specifically, we find that as the influence of the corporate traders and their incentive to trade increase the volume of trade increases significantly, especially in the high yield stocks.

While our analysis focuses on the ex-dividend day, we believe that the implications of this work can be extended beyond this specific event and that the methodology developed here can be generalized to better our understanding of trading volume in other contexts as well. For instance a more general framework allowing for heterogenous information, as opposed to heterogenous valuation, could be used to analyze the abnormal trading volume around information shocks such as dividends or earnings announcements or takeover rumors. Modelling the interaction between trading volume, private information, risk and transactions costs will not be an easy task. However, we think that the insights developed herein will be useful and that our main results will hold true.

Finally, an important policy implication may be drawn from this line of research. Using the volume of trade and the price movement on the ex-dividend day one may come with an estimate of the amount of tax revenues that are lost due to those trades. Our empirical results show that the amount of tax-related trading is substantial. There are three parties involved in those trades: the buyer, the seller and the government. Both the buyer and the seller expect a gain while the government (the third party) looses through its loss of tax revenues. In addition to a transfer of wealth from the government to the traders, tax related trading around the ex-day creates deadweight loss. This deadweight loss is due to the cost of trading the tax shields (commission, time spent etc.) and the risk involved in the transactions (deviation from pareto optimal risk sharing). From our above discussion it follows that an estimate of the tax revenue losses due to ex day trading will shed some light on the distributional and efficiency impacts of tax 'arbitrage'. As a result such an estimate will undoubtedly be of interest to policy makers. Indeed even if the wealth transfer due to tax 'arbitrage' is desirable the fact that risk and transactions costs create a deadweight loss suggest that there should be a more

Appendix A

To solve for the equilibrium trading strategies, we show that at the zero transactions costs prices

$$p^{*} = \bar{p}_e + \bar{\alpha} d - \frac{\sigma^2}{\theta}(1+K\tau)\bar{x} \qquad \text{for dividend paying stocks and}$$

$$p^{*} = \bar{p}_e - \frac{\sigma^2}{\theta}(1+K\tau)\bar{x} \qquad \text{for non dividend paying stocks}$$

supply equals demand. We then calculate trading volume at these prices.

Consider an investor n with $\alpha^n > \bar{\alpha}$. Let

$$y^n = x_c^n - \bar{x}^n$$

From equation (6) and (7), the investor's objective is to maximize

$$(-\bar{\alpha} d + \frac{1}{\theta}\omega_e \bar{x})'(\bar{x}^n + y) + \alpha^n d'y - (c^n)'|y| - \frac{1}{2\theta^n}[\bar{x}^{n\prime}\omega_e \bar{x}^n + 2\bar{x}^n \omega_e y + y'\omega_e y] \tag{a1}$$

with respect to y. Since

$$\bar{x}^n = \frac{\theta^n}{\theta}\bar{x}$$

investor n's objective is reduced to maximizing

$$(\alpha^n - \bar{\alpha})d'y - (c^n)'|y| - \frac{1}{2\theta^n}y'\omega_e y \,. \tag{a2}$$

Given the symmetry, the investor's problem can be described as follows: Choose how many shares a of the dividend paying assets to buy and how many shares b of the non dividend paying assets to sell for hedging motives. Indeed, since transactions costs are proportional diversification is not costly. Hence, the investor prefers to buy *all* dividend paying assets than just a subset.[31] From (a2), a and b are chosen so as to maximize

$$(\alpha^n - \bar{\alpha})Sda - c[Sa+(K-S)b]\ \frac{\sigma^2}{2\theta^n}[a^2(S^2\tau+S)+b^2((K-S)^2\tau+K-S)-2abS(K-S)\tau] \tag{a3}$$

with respect to $a \geq 0$ and $b \geq 0$. The solution to (a3) is described below

[31] In the presence of fixed transactions costs, the investor will trade only a subset of the dividend paying assets.

