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Alternative Explanations of the Price Behavior on the Ex-Dividend Day of Common Stocks Listed in U.S. and Greek Exchanges

by

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ΠΕΡΙΛΗΨΗ

Η παρούσα διδακτορική διατριβή στοχεύει στο να συνεισφέρει στη βιβλιογραφία της χρηματοοικονομικής με τρεις συσχετιζόμενες μελέτες οι οποίες διερευνούν τη συμπεριφορά των τιμών κοινών μετοχών κατά την ημέρα αποκοπής του μερίσματος («*ex-dividend day*»). Συνολικά, τα αποτελέσματα της εμπειρικής ανάλυσης που παρουσιάζεται στις τρεις μελέτες αναδεικνύουν την περιορισμένη δυνατότητα των νεοκλασικών υποθέσεων καθώς και υποθέσεων μικροδομής («*microstructure*») που έχουν ήδη καταγραφεί στη βιβλιογραφία να εξηγήσουν πλήρως την ανωμαλία που χαρακτηρίζει την ημέρας αποκοπής του μερίσματος. Ως εκ τούτου, θα πρέπει να εξεταστεί κατά πόσο συμβάλλει η αλληλεπίδραση των παραδοσιακών θεωριών με νέες υποθέσεις, όπως αυτές που προτείνονται από τη συμπεριφορική χρηματοοικονομική, στην ερμηνεία του φαινομένου της ημέρας αποκοπής του μερίσματος.

Η πρώτη μελέτη διερευνά κατά πόσο η διαφαινόμενη προδιάθεση των επενδυτών να ρευστοποιούν κερδοφόρες μετοχές με μεγαλύτερη ευκολία απ’ ότι μετοχές που έχουν καταγράψει ζημιές στο χαρτοφυλάκιο τους, όπως ορίστηκε από τους Shefrin and Statman (1985) («*disposition effect*»), έχει σημαντική επίδραση στην αναμενόμενη πτώση της τιμής των μετοχών κατά την ημέρα αποκοπής του μερίσματος. Αρχικά, χρησιμοποιώντας ημερήσια χρηματιστηριακά στοιχεία για δείγμα μερισμάτων που διανέμονται από κοινές μετοχές που είναι εισηγμένες στο χρηματιστήριο της Νέας Υόρκης («NYSE») και στο αμερικάνικο χρηματιστήριο («AMEX») κατά την περίοδο 2001-2008, το αντιπροσωπευτικό μέτρο κερδοφορίας που προτάθηκε από τους Grinblatt and Han (2005) («*capital gains overhang*») υιοθετείται από την μελέτη για να μετρήσει τη διαχρονική συσσώρευση κερδών ή ζημιών των μετοχών πριν από την ημέρα αποκοπής.

Εν συνεχεία, η εμπειρική ανάλυση της μελέτης δείχνει ότι μετοχές που έχουν καταγράψει κέρδη εμφανίζουν μεγαλύτερη πτώση στην τιμή τους κατά την ημέρα αποκοπής απ’ ότι μετοχές που έχουν προηγουμένως καταγράψει ζημιές. Παράλληλα, τα αποτελέσματα της ανάλυσης παλινδρόμησης δείχνουν ότι υπάρχει θετική σχέση μεταξύ της πτώσης της τιμής της μετοχής και του αντιπροσωπευτικού μέτρου κερδοφορίας των μετοχών η οποία αποδεικνύεται στατιστικά σημαντική. Κατ

αντιστοιχία, οι υπερβάλλουσες αποδόσεις που παρατηρούνται στην ημέρα αποκοπής, εξαιτίας του ότι η πτώση της τιμής των μετοχών είναι μικρότερη του μερίσματος, σχετίζονται αρνητικά με το αντιπροσωπευτικό μέτρο κερδοφορίας των μετοχών. Τα παραπάνω αποτελέσματα συμφωνούν με τη βασική υπόθεση της μελέτης, η οποία αναμένει ότι η προδιάθεση των επενδυτών να ρευστοποιούν κερδοφόρες μετοχές με μεγαλύτερη ευκολία θα διευκολύνει την πτώση της τιμής των μετοχών. Κατά τον ίδιο τρόπο, η προδιάθεση των επενδυτών να ρευστοποιούν ζημιογόνες μετοχές με μεγαλύτερη απροθυμία θα περιορίσει την πτώση της τιμής των μετοχών κατά την ημέρα αποκοπής. Τέλος, η εμπειρική ανάλυση δείχνει ότι η ίδια μετοχή εμφανίζει μεγαλύτερη πτώση της τιμής της σε περιόδους που είναι κερδοφόρα απ' ότι σε περιόδους που οι επενδυτές-κάτοχοί της καταγράφουν ζημιά στο χαρτοφυλάκιό τους, σε συμφωνία με την υπόθεση προδιάθεσης των επενδυτών. Συνεπώς, η μελέτη συνεισφέρει στη βιβλιογραφία της ημέρας αποκοπής του μερίσματος, στο βαθμό που προτείνει έναν νέο παράγοντα, ήτοι την προδιάθεση πώλησης των επενδυτών σε συνάρτηση με το μέγεθος προηγούμενης κερδοφορίας της μετοχής, ως ερμηνευτικό της διαχρονικής μεταβλητότητας της πτώσης της τιμής μια μετοχής η οποία είναι είτε κερδοφόρα είτε ζημιογόνα διαφορετικές χρονικές στιγμές.

Η δεύτερη μελέτη της διατριβής θέτει την υπόθεση της προσαρμογής των οριακών εντολών κατά την ημέρα αποκοπής του μερίσματος («*limit order adjustment hypothesis*»), όπως διατυπώθηκε από τον Dubofsky (1992), κάτω από το μικροσκόπιο ενδο-ημερήσιας («*intraday*») ανάλυσης. Η υπόθεση της προσαρμογής των οριακών εντολών κατά Dubofsky (1992) αναφέρει ότι η διαφαινόμενη ύπαρξη υπέρ-κανονικών αποδόσεων κατά την ημέρα αποκοπής του μερίσματος οφείλεται κατά βάση στην ασύμμετρη προσαρμογή των τιμών οριακών εντολών που έχουν εκδοθεί πριν από την ημέρα αποκοπής αλλά παραμένουν ανοιχτές στο άνοιγμα αυτής, σύμφωνα με τους κανονισμούς των υπό εξέταση χρηματιστηρίων. Ειδικότερα, μολονότι η τιμή ανοιχτών οριακών εντολών αγοράς («*bid quote*») μειώνεται αυτόματα από τους θεσμικούς μηχανισμούς των χρηματιστηρίων κατά το άνοιγμα της συνεδρίασης διαπραγμάτευσης την ημέρα αποκοπής του μερίσματος, δεν γίνεται καμία ανάλογη προσαρμογή στην τιμή ανοιχτών οριακών εντολών πώλησης («*ask quote*»). Ο Dubofsky (1992) υποστηρίζει ότι στο βαθμό που οι μη προσαρμοσμένες οριακές εντολές πώλησης παραμένουν ανοικτές μέχρι το κλείσιμο της ημέρας αποκοπής αυτές θ' αποτελέσουν τον κύριο λόγο για τον οποίο η πτώση της χρηματιστηριακής τιμής της μετοχής δεν θα ισούται με το μέρισμα στο κλείσιμο της ημέρας αποκοπής του μερίσματος.

Η εμπειρική ανάλυση της μελέτης χρησιμοποιεί χρηματιστηριακά στοιχεία τιμών συναλλαγών αλλά και εντολών σε ανά λεπτό συχνότητα για δείγμα ημερών αποκοπής μερίσματος κοινών μετοχών που είναι εισηγμένες στο χρηματιστήριο της Νέας Υόρκης («NYSE»), στο αμερικάνικο χρηματιστήριο («AMEX») και στο χρηματιστήριο «NASDAQ» το χρονικό διάστημα 21 Οκτωβρίου 2010 μέχρι 31 Δεκεμβρίου 2011. Τα αποτελέσματα της ενδο-ημερήσιας ανάλυσης δείχνουν ότι η επίδραση της ασύμμετρης προσαρμογής των οριακών εντολών ουσιαστικά καθορίζει τη θετική υπερβάλλουσα απόδοση των μετοχών από το κλείσιμο της προηγούμενης ημέρας μέχρι το άνοιγμα της ημέρας αποκοπής του μερίσματος, αλλά ταυτόχρονα, αυτή φαίνεται να διορθώνεται σημαντικά διαμέσου της συναλλακτικής δραστηριότητας που λαμβάνει χώρα από το άνοιγμα μέχρι το κλείσιμο της διαπραγμάτευσης της ημέρας αποκοπής του μερίσματος. Ως εκ τούτου, η σημαντική σχέση μεταξύ της πτώσης της τιμής της μετοχής και της επίδρασης της ασύμμετρης προσαρμογής των οριακών εντολών που καταγράφεται στο άνοιγμα τελικά παύει να υφίσταται στο κλείσιμο της χρηματιστηριακής συνεδρίασης της ημέρας αποκοπής του μερίσματος. Εν τέλει, σύμφωνα με τα εμπειρικά αποτελέσματα της μελέτης, η διόρθωση της προσωρινής επίδρασης της ασύμμετρης προσαρμογής των οριακών εντολών φαίνεται να είναι ταχύτερη για μετοχές που έχουν μεγαλύτερη συναλλακτικό όγκο κατά την ημέρα αποκοπής καθώς και για μετοχές που είναι εισηγμένες στο χρηματιστήριο «NASDAQ», όπου ο έντονος ανταγωνισμός μεταξύ των ειδικών διαπραγματευτών («*dealers*») αναμένεται να διορθώσει τις αρχικώς μη προσαρμοσμένες τιμές των οριακών εντολών πώλησης ώστε ν' αντανακλούν τη δίκαιη αποτίμηση του μερίσματος κατά την ημέρα αποκοπής του.

Τέλος, η τρίτη μελέτη της διατριβής αποσκοπεί στο να εντοπίσει το βασικό λόγο ύπαρξης θετικών υπέρ-κανονικών αποδόσεων κατά την ημέρα αποκοπής του μερίσματος μετοχών που είναι εισηγμένες στο ελληνικό χρηματιστήριο. Κατά την περίοδο 1992-2008, τα μερίσματα και τα κεφαλαιουχικά κέρδη των εισηγμένων μετοχών του Χρηματιστήριου Αξιών Αθηνών δεν υπόκειται σε καμία φορολόγηση. Κατ' αυτόν τον τρόπο, η νεοκλασική θεωρία που ερμηνεύει την ανεπαρκή πτώση της τιμής την ημέρα αποκοπής του μερίσματος με βάση τη διαφορετική φορολόγηση μερισμάτων και κεφαλαιουχικών κερδών, κατά Elton and Gruber (1970), προβλέπει ότι η πτώση της τιμής της μετοχής θα έπρεπε να ισούται με το μέρισμα. Παρ' όλ' αυτά, οι τιμές των ελληνικών μετοχών καταλήγουν να πέφτουν, κατά μέσο όρο, λιγότερο απ' ότι είναι το μέγεθος του μερίσματος και έτσι, καταγράφονται σημαντικές θετικές υπέρ-κανονικές αποδόσεις κατά την ημέρα αποκοπής του μερίσματος. Παράλληλα, μικροδομιακά χαρακτηριστικά όπως είναι το μέγεθος του βήματος των τιμών («*tick size*») ή η διαφορά μεταξύ τιμών πώλησης και αγοράς («*bid ask bounce*») δεν φαίνεται να έχουν βάσιμη ερμηνευτική ιδιότητα σε σχέση με την ανωμαλία που διαφαίνεται στην ημέρα αποκοπής του μερίσματος των ελληνικών μετοχών.

Η εμπειρική ανάλυση της μελέτης αποφαίνεται ότι η υπερβάλλουσα αγοραστική πίεση που παρατηρείται σ' ένα σημαντικό αριθμό μετοχών του εξεταζόμενου δείγματος δεν αφήνει την τιμή τους να μειωθεί κατά το ποσό του μερίσματος. Αυτή η έντονη συναλλακτική ζήτηση φαίνεται να οφείλεται στην άγνοια της αποκοπής του μερίσματος από τους επενδυτές, οι οποίοι μεταφράζοντας την πτώση της τιμής των συγκεκριμένων μετοχών ως αδικαιολόγητη υποτίμησή τους πραγματοποιούν σημαντικές συναλλαγές αγοράς αυτών. Η εν λόγω θεωρία επενδυτικής άγνοιας («*investor unawareness*») για την αποκοπή του μερίσματος μετοχών με ιδιαίτερα χαρακτηριστικά, όπως είναι η μικρή κεφαλαιοποίηση, η μικρή συναλλακτική ρευστότητα και το σύντομο ιστορικό διαπραγμάτευσης, αποτελεί τη μόνη εύλογη εξήγηση της ανωμαλίας που παρατηρείται στην ημέρα αποκοπής του μερίσματος των ελληνικών μετοχών, η οποία δεν μπορεί να ερμηνευθεί από άλλη καταγεγραμμένη υπόθεση της σχετικής βιβλιογραφίας.

ABSTRACT

This thesis aims to contribute to the literature with three interrelated studies, which investigate the stock price behavior on the ex-dividend day. Taken together, the empirical results from the three studies indicate that the traditional neoclassical and microstructure hypotheses of the ex-dividend day literature bear limitations in explaining the ex-day anomaly and in this respect the interplay of other factors taken from behavioral finance may also be considered.

The first study empirically tests whether the disposition effect, the inclination of investors to sell winning stocks more readily than losing stocks, has an asymmetrical impact on the price adjustment on the ex-dividend day. Using aggregate market data for a sample of ordinary taxable dividends of common stocks listed in NYSE and AMEX during 2001-2008, the capital gains overhang proxy is employed to measure accrued gains or losses for individual stocks. Stocks with accrued gains are found to have a higher market adjusted price drop than stocks with accrued losses on the ex-dividend day. Moreover, there is a significantly positive relationship between the ex-day price drop and the capital gains overhang. Both results are attributed to the disposition effect since active (limited) selling by holders of winning (losing) stocks will most likely speed up (restrain) the downward price adjustment on the ex-dividend day. This study contributes to the ex-dividend day literature, insofar as it proposes a new factor, namely, the past accrued gain or loss, to explain the time-series variation of the ex-day price drop ratio for a particular stock that can be a winner or a loser at different times.

The second study places Dubofsky's (1992) "limit order adjustment hypothesis" under the microscope of an intraday analysis, which employs a minute-by-minute trade and quote data recorded during the ex-dividend days of common stocks listed on NYSE, AMEX and NASDAQ. Dufosky's (1992) model concluded that the asymmetric adjustment of open limit orders for cash dividend payments under the NYSE and AMEX rules is sufficient to create abnormal returns on the ex-dividend day. This study's empirical evidence shows that the limit order bias incurred due to the exchange rules seems to dominate the overnight ex-day returns but at the same time, it is significantly corrected via active trading up until the close of the ex-

dividend day. As a result, the significant association of the ex-day price drop discrepancy with the opening limit order bias eventually disappears before the ex-dividend day close. Finally, it is found that the reversal of the limit order bias is in fact quicker in stocks which are more liquid or listed on NASDAQ where strong competition among dealers is envisaged to drive stale quotes closer to the fair adjustment of the dividend.

The third study aims to identify the driver of positive abnormal returns that persist on the Greek ex-dividend day. Common stocks listed in the Athens Stock Exchange paid out tax-free annual dividends and capital gains to all investors during the 1992-2008 period. Thereby, the neoclassical theory for the ex-dividend day predicts zero abnormal returns on the Greek ex-dividend day, in contrast to our empirical results. In addition, microstructure factors such as the “tick size” and “bid-ask bounce” effects play no role in explaining the Greek ex-day anomaly. It is shown that that abnormal buying pressure on the ex-day of numerous stocks prevents the stock price from falling by the full dividend amount. The evident buying pressure is attributed to investors who do not recognize that the price initially drops due to the dividend on the ex-day and therefore, initiate buy trades for the seemingly undervalued stocks. This “investor unawareness” hypothesis seems to explain the empirical evidence found on the Greek ex-dividend day, which cannot be otherwise interpreted.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

1.1.1 The Ex-Dividend Day of Common Stocks

The behavior of share prices around ex-dividend days has been the subject of considerable theoretical and empirical research for more than 40 years. Prior empirical studies document consistently that, on average, share prices decline on the ex-dividend day by less than the dividend amount, giving rise to positive abnormal returns on the ex-day. Extant literature provides two primary explanations. First, many studies attributed the ex-day return anomaly to the fact that individual shareholders face higher tax rates on dividend income as compared to long-term capital gains, causing cum-day prices to reflect a dividend tax penalty (Elton and Gruber 1970). Related studies argued that, when transactions costs are small relative to the dividend tax penalty, arbitragers will trade around the ex-day to reduce tax-induced abnormal returns to a point where they reflect transactions costs rather than the tax rate differential (Kalay 1982). Second, positive ex-day returns may be ascribed to market microstructure related reasons such as the exchange rules governing the dividend adjustment of open limit orders at the ex-day in U.S markets (Dubofsky (1992)), pricing of stocks in discrete ticks in U.S markets before 2001, (Bali and Hite (1998)) or the bid-ask bounce in the Hong Kong stock market during a period in which cumbersome physical settlement procedures were used (Frank and Jagannathan (1998)). These microstructure explanations involve no explicit role for tax.

Understanding the causes of the ex-day return anomaly is central to understanding why capital markets are less than perfect. In addition to supporting the theory that the dividend tax penalty incurred by some shareholders is impounded into share prices, evidence consistent with the tax explanation would indicate that transaction costs are too great to enable tax-neutral arbitrageurs to eliminate the resulting tax discount on individual dividend payments. On the other hand, if microstructure arguments explain positive ex-day returns, then neither taxes nor transaction costs are necessarily limits to market perfection in this setting. Today, after so many years of debate among academics, no consensus has been reached regarding the main drivers of the pricing anomaly on the ex-dividend day.

1.1.2 The Disposition Effect

Given that the ex-dividend day literature centers on the notions of the neoclassical finance paradigm, no attempt has been made to examine whether behavioral finance can contribute to it. For example, empirically observed trading behaviors, such as the "disposition effect" could play a distinctive role in the valuation of the dividend on the ex-dividend day. The term "disposition effect" was conceived by Shefrin and Statman (1985) to name the inclination of investors to sell stocks with accrued gains more readily than stocks with past losses accumulated in their portfolios. A major question crucial for security valuation is raised; that is, whether an investor behavior prescribed by the disposition effect can affect market prices. By affecting supply, the disposition effect may also contribute to price setting during the day when a corporate event takes place. If many investors have bought a stock at a particular price, that price may become their reference point. If the stock falls below this reference point, these investors will be averse to selling for a loss, reducing the supply of potential sellers. A reduced supply of potential sellers could slow further price drops that occur as the corporate event is valued by marginal investors. On the other hand, if the stock rises above the reference point, these investors will be more willing to sell, increasing the supply of potential sellers, and possibly accelerating further price drops.

At the instance of one unique corporate event, namely, the ex-dividend day, the stock price is due to fall in order to incorporate the loss of the right to the dividend into prices. If the disposition effect is prevalent among the majority of investors, the price drop on the ex-dividend day will be expected to be accelerated for previously winning stocks and, at the same time, slowed down for losing stocks. Chapter 3 presents the results of a series of empirical tests conducted to determine the importance of the disposition effect in the price-setting process of the ex-dividend day. The empirical analysis focuses on the price behavior on the ex-dividend day of common stocks listed on NYSE and AMEX during the 2001-2008 period. This corporate event offers a number of unique advantages, over other corporate events and market settings, in assessing the existence of the disposition effect and any consequences this might have for stock prices. Moreover, the lack of consensus within the neoclassical finance literature of the ex-dividend day as to what factors own the greater explanatory power for ex-day returns automatically renders the disposition effect a candidate factor for explaining ex-day price variation across stocks. Naturally, the extent to which the disposition effect affects ex-day prices depends on the impact of trades of all market participants such as individual investors and professional traders, and the market frictions present on the ex-dividend day.

1.1.3 Microstructure effects on the ex-dividend day of US common stocks

Within the microstructure framework, the "limit order adjustment hypothesis" introduced by Dubofsky (1992), the "tick size hypothesis" introduced by Bali and Hite (1998), and the "bid-ask bounce hypothesis" introduced by Frank and Jagannathan (1998) directly challenge the tax hypothesis as the main driver of positive abnormal returns on the ex-dividend day.

Dubofsky (1992), in particular, proposed the "limit order adjustment hypothesis" as an explanation for the ex-dividend day anomaly prevalent in U.S. common stocks, which is based on how NYSE Rule 118 and AMEX Rule 132 dictate how previously placed ("good-till-canceled") limit orders to buy and sell stock are handled on ex-days. On both exchanges, open limit orders to buy a stock (at the bid) must be reduced by the cash dividend amount at the opening of the ex-dividend day. Moreover, in case the adjusted limit buy order price is not a multiple of the tick size, (equal to $1/8 over Dubofsky's (1992) period examined), it is further reduced to the next lower tick. On the other hand, limit orders to sell (at the ask) are not consistently reduced by the ex-cash dividend amount. The author argued that, the asymmetric adjustment of open limit orders on ex-days under the NYSE and AMEX rules is sufficient to create ex-day abnormal returns under three assumptions: (i) the cum-dividend day closing price is the mean of the best bid and ask quotes specified by open good-till-canceled buy and sell limit orders, respectively (ii) on the ex-dividend day close, the best bid and ask quotes are those of the outstanding limit orders previously placed by investors during the cum-dividend period and adjusted as specified by the aforementioned NYSE and AMEX rules and (iii) the opening or closing trade on the ex-day is executed at one of these two quotes, with equal probabilities.

Chapter 4 revisits Dubofsky's (1992) main prediction of the impact of the limit order adjustment on the ex-dividend day of NYSE, AMEX and NASDAQ stocks and attempts to demarcate the framework under which the limit order adjustment is important in explaining the ex-day price drop discrepancy. More specifically, the afore mentioned hypothesis (ii) comes into question given that any positive return bias incurred by the asymmetric adjustment of limit orders to sell/buy at the ex-day open proves to fade away in the course of interim trading activity taking place before the close of the ex-dividend day.

1.1.4 The Ex-Dividend Day of Greek Common Stocks

There has been a plethora of research papers that attempt to explain why the stock price falls less than the dividend amount on the ex-dividend day. Several lines of argument have attempted to explain the ex-day curiosity: (i) the higher taxation on dividends than capital gains for individual investors (Elton and Gruber (1970, 1984)) (ii) the barrier that transaction costs raise to tax-neutral arbitrageurs in their attempt to completely eliminate ex-day abnormal returns (Kalay (1982, 1984)) (iii) the wide tick size that leads to a systematic downward rounding of the ex-day price drop (Bali and Hite (1998)) (iv) the buy versus sell order imbalance prevailing on the ex- versus cum-dividend day creating the bid-ask bounce effect (Frank and Jagannathan (1998)). In markets where tax, short-term trading and microstructure effects are interlaced, it is hard to establish a clear-cut explanation for the ex-day phenomenon. On the other hand, in markets where tax implications are neutralized due to tax laws, the tick size is not considered major due to microstructure rules and short-term arbitrage is not effective due to high transaction costs imposed on arbitrage, the factors explaining ex-dividend price behavior should supposedly be determined in a more straightforward way.

The case of the Athens Stock Exchange (ATHEX) constitutes one such case, as dividends and capital gains have been tax free for all investors since 1992, the tick size is considered minor in relation to the annually paid dividends and transaction costs born by a "round-trip" trade are high enough to prevent pure arbitrage strategies around the ex-day. Therefore, two subjects of empirical examination naturally arise in the context of the Greek ex-dividend day. First, given that the "traditional" ex-dividend day hypotheses are *a priori* expected to play a minor role on the ex-dividend day of Greek stocks, this needs to be verified by formal statistical hypothesis testing.

Second, subject to the validation of the previous argument and to the extent that stocks are on average mispriced on the Greek ex-dividend day, an alternative theory needs to be established to explain potential deviations from the efficient valuation of the dividend on the ex-dividend day, consistent with the exceptional characteristics of the Greek institutional framework and the degree of market efficiency that is presumed for valuing Greek stocks. Chapter 5 explicitly addresses the aforementioned issues and contributes to the international ex-dividend day literature in several unique ways.

1.2 Objectives and Contributions of the Thesis

1.2.1 Examining the Price Impact of the Disposition Effect on the Ex-Dividend Day of U.S. Common Stocks

Empirical tests of the disposition effect face a number of challenges. First, relevant models cannot be easily tested with aggregate market data. As a result, testing the disposition effect is quite difficult without detailed information on the trading behavior of market participants. Unfortunately, given the issue of confidentiality associated with such data, availability of such information is generally quite narrow. An additional difficulty is that an investor's horizon, while highly ambiguous in most empirical settings, represents a key dimension in behavioral models investigating the existence of the disposition effect. For example, when investors are deemed averse to losses, it is not clear whether their aversion relates to returns at the monthly, quarterly, or annual horizons, or even whether they view losses on positions taken recently as equivalent to losses on positions entered into years ago. On the other hand, if biases can be identified in investor behavior, to demonstrate that this is more than just instances of noise trading, empirical tests that only use aggregate market data must be employed to identify a link between the disposition effect and the ex-dividend day price setting. This thesis adopts the second stance, and using aggregate market price data for NYSE and AMEX finds a direct relation between the price drop on the ex-dividend day and the inclination of marginal investors to sell stocks with prior positive returns more easily than stocks with prior negative returns accrued in their trading portfolios.

In particular, if the disposition effect is pervasive in the investor trading behavior, we expect holders of winning stocks to be more willing to sell than those of losing stocks on the ex-day. Therefore, assuming a downward-sloping demand curve, two testable predictions can be made with respect to the expected price impact of the disposition effect on the ex-day:

Hypothesis I: Excess (limited) supply for winning (losing) stocks will result in wider (smaller) price drop ratios on the ex-dividend day.

Hypothesis II: The higher the unrealized gain (loss) accrued on the stock, the larger (smaller) the ex-dividend day price drop ratio because the influence of the disposition effect on trading activity will be amplified.

We use the capital gains overhang proxy, as computed by Grinblatt and Han (2005), to measure the accrued gain or loss for individual stocks just before the ex-day based on market-wide data on stock prices and turnovers. Consistent with the disposition effect, we find that stocks with a positive capital gains overhang have a higher price drop ratio than stocks with a negative capital gains overhang on the ex-day. Moreover, the market-adjusted price drop ratio is positively related to the level of the capital gains overhang. We attribute our results to the fact that active (limited) selling by holders of winning (losing) stocks accelerates (restrains) the downward price adjustment on the ex-day. Overall, our results remain robust to numerous ex-day normal return specifications, panel data models adjusting for clusters along stock and time dimensions or fixed effects, different holding period length assumptions and the use of opening prices instead of closing prices on the ex-day.

1.2.2 Examining the Limit Order Bias at the Ex-Dividend Day of U.S. Common Stocks: Intraday Analysis

The analysis in Chapter 4 is motivated by Dufosky's (1992) model which concludes that the asymmetric adjustment of open limit orders for cash dividend payments under the NYSE and AMEX rules is sufficient to create abnormal returns on the ex-dividend day. The power of such prediction is investigated by using minute-by-minute trade and quote data recorded during the ex-dividend days of common stocks listed on NYSE, AMEX and NASDAQ over the period from the 21st of October 2010 until the 31st of December 2011. In this context, the Conrad and Conroy's (1994) order flow bias metric is deployed to proxy for the impact of the asymmetric limit order adjustment at the opening of the ex-dividend day.

The order flow bias, which encompasses the anticipated widening of the bid-ask spread at the opening of the ex-dividend day, is found to dominate the overnight returns but at the same time, is significantly corrected before the close of the ex-dividend day. As a result, the significant association of the ex-day price drop discrepancy with the opening order flow bias disappears at the ex-dividend day close. Finally, empirical evidence shows that the reversal of the bid-ask spread widening, which constitutes the main component of the order flow bias at the ex-day open, is in fact quicker in stocks which are more liquid or listed on NASDAQ where strong competition among dealers is envisaged to drive stale quotes closer to the fair adjustment of the dividend.

This study contributes to the ex-dividend literature by highlighting that although the impact of the asymmetric limit order adjustment hypothesis is indeed important at the ex-day opening, it loses its explanatory power before the ex-day close is reached. As a result, the validity of Dufosky's (1992) theory in explaining ex-day abnormal returns is considered to be restricted to the ex-day open. Furthermore, this study constitutes one of the very few that test microstructure effects using time stamped price and quote data over the entire course of ex-dividend day trading for U.S. common stocks.[1] Finally, it is also the first study that investigates the impact of the open order adjustment at the ex-dividend day of NASDAQ listed stocks (NASDAQ Rule 3220), in parallel with NYSE and AMEX stocks, for which the exchange rules (NYSE Rule 118 and AMEX Rule 132) regarding the dividend adjustment are essentially the same.

1.2.3 Examining the Abnormal Buying Pressure on the Ex-Dividend Day of the Greek Stock Market

Chapter 5 is structured in a way as to successively deal with three issues regarding the ex-dividend day pricing in the Athens Stock Exchange (ATHEX). First, it is confirmed that none of the traditional hypotheses of the ex-day literature are in fact explanatory of the average abnormal returns which are apparent on the ex-dividend day of Greek stocks. Second, it shows that abnormal buying pressure is the main cause of the positive abnormal returns that are found to be statistically significant for the examined sample of ex-dividend days. In order to isolate the possible buying pressure effect, the average daily price is employed to break down the ex-day price

[1] To the best of my knowledge, the only other study that employs high frequency ex-day data is made by Balasubramaniam et al. (2010) who perform an intraday analysis of ex-dividend days collected from the NYSE, AMEX and NASDAQ under different tax and price quotation regimes over the period from 1994 to 2003.

abnormal return into three components; the component from the close of the cum-dividend day to the opening of the ex-dividend day, the percentage deviation of the average price prevalent during the ex-dividend day from the opening price at the ex-day and the percentage deviation of the closing ex-day price from the average ex-day price. The last return component is selected to serve as a proxy variable for abnormal buy pressure.[2] Subsequently, the sample is split between stocks with and stocks without significant abnormal buy pressure on their ex-dividend day. After computing ex-day abnormal returns separately for the two samples, it is found that stocks with no abnormal buy pressure have in fact price drop ratios and ex-day abnormal returns equal to their fundamental values. In specific, the average price drop ratio and ex-day abnormal return are found not to be significantly different than one and zero, respectively, for this partition of the sample. On the other hand, for the stocks that exhibit abnormal buy pressure during the ex-day, abnormal ex-day returns are significantly positive, in such a degree that they seem to drive the average ex-day price drop and return statistics of the total sample.

Third, a unique hypothesis as to what causes the abnormal buy pressure for a particular set of stocks with special characteristic is stated and empirically tested. In particular, stocks that are widely recognized by investors are anticipated to have no abnormal buying pressure that might be exerted by investors who are not informed of the dividend payment and hence, are not aware that the dividend goes ex on the sample days. If there is a group of stocks whose ex-dividend days are overlooked by not informed investors, these are most likely to be small with low trading volume and belong to relatively new firms. The results presented in the thesis indicate that small, young, illiquid stocks exhibit high abnormal buy pressure on the ex-day, resulting in large deviations from the fundamental price drop ratios and hence, significantly positive abnormal returns on their ex-dividend days. To the extent that this intriguing mispricing is not offset by informed traders who can be effective in correctly valuing stocks on their ex-days, trading volume for this sample is anticipated to be relatively low, as verified by the empirical results shown in Chapter 5. The main contribution of this study is that it introduces an "investor unawareness" hypothesis, lying outside the

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[2] The average ex-day price is computed as the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to.

extant conventional literature that is capable of explaining the prevalent mispricing on the ex-dividend day of Greek stocks, which cannot be otherwise warranted.

CHAPTER 2: LITERATURE REVIEW

2.1. The Ex-Dividend Day of Common Stocks

2.1.1 Introduction

Miller and Modigliani (1961) proposed that in an efficient market with no taxes and transaction costs, at the ex-dividend day, the price of the stock should theoretically decrease by the exact amount of the cash dividend. The proponents of efficient markets state that the value of assets per share fall by the amount of the dividend and thus the price per share should fall by this amount, ceteris paribus. However, empirical research has shown that the price drops by less than the amount of the dividend. The "tax hypothesis" (described in Section 2.1.2), the "short term arbitrage and transaction cost hypothesis" (described in Section 2.1.3), and two market microstructure hypotheses, the "tick size hypothesis" and the "bid-ask bounce hypothesis" (described in Section 2.1.4), all attempt to explain the empirical inefficiency of the price drop on the ex-dividend day.[3]

2.1.2 Tax Hypothesis: Marginal Stockholder Tax Rates and the Clientele Effect

A shareholder selling his stock before the ex-dividend day loses the right to the dividend that has been declared a few days ago.[4] If he sells the stock on the ex-dividend day he retains the dividend but should expect to sell it at a lower price in order for the price drop to make up for the dividend cash amount that will be received later on. In a rational market the fall in price on the ex-dividend day should reflect the value of dividends vis-à-vis capital gains to the marginal shareholders. Dividends in the U.S. are included in ordinary taxable income and thus, taxable according to the income tax brackets stated by current Tax Rules. Because these have been historically different to tax rates on capital gains, the value of the dividend reflected on the ex-

[3] Notably, attributing the abnormal ex-dividend day returns to the differential tax treatment of capital gains and dividends is the most widely documented explanation in the literature.

[4] An exception to the process of mandatorily declaring a dividend before the ex-dividend day is Japan. According to Kato and Loewenstein (1995), Japanese corporations are not required or expected to announce the size of their dividend before the ex-dividend day.

dividend day should incorporate the relative dividend tax differential with respect to capital gains. Thus, an expression can be derived between the ex-dividend behavior of common stock prices and the marginal tax rates of marginal stockholders, as follows.

Let: P_i^o = Price at which the shareholder has initially bought stock *i*,

P_i^{cum} = Closing price on the day before the ex-day (cum-dividend day) for stock *i*,

P_i^{ex} = Closing price on the ex-dividend day for stock *i*,

D_i = The amount of the dividend for stock *i*,

t_d = The tax rate on ordinary income / dividend,

t_{cg} = The capital gains tax rate.

If a shareholder were to sell a common stock he owns before this goes ex-dividend, his expected per share realized value would be equal to the capital gain accrued on the cum-dividend day net of capital gain taxes:

$$\left(P_i^{cum} - P_i^o\right) - t_{cg}\left(P_i^{cum} - P_i^o\right)$$

If he were to sell on the ex-dividend day his expected per share wealth would be equal to the capital gain accrued on the ex-dividend day net of taxes plus the dividend net of income taxes:

$$\left(P_i^{ex} - P_i^o\right) - t_{cg}\left(P_i^{ex} - P_i^o\right) + D_i - t_d D_i$$

For him to be indifferent as to the timing of his sale, the wealth received from either decision must be the same, as follows.[5]

$$\left(P_i^{ex} - P_i^o\right) - t_{cg}\left(P_i^{ex} - P_i^o\right) + D_i - t_d D_i = \left(P_i^{cum} - P_i^o\right) - t_{cg}\left(P_i^{cum} - P_i^o\right)$$

By rearranging terms of the equation:

$$\left(P_i^{ex} - P_i^o\right)\left(1 - t_{cg}\right) + D_i\left(1 - t_d\right) = \left(P_i^{cum} - P_i^o\right)\left(1 - t_{cg}\right) \Leftrightarrow$$

$$\left(P_i^{cum} - P_i^o\right)\left(1 - t_{cg}\right) - \left(P_i^{ex} - P_i^o\right)\left(1 - t_{cg}\right) = D_i\left(1 - t_d\right) \Leftrightarrow$$

[5] In reality, the investor will also consider the uncertainty of the ex-dividend day price and transaction costs pertinent to his sale trades. However, these are ignored in this basic framework.

$$\left(P_i^{cum} - P_i^{ex}\right)\left(1 - t_{cg}\right) = D_i\left(1 - t_d\right) \Leftrightarrow$$

$$\frac{\left(P_i^{cum} - P_i^{ex}\right)}{D_i} = \frac{\left(1 - t_d\right)}{\left(1 - t_{cg}\right)}$$

This statistic that is labeled as the Price Drop Ratio (PDR_i) represents the equilibrium ex-day stock price drop that would cause a shareholder with a particular set of tax rates to be indifferent as to the timing of sales of common stocks before or after the opening of the ex-dividend day. If the expected ex-dividend price is either too high or too low for the marginal ex-day investor, he will change the timing of his trades until ex-day stock prices revert to the equilibrium. Elton and Gruber (1970) who devised this statistic, formally expressed two natural implications for the ex-dividend day. First, given that income tax rates have been historically higher than capital gain tax rates for medium to high tax bracket individual investors ($t_d > t_g$), they should price the dividend at a value that is less than the cash amount distributed by corporations, resulting in a PDR of less than one on the ex-dividend day.[6] Whenever the price drop falls short of the dividend, abnormal positive total returns accrue to those who are eligible to receive the dividend. Second, because PDR must reflect the marginal tax rates of the marginal stockholders trading on the ex-day, one should be able to infer these tax rates by observing PDR values.