$$a = 0, \quad b = 0 \qquad \text{if} \quad \alpha^n \le \bar{\alpha} + \frac{c}{d}$$

$$a = \theta^n \frac{(\alpha^n - \bar{\alpha})d - c}{\sigma^2(1 + S\tau)}, \qquad b = 0 \qquad \text{if } \bar{\alpha} + \frac{c}{d} < \alpha^n \le \bar{\alpha} + \frac{c}{d}[2 + \frac{1}{S\tau}] \tag{a4}$$

$$a = \frac{\theta^n}{\sigma^2} \frac{[(\alpha^n - \bar{\alpha})d - 2c](1 + (K-S)\tau) - c}{1 + K\tau}, \qquad b = \frac{\theta^n}{\sigma^2} \frac{[(\alpha^n - \bar{\alpha})d - 2c]S\tau - c}{1 + K\tau}$$

$$\text{if} \quad \alpha^n > \bar{\alpha} + \frac{c}{d}[2 + \frac{1}{S\tau}]$$

Therefore,

$$t = \frac{c}{d} \quad \text{and} \quad h = \frac{c}{d}[2 + \frac{1}{S\tau}] .$$

Since the distribution of α^n is symmetrical, for every $\alpha^n > \bar{\alpha}$ there exists a $\alpha^m < \bar{\alpha}$ such that $\theta^n = \theta^m$ and $\alpha^n - \bar{\alpha} = \bar{\alpha} - \alpha^m$. From equation (a4), it can be seen that $y^n + y^m = 0$ and hence supply equals demand.

Having derived a and b, we calculate the trading volume on any dividend paying stock under the assumption that K is large:

$$V_c = \frac{\theta}{\sigma^2} [\sum_{t \le \alpha^n - \bar{\alpha} < h} \delta^n \frac{(\alpha^n - \bar{\alpha})d - c}{1 + S\tau} + \sum_{\alpha^n - \bar{\alpha} \ge h} \delta^n ((\alpha^n - \bar{\alpha})d - 2c)] . \tag{a5}$$

A convenient way to write the volume on the cum day is to define

$$\mu^n = \alpha^n - \bar{\alpha} \quad \text{and} \quad \gamma = \frac{c}{d} .$$

Then the volume can be written

$$V_c = \frac{\theta d}{\sigma^2} [\sum_n \delta^n \max \{ \frac{\mu^n - \gamma}{1 + S\tau}, \mu^n - 2\gamma; 0 \}] . \tag{a6}$$

From equation (a6), we can see that

$$0 \ge \frac{\partial V_c}{\partial \tau} = - \frac{S}{1 + S\tau} \frac{d\theta}{\sigma^2} \sum_{\gamma \le \mu^n < \gamma(2 + \frac{1}{S\tau})} \frac{\mu^n - \gamma}{1 + S\tau} \ge - \frac{S}{1 + S\tau} V_c ; \tag{a7}$$

$$\frac{\partial V_c}{\partial \sigma^2} = - \frac{V_c}{\sigma^2} - \frac{\tau}{\sigma^2} \frac{\partial V_c}{\partial \tau} ; \tag{a8}$$

$$\frac{\partial V_c}{\partial \sigma_M^2} = \frac{1}{\sigma^2} \frac{\partial V_c}{\partial \tau} . \tag{a9}$$

Combining (a7)-(a9) it follows that

$$\frac{\partial V_c}{\partial \sigma_M^2} \leq \frac{\partial V_c}{\partial (\frac{\sigma^2}{S})} \; .$$

We next show that the effect of the idiosyncratic risk σ^2 is smaller in the presence of transactions costs. In the no transactions costs case volume is given by

$$V_c^* = \frac{d\theta}{\sigma^2} \sum_{\mu^n > 0} \mu^n$$

so that

$$\frac{\partial V_c^*}{\partial \sigma^2} = -\frac{V_c^*}{\sigma^2} < -\frac{V_c}{\sigma^2} < \frac{\partial V_c}{\partial \sigma^2} \; . \tag{a8}$$

Finally, we can analyze the effect of the number of stock S going X

$$0 \geq \frac{\partial V_c}{\partial S} = \frac{\tau}{S} \frac{\partial V_c}{\partial \tau} \geq -\frac{\tau}{1+S\tau} V_c \; .$$

■

Appendix B

A simple model with non unit betas

In order to solve for trading volume with non unit beta, we make the simplifying assumptions:

i) Two risky assets are traded. The first one is and index that pays δ at the ex. The other one is a stock which pays $\beta\delta+\tilde{\epsilon}$ at the ex. The random variables δ and $\tilde{\epsilon}$ are independently normally distributed with mean zero and variance σ_M^2 and σ^2.

ii) Trading in the stock is stock is subject to proportional transactions costs c_S while trading in the index is subject to proportional transactions costs c_I.

iii) The stock pays a dividend d.

iii) The distribution of the parameter α^n is symmetrical.

Following the analysis in appendix A, it is easy to show that the zero transactions costs prices are equilibrium prices.

We next calculate the investor's trading strategy. If $\alpha^n > \bar{\alpha}$, the investor buys a shares of the stock and hedges by shorting b shares of the index. His objective is to maximize

$$(\alpha^n - \bar{\alpha})da - c_S a - c_I b - \frac{\sigma_M^2(\beta a - b)^2 + \sigma^2 a^2}{2\theta^n} \tag{b1}$$

with respect to $a \geq 0$ and $b \geq 0$.

It is useful to rewrite the objective (b1) with respect to a and the *unhedged market risk* $z = \beta a - b$:

$$(\alpha^n - \bar{\alpha})da - (c_S + \beta c_I)a + c_I z - \frac{\sigma_M^2 z^2 + \sigma^2 a^2}{2\theta^n} \tag{b2}$$

with respect to $x \geq 0$ and $z \leq \beta x$.

The solution to (b2) is described below

$$a = 0, \quad z = 0 \qquad \text{if} \quad \alpha^n \le \bar{\alpha} + \frac{c_S}{d}$$

$$a = \theta^n \frac{(\alpha^n - \bar{\alpha})d - c_S}{\beta^2 \sigma_M^2 + \sigma^2}, \qquad z = \beta a \qquad \text{if } \bar{\alpha} + \frac{c_S}{d} < \alpha^n \le \bar{\alpha} + \frac{1}{d}[c_S + (\frac{\sigma^2}{\beta \sigma_M^2} + \beta)c_I] \tag{b3}$$

$$a = \theta^n \frac{[(\alpha^n - \bar{\alpha})d - c_S - \beta c_I]}{\sigma^2}, \qquad z = \theta^n \frac{c_I}{\sigma_M^2} \qquad \text{if} \quad \alpha^n > \bar{\alpha} + \frac{1}{d}[c_S + (\frac{\sigma^2}{\beta \sigma_M^2} + \beta)c_I].$$

With this formulation it is easy to see that:

(i) When $c_S = c_I = 0$, then implications 1-4 hold. In addition we obtain

Implication b1: If transactions costs are zero, trading volume is independent of β.

(ii) When $c_S > 0$ or/and $c_I > 0$, then implications 6, 4' and 7 still hold. In addition we obtain

Implication b1': In the presence of transactions costs, the trading volume is decreasing in β.

This result follows from two concurring effects: First high beta stocks are risky for traders who cannot afford to hedge. Second high beta stocks are costlier to hedge since more shares of the index must be shorted.

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Table I

Descriptive statistics on ex-dividend day abnormal volume, cumulative abnormal volume for the eleven days centered around the ex-dividend day, the dividend yield and the bid-ask spread for a sample of ex-dividend events on NYSE/AMEX stocks in the years 1963-1991. Statistics are provided for the entire sample and for each of the three dividend groups separately. Abnormal volume is calculated as the daily turnover relative to normal turnover, and the dividend yield is defined as the dividend amount over the cum-day price. The bid-ask spread for each stock is calculated as:

$$BAS_i = \frac{1}{T_i} \sum_{t=-45}^{-6} \frac{1}{3} \sum_{j=1}^{3} \left\{ (Ask_{tji} - Bid_{tji}) / \left[\frac{Ask_{tji} + Bid_{tji}}{2} \right] \right\}$$

where j = open, mid-day, and close transaction, t is the day relative to the ex-dividend day, and T_i is the number of days in the estimation period with valid bid-ask observations (usually 40 days).