In alignment with Miller and Modigliani (1961) who introduced the clientele effect, Elton and Gruber (1970) acknowledged that the identity of the marginal investor on the ex-day will vary for firms with different fundamental characteristics. The authors hypothesized that the interaction of corporate dividend policy with investor tax-preferences will determine the allocation of various investor clienteles to the population of common stocks. In particular, the lower a firm's dividend yield the smaller the percentage of total return that a stock holder expects to receive in the form of dividends and the larger the percentage he expects to receive in the form of capital gains. Therefore, firms that pay higher dividend yields should attract stockholders in low income tax brackets while firms with high dividend yields should attract stockholders in high income tax brackets. According to the dividend (tax) clientele

[6] This inference is based on the premise that the marginal investor on the ex-dividend day is in fact an individual investor carrying a tax-disadvantage on the dividend he receives.

hypothesis, corporate dividend yields will be in direct relation to the relative dividend tax rate of the marginal investor, which can be inferred by the PDR statistic, as stated above. The dividend (tax) clientele theory implies a positive relationship between the dividend yield of stocks and the PDR that became the subject of empirical investigation by several studies of the ex-dividend day literature.[7]

In this context, Elton and Gruber (1970) examined the ex-day behavior of all common stocks listed on NYSE that paid a dividend during the period April 1, 1996 to March 31, 1967. They divided their ex-day sample into deciles on the basis of the dividend yield that was assumed to provide for dividend clienteles and calculated the mean PDR for each decile. They found that the PDR almost monotonically increases - hence, the implied income tax bracket for the marginal investor decreases - as the dividend yield increases, consistent with the dividend clientele theory.

Later, a long series of papers examining the ex-dividend day stock behavior in U.S., U.K. or other international markets presented evidence supporting the "tax hypothesis" such as Barclay (1987), Robin (1991), Lasfer (1995), Koski (1996), Green and Rydqvist (1999), Bell and Jenkinson (2002), Elton, Gruber, and Blake (2005), Milonas et al. (2006) and Zhang, Farell and Brown (2008).

Barclay (1987) compared U.S. ex-day PDR in periods when dividend and capital gains were not at all taxed with PDR after federal income taxes were enacted, as a natural test of the tax hypothesis. In specific, his pre-tax sample consisted of dividends of stocks traded at NYSE from January 1, 1900 to December 31, 1906 and from December 12, 1909 to June 30, 1910 while his post-tax sample referred to the period between July 2, 1962 and December 31, 1985. His findings revealed that stock prices fell by the full amount of the dividend during the pre-tax period while they fell less than the dividend in the post-tax period when dividends carried a tax-disadvantage relative to capital gains. The author concluded that when investors are tax-indifferent, they value dividends and capital gains as perfect substitutes but when a higher tax rate is levied on dividends, investors will discount the value of taxable dividends relative to capital gains.

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[7] In this thesis the terms "dividend clienteles", "tax clienteles" and "tax induced clienteles" are used interchangeably to define the dividend (tax) theory stated by Elton and Gruber (1970).

The 1986 Tax Reform Act (1986 TRA) abolished the tax differential on dividend income and capital gains for the individual investor. Robin (1991) hypothesized that such a tax amendment should reduce ex-dividend day abnormal returns previously incurred due to the tax differential between dividends and capital gains, as well as weaken short-term trading activity around the ex-day. He tested these hypotheses on a sample of all common stocks listed on NYSE and American Stock Exchange (AMEX) over the period 1984-1988. He found a statistically significant drop in ex-day abnormal returns from 0.152% during 1984-1986 to 0.038% during 1987-1988, consistent with the tax-hypothesis. Also, post-1986 TRA abnormal returns continued to be significantly different to zero, implying that certain investors continued to exhibit a relative tax-preference to capital gains over dividend income. Finally, contrary to tax-based predictions, the relationship between ex-day abnormal returns and the transaction costs, while significant during 1984-1986, became stronger during 1987-1988.

Lasfer (1995) examined a large sample of UK listed companies and compared the ex-day abnormal returns in the pre- and post-1988 Income and Corporation Taxes Act (ICTA), which equalized the taxation of dividends and capital gains. On the grounds of the tax hypothesis, he hypothesized that while the pre-1988 ex-day returns were expected to be positive and significant to reflect the tax differential between dividends and capital gains, the post-1988 abnormal returns should be insignificant and even negative to reflect the enacted tax credit associated with the cash dividend. He found that ex-day returns in the post-1988 period were not significant. In contrast, in the pre-1988 period, ex-day returns were positive and significant, in favor of the tax-hypothesis. Nevertheless, the remarkable shift in ex-day returns between these two tax periods was found to be driven mainly by the highest dividend yield stocks.

Koski (1996), following Robin (1991), estimated the impact of the 1984 Tax Act and 1986 Tax Act on the ex-day PDR and at the same time, incorporated the bid-ask spread as a variable reflecting the marginal transaction cost in order to minimize potential biases caused by bid-ask measurement error. He compared ex-day behavior in 1983 to ex-day behavior in 1988 for all stocks included in the Standard and Poor's 500 index in either year. In between the two years, two Tax Acts were enacted in 1984 and 1986 resulting in the complete elimination of the preferential capital gains tax treatment relative to dividends. In alignment with the tax hypothesis he found that ex-day PDR significantly increased from 1983 to 1988, converging to unity for several dividend yield partitions.

Green and Rydqvist (1999) exploited Swedish lottery bonds as a unique opportunity to study ex-day effects in an environment where cash distributions are tax advantaged relative to capital gains, opposite to the tax treatment of dividends paid by U.S. common stocks. Swedish lottery bonds, issued by the Swedish Treasury, pay fixed coupon payments that are distributed randomly to several holders by means of lottery. Swedish lottery bonds offer the advantage of having much less volatile prices than ordinary stocks while their institutional setting precludes any sort of arbitrage transactions around the ex-day. Like municipal bonds in the U.S., lottery bonds' coupon payments are tax-exempt while capital gains are taxed suggesting that price drops would greater be than the cash amount. The study's results supported the tax-based interpretation of ex-day returns because it found that bond prices fell by 130 percent of the coupon payment across the entire tested sample.

Bell and Jenkinson (2002) investigated the valuation of dividends paid by UK corporations before and after the 1997 UK tax reform. They pointed out that around 1997, tax-exempt pension funds constituted the single biggest class of investors in UK equities with over one third of total UK stock market capitalization held by them, rendering them the most likely candidates for marginal trading on the ex-dividend day. Furthermore, between April 1973 and July 1997, dividends were actually tax preferred by pension funds since these were eligible for a tax credit on the received cash amount that could be sent to the tax authorities to obtain a full cash refund. The July 1997 reform, however, withdrew the ability of tax-exempt investors to reclaim the tax-credits thereby significantly reducing their positive valuation over dividends.[8] The authors, presuming that pension funds were indeed the marginal investors on the ex-dividend day hypothesized that ex-day PDR should drop after the 1997 tax reform. Their findings showed that PDR significantly fell after 1997, especially for highest dividend yield stocks that were most likely to be included in pension funds' portfolios, consistent with the tax hypothesis.

[8] Bell and Jenkinson (2002) estimated that the withdrawal of the tax-credit reduced the positive valuation of dividend income by twenty percent.

Elton, Gruber, and Blake (2005) tested for ex-dividend effects on two samples of shares in closed-end mutual funds with unique tax characteristics during the interval January 4, 1988 through September 10, 2001. In specific, one of the two samples referred to municipal bond mutual funds that pay dividends that are non-taxable while the other type of municipal bonds pay dividends that are taxed at a higher tax rate than capital gains. They found that the mean PDR was greater than one for the non-taxable funds and less than one for the taxable funds during 1997-2001 when dividends born a tax-disadvantage relative to capital gains. Overall, their results confirmed the marginal stockholder tax and tax clientele hypotheses that were introduced by the same authors in 1970.

In the international ex-day literature, Milonas et al. (2006) analyzed the ex-day price reaction for a sample of Chinese common stocks for the period January 1996 to December 1998. Chinese stocks that paid taxable dividends were compared with stocks that paid non-taxable dividends, while keeping microstructure effects constant. The authors found that ex-day price drops were not significantly different to the dividend amount for non-taxable stocks, whereas for the taxable sample, stock prices of small dividend yield stocks fell proportionately to the dividend paid. For the large dividend yield stocks, the ex-day price adjustment depended on the effective tax rate on taxable income. Milonas et al. (2006) concluded that their findings were overall consistent with the tax-hypothesis.

More recently, Zhang, Farell and Brown (2008) examined the impact of the 2003 Jobs and Growth Tax Relief Reconciliation Act, which equated dividend tax rates to capital gain tax rates for the individual investor, on the ex-dividend day pricing and trading volume. The authors compared PDR and ex-day abnormal returns in 2001-2002 (pre-Act) to PDR and ex-day abnormal returns in 2004-2005 (post-Act) for all CRSP common stocks that paid taxable dividends throughout these periods. They showed that ex-day PDR increases and ex-day abnormal returns decrease in the post-Act period, in support of the tax-based explanation. Moreover, their evidence suggested that overall dividend clienteles weakened after 2003 Tax Act in alignment with the convergence of tax preferences among different classes of investors induced by the 2003 Tax Act. Finally, they concluded that individual investors seem to play an important role in the price setting on the ex-dividend day of U.S. stocks.

2.1.3 Short-Term Arbitrage and Transaction Cost Hypothesis

Despite the long series of studies providing support for the tax-hypothesis, there have been few authors who present empirical results that cast doubt on its validity. For example, Eades, Hess and Kim (1984) who estimated ex-day abnormal returns for both taxable and non-taxable distributions made by NYSE common stocks during the period July, 2 1962 to December 31, 1980 documented considerable objections to the tax explanation and the hypothesis of tax-induced dividend clienteles. Although they estimated positive ex-day abnormal returns for taxable dividends, in favor of the tax hypothesis, their results also revealed two intriguing deviations from the postulates of the tax effect proponents. First, the ex-day abnormal returns of a sample of taxable preferred stock dividends were found to be negative, inconsistent with the tax-disadvantage that individual investors carried on their received dividends.[9] Second, when the authors examined alternative samples of non-taxable distributions, they found that abnormal returns for stock dividends and stock splits were significantly positive whereas abnormal returns for non-taxable cash dividends were significantly negative. These results provided weak evidence for the tax hypothesis overall, and motivated the authors to look for alternative explanations. Thus, Eades, Hess and Kim (1984) examined the possibility that dividend announcements were in fact contaminating their methodology design but eventually deduced that neither the proximity nor the strength of the announcement were able to completely explain the asymmetric ex-day pricing among their different samples. In their concluding remarks, the authors recognize that the ex-dividend day price reaction cannot be explained by taxes alone, as quoted:

...[T]his result suggest that the ex-day returns are part of a larger ex-dividend period anomaly, and we find ourselves with a large set of puzzling results in search of a new interpretation.

In addition, Kalay (1982) was the first to introduce an alternative hypothesis to the ex-dividend day literature that posed series questions as to the extent that ex-day price drop variation reflects the existence of various tax-induced clienteles, as was previously postulated by Elton and Gruber (1970). In brief, Kalay (1984) argued that

[9] The authors acknowledged though that this empirical evidence could be warranted if it is assumed that the marginal investors of preferred stocks were corporations that are subject to lower tax rates on dividends than on capital gains.

long-term investors' marginal tax rates cannot be inferred from the ex-dividend day stock price behavior because of the concurrent presence of short-term traders in the market. His theoretical model was based on the assumption that short-term traders were risk neutral, facing the same marginal tax rate on both dividends and capital gains (i.e. tax-neutral as well) and active in executing arbitrage trades. Moreover, transaction costs of roundtrip trades were assumed to be estimated with certainty by short-term traders as a fixed proportion of the stock price. In this framework, short-term traders will buy the stock at cum-day and subsequently sell it on the ex-day in order to profit from ex-day abnormal returns, which are expected to be generated due to the adverse valuation of dividends by tax disadvantaged long-term investors. Although Kalay's (1982) model did not directly challenge whether the tax hypothesis adequately explains why do ex-day abnormal return occur in the first place, it did deviate from the tax hypothesis in two substantive ways. First, it suggested that it is the tax-neutral short-term trader who constitutes the marginal investor on the ex-dividend day rather than the tax-sensitive long-term investor.[10] Second, to the extent that short-term traders are the ex-day price setters, the empirically observed discrepancy between the ex-day price drop and the dividend will merely reflect the roundtrip transaction cost that prevents short-term traders from fully eliminating ex-day abnormal returns. In specific, his theoretical model came up with a range of possible values for the price drop ratio that is eventually bounded by the transaction cost born by short-term traders as follows:

$$1-\frac{\alpha P^*}{D_i} \leq \frac{\left(P_i^{cum}-P_i^{ex}\right)}{D_i} \leq 1+\frac{\alpha P^*}{D_i}$$

where P^* is the average between P_i^{cum} and P_i^{ex} and α is the charge of the transaction cost of a roundtrip trade, as a percentage of the average price. As a result, in any instance that price drop ratios reflecting marginal tax rates of taxable investors fall outside these bounds, short-term traders will intervene in the ex-day trading and exploit abnormal returns until the price drop ratio falls back to this “no-arbitrage”

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[10] The distinction between the long-term investor and short-term trader is stated by Kalay (1982) as follows; the long-term investor will buy or sell the stock around the ex-dividend day for reasons unrelated to the dividend whereas the short-term trader will trade only because of the dividend-related mispricing.

range.[11] Finally, Kalay (1982) argued that the positive relationship between the ex-day price drop ratio and the dividend yield reported in Elton and Gruber's (1970) study simply reflects the fact that the trading transaction cost is inversely proportional to the dividend yield rather than the dividend valuation of different tax-induced clienteles.[12]

On the other hand, Booth and Johnston (1984) provided no support for the "short-term and transaction cost hypothesis" in their attempt to identify the marginal investor on the ex-dividend day of Canadian stocks trading on Toronto Stock Exchange (TSE) during the period from 1970 to 1980. They outlined four distinct scenarios under which a different type of marginal investor with different tax preferences will determine the magnitude of the price drop ratio on the ex-dividend day. Out of these scenarios, two are in accordance to the Elton and Gruber's (1970) tax hypothesis while the other two are built on the premises of Kalay's (1982) "short-term and transaction cost hypothesis". The first is the normal case of an individual investor at a high income tax bracket who has adopted an active investment strategy with realized capital gains being less taxed that dividend income. In the second case, the individual investor is tax savvy and manages to reduce his effective tax rate on capital gains to zero, either through deferral or optimal tax-loss selling. The third case assumes that tax-neutral institutional investors will step in to exploit any possible profit opportunities on the ex-dividend day, thus, driving the price drop ratio equal to one.[13] In the fourth case, professionally trading individuals who are tax favored in realizing capital gains but with different relative tax preferences compared to long-term individual investors, will also exploit arbitrage opportunities, making the price drop

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[11] Michaely and Vila (1995) used a rational expectations equilibrium framework to model the cum-ex price differential. They found that this differential depends on two factors: first, the relative tax rate difference between dividend and capital gains income, and second a risk component. The implication of the above theory is that the short-term trader is constrained not only by transaction costs, but also by the extra risk of not being diversified. It is a an empirical matter to ascertain which group dominates security pricing on the-day - the short-term traders or the ordinary investors who trade for portfolio reasons. If the short-term traders dominate, ex-day abnormal returns will be related to transaction costs, and if the ordinary investors dominate, ex-day abnormal returns will reflect the tax discrepancy between dividend income and capital gains.

[12] Accordingly, a high dividend yield results in a lower relative transaction cost that results in a higher price drop ratio on the ex-dividend day, ceteris paribus.

[13] Tax-exempt institutions such as pension funds and dealers for which both dividends and capital gains are considered ordinary income, therefore are equally taxed, belong in this category of tax-neutral investors.

ratio imply their own marginal tax rates. Initially, Booth and Johnston (1984) estimated the price drop ratio bounds outside of which arbitrage on the Canadian ex-day is not profitable, according to the lowest commission rate schedule provided by TSE. They derived two theoritical ranges equal to $-0.008 \leq$ price drop ratio ≤ 2.008 and $0.496 \leq$ price drop ratio < 1.504 for an average $30 stock with a quarterly dividend yield of 1.25% and 2.5%, respectively. As a result, they anticipated that the upper and lower bounds were too extreme to make it possible for a price drop ratio implying the marginal tax rate of a particular tax-clientele to lie outside these bounds. On these grounds, they *a priori* rebuffed the prediction that the ex-day pricing is set by short-term traders, either professional or institutional ones. Subsequently, the authors estimated the actual ex-day price drop ratios and compared them to the ones implied by the relative income tax rates of the assumed marginal ex-day investor in each aforementioned scenario.[14] Their results rejected all possible marginal investor scenarios expect from the second one that assumes that ex-dividend day prices are set by high income individual investors who bear though a zero effective tax rate on capital gains. Although this finding provides support for the tax-hypothesis, they rejected the existence of Elton and Gruber's (1970) tax-induced clienteles since they found no significant relationship between the price drop ratio and the dividend yield.

Lakonishok and Vermaelen (1986) were the first to extensively investigate abnormal trading volume patterns around the ex-dividend day with respect to tax incentives influencing the timing of scheduled trades by long-term investors as well as transaction costs influencing short-term trading. They found that trading volume significantly increases both before and after the ex-day but abnormal trading volume is more substantial before the ex-dividend day. At the same time, abnormal returns are positive in the five days before the ex-day and on the ex-day itself, while they become negative in the following five days. The authors ascribed this result to round-trip trades executed by dividend capturing investors, possibly corporations that have a dividend-seeking appetite. In addition, the increase in abnormal volumes was more pronounced for high dividend yield stocks that were more liquid especially during the period after the introduction of negotiated commissions (May 1975). After this improvement in transaction costs, ex-day abnormal returns significantly declined and

[14] After confirming that the estimated price drop ratios per year fall indeed inside the no-arbitrage range implied by the "short-term and transaction cost hypothesis".

the authors attributed this result to more cost-effective short-term trading. Overall, Lakonishok and Vermaelen (1986) highlighted the evident presence of short-term trading around the ex-dividend day and its impact in eliminating ex-day abnormal returns, without though pointing out whether this is tax or arbitrage opportunity motivated, in a clear way. Moreover, one of their concluding remarks suggested that ex-day trading activity makes it difficult to infer the marginal tax brackets of the average investor or the existence of clientele effects. [15]

Karpoff and Walkling (1988) explicitly tested the "short-term and transaction cost hypothesis" with an extensive sample of 50,645 dividends paid by U.S. common stocks included in the CRSP master file, throughout the period from January 1, 1965 to December 31, 1984. According to the authors, a significantly negative relationship between ex-dividend day abnormal returns and several proxies for trading transaction costs, would be enough to support the "short-term and transaction cost hypothesis". Karpoff and Walkling (1988) found that in the highest dividend yield quintile of their sample, ex-day abnormal returns decreased with the market size, number of outstanding stocks and stock price, and increased with the return volatility.[16] Moreover, they juxtaposed separate results for the two periods before and after May 1975 when negotiated commissions were introduced in the NYSE market and indicated that all transaction cost proxies used had no significant explanatory power on the ex-day abnormal returns prior to May 1975, when short-term trading was severely hindered by the high level of transaction costs. The authors deduced that

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[15] Lakonishok and Vermaelen (1986) outlined the theoretical predictions about whether abnormal trading volume should be present around the ex-day implied by the two competing hypotheses introduced by Elton and Gruber (1970) and Kalay (1982). In particular, according to the tax-induced clienteles hypothesis, if investors in the same tax bracket are holding similar yield stocks, if there are as many clienteles as tax brackets and if stock prices on ex-days reflect the tax bracket of the specific clientele, then no abnormal volume should be observed. Likewise, according to the short-term arbitrage hypothesis, the magnitude of abnormal volume will depend on the weight of those investors who accelerate their trades (sales or purchases) relative to those who delay their trades (sales or purchases). If, for example, the amount of accelerated purchase is exactly offset by the amount of delayed purchases and the amount of accelerated sales is exactly offset by the amount of delayed sales, then again no abnormal volume should be observed around the ex-dividend day. Nevertheless, the authors acknowledged that such en exact match among investors with different targeted timing of trades is not obtainable in practice.

[16] The authors presumed that short-term arbitrage is most likely to be present in stocks with high dividend yields. Additionally, they assumed that a lower market capitalization, a lower number of available stocks for trading, a lower stock price and a higher standard deviation of stock returns will represent a higher transaction cost.

their findings are in favor of the "short-term and transaction cost hypothesis", even though, this only applied to the highest dividend yield quintile of stocks.[17]

Michaely (1990) provided evidence against the tax hypothesis and in favor of the short-term trading hypothesis after testing ex-day price drop ratios and abnormal returns of stocks listed on NYSE during the 1986 - 1989 period. His analysis was motivated by the 1986 Tax Reform Act (TRA) that eliminated the preferential tax treatment of long-term capital gains for individual investors rendering capital gains equally treated with dividends for tax purposes. He estimated price drop ratios before and after the tax reform and found them indistinguishable from one in both cases. He concluded that the change in the relative tax rates between dividend and capital gain income for long-term individual investors had no significant effect on the ex-day pricing. Moreover, the author showed that price drop ratios were consistently above one for high dividend yield stocks due to dividend capturing activity around the ex-dividend day. The results were considered by the author as in support of the argument that corporate traders dominate price setting on the ex-dividend day.

Eades, Hess and Kim (1994) were in agreement with Michaely (1990) in that they also ascribed the great time-series variation of ex-day abnormal returns of high-dividend yield stocks to corporate dividend activity around the ex-dividend day. According to the results of their ex-day analysis for the period July 1962 - October 1989, they were unable to explain any of the ex-day return variation to changes in the tax code over time. On the other hand, the apparent significant decrease of ex-day abnormal returns after the introduction of negotiated commissions made them argue that lower transaction costs resulted in short-term traders arbitraging away any ex-dividend day mispricing. Moreover, they found that ex-day returns of high dividend yield stocks are positively related to one-month Treasury bill rates and negatively related to dividend yields. Eades, Hess and Kim (1994) stated that these findings are indicating that corporate dividend capturing is mostly affecting ex-dividend day price patterns.

Hereupon, Naranjo, Nimalendran and Ryngaert (2000) extended the analysis of Eades, Hess and Kim (1994) through 1994 and found similar results, with one

[17] Karpoff and Walkling (1988) commented that the tax and the short-term trading explanations of ex-day abnormal returns are not competing, but complementary hypotheses.

exception; the observed abnormal returns on ex-days of high-dividend yield stocks after the 1975 introduction of negotiated commissions were in fact negative, rather than positive or zero. The authors stated that dividend capturing targeted to utility stocks that paid high dividend payouts during the sample period was the main driver of their findings.[18] Moreover, they attributed the intense ex-day activity of corporate traders to tax reasons. In particular, the 1981 Tax Act allowed investors in most utility stocks to reinvest dividends through dividend reinvestment plans without paying a tax on the dividend income, hence making dividend payments more attractive than realized capital gains. Consequently, the tax preference for dividends motivated corporations to engage in excess buying of utility stocks before the ex-day that resulted in ex-day price drops larger than the dividend amount. Nevertheless, Naranjo, Nimalendran and Ryngaert (2000) did not take a stance on whether the tax hypothesis dominates the short-term arbitrage hypothesis because, at the same time, their results also suggested that increases in transaction costs and risk reduce incentives to engage in tax-induced dividend capturing.

Kadapakkam (2000) examined the impact of the introduction of electronic settlement on ex-dividend day returns in Hong Kong where neither dividends nor capital gains are taxed. The electronic settlement lowered costs for arbitrageurs by reducing the required minimum holding period for trades around ex-dividend days. The author's starting point is the study made by Frank and Jagannathan (1998) who estimated the average price drop ratio for the Hong Kong market and found it to be equal to 0.43 during the period from 1980 to 1993, leading to an average ex-day abnormal return of 1.33%. Kadapakkam (2000) argued that in an efficient market such a large abnormal return should have been exploited and eliminated by short-term traders. However, effective short-term trading around the ex-day was not feasible in Hong Kong prior to 1992 because until then, as stock sale required physical delivery of the share certificates within a day, and in order to obtain dividends, shareholders needed to be registered with the firm for twenty one days on average. Investors could not sell their shares during the registration period as they could not fulfill the requirement of physical delivery, therefore, quick roundtrip trades to exploit the positive ex-day

[18] Naranjo, Nimalendran and Ryngaert (2000) pointed out that Eades, Hess and Kim (1994) had inadvertently excluded utility stocks from their sample, and for this reason, the results differed in the two studies.

returns were not possible. Nevertheless, an electronic clearing and settlement system introduced in 1992 raised the obstacle of need for physical delivery of shares. Kadapakkam (2000) considered the relaxation of constraints on short-term trading as a unique opportunity to study the role of arbitrage activity in eliminating abnormal returns. The author's results revealed that the introduction of electronic settlement significantly reduced the ex-day abnormal returns evident before 1992. In particular, during the 1990 to 1995 period examined in the study, ex-day abnormal returns dropped to an insignificant 0.17% after the switch to electronic settlement. For the high dividend yield stocks, which were most likely to attract potential arbitragers, the drop in abnormal returns was more pronounced. This drop occurred soon after the switch to electronic settlement, rather than as a gradual decline over time. Under electronic settlement, trading activity was enhanced prior to the ex-day but was normal after the ex-day. There was also an increase in trading volume both before and after the ex-day in comparison to the physical settlement period. The author concluded that his evidence suggested that the mere greater potential for arbitrage under electronic settlement was sufficient to reduce ex-day abnormal returns.

Finally, Lasfer (2008) provided a comparative analysis of ex-day abnormal returns in the UK and Germany for the period 1982 - 2002, two countries with similar tax treatment for dividends and capital gains but with major differences with respect to their institutional framework.[19] In particular, although there is a higher tax on dividends than capital gains in both countries, short-term arbitrage is disallowed in the UK - where high transaction costs such as a stamp duty on trades apply - while the same does not apply for Germany. Results showed that ex-day abnormal returns were equal to 0.75% on average in the UK, significantly higher than the 0.57% observed in Germany. The author concluded that the differential tax rates on dividends and capital gains seem to warrant the high abnormal UK returns but this tax effect is mitigated by the short-term arbitrage that is freely active in Germany.[20] In his concluding remark, Lasfer (2008) suggested that the magnitude of ex-day abnormal returns may also be

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[19] Both countries have adopted, during the sample period, an imputation system for dividends whereby dividends carry tax credits and are taxed at lower rates than capital gains for basic taxpayers and tax-exempt investors.

[20] Lasfer's (2008) conclusions are, overall, in agreement with McDonald (2001) who also studied ex-dividend day trading in Germany for the period January 1989 through February 1998.

affected by factors other than taxes, arbitrage and microstructure interventions, without though naming these.

2.1.4 Microstructure Hypotheses: The Limit Order Adjustment, Tick Size and Bid-Ask Bounce

The first study that suggested that abnormal returns are generated on the ex-dividend day due to microstructure influences was made by Dubofsky (1992) who employed a sample of all NYSE and AMEX ex-dividend days between July 2, 1962 and December 31, 1987. The microstructure framework that existed at that time in the two U.S. exchanges was dictated by the NYSE Rule 118 and AMEX Rule 132 as follows. In NYSE, good-till-canceled limit orders to buy, which were open on the ex-day, ought to be reduced by the exchange specialists by the cash dividend amount at the day's opening. If the resulting price was not a multiple of the tick size equal to $0.125, then the limit buy order price was due to be reduced to the next lower tick point.[21] On the other hand, good-till-canceled limit orders to sell were not "mechanically" reduced by the declared cash dividend.[22] In AMEX though, both good-till-canceled limit orders to buy and good-till-canceled limit orders to sell were reduced by the "truncated" dividend amount accordingly. Dubofsky (1992) naturally presumed that

[21] In specific, the new limit order to buy price on the ex-dividend day was calculated as the original limit order to buy price divided by [100% plus the dividend yield). For example, for a dividend of $0.5 distributed by a stock with a $10 price, the original limit order to buy price would be divided by 105% resulting in an updated limit order to buy price equal to $9.524 that was further rounded to $9.500 which constituted an exact multiple of 76 ticks.

[22] As pointed out by Jakob and Ma (2005), even if there were no adjustment at either limit orders to buy or limit orders to sell at the ex-dividend day opening, investors who place limit buy orders at the bid have greater incentives to adjust their orders for the dividend than investors who place limit sell orders at the ask. This is because on the bid side, limit order traders would prefer to buy at the lower adjusted price whereas on the ask side limit order traders would not voluntarily pursue to sell their stocks at a price reduced by the dividend amount, although such an initiative would result in the fair valuation of the stock price on the ex-dividend day. In this context, one would reasonably wonder why the NYSE and AMEX exchanges mechanically adjust the open ex-day prices in a direction in which limit order investors should be inherently inclined to do in the first place. One plausible explanation for this is that the stock exchange regulators assume that investors placing market orders are more likely to be aware of the deprivation of the right to the dividend at the ex-day than investors who have placed "good-till-canceled" limit orders to sell or buy before the ex-day. In this respect, limit order investors would be protected from buying the stock at the ex-dividend day at a price higher than one that is fairly reduced by the dividend amount, whereas market order investors would only buy the stock at the adjusted fair price, thereby forcing stale limit sell orders remained at the order book overnight to be canceled or adjusted downward for as to be executed.

marginal investors on the ex-dividend day would trade at the bid and ask quotes of those good-till-canceled limit orders that were previously placed by long-term investors during the cum-dividend period and adjusted on the ex-day as specified by the NYSE Rule 118 and AMEX Rule 132.

Dubofsky's (1992) results suggested that the trades executed at the unadjusted quote of open limit orders to sell were in fact hindering the price to drop by the full dividend and incurring positive ex-day abnormal returns ("limit order adjustment hypothesis"). Furthermore, abnormal returns were found to be significantly greater for dividends just below than for dividends just above the tick size because the downward rounding of the quote of open orders to buy towards the next tick was wider in the latter than the former case, in favor of his theory. Lower ex-day abnormal returns in AMEX stocks than in NYSE stocks were attributed to the differential treatment of good-till-canceled limit orders to sell by specialists among the two exchanges. Nevertheless, when Dubofsky (1992) limited his hypothesis testing to the sub-sample of stocks with the largest cash dividends he found lack of support for the market microstructure predictions. The author warranted this result by arguing that active arbitrage trading for such stocks intraday would reduce the possibility that unadjusted open limit order quotes would constitute equilibrium prices on the ex-dividend day of these stocks.

Bali and Hite (1998) argued that because prices are constrained to discrete tick multiples whereas dividends are not, ex-dividend price drops will not equal dividends, irrespective of tax-preferences. The authors examined a sample of taxable distributions made by stocks listed at NYSE and AMEX for the period from July 2, 1962 until December 31, 1994 during which the tick size was equal to 12.5 cents. They hypothesized that whenever the dividend is an inexact multiple of the regulatory tick size, the stock price drop will be systematically rounded downwards. For example, if the dividend is \$0.20, the stock price will drop by just one full tick (i.e. by \$0.125) resulting in ex-dividend day price anomaly, that was until that time attributed to the relative tax-disadvantage of dividends. In this case, Bali and Hite (1998) ruled out a price drop of two ticks, therefore resulting in an upward rounding of the stock price, on the grounds that no investor would be willing to pay more than \$0.20 in terms of ex-day capital losses, to "buy" the dividend. Furthermore, if the dividend amount is relatively high compared to the tick size, this rounding would be deemed relatively unimportant for investors. As a result, discreteness in stock prices would be of declining importance as dividend size increases and the expected price drop would be proportionately closer to the full amount of the dividend. Based on their theory, the authors postulated that price drop ratios will be consistently less than one, due to the discrete tick size, and increasing with the size of the dividend, which was what had been found in the Elton and Gruber (1970) study that established the tax clienteles as the main factor of ex-day price drops' variation.

In summary, Bali and Hite (1998) found an average ex-day price drop of $0.2652 compared to an average dividend of $0.3259, with their difference of $0.0607 attributed to the tick-related rounding. Price drops were shown to be bounded from above by the dividend and from below by the dividend less one tick, in favor of the “tick size hypothesis”. Additionally, when the price drop was regressed on the dollar value of the tick below the dividend, the slope coefficient was estimated to be equal to one.[23] Finally, when they replicated their analysis for a sample of stock dividends, which were subject to discreteness but had no tax-effects, they estimated an average price drop ratio equal to 0.8626, corroborating their tick size theory.

Concurrently, Frank and Jaganathan (1998) investigated ex-dividend day price reactions in the Hong Kong Stock Exchange (HKSE) where neither dividends nor capital gains are taxable, so that anything other than a one-for-one price drop on the ex-day cannot be driven by taxes. Given that there are no particular tax-induced preferences for dividend vis-à-vis capital gains one would expect that the ex-day price drop should equal the dividend amount on average. Nonetheless, in their sample of all ex-dividend dates of HKSE listed stocks for the period starting in January 1980 and ending in December 1993, stocks prices were found to drop by less than the dividend.[24] In specific, the average ex-day price drop was estimated at HK$0.06, half of the average dividend amount of HK$0.12. The authors came up with a model that accommodates for such an empirical result and which is based on the assumption that long-term investors “find dividends more of a nuisance” due to the cost of collecting and reinvesting dividends and therefore, will pursue to avoid dividends. Thus, investors who own the dividend-paying stock will tend to sell the stock on the cum-

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[23] In strictly statistical terms, the hypothesis that the beta coefficient is equal to one could not be rejected at a 1% significance level.

[24] The dataset was retrieved from the PACAP database that is supplied by the Pacific Basin Capital Markets Research Center of the University of Rhode Island, US.

day and repurchase it on the ex-day. Likewise, investors who would like to buy the stock for exogenous reasons, namely unrelated to the dividend, will tend to postpone their purchase until the ex-day. Both investor decisions will incur a "sell at cum-day versus buy at ex-day" order imbalance that will be met by market makers who purchase the stock at the bid price on the cum-day and subsequently sell it at the ask price on the ex-day. As a result, the expected price drop on the ex-dividend day will ultimately be "discounted" by the bid-ask spread. Their empirical results supported their model and verified that the ex-dividend day discrepancy is proportional to the bid-ask spread within the cross-section of their stock sample. Moreover, their model implied that in the absence of tax or discrete tick size effects, the price drop that is calculated with bid at cum-day and bid at ex-day prices - as opposed to trade prices should converge to the dividend amount.

Jakob and Ma (2004) re-tested the "limit order adjustment hypothesis" and "tick size hypothesis" suggested by Dubofsky (1992) and Bali and Hite (1998), respectively, using an extensive sample of 52,179 ex-days of NYSE stocks spanning through the period from January 1993 to December 2001. During this period, two important tick size changes took place; the tick size was initially reduced from $1/8 ($0.125) to $1/16 ($0.0625) on June 24, 1997 and further reduced to $1/100 ($0.01) on January 29, 2001.[25] At the beginning of their study, Jakob and Ma (2004) outlined the main implications derived from the Dubofsky's (1992) and Bali and Hite's (1998) studies that were subject to verification by their own analysis, as follows.

According to the authors, Bali and Hite (1998) suggested that the average price drop should never exceed the dividend amount for any dividend size, and for dividends less than or equal to the prevailing tick size, price drops should equal zero. Also, asymmetric changes should not be expected if bid and ask quotes were used rather than trade prices to calculate price drop ratios, and as the tick size declines the magnitude of the ex-day price drop anomaly should also decline, and eventually disappear after full decimalization. Furthermore, the main inferences from Dubofsky's (1992) study were that price drop ratios calculated with quoted ask prices would be smaller than quoted bid prices and that the average ex-day price drop would become

[25] The reduction of the tick size to 1 cent (process of decimalization of stock prices) was effective for three pilot groups of stocks in August, September and December 2000, respectively. By end of January 2001, all stock prices were fully decimalized and remained as such until today.

smaller, thus exacerbating the ex-day anomaly, as the tick size was reduced. However, Jakob and Ma (2004) stressed the fact that Dubofsky's (1992) arguments were based on the presumption that the ex-dividend trades would be executed either at the bid or the ask quote, with equal probability of 50%, set by the limit orders that were placed on the cum-day but were still open on the ex-day.

Jakob and Ma (2004) found that ex-day price drops were just as likely to be equal to the tick above the dividend as to be equal to the tick below the dividend, namely, not bounded by the tick below the dividend. Furthermore, for all three tick size regimes, the average cum-day bid to ex-day bid price drop was found to be larger than the dividend on average, and also significantly larger than the cum-day ask to ex-day ask price drop, in particular at the open of the ex-day, thereby providing support for Dubofsky's (1992) “limit order adjustment hypothesis”. Finally, there was no evident reduction of the price drop, which was presumed to be dependent upon the changing tick size, as the tick size was reduced twice throughout the period examined. Jakob and Ma (2004) regarded their empirical results as inconsistent with Bali and Hite's (1998) “tick size hypothesis” but qualitatively consistent with Dubofsky's (1992) “limit order adjustment hypothesis”.[26] Nonetheless, the plausibility of the assumptions upon which Dubofsky's (1992) model was grounded was explicitly questioned by Jakob and Ma (2004) and finally concluded that Dubofsky's (1992) model, if taken “ literally”, cannot provide a complete explanation of the ex-day price drop anomaly. In parallel, Chapter 4 of this thesis presents an intraday analysis that raises doubts, in particular, on the validity of Dubofsky's (1992) presumption that limit orders that remain un-adjusted for the dividend will continue to impact trade prices at the ex-dividend close.