	Entire Sample	Dividend Yield Group: High	Medium	Low
(1) AV(0)	14.69% (24.62)	32.82% (23.92)	6.18% (8.22)	5.07% (5.86)
(2) CAV(-5 -> +5)	100.6% (33.07)	196.3% (25.47)	53.63% (15.27)	51.85% (15.50)
(3) WCAV (-5 -> +5)	179.7% (21.93)	449.2% (18.99)	62.87% (8.59)	26.96% (4.51)
(4) Mean Dividend Yield (%)	1.001	1.70	0.89	0.41
(5) Number of Observations	155302	51767	51767	51768
(6) Average Daily Turnover	0.0016	0.0012	0.0015	0.0021

Bid-Ask Spread (1988-1990)

Mean (%)	1.53
Median (%)	1.32
Standard Deviation	0.96
Number of Observations	15900

Table II

The Effect of Risk on Trading Volume

The effect of dividend yield, idiosyncratic risk and beta on abnormal volume in the 11 days around the ex-day is analyzed using a regression analysis. Abnormal volume is defined as the daily turnover relative to average turnover and the cumulative abnormal volume (CAV) is the sum of abnormal volume in the 11 days around the ex-day. Dividend yield is calculated as the dividend paid over the cum-day price. The idiosyncratic variance, scaled by the market variance in the same time period, and beta are estimated from the OLS market model in the estimation period (using daily returns). 155,302 ex-dividend events on NYSE/AMEX dividend-paying stocks in the period 1963-1991 are included in the sample. Standard errors are adjusted for heteroscedasticity using White's (1980) procedure. T-statistics are reported in parentheses.

$$CAV_i = \beta_0 + \beta_1 \frac{D_i}{P_{i,\,t-1}} + \beta_2 \frac{\sigma_{\varepsilon i}}{\sigma_m} + \beta_3 \, Beta_i + \varnothing_i$$

Dependent Variable (Mean)	Intercept	$\frac{D_i}{P_{i,\,t-1}}$	$\frac{\sigma_{\varepsilon i}}{\sigma_m}$	$Beta_i$
CAV(-5 -> +5) (100.6)	1.96 (16.43)	63.08 (8.51)	-0.49 (-18.65)	-0.33 (-7.82)

Table III

Transaction Costs and Ex-Day Trading Volume: Cross-Section Analysis

Ex-dividend events are divided into nine categories by dividend yield and bid-ask spread (Panel A) and by dividend yield and market value of equity (Panel B). The sample is first sorted by yield into three groups and then by bid-ask spread, resulting in nine subgroups. The bid-ask spread is calculated as the average bid-ask spread in the 40 days prior to the ex-day (see equation 9 in the text). Dividend yield is calculated as dividend amount over the cum-dividend day price, and the market value of equity is calculated as its average value in the estimation period. The average cumulative abnormal volume (in percentage) is then calculated for each category. T-statistics appears in parentheses and number of observations appears in brackets. In Panel A, the ex-dividend day events are constraint to the years 1988-1990, and in Panel B the sample contains the entire sample period of 1963-1991.

Panel A: Sorting by Dividend Yield and Bid-Ask Spread (BAS)

← BAS Category →

dividend yield category		Low (1.47%)	Medium (1.49%)	High (1.64%)	All (1.53%)
	Low (0.387%)	31.29 (1.56) [1829]	68.54 (3.35) [1767]	45.24 (2.47) [1704]	48.19 (4.25) [5300]
	Medium (0.805%)	74.59 (4.76) [1836]	28.73 (1.90) [1772]	34.62 (1.63) [1692]	46.50 (4.66) [5300]
	High (2.08%)	1557.00 (9.11) [1635]	1234.23 (13.74) [1761]	230.70 (4.12) [1904]	974.3 (15.12) [5300]
	All (1.09%)	519.68 (9.54) [5300]	441.72 (13.84) [5300]	108.2 (4.91) [5300]	

Panel B: Sorting by Dividend Yield and Market Capitalization (Size)

SIZE Category (in millions of $)

dividend yield category	Large (22207.73)	Medium (182.55)	Small (35.04)	All (808.45)
Low (0.41%)	23.20 (5.211) [18787]	48.07 (8.77) [18845]	95.75 (11.96) [14135]	52.06 (15.43) [51767]
Medium (0.89%)	46.93 (10.44) [16938]	47.33 (7.47) [17197]	65.56 (9.58) [17632]	53.41 (15.40) [51767]
High (1.70%)	468.72 (20.99) [16043]	59.50 (8.55) [15725]	85.03 (12.81) [20000]	196.21 (25.42) [51768]
All (1.001%)	169.01 (23.12) [51768]	51.38 (14.29) [51767]	81.32 (19.84) [51767]	

Table IV

Transaction Costs and Ex-Day Trading Volume: Time Series Analysis

Mean cumulative abnormal volume, CAV, for the first subperiod, 1963-1975, and for the second subperiod of 1976-1991. CAV is calculated in the 11 days around the ex-dividend day. In the first subperiod the mean dividend yield is 0.93% and the mean daily turnover is 0.12%. There are 21,287 observations in each subgroup with a dividend yield of 1.52%, 0.87%, and 0.41% for the high, medium, and low yield groups respectively. In the second subperiod (1976-1991), the mean dividend yield is 1.05% and the mean daily turnover is 0.19%. Each subgroup contains 30,398 observations with a dividend yield of 1.82%, 0.91%, and 0.41% for the high, medium, and low yield groups respectively. T-statistics appears in parentheses.

			Dividend Yield Group		
	Dependent Variable: CAV	Entire Sample	High	Medium	Low
(1)	1963-1975 (63862 obs.)	29.42% (10.14)	26.22% (4.18)	29.46% (5.75)	32.57% (7.70)
(2)	1976-1991 (91193 obs.)	150.10% (31.36)	311.92% (25.22)	73.49% (15.57)	62.67% (13.42)

Table V

The Effect of Transaction Costs and Risk on Ex-Day Trading

The effect of transaction costs and risk on ex-day trading is analyzed using a regression analysis. The dependent variable is the cumulative abnormal volume in the 11 days around the ex-dividend day for the entire sample (first row), for the high yield group (second row), for the medium yield group (third row), and for the low yield group sample (fourth row). The independent variables are the stock's dividend yield, calculated as the dividend paid over the cum-day price, the idiosyncratic variance, scaled by the market variance in the same time period, and the systematic risk, estimated by beta. The latter two variables are estimated using the OLS market model during the estimation period. In Panel A we use the average bid-ask spread (BAS) calculated as the average BAS in the 40 days prior to the event (see equation 9) as a proxy for the cross-sectional variation in transaction costs, and in the Panel B market value of equity is used as the transaction costs proxy. Standard errors are adjusted for heteroscedasticity using White's (1980) procedure. T-statistics are reported in parentheses.

$$CAV_i = \alpha_0 + \alpha_1 \frac{D}{P_i} + \alpha_2 \frac{\sigma_{\varepsilon i}}{\sigma_m} + \alpha_3\ Beta_i + \alpha_4\ BAS_i$$

Panel A: 1988-1990

	Dep. Var.	Intercept	D/P	$\sigma_{\varepsilon i}/\sigma_m$	BETA	BAS
(1)	CAV	8.16 (9.5)	83.55 (5.31)	-2.17 (-4.97)	-0.84 (-3.33)	-132.44 (-5.72)
(2)	High Yield {CAV}	18.63 (9.43)	34.19 (3.59)	-3.35 (-5.66)	-0.22 (-0.23)	-190.95 (-8.76)
(3)	Medium Yield {CAV}	0.55 (0.65)	48.5 (0.57)	-0.65 (-4.64)	-0.45 (-1.35)	-9.55 (-0.59)
(4)	Low Yield {CAV}	1.67 (2.64)	-80.1 (-0.851)	-0.49 (-4.11)	-0.11 (-0.56)	-3.71 (-0.32)