Graham, Michaely and Roberts (2003) presented another important empirical analysis that challenges the impact of the tick size on the ex-dividend day, in support of the criticism against the “tick size hypothesis” raised by Jakob and Ma (2004). The three authors exploited a sample of all taxable distributions made by NYSE stocks over the period January 1, 1996 to December 31, 2001, during which the two tick size reductions took place. Their results indicated that ex-day price drop ratios fall and

[26] Cloyd, Li and Weaver (2006) also cast doubt on the tick size hypothesis as they also found that ex-day abnormal returns persisted after tick size impediments were raised by the decimalization of U.S. stock markets in January 2001.

abnormal returns increase as the pricing grid changes from $1/8 ($0.125) to $1/16 ($0.0625) in 1997, and further to $1/100 ($0.01) in 2001. Naturally, this is evidence against the argument that dividends exceed ex-day price drops due to price discreteness. Furthermore, Graham, Michaely and Roberts (2003) plausibly assumed that the reduction and eventual elimination of the coarse tick system in prices would also minimize transaction costs and therefore, enhance short-term trading targeted to the ex-day abnormal returns observed in ex-days. As a result, even if microstructure did not matter, less restrained arbitrage should be more effective in eliminating abnormal returns, which was not verified by the analysis. In particular, although bid-ask spreads significantly decreased after the tick size reductions, abnormal trading volumes remained low and positive abnormal returns persisted, providing lack of support for the "short term arbitrage and transaction cost hypothesis". The only reason that the authors could come up with for explaining this was that at the same time that bid-ask spreads fell, overall trading depth fell too, implying that aggregate transaction cost might not have decreased as considerably as predicted. Graham, Michaely and Roberts (2003) concluded that their results cast doubt on the microstructure explanations but are consistent with the tax hypothesis.

It is worthy of pointing out the last sentence of Graham, Michaely and Roberts' (2003) study, as quoted:

> ...It is also possible that ex-day pricing patterns are caused by a phenomenon that has not yet been identified in the financial economics literature.

In this respect, this thesis investigates whether other parts of the financial economics literature, such as the behavioral finance paradigm can provide the readers with fruitful insights in solving the "ex-dividend day puzzle". For example, the notion of the disposition effect is envisaged to be linked to ex-day pricing patterns and therefore, a literature review on the disposition effect is going to follow.

2.2 The Disposition Effect

2.2.1 Neoclassical Finance versus Behavioral Finance: Tax-Optimal Investor Trading versus Disposition Effect

Traditionally, neoclassical finance literature has relied on the assumption that investors are fully rational and trade in a way that maximizes their investment returns after taxes and transaction costs. Investors pay (deduct) taxes on capital gains (losses) whenever they sell their stocks and not when these gains accrue. Assuming that there is no differential tax rate between short-term and long-term capital gains, the tax-optimal trading strategy for the investor would be to realize capital losses immediately and defer capital gains until the end of the investment horizon ("lock-in effect"). This way, the investor will effectively reduce the present value of future tax payments and maximize future tax deductions on capital losses (Stiglitz (1983) and Constantinides (1984)). In particular toward the end of each income tax year, which coincides with the calendar year for most investors, an investor who has an unrealized capital loss in a stock must decide whether to have that loss recognized for tax purposes in the current period or in a future period. Since an immediate tax deduction is preferable to a deferred tax deduction, many investors will choose to sell such securities before the end of the current income tax period in order to obtain the tax benefit. Conversely, an investor who has an unrealized capital gain in a holding stock will have an incentive to defer the taxation of the gain in the subsequent tax period.

These tax-induced trading preferences assumed for the rational investor were translated into testable hypotheses about the effect of capital gains taxation on the stock market by several authors. For example, Dyl (1977) tested whether the incentive for year-end tax loss selling led to abnormally high trading volume in stocks with unrealized capital losses in investors' portfolios toward the year end. Likewise, he tested whether the tax disincentive to realize capital gains led to abnormally low trading volume in stocks with unrealized capital gains accrued in investors' portfolios toward the year end. Using buy-and-hold returns over the first eleven months of the calendar year (January to November) to proxy for the capital gain or loss accrued in investors' portfolios for a sample of U.S. stocks from 1948 to 1970, he found significantly higher (lower) volume in December for stocks that had depreciated (appreciated) during the previous months in support of the “lock-in effect”.

Furthermore, according to U.S. tax laws, the tax rate on long-term capital gains has historically been significantly lower that the tax rate on short-term capital gains.[27] As a result, deferring short-term capital gains and realizing short-term capital losses provides for a second level option that can prove valuable for the tax-optimal investor. Based on these notions, Constantinides (1984) postulated the principles of tax-optimal trading for the rational investor with an one year investment horizon; at any time, the investor should defer the realization of short-term gains, sell and subsequently repurchase stocks with short-term losses before these become long-term, and sell and subsequently repurchase long-held stocks with neither a gain or a loss in order to regain short-term status for tax purposes. Simulating these specified tax-optimal trading strategies with stock price data, the author found that his recommended strategies significantly outperform a buy-and-hold investment policy. In addition, he showed that these tax-optimal trading strategies perform better with high variance stocks for which the option to realize losses and defer gains becomes more valuable.

Badrinath and Lewellen (1991), analyzing a compilation of 80,000 common stock round trip trades executed by 3,000 individual investors, also provided empirical evidence in support of tax-motivated trading behavior. Their results indicated a clear tendency for trades which give rise to realized losses, and hence, implied tax credits, to be concentrated near the end of the calendar year, namely during December. They also predicted that loss-taking trades should be more prevalent just prior to the dates when investments become eligible for long-term status in the same rationale as Constantinides (1984). Nevertheless, their data suggested weak evidence for the effect that the distinction between short-term and long-term gains could have on the timing of tax-loss realization by investors.

Choi et al. (2006) acknowledged that the option regarding the timing of the realization of capital gains and losses is valuable to the extent that it can be used to lower one's expected tax liability. They moved one step further to market value this timing option by using a unique type of capital gain that is distributed to shareholders in the form of

[27] The minimum holding period that determines the distinction between short and long term, varied from six to eighteen months for the last two decades. For more details, see Appendix (A-1).

a cash dividend. The tax status of this cash capital gains distribution is identical to investor initiated realization of capital gains in all respects, except that this distribution is payable and hence, taxable at the day that the company decides to distribute it.[28] Thus, the distribution is taxed as a capital gain, but the shareholder does not enjoy any tax-timing option. The authors inferred the value of the timing option by comparing the ex-distribution day price decline, which corresponds to the equivalent value of unrealized capital gains that includes a tax-timing option, to the value of the cash capital gains distribution that does not include the tax-timing option. They hypothesized that if the tax-timing option is not valued by investors on the ex-day of the cash capital gains distribution, the price drop on the ex-day would be equal to the capital distribution. Similarly, if the tax-timing option is correctly valued on the ex-day the price drop on the ex-day would be less that the cash capital distribution, accounting for the lower effective tax rate on unrealized capital gains recognized by investors. Notably, their motivation and methodology are similar to the ones evident in the standard ex-dividend day bibliography described in Section 2.1 but with one major advantage; In their case, the tax rate on capital gain cash distributions that investors pay is the same one that they face on a capital gain realized through a market transaction. Thus, their ex-distribution framework is not complicated by different income tax brackets and hence, clienteles with different trading preferences around the ex-day, as in the standard ex-dividend day case. Their empirical results showed that $1 of realized capital gains is equivalent to 93 cents of unrealized gains implying that the market value of the tax-timing option is 7 cents for each $1 of deferred capital gains.

Finally, Jin (2006) assessed whether tax-sensitive and tax-insensitive institutional investors react differently to a selling event and whether such as pronounced phenomenon can affect stock prices. First, he found that both the likelihood and magnitude of selling by institutions that serve taxable clients are negatively related to

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[28] This type of cash dividend is paid out by investment funds that qualify for tax-exempt status through the U.S. Internal Revenue Code. The purpose of this tax treatment is to protect corporations that serve as investment conduits for investors from double taxation. In specific, this tax status pertains to open and closed-end funds, real estate investment trusts (REITs) and some holding companies that pay the realized gains generated from their portfolios' rebalancing as a cash distribution similar to a typical dividend paid out by standard corporations. Then, shareholders of these investment funds must pay tax on the capital gain distribution they receive as though they realized the gain through a market transaction.

cumulative capital gains on the stocks held within their portfolios. He concluded that large capital gains seem to discourage, and large capital losses seem to encourage stock-selling by tax-sensitive investors, ceteris paribus. On the other hand, the behavior of institutions that serve predominantly tax-exempt clients did not seem to be related to the prior accrued gains. Furthermore, focusing on the case of large quarterly earnings surprises that generate significant price and trading volume reactions during the announcement window, he found that positive abnormal returns observed around earnings announcement are significantly larger for stocks with prior cumulative capital gains. He attributed this result to the order imbalance created by reluctant sellers who are taxable on the capital gains that have accrued in their holdings, as opposed to potential buyers who are unaffected by the tax implications of stock selling. Jin (2006) stated that, assuming a downward sloping demand curve, this order imbalance will translate into a positive price pressure for stocks widely held by tax-sensitive investors, and hence, higher abnormal returns around corporate earnings releases. Again, his evidence is in support of the tax-motivated trading theory, even though the implications of his stated theory were not evident in the case of stocks that are predominantly held by tax-neutral (exempt) investors.

Lakonishok and Smidt's (1986) study was one of the first, which directly challenged the capital gain “lock-in effect” and the notion of tax-optimal trading policies that were formally stated by Constantinides (1984). The authors tested whether trading volume is generally higher for losing stocks than for winning stocks, as implied by the tax hypothesis. They found relatively higher trade turnover for losers in December and for winners in January, in support of the arguments of the proponents of the “lock-in effect”, but an inverse pattern of trading behavior throughout the rest of the calendar year. They also explicitly raised several normative limitations to the importance of taxation on the decision of investors to sell the stocks they hold; First, they pointed out that the amount of tax credits raised from realizing short-term losses that can be offset against ordinary income or short-term capital gains may be limited by tax authorities. Second, the “wash-sale provisions” in the tax code prohibits realizing tax benefits from stock sales, if the same asset is repurchased within thirty days, hence, reducing the motivation to realize losses. Third, because taxes are reported and settled towards the end of the calendar year, an individual who realizes a capital loss early in the year will not know beforehand whether the incurred tax credit will eventually be utilized at the end of the tax-year. This uncertainty may reduce tax-induced trading early in the tax year. Fourth, it is reported that a substantial number of tax-payers do not report the capital gains that they cash-in on their tax returns (Poterba (1987)) and therefore, may not need to concern themselves about the tax-consequences of such gains. Fifth, the increasing population of tax-exempt investors and tax-deferred accounts will most likely weaken tax incentives for trading. In short, Lakonishok and Smidt (1986) concluded that the prior stock gain or loss history does indeed influence trading volumes but perhaps, for other non-tax related reasons as well, such as window dressing by corporate investors, portfolio rebalancing by institutional investors, and increased investor awareness and trading turnover for stocks that have appreciated in the past.

Shefrin and Statman (1985) were the first to introduce an alternative positive theory of capital gain and loss realization that came at odds with Constantinides' (1984) tax-induced trading strategies and which the authors label as the disposition effect, as quoted from Shefrin and Statman (1985) paper:

> We will develop a positive theory of capital gain and loss realization in which investors tend to "sell winners too early and ride losers too long" relative to the prescriptions of Constantinides normative theory. We shall refer to this tendency as the "disposition effect". The disposition effect is part of the general folklore about investing, yet does not arise within the standard neoclassical framework.

As regards their empirical analysis, Shefrin and Statman (1985) used monthly transaction data for mutual funds to calculate the ratio of the number of redemptions in month t over the number of purchases in month t-1 for two samples: mutual funds with high past gains (winners) and mutual funds with high past losses (losers). Their results showed that this ratio tends to be higher for winning mutual funds than for losing mutual funds, in favor of the so-called "disposition effect". The authors, in their conclusion, indicated the need to analyze more detailed data on loss and gain realization at the individual investor transaction account level. Their recommendation initiated a series of studies using extensive samples of round-trip transactions executed by both professional and non-professional investors that corroborate the impact of the disposition effect on trading decisions, as will be shown in Section 2.2.3 below.

Finally, Ivcovic et al. (2005) attempted to reconcile the two competing theories, namely the capital gain lock-in effect versus the disposition effect by analyzing a large dataset of trades made by a sample of individual investors at a large U.S. discount brokerage house during the period from 1991 to 1996. The authors compared the trading behavior in both taxable and tax-deferred accounts with view to simultaneously evaluating the importance of tax incentives and the disposition effect. Using a hazard model, in order to allow for the probability of stock sale to vary by holding period, they found empirical evidence in line with either the lock-in effect or the disposition effect, conditional upon the tax status of the trade account and the length of the investment period. Specifically, for short horizons (less than twelve months) the probability of selling a stock seems to be higher for stocks with past accrued gains in both types of accounts, but the effect is somewhat attenuated in taxable accounts. Furthermore, they reported a positive relationship between the prior capital gain and the stock realization rate that was more pronounced in tax-deferred accounts in favor of the disposition effect. On the other hand, for stocks held for longer than twelve months the relationship between the prior capital gain and the stock realization rate turned significantly negative in taxable accounts - supporting the lock-in effect - but not in tax-deferred accounts.

Although the above references demonstrate the long-lived debate amongst neoclassical finance professors and behavioral finance supporters with regard to the effect of capital gains or losses accrued on the investors' trading decisions, nothing has been said on the actual causes of the disposition effect; the section that follows sheds more light to this issue.

2.2.2 Explanations for the Existence of the Disposition Effect

Several theories have been advanced to explain the prescribed tendency of shareholders to be willing to sell winning stocks and at the same time reluctant to sell losing stocks held in the portfolios within the behavioral context. In a nutshell, the disposition effect has been attributed to prospect theory, to regret versus pride sentiment, and to an irrational belief of mean reversion by investors. Alternatively, those who posit rationality among investors state that the need for optimal portfolio rebalancing and transaction cost minimization could lead to investor decisions with the same characteristics as the disposition effect.

First, Shefrin and Statman (1985) set the theoretical framework that could give rise to the disposition effect by invoking the notion of mental accounting (Thaler (1985)) and the postulates of prospect theory (Kahneman and Tversky (1979)). According to this explanation, many investors value equivalent - in terms of current fundamentals - stocks differently on the basis of their past accrued gains or losses, which are "book-kept" in separate mental accounts for each stock. At the same time, the accrued gains or losses of a particular stock are evaluated with respect to a reference price that can be proxied by the average cost basis of the stock holdings. A combination of prospect theory and mental accounting (PT-MA) tends to generate a "disposition effect" that is, a tendency to sell securities that have gone up in value since purchase.

In short, Prospect Theory's value function is S-shaped and implies that investors are risk averse with respect to winning stocks but risk takers with respect to losing stocks. This automatically renders investors prone to selling past winners to quickly realize their capital gains and to holding losers with a low probability of turning out to be profitable in the future. Moreover, the steeper convex slope in the loss domain implies a loss aversion that exacerbates their reluctance to realize capital losses already accrued.[29]

For example, assume that an investor purchased one share at $50 and the price is now $40. Suppose that in the next month, the price could go either up $10 or down $10 (with equal probability). The investor must choose between selling the stock now and realizing an accrued loss of $10, or keeping the stock in his portfolio, in which case he has a 50% probability of losing $20 and breaking even. A risk-averse investor will sell the stock. An investor who is risk seeking on the loss domain, employing the purchase price as the base (or reference price) to compute gains and losses, will not sell the stock. This example is illustrated in Figure 2-1; the PT-MA investor prefers the chance of breaking even to the certain pain of experiencing a loss.

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[29] In a recent paper, Barberis and Xiong (2009) run a simulation test on artificial stock trade data from 10,000 investors who are supposed to have prospect theory preferences and deduce that on certain occasions, prospect theory fails to predict a disposition effect. Specifically, when the expected annual stock return is high and the trading intervals within a one-year horizon are few, the prospect theory value function predicts that investors will have a greater propensity to sell a stock with a prior loss than one trading at a prior gain.

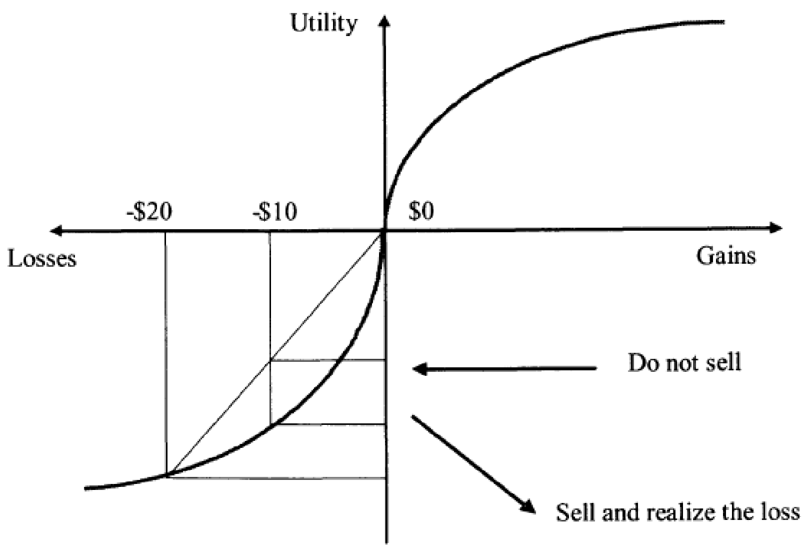

Figure 2-1a Reluctance to realize a loss by PT-MA (Prospect Theory / Mental Accounting) disposed investors.

On the other hand, assume that the investor purchased one share at $50 and the price is now $60, again with a 50% chance of going up or down by $10. In this case, a PT-MA investor will prefer the immediate realization of the $10 gain and he will sell the stock. This example is illustrated in Figure 2-2.

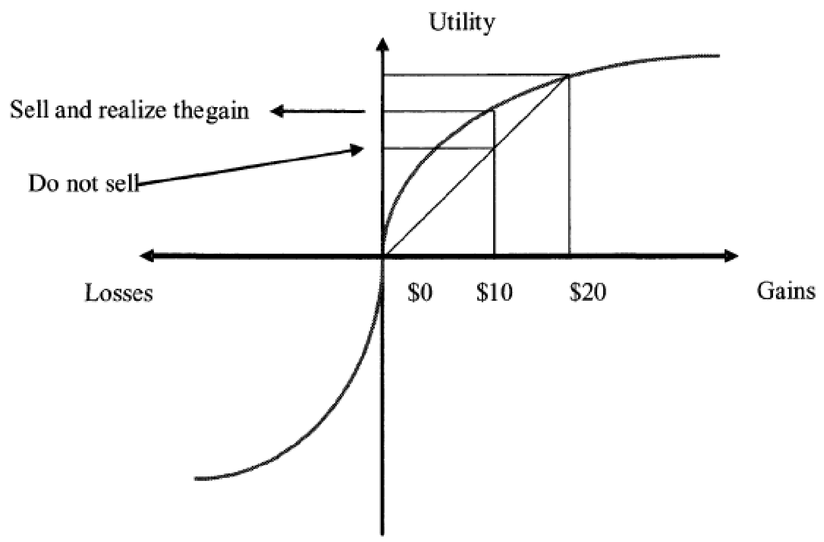

Figure 2-1b Willingness to realize a gain by PT-MA (Prospect Theory / Mental Accounting) disposed investors.

Another purely psychological explanation of the disposition effect is the pursuit of a feeling of pride from realizing gains and the avoidance of feeling regret by deferring losses, as noted in Shefrin and Statman (1985). In addition, Odean (1998) suggested that an irrational mean reversion belief could serve as an alternative behavioral explanation of the disposition effect. He reasons that investors who fail to rationally update their expected returns for the stocks that they own might mistakenly believe that today's losers will soon outperform today's winners. In particular, the holder of a stock that appreciated in the past might wrongly revise his expected return downward, leading him to a sell decision. Similarly, if the stock depreciated in the past due to negative information about its long-term prospects, the investor might insist on keeping the stock within his portfolio because he fails to revise his expected return downwards accordingly. Other authors have also proposed rational interpretations of the disposition effect. Lakonishok and Smidt (1986) argue that the disposition to sell winning stocks might be related to the rebalancing of portfolios held by imperfectly diversified investors. As a stock that has consistently appreciated in the past becomes over-weighted among overall stock holdings, investors will sell a portion of it to restore diversification to their portfolios. Also, a descriptive comment made by Harris (1988) suggests that the reticence of investors to sell losing stocks implied by the disposition effect can also be explained by the higher transaction cost per dollar of investment implicit in low-priced stocks that have been performing badly in the market.

In specific, Lakonishok and Smidt (1986) attributed the observation of proportionately higher realization of profitable stocks to the rational inclination of investors, who care about having a balanced portfolio of stocks, to sell appreciated stocks and hold on to depreciated stocks in an effort to restore targeted portfolio weights (rebalancing hypothesis). Odean (1998), however, rebuffed this neoclassical finance explanation by formally testing this on his thorough dataset of 10,000 nationwide discount brokerage accounts from January 1987 through December 1993. The author used to unique measures in order to quantify the tendency to sell winners (PGR ratio) or to sell losers (PLR ratio). PGR was defined as the realized gain as a proportion of the sum of both realized and paper gains and PLR was defined as the realized loss as a proportion of the sum of both realized and paper losses. Odean (1998) assumed that investors who are rebalancing their portfolios will sell a portion of their shares of winning stocks rather than their entire positions in the stocks, according to the prediction that a sale of the entire holding is most likely not motivated by the desire to rebalance. At the same time, they will seek to make new stock purchases within a short period of time from the sale trade. Subsequently, Odean (1998) re-calculated the difference between mean PGR and mean PLR using only trades that refer to the sale of the entire position of the investor in a stock at a particular point of time and trades for which there was no new purchase into the account on the same sale date or during the three weeks that followed. In both cases, the disposition effect was still prevalent as investors were found to be more willing to realize winning than losing stocks, - namely, the difference PGR - PLR was found significantly positive - counter to the rebalancing hypothesis.

Furthermore, Harris (1988), in response to Shefrin and Statman's (1985) empirical findings, suggested that investors' reluctance to sell losers could be attributed to their conscious decision to avoid the higher transaction costs per se born when selling low priced stocks. Odean (1998) explicitly tested for this hypothesis by calculating the difference between mean PGR and mean PLR for different samples partitioned within the same price ranges. Again, when comparing winners with losers of similar price level, investors appeared to prefer selling winners and holding losers although these represented transactions costs of about the same magnitude. Odean (1998) concluded that the disposition effect was more likely to have a behavioral cause rather than be attributed to the plausible avoidance of higher trading costs of low priced stocks.

Odean (1998) suggested an alternative explanation for the disposition effect on top of the combined implications of prospect theory and mental accounting. He claimed that investors with a strong belief in mean reversion will also tend to realize their profitable stocks at a much higher rate than their unprofitable ones as follows. In particular, the author reasoned that investors who fail to rationally update their expected returns for the stocks that they own might mistakenly believe that today's losers will soon outperform today's winners. In particular, the holder of a stock that appreciated in the past might wrongly revise his expected return downward, leading him to a sell decision. Similarly, if the stock depreciated in the past due to negative information about its long-term prospects, the investor might insist on keeping the stock within his portfolio because he fails to revise his expected return downwards accordingly. Odean (1998) tested whether such beliefs were justified for presumably rational investors, ex post. He calculated excess returns for various periods following the sale of a winning stock or the persistent holding of an accrued loss for the average investor in his sample. He reported that for winners that are sold, the average excess return over the year following the trade was significantly more that it was for losers that were kept in the investor portfolios, leading to the conclusion that investors who intentionally insist on selling winners and holding losers are losing money, on average. Therefore, he deduced that it is more likely that there are behavioural causes for the disposition effect.

Finally, Frino, Johnstone and Zheng (2004) examined the propensity of traders in futures markets to ride losses and suggested that the prevalent aversion to losses amongst the on-floor traders was in fact rational given that it contributed to improving the overall profitability of their trades. In specific, their data consisted of 312,670 trade records describing the activity of on-floor (local) and off-floor (non-local) traders in the four main futures contracts traded on the Sydney Futures Exchange, over the period March 15, 1999 to June 30, 1999. The aim of their study was to verify the existence of the disposition effect amongst professional traders and to compare the trading behavior of local traders against similar non-locals who were matched on the basis of trade frequency and trade size. They applied Odean's (1998) methodology (PGR and PLR proportions) to their data and found that both local and non-local traders exhibited the disposition effect, and this was much stronger for the local trader group. Frino, Johnstone and Zheng (2004) argued that the stronger loss aversion present in the sample of locals could not be due to a behavioral aberration because local traders are usually imperfectly but better informed than non-local traders. Floor traders were assumed to be able forecast short-term price changes with success but unable to do the same with instantaneous price changes. Therefore, when immediate price changes were in the opposite of the anticipated direction, the local (better informed) trader's expectation of subsequent reversal could warrant leaving his position open for at least on more trade. Namely, local traders intended to ride on their losses waiting for the anticipated price shift that would make their initial position prove to be profitable after all. The authors suggested that such behavior would be consistent with the disposition effect but, at the same time, motivated at least partially by short-term informed trading rather than by an irrational psychological aversion to realizing losses. Their empirical analysis showed that instantaneous accrued losses became profitable (by the next trade) more often for local traders than their non-local peers, in support of their hypothesis.

Section 2.2.3 that follows, provides empirical evidence drawn from the behavioral finance literature that verifies the prevalence of the disposition effect in the trading behavior of all types of investors, individuals, institutional investors and professional traders in equity and derivative markets.

2.2.3 Empirical Evidence on the Disposition Effect over the Last 30 Years and Counting

The very first citation to the term "disposition to sell the winners and ride the losers" is traced in Schlarbaum, Lewellen and Lease's (1978) study, which attempted to assess the individual investor ability to outperform the performance of passively managed market-like portfolios. The authors analyzed the actual round-trip trades of the transactions history of a representative sample of some 2,500 individual brokerage house customers over the period January 1964 through December 1970. They showed that the rates of return realized by their sample from actively investing in common stocks were higher than those that would have been attained if the individual investors invested instead in several broad-based market portfolios or a representative collection of mutual funds. In their concluding summary, they refer to the disposition effect – without though naming it so – as a plausible reason for their intriguing results, which would merely be based on investor psychology rather than superior investment skills. In their own words:

> It could be that what we observe is a psychological rather than an economic phenomenon: a tendency for investors to sell those securities which rise in price and hold the ones which fall, in hopes the latter ultimately recover. A favorable short-term price movement, therefore, may lead to quick profit realization, while an unfavorable one induces deferral. If that were the case, the data would merely imply a willingness to take, not a special ability to generate, short-run trading gains……..[Nevertheless,] a disposition to sell the winners and ride the losers [does] not seem to account for the observed profit/duration profile.

Few years after, Shefrin and Statman (1985) introduced the concept of the disposition effect in a formal and substantive way and since then, numerous researchers have provided empirical support for the disposition effect among both retail and professional investors. For example, Ferris, Haugen and Makhija (1988) analyzed abnormal trading volumes throughout the calendar year for a sample of thirty stocks with the smallest market capitalization listed on the CRSP tape from December 1981 to January 1985 with view to providing support for the disposition effect versus the tax-loss selling hypothesis.[30] They found that abnormal trading volume in stocks with prior capital gains far exceeded abnormal trading volume in stocks with prior capital losses in all months of the year, including December when the option of tax-loss selling is mostly valuable. They concluded that their findings were inconsistent with the tax-loss trading hypothesis and consistent with the disposition effect. Following this study, Heisler (1994) examined the disposition effect amongst a group of small off-floor traders in Treasury bond futures listed on the Chicago Mercantile Exchange. He found that the average round trip trade is significantly longer in time for positions that show an initial loss than for those showing an initial accrued gain that is clear evidence of the disposition effect, and that the magnitude of the disposition effect is negatively related to the success (profit per trade) of traders.

The first elaborate study that focused on empirically testing the existence of the disposition effect was made by Odean (1998) whose data included 162,948 records of all trades made in 10,000 nationwide discount brokerage accounts from January 1987 through December 1993. Odean (1998) drew attention to the fact that in an upward-moving market, investors will have more winners than losers in the portfolios to sell even if they had no particular preference for doing so. For this reason, by simply comparing the number of stocks sold at a gain to the number of stocks sold at a loss to confirm the disposition effect, it would not be possible to extract credible results. Thus, he devised two refined indicators that measured the frequency with which investors sell winners and losers relative to the available opportunities to sell in each case. In specific, each time there was a profitable trade, he calculated both the realized gain and paper (unrealized) gain accrued in the pertinent trade account. Likewise, each time there was a loss-making trade, he calculated both the realized loss and paper (unrealized) loss accrued in the trade account. Following, he calculated the

[30] Small cap stocks were selected because these were likely to exhibit the highest volatility in returns, making them ideal candidates for tax minimization strategies followed by taxable investors, according to the authors.

realized gain (loss) as a proportion of the sum of realized and paper gains (losses), which reflected the available opportunities to sell each time a trade was realized. He found that the mean proportion of profitable held stocks that was sold (PGR) during the entire calendar year was significantly higher than the mean proportion of stocks sold out of the pool of loss-making stocks (PLR).[31] The test was repeated after re-calculating realized and paper gains and losses in terms of dollars rather than shares or trades, in order to account for the possibility than investors frequently realize small gains and relatively less frequently realize large losses. His results proved to be robust in this case, as well in different partitions according to different time periods and groups of traders. Although his overall results contradicted the prediction of avoiding the realization of losses made by the optimal tax trading hypothesis, he did find evidence implying that the losses that are realized in December are of much greater magnitude than those realized throughout the rest of the year.

Locke and Mann (2000) used the first six months of detailed trade records of 334 professionals trading in the Deutsche mark and Swiss franc futures, and the Live cattle and Pork bellies commodities at the Chicago Mercantile Exchange to test the implications of loss-aversion in professional trading.[32] The authors examined whether traders are subject to loss-aversion in their trading behaviour and if this is prevalent, whether it impacts their intra-day profitability and overall success. They calculated unrealized gains by marking to market the traders' account minute by minute and estimated holding time for round trip trades in both long / short positions. They results clearly indicated that traders hold losing positions open for a longer time than winning positions, in support for the hypothesized loss-aversion. In addition, they suggested an alternative explanation for the loss realization aversion that is consistent with entirely rational activity; losses might be held longer only because successful market making would imply that opportunities for gains occur more rapidly than opportunities for losses and not because of an inherent loss aversion in traders. This theory assumes that while correct predictions on the intra-day price movement are quickly fulfilled, adverse price changes relative to the open position take much longer to materialize

[31] It is worth mentioning that the difference between the two proportions was found to be significant with a t-statistic greater than 35.

[32] These traders were responsible for 99.54% of the total personal account volume trades in these contracts during this six-month period.

and hence, result in losses for traders. Locke and Mann (2000) make a direct test on this theory by identifying the opportunities to realize a gain or a loss (potential exit opportunities) prior to the actual realization of a gain or a loss for each trade. They postulated that if this alternative theory of rational market making is correct, then, average potential opportunities for exit should be the same for both winning and losing positions. However, their results showed that traders, on average, pass up more opportunities to exit losing trades at a loss than they do for winning trades. In other words, trades that eventually result in a loss were found to be preceded by significantly more prior opportunities to realize at a loss than prior gainful opportunities for their counterpart winning trades, therefore, providing weak evidence for the alternative hypothesis of efficient market making. Finally, traders most averse to realizing losses were found to have lower subsequent profits and higher risk exposure relative to traders who were more disciplined and thus, less loss averse.

Next, Grinblatt and Keloharju (2001) employed a comprehensive dataset from the central register of the Finish Central Securities Depository that included the daily shareholding balances of virtually all Finish investors (both retail and institutional) from December 27, 1994 through January 10, 1997 to examine whether past stock returns affects current investor trading. Using a Logit regression, they tested whether the sell versus hold decision was conditional upon past abnormal cumulative returns broken down is various holding periods. Their empirical results showed that the existence of prior positive (negative) returns increased (decreased) the probability of selling a stock held in the investor's portfolio. This finding was particularly evident when prior returns where measured over short time intervals (e.g. up to one month) before the day that a sale was executed. Their evidence also suggested that recent large positive returns were more effective in triggering a stock sale than recent negative returns were in reducing the probability of a sale. They also plotted the statistical distribution of realized capital gains against the statistical distribution of unrealized capital gains – for the same period – and concluded that the former was notably more positively skewed compared to the latter, implying that the relative realization of accrued gains was greater than the relative realization of accrued losses. In their own words, these results "*tell a story that is very hard to explain as anything but a disposition effect*". Furthermore, their analysis suggested that the second half of December was the only time of the calendar year that investors had a greater propensity to sell stocks with prior negative returns, indicating that they were engaging in tax-loss selling. On the other hand, they showed that a presumed inclination to sell a stock with a positive return on the prior date was moderated by the existence of an overall capital loss accrued over the entire period the stock was held by the investor. They reasoned that due to severe loss aversion, an instantaneous price run-up is less likely to motivate a trade that would realize a loss than a trade that would realize a gain, again consistent with the implications of the disposition effect.

Shapira and Venezia (2001) used the records of all investment transactions of a large random sample of clients of one of the largest brokerages in Israel for the entire 1994 year to investigate whether the disposition effect that was demonstrated for individual investors in previous studies, also holds for professional investors. They were able to distinguish between two types of clients; independent clients who manage their own portfolios and "managed" clients who follow the advice of professional portfolio and money managers. They calculated the average duration of a losing round-trip and found it equal to 55.42 days remarkably higher than the average duration of a winning round-trip trade (24.84 days), in support of the disposition effect. Moreover, although the duration difference in days between winning and losing round-trip trades was significant in both types of investors, it was much longer for the independent clients, implying a stronger influence of the disposition effect for this investor group.

The examination of the disposition effect particularly in professional trading was resumed by Garvey and Murphy (2004) who employed a sample of fifteen highly skilled proprietary traders trading almost exclusively in NASDAQ stocks for the period from March 8, 2000 through June, 13 2000. They reasoned that their sample selection was highly relevant for asset pricing given that the high frequency nature of their trading and the block size of trades that these professional investors execute will most likely have strong implications for the price discovery process of active stocks.[33] Their results showed that despite their financial sophistication, the proprietary traders tended to hold losers much longer than winners according to the prescriptions of the disposition effect. In specific, the mean (median) duration of losing round-trip trades

[33] Another unique advantage of this dataset is that the ambiguity of the true reference point, against which the capital gains or losses are measured, is minimised, due to the very short holding duration of these investors' round-trip trades. In other words, proprietary traders have such a short horizon that the previous intra-day purchase price is considered to be the true reference point, with almost certainty.

was estimated at 268 (102) seconds compared to the mean (median) duration of winning round-trip trades measured at 166 (64) seconds. Their results also remained robust when they re-run the tests after partitioning the total of round-trip trades into 3 intra-day intervals (i.e. opening, midday and closing). Going one step further, they confirmed that this tendency was in fact reducing the traders' profitability and recommended holding winners longer and selling losers sooner than observed, in order for proprietary traders to enhance their profit record.

Coval and Shumway (2005) investigated whether any of the behavioral biases that had been previously reported in the literature could be linked to the intra-day trading patterns of market makers in the Treasury bond futures contract at the Chicago Board of Trade (CBOT) operating in all of 1998. On one hand, the authors hypothesized that if traders overly attribute past trading profitability to their own ability ("self-attribution bias"), or if they are more willing to assume risk when gambling with prior accumulated profits rather than capital ("house-money effect"), or if traders view past trading profits as a signal that "more money is going to come" ("representativeness bias"), then, they will pursue to take more risks as they become more profitable. On the other hand, they argued that if traders are genuinely loss-averse throughout the trading day, they will take fewer (more) risks as they become more profitable (loss-makers). They found support for loss-aversion – self-evidently, not for other aforementioned biases – because they estimated that a trader with morning losses had a 31.2% probability of taking above average risk in the afternoon, compared to a trader who earns a profit in the morning, who has only a 27.0% probability of excess risk-taking. Although the documented loss-aversion is in accordance with the disposition effect, Coval and Shumway (2005) performed an explicit test focused on the disposition effect. In specific, they used the Cox proportional hazard[34] model to examine whether traders were truly more reluctant to unwind positions (both short and long open positions) after losing and likewise, more willing to unwind positions after being profitable in the morning. Their findings showed that morning profits are highly significant in explaining the speed at which midday positions are closed. In

[34] The model assumes a baseline (unconditional) probability (hazard rate) for unwinding an initial position intra-day, and estimates how this baseline probability is reduced or increased with response to changes in other independent variables, such as the profit / loss accrued on the trader's account in the morning, his stock inventory and risk exposure.

specific, in support of the disposition effect, traders who carried a losing position in the afternoon tended to take longer to unwind it than those traders with a winning position. Finally the authors presented evidence that losing traders, eager to "make up for their losses", are more inclined to purchase contracts at higher prices and sell contracts at lower prices than the prices at which prior trades were executed, implying a inferior overall performance for loss-averse market makers.