Panel B: 1963-1991

	Dep. Var.	Intercept	D/P	$\sigma_{\varepsilon i}/\sigma_m$	BETA	SIZE
(1)	CAV	1.89 (15.89)	63.17 (8.51)	-0.49 (-18.19)	-0.37 (-9.34)	0.134 (5.72)
(2)	High Yield {CAV}	4.28 (14.36)	52.23 (6.27)	-1.18 (-14.28)	-0.91 (-8.02)	0.21 (9.09)
(3)	Medium Yield {CAV}	1.476 (5.81)	-12.65 (-0.48)	-0.22 (-7.99)	-0.16 (-3.88)	-0.007 (-1.19)
(4)	Low Yield {CAV}	0.943 (7.567)	41.649 (2.51)	-0.117 (-4.29)	-0.23 (-4.39)	-0.04 (-5.01)

Table VI

The Effect of the Systematic and Idiosyncratic Risk Components in the Two Different Transaction Costs Regions

The model implies that the systematic risk will have a greater effect on trading volume when transaction costs are high, and the idiosyncratic risk will have lower impact on trading volume when transaction costs are high. The dependent variable is the cumulative abnormal volume (CAV) in the 11 days around the ex-day for the entire ex-day sample (first row), for the high yield group only (second row), and for the low and medium yield groups combined (third row). The independent variables are the stock's dividend yield, calculated as the dividend paid over the cum-day price; the idiosyncratic variance, scaled by the market variance; the systematic risk, estimated by beta: and the average market value of equity. The risk components are estimated using the OLS market model during the estimation period. Q_i is a dummy variable that takes the value of one if the ex-day occurred after 12/31/75 and zero otherwise. Using these variables we create two slopes dummies, one for each risk component. Standard errors are adjusted for heteroscedasticity using White's (1980) procedure. T-statistics are reported in parentheses.

$$Cav_i = \alpha_0 + \alpha_1\left(\frac{D}{P}\right)_i + \alpha_2\frac{\sigma_{\varepsilon i}}{\sigma_m} + \alpha_3\frac{\sigma_{\varepsilon i}}{\sigma_m}Q_i + \alpha_4 beta_i + \alpha_5 beta_i Q_i + \alpha_6 size$$

	Dep Var. CAV	Intercept	$\left(\frac{D}{P}\right)_i$	$\frac{\sigma_{\varepsilon i}}{\sigma_m}$	$\left(\frac{\sigma_{\varepsilon i}}{\sigma_m}\right)Q_i$	$beta_i$	$beta_i \cdot Q_i$	$size_i$
(1)	Entire Sample	1.83 (15.1)	68.08 (8.49)	-0.43 (-16.75)	-0.06 (-1.98)	-0.58 (-10.66)	0.44 (6.10)	0.043 (6.14)
(2)	High Yield	4.225 (13.97)	51.70 (6.21)	-0.982 (-13.85)	-0.291 (-4.05)	-2.356 (-14.40)	2.27 (11.53)	0.173 (7.82)
(3)	Medium and Low Yield Groups Combined	1.124 (12.19)	4.59 (0.53)	-0.171 (-7.80)	0.06 (1.67)	-0.24 (-4.27)	0.013 (0.17)	-0.02 (-4.08)

Table VII

The table provides descriptive statistics for options listed on NYSE and AMEX stocks from April 1973 through December 1987. A firm is included in the sample if it has at least four ex-dates in the three years prior to the option listing and at least four ex-dates in the three years after the option was listed. The dividend yield and dollar dividend is calculated as the mean over the pre- and post-listing periods. Average prices are calculated using the cum day prices, and the daily standard deviation is calculated using daily prices for the year before and after the option listing. Average values are reported in the body of the table, and standard deviation are in parentheses. 448 companies are included in the sample.

	Dividend Yield (%)	Dollar Dividend	Average Price/Share	Daily Standard Deviation (%)
Pre-listing	0.834	0.298	40.42	2.257
	(0.48)	(0.24)	(27.6)	(0.68)
Post-listing	0.900	0.312	36.70	2.153
	(0.49)	(0.24)	(21.2)	(0.67)
Difference[a]	-0.066	-0.140	3.73	0.103
	(0.41)	(0.17)	(19.4)	(0.69)

Panel B: Option Listing by Year

Year	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	Total
# of option listed[b]	29	8	89	46	13	1	0	59	8	56	17	15	37	28	42	448

[a] Standard deviations are calculated using a pairwise comparison.
[b] Only stocks that are included in our sample.