Locke and Onayev (2005) used the same dataset of Locke and Mann (2005) to examine the relation between futures trade duration and profitability, volatility, and volume. In their findings, traders appeared to hold unprofitable trades for a significantly longer period than profitable trades for all segmented trading intervals throughout the day. The authors stated that this result was in alignment with the hypothesized disposition effect. Furthermore, they presumed that intra-day patience is compensated with better execution prices when unwinding open positions and hypothesized that impatient traders closing winning positions will eventually pay worse prices than traders closing (contemporaneous) losing positions. Their analysis verified this inference by statistically proving that traders systematically offset winning short positions with buy transactions at higher prices and offset losing long positions with sales at, also, higher prices throughout the day. Their theory implies that traders prone to the disposition effect will receive better execution prices when exiting losing trades – "with patience" – rather than when exiting losing trades – "in a rush".[35]

Dhar and Zhu (2006) adopted the indicators that were devised by Odean (1998), that is PGR and PLR, and measured the magnitude of disposition effect exhibited at the individual – rather than the average – investor level. Using the trading records of 50,000 individual investors from a large U.S. discount brokerage firm between 1991 and 1996, they specified those factors that significantly explain the disposition bias across individuals in terms of underlying investor characteristics. In short, they found that wealthier individuals and individuals employed in professional occupations exhibited a lower disposition effect, which also tended to diminish as trading became more frequent by investors.

[35] This inference is in contrast to other studies that imply that a loss-averse attitude is indeed detrimental to the profitability of traders (e.g. Coval and Shumway (2005)).

Barber et al.' s (2007) work is one of the few studies that utilizes a comprehensive data set to explicitly test for the existence of the disposition effect. Specifically, the authors applied the Odean (1998) methodology upon the complete transaction history of all traders (individuals, corporations, dealers, foreign investors, and mutual funds) on the Taiwan Stock Exchange (TSE) from January 1, 1995 through December 31, 1999 (over one billion trades). Their results suggested that investors in Taiwan are about twice as likely to sell a stock if they are holding that stock for a gain rather than for a loss. A proportion of 85% of all Taiwanese investors, of them (especially, individuals, corporations and dealers) were selling winners at a faster rate than losers. The disposition effect was also found to be prevalent in short-sellers because they were proved to be reluctant to buy already appreciated stocks that were initially short-sold. Finally, Barber et al. (2007) concluded that the impact of the disposition effect on market prices in TSE did not lead to evident momentum in Taiwanese stock returns, in contradiction to Grinblatt and Han (2005).

CHAPTER 3: THE PRICE IMPACT OF THE DISPOSITION EFFECT ON THE EX-DIVIDEND DAY OF U.S. COMMON STOCKS

3.1 Theory and Hypotheses

3.1.1 Theory and Motivation

One of the most important phenomena in trading behavior is the "disposition effect," that is, when an investor faces the decision to select among candidate stocks to sell from his portfolio, he is more inclined to pick the stocks that have experienced prior gains than those with prior losses since their purchase. Various empirical studies have exploited information from the trade accounts of individual and professional investors to confirm the existence of the disposition effect. In particular, they find that losing market positions are held longer than winning positions (Locke and Mann (2005), and Locke and Onayev (2005)), and the proportion of accrued gains that are realized is greater than the proportion of accrued losses that are realized in the average portfolio (Odean (1998), and Barber et al. (2007)). In addition, attempts have been made to propose possible causes of the disposition effect in terms of a behavioral bias resulting from prospect theory preferences (Kahneman and Tversky (1979)), irrational investor beliefs (Odean (1998)), or a natural implication of optimal portfolio management (Lakonishok and Smidt (1986), and Harris (1988)).

Although most studies explore whether and why the disposition effect exists, few papers address the question of whether it has an effect on stock prices. In Coval and Shumway' s (2005) words:

> Even if biases can be identified in investor behavior, to demonstrate that this is more than just instances of noise trading, empirical tests must be positioned to identify a link between biases in individual trader behavior and overall prices (p. 2).

Namely, a key question is whether the biases that are evident in trading behavior impact prices. Following Grinblatt and Han (2005), and Frazzini (2006), a regular corporate event is selected, namely, the deprivation of the right to the dividend on the ex-dividend day, to test whether the disposition effect matters for asset pricing. Compared to other corporate events, the choice of the ex-dividend day is considered advantageous due to three unique characteristics. First, because the disposition effect refers to investors' selling decisions, the natural downward price adjustment to the dividend on the ex-dividend day renders it an appropriate setting to make accurate predictions about the direction of contingent mispricing caused by the disposition effect. Second, given that no corporate information is conveyed on the ex-dividend day, there is no need to speculate on the direction of price changes that depend upon investors' interpretations of the content of the corporate release. Third, the magnitude of the expected ex-day price drop can be approximated by the dividend amount. From another perspective, the lack of consensus on the factors that explain the time-series variation of the price drop ratio (the stock price drop on the ex-dividend day divided by the dividend amount) that is apparent in the standard ex-day literature leads the reader to suspect that the disposition effect could be one such factor.

To ascertain whether the disposition effect can affect stock prices at the ex-dividend day, market-wide daily stock data is used for two reasons. First, data on the daily portfolio holdings and trades from the universe of participants in wide stock markets such as the NYSE and AMEX exchanges are not readily available.[36] Second, because market prices reflect the trade decisions of both rational and behaviorally biased investors, a possible divergence from the fundamental prices induced by the trades of disposition effect-investors might be arbitraged away quickly by their rational counterparts. Whether arbitrage is effective at repressing price perturbations caused by the disposition effect can only be depicted in equilibrium market prices. Of course, the use of market-wide data also entails a cost in that it requires a number of crucial assumptions and approximations to be included in the empirical analysis. In particular, a proxy must be constructed from aggregate data to measure the accrued gain or loss to the average investor who owns a particular stock at any time.[37] It is acknowledged that this imperfect measure absorbs substantial noise that is unrelated to the testable hypotheses. However, it is possible that this can only make the reader more optimistic about the veracity of a significant relationship found in support of the prediction, as long as it proves to be robust. Jin (2006) consents to this rationale by stating the following:

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[36] There are a few exceptions that have used comprehensive datasets of investor holdings and trades of all market participants over long time periods, such as Grinblatt and Keloharju (2001), and Barber et al. (2007).

[37] One of the most ambiguous inputs of the capital gain proxy measurement is the assumed average investor horizon over which capital gains or losses accrue. Naturally, investors buy and sell stocks at different times, and therefore, for a given price stock appreciation, different amounts of gain will accrue to different investor holding durations.

The error introduced by the imprecise measurement of capital gains creates an attenuation bias toward 0 in the estimated coefficient on the impact of capital gains. If evidence of price pressure is found due to capital gains in the presence of the attenuation bias, the real magnitude of the price pressure is likely to be more significant (p. 1420).

In the empirical analysis that follows, it is found that stocks that appreciated in the past have higher price drop ratios on the ex-dividend day than stocks that declined in value, implying a positive relationship between the capital gains overhang and the ex-dividend day price drop ratio that is found to be both statistically and economically significant. Results are in alignment with the disposition effect, which postulates that the expected downward price adjustment on the ex-day will be facilitated by willing sellers of winning stocks and hindered by reluctant sellers of losing stocks.

The remainder of this chapter is organized as follows. Section 3.1.2 states the hypotheses that will be empirically investigated. Section 3.2 describes the data selection, the filters applied to the data, and the methodology used to compute the variables that are employed in the tests. Section 3.3 reports the empirical results that are driven by the influence of the disposition effect on the stock price behavior on the ex-dividend day. In Section 3.4, connections are made to the ex-dividend day literature, and Section 3.5 concludes the chapter.

3.1.2 Hypotheses

Although there has been sufficient evidence of the prevalence of the disposition effect in trading behavior, little empirical research has examined its impact on asset pricing.[38] In this direction, Grinblatt and Han (2005) suggest that in a market where rational investors co-exist with investors who are prone to the disposition effect, the equilibrium market price will be a weighted average of the fundamental value and the aggregate cost basis, which is the reference price for disposition effect investors.[39] As long as the absolute difference between the aggregate cost basis and the market price

[38] Coval and Shumway (2005), Grinblatt and Han (2005), and Frazzini (2006) have directly addressed this issue.

[39] Grinblatt and Han (2005) presume that investors who sell winning stocks faster than losing stocks are governed by an S-shaped prospect theory value function and mental accounting of accrued gains or losses.

(called “capital gains overhang”) is large, investors prone to the disposition effect will underreact to prior news, rendering past winners undervalued and past losers overvalued. However, as disposition-free investors initiate trades to exploit the mispricing, the aggregate cost basis for a stock will update closer to the market price, that is, closer to the fundamental value. Thus, as gains and losses are realized via trading, the capital gains overhang diminishes, and the market price converges to the fundamental value. This dynamic effect leads to momentum in stock returns and stock return predictability.[40] From a similar perspective, the impact of the disposition effect can be effectively tested with market-wide data whenever there will be a significant price reaction at a particular date and an *a priori* prediction can be made on the direction of the price change. If the disposition effect is prevalent among investors, it will either accelerate or hinder the predicted price movement, depending on its direction.

Corporate events constitute a plausible market setting to apply this principle. By changing the fundamental value of the stock, corporate events often initiate investor trading until the market price adjusts to the new perceived valuation. Whether the disposition effect has a destabilizing character in restoring equilibrium prices remains subject to empirical examination. Within this rationale, Frazzini (2006) exploits corporate earnings' announcements to test whether the disposition effect causes the stock price to underreact to the release of new information to the market. The author claims that whenever positive earnings surprises occur for stocks with past accrued gains, active selling by investors who are disposed to realize their capital gains will create excess supply that leads to a lower price increase than expected on the announcement day. Likewise, whenever negative earnings surprises occur for stocks with past accrued losses, sluggish selling by investors who are reluctant to realize their capital losses will lead to a lower price decrease than expected. The underreaction to good or bad news on the earnings announcement day will be corrected in the days following the news release, generating the post-earnings announcement drift that has been widely reported in the finance literature. The author

[40] Using Fama-MacBeth’s (1973) regressions, Grinblatt and Han (2005) find a significantly positive cross-sectional relationship between a stock's capital gains overhang and its future stock return. They explicitly suggest that the capital gains overhang, which accounts for both past price direction and trading turnover, is a superior predictor of future returns than raw past returns.

concludes that post-event drift is greater when the news and capital gains have the same sign and that its magnitude is directly related to the amount of unrealized gains (losses) experienced by the stockholders on the announcement date.[41]

Similar to Frazzini (2006), the ex-dividend day is regarded as a favorable corporate event to empirically test whether the disposition effect plays an important role in asset pricing. On the ex-day, the price change is foreordained; the stock price will drop. In addition to the direction of the price, the magnitude of the expected fundamental adjustment is also known as it must approximate the relative value of the dividend *vis-à-vis* capital gains. In the case of Frazzini (2006), the expected stock value at the close of the announcement day is equal to the previous close price plus or minus the change of the fundamental stock value, which is caused by the revision of investor expectations according to the earnings surprise. In this case, the expected stock value at the close of the ex-day will be equal to the cum-dividend day close price minus the dividend, adjusted for any tax preferences. In both cases, people trade intraday until the stock price at the close equals the aggregate expected value. In addition, given that the ex-day constitutes an informationless event, no conjecture must be made on the market's interpretation of corporate signals before predicting the impact of the disposition effect.[42] If the disposition effect is pervasive in the investor trading behavior, holders of winning stocks are expected to be more willing to sell than those of losing stocks on the ex-day. Therefore, assuming a downward-sloping demand curve, two testable predictions can be made with respect to the expected price impact of the disposition effect on the ex-day:

Hypothesis 3-1: Excess (limited) supply for winning (losing) stocks will result in wider (smaller) price drop ratios on the ex-dividend day.

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[41] Another study that examines whether the presence of accumulated capital gains can distort stock prices around large earnings surprises using market-wide data is that of Jin (2006). Jin (2006) finds that stocks that are mostly owned by institutional investors who care about the tax consequences of their trades (the author calls these investors "tax-sensitive") and whose stocks have appreciated in the past have a higher cumulative abnormal return during the three-day span around the earnings announcement. He states that tax-sensitive investors, following an optimal tax strategy, postpone their sell trades to defer the realization of the accrued gains. As a result, because they limit their supply around earnings surprises for the stocks that they hold, an upward price pressure will lead to inflated market prices. Although his results contradict the implications of the disposition effect, they are confined to stocks with the highest concentration of tax-sensitive investors.

[42] This point is considered fairly important because the disposition effect might be hidden by the price impact of the divergence of opinions over the information that is conveyed in the market, as in the case of corporate announcements.

Hypothesis 3-2: The higher the unrealized gain (loss) accrued on the stock, the larger (smaller) the ex-dividend day price drop ratio because the influence of the disposition effect on trading activity will be amplified.

Next, the validity of these two hypotheses is empirically tested and the implications of the results are positioned in the ex-dividend day literature.

3.2 Data and Methodology

3.2.1 Sample Construction and Filtering

This study employs the CRSP history of prices and dividends paid by stocks listed on NYSE and AMEX from February 1, 2001 until December 31, 2008. This includes all common stocks (CRSP codes: 10 and 11) that paid ordinary taxable cash dividends throughout the period. The beginning of the examined period was carefully selected to eliminate a possible tick size effect (Bali and Hite (1998)), and to minimize the bid-ask bounce effect (Frank and Jagannathan (1998)) and tax effect (Elton and Gruber (1970)). Beginning in February of 2001, both NYSE and AMEX were fully decimalized,[43] and only one main tax law amendment took effect between early 2001 and late 2007, the "*2003 Jobs and Growth and Tax Relief Reconciliation Act.*" This Tax Act, which went into effect in May of 2003, equated the tax rate on qualified dividends to the long-term capital gain tax rates, which were reduced to 15% for the medium and high income tax brackets (For the history of U.S. Tax reforms / Tax Acts from 1969 to 2010 and their effect on taxation of dividends and capital gains, see Appendix (A-1)).[44]

The initial sample comprises 29,004 cash dividends that are fully taxable throughout the years 2001-2008.[45] Consistent with the prior ex-day literature, several screening filters are applied to the sample to increase the power of the tests. First, dividends that go ex within 20 trading days after the previous ex-day of the same stock are excluded. Second, dividends with an announcement day that is within four trading days before the respective ex-day are also excluded. Third, ex-days with confounding corporate events are eliminated. Specifically, if a stock split, stock dividend, rights issue, or bonus issue occurs within a [−4, +4] window around the ex-day, then the ex-day is

[43] Graham, Michaely and Roberts (2003) show that bid-ask spreads and the quoted depth are significantly reduced due to the increasing fineness of the pricing grid in the decimal era, which began on January 29, 2001.

[44] The "*2005 Tax Increase Prevention and Reconciliation Act*" went into effect on January 1, 2008. Thus, this amendment is anticipated to have a minor influence on the eight-year average relative valuation of the dividend on the ex-day based on tax grounds. According to the Tax Act, qualified dividends remained taxable at the long-term capital gain tax rates, which were set to zero for taxable income brackets that refer to tax rates less than 25%.

[45] After eliminating ex-days with multiple ordinary cash dividends and/or a return-of-capital distribution on the same date.

removed from the sample. Fourth, following Elton, Gruber, and Blake (2005), “penny dividends” that pay less than $0.01 to investors are dropped.

Table 3-1: Filters of Sample Screening NYSE and AMEX Ex-Days of Ordinary Cash Dividends of Common Stocks for Years 2001-2008

The initial sample consists of the entire CRSP history of ordinary cash dividends paid by common stocks listed on NYSE and AMEX from February 1, 2001 until December 31, 2008. The initial sample size (29,004 obs.) is reduced by the removal of dividends going ex within 20 trading days after the previous ex-day of the same stock, dividends with an announcement day within 4 trading days before their respective ex-day, ex-days with confounding corporate events (stock split, stock dividend, rights issue, bonus issue) within a [−4, +4] window around the ex-day, “penny dividends” < $0.01, dividends whose stocks did not trade either on the ex-day or the cum-day, dividends whose stocks are priced at less than $5 on the cum-day, and finally, those dividends whose stocks were thinly traded over the estimation period [(−130, −31) & (+31, +130)]. The third column counts removed observations as a percentage of the initial sample size (29,004 obs.). In addition, in order to mitigate the outlier impact the PDR and the AR^{ex} total distributions are separately trimmed at the 2.5% upper and 2.5% lower tail.

Filters and Trimming applied to the ex-day sample (2001-2008)	Removed Obs	Removed %	Residual Obs
Ex-days for all ordinary cash dividends (2001-2008).			29,004
Exclude dividends going ex within 20 trading days after the previous ex-day of the same stock.	61	0.2%	28,943
Exclude dividends with an announcement day within 4 trading days before their respective ex-day [−4, −1].	394	1.4%	28,549
Exclude dividends with a corporate event within 4 trading days before or after their respective ex-day [−4, +4].	167	0.6%	28,382
Exclude all “penny dividends” < $0.01.	295	1.0%	28,087
Exclude ex-days with no trade on either the ex-day or the cum-day.	745	2.6%	27,342
Exclude ex-days with stock price < $5.0 on the cum-day.	302	1.0%	27,040
Exclude ex-days whose estimation period [(−130, −31) & (+31, +130)] has less than 60 observations.	3	0.0%	27,037
Trim the 2.5% upper tail and 2.5% lower tail of the ex-day Price Drop Ratio/Abnormal Return distribution of the total sample.	1,351		25,686

Fifth, dividends of stocks that did not trade either on the cum-day or the ex-day are omitted. Sixth, dividends that pertain to stocks with a cum-price of less than $5 to reduce extreme values and noise in the sample are eliminated.[46] Seventh, ex-days whose estimation period [(–130, –31) & (+31, +130)] has less than 60 observations are dropped.[47] In total, 1,967 ex-days (6.8% of the initial sample size of 29,004 ex-days) are filtered out, yielding 27,037 usable observations (100% of the "clean" sample), as illustrated in Table 3-1.

3.2.2 Price Drop Ratio and Abnormal Return on the Ex-Day

Standard event-study methodology is performed, where various statistics are estimated around the ex-dividend day. First, the Price Drop Ratio (PDR_i) adjusted for the expected return on the ex-day is calculated, which reflects the relative valuation of the dividend by the marginal investor as follows:

$$PDR_i = \frac{P_i^{cum} - \left(\dfrac{P_i^{ex}}{1 + R_i^{norm}} \right)}{D_i} \qquad (3.1)$$

where P_i^{cum} is the closing price on the cum-day for stock i, P_i^{ex} is the closing price on the ex-day for stock i, D_i is the amount of the dividend for stock i, and R_i^{norm} is the ex-day expected return that accounts for both the market return and the beta risk of stock i given by

$$R_i^{norm} = \hat{\alpha}_i + \hat{\beta}_i R^{mkt} \qquad (3.2)$$

where α_i and β_i are estimated with the OLS market model over the estimation window of [(–130, –31) & (+31, +130)] days, and day "0" is the ex-dividend day. As a proxy for the market return (R^{mkt}), the percentage change of the daily value of the CRSP equal-weighted NYSE/AMEX index on the ex-day is used.[48] Second, the Abnormal Return (AR_i^{ex}) that occurs on the ex-day, adjusted for the expected return, is computed as follows:

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[46] Elton, Gruber, and Blake (2005) suggest that the bid-ask spread of low priced securities is sufficiently large relative to the dividend that it can generate substantial noise in the empirical results.

[47] This estimation period was intentionally selected because it comprises trading days both before and after the ex-day central time point and thus, avoids a total overlap with the estimation horizon used to calculate the capital gain overhang as described in Section 3.2.5 below.

[48] Elton and Gruber (1970, footnote 10) suggest that an equal-weighted index is preferable to a value-weighted index for calculating the market movement on the ex-day.

$$AR_i^{ex} = \frac{P_i^{ex} - P_i^{cum} + D_i}{P_i^{cum}} - R_i^{norm} \qquad (3.3)$$

The AR^{ex} is an alternative measure of the ex-day anomaly that has a lower variance and is less susceptible to the statistical problems of skewness and kurtosis compared to PDR, as will be shown below.

3.2.3 Outlier Control and Descriptive Statistics

Price drop ratios can be relatively extreme for firms with negligible dividend payouts and large price drops on the ex-dividend day or vice versa. Therefore, the upper and lower 2.5% quantiles of the PDR sample are trimmed to limit the impact of outliers following Graham, Michaely, and Roberts (2003). The trimming is also repeated separately for the AR^{ex} total sample so that both the PDR and AR^{ex} testable distributions move closer to normal.[49] After excluding 1,351 outlier observations, a final sample of 25,686 ex-days will be used for the analysis that follows. Table 3-2 reports descriptive statistics for PDR/AR^{ex} before and after trimming, thereby illustrating the marginal effect of the elimination of outliers. This elimination has a tremendous normalizing effect for the PDR sample such that it reduces the standard deviation of the sample from 10.24 to 4.15 (–59%), skewness from 2.49 to –0.06 (–102%), and kurtosis from 168.65 to 5.65 (–97%).[50] Likewise, for the AR^{ex} sample, the 2.5% trim reduces the standard deviation from 1.96% to 1.32% (–33%), skewness from 1.39 to 0.14 (–90%), and kurtosis from 63.15 to 3.33 (–95%). Furthermore, it is confirmed that for the 2.5% trimmed sample, the mean (median) PDR is 0.741 (0.832), which is significantly less than the hypothesized value of unity, and that the mean (median) AR^{ex} is 0.124% (0.097%), which is significantly higher than the hypothesized value of zero (at the 1% level).

[49] The PDR and AR^{ex} distributions do not share the same outliers. Performing separate trims on either PDR or AR^{ex} contributes to the robustness of the following regressions where each is used as an alternate dependent variable.

[50] Boyd and Jagannathan (1994) explicitly point out the severe kurtosis that can be generated by outliers in the PDR distribution and employ an averaging procedure to reduce the sensitivity of their regression estimates to outliers.

Table 3-2: Descriptive Statistics of the Price Drop Ratio (PDR) and Abnormal Return (AR^{ex}) on the Ex-Day, for the Entire Sample and the 2.5% Trimmed Sample

This table presents summary statistics for the price drop ratio (PDR) and the abnormal return (AR^{ex}) on the ex-day, as well as t-tests on the theoretical values for PDR =1 and AR^{ex} =0. The second and fourth columns show statistics for the PDR and the AR^{ex} respectively, for the entire sample (100%). The third and fifth columns show statistics for the PDR and the AR^{ex} respectively, after trimming the top and bottom 2.5 percentiles (95%) separately for each measure. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The Wilcoxon signed-rank test is used for testing median values. *** denotes statistical significance at the 1% level, using a two-tailed test.

Variable	PDR (Ho: PDR=1)		AR^{ex} (Ho: AR^{ex}=0)	
Distribution	100%	95%	100%	95%
Obs	27,037	25,686	27,037	25,686
Mean	0.783***	0.741***	0.134%***	0.124%***
Std Error	0.062	0.026	0.012%	0.008%
t-stat	-3.48	-9.97	11.25	15.13
Median	0.832***	0.832***	0.097%***	0.097%***
z-stat	-10.95	-11.84	12.78	13.72
Std. Dev.	10.244	4.154	1.955%	1.318%
Variance	104.939	17.260	0.038%	0.017%
Min	-277.107	-14.890	-33.670%	-3.529%
Max	373.260	16.834	63.547%	4.041%
Skewness	2.492	-0.063	1.388	0.137
Kurtosis	168.648	5.648	63.145	3.329

3.2.4 Abnormal Turnover

Few event studies quantify the abnormal trading volume on the ex-day by measuring the percentage deviation of the ex-day turnover from its mean turnover calculated over the estimation window for an individual stock (raw ATO). As documented by Ajinkya and Jain (1989), this raw measure of abnormal trading volume for individual securities is highly non-normal, while a natural log-transformation yields abnormal turnover values that are approximately normally distributed, depending on the sample size. Given the excessive skewness and kurtosis inherent in raw ATO measures, an approach that provides abnormal turnover estimates that deviate least from normality is selected, as follows. Initially, the abnormal turnover on the ex-day of the PDR 2.5% trimmed sample is calculated using three alternative methodologies: i) raw ATO, which assumes that the mean turnover over the estimation period is representative of the normal stock turnover, ii) natural log-transformed ATO as described in Campbell and Wasley (1996), and iii) natural log-transformed ATO as described in Lynch and Mendenhall (1997). Then, the three measures are compared and the one whose statistical distribution is regarded as closer to normal is selected.

According to Campbell and Wasley (1996), the abnormal turnover for stock *i* at day *t* (ATO_{it}) is calculated by

$$ATO_{it} = TO_{it} - \left(\hat{\alpha}_i + \hat{\beta}_i TO_{mt}\right) \qquad (3.4)$$

where α_i and β_i coefficients are obtained via an ordinary least squares (OLS) regression of TO_{it} against TO_{mt} throughout the estimation window of [(–130, –31) & (+31, +130)] trade days.[51] TO_{mt} is the daily turnover for the market portfolio for a given day *t*, calculated as follows:

$$TO_{mt} = \frac{1}{n}\sum_{i=1}^{n} TO_{it} \qquad (3.5)$$

where *n* is the number of all NYSE/AMEX common stocks reported in CRSP at a particular date *t* and TO_{it} is the natural log-transformed daily turnover for an individual stock *i*, given as follows:[52]

$$TO_{it} = \log\left(100 * \left(\frac{V_{it}}{N_{it}}\right) + 0.000255\right) \qquad (3.6)$$

[51] Following Campbell and Wasley (1996), the α_i and β_i coefficients are also obtained using a two-step estimated generalized least squares procedure (EGLS) to control for possible autocorrelation in the parameter estimation. First, the usual OLS market model regression is employed. The estimated OLS residuals are then exploited to transform the original data and re-estimate α_i and β_i using the Yule-Walker AR(1) correction. The EGLS procedure makes only a minor difference to these results because the correlation between the OLS and the EGLS estimated ex-day ATO values is close to unity for the PDR 2.5% trimmed sample.

[52] The ATO of Campbell and Wasley (1996) is similar to the one computed in the ex-day event study of Kadapakkam (2000). Both papers use the logarithm of the stock turnover to remove the pronounced skewness and the market model to compute the normal turnover on the ex-day. Their main difference is that while Kadapakkam (2000) adds a constant of 0.01, Campbell and Wasley (1996) add a constant of 0.000255 to the logarithmic turnover to preclude taking the logarithm of zero trading volume on a given day.

where V_{it} and N_{it} are the trading volume in shares and the number of outstanding stocks, respectively, for a single security *i* at day *t*. Alternatively, the Lynch and Mendenhall (1997) approach takes the ratio of the [log(1+$value of trading volume)/log(1+$value of outstanding stocks)] rather than the log of the ratio of (trading volume/No of outstanding stocks) to calculate the daily stock turnover.

Table 3-3 reports the descriptive statistics and the χ^2-statistic of the D'Agostino, Belanger, and D'Agostino (1990) normality test for the distribution of the ex-day ATO computed with the three alternative methodologies.

It is observed that the percentage raw ATO has almost 90 times higher skewness (16.35) and 50 times higher kurtosis (451.73) than the logarithmic ATO as per Campbell and Wasley (1996) (skewness = 0.18 and kurtosis = 9.18). Likewise, it has almost 7 times higher skewness and 26 times higher kurtosis than the logarithmic ATO as per Lynch and Mendenhall (1997) (skewness = 2.41 and kurtosis = 17.61). Because the ATO of Campbell and Wasley (1996) yields the lowest positive skewness, kurtosis and χ^2-statistic compared to the two alternatives, the Campbell and Wasley (1996) measure is selected. Daily abnormal turnover values combined with daily abnormal returns will be used in the assessment of the relevance of dividend motivated trading before and after the ex-day, as reported in the empirical results in Section 3.3.

Table 3-3: Descriptive Statistics for the Abnormal Turnover (ATO) on the Ex-Day for the PDR Sample

This table reports descriptive statistics for the abnormal turnover (ATO) on the ex-day for the PDR sample after trimming the top and bottom 2.5 percentiles, using three alternative methodologies. The second column reports the raw percentage ATO that is computed as the percentage deviation of stock turnover (TO) on the ex-day from the stock mean TO over the estimation window of [(–130, –31) & (+31, +130)] days around the ex-day where TO is defined as the simple ratio of (trading volume/No of outstanding stocks). The third column reports the log-transformed ATO as described in Campbell and Wasley (1996) who measure TO as the natural log of (the ratio of (100 × (trading volume/No of outstanding stocks)) + 0.000255) and ATO as the TO on the ex-day in excess of the normal stock TO estimated using the market model (OLS) over the estimation window of [(–130, –31) & (+31, +130)] days around the ex-day. The fourth column reports the natural log-transformed ATO as described in Lynch and Mendenhall (1997) who measure TO as the ratio of the [log(1+$value of trading volume)/log(1+$value of outstanding stocks)] and ATO as the TO on the ex-day in excess of the normal stock TO estimated using the market model (OLS) over the estimation window of [(–130, –31) & (+31, +130)] days around the ex-day. The market portfolio is defined as all NYSE/AMEX common stocks reported in CRSP at a particular date. The last row provides the χ^2 statistic of the D'Agostino, Belanger, and D'Agostino (1990) test that tests the null hypothesis of assumed normality based on the levels of skewness and kurtosis, in combination. *** denotes significance at the 1% level.

	Abnormal Turnover on the ex-day (ATO)		
Methodology	Raw %	Cambell and Wasley (96)	Lynch and Mendenhall (97)
Obs	25,686	25,686	25,686
Mean	0.1082	0.0189	0.0067
Median	-0.1265	-0.0053	0.0012
Std. Dev.	1.4897	0.6311	0.0436
Min	-0.9945	-4.5875	-0.2773
Max	64.2393	4.8286	0.5488
Skewness	16.353	0.183	2.408
Kurtosis	451.727	9.180	17.611
Normality (χ^2)	51,524***	3,436***	14,718***

3.2.5 The Capital Gains Overhang Proxy

To test the disposition effect hypothesis on the ex-day, it is required to have an indicator that distinguishes stocks with an accrued gain (winner) from stocks with an accrued loss (loser) just before the ex-day. Ideally, aggregate accrued gains or losses could be calculated accurately if the actual cost basis and holding period of all investors holding an individual stock was known at each point in time. However, because market-wide data is used rather than data extracted from trade records of all market participants, it is not feasible to estimate either element with precision. This issue is addressed using the capital gains overhang that was introduced by Grinblatt and Han (2005) to proxy for the market wide gain/loss accrued on a particular stock using the time series of its past prices and the time series of concurrent and forward turnover values. In particular, for each ex-day *t* of stock *i*, the stock's aggregate cost basis is calculated, which is assumed to be the relevant reference price on the cum-day (RP_i^T), using daily data, as follows:[53]

$$RP_i^T = \frac{1}{\sum_{n=1}^{T} w_{t-n}} \sum_{n=1}^{T} w_{t-n} P_{t-n} \quad where \; w_{t-n} = \left[TO_{t-n} \prod_{\tau=1}^{n-1} \left(1 - TO_{t-n+\tau}\right) \right] \quad (3.7)$$

In essence, the aggregate cost basis is a turnover-weighted average of past prices, where P_{t-n} is the stock price (adjusted for stock distributions) *n* days before the ex-day, TO_{t-n} is the turnover *n* days before the ex-day, and $TO_{t-n+\tau}$ is the "forward-looking" turnover τ days after the *t-n* day point over an assumed holding period of T days.[54] The inverse of the sum of the weights is a normalizing constant that makes all TO weights of past prices sum to one. This measure can be interpreted as follows. If a stock had a high TO value T days before the ex-day but low TO during the trading days that follow, then it is reasonable to assume that most investors that hold the stock just before the ex-day use distant purchase prices in their cost basis calculation. However, if the TO was very low at the beginning of the investors' holding period but very high just before the ex-day, then, investors would most likely use purchase prices proximate to the ex-day price to calculate their accrued gains or losses. Thus, the capital gains overhang (hereafter, "CGOH") of stock *i* for an assumed investor holding period of T days can be reasonably defined as the percentage deviation of the closing trade price from the aggregate cost basis proxy on the cum-day:

$$CGOH_i^T = \frac{P_i^{cum} - RP_i^T}{P_i^{cum}} * 100\% \qquad (3.8)$$

Given that it is impossible to infer the average holding period of all owners of a particular stock with precision from market data, the validity of the hypothesized relationship between the CGOH and the ex-day PDR/AR^{ex} is tested using seven

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[53] Grinblatt and Han (2005) consider this aggregate cost basis as a proxy for the average reference price adopted by all investors holding a stock, the risk aversion against trades of which reflects an S-shaped value function of accrued gains or losses that pertains to the inferences of prospect theory.

[54] Following Grinblatt and Han (2005), turnover is calculated as the stock trading volume divided by the number of outstanding shares.

different assumed holding periods in calendar time: T = 360, 250, 150, 90, 60, 30, 15 calendar days before the ex-day.

Table 3-4 reports Pearson correlations for the CGOH calculated at seven different calendar-day holding periods for the PDR 2.5% trimmed sample. It is worth noting that the estimated correlations (ρ) are all significant at the 5% level and range from ρ (360, 250) = 0.98 for the longer horizons to ρ (360, 15) = 0.37 for those with the smallest overlap. Although the empirical results presented in this Chapter are based on the assumption of a 90-calendar-day holding period, all other calendar periods are also used as a robustness test. Furthermore, Odean (1998) reports that the median holding period for the stocks held by his sample of U.S. discount broker investors is 84 trading days, or approximately 120 calendar days, which is close to the adopted 90-calendar-day holding horizon assumption.[55]

[55] In the case of quarterly dividends, the 90-calendar-day horizon can be considered as non-arbitrary in the case that all current owners of the stock decide to sell the stock around each quarterly ex-day. Given that a significant number of investors sell or buy the stock around the ex-day due to dividend capture or avoidance attitudes, it might be reasonable to assume that the aggregate cost basis is widely updated each quarter.

Table 3-4: Pearson Correlations between Various Time Horizons of the Capital Gains Overhang (CGOH) for the PDR Sample

This table reports pairwise Pearson correlations for the capital gains overhang (CGOH) calculated at seven different calendar holding periods for the PDR sample after trimming the top and bottom 2.5 percentiles; T = 360, 250, 150, 90, 60, 30, 15 calendar days before the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy, that is computed as in Grinblatt and Han (2005) using daily price and turnover data:

$$CGOH_i^T = \frac{P_i^{cum} - RP_i^T}{P_i^{cum}} * 100\%, \quad RP_i^T = \frac{1}{\sum_{n=1}^{T} w_{t-n}} \sum_{n=1}^{T} w_{t-n} P_{t-n}, \quad w_{t-n} = \left[TO_{t-n} \prod_{\tau=1}^{n-1} \left(1 - TO_{t-n+\tau}\right) \right]$$

P_{t-n} is the stock price n days before the ex-day, TO_{t-n} is the turnover n days before the ex-day and $TO_{t-n+\tau}$ is the “forward-looking” turnover τ days after the t-n day point. The inverse of the sum of the weights is a normalizing constant that makes all turnover weights to past prices sum to one. ** denotes significance at the 5% level.

T period	360	250	150	90	60	30	15
360	1						
250	0.982**	1					
150	0.918**	0.963**	1				
90	0.823**	0.875**	0.951**	1			
60	0.719**	0.771**	0.859**	0.954**	1		
30	0.526**	0.570**	0.654**	0.765**	0.876**	1	
15	0.374**	0.407**	0.470**	0.560**	0.669**	0.867**	1

3.3 Empirical Results

3.3.1 Difference of Means and Capital Gains Overhang Quantile Analysis

To test Hypothesis 3-1, the PDR/AR^{ex} 2.5% trimmed sample is split into losers and winners on the basis of the CGOH estimated over the 90-calendar-day holding period, and pooled arithmetic means and medians are calculated for each sample. Approximately 58% of the ex-days refer to stocks with positive CGOH (winners), and 42% refer to stocks with negative CGOH (losers).

Panel A of Table 3-5 shows that the mean PDR for winners is 0.887 (median = 0.928), which is significantly higher than the mean PDR = 0.539 for losers (median = 0.684) at the 1% level of significance (t-statistic = –6.62). Similarly, the mean AR^{ex} for winners is 0.071% (median = 0.046%), that is significantly lower than the mean AR^{ex} = 0.202% for losers (median = 0.184%) at the 1% level (t-statistic = 7.70). The difference between median values using the Wilcoxon rank-sum test remains statistically different from zero at the 1% level, providing strong evidence that the ex-day price drops more for winners than for losers on a market-adjusted basis. Hypothesis 3-2 can be tested by separately dividing each sample of losers and winners into three equally sized CGOH90 quantiles and calculating mean (median) PDR/AR^{ex} values for each of the resulting six quantiles. As shown in panel B of Table 3-5, the mean (median) PDR increases monotonically from 0.431 (0.639) in the quantile with the highest accrued loss (–14.7%) to 1.008 (1.022) in the quantile with the highest accrued gain (9.8%). Similarly, in Panel C of Table 3-5, the mean (median) AR^{ex} decreases monotonically from 0.250% (0.234%) in the quantile with the lowest CGOH (–13.5%) to 0.032% (0.003%) in the quantile with the highest CGOH (9.8%). Notably, in the biggest winner quantile, the hypothesis that the mean PDR is significantly different from one (t-statistic = 0.13) cannot be rejected, and the mean AR^{ex} is only marginally significantly different from zero at the 10% level (t-statistic = 1.65). As a robustness test, Table 3-5 is replicated for the other six (T = 360, 250, 150, 60, 30, 15 calendar days) CGOH estimation periods, and according to results presented in the Appendix (A-2.1), it is deduced that the results remain qualitatively similar. In short, it is found that the higher is the accrued gain on a stock before it goes ex, the higher (lower) the PDR (AR^{ex}) will be on the ex-day, in alignment with Hypothesis 3-2.

Table 3-5: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} per CGOH Quantile

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 90 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between losers and winners

	PDR			AR^{ex}		
Status (CGOH90)	Obs	Mean	Median	Obs	Mean	Median
Losers	10,752	0.539	0.684	10,570	0.202%	0.184%
Winners	14,934	0.887	0.928	15,116	0.071%	0.046%
Diff.		-0.348***	-0.244***		0.131%***	0.138%***
t-stat / z-stat		-6.62	-8.09		7.70	8.19
Total	25,686	0.741	0.832	25,686	0.124%	0.097%

Panel B: PDR per CGOH90 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-14.7%	-4.4%	-1.2%	1.5%	4.5%	9.8%	Total
Median	0.639	0.709	0.702	0.880	0.918	1.022	0.832
Mean	0.431***	0.584***	0.602***	0.775***	0.878**	1.008	0.741***
t-stat	-7.34	-6.08	-6.35	-4.26	-2.22	0.13	-9.97
Obs	3,584	3,584	3,584	4,978	4,978	4,978	25,686

Panel C: AR^{ex} per CGOH90 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-13.5%	-4.3%	-1.2%	1.5%	4.6%	9.8%	Total
Median	0.234%	0.166%	0.157%	0.072%	0.056%	0.003%	0.097%
Mean	0.250%***	0.188%***	0.166%***	0.105%***	0.074%***	0.032%*	0.124%***
t-stat	9.17	8.35	8.20	6.26	4.42	1.65	15.13
Obs	3,523	3,523	3,524	5,039	5,039	5,038	25,686

3.3.2 Regression Analysis

Hypothesis 3-2 states that the higher the unrealized gain (loss), the larger (smaller) the ex-dividend day price drop ratio, which translates into an expected positive (negative) relationship between the PDR (AR^{ex}) and the CGOH. To perform a direct test on Hypothesis 3-2, the PDR/AR^{ex} of the 2.5% trimmed samples are regressed against CGOH and a group of other explanatory variables that have been consistently used in the ex-day literature to control for alternative tax, transaction cost, short-term arbitrage and microstructure effects on the ex-day. Accordingly, the regression equation takes the following form:

$$PDR_{it} / AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it}^{T} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it} \quad (3.9)$$

where $CGOH^T$ is the capital gains overhang of stock *i* for an assumed investor holding period of T = 90 calendar days before the ex-dividend day *t*. *DY* is the stock dividend yield equal to the dividend amount over the closing price on the cum-day. *MCap* is the mean stock relative size equal to the natural logarithm of the ratio of individual stock capitalization to the capitalization of the CRSP equal-weighted NYSE/AMEX index, averaged over the estimation window of [(−130, −31) & (+31, +130)] trade days. *TO* is the average stock turnover over the estimation window of [(−130, −31) & (+31, +130)] trade days.[56] *IVol* measures the idiosyncratic volatility as the ratio of the individual stock standard deviation to the standard deviation of the market portfolio returns over the estimation window of [(−130, −31) & (+31, +130)] trade days. Again, the market portfolio is represented by the CRSP equal-weighted NYSE/AMEX index. *Tax03* is a dummy variable that takes the value of one if the ex-day is located after May 22, 2003 when the 2003 Tax Act went into effect, and zero otherwise. The dividend yield has been consistently used in the ex-day literature as a proxy for dividend-tax clienteles, whereas the mean relative size, mean turnover and idiosyncratic volatility should capture liquidity, arbitrage and microstructure effects.[57]

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[56] The daily turnover is computed by Equation 3.6, in Section 3.2.4, as per Campbell and Wasley (1996).

[57] Michaely and Vila (1995), Kadapakkam (2000), and Zhang, Farrell and Brown (2008) are examples of ex-day studies that employ some or all of these regressors.

Three different models are employed to estimate Equation 3.9; a pooled sample regression, a panel regression adjusting standard errors for clustering across both ex-days and stocks, and a fixed effects model that simultaneously controls for year and stock effects. Michaely and Vila (1995) suggest that PDR volatility is a function of the dividend yield and daily return volatility, which could generate severe heteroscedasticity in the estimation. Therefore, the Weighted Least Squares method (WLS) is utilized for the pooled PDR regression, where the weight is equal to the squared ratio of the dividend yield over the standard deviation of the stock returns over the estimation period,[58] whereas the Ordinary Least Squares (OLS) method is selected for the pooled AR^{ex} regression.[59] The U.S. ex-day literature has pointed out that severe clustering of observations on the same ex-dividend date could induce cross-sectional dependence in the PDR/AR^{ex} samples. This econometric problem is addressed using calendar time portfolios, whereby stocks that go ex-dividend on the same date are pooled together, and the portfolio mean PDR/AR^{ex} value is treated as a single observation (e.g., Barclay (1987), Kadapakkam (2000), and Naranjo, Nimalendran, and Ryngaert (2000)). The calendar time portfolios method is not adopted in this study to avoid grouping winning stocks together with losing stocks that share the same ex-day. This also allows to avoid the drawback of weighting stocks within ex-day PDR/AR^{ex} portfolios with fewer observations more than portfolios with a larger number of observations. Thomson (2011) describes a panel data method for computing standard errors that are robust to correlation along both firm and time dimensions. He recommends its application when the regression errors and/or the regressors include evident time and firm components and when the number of firms is close to the number of time periods. Given that there are 1,943 ex-day clusters and 1,359 stock clusters in the PDR/AR^{ex} 2.5% trimmed samples, "double-clustered" standard errors are calculated, as per Thompson (2011) and Cameron,

[58] Following Zhang, Farrell and Brown (2008).

[59] The t-statistics of the estimated OLS coefficients are computed with heteroscedasticity consistent standard errors, according to the White (1980) correction.

Gelbach and Miller (2011).[60] Finally, a fixed effects model is also employed that includes year and stock dummies in the specification of Equation 3.9.[61]

According to the results of the pooled WLS/OLS regressions in Table 3-6, the relationship between the PDR and the accrued gain/loss measured by CGOH is positive (coefficient = 1.8029), whereas the relationship between the AR^{ex} and the CGOH is negative (coefficient = –0.0083). Both results are significant at much less than the 1% level (t-statistic = 7.49 for PDR and t-statistic = –6.43 for AR^{ex}). In the PDR/AR^{ex} panel data regressions with clustered standard errors and fixed effects, the CGOH coefficients remain statistically significant at the 1% level with the predicted signs. The results also indicate weak evidence on the importance of alternative hypotheses on the ex-day. For example, the coefficient of the dividend yield is significantly positive (at the 5% level) in the pooled WLS and the clustered standard errors regression of the PDR sample but becomes insignificant in the fixed effects model. Moreover, it is positively and significantly correlated with AR^{ex} across all three specifications. Larger stocks appear to have lower abnormal returns (implying higher ex-day price drops), but this result is only significant for the AR^{ex} sample. Likewise, more liquid stocks seem to have higher PDR (lower AR^{ex}) values, possibly due to short term trading on the ex-day, though this relationship does not significantly hold for the fixed effects model. The idiosyncratic volatility and the 2003 Tax Act dummy variables are overall insignificant across the six regressions.

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[60] The programming code for this estimation can be found on Doug Miller's web page: (http://www.econ.ucdavis.edu/faculty/dlmiller/statafiles/).

[61] Jakob and Ma (2004), following Hayashi and Jagannathan (1990), adopt a panel data model that allows for fixed ex-dividend day effects only. To the best of my knowledge, this analysis is the first in the ex-dividend day literature to employ panel data techniques that simultaneously account for correlations along both time and firm dimensions.

Table 3-6: Relationship between PDR/AR^{ex} and CGOH

This table reports the estimated coefficients and their t-statistics of the regressions of PDR/AR^{ex} of the 2.5% trimmed samples against CGOH and a group of control variables as:

$PDR_{it} / AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T = 90 calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. Both PDR and AR^{ex} are computed using closing prices on the ex-day and the expected ex-day return is estimated with the market model. The estimation window is [(−130, –31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 90 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The Clustered SE-method refers to standard errors adjusted for both ex-day and stock clusters, as per Thompson (2011), and Cameron, Gelbach, and Miller (2011). The Fixed Effects estimation includes year and stock dummies to the regression equation above. The number in parentheses below the coefficient is the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
Var./Model	WLS	Clustered SE	Fixed Effects	OLS	Clustered SE	Fixed Effects
Intercept	1.1558***	0.9830***	1.4438*	-0.0016***	-0.0016***	-0.0044*
	(10.34)	(6.08)	(1.82)	(-3.35)	(-2.84)	(-1.74)
CGOH90	1.8029***	2.0335***	2.1089***	-0.0083***	-0.0083***	-0.0084***
	(7.49)	(5.42)	(6.81)	(-6.43)	(-5.63)	(-7.85)
DY	1.4637**	3.5508***	-0.9106	0.0217**	0.0217**	0.0450***
	(2.03)	(3.33)	(-0.29)	(2.34)	(2.36)	(4.30)
MCap	0.0169	-0.0012	0.1097	-0.0002***	-0.0002***	-0.0007**
	(1.31)	(-0.07)	(1.21)	(-4.17)	(-3.64)	(-2.39)
TO	0.0789***	0.0931**	-0.0948	-0.0004***	-0.0004***	-0.0001
	(2.86)	(2.19)	(-1.08)	(-3.11)	(-2.80)	(-0.25)
IVol	-0.0668***	-0.0600*	-0.0109	0.0002*	0.0002	0.0000
	(-2.85)	(-1.72)	(-0.26)	(1.65)	(1.51)	(-0.32)
Tax03	-0.0256	-0.0558	-0.4536***	0.0000	0.0000	0.0010***
	(-0.53)	(-0.76)	(-2.94)	(0.07)	(0.06)	(2.05)
Adj. R^2	0.003	0.002	0.014	0.005	0.005	0.018
F-stat	13.56	9.02	4.88	17.44	17.44	8.13
Obs	25,686	25,686	25,686	25,686	25,686	25,686

In brief, a significant positive (negative) relationship is found between the PDR (AR^{ex}) and the CGOH, which is the only explanatory variable that remains statistically significant (at the 1% level) across both PDR/AR^{ex} regressions and all three pooled and panel data model specifications.[62] The effect of the capital gains overhang on the ex-day is also economically significant. If a stock held by the aggregate investor depreciated by 5% over the assumed holding period of 90 days, its AR^{ex} will be 0.0415% higher (–0.0083 × –5%, based on the estimates of the OLS pooled regression) as compared to a stock with no gain or loss accrued on the cum-day. This is substantial given that this extra return is one-third of the mean AR^{ex} (0.124%) for the entire 2.5% trimmed sample.

Next, it is shown that both a long array of robustness tests and empirical testing of whether abnormal trading pressure around the ex-day can be charged for the results presented so far corroborate the disposition effect-driven hypotheses I and II.

3.3.3 Robustness Tests

3.3.3.1 Opening Prices

In frictionless markets, the price adjustment due to the dividend on the ex-day should occur between the cum-day close and the ex-day open. Therefore, the analysis is repeated after replacing the closing ex-day price with the opening ex-day price to eliminate any noise associated with intra-day stock-specific volatility. Furthermore, following Graham, Michaely, and Roberts (2003), PDR/AR^{ex} is adjusted for the overnight market movement by assuming that the overnight normal return is half of

[62] According to Frazzini (2006), the disposition effect that is prevalent among investors will cause underreaction to negative news for stocks with accrued capital losses, which, in turn, will generate a negative post-announcement price drift. Likewise, underreaction to positive news for stocks with accrued capital gains will generate a positive post-announcement price drift, implying that any mispricing on the event date will be corrected after the event. If this were true for the ex-dividend day, positive abnormal returns for winners and negative abnormal returns for losers should occur after their ex-dividend dates. To identify any possible post ex-day drift effects, daily cumulative abnormal returns are estimated for a [0, +20] trade window starting from the ex-day "0" separately for winners and losers that are defined on the basis of the CGOH of 90 calendar days before the ex-day. Unreported results indicate that the already depreciated ex-day positive AR^{ex} for winners wears out completely and becomes a negative cumulative abnormal return, whereas the high ex-day positive AR^{ex} for losers seems to persist over the post ex-day [0, +20] window. Although these results do not support the existence of post ex-day price drifts, they do not challenge the theory predicted by this thesis and conclusions drawn from the analysis on the actual ex-dividend day.

the full ex-day normal return computed with the market model estimation.[63] What follows is the replication of the tests on the difference of mean and median PDR/AR^{ex} between winners/losers and the calculation of the mean PDR/AR^{ex} per CGOH quantile (as reported in Table 3-5 for closing prices) using the alternative PDR/AR^{ex} computed with ex-day opening prices.[64]

Panel A of Table 3-7 shows that the mean PDR for winners is 0.836 (median = 0.860), which is significantly higher than the mean PDR = 0.651 for losers (median = 0.690) at the 1% level (t-statistic = –7.18 for the difference of means, and z-statistic = –9.46 for the difference of medians). Similarly, the mean AR^{ex} for winners is 0.104% (median = 0.075%), which is significantly lower than the mean AR^{ex} = 0.209% for losers (median = 0.179%) at the 1% level (t-statistic = 12.31 for the difference of means, and z-statistic = 12.25 for the difference of medians). Elton and Gruber (1970) and Elton, Gruber, and Blake (2005) refrain from using opening prices because all limit orders on the specialists' books on the ex-day opening are adjusted by the full amount of the dividend. They reason that this will bias the ex-day opening price downwards. Nevertheless, if Panel A from Table 3-5 is compared to Panel A from Table 3-7, it is concluded that the PDR (AR^{ex}) values calculated with opening ex-day prices are very similar to those calculated with closing ex-day prices, if not lower (higher). For example, the mean PDR calculated with opening prices for the all-stocks sample is equal to 0.759 (median = 0.798), which is very close to the mean PDR = 0.741 (median = 0.832) calculated with closing prices. Moreover, the mean AR^{ex} calculated with opening prices is equal to 0.147% (median = 0.114%), which is higher than the mean AR^{ex} = 0.124% (median = 0.097%) calculated with closing prices; this finding contradicts Elton and Gruber's (1970) prediction.

[63] It is confirmed that using one-third of the full ex-day normal return as an alternative overnight market adjustment makes a minor difference to the reported results.

[64] The 2.5% trimmed sample size falls from 25,686 to 25,628 observations because CRSP did not provide opening prices for 58 ex-days.

Table 3-7: Difference of Mean and Median PDR/ARex between Losers and Winners, and PDR/AR^{ex} per CGOH Quantile, Using Opening Prices on the Ex-Day

Both PDR and AR^{ex} are computed as described in Graham, Michaely, and Roberts (2003) using opening prices on the ex-day. Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} – (P^{ex}/(1 + 0.5R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} – P^{cum} + Div) / P^{cum}) – 0.5R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the opening price on the ex-dividend day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 90 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Ex-day opening prices; difference of mean and median PDR/AR^{ex} between losers and

	PDR			AR^{ex}		
Status	Obs	Mean	Median	Obs	Mean	Median
Losers	10,702	0.651	0.690	10,501	0.209%	0.179%
Winners	14,926	0.836	0.860	15,127	0.104%	0.075%
Diff.		-0.184***	-0.170***		0.105%***	0.104%**
t-stat / z-stat		-7.18	-9.46		12.31	12.25
Total	25,628	0.759	0.798	25,628	0.147%	0.114%

Panel B: Ex-day opening prices; PDR per CGOH90 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-14.7%	-4.4%	-1.2%	1.5%	4.6%	9.8%	Total
Median	0.552	0.720	0.776	0.819	0.870	0.909	0.798
Mean	0.508***	0.685***	0.760***	0.803***	0.843***	0.861***	0.759**
t-stat (PDR=1)	-12.47	-9.44	-7.81	-7.83	-5.86	-4.47	-19.21
Obs	3,567	3,567	3,568	4,976	4,975	4,975	25,628

Panel C: Ex-day opening prices; AR^{ex} per CGOH90 Quantile

	Losers			Winner			
Quantile	3	2	1	1	2	3	
CGOH90	-13.3%	-4.3%	-1.2%	1.5%	4.6%	9.9%	Total
Median	0.289%	0.157%	0.128%	0.106%	0.073%	0.042%	0.114%
Mean	0.288%***	0.186%***	0.153%***	0.126%***	0.101%***	0.085%***	0.147%**
t-stat (AR^{ex}=0)	21.43	16.46	14.54	14.80	11.97	9.14	35.77
Obs	3,500	3,500	3,501	5,043	5,042	5,042	25,628

According to Panel B of Table 3-7, the mean (median) PDR increases monotonically from 0.508 (0.552) in the quantile with the most negative CGOH to 0.861 (0.909) in the quantile with the most positive CGOH. Similarly, in Panel C, the mean (median) AR^{ex} decreases monotonically from 0.288% (0.289%) in the quantile with the highest accrued loss to 0.085% (0.042%) in the quantile with the highest accrued gain. For the highest CGOH quantile, the mean PDR calculated with closing prices, equal to 1.008 (Panel B of Table 3-5), is higher than its respective value calculated with opening prices, which is equal to 0.861 (Panel B of Table 3-7). In non-tabulated results, it is found that their difference is statistically significant at the 5% level using a two-tailed test (t-statistic = 2.00). This is in alignment with the disposition effect because the investors holding the biggest winners will get a chance to provide their entire excess supply of the stock after the opening of the ex-day, resulting in a price drop calculated with closing ex-day prices that slightly exceeds the dividend amount.

In addition, the estimation of the three regression models (pooled WLS/OLS regression, clustered standard errors, and fixed effects) depicted in Table 3-6 is repeated with the alternative PDR/AR^{ex} measures that are computed with opening ex-day prices and results are presented in Table 3-8.

In the pooled WLS/OLS regressions, the coefficient of the CGOH is positive (0.7643) for the PDR sample and negative (−0.0074) for the AR^{ex} sample, and both of these coefficients are significant at much less than the 1% level (the t-statistic is equal to 6.51 for PDR and −11.35 for AR^{ex}). In the panel data regressions (as reported in Table 3-8), the PDR (AR^{ex}) continues to be positively (negatively) related to the CGOH, and significance levels remain at 1%, except in the clustered standard errors estimation of the PDR sample, where the CGOH coefficient is significant at the 5% level.[65]

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[65] The clustered standard errors estimation is conservative in that it simultaneously adjusts t-statistics for two-dimensional clustering and heteroscedasticity according to the White (1980) correction (for more technical details, see Thompson (2011), and Cameron, Gelbach, and Miller (2011). Therefore, the evident reduction of significance is somehow expected.

Table 3-8: Relationship between PDR/AR^{ex} and CGOH, Using Opening Prices on the Ex-Day

Both PDR and AR^{ex} are computed as described in Graham, Michaely, and Roberts (2003) using opening prices on the ex-day. This table reports the estimated coefficients and their t-statistics of the regressions of PDR/AR^{ex} of the 2.5% trimmed samples against CGOH and a group of control variables as:

$$PDR_{it} / AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T = 90 calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. Both PDR and AR^{ex} are computed using opening prices on the ex-day and adjusted for one half of the expected overnight return that is estimated with the market model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 90 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The Clustered SE-method refers to standard errors adjusted for both ex-day and stock clusters, as per Thompson (2011), and Cameron, Gelbach, and Miller (2011). The Fixed Effects estimation includes year and stock dummies to the regression equation above. The number in parentheses below the coefficient is the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
Var./Model	WLS	Clustered SE	Fixed Effects	OLS	Clustered SE	Fixed Effects
Intercept	0.7098***	0.6054***	0.2161	0.0014***	0.0014***	-0.0010
	(12.96)	(6.56)	(0.56)	(5.68)	(3.77)	(-0.79)
CGOH90	0.7643***	0.8362**	0.6496***	-0.0074***	-0.0074***	-0.0059***
	(6.51)	(1.96)	(4.32)	(-11.35)	(-7.01)	(-10.87)
DY	0.6544*	-0.1133	1.4206	0.0362***	0.0362***	0.0148***
	(1.86)	(-0.18)	(0.92)	(3.66)	(3.63)	(2.81)
MCap	-0.0050	-0.0178*	-0.0749*	0.0000	0.0000	-0.0002
	(-0.79)	(-1.80)	(-1.69)	(-1.23)	(-0.88)	(-1.60)
TO	-0.0637***	-0.0653**	-0.0340	0.0003***	0.0003***	0.0003**
	(-4.72)	(-2.45)	(-0.80)	(4.83)	(2.74)	(2.53)
IVol	-0.0248**	-0.0260	-0.0657***	-0.0001	-0.0001	0.0002***
	(-2.16)	(-1.12)	(-3.21)	(-1.55)	(-0.97)	(3.71)
Tax03	-0.0103	0.0038	0.1799**	0.0001	0.0001	-0.0011***
	(-0.43)	(0.06)	(2.40)	(0.94)	(0.38)	(-4.63)
Adj. R^2	0.004	0.003	0.012	0.014	0.014	0.043
F-stat	16.96	10.59	7.11	30.55	30.55	33.23
Obs	25,628	25,628	25,628	25,628	25,628	25,628

Again, the significance of the coefficients of the control variables implies weak evidence for the power of the tax, transaction cost and microstructure hypotheses to explain the dispersion of PDR/AR^{ex}. The coefficient on dividend yield remains significantly positive for the AR^{ex} sample but becomes almost insignificant in the PDR sample. The only control variable that remains significant at the 1% level across five of the six regressions is the mean stock turnover, but the signs are reversed as compared to the regressions that use closing prices, implying that higher liquidity, in fact, hinders the overnight price adjustment to the dividend on the ex-day. In summary, both hypotheses 3-1 and 3-2 are confirmed with both closing and opening prices on the ex-day, enhancing the support for the predicted price impact of the disposition effect on the ex-day.

3.3.3.2 Alternative Methodologies and Capital Gains Overhang Windows

With a view to increasing the strength of the results, a set of alternative methodologies is deployed to measure the normal return on the ex-day that adjusts the PDR/ARex for the market movement.[66] Specifically, these are i) the mean-adjusted model, where the average individual stock return over the estimation window is used as the normal return on the ex-day; ii) the market-adjusted model, where the return of the CRSP equal-weighted NYSE/AMEX index on the ex-day is used as the normal return; iii) the three-factor Fama and French (1997) model; iv) the four-factor Carhart (1997) model[67] and v) the market model as described in Section 3.2.2 while adopting the CRSP value-weighted NYSE/AMEX index as the market portfolio proxy. Simultaneously all seven different assumed holding periods for the $CGOH^T$ are used alternatively, that is, for T = 360, 250, 150, 90, 60, 30, 15 calendar days before the ex-day.[68] Subsequently, Hypothesis 3-1 is examined by repeating the test of the difference in the mean and median PDR/AR^{ex} between winners and losers (Panel A of Table 3-5), and Hypothesis 3-2 is tested by re-estimating Equation 3.9 using the WLS

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[66] Each PDR/AR^{ex} sample distribution that was derived with the alternative specifications was independently trimmed at the upper and lower 2.5 percentile.

[67] Fama and French's (1997) three factors and Carhart's (1997) momentum factor are extracted from Kenneth French's web site (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/).

[68] Naturally, if the results prove robust across all seven holding periods, they are anticipated to remain qualitatively similar for all other investor horizons between 360 and 15 calendar days before the ex-day.

(OLS) pooled regression for the PDR (AR^{ex}) sample (columns 2 and 5 of Table 3-6) with all alternative ex-day normal return specifications and assumed CGOH holding periods.

In total, 84 tests of difference of means and medians between winners and losers are performed (2 measures (PDR/AR^{ex}) of the ex-day adjustment × 7 CGOH holding periods × 6 different ex-day normal return specifications - counting the market model estimation of the ex-day normal return twice, once with the equal-weighted and again with the value-weighted NYSE/AMEX index). In results that are reported in the Appendix (A-2.2), it is found that in 76 of the 84 tests, the difference in the mean and median PDR/AR^{ex} between winners and losers is significant at the 1% level, in three tests it is significant at the 10% level, and in the remaining five tests, the insignificant differences pertain to the 15-calendar day holding period.[69] Similarly, 112 alternative regressions are estimated (84 as described above + 2 measures (PDR/AR^{ex}) of the ex-day adjustment × 7 CGOH holding periods × 2 panel data clustered standard errors and fixed effects models). In the Appendix (A-2.3), it is shown that out of the 112 regressions, the beta coefficient on the CGOH is significant at the 1% level in 110 estimations and significant at the 10% level for the remaining 2 cases (t-statistics range between 2.85 (–1.92) and 9.23 (–9.89) across all 112 PDR (AR^{ex}) estimated regressions). Overall, the results remain robust to the various ex-day normal return specifications, panel data econometric models and different holding period length assumptions.

3.3.4 Abnormal Trading Pressure around the Ex-Day

Graham and Kumar (2006) investigate the dividend preferences of retail investors by inspecting the trading records of 77,995 U.S. households taken from a major U.S. discount brokerage house. They find significant evidence of abnormal trading and buy-sell order imbalances around ex-days driven by age and income investor clienteles.[70] Naranjo, Nimalendran, and Ryngaert (2000) claim that systematic

[69] Assuming a two-tailed test on the difference of means.

[70] Briefly, they find that old and low-income investors aggressively buy the stock prior to the ex-day to capture the dividend, while young investors prefer to wait until the ex-day to buy the stock, indicating a

dividend capture by corporations that are taxed more heavily on capital gains than on dividends could extend price drops such that ex-day abnormal returns have a negative sign. If sizeable dividend capture (avoidance) trades take place a few days before the ex-day, they can generate significant upward (downward) pressure on the stock price until the cum-day and perhaps even a price reversal on the ex-day when initial buy (sell) positions are closed. This consideration might raise doubts about whether the empirical results presented thus far can be attributed to the disposition effect or are simply an artifact of upward or downward pressure by dividend-induced trades. For example, stocks that rise before the ex-day due to abnormal buying by investors who pursue the right to the dividend are expected to have a greater price drop because the prior upward pressure is reversed on the ex-day. In the same manner, investors who dislike the dividend will hasten to sell the stock prior to the ex-day, hence depreciating the stock until the cum-day and inducing a deflated price drop on the ex-day. If the majority of stocks with a positive CGOH on the cum-day exhibit excess short-term buying pressure and most stocks with a negative CGOH are subject to excess short-term selling pressure before the ex-day, then the disposition effect explanation will merely “mask” the price impact of the dividend-motivated trades of particular tax, income or age clienteles. In theory, dividend capture targeted toward winning stocks can be justified in the following two ways. Investor sentiment might make investors believe that stocks with positive momentum will quickly recover the price drop on the ex-dividend day. In addition, stocks that have already appreciated with deeply in-the-money call options are more likely to bear upward pressure before the ex-day because the call options are optimally exercised early by their holders (Roll (1977), and Kalay and Subrahmanyam (1984)).[71]

To examine whether the above concern is valid, the cumulative abnormal return over a window of 20 trading days ending on the cum-day is used to measure significant abnormal buying (selling) pressure for stocks with prior longer-term accrued gains (losses). Using the AR^{ex} 2.5% trimmed sample of ex-days, winning (losing) stocks

possible dividend aversion. Rantapuska (2008), examining the universe of trades in the Finnish market over an 8-year period, also concludes that there is evident abnormal buying or selling around the ex-day on the basis of relative dividend taxation at the investor level.

[71] Roll (1977), and Kalay and Subrahmanyam (1984) report that as the underlying stock price increases, that is, the call option becomes more deeply in-the-money, and as the dividend amount also increases and the duration until option maturity decreases, the probability of early exercise of American call options before the ex-day increases.

with a positive (negative) CGOH90 are separately divided into three quantiles on the basis of the value of their [−20, −1] cumulative abnormal return ($CAR_{[-20, -1]}$). The winners that belong to the top 3rd $CAR_{[-20, -1]}$ quantile are considered as having abnormal buying pressure and those losers in the bottom 1st (most negative) $CAR_{[-20, -1]}$ quantile as having abnormal selling pressure prior to the ex-day.

Table 3-9 reports the daily abnormal return (AR), cumulative abnormal return (CAR), daily abnormal turnover (ATO) and cumulative abnormal turnover (CATO) for a window of 20 trading days before or after the ex-day for the winner and loser quantiles described above.[72] According to Panel A, which refers to winners, both daily ARs and ATOs in the [−20, −1] trading day window are significantly positive at the 1% level (except from the ATO on day "−20"). CAR starts from 0.51% 20 days before the ex-day and increases to 11.02% on the cum-day. Notably, CATO starts from 0.91% on day "−20" and continuously increases until the ex-day, when it reaches a value of 146.72%. After the ex-day, both AR and ATO abruptly decrease to lower levels than before the ex-day, although they remain positive for another 10-15 days. For this particular sample, it is deduced that there is significant upward pressure prior to the ex-day, as indicated by both return and turnover measures.[73] Panel B illustrates an equivalent picture for the losers that are subject to the highest abnormal selling pressure prior to the ex-day. During the [−20, −1] trading day window, daily ARs are significantly negative, and daily ATOs are significantly positive within the [−15, −1] trading day window at the 1% level. In particular, CAR starts from −0.63% on day "−20" and falls to −12.18% on the cum-day, while CATO starts from 5.86% 15 days before the ex-day and increases to 138.31% on the cum-day. After the ex-day, ARs remain negative but insignificant (except from day "+2" and day "+15"),

[72] Abnormal return before or after the ex-day is calculated as the percentage deviation of daily closing prices adjusted for market movement, estimated using the market model during the estimation period. The abnormal return on the ex-day (AR^{ex}) includes the dividend, as illustrated in Section 3.2.2. Abnormal turnover is calculated according to the methodology of Campbell and Wasley (1996).

[73] Most ex-day studys that consider samples of stocks that are mostly subject to dividend capture select stocks that belong to the quantile with the highest dividend yield on the grounds that dividend capturing trades will be more profitable when dividends are large in magnitude relative to the stock price. Nevertheless, when adopting this criterion, there was weak evidence of abnormal trading pressure prior to the ex-day; the [−20, −1] CAR was only 2.97%, and the [−20, −1] CATO was negative at −14.44%.

whereas ATOs remain significantly positive at the 1% level for another 20 days after the ex-day.[74]

To test whether short-term abnormal trading prior to the ex-day is responsible for the differential AR^{ex} between winning and losing stocks, the AR^{ex} of winning (losing) stocks that appear to have the highest upward (downward) pressure is compared to the AR^{ex} of those with the lowest upward (downward) pressure prior to the ex-day.[75] In particular, the difference of the mean AR^{ex} between winners/losers in the highest (3rd) $CAR_{[-20, -1]}$ quantile and winners/losers in the lowest (1st) $CAR_{[-20, -1]}$ quantile are tested. If the short-term abnormal trading theory was true, the sample of winners with the highest prior upward pressure should have a lower mean AR^{ex} than those with the lowest prior upward pressure. Likewise, the sample of losers with the highest prior downward pressure should have a higher mean AR^{ex} than those with the lowest prior downward pressure.

[74] Similar abnormal return and turnover trends were confirmed when the median rather than the mean values were employed for the same analysis.

[75] Unreported results indicate that winners in the lowest $CAR_{[-20, -1]}$ quantile have significantly negative [−20, −1] ARs and [−20, −1] ATOs at the 1% level, confirming that no abnormal buying occurs in the sample prior to the ex-day. Similarly, losers in the highest $CAR_{[-20, -1]}$ quantile have significantly positive [−20, −1] ARs and insignificant [−20, −1] ATOs at the 10% level, indicating that no abnormal selling pressure is evident prior to the ex-day.

Table 3-9: Abnormal Trading Pressure around the Ex-Day

Using the AR^{ex} 2.5% trimmed sample of ex-days, winning/losing stocks with a positive/negative CGOH over a 90-calendar day window are separately split into three quantiles on the basis of the value of their [−20, −1] cumulative abnormal return ($CAR_{[-20, -1]}$). Winners in the highest $CAR_{[-20, -1]}$ quantile are assumed to bear the highest abnormal buying pressure and losers in the lowest $CAR_{[-20, -1]}$ quantile are assumed to bear the highest abnormal selling pressure before the ex-day. Panel A reports daily and cumulative abnormal returns (AR and CAR), and daily and cumulative abnormal turnovers (ATO and CATO), for a window of [−20, +20] trading days around the ex-day of winners with the highest upward pressure prior the ex-day. Panel B reports daily and cumulative abnormal returns (AR and CAR), and daily and cumulative abnormal turnovers (ATO and CATO), for a window of [−20, +20] trading days around the ex-day of losers with the highest downward pressure prior the ex-day. Abnormal return before or after the ex-day is calculated as the percentage deviation of daily closing prices adjusted for the market movement using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The abnormal return on the ex-day (AR^{ex}) includes the dividend as illustrated in Section 3.2.2. Abnormal turnover is calculated according to the Campbell and Wasley (1996) methodology described in Section 3.2.4. T-statistics test whether daily or cumulative AR or ATO is significantly different to zero on each day. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Winners in the top $CAR_{[-20, -1]}$ quantile (Obs. 5,038)

	AR		CAR		ATO		CATO	
Day	mean	t-stat	mean	t-stat	mean	t-stat	mean	t-stat
-20	0.51%***	16.51	0.51%***	16.51	0.91%	0.97	0.91%	0.97
-15	0.54%***	17.62	3.18%***	43.56	3.37%***	3.62	14.69%***	4.00
-10	0.59%***	18.27	6.06%***	68.53	8.74%***	9.24	49.38%	8.36
-5	0.56%***	16.80	8.87%***	94.54	11.28%***	12.44	102.06%**	13.06
-4	0.47%***	13.96	9.35%***	99.08	10.46%***	11.29	112.52%**	13.81
-3	0.55%***	17.06	9.89%***	105.02	10.90%***	12.06	123.43%**	14.55
-2	0.55%***	17.17	10.45%***	111.08	11.46%***	12.89	134.89%**	15.29
-1	0.57%***	19.59	11.02%***	117.79	11.83%***	13.05	146.72%**	15.96
Ex-Div	0.14%***	6.92	11.16%***	116.86	6.19%***	7.10	152.91%**	15.97
+1	0.01%	0.24	11.16%***	112.98	3.46%***	3.98	156.37%**	15.76
+2	0.02%	0.93	11.19%***	108.31	3.26%***	3.69	159.92%**	15.55
+3	0.07%***	2.68	11.26%***	105.11	2.72%***	3.08	162.81%**	15.25
+4	0.07%***	2.51	11.33%***	102.91	1.95%**	2.21	164.85%**	14.91
+5	0.03%	1.31	11.36%***	99.63	1.89%**	2.06	166.74%**	14.57
+10	0.06%**	1.97	11.51%***	88.86	1.07%	1.21	175.38%**	13.22
+15	0.00%	-0.09	11.73%***	80.67	-0.12%	-0.13	177.07%**	11.86
+20	0.04%	1.52	11.92%***	73.90	-1.46%	-1.58	171.97%**	10.43

Panel B: Losers in the bottom $CAR_{[-20, -1]}$ quantile (Obs. 3,524)								
	AR		CAR		ATO		CATO	
Day	mean	t-stat	mean	t-stat	mean	t-stat	mean	t-stat
-20	-0.63%***	-15.84	-0.63%***	-15.84	-1.60%	-1.44	-1.60%	-1.44
-15	-0.68%***	-16.51	-3.52%***	-41.04	4.06%***	3.42	5.86%	1.36
-10	-0.68%***	-16.86	-6.67%***	-63.72	8.71%***	7.38	39.02%***	5.59
-5	-0.64%***	-15.33	-9.85%***	-87.91	12.21%***	10.78	94.70%***	10.08
-4	-0.62%***	-15.77	-10.47%***	-91.52	10.36%***	8.95	105.07%***	10.65
-3	-0.59%***	-15.69	-11.06%***	-97.26	10.43%***	9.15	115.49%***	11.22
-2	-0.58%***	-16.21	-11.64%***	-103.12	11.29%***	10.29	126.79%***	11.82
-1	-0.55%***	-14.47	-12.18%***	-109.92	11.52%***	10.22	138.31%***	12.38
Ex-Div	0.18%***	7.27	-12.00%***	-105.90	8.92%***	8.44	147.23%***	12.73
+1	-0.01%	-0.14	-12.00%***	-101.45	6.66%***	6.22	153.99%***	12.86
+2	-0.13%***	-3.43	-12.12%***	-95.84	7.82%***	7.22	162.38%***	13.12
+3	-0.01%	-0.21	-12.12%***	-91.78	6.30%***	6.17	169.18%***	13.23
+4	-0.01%	-0.34	-12.14%***	-88.68	5.64%***	5.16	174.82%***	13.19
+5	-0.01%	-0.29	-12.14%***	-86.79	6.98%***	6.51	181.79%***	13.28
+10	-0.03%	-0.71	-12.33%***	-74.74	4.69%***	4.20	210.83%***	13.41
+15	-0.09%**	-2.42	-12.53%***	-67.52	4.03%***	3.67	235.37%***	13.31
+20	-0.06%	-1.45	-12.87%***	-62.43	3.31%***	3.03	257.27%***	13.23

Table 3-10 reports two-tailed tests of the differences in the mean and median AR^{ex} between the highest and lowest abnormal trading pressure quantiles separately for winners and losers. The mean AR^{ex} of the one-third of winners with the highest upward pressure prior to the ex-day is equal to 0.135% and significantly higher than the mean AR^{ex} of the winners with the lowest upward pressure (0.002%) at the 1% level (t-statistic = 5.16). Moreover, the mean AR^{ex} of losers with the highest downward pressure (0.181%) is lower and not significantly different from the mean AR^{ex} of losers with the lowest downward pressure (0.231%) at the 10% level (t-statistic = −1.46). The same conclusions are drawn for the median values. Because the latter results do not support the predictions implied by the short-term abnormal pressure theory, the argument that it is the disposition effect that drives the variability of the ex-day abnormal returns across stocks with accrued gains or losses cannot be rejected.[76]

[76] As a robustness test, the analysis in this section is repeated using the CGOH estimated over 360, 250, 150, 60 and 30 calendar days to distinguish between winners and losers and the same qualitative results are found.