Table VIII

Trading Volume Before and After Option Listing

The table reports the cumulative abnormal volume (CAV) in the 11 days centered around the ex-dividend day for a sample of stocks with traded options, in the three years before and the three years after the option start to trade. A firm is included in the sample if it has at least four ex-dates in the three years prior to the option listing and at least four ex-dates in the three years after the option is listed. CAV_i is first calculated for each firm (either before or after the option listing), and then the average CAV for each respective sample is calculated. The sample contains 448 firms. In the second column we exclude all stocks that pay dividends less than 12.5 cents and in the last column only the top third of the stocks in terms of yield are included. T-statistics are in parentheses.

	Cumulative Abnormal Volume (%)		
	Entire Sample (448 obs.)	Only Stocks With Dividend > 12.5 cents (347 obs.)	Top 1/3 of sample (by yield) (149 obs.)
Pre-listing	32.8	42.64	83.61
	(4.06)	(7.33)	(3.95)
Post-listing	118.6	146.3	297.28
	(7.27)	(12.33)	(4.35)
Pre-listing minus Post-listing[a]	-85.82	-103.6	-213.67
	(5.88)	(9.94)	(5.55)

[a] T-statistics are based on pairwise comparison.

Table IX

The table compares the average price, size, dividend yield and standard deviation of return between a group of stocks with option traded and a matched group of stocks without traded option. For each stock in the former group we select a matching stock using the following criteria: we first screen the CRSP tapes for stocks without options traded in the same time period, with a dividend yield in the range of ±20% of the yield of the stock with option. From this group we select all stock with market value of equity in the range of ±50% of the equity value of the stock with option and then we choose the stock that is closest in price. Standard deviations are in parentheses.

Panel A: (368 pairs)

	Dividend Yield (%)	Market Value (in billions of $)	Price	Standard Deviation
Stocks with options	0.83 (0.508)	1.112 (0.923)	34.21 (16.54)	2.22 (0.68)
Stocks without options	0.823 (0.537)	0.8495 (1.17)	31.64 (21.08)	1.97 (1.22)
Mean difference	0.0177 (0.11)	0.2623 (0.705)	2.57 (17.24)	0.249 (0.75)

Table X

The table reports the cumulative abnormal volume (CAV) in the eleven days centered around the ex-dividend day for a sample of stocks with traded options and a matched sample of stocks without options. For each stock with option we match a dividend paying stock without option that traded in the five year period after the option listing. Matching is based on dividend yield, market capitalization, and size. T-statistics are reported in parentheses.

	CAV (%) Entire Sample (N = 368)	CAV (%) Only Stocks With Yield Greater Than 12.5 cents (N = 288)	High Yield Stocks Only
Stocks with option	130.4	156.4	322.6
	(10.83)	(4.29)	
Stocks without option	99.4	117.6	208.7
	(5.84)	(3.45)	(2.80)
Mean-difference (without-with)	-30.95	-38.78	-113.9
	(2.25)	(2.44)	(2.29)

Table XI

Descriptive statistic about the number of stocks that had an ex-dividend day in the same day (ND). Statistics are calculated for the entire sample of NYSE/AMEX stocks with at least one ex-dividend day in the period 1963-1991, as well as for the three yield subgroups.

	Mean	Standard Deviation	Min	Max	Median	Dividend Yield%
Entire Sample	20.92	20.89	0	153	13	1.001%
High Yield	6.97	8.92	0	71	4	1.70%
Medium Yield	6.97	7.59	0	76	4	0.89%
Low Yield	6.97	7.62	0	72	4	0.41%

Table XII

The Portfolio Effect on Ex-Day Trading

We examine the effect of the number of stocks that go ex in the same day (ND), on the trading volume activity of each stock. Standard errors are adjusted for heteroscedasticity using White's (1980) procedure.