Table 3-10: Difference of Mean and Median AR^{ex} between Highest and Lowest Abnormal Trading Pressure, Separately for Winners and Losers

Using the AR^{ex} 2.5% trimmed sample of ex-days, winning/losing stocks with a positive/negative CGOH over a 90-calendar day window are separately split into three quantiles on the basis of the value of their [−20, −1] cumulative abnormal return ($CAR_{[-20, -1]}$). Winners in the highest (lowest) $CAR_{[-20, -1]}$ quantile are assumed to bear the highest (lowest) abnormal buying pressure. In the same manner, losers in the lowest (highest) $CAR_{[-20, -1]}$ quantile are assumed to bear the highest (lowest) abnormal selling pressure before the ex-day. The left part of the table reports tests on the difference of mean and median AR^{ex} between the highest and lowest abnormal buying pressure samples of winners. The right part of the table reports tests on the difference of mean and median AR^{ex} between the highest and lowest abnormal selling pressure samples of losers. The AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, and * denote statistical significance at the 1%, and 10% level, respectively, using a two-tailed test.

Winners(CGOH90)	Obs	Mean	Median	Losers (CGOH90)	Obs	Mean	Median
Highest $CAR_{[-20, -1]}$	5,038	0.135%	0.114%	Lowest $CAR_{[-20, -1]}$	3,524	0.181%	0.176%
Lowest $CAR_{[-20, -1]}$	5,039	0.002%	-0.018%	Highest $CAR_{[-20, -1]}$	3,523	0.231%	0.228%
Diff.		0.133%***	0.132%***	Diff.		-0.050%	-0.052%*
t-stat/z-stat		5.16	5.10	t-stat/z-stat		-1.46	-1.76

3.4 Implications for the Ex-Dividend Day Literature

Although the motivation for this study stems from the need to identify whether widely observed "taints" of trading behavior such as the disposition effect matter for asset pricing, the empirical results presented here also have direct implications for the ex-dividend day research. Elton and Gruber (1970), Elton, Gruber and Rentzler (1984), and Elton, Gruber and Blake (2005) explicitly state that the marginal income tax rates of different tax clienteles can be inferred by the cross-sectional variation of the price drop on the ex-day. Because shareholders optimally select stocks whose dividend policy is catered to the tax-efficiency of their shareholdings, shareholders in high (low) income-tax brackets will invest in stocks with low (high) dividend yields. As a result, the magnitude of the price drop that implies the marginal income-tax status of each dividend clientele within a sample of ex-days will be positively correlated to the stock dividend yield.[77] Subsequently, Kalay (1982, 1984) challenged the inference of investor tax-brackets from the ex-day price behavior. He stated that if the transaction cost of round-trip trades is not substantial, short-term traders will engage in arbitrage until the difference between the dividend and the ex-day price drop equals the minimum transaction cost borne for trading the stock. As a result, where the discrepancy between the expected ex-day price drop and the dividend is reduced due to arbitrage, the PDR will merely reflect the level of transaction costs for which profitable arbitrage opportunities are not feasible.

While the above mentioned theories compete to explain the cross-sectional dispersion of the price drop on the ex-dividend day, little has been documented on the factors driving the time-series dispersion of the ex-day PDR. Eades, Hess and Kim (1994), and Naranjo, Nimalendran and Ryngaert (2000) examine the fluctuation of ex-day average abnormal returns for portfolios of stocks that are ranked on the basis of dividend yield. From a different angle, the focus is put on explaining the variability of PDR/AR^{ex} at the individual stock level on the grounds of the predicted disposition

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[77] As reported in the PDR regression results in Table 3-5, the beta coefficient of the dividend yield is significantly positive for the WLS and clustered standard errors estimations, which may lend support to the dividend clientele theory. However, the beta coefficient is insignificant in the fixed-effects model. Further, although one would expect the coefficient sign to be negative in the AR^{ex} regression, it remains significantly positive across all three estimations. Consequently, these empirical findings do not support the dividend clientele argument.

effect theory. Given that the same stock will be a winner at good times and a loser at bad times, its ex-day price drop is expected to vary over time on the basis of whether a gain or a loss has accrued on the stock at different points in time. Namely, for the same stock, a significantly lower (higher) PDR (AR^{ex}) is predicted when its CGOH is negative compared to when its CGOH is positive, ceteris paribus. This can be easily inspected by testing the significance of the mean difference of PDR/AR^{ex} values that are paired as follows. First, the PDR/AR^{ex} of the 2.5% trimmed samples are split into winning and losing ex-days on the basis of the CGOH estimated over the 90-calendar day holding period. Second, the ex-days in each winner/loser sample are double-sorted by their dividend amount and ex-dividend day. Third, for each individual stock, one ex-day from the "winner" sample is successively matched with its closer ex-day from the "loser" sample, provided that an equal dividend amount is paid on both ex-days.[78] Fourth, the mean/median difference between the PDR/AR^{ex} value of the losing ex-day and its respective value of the winning ex-day across all created pairs is calculated. The final sample consists of 7,893 (7,874) differences of the PDR (AR^{ex}) paired values.[79] Implicitly, by comparing ex-days of the same stock, this test design effectively controls for liquidity, size, and idiosyncratic volatility, and by additionally requiring the same dividend amount on both ex-days, it controls for the marginal effect that an investor clientele with particular dividend-tax preferences might have on the ex-day.

Table 3-11 reports that the mean (median) difference of PDR between paired losing and winning ex-days is equal to –0.286 (–0.222) and significant at the 1% level (t-statistic = –4.32 and z-statistic = –4.92 for the mean and median difference, respectively). Similarly, the mean (median) difference of AR^{ex} is equal to 0.097% (0.105%) and is significant at the 1% level (t-statistic = 4.58 and z-statistic = 4.77 for the mean and median difference, respectively). Overall, it is found that the significant negative (positive) mean difference found for the PDR (AR^{ex}) paired observations

[78] The median duration between the two paired ex-dividend dates is 182 calendar days (6.1 months) for the PDR and AR^{ex} samples.

[79] Naturally, the final pair count is less than the maximum possible number of ex-day pairs (10,752) due to cases where the same stock distributes a different dividend amount in good and bad times and cases where the number of winning ex-days is different from the number of losing ex-days for the same stock over the examined period.

provides clear evidence that the disposition effect contributes to the time-series variation of the ex-day relative valuation of the dividend for the individual stock.[80]

Table 3-11: Mean and Median Difference of PDR/AR^{ex} between Losing and Winning Ex-Dividend Days

This table reports the significance of the mean and median difference of paired values of PDR/AR^{ex}, where each pair refers to one ex-dividend day with a negative CGOH (loser) and another ex-dividend day with a positive CGOH (winner) of the same stock. Losing and winning ex-days of the same stock are paired on the basis of equal dividend amount and time proximity. The ex-days have been matched after trimming the top and bottom 2.5 percentiles of the initial PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The Wilcoxon signed-rank test is used for testing the median difference of the PDR/AR^{ex} paired values. *** denotes statistical significance at the 1% level, using a two-tailed test.

	Loser(PDR) - Winner(PDR)		Loser(AR^{ex}) - Winner(AR^{ex})	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.286***	-0.222***	0.097%***	0.105%***
t-stat/z-stat	-4.32	-4.92	4.58	4.77
Obs	7,893	7,893	7,874	7,874

Above, the PDR for the same individual stock is assumed to vary over time on the basis of whether this is perceived as a winner or loser by holding investors. Is this enough to explain the temporal variation of the aggregate PDR over a long period? Chetty, Rosenberg, and Saez (2007) examine the long-term relationship between changes in tax rates and the ex-day price drop ratio. They graphically show that the time-series of the aggregate yearly PDR over the 1963-2004 period is so volatile that tax amendments alone cannot explain the large time-series PDR dispersion. Even after they add controls for other factors that may contribute to the average PDR volatility (such as firm assets, liabilities, earnings), the explanatory power does not increase for the PDR fluctuation. Based on their time-series analysis, they conclude the following:

[80] As a robustness test, these tests on the mean and median differences on paired PDR/AR^{ex} values are repeated using all other CGOH horizons (T = 360, 250, 150, 60, 30 calendar days) to distinguish between winning and losing ex-days. In addition, the test for two subsamples is repeated with maximum duration between the two paired ex-dividend dates equal to 182 (the median duration for the subsample equals 92 days). As reported in Appendix (A-2.4), in all cases, the mean/median differences remain statistically significant at the 1% level.

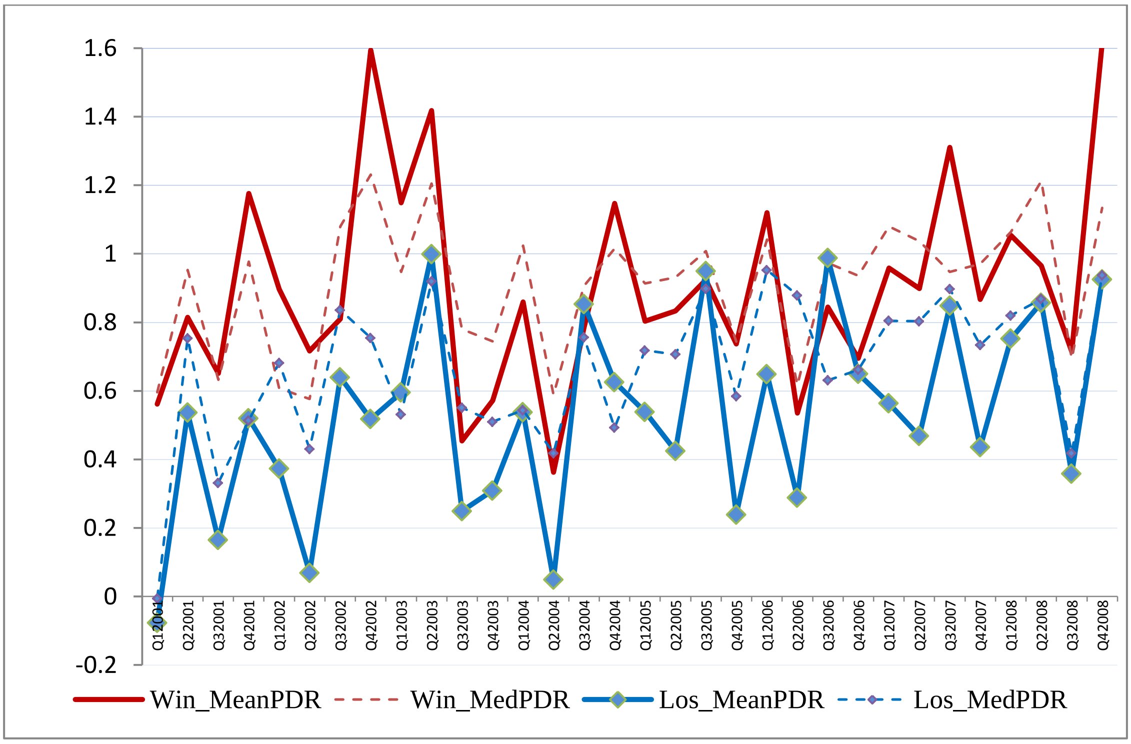
[T]he lack of monotonicity in the excess premiums suggests that it is impossible to explain the evolution of the premium with variables such as reductions in trading transaction costs, the elimination of discrete pricing rules, or the development of tax-sophisticated arbitrage techniques (p. 21).

Based on the evidence presented thus far, it is possible that the disposition effect also contributes to the time-series variation of the ex-day price drop of the aggregate sample. Specifically, the more winners (losers) are present within a quarter, the higher (lower) the average PDR will be in the market. To confirm whether the winner/loser effect is a primary factor that makes the aggregate PDR fluctuate substantially over time, the time-series of the quarterly mean and median PDR is plotted separately for winners and losers (Figure 3-1).

Two observations are evident in Figure 3-1. First, the aggregate PDR of the winners' sample is higher than that of the losers' sample in 29 of the 32 quarters, which conforms to the disposition effect that is hypothesized in this Chapter. Second, the PDR fluctuation looks rather noisy for both winners and losers with no sign of the smoothing that would take place if the winner versus loser concentration constituted a determinant of the temporal variation of the aggregate PDR. Further, the two time-series seem to move in parallel throughout almost the entire period (the correlation coefficient between winners' PDR and losers' quarterly mean PDR = 0.65 and is significant at the 1% level), which implies that another set of systematic factors, unrelated to the disposition effect and common to both samples of winners and losers, drives the aggregate price drop ratio on the ex-dividend day within the time-series dimension. Admittedly, the search for these factors serves as a good starting point for future research in this area.

Figure 3-1 The Time Series of the Average Quarterly PDR Separately for Winners and Losers: 2001-2008.

This figure depicts the time series dispersion of the average PDR computed quarterly, separately for winners and losers. Winners are defined as those stocks with a positive CGOH while losers are those with a negative CGOH. Means and medians have been calculated for winners (*Win_MeanPDR* and *Win_MedPDR*) and losers (*Los_MeanPDR* and *Los_MedPDR*) for each quarter after trimming the top and bottom 2.5 percentiles of the initial PDR sample (final sample Obs = 25,628). The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 90 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5.



3.5 Conclusion

In this Chapter, the "capital gains overhang" proxy, as computed by Grinblatt and Han (2005), is employed to measure the gain or loss accrued by the aggregate investor who holds a particular stock and the price drop ratio proposed by the ex-dividend day literature to measure the market-adjusted ex-day price adjustment. The purpose of the study is to answer whether the magnitude of the expected price drop ratio on the ex-dividend day is conditional upon the prior positive or negative record of the stock price, as predicted by the disposition effect. It is found that stocks that appreciated in the past have higher price drop ratios on the ex-dividend day than stocks that declined in value, implying a positive relationship between the capital gains overhang and the ex-dividend day price drop ratio that is found to be both statistically and economically significant. In fact, in the multivariate regression analysis that employs a pooled sample and, alternatively, two panel data models used to test the relationship between the price drop ratio and the capital gains overhang, the latter variable proves to be the only one with significant explanatory power across all specifications. The same conclusions are drawn by substituting the ex-day abnormal return for the price drop ratio, by employing alternative methodologies for the calculation of the ex-day normal return, by using opening rather than closing ex-day prices, and assuming different investor holding period lengths.

Results are in alignment with the disposition effect, which postulates that the expected downward price adjustment on the ex-day will be facilitated by willing sellers of winning stocks and hindered by reluctant sellers of losing stocks. The results also contribute to the ex-dividend day literature, insofar as they propose a new factor, namely, the past accrued gain or loss, to explain the time-series variation of the price drop ratio on the ex-day for a particular stock that can be a winner or a loser at different times.

CHAPTER 4: INTRADAY ANALYSIS OF THE LIMIT ORDER BIAS AT THE EX-DIVIDEND DAY OF U.S. COMMON STOCKS

4.1 Theory and Hypotheses

4.1.1 Theory and Motivation

Dubofsky (1992) argued that a special microstructure feature, that is, the effect of exchange rules dictating the dividend adjustment on limit orders that are still open at the ex-dividend day of US common stocks, is the main cause for the ex-day abnormal returns that have been widely evidenced in the ex-day literature. Dubofsky's (1992) hypothesis challenges the so called "tax hypothesis" that was initially introduced by Elton and Gruber (1970) and subsequently supported by several authors researching the e-dividend day. Furthermore, recent evidence by Jakob and Ma (2004, 2005) qualify Dubofsky's (1992) model as a valid, although imperfect, explanation for the ex-dividend price drop anomaly.

Dubofsky (1992, 1997) stated that previously placed limit orders that are still standing on the opening of the ex-dividend day are capable of inducing a positive return bias on the basis of the non-adjustment of limit orders to sell for the omission of the dividend, as dictated in the exchange rules. Naturally, the positive abnormal returns are envisaged to last until the ex-day close insofar as non-adjusted open limit orders continue to impact transaction prices up until the closure of the trading session.

The analysis presented in this chapter employs high frequency data for stocks listed on NYSE, AMEX and NASDAQ which pay cash dividends during the period from the 21st of October 2010 until the 31st of December 2011, to examine in particular whether the impact of the order flow bias is in fact prevailing throughout the entire duration of the ex-dividend day.

The remainder of this chapter is organized as follows. Section 4.1.2 states the hypotheses that will be empirically investigated. Section 4.2 lays out the institutional framework applicable to the analysis, the sample selection and filters applied to the data and finally, the methodology employed to compute relevant variables, Section 4.3 presents the empirical results in the context of testing the stated hypotheses and Section 4.4 concludes the chapter.

4.1.2 Hypotheses

The most straightforward inference made by Dubofsky's (1992) model is that the bid-ask spread will substantially increase from cum-day close to ex-day open, which is confirmed by the empirical results of Jakob and Ma (2004, 2005). A starting point for this study would be to attempt to endorse such an argument by identifying the positive return bias expected due to the increase of the bid-ask spread at the opening of the ex-dividend day, as stated in *Hypothesis 4-1*:

Due to the significant bid-ask spread increase at the opening of NYSE, AMEX and NASDAQ caused by the asymmetric dividend adjustment of open limit buy/sell orders, a positive return bias will be present at the ex-day opening.

In addition, Dubofsky (1992) hypothesized that active ex-day trading supported by greater specialist intervention will minimize the likelihood that the bias incurred by the asymmetrical limit order adjustment at the ex-day open will have any impact on closing prices. In this context, the high frequency nature of our data provides us with a unique opportunity to examine whether the open order bias diminishes in the course of intraday trading, as noted by *Hypothesis 4-2*:

As active trading takes place during the ex-day, new limit orders entered and market orders executed at prices that effectively reflect the dividend adjustment, the open order bias evident at the ex-day opening is expected to be corrected before the closing of the ex-dividend day.

Naturally, the open order bias should be the main factor contributing to the ex-dividend anomaly, as measured by the price drop ratio (PDR) or the abnormal returns (AR^{ex}) calculated at the ex-dividend day open. At the same time, to the extent that the positive return bias at the open is reversed before the close of the ex-day, it should also cease to affect the valuation of the dividend at the ex-day close. These predictions are briefly summarized by *Hypothesis 4-3*:

The ex-day price drop discrepancy, as measured by the overnight PDR and AR^{ex} *(estimated with opening ex-day prices), should be significantly associated to the open order bias. Nevertheless, the intraday correction of the ex-day open order bias will render PDR and* AR^{ex} *at the ex-day close unaffected by the transitory impact of the asymmetric dividend adjustment of open limit buy/sell orders.*

Dubofsky (1992) commented that, most likely, the abnormal returns created by the limit order exchange rules at the ex-day open will persist until the ex-day close, primarily in samples of low-yielding, thinly traded stocks. In relation to this, Jakob and Ma (2005) formally tested whether higher trading volumes, dividend dollar amounts or dividend yields have any power in reducing the abnormal returns generated by the asymmetrical limit order adjustment. They found that it is only trading volume created by active trading during the ex-dividend day that significantly reduces the ex-day abnormal returns. Thereby, *Hypothesis 4-4* associates the speed of the correction of the open order bias at the ex-day open with the volumes of trades executed during the ex-day trading session, as follows:

Intraday trading volume, which represents the intensity with which investors update their quoted prices to adjust trades for the omission of the dividend on the ex-day, will contribute to a faster reversal of the bid-ask spread widening incurred at the ex-day opening.

Finally, Dubofsky (1992) makes special mention to the designated exchange's specialists who will satisfy market orders with the view to reducing the bid-ask spread in the context of their duty in maintaining an orderly and liquid market. The effectiveness of professional market makers in accelerating the narrowing of the bid-ask spread, which is expanded at the ex-day open, will most likely be determined by the distinct institutional characteristics of each exchange, in accordance with *Hypothesis 4-5*:

The speed of the narrowing of the bid-ask spread is expected to be higher in the exchange where professional market makers intensely compete to provide liquidity to the market.

Next, Section 4.2.1 gives a brief description of the institutional framework, which provides the main ground for the empirical analysis that will follow.

4.2 Institutional Framework, Data and Methodology

4.2.1 NYSE, AMEX and NASDAQ Institutional Framework

NYSE is an order driven market where each stock is assigned a designated specialist who oversees the consolidated order book for all the stock's orders routed to the exchange's floor. At the opening and closing of the trading day, the specialist monitors a call auction by which any orders standing in the order book are matched on the basis of the exchange's order precedence rules and executed at a single market clearing price. Between the open and close, placed orders are executed, if marketable, or remain in the order book, if not, on a continuous basis. The exchange rules also require the specialist to promote a "fair and orderly market" by posting bid and ask quotes with the view to mitigating potential order flow imbalances.[81]

On the other hand, NASDAQ constitutes a computerized quote driven market where the order flow for a specific stock is allocated to many dealers who maintain their own separate order book but compete with each other via the continuous notification of their bid and ask quotes to other traders. The dealers are obliged to include limit orders placed by other investors in their books against which marketable orders can trade in priority. At the opening (closing) of the trading day, NASDAQ operates consolidated order crossing facilities by which all on-open (on-close) orders and standing orders from the continuous order book are brought together, matched and executed at a single price. Furthermore, interdealer markets exist to enable dealers arrange trades among themselves, in particular, in the course of minimizing their stock inventory accumulation. Overall, NASDAQ dealers are assumed to have a greater discretion in choosing their trading counterparts whereas NYSE specialists are envisaged to own a unique informational advantage over other traders provided by the knowledge of the entire order flow for a particular stock at any time.

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[81] Since the acquisition of AMEX by NYSE Euronext in October 2008, which represents a family of exchanges including, inter alia, the NYSE and Euronext equity markets, the existing AMEX market systems were transitioned to the NYSE Euronext technology under which the NYSE also operates.

Regarding the adjustment of dividends on the ex-dividend day, the treatment is quite uniform for all three exchanges. According to NYSE Rule 118 and AMEX Rule 132, when a security is quoted ex-dividend, any limit orders to buy that are still active at the opening of the ex-dividend day shall be automatically reduced by the amount of the cash dividend whereas any open limit orders to sell shall not do so. Alike, according to NASDAQ Rule 3220, any dealer holding an open limit order to buy from a customer or another broker/dealer shall, prior to executing the order, reduce the order price by the amount of the cash dividend.[82] On the other hand, open limit orders to buy are not symmetrically adjusted for the dividend in any of the three exchanges.

Finally, over the examined period, the minimum price variation (tick size) is $0.01 for securities with prices greater or equal than $1.00 and $0.0001 for securities with prices less than $1.00, in both NYSE and NASDAQ. In AMEX, the tick size is equal to $0.01 for all price ranges of securities.[83] As a result, given that all examined markets are fully decimalized, we presume that no tick size effects will be posing any material disturbance to the pricing of the ex-dividend day.[84]

4.2.2 Data Sample Construction and Filtering

The examined sample contains all cash dividends distributed by U.S. common stocks that are primarily listed on NYSE, AMEX and NASDAQ during the period from the 21st of October 2010 until the 31st of December 2011. The final dataset is assembled through a stepwise match of data retrieved from Bloomberg, whereby each cash dividend is merged with daily price, quote and volume data on the ex-dividend day, which is subsequently merged with time stamped intra-ex-day price, quote and volume data extracted on a

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[82] For relevant excerpts from the exchange rulebooks regarding the open order price adjustment on the ex-dividend day of NYSE, AMEX and NASDAQ stocks, see Appendix (A-3.1).

[83] For relevant exchange rules regarding minimum price variations in NYSE, AMEX and NASDAQ, see Appendix (A-3.2).

[84] In particular, the tick size effects described in the studies made by Dubofsky (1992), Bali and Hite (1998), and Jakob and Ma (2005), which mainly examined periods when markets were not fully decimalized, are assumed not to have a significant impact on our tested samples.

minute-by-minute frequency.[85] Likewise, daily prices for the composite indices corresponding to NYSE, AMEX and NASDAQ (with Bloomberg codes: NYA, XAX and CCMP respectively) are merged with their minute-by-minute prices on the ex-dividend day, which are successively matched with the intra-ex-day prices of the common stock sample on the basis of the time stamp.

The initial cash dividend sample comprises 7,318 cash dividends out of which 98.0% corresponds to regular dividends with the rest being mostly special dividends (1.8%) and return of capital (0.2%) cash distributions. Several screening filters are applied to the initial sample in order to mitigate the effect of non-complete data history, thin trading and outliers. First, I excluded dividends for which no closing trade price on the cum/ex-dividend day or intra-day data was reported, the last time-stamped trade price is greater than \$200 or less than \$1 at the ex-dividend day close, or deviates by more than \$0.3 from the daily closing price. Next, dividends with less than or equal to only five traded minutes during the ex-day and those distributed by NYSE and AMEX stocks on the 27th of May 2011 for which date Bloomberg did not report index intra-day data for the corresponding indices were also deleted from the sample. In total, 1,269 (17.3% of the initial sample) are filtered out resulting in a "clean" sample of 6,049 observations, as illustrated in Table 4-1. Finally, after calculating the PDR and AR^{ex} (both being described in Section 4.2.3), at both the opening and closing of the ex-dividend day, I perform an upper and lower 2.5% quantile trim on the basis of the closing PDR and AR^{ex} distributions to control for extreme values.[86]

[85] More specifically, the minute-by-minute prices, bid quotes and ask quotes refer to last trade that took place within each consecutive minute during the ex-dividend day whereas the minute-by-minute volume figures refer to the total volume of all trades carried out within each consecutive minute.

[86] The 2.5% upper and lower quantile trim follows Graham, Michaely and Roberts (2003), with the difference that this study's PDR and AR^{ex} samples are separately trimmed on the grounds that their distributions do not share the same outliers.

Table 4-1: Filters of Sample Screening Cash Dividends Distributed by NYSE, AMEX and NASDAQ Common Stocks

The initial sample consists of the Bloomberg history of cash dividends paid by common stocks primarily listed on NYSE, AMEX and NASDAQ from October 21st, 2010 until December 31st, 2011. The initial sample size is reduced by the removal of dividends, for which a closing trade price on the cum/ex-dividend day or intra-day data during the ex-day were unavailable, whose last time-stamped trade price is greater than $200 or less than $1 at the ex-dividend day close, or deviates by more than $0.3 from the daily closing price, which report less than or equal to only five traded minutes during the ex-day, and which are distributed by NYSE and AMEX stocks on the 27th of May 2011, on which date index intra-day data for the corresponding indices was unavailable. The second and third column of the table report the quantity of observations removed as a number and as a percentage of the initial sample size, respectively. In addition, in order to mitigate the outlier impact the PDR and the AR^{ex} total distributions are separately trimmed at the 2.5% upper and 2.5% lower tail.

Filters and Trimming applied to the ex-day sample; 21st October 2010 - 31st December 2011	Removed Obs	Removed %	Residual Obs
Ex-days for all cash dividends.			7,318
Exclude dividends for which no daily cum-day or ex-day trade price was available.	488	6.7%	6,830
Exclude ex-days for which no intra-day time-stamped data was retrieved.	291	4.0%	6,539
Exclude dividends for which the last time-stamped trade price on the ex-day is greater than $200 or less than $1.	5	0.1%	6,534
Exclude ex-days for which the last time-stamped trade price on the ex-day is higher or lower than the daily closing price by more than $0.3.	32	0.4%	6,502
Exclude ex-days of thinly traded stocks (with less than or equal to five traded minutes within the ex-day).	399	5.5%	6,103
Exclude dividends going ex on the 27th of May 2011, for which no intra-day time-stamped data was retrieved for the NYSE & AMEX exchanges.	54	0.7%	6,049
Trim the 2.5% upper tail and 2.5% lower tail of the ex-day PDR/AR^{ex} distribution of the total sample.	326		5,723

4.2.3 Methodology

At the ex-dividend day open, the bid-ask spread is envisaged to increase relative to the one existing at the cum-dividend close due to the asymmetrical adjustment of the limit orders still open at the ex-day opening. In order to test Hypotheses 4-1 and 4-2, the impact of the limit order adjustment rules of the exchanges on the pricing of stocks at the opening of the ex-dividend day needs to be quantified. For this reason, I employ the order flow bias as computed by Conrad and Conroy (1994), which is due to measure the expected change of the bid-ask spread in combination with the tendency of a stock to close at the ask price due to the execution of a buy trade. I opt for the order flow bias measure rather than just the change of the bid-ask spread because the effect of the non-adjustment of open limit order to sell will be evidently recorded at the opening price of the ex-dividend day insofar as it is combined with a high probability of the opening trades to take place at the ask side.

Following Conrad and Conroy's (1994) methodology, the ex-dividend day trade returns are decomposed into bid returns and order flow effects occurring at the ex-dividend day. More specifically, the intraday trade return (TR_{im}) at each minute m of an i ex-dividend day for a particular stock can be approximated by the sum of the bid return (BR_{im}) and the order flow bias ($OFbias_{im}$), which captures the change of the proportional bid-ask spread (BAS_{im}) and the change of the within spread location of the trade (Loc_{im}) from one minute to the other.[87] In particular,

$$TR_{im} = \frac{\left(P_{im} - P_{im-1}\right)}{P_{im-1}} * 100\% \approx BR_{im} + OFbias_{im} \quad (4.1)$$

where:

$$BR_{im} = \frac{\left(B_{im} - B_{im-1}\right)}{B_{im-1}} * 100\% \quad (4.2)$$

$$OFbias_{im} = \left(Loc_{im} * BAS_{im}\right) - \left(Loc_{im-1} * BAS_{im-1}\right) \quad (4.3)$$

$$Loc_{im} = \frac{\left(P_{im} - B_{im}\right)}{\left(A_{im} - B_{im}\right)} \quad (4.4) \qquad BAS_{im} = \frac{\left(A_{im} - B_{im}\right)}{B_{im}} * 100\% \quad (4.5)$$

[87] According to Conrad and Conroy (1994), the approximation of the trade return holds for small values of (Loc_{im}*BAS_{im}). For a simplified proof of the approximation, see Appendix (A-4).

where P_{im}, B_{im} and A_{im} are the price of the closing trade, best bid quote and best ask quote, respectively, at each minute *m* of an *i* ex-dividend day for a particular stock. *Loc* ranges from zero to one and reflects the probability that the trade will be executed at the ask price. In specific, a mean *Loc* value above 0.5 indicates the tendency of the trade to take place at the ask whereas a mean *Loc* value below 0.5 indicates the tendency of the trade to take place at the bid.

Hypothesis 4-3 explicitly associates the asymmetric adjustment of open limit buy/sell orders at the opening of the ex-dividend day with the price drop anomaly widely documented in the ex-day literature. To measure the ex-day discrepancy, I calculate the standard metrics employed in the ex-dividend day bibliography, namely, the Price Drop Ratio (PDR_i) and the ex-day Abnormal Return (AR_i^{ex}) both adjusted for the market return as follows:

$$PDR_i = \frac{P_i^{cum} - \left(\dfrac{P_i^{ex}}{1 + R^{index}} \right)}{D_i} \quad (4.6), \qquad AR_i^{ex} = \frac{P_i^{ex} - P_i^{cum} + D_i}{P_i^{cum}} - R^{index} \quad (4.7)$$

where P_i^{cum} is the closing daily price on the *i* cum-dividend day for a particular stock, P_i^{ex} is the price of the closing/opening trade of an *i* ex-dividend day for a particular stock, D_i is the amount of the dividend corresponding to the *i* ex-dividend day for a particular stock, and R_i^{index} is the contemporaneous ex-day return of the respective index of each exchange, namely NYSE, AMEX and NASDAQ. The PDR and AR^{ex} are calculated both at the opening, where the limit order adjustment will mostly have an effect on the stock price, and the closing of the ex-dividend day. In theory, if the ex-dividend day opening trade takes place at the fully adjusted bid price, Loc will be zero and the ex-day price drop will be equal to the dividend. Correspondingly, if the ex-dividend day opening trade takes place at the non-adjusted ask price, Loc will be one and the ex-day price will not drop. In alignment with Dubofsky's (1992) theoretical framework, if the opening trade takes place at the ask or bid price with an equal probability on average across the sample, the mean Loc will be 0.5 and the average ex-day price drop will be equal to one half of the dividend amount.

4.3 Empirical Results

4.3.1 Descriptive Statistics and Graphs

This section presents descriptive statistics for the general characteristics of the sampled stocks listed on NYSE, AMEX and NASDAQ, the intraday pattern of their trading volume throughout the ex-dividend day and finally, the PDR and AR^{ex} distributions derived from the 95% trimmed samples.

First, Table 4-2 presents summary statistics for the dividends and trading activity of common stocks together for NYSE and AMEX, and separately for NASDAQ, on the basis of the 95% trimmed PDR sample.

Table 4-2: Descriptive Statistics for NYSE, AMEX and NASDAQ Common Stocks

This table presents descriptive statistics for the dividend yield (DY%), dividend amount (Div$), trade price at the close of the cum-dividend day (Price), daily trade volume (Vol(day)) and minute average trade volume (Vol(min)) on the ex-dividend day separately for stocks listed on the NYSE and AMEX and stocks listed on the NASDAQ. Panel A reports means and Panel B reports medians on the basis of the 95% trimmed closing PDR sample.

Panel A: Means	Obs	DY(%)	Div($)	Price	Vol(day)	Vol(min)
NYSE & AMEX	3,738	0.698%	0.236	37.857	566,383	1,668
NASDAQ	1,985	0.956%	0.181	24.090	353,696	1,236
All Exchanges	5,723	0.787%	0.217	33.082	492,613	1,518
Panel B: Medians	**Obs**	**DY(%)**	**Div($)**	**Price**	**Vol(day)**	**Vol(min)**
NYSE & AMEX	3,738	0.548%	0.175	32.945	218,057	749
NASDAQ	1,985	0.635%	0.120	18.690	38,530	429
All Exchanges	5,723	0.578%	0.150	27.540	131,071	590

The mean dividend amount and dividend yield paid by NYSE & AMEX stocks is $0.236 and 0.698% respectively. On the other hand, although NASDAQ stocks distribute a smaller average dividend amount of $0.181 than NYSE and AMEX stocks, they offer a higher mean dividend yield equal to 0.956% because they are relatively low priced compared to their NYSE and AMEX counterparts (mean stock price at the cum-dividend day close approximately equal to $24 for NASDAQ while close to $38 for NYSE and

AMEX). Furthermore, the average stock listed on NYSE and AMEX is more liquid than the average NASDAQ stock as it reports a total daily volume of 566,383 shares and a volume of 1,668 shares traded every minute on average during its ex-day (compared to 353,696 shares and 1,236 shares of total and minute average ex-day volume, respectively, for NASDAQ stocks). The same conclusions are drawn from the respective median values, reported in Panel B of Table 4-2.

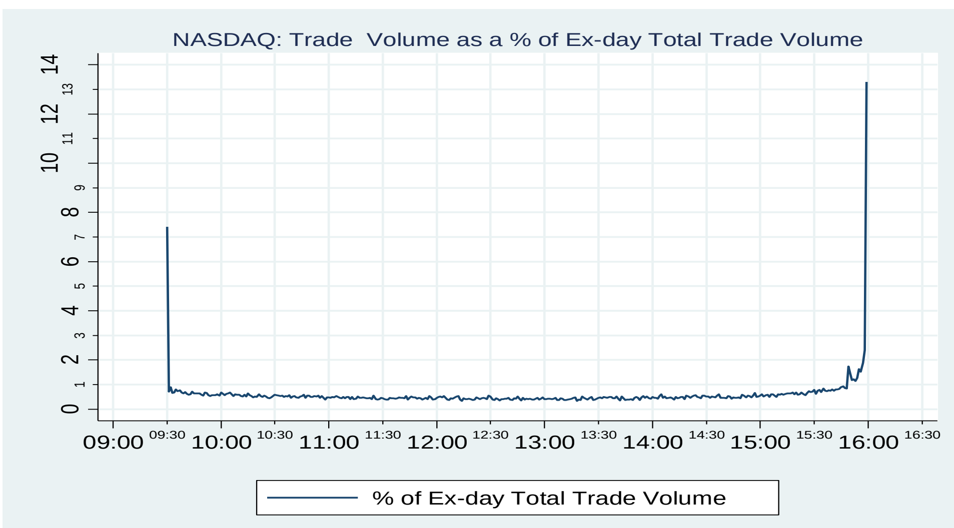
Prior microstructure literature (Jain and Joh (1988), Foster and Viswanathan (1993), Gerety and Mulherin (1992), McInish and Wood (1990) and Chan, Christie and Schultz (1995)) has documented a U-shaped pattern for intraday trade volume for all major financial markets. I investigate whether such a pattern is also observed in particular at the ex-dividend day of U.S. common stocks. In this respect, trade volume per minute is expressed as a % of total ex-day volume which is subsequently averaged across ex-dividend days for each minute. As depicted in Figure 4-1, trade volume peaks at the open and close whereas remains at stable low levels in the interim of the ex-dividend day, thereby confirming its U-shaped evolution for both the NYSE and AMEX stocks, and the NASDAQ stocks. The same intra-day pattern is recorded when trade volume per minute is alternatively expressed as a multiple of the ex-dividend day minute average trade volume, as illustrated in the Appendix (A-5.1).

Finally, descriptive statistics are presented in Table 4-3 for the PDR and the AR^{ex} as computed either at the opening or the closing of the ex-day, separately for NYSE and AMEX stocks, and NASDAQ stocks, as well as for the group of all stocks listed on all exchanges. In addition, tests are performed on median and mean values to examine whether the sample PDR (AR^{ex}) is equal to its theoretical value, namely, whether PDR is equal to one (AR^{ex} equal to zero).[88]

[88] All statistics have been calculated after trimming the top and bottom 2.5% percentiles separately for the closing PDR and closing AR^{ex} samples.

Figure 4-1 Intra Ex-Dividend Day Evolution of Trade Volume: As a % of Ex-day Total Trade Volume

This figure illustrates the evolution of trade volume over minute intervals during the ex-dividend day separately for stocks listed on the NYSE and AMEX and stocks listed on the NASDAQ. Trade volume per minute is expressed as a % of total trade ex-day volume which is subsequently averaged across the sample of ex-dividend days for each minute.



For NYSE and AMEX stocks, the mean PDR at the open is 0.798 significantly lower than one at the 1% level (t-stat = –4.16) whereas the mean PDR at the close, equal to 0.959, is higher than the one calculated at the open and not significantly different to one at the 10% level (t-stat = –0.67). The median PDR at the close, equal to 0.925 (z-stat = –2.62) is also found higher than the median PDR at the open (0.866, z-stat = –8.38). Similarly, the mean and median AR^{ex} at the close, equal to 0.053% (t-stat = 2.48) and 0.045% (z-stat = 2.50) respectively, are almost half of the mean and median AR^{ex} at the open equal to 0.101% (t-stat = 7.72) and 0.088% (z-stat = 9.31) respectively.

For NASDAQ stocks, the mean PDR at the open, equal to 1.023 (t-stat = 0.37), is not significantly different to one at the 10% level but the median PDR at the open, equal to 0.905 (z-stat = –3.15) is significantly different to one at the 1% level. On the other hand, the mean and median AR^{ex} at the open, equal to 0.049% (t-stat = 2.48) and 0.058% (z-stat = 3.65) respectively, and the mean and median AR^{ex} at the close, equal to 0.092% (t-stat = 2.74) and 0.076% (z-stat = 2.37) respectively, are all significantly different to zero at the 1% level.[89]

The fact that, for NYSE and AMEX stocks, the PDR at the close is higher than the PDR at the open and, likewise, the AR^{ex} at the close is lower than the AR^{ex} at the open provides preliminary evidence that the order flow bias assumed to create the ex-day anomaly at the open is somehow corrected, thereby leading to higher (lower) PDR (AR^{ex}) values at the close.[90] The same evidence of higher PDR and lower AR^{ex} values at the close versus the open of the ex-day is also obtained in the aggregate sample that contains the stocks from all three exchanges.

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[89] The mean PDR and AR^{ex} calculated using the daily open and close trade prices differ immaterially from the ones presented here, which are computed with the trading prices of the opening or closing minute of the ex-dividend day.

[90] A similar conclusion cannot be drawn for the PDR and AR^{ex} values of the NASDAQ sample. Nevertheless, due to its relatively smaller size, we consider its means and medians as less robust than the ones reported for the NYSE and AMEX.

Table 4-3: Descriptive Statistics for the PDR and AR^{ex}: At the Open and at the Close of the Ex-Dividend Day

This table presents summary statistics for the price drop ratio (PDR) and the abnormal return (AR^{ex}) as computed either at the opening or the closing of the ex-day, separately for NYSE and AMEX stocks and NASDAQ stocks, as well as for all stocks listed on all exchanges. In addition, t-statistics and z-statistics are reported for testing whether the sample mean and median values are equal to their theoretical values (PDR =1 and AR^{ex} =0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the closing PDR and closing AR^{ex} samples. Panel A refers to PDR statistics while panel B refers to AR^{ex} statistics. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{index}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{index}]$. P^{cum} is the daily trade price at the closing of the cum-dividend day, P^{ex} is the price of either the closing or opening trade of the ex-dividend day, and Div is the dividend amount. Both PDR and AR^{ex} are adjusted for the contemporaneous ex-day return of the respective composite index (R^{index}) for each exchange, namely, NYSE, AMEX and NASDAQ. The Wilcoxon signed-rank test is used for testing median values. The Wilcoxon signed-rank test was used for testing median values. *** and ** denote statistical significance at the 1% and 5% level, respectively, using a two-tailed test.

Panel A	NYSE & AMEX		NASDAQ		All Exchanges	
PDR	Open	Close	Open	Close	Open	Close
Obs	3,738	3,738	1,985	1,985	5,723	5,723
Mean	0.798***	0.959	1.023	1.046	0.876***	0.989
t-stat (PDR=1)	-4.16	-0.67	0.37	0.53	-3.22	-0.22
Median	0.866***	0.925***	0.905***	0.901	0.876***	0.920***
z-stat (PDR=1)	-8.38	-2.62	-3.15	-1.51	-8.64	-3.01
Min	-32.685	-13.930	-38.495	-12.174	-38.495	-13.930
Max	68.645	18.537	28.051	19.310	68.645	19.310
Variance	8.792	14.078	7.791	15.068	3.136	14.421
Skewness	2.463	0.436	0.312	0.616	1.795	0.504
Kurtosis	93.087	6.348	44.077	6.355	78.551	6.362

Panel B	NYSE & AMEX		NASDAQ		All Exchanges	
AR^{ex}	Open	Close	Open	Close	Open	Close
Obs	3,764	3,764	1,959	1,959	5,723	5,723
Mean	0.101%***	0.053%**	0.049%**	0.092%***	0.083%***	0.066%***
t-stat (AR^{ex}=0)	7.72	2.48	2.48	2.74	7.58	3.65
Median	0.088%***	0.045%**	0.058%***	0.076%**	0.080%***	0.052%***
z-stat (AR^{ex}=0)	9.31	2.50	3.65	2.37	9.64	3.40
Min	5.110%	-3.965%	-4.622%	-5.981%	-5.110%	-5.981%
Max	5.021%	4.282%	7.680%	4.293%	7.680%	4.293%
Variance	0.006%	0.017%	0.008%	0.022%	0.007%	0.019%
Skewness	0.204	0.023	0.668	0.046	0.387	0.038
Kurtosis	9.318	3.323	13.765	3.187	11.308	3.310

4.3.2 Limit Order Adjustment and Order Flow Bias

Jakob and Ma (2005) found evidence of a substantial widening of the bid-ask spread from cum-day close to ex-day open at the ex-dividend day of stocks listed on the Toronto Stock Exchange despite the fact that both the ask quote and bid quote are not mechanically adjusted by the dividend amount on the basis of the exchange's rule. In relation to Hypothesis 4-1, I investigate the possibility of a widening and subsequent narrowing of the bid-ask spread during the ex-dividend day of NYSE, AMEX and NASDAQ stocks by graphing the evolution of their relative trade price, ask quote and bid quote averaged over 15 minute intervals during the ex-dividend day. The relative trade price is the ratio of ($P^{ex,m}/P^{cum}$) where $P^{ex,m}$ is the intra-day trade price at each *m* minute during the ex-dividend day and P^{cum} is the closing trade price at the cum-dividend day. The relative ask quote is the ratio of ($A^{ex,m}/A^{cum}$) where $A^{ex,m}$ is the intra-day best ask quote at each *m* minute during the ex-dividend day and A^{cum} is the best ask quote at the cum-dividend day close. The relative bid quote is the ratio of ($B^{ex,m}/B^{cum}$) where $B^{ex,m}$ is the intra-day best bid quote at each *m* minute during the ex-dividend day and B^{cum} is the best bid quote at the cum-dividend day close. The minute-by-minute relative trade price, ask quote and bid quote are first averaged over 15 minute intervals during each ex-dividend day, and the 15 minute averages of the relative trade price, ask quote and bid quote are subsequently averaged across the sample of ex-dividend days.[91]

According to Figure 4-2, for the NYSE and AMEX stocks, the magnitude of the drop of the ask quote does not follow that of the drop of the bid quote at the opening of the ex-dividend day resulting in a substantial widening of the bid-ask spread. Nevertheless, the extended opening bid-ask spread seems to narrow quickly in the first 30 minutes of the ex-day trading session and eventually falls to its lowest intra-day level at the closure of the market.

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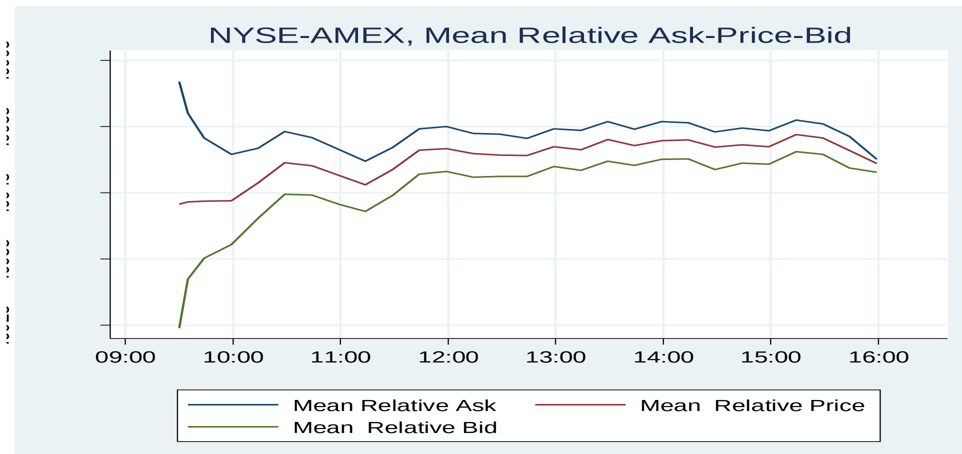
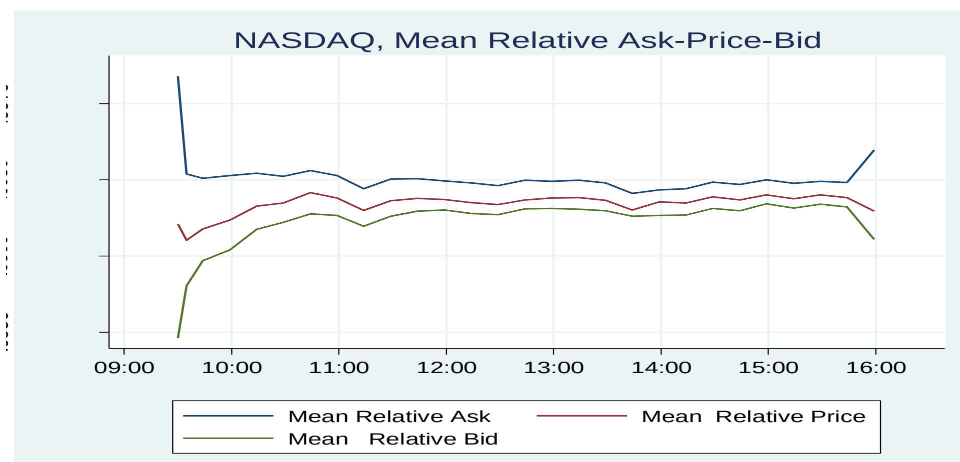
[91] More precisely, given the particular focus of this study on the opening of the ex-day, the first relative trade and quote values are calculated at the opening minute, that is, 9:30 a.m,, the second ones refer to the interval from 9:31 a.m. to 9:35 a.m., the third ones refer to the interval from 9:36 a.m. to 9:45 a.m., while the fourth (i.e. 9:46 a.m. - 10:00 a.m.) and all subsequent intervals are 15 minute intervals. In total, means are calculated for 28 intervals until the close of the ex-dividend day.

Figure 4-2 Intra Ex-Dividend Day Evolution of the Relative Trade Price, Ask & Bid Quotes

This figure illustrates the evolution of the relative trade price, ask quote and bid quote averaged over 15 minute intervals during the ex-dividend day separately for stocks listed on the NYSE and AMEX and stocks listed on the NASDAQ. The relative trade price is the ratio of ($P^{ex,m}/P^{cum}$) where $P^{ex,m}$ is the intra-day trade price at each *m* minute during the ex-dividend day and P^{cum} is the closing trade price at the cum-dividend day. The relative ask quote is the ratio of ($A^{ex,m}/A^{cum}$) where $A^{ex,m}$ is the intra-day best ask quote at each *m* minute during the ex-dividend day and A^{cum} is the closing best ask quote at the cum-dividend day. The relative bid quote is the ratio of ($B^{ex,m}/B^{cum}$) where $B^{ex,m}$ is the intra-day best bid quote at each *m* minute during the ex-dividend day and B^{cum} is the closing best bid quote at the cum-dividend day. The minute-by-minute relative trade price, ask quote and bid quote are first averaged over 15 minute intervals during each ex-dividend day, and the 15 minute averages of the relative trade price, ask quote and bid quote are subsequently averaged across the sample of ex-dividend days.





For the NASDAQ stocks, a similar pattern is evident with two distinct features in comparison to the NYSE and AMEX stocks; the narrowing of the bid-ask spread is more rapid as it takes place within a few minutes from the ex-day opening while at the ex-day close it is again abruptly widened to a higher than its prior intra-day level.[92] The same conclusions are drawn when, instead of the means, the cross sectional medians of the relative trade price, ask quote and bid quote are computed for each 15 minute interval as depicted in the Appendix (A-5.2).

On the basis of the definition of the order flow bias (Equation 4.3), it is reasonable to assume that its evolution will be driven by the change of the bid-ask spread during the ex-dividend day. In this respect, the evidence provided by the graphs illustrated in Figure 4-2 is expected to also be confirmed by formal statistical tests on the order flow bias. In specific, the order flow bias is hypothesized to be significantly positive at the ex-day open (Hypotheses 4-1) and significantly negative during the ex-day trading session (Hypotheses 4-2) for both NYSE and AMEX, and NASDAQ samples. Furthermore, as indicated by Figure 4-2, the order flow bias in particular for the NASDAQ sample is anticipated to be significantly positive again at the ex-dividend day close.

Table 4-4 presents the breakdown of the mean total return (*TR*) into the mean bid return (*BR*) and the mean order flow bias (*OFbias*), at the opening, at the closing and in the interim minutes of the ex-dividend day, separately for NYSE and AMEX stocks, and NASDAQ stocks, as well as for all stocks listed on all exchanges. Consistent with Hypothesis 4-1, the mean order flow bias at the ex-day open of the NYSE and AMEX sample is equal to 0.19%, which is significantly positive at the 1% significance level (t-stat = 27.48). Similarly, the mean order flow bias at the ex-day open of the NASDAQ sample is equal to 0.62%, which is also significantly positive at the 1% significance level (t-stat = 21.43).

In addition, in agreement with Hypothesis 4-2, the positive order flow bias existing at the ex-day open is almost fully reversed before the ex-day close, as active intra-day trading will pertain to new limit and market orders executed at prices that fully reflect the dividend adjustment. For the NYSE and AMEX sample, the interim cumulative order

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[92] Brock and Kleidon (1992), McInish and Wood (1992), and Lee, Mucklow and Ready (1993) found evidence of a U-shaped intraday pattern for the bid-ask spread for NYSE stocks, where spreads are widest immediately after the open and immediately preceding the close. Chan, Christie and Schultz (1995) on the other hand, found that spreads are relatively stable during the trading session but narrow quickly near the close for NASDAQ stocks.

flow bias and the order flow bias at the ex-day close are -0.18% and -0.01%, the aggregate of which entirely offsets the high positive order flow bias incurred at the ex-day open. As a result, the cum-day close to ex-day close cumulative order flow bias is not significantly different to zero (t-stat = 0.87), thereby confirming the full correction of the opening order flow bias.

Table 4-4: Mean Trade Return, Bid Return and Order Flow Bias: At the Open, Close and during the Ex-Dividend Day

This table presents the breakdown of the mean total return (TR) into the mean bid return (BR) and the mean order flow bias (OFbias), at the opening, at the closing and in the interim minutes of the ex-dividend day, separately for NYSE and AMEX stocks and NASDAQ stocks, as well as for all stocks listed on all exchanges. TR is the minute-by-minute percentage change of the trade price and BR is the minute-by-minute percentage change of the bid quote. The OFbias is equal to $[(Loc_m*BAS_m) - (Loc_{m-1}*BAS_{m-1})]$ where Loc_m is the within spread location of the trade and BAS_m is the proportional bid-ask spread at each minute *m* of the ex-dividend day. Loc is equal to [(P – B) / (A – B)] and BAS is equal to [(A – B) / B] where P is the trade price, B is the best bid quote and A is the best ask quote at the close of each minute over the ex-dividend day. For the intra-day period between the opening and the closing of the ex-dividend day, minute-by-minute TR, BR and OFbias are first summed over the interim minutes for each ex-dividend day, and then averaged across the sample of ex-dividend days. The number below the mean values is the t-statistic. [a] denotes statistical significance at the 1% level, using a two-tailed test.

	NYSE & AMEX			NASDAQ			All Exchanges		
Minute	TR	BR	OFbias	TR	BR	OFbias	TR	BR	OFbias
Open	-0.59%[a]	-0.78%[a]	0.19%[a]	-0.84%[a]	-1.43%[a]	0.62%[a]	-0.67%[a]	-1.00%[a]	0.34%[a]
	-22.24	-28.55	27.48	-17.82	-27.63	21.43	-28.35	-39.24	30.09
Interim	0.04%	0.22%[a]	-0.18%[a]	0.10%	0.70%[a]	-0.59%[a]	0.06%[a]	0.39%[a]	-0.32%[a]
	1.34	8.01	-26.97	2.06	13.28	-20.54	2.39	14.99	-29.03
Close	0.01%[a]	0.02%[a]	-0.01%[a]	-0.01%	-0.51%[a]	0.56%[a]	0.00%	-0.17%[a]	0.19%[a]
	3.41	5.65	-2.94	-0.67	-10.73	9.51	0.97	-9.90	9.16
All	-0.54%[a]	-0.54%[a]	0.00%	-0.74%[a]	-1.24%[a]	0.59%[a]	-0.61%[a]	-0.78%[a]	0.21%
	-14.84	-14.89	0.87	-11.88	-15.64	9.86	-18.96	-21.43	9.75
Obs	3,738	3,738	3,738	1,984	1,984	1,984	5,722	5,722	5,722

For the NASDAQ sample, although the interim cumulative order flow bias is -0.59%, hence, indicating a significant reversal of the positive order flow bias at the open, the minute order flow bias at the close rises to 0.56% due to the sudden increase of the bid-ask spread at the last minute of the trading session illustrated in Figure 4-2. Overall, empirical evidence shows that the positive order bias evident at the ex-day open is in fact reversed before the closing of the trading day in all examined exchanges, which is in alignment with Hypothesis 4-2. As a robustness test, I replicated Table 4-4 using medians rather than means. Median values for TR, BR and OFbias presented in the Appendix (A-5.3) provide similar conclusions in support of Hypotheses 4-1 and 4-2.

4.3.3 Impact of the Limit Order Adjustment on the Ex-Dividend Day Price Drop

Hypothesis 4.3 states that although the positive order flow bias evident at the ex-dividend day opening is expected to have a significant explanatory power on the PDR/AR^{ex} computed with opening trading prices, this will not be the case when PDR/AR^{ex} is calculated at the ex-day close. To perform a direct test on Hypothesis 3, the PDR/AR^{ex} of the 95% trimmed samples are regressed against the OFbias, a group of control variables that capture other microstructure effects on the ex-day and the dividend yield which constitutes the explanatory variable most widely used in the ex-dividend bibliography. Accordingly, the regression equation that is estimated with the method of OLS[93] takes the following form:

$$PDR_{it} / AR_{it}^{ex} = \alpha + \beta_1 OFbias_i^{open} + \beta_2 BAS_{it} + \beta_3 Loc_{it} + \beta_4 TVol_{it} + \beta_5 DY_i + \varepsilon_{it} \quad (4.8)$$

where, $OFbias^{open}$ is the order flow bias at the opening of the i ex-dividend day for a particular stock, *BAS* is the proportional bid-ask spread, *Loc* is the within spread location of the trade, *TVol* is the natural logarithm of the trading volume over the relevant minute, and *DY* is the stock dividend yield equal to the dividend amount over the closing price on the cum-day. The subscript t refers to the time when the regression model is estimated, namely to either the opening or the closing of the ex-dividend day. Finally, all microstructure explanatory variables, namely, $OFbias^{open}$, BAS, Loc and TVol, are orthogonalized before Equation 4.8 is estimated to account for implicit collinearity incurred due to the contemporaneous nature of these regressors.

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[93] The t-statistics of the estimated OLS coefficients are computed with heteroscedasticity consistent standard errors, according to the White (1980) correction.

According to Hypothesis 4-3, when regressing PDR (AR^{ex}), β_1 is predicted to be significantly negative (positive) at the ex-day opening when the asymmetrical limit order adjustment is due to hinder the full price drop. In contrast, it is expected to be found insignificantly different to zero at the ex-day closing by which time the opening order flow bias is envisaged to be already corrected. Table 4-5 presents the empirical results for the set of estimations of Equation 4.8 at the open and close of the ex-dividend day performed separately for NYSE and AMEX stocks, and for NASDAQ stocks. As reported in Panel A, the OFbias is negatively associated with the open PDR at the 1% significance level, whereas it becomes insignificant when the PDR is calculated at the close. Similarly, Panel B shows that the OFbias is positively related to the AR^{ex} at the open at the 1% significance level but again, it is insignificant in relation to the AR^{ex} at the close. Estimation results are consistent when the NYSE and AMEX sample, and the NASDAQ sample are either tested separately or together, thereby providing support for Hypothesis 4-3, which predicts that OFbias will lose its explanatory power over the ex-day price drop anomaly towards the close of the ex-dividend day.

Furthermore, Loc constitutes the only regressor which seems to significantly influence the ex-day close dividend valuation at the 5% (1%) level for the NYSE and AMEX (NASDAQ) sample. More specifically, the higher the probability that the stock price will close at the ask, the lower (higher) the ex-day close PDR (AR^{ex}) will be, thus implying that microstructure effects, other than the open limit order adjustment, remain important for the explanation of the ex-day price drop discrepancy.[94]

[94] As a robustness test, I repeated all estimations illustrated in Table 4-5 after omitting the orthogonalization of regressors. Estimated coefficient signs and significance levels presented in the Appendix (A-5.4) do not materially differ from the ones reported here.

Table 4-5: Relationship between PDR/AR^{ex} and OFbias at the Open and at the Close of the Ex-Dividend Day: Orthogonal Regressors

This table reports the estimated coefficients and their t-statistics of the regressions of PDR/AR^{ex} of the 95% trimmed samples against OFbias and a group of control variables separately for NYSE and AMEX stocks and NASDAQ stocks, as well as for all stocks listed on all exchanges. The estimated equation is:

$$PDR_{it} / AR_{it}^{ex} = \alpha + \beta_1 OFbias_i^{open} + \beta_2 BAS_{it} + \beta_3 Loc_{it} + \beta_4 TVol_{it} + \beta_5 DY_i + \varepsilon_{it}$$

where, OFbias^{open} is the order flow bias at the opening of the *i* ex-dividend day for a particular stock, BAS is the proportional bid-ask spread, Loc is the within spread location of the trade, TVol is the natural logarithm of the trading volume over the relevant minute, and DY is the stock dividend yield equal to the dividend amount over the closing price on the cum-day. The subscript *t* refers to the time when the regression model is estimated, namely to either the opening or the closing of the ex-dividend day. The microstructure explanatory variables, namely, OFbias^{open}, BAS, Loc and TVol, are orthogonalized before OLS coefficients are computed with heteroscedasticity consistent standard errors, according to the White (1980) correction. The number in parentheses below the coefficient is the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A	NYSE & AMEX		NASDAQ		All Exchanges	
PDR	Open	Close	Open	Close	Open	Close
Intercept	0.7620***	0.9940***	1.0365***	1.0538***	0.8825***	1.0010***
	9.69	11.10	15.74	11.50	20.38	18.25
OFbias	-0.1213***	0.0418	-0.2743***	-0.0818	-0.1563***	-0.0209
	-3.07	0.72	-4.09	-0.96	-3.94	-0.41
BAS	0.2015***	-0.0745	0.2290***	0.0400	0.2202***	0.0249
	4.80	-1.38	3.52	0.53	5.10	0.55
Loc	0.0050	-0.2015**	-0.2553***	-0.2218***	-0.1145***	-0.1961***
	0.13	-2.33	-2.94	-2.61	-3.18	-2.77
TVol	-0.0605	0.0140	-0.0602	0.0803	-0.0898**	0.0418
	-1.14	0.23	-0.93	0.95	-2.14	0.83
DY	5.2185	-5.0594	-1.7991***	-1.5243*	-0.9473	-1.8246
	1.10	-1.05	-2.95	-1.67	-0.93	-1.65
Adj. R^2	0.007	0.004	0.025	0.004	0.011	0.003
F-stat	5.78	1.80	6.93	2.51	11.55	2.41
Obs	3,738	3,738	1,984	1,984	5,722	5,722

Panel B	NYSE & AMEX		NASDAQ		All Exchanges	
AR^{ex}	Open	Close	Open	Close	Open	Close
Intercept	0.0012***	0.0006*	0.0003	0.0004	0.0008***	0.0004*
	5.75	1.94	0.91	1.03	4.49	1.74
OFbias	0.0006***	0.0001	0.0011***	0.0002	0.0007***	0.0002
	3.67	0.31	3.51	0.46	3.75	0.66
BAS	-0.0011***	0.0003	-0.0011***	-0.0006	-0.0010***	-0.0003
	-4.99	1.05	-4.19	-1.34	-5.70	-1.22
Loc	0.0001	0.0007**	0.0011***	0.0009***	0.0006***	0.0007**
	0.39	2.03	5.52	2.90	4.64	2.43
TVol	0.0002	-0.0002	0.0001	-0.0007*	0.0003**	-0.0004**
	1.35	-0.85	0.33	-1.95	2.07	-2.20
DY	-0.0227	-0.0092	0.0263	0.0616**	0.0040	0.0372*
	-0.99	-0.27	0.85	2.37	0.19	1.83
Adj. R^2	0.027	0.004	0.048	0.011	0.029	0.005
F-stat	10.42	1.27	15.36	4.26	19.22	3.48
Obs	3,764	3,764	1,959	1,959	5,723	5,723

4.3.4 Factors Contributing to the Speed of the Limit Order Bias Correction

In the discussion of his results, Dubofsky (1992) named the active trading volume and professional market makers' intervention as two of the factors which would most likely contribute to the fast correction of the open limit order bias, without though performing any direct test on the basis of these predictions. In an attempt to fill this gap, I examine whether the speed of the correction of the limit order bias can be indeed associated with the ex-day trading volume or the distinct exchange characteristics that determine the intensity with which professional market makers assist in the fair reflection of the dividend adjustment into stock prices.

Hypothesis 4-4 associates the speed of the intraday correction of the BAS widening incurred at the ex-day opening with the volume of trades executed during the ex-day trading session. In order to test this hypothesis, I first define the first minute in which the cumulative percentage change of the BAS from the cum-day close becomes equal to or less than zero as the assumed point in time when the full reversal of the BAS widening has been achieved. Next, I group ex-days on the basis of the minute within which the BAS widening is fully reversed, over the interval from the ex-day open until 10:00 a.m., during which period the majority of the sample reports a reversal of the BAS widening. Finally, for each group of ex-days, I calculate the cross-sectional median of the average trading volume recorded over their entire ex-dividend day and thus, graph the computed median values against each minute within which the reversals of the BAS widening have materialized, separately for the NYSE and AMEX sample, and NASDAQ sample.[95]

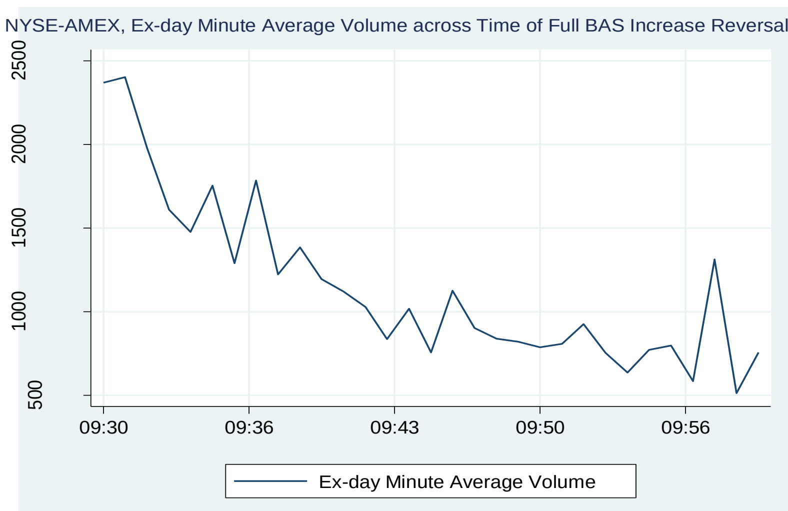
As demonstrated in Figure 4-3, ex-days for which the open BAS widening is reversed immediately after the ex-day open are the ones with the highest reported average intraday volume during the ex-dividend day. On the basis of the downward sloping curve of the graph, it is concluded that the smaller the ex-day trading activity for a particular stock the longer it will take for the reversal of the BAS widening incurred at the ex-day open. This

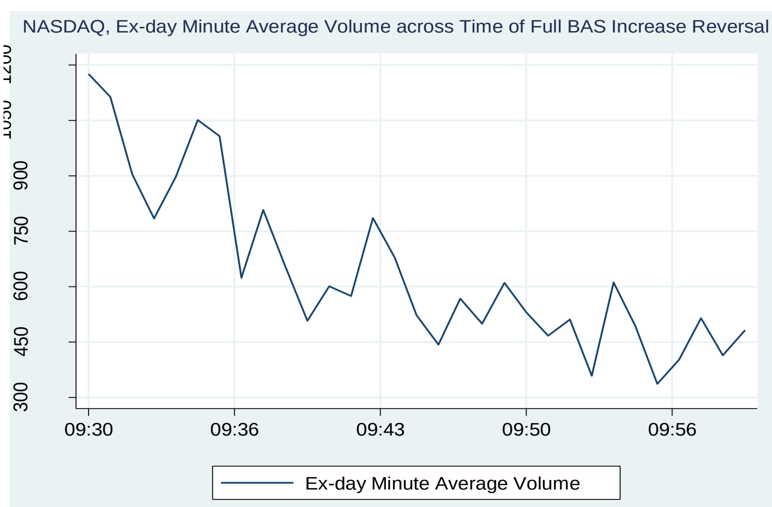
[95] Due to the small size of the minute-by-minute ex-day samples constructed for the purpose of plotting Figure 4-3, means are particularly affected by trade volume outliers and therefore, they are not reported.

conclusion is derived for both the NYSE and AMEX, and NASDAQ samples, thereby providing support for Hypothesis 4-4.

Figure 4-3 Ex-day Minute Average Volume across Time of Full Bid-Ask Spread Increase Reversal

This figure illustrates the median of the ex-day minute average volume across stocks that share the same point in time when the open bid-ask spread (BAS) widening is fully reversed over the interval from the ex-dividend day open until 10:00 a.m. The reversal of the open BAS widening is assumed to take place within the minute in which the cumulative percentage change of the BAS from the cum-day close becomes equal to or less than zero for the first time during the ex-day. The ex-day minute average volume is defined as the average number of shares traded over one minute within the ex-dividend day for each stock. The medians of the ex-day minute average volume are plotted against each minute within which the reversals of the BAS widening have materialized, separately for the NYSE and AMEX sample, and NASDAQ sample.



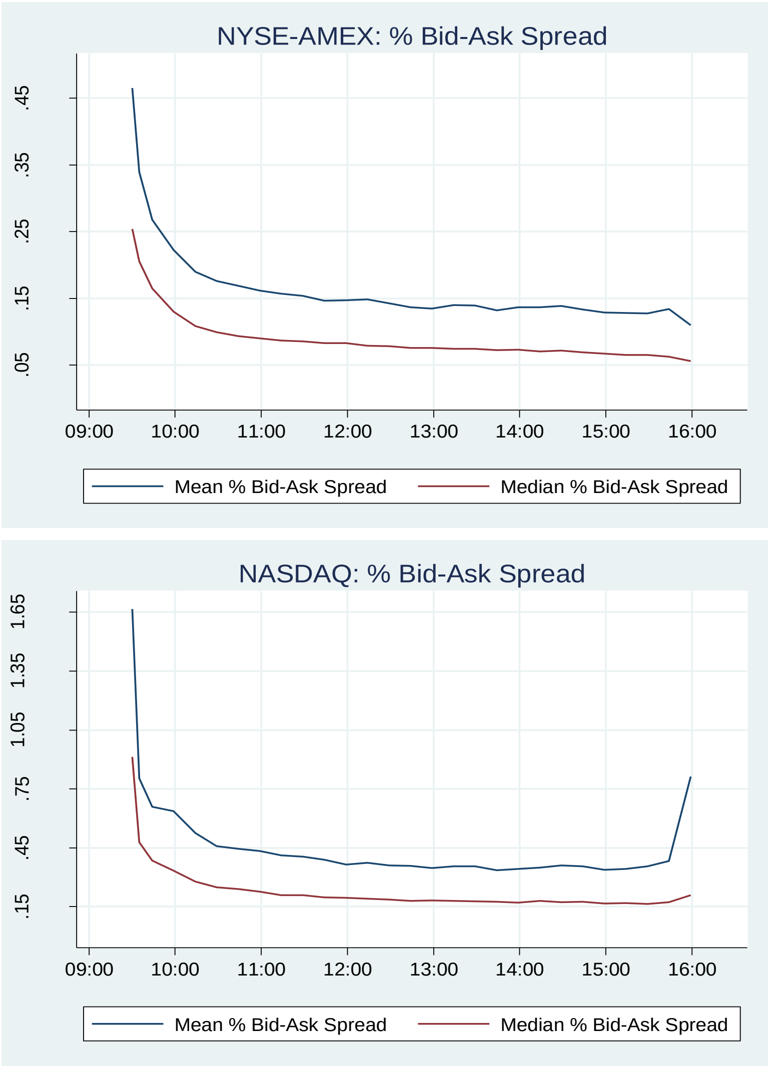


Stoll and Whaley's (1990) and Brock and Kleidon's (1992) models associated the widening of bid-ask spreads for NYSE stocks with the exchange's specialists market power and control of the aggregate order book. The main implication of these models is that the dissimilar institutional characteristics of different markets are expected to have a material impact on the evolution of bid-ask spreads during the trading day. In this context, Chan, Christie and Schultz (1995) found that NASDAQ stocks are characterized by narrower bid-ask spreads than NYSE stocks towards their trading close and attributed their result, again, to the lack of market power over order flow among the various dealers operating in NASDAQ. On the basis of such contention, I would expect differences with regards to the speed of reversal of the bid-ask spread increase evident at the ex-day opening between NYSE and AMEX stocks, and NASDAQ stocks.

Hypothesis 4-5 implies that the widened BAS at the ex-day open is anticipated to narrow more quickly in NASDAQ, where professional dealers intensely compete for order flow in the market, than in NYSE and AMEX stocks, where the single specialist assigned to each stock has greater control on the spread determination. Figure 4-4 depicts the evolution of cross-sectional means and medians of the BAS which is first averaged over 15 minute intervals for each stock. Is it evident that the decline of the BAS after the ex-day open is more abrupt for the NASDAQ sample but relatively slower for the NYSE and AMEX sample. In unreported analysis, I found that, until 9:35 a.m., the mean BAS for the NASDAQ sample has decreased by -52% (from 1.67% to 0.80%) whereas for the NYSE and AMEX sample its reduction, over the same interval, is only -27% (from 0.47% to 0.34%). Moreover, from the ex-day open until 9:44 a.m., the mean BAS percentage reduction is equal to -60% for the NASDAQ sample versus -42% for the NYSE and AMEX sample, thereby, providing evidence in favor of the Hypothesis 4-5.