Dependent Variable: Cumulative Abnormal Volume

Sample	Intercept	$(D/P)_i$	$\sigma\varepsilon_i/\sigma_m$	$Beta_i$	$Size_i$	ND
All Ex-Day	2.42	63.81	-0.477	-0.371	0.05	-0.013
	(18.07)	(8.47)	(-18.22)	(-8.55)	(6.73)	(-13.14)
High Yield	5.49	51.14	-1.17	-0.88	0.19	-0.028
	(15.72)	(6.137)	(-14.124)	(-7.58)	(8.78)	(-13.25)
Medium and	1.33	4.035	-0.164	-0.24	-0.02	-0.003
Low Yield	(13.73)	(0.47)	(-8.48)	(-5.74)	(-3.07)	(-3.78)

Table XIII

The Effect of Tax Heterogeneity on Trading Volume

We construct a series of monthly mean abnormal volume, using the cumulative abnormal trading volume of all NYSE/AMEX stocks with an ex-dividend day in that month. We test the effect of tax heterogeneity and risk on abnormal volume using regression analysis. The dependent variable is a monthly time series cumulative abnormal volume, (CAV) calculated as the average of the cumulative abnormal volume for all securities with an ex-day on that month, weighted by the market capitalization of the firm's equity. The independent variables are the monthly dividend yield, D/P, the market return in prior year RM_{t-1}, and current year, RM_t, the weight average of preference of dividends relative to capital gains, $\overline{\alpha}$, a tax heterogeneity variable, $var(\alpha_i)$, the variance of market return in the prior three months, σ_m^2 and an indicator variable for time, log(t). For each month, the weighted mean CAV of all securities paying dividends are calculated, weighted by firm's market capitalization. The weighted average dividend yield is calculated in a similar way. The market return on the NYSE/AMEX value weighted portfolio in the current and prior year are used as a proxy for corporate capital gains, which affect their incentive to engage in dividend capture. $\overline{\alpha}$ is calculated using data on the marginal rate of substitutions between dividends and capital gains for each trading group, as well as actual statistics (for the SOI bulletin) on the relative weights of each group. The tax heterogeneity variable measures the within year variability in those preferences. Lastly, the market variance tries to capture the perceived risk involved in those transactions. We account for the serial correlation present in the data using a maximum likelihood procedure as in Beach and Mackinnan (1978). The regression is estimated in the period 1963-1985. We truncated the data at the end of 1985 to avoid a time period in which heavy trading that is not related to taxes by Japanese insurance companies affected the volume statistics in a significant way, see Koski (1992). In the first row of the table the results are presented for the entire sample of securities; in the second row we analyze the top 1/3 stocks, in term of their yield, alone and in the last row the analysis is applied to the bottom 2/3 of securities, sorted by yield. T-statistics are in parenthesis.

	Dep Variable: Monthly CAV	Constant	D/P	RM_t	RM_{t-1}	$\overline{\alpha}$	$Var_1(\alpha_i)$	$Var_2(\alpha_i)$	σ_m^2	log(t)	R^2	DW[a]
(1)	All Securities	-1.49	111.41	0.52	0.58	0.45	0.35		-0.47	-0.36	13.76	2.05
		(-0.47)	(2.10)	(0.93)	(1.03)	(1.13)	(0.31)		(-2.24)	(-1.29)		
(2)		-17.13	141.22	0.93	0.57	1.67		4.77	-0.52	0.007	12.92	2.03
		(-3.41)	(2.41)	(1.65)	(1.00)	(3.14)		(2.76)	(-2.44)	(0.03)		
(3)	High Yield Group	-32.48	241.33	2.21	1.27	4.17		7.04	- 0.85	- 0.31	21.07	2.01
		(-4.34)	(2.47)	(2.60)	(1.74)	(3.22)		(2.69)	(-2.64)	(-0.80)		
(4)	Low and Medium Yield Group	1.59	102.23	0.16	- 0.01	- 0.20	-0.48		- 0.34	0.21	1.39	2.09
		(0.49)	(1.11)	(0.29)	(-0.02)	(-0.47)	(-0.86)		(-1.60)	(0.82)		

[a]Durbin-Watson statistics for transformed residuals.