Figure 4-4 Intra Ex-Dividend Day Evolution of the Bid-Ask Spread: NYSE and AMEX versus NASDAQ

This figure illustrates the evolution of the percentage bid-ask spreads (BAS) averaged over 15 minute intervals during the ex-dividend day, separately for stocks listed on the NYSE and AMEX, and stocks listed on the NASDAQ. The BAS is equal to [(A – B) / B] where B is the best bid quote and A is the best ask quote at the close of each minute over the ex-dividend day. The minute-by-minute BAS figures are first averaged over 15 minute intervals during each ex-dividend day, and subsequently the mean and median values of the 15 minute averages of the BAS are calculated across the sample of ex-dividend days.



4.4 Conclusion

According to the empirical results presented by Dubofsky (1992), support for his model was only provided by samples of stocks paying small dividends given that abnormal returns at the ex-day close for high dividend yield stocks were found to be statistically insignificant on average. The author attributed this result to the active trading and specialist intervention taking place for high dividend yield stocks, by which intraday quotes from unadjusted orders to sell are revised towards the fully adjusted price, thereby correcting for the abnormal returns evident at the ex-day open.[96]

In this context, Chapter 4 evaluates the impact of the asymmetric limit order adjustment at the opening and the closing trade price of the ex-dividend day and its corresponding association to the ex-day abnormal returns. The analysis presented herein suggests that Dufosky's (1992) limit order adjustment hypothesis has indeed evidenced explanatory power for the price drop discrepancy evident at the ex-day open, which nonetheless fades out, due to active trading and market makers intervention, before the ex-day close. Also, in agreement with Dubofsky's (1992) conjecture on what factors lead to a more effective correction of the limit order bias mentioned above, empirical evidence presented herein shows that high trading volume and the presence of numerous professional market makers in the exchange contribute to a faster reversal of the limit order bias evident at the ex-day open, thereby rendering it irrelevant for the fair valuation of the dividend at the ex-day close.

Finally, the only factor found to have a significant influence on the cum-day close to ex-day close price drop, was the within spread location of the closing trade, thus implying that the importance of microstructure effects on the ex-day valuation of the dividend cannot be altogether rejected.

[96] Furthermore, Dubofsky (1992) argued that the specialists' intervention during the ex-dividend day is expected to be substantial compared to a normal trading day as short-term traders and low-taxed, long-term investors engaging in dividend capturing are envisaged to sell their stock holdings in order to cash the accrued profit from their trading strategies.

CHAPTER 5: ABNORMAL BUYING PRESSURE ON THE EX-DIVIDEND DAY OF THE GREEK MARKET

5.1 Theory and Motivation

The Greek stock market provides a rather simple case free of the complexities that arise due to differential taxation, price discreteness, and trading by a variety of investor clienteles around the ex-day. In specific, since 1992, dividends and capital gains have been tax free for all investors, the tick size is considered minor in relation to the annually paid dividends and transaction costs incurred by a "round-trip" transaction are high enough to prevent pure arbitrage strategies around the ex-day. Assuming that no significant information unrelated to the dividend is transmitted to the market on the ex-day, one should expect the price drop to equal the dividend amount, on average. Still, the price of Greek common stocks drops significantly less than the dividend, a puzzle that remains unresolved in the international literature until today. Extant theory postulates that the stock price on the ex-day can only decrease, on a market adjusted basis, in order to incorporate the loss of the right to the dividend for those who sell or refrain from buying the stock on the (cum-) day before the ex-day. Nothing can explain, though, the abnormal buying pressure that is present on the ex-day of numerous stocks listed on the Greek stock exchange. The empirical evidence implies that ex-day buying pressure is so pervasive that it does not allow the stock price drop by the full amount of the dividend for a particular group of stocks. This anomaly generates significant positive abnormal returns that cannot be eliminated despite the dividend capturing attitude that is apparent around the ex-day of high dividend yield stocks. Dividend capturing is attributed to Greek corporate and institutional investors who seem to have a tax related incentive to pursue dividends according to Greek tax rules.

In addition, positing that all investors are fully aware of the ex-days of all stocks traded on the exchange can be questionable in a realistic framework and remains a subject for empirical investigation. In particular, if a group of investors who are uninformed of the dividend observe an initial price drop on the ex-day that cannot be predicted by their incomplete information set, they will be prone to believe that the stock is undervalued. Based upon their beliefs, they will rush to buy the stock exerting buying pressure on the ex-day. Chen et al. (2004) argue that stocks that are inadequately followed by a big group of investors will most likely belong to small, young firms with low trading turnover. Therefore, small, illiquid stocks with a short trading history will most likely be subject to evident abnormal buying pressure and abnormal positive returns on their ex-days. The empirical results of this study corroborate this "Investor Unawareness" hypothesis since it is found that small cap stocks with short listing life and low trading turnover are characterized by excess buying pressure on their ex-days leading to price drops that are remarkably smaller than their dividends. On the other hand, large cap, liquid stocks with a long listing history have price drops and abnormal returns on the ex-day that are not different from the dividend amount and zero, respectively, in the statistical sense.

This Chapter is organized as follows. Section 5.2 delineates the institutional and tax framework within which Greek stocks are traded. Section 5.3 describes the data and methodology. Section 5.4 explains why all traditional hypotheses already stated in the literature fail to explain the Greek ex-dividend day anomaly. Section 5.5 presents empirical results that prove that abnormal returns are generated by abnormal buying pressure at the ex-dividend day of the Greek stock market. Section 5.6 presents the "Investor Unawareness" hypothesis that possibly explains the abnormal buying pressure and hence, the price drop puzzle on the ex-dividend day. Finally, Section 5.7 concludes the study.

5.2 Institutional and Tax Environment in Greece

5.2.1 The Institutional Characteristics of the Athens Exchanges (ATHEX)

Since 1992, trading in the Greek stock exchange has been computerized for all members having access to the integrated exchange O.A.S.I.S platform (Integrated Automatic System for Electronic Trading). Until 2005, ATHEX operated four stock markets, the "Main Market" where large cap firms were traded, the "Parallel Market"[97] where Medium and Small cap firms were traded, the "New Market" (NEHA)[98] and the "Greek Emerging Market" (EAGAK).[99] In November 2005, under a major restructuring decision by the ATHEX management, all stocks from all markets where integrated into a unique securities market that had two main segments, the "Big Cap" and the "Mid & Small Cap" categories.[100] Stocks would be classified among these two, according to market capitalization, liquidity, corporate governance and other criteria.[101] In addition to the stock market, a Derivative (Futures, Options) and a Repo Market exist. Daily stock trades have been executed in different phases/mechanisms within the trading day; at the Open Auction, Continuous Trading, Intraday Auctions, at the Close Auction and Block Trades (Pre-Agreed Trades of large volumes). In addition, market, limit, stop, and at the open orders can be used to trade on the exchange. The majority of the trades is executed through a Continuous Automatic Matching Mechanism by which orders taken from the Order Book are first

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[97] The Parallel Market established by the Law 1806/1988 (Gov. Gaz. 207A/20-9-1988) allowed listing with lower requirements than the Main Market; lower book value of equity at the time of application for listing, lower profit figures for fiscal years prior to the listing etc. The listing prerequisites were later revised by the Regulation 2/305/18.6.2004 of the Capital Market Commission (Gov. Gaz. 1360B/3-9-2004).

[98] The New Market (NEHA) was established in 1999 by the Law 2733/1999 in order to provide a trading environment for companies with small market capitalization and low ownership dispersion but which are characterized as innovative and dynamic and operate under a specified Investment Plan.

[99] The Greek Market of Emerging Capital Markets (EAGAK) is a parallel market providing for cross-border trading in securities comprising shares in emerging market companies. It was established in 1997 by the Law 2533/1997 but it did not start its operation until the 21st of May 2004.

[100] The rest of the categories were the "Special Financial Characteristics" (SFC), the "Under Supervision" and the "Under Suspension" stocks.

[101] In February 2008, the "Alternative Market" (EN.A) also started operating in ATHEX, as a semi-regulated Multilateral Trading Facility. EN.A is addressed to companies that seek easier access to the secondary market and to investors who are willing to accept higher risk.

matched by price and secondly, by the time that they have been introduced. Furthermore, execution priority does not vary with the size of the trade in order not to discriminate against investors that trade in small volumes. Trading commissions were deregulated in 1995 and have been set freely by the trading partners, ever since.

Since May 2001,[102] both short selling and market making[103] have been allowed in the Greek stock market. Short selling is executed by the ATHEX Members through a reverse stock repo agreement with the Athens Derivatives Exchange Clearing House (ADECH).[104] Both market makers' and short sellers' trading has been minimal for the whole period examined. Evidential of this is Table 5-1, which reports that neither market making nor short selling as a percentage of the average daily transaction value ever exceeded 4%, for the years 2007 and 2008.[105] Notably, more than 90% of the total daily trading activity refers to the large capitalization stocks and almost 70% of the daily trading takes place after the opening using the intra-day continuous and automatic order book.

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[102] For reference, see Regulation 1/216/17-5-2001 of the Capital Market Commission (Gov. Gaz. 667B/31-5-2001): "Market makers in the Main and Parallel Markets of the Athens Stock Exchange" and Regulation 2/216/17-5-2001 of the Capital Market Commission (Gov. Gaz. 667B/31-5-2001): "Short Sales in the Main and Parallel Markets of the Athens Stock Exchange".

[103] There are strict requirements for acquiring and holding on the license of market making such as adequate trading technology and organization, professionally certified staff, internal rules and controls, minimum duration for market making of financial instruments etc.

[104] This means that in order to realize a short sale, the investor must have previously (or the same day at the latest) acquired the shares he short sells through a stock lending contract with ADECH. Currently, the maximum allowed short selling open position per investor and per share is the 1% of the free float of the share.

[105] Only the first 9 months of year 2008 are employed, because in October 2008, the short sales mechanism was temporarily suspended until May 2009, due to the worldwide market downturn.

Table 5-1: Average Daily Value of Transactions per Trading Phase / Mechanism in Years 2007 and 2008, for All Stocks and for Large Capitalization Stocks Listed on ATHEX

In ATHEX, stock trades have been executed in different phases / mechanisms within the trading day; at the Open Auction, Continuous Trading, Intraday Auctions, at the Close Auction and Block Trades (Pre-Agreed Trades of large volumes). This table shows the average daily Euro value of transactions that take place within each trading day phase for years 2007 and 2008. Since May 2001, both short selling and market making have been allowed in the Greek stock market. Only the first 9 months of year 2008 are used because in October 2008 the short sales mechanism was temporarily suspended until May 2009, due to the worldwide market downturn. The majority of the trades is executed through a Continuous Automatic Matching Mechanism by which orders taken from the Order Book are first matched by price and secondly, by the time that they have been introduced. More than 90% of the total daily trading activity refers to the large capitalization stocks and almost 70% of the daily trading takes place after the opening using the intra-day continuous and automatic order book.

Panel A: Average daily value of transactions for all

Average daily trade value	01.01.2007 - 31.12.2007		01.01.2008 - 30.09.2008	
per trading phase	in euros (€)	% of Grand total	in euros (€)	% of Grand total
At the Open	6.99	1.6%	7.84	2.2%
ContinuousTrading	297.56	67.4%	246.4	69.4%
Intraday Auctions	2.28	0.5%	1.13	0.3%
Closing Auction	22.42	5.1%	25.78	7.3%
At the Close	11.49	2.6%	8.86	2.5%
Total	340.73	77.2%	290.03	81.6%
BlockTrades	100.52	22.8%	65.24	18.4%
Grand total	441.25	100.0%	355.26	100.0%
% Short selling	-	2.3%	-	1.6%
% Market Makers	-	2.9%	-	3.9%

Panel B: Average daily value of transactions for large cap stocks listed on ATHEX

Average daily trade value	01.01.2007 - 31.12.2007		01.01.2008 - 30.09.2008	
per trading phase	in euros (€)	% of Grand total	in euros (€)	% of Grand total
At the Open	6.41	1.6%	7.21	2.1%
ContinuousTrading	271.68	67.1%	238.33	69.3%
Intraday Auctions	0.89	0.2%	0.74	0.2%
Closing Auction	22.30	5.5%	25.78	7.5%
At the Close	10.34	2.6%	8.48	2.5%
Total	311.62	76.9%	280.54	81.6%
BlockTrades	93.42	23.1%	63.35	18.4%
Grand total	405.04	100.0%	343.89	100.0%
% Short selling	-	2.5%	-	1.6%
% Market Makers	-	3.0%	-	4.0%

(Values in millions of Euros - Source: ATHEX, Monthly Statistics Bulletin, 2007-2008)

For most of the period examined foreign investors executed their trades through a domestic broker - member of ATHEX. In the last quarter of 2006 they started to trade directly on the exchange for the first time under a “remote member” status but overall remote member trading was minimal since then.[106]

5.2.2 Taxation on Capital Income Distributed from Greek Listed Firms

Since July of 1992, dividends are distributed to stock holders net of corporate income taxes.[107] Nevertheless, at the shareholder level, neither dividends nor realized capital gains (short-term or long-term) are subject to income taxes.[108] This way, double taxation of dividends is avoided for the period 1992-2008 examined. Also, no minimum holding period is required to make investors exempt from income taxes on the dividend or capital gains.[109] Given the zero effective tax rate on dividends for individual domestic investors, they are deemed indifferent as to whether they receive their share of the distributed profits of the firm in a dividend or realized capital gain form.

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[106] A remote member is an ATHEX Member not legally established in Greece that trades through a single Custodian acting as their representative. Trading by foreign investors under a “Remote member Status” was allowed since 2001 according to Regulation No 65 of the ATHEX Board of Directors (15-03-01) (Gov. Gaz. 632B/28-5-2001): “Granting of remote member qualification to EU Investment Services Companies”. The first company that started trading as a Remote member in October 2006 was from Cyprus, within the framework of the common trading platform of Athens Exchange and Cyprus Stock Exchange. Since then, Remote member trading hardly exceeded 1% of the total annual trading value in ATHEX, until the year 2008 when the inclusion of UBS, Merill Lynch, Societe Generale and Deutche Bank in the Remote member list raised the Remote member annual participation to 2.82%.

[107] According to Greek Law 2065/1992 (article 9), after July 1992, all corporate profits are only taxed at the corporate income tax rate irrespective of whether these profits are distributed as dividends or retained by the firm. Before 1992, there was differential taxation on the basis of whether the current income of the corporation was distributed or not. In specific, retained profits were only taxed at the corporate tax rate while profits paid out as dividends were only taxed at the shareholder level according to the individual income tax brackets.

[108] For dividends payable within the year 2009 a 10% tax is being withheld at the time of the dividend receipt that will constitute the final tax paid for dividends received by shareholders.

[109] This is in contrast with the U.S. tax law, according to which, U.S. corporations must hold the stock for a minimum holding period in order for them to qualify for a tax exemption (this period is increased from 14 days to 45 days, with the Tax Reform Act of 1984). If corporations attempted to buy on the cum-date and sell on the ex-date, they would lose the deduction and pay ordinary taxes on the full dividend.

Although one could argue that the same applies for corporations, namely, for both corporate and institutional investors, it is believed that this is not the case. According to the Income Tax Law of Greek tax regulation, corporations, including banks, are allowed to exclude both dividends and realized capital gains from the taxable income that is accrued during the financial year. However, realized capital gains from selling stocks are being accumulated within a tax reserve that will remain tax-free unless it is distributed to the shareholders of the investing company. In such an instance, the reserve's balance will be taxed at the regular corporate income tax rates prevailing at that time. This tax regime that allows the transfer of capital charges from one year to another, applies for both institutional and corporate investors for the whole period examined until 2007, inclusive.[110] Thus, corporations that have accumulated positive realized capital gains, have a strong incentive to buy stocks with high dividend yields, in order to net off the capital gain reserve balance with the capital loss that is incurred due to the stock price drop on the ex-dividend day. In effect, this will result in substantial tax saving for those corporations that decide to distribute the capital gain reserve. Consequently, if it is feasible for a corporation to buy the stock on the cum-day and sell it on the ex-day, in effect, it would perform tax arbitrage, with a net gain of the dividend received minus the ex-day capital loss net of the tax that is payable upon distribution of the capital reserve, ceteris paribus. Eades et al. (1994) and Naranjo et al. (2000) suggest that high yield securities are the primary targets for tax arbitrage and strategic dividend capture by corporations. If these tax-induced dividend capture trades are significant in the Greek stock market, they should lead to positive abnormal returns before the ex-day and negative abnormal returns after the ex-day, especially for stock with higher dividend payouts.

Finally, all foreign investors can freely receive dividends and realize capital gains from companies that are listed on the ATHEX without being subject to any withholding income or capital tax, under Greek domestic law for the entire period examined.

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[110] Since 2008, according to new tax legislation (Greek Law 3634/2008, article 26) issued for financial institutions, it is no longer permissible to transfer non taxed realized stock gains from one year to another in the form of a capital reserve. According to the new rules, banks can net annual gains from selling stocks off current or prior year capital losses (realized or unrealized) but any remaining positive value will be, necessarily, taxed at the prevailing corporate income tax rate in the year that it was accrued.

5.3 Data and Methodology

5.3.1 Sample Construction and Filtering

As a starting point, the entire Datastream history of prices and dividends paid by stocks listed on ATHEX from the 1st of July 1992, until December 31, 2008 is employed. This includes 467 common and preferred stocks of financial, non financial and utility corporations that pay dividends on an annual basis. On January 2, 2001, Datastream converts all historical numerical data from Greek Drachmas to Euros. This currency translation is "reversed" in order to have both dividends and closing prices in Greek Drachmas for the period before January 2, 2001 and in Euros for the period after January 2, 2001. Ex-dividend dates, dividend amounts, daily volumes, outstanding number of shares market capitalizations and closing prices are taken from Datastream. This data file is merged with the database of daily opening and closing prices, closing bid and ask quotes, average trading prices and number of transactions that has been provided by ATHEX. In order to validate the accuracy of the merge, closing prices are compared between the two different sources and it is found that out of the 1,279,494 daily observations, 3,423 observations (0.27%) did not match. Out of these mismatches, 1,525 referred to one preferred stock and three common stocks with thinly traded dates before the end of 1993. Nevertheless, these stocks within the pertinent dates are not included in the final estimation and event sample, hence not affecting the analysis. The residual of 1,898 mismatches (0.15%) is distributed across many stocks with less than 50 mismatches per stock over the entire selected period so that it is not regarded material enough for further investigation.

The Total Return Index of Datastream is used to calculate daily returns except from the ex-dividend day.[111] As a market proxy, the ATHEX Composite Share Price Index is employed, which is a market capitalization weighted index that depicts the performance of the 60 largest companies that are traded in the Big Cap category of

[111] According to the definition provided by Datastream, the Total Return Index (datatype reference: "RI") is a theoretical price index that assumes that dividends are re-invested to purchase additional units of the stock at the closing price on the ex-dividend date. Furthermore, it is adjusted for subsequent capital changes such as stock splits and stock dividends.

ATHEX. Finally, daily trading volumes are used to distinguish trading from non trading days for individual stocks.[112]

The initial sample comprises 3,372 ex-dividend days spanning throughout a 16 year and a half period. In order to increase the power of the tests, several screening filters are applied to the sample. First, all dividends of preferred stocks are removed because these were taxable throughout the whole period examined. Second, all ex-days with confounding capital events are dropped. In specific, if a stock split, stock dividend, rights issue, bonus issue occurs within a [-5, +5] window around the ex-day, then, the ex-day is removed from the sample. Third, in order to reduce the influence of thinly traded stocks, ex-days that have more than 70 days with no trading activity within the 100 day long estimation window [-130, -31] are excluded.[113] Fourth, for quite a few of dividends, the value of the ex-day price or the cum-day price could be missing because the stock did not trade on those days. In this case, abnormal returns or price drop ratios cannot be calculated and hence, these observations are eliminated from the sample. In total, 947 ex-days are filtered out yielding a number of 2,425 usable observations (100% of the sample), as illustrated in Table 5-2.

Furthermore, price drop ratios can be relatively extreme for firms with negligible dividend payouts that also have substantially volatile prices on the ex-dividend day. Therefore, the upper and lower 2.5% quantile of the ex-day sample are trimmed in order to limit the outliers' impact, following Graham et al. (2003).[114] By excluding 121 outlier observations, the final sample comprises 2,304 ex-days that will be used for the analysis that follows.

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[112] The shares that are eligible for inclusion in the index are first ranked on the basis of their Average Market Capitalization. Next, these shares are ranked on the basis of their Trading Value excluding blocks. The final criterion for the ranking of the shares results from the numeric average of the two ranking sequences. Then, the 60 first shares in this final criterion rank are selected for the composition of the Composite Index.

[113] Bali and Hite (1998) omit ex-days that have less than 20 actual trading during the 50-day estimation period [+5, +54], implying that 30 observations are enough to consider their regression coefficient estimates unbiased.

[114] This is considered reasonable, also because data entry errors are likely; within the outliers that were dropped two instances were detected where although the actual dividend payment was 40.0 or 80.0 Greek Drachmas (0.12 or 0.24 Euros), the figures extracted from the database were 4.0 or 8.0 Greek Drachmas respectively (0.012 or 0.024 Euros), hence distorting the calculated ex-day returns.

Table 5-2: Filters of Sample Screening

The initial sample consists of the entire Datastream history of prices and dividends paid by stocks listed on ATHEX from the 1st of July 1992, until December 31, 2008. This sample size diminishes due to the removal of dividends of preferred stocks, of ex-days with confounding capital events (stock split, stock dividend, rights issue, bonus issue) within a [-5, +5] window around the ex-day, of ex-days with more than 70 days with no trading activity within the estimation window [-130, -31] and of those dividends whose price on the ex-day or the cum-day price is missing. In total, 947 ex-days are filtered out yielding a number of 2,425 usable observations (100% of the distribution).

Sample Screening	Ex-days removed	Remaining amount
Number of Ex days extracted from Datastream (over period 1992 - 2008)		3,372
Ex-days that pertain to Preferred stocks	398	
Ex-days with (confounding) capital changes within a [-5, +5] window	156	
Ex-days that have less than 30 trading days within the [-130, -31] window	235	
Ex-days that report a missing price either on the cum or the ex-day	158	
Total	947	**2,425**

5.3.2 Methodology

Standard event-study methodology is performed where various statistics are estimated around the ex-dividend day for different groups of stocks. First, the Price Drop Ratio (PDR adjusted for the expected return on the ex-day) is calculated, which reflects the relative valuation of the dividend by the marginal investor:

$$PDR_i = \frac{P_i^{cum} - \left(\frac{P_i^{ex}}{1 + \hat{R}_{i\,exday}^{normal}} \right)}{D_i} \qquad (5.1)$$

where P_i^{cum} is the closing price on the cum-day for stock *i*, P_i^{ex} is the price on the ex-day for stock *i*, D_i is the amount of the dividend for stock *i* and R_i^{normal} is the expected daily return of stock *i* on the ex-day. The ex-day expected return accounts for both the market return and the beta risk as below:

$$\hat{R}_{i\,exday}^{normal} = \hat{\alpha}_i + \hat{\beta}_i R_{exday}^{market} \qquad (5.2)$$

where α_i and β_i are estimated with the OLS market model over the estimation window of [-130, -31] days, where day "0" is the ex-dividend day and R^{market} is the daily market return. As a proxy for the market return, the % change of the daily value of the ATHEX Composite Share Price index is used.

Second, using the same inputs, the Abnormal Return (AR^{ex}) is computed, which occurs due the relative mispricing of the dividend adjusted for the expected return on the ex-day:

$$AR_i^{ex} = \frac{P_i^{ex} - P_i^{cum} + D_i}{P_i^{cum}} - \hat{R}_{i\,exday}^{normal} \qquad (5.3)$$

Whether event clustering is important in the sample is investigated by calculating the number of observations falling on the same weekday, month and calendar date. As presented in Table 5-3, ex-days are distributed across all weekdays with the largest percentage falling on Monday while there is severe month clustering with 69% of the dividends going ex in June and July. In addition, the 2,304 dividends of the sample are distributed among 951 distinct calendar dates. Given that there are only 85 calendar dates on which more than 5 dividends are clustered (8.9% of all calendar dates), it is deduced that calendar date clustering is weak. Therefore, there is no need for the calendar time portfolio methodology whereby observations that coincide on the same date are pooled into portfolios. Nevertheless, in the regressions to follow, t-tests for the estimated coefficients are also computed with standard errors adjusted for ex-day clustering, as a robustness check.

Following Koski and Scruggs (1998), the statistical inferences regarding abnormal trading activity are based on both daily percentage and standardized abnormal trading activity ratios. For each observation, using the mean volume (V_i^{averg}) during the estimation [-130, -31] window, the % Abnormal Volume (%AV) is computed as:

$$\%AV_{it} = \frac{V_{it} - V_i^{averg}}{V_i^{averg}} * 100\% \qquad (5.4)$$

After estimating the standard deviation of volume, $\sigma(V_i)$, during the estimation [-130, -31] window, the Standardized Abnormal Volume (SAV) is also calculated:

$$SAV_{it} = \frac{V_{it} - V_i^{averg}}{\sigma(V_i)} \qquad (5.5)$$

Table 5-3: Clustering Analysis

This table presents the degree of clustering for the 2.5% trimmed sample of 2,304 ex-days of stocks listed in ATHEX during the period 1992 - 2008. The first and second columns show the number of observations falling on the same weekday and month respectively. The 2,304 dividends of the sample are distributed among 951 distinct calendar dates. The third column shows the number of calendar dates with more than one, five, ten, twenty and forty five dividends being clustered on these. Given that there are only 85 calendar dates on which more than 5 dividends are clustered (8.9% of all calendar dates), it is deduced that calendar date clustering is weak.

Trimmed Sample 2.5%, Period 1992-2008 (Obs=2,304)								
Weekday	Obs.	Percentg.	Month	Obs.	Percentg.	Dividends	Dates	Percentg.
Monday	791	34.3%	May	215	9.3%	> 1	460	48.4%
Tuesday	398	17.3%	June	755	32.8%	> 5	60	6.3%
Wednesday	316	13.7%	July	828	35.9%	> 10	19	2.0%
Thursday	407	17.7%	August	204	8.9%	> 20	6	0.6%
Friday	392	17.0%	Other	302	13.1%	> 45	0	0.0%

To reduce the impact of size and liquidity differences across stocks, the daily turnover (TO) is alternatively calculated as:

$$TO_{it} = \frac{V_{it}}{No\ of\ shares_{it}} \qquad (5.6)$$

in order to calculate the % Abnormal Turnover (%ATO), in a similar manner:

$$\%ATO_{it} = \frac{TO_{it} - TO_i^{averg}}{TO_i^{averg}} * 100\% \qquad (5.7)$$

and the Standardized Abnormal Turnover (SATO) as:

$$SATO_{it} = \frac{TO_{it} - TO_i^{averg}}{\sigma(TO_i)} \qquad (5.8)$$

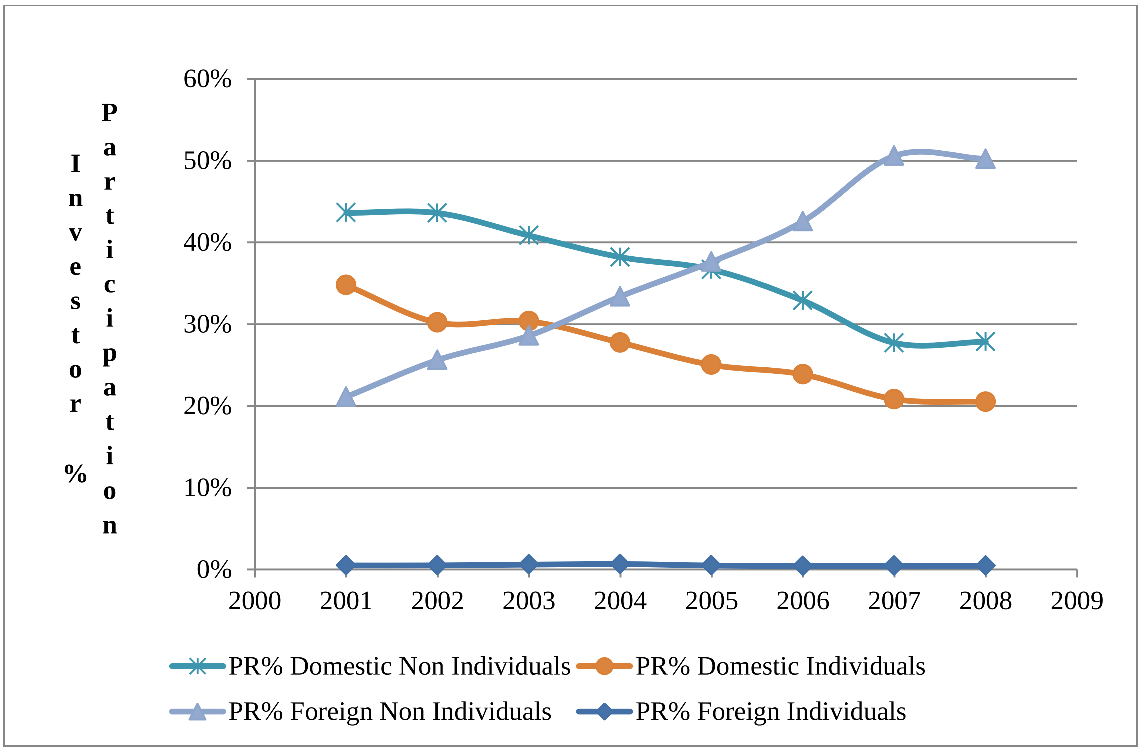
where TO_i^{averg} is the mean and $\sigma(TO_i)$ is the standard deviation of individual stock turnover (TO) during the estimation [-130, -31] window. Finally, the same methodology is used to calculate the daily percentage (%ATR) and standardized abnormal number of transactions (SATR) per stock and ex-day.

5.4 Examination of Traditional Hypothesεs of the Ex-Dividend Day

5.4.1 Tax Hypothesis - Elton and Gruber (1970)

Four distinct dividend clienteles are defined on the basis of their different tax preference towards the dividends received from their ownership in Greek stocks; domestic individual investors, domestic corporations and institutional investors, foreign individual investors and foreign corporations and institutional investors. As already discussed, domestic individual investor will be neutral and domestic corporations will have a strong preference towards dividends.

Figure 5-1 The Time Series of the % Participation of Domestic Individual, Domestic Non- Individual, Foreign Individual and Foreign Non-Individual Investors



(Source: ATHEX, Monthly Statistics Bulletin, 2003-2008)

In addition, the participation of foreign investors in the Greek stock market grew steadily from 2000 until 2008 as shown in Figure 5-1.[115]

The four countries with the largest participation in the Greek stock market within the period examined are, the United States of America, Luxembourg, United Kingdom and Cyprus contributing to the 55% - 65% of the total foreign trading activity in ATHEX. Over the period 2003 – 2008, their combined shareholdings varied within the range of 20% - 30% of the total market capitalization of the Greek stock market. Table 5-4, depicts the evolution of the % ownership and the % trade value from 2001 until 2008 for the four tax clienteles. It is worth pointing out that in 2008, foreign corporations and institutional investors had a share of 50% of the total market capitalization and a participation of 60% in the trading activity taking place in ATHEX.[116]

The absence of tax withheld by the Greek tax authorities on dividends or capital gains received abroad in combination with the tax exempt status that foreign institutional investors have for both dividends and capital gains under their tax legislation, makes them being perceived as tax neutral. One could reasonably argue that they could also be inclined to pursue Greek dividends given that the Greek tax rules are more favorable on dividends compared to other European candidates for long term investment, with the argument being stronger for corporations. On the other hand, as has been extensively stated in the literature, individual investors in the USA, UK and Luxembourg bear an income tax disadvantage over dividends due to the lower tax rate imposed on realized long term capital gains and due to the right to deduct capital losses from capital gains before the tax is accrued. Nevertheless, the participation of foreign individual investors in Greek stocks has been limited to 0.5% as shown in the last column of Table 5-4.

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[115] The case that a foreign investor, whose tax preferences differ from the ones of domestic investors, might be the marginal trader on the ex-day has not been widely identified in the literature. Booth and Johnston (1984), Robin (1991), Liljeblom et al. (2001), Rantapuska (2008) and Kadapakkam and Martinez (2008) have explicitly accounted for inter-country dividend clienteles.

[116] Annual percentages are calculated by averaging monthly percentages as recorded in the ATHEX Monthly Statistics Bulletin issued for the period 2003-2008. Official monthly % participation and % trade rates per investor type are available from ATHEX from May 2001 onwards. Monthly statistics are limited to only May for year 2001, to January, May, September and December for year 2002 and after April for year 2003. All the later years number a complete monthly frequency of data.

Table 5-4: Year by Year % Participation of Tax Clienteles and their Hypothesized Price Drop Ratios

Four distinct dividend clienteles are defined on the basis of their different tax preference towards the dividends received from their ownership in Greek stocks; domestic individual investors, domestic corporations and institutional investors, foreign individual investors and foreign corporations and institutional investors. This table depicts the annual average % ownership and % trade value from 2001 until 2008 for the four tax clienteles. Annual percentages are calculated by averaging monthly percentages as recorded in the ATHEX Monthly Statistics Bulletin issued for the period 2003-2008. Official monthly % participation and % trade rates per investor type are available from ATHEX from May 2001 onwards. Monthly statistics are limited to just May for year 2001, to January, May, September and December for year 2002 and after April for year 2003. All the subsequent years number a complete monthly frequency of data. In addition, at the bottom of the table, the hypothesized PDR for each clientele is reported on the basis of their dividend tax preferences. If the average ex-day price drop reflects the effective tax rate on dividends received by all four tax clienteles, the sample PDR should be equal or greater to unity, after taking into account the investors' relative ownership weight in the Greek stock market.

	Domestic Corporat. & Institut.Investors		Domestic Individuals		Foreign Corporat. & Institut.Investors		Foreign Individuals
Year	% Holding	% Trade	% Holding	% Trade	% Holding	% Trade	% Holding
2001	43.61%		34.77%		21.12%		0.50%
2002	43.59%		30.19%		25.63%		0.51%
2003	40.84%		30.34%		28.59%		0.60%
2004	38.20%	22.95%	27.74%	31.84%	33.39%	45.21%	0.67%
2005	36.67%	20.27%	25.02%	28.86%	37.63%	50.77%	0.49%
2006	32.88%	19.42%	23.86%	28.33%	42.59%	51.97%	0.42%
2007	27.71%	19.81%	20.83%	22.72%	50.59%	56.33%	0.45%
2008	27.86%	17.03%	20.51%	21.67%	50.22%	60.37%	0.45%
Average	36.42%	19.90%	26.66%	26.68%	36.22%	52.93%	0.51%
Hypothesized Price Drop Ratio	≥ 1		= 1		≥ 1		< 1

(Source: ATHEX, Monthly Statistics Bulletin, 2003-2008)

As a result, if the ex-day price drop reflects the effective tax rate on dividends received by all four tax clienteles, the average PDR should be equal or greater to unity, taking into account their tax preferences and relative ownership weight in the Greek stock market (see hypothesized PDR for each clientele in Table 5-4).

Table 5-5: Descriptive Statistics

In this table, summary statistics are presented for the Euro price drop, the % price drop, the price drop ratio (PDR) and the abnormal ex-day return (AR) on the ex-day, as well as t-tests on the theoretical values for PDR (=1) and AR (=0). Panel A shows statistics for the entire 100% sample (Obs=2,425) and panel B for the 95% trimmed sample (Obs=2,304) for the period 1992-2008. Panel C shows the number of PDRs that fall within four different value ranges; PDR ≤ 0, 0 < PDR ≤ 0.5, 0.5 < PDR ≤ 1 and PDR > 1. The PDR is defined as $(P_{cum} - P_{ex}^{adjusted})/Div$ and the AR is defined as $[(P_{ex}-P_{cum} + Div)/P_{cum} - R^{normal}]$. P_{cum} is the closing price on the cum-dividend day, $P_{ex}^{adjusted}$ is the closing price on the ex-dividend day adjusted for the market risk (R^{normal}) on that day and Div is the dividend amount. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. The Wilcoxon signed-rank test was used for testing median values. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Panel A: Entire Sample, Period 1992-2008 (Obs=2,425)

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Div (€)	0.227	0.110	0.395	0.004	4.566
P^{cum} (€)	10.02	5.46	15.19	0.20	298.46
DY(%)	2.69%	2.22%	2.04%	0.08%	22.52%
$P^{cum}- P^{ex}$	0.158	0.060	0.664	-6.254	11.445
$(P^{cum}- P^{ex})/P^{cum}$	1.59%	1.59%	3.60%	-20.00%	18.88%
Ho: PDR=1	0.650***	0.619***	4.798	-47.019	132.920
	-3.59	-16.36			
Ho: AR=0	1.15%***	0.92%***	3.08%	-15.62%	25.48%
	18.43	19.23			

Panel B: Trimmed Sample 2.5%, Period 1992-2008 (Obs=2,304)

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Div (€)	0.235	0.117	0.403	0.004	4.566
P^{cum} (€)	9.62	5.26	14.98	0.20	298.46
DY(%)	2.80%	2.35%	2.03%	0.10%	22.52%
$P^{cum}- P^{ex}$	0.168	0.060	0.602	-3.082	11.445
$(P^{cum}- P^{ex})/P^{cum}$	1.69%	1.60%	3.33%	-20.00%	18.88%
Ho: PDR=1	0.572***	0.619***	1.672	-5.841	7.770
	-12.29	-17.70			
Ho: AR=0	1.18%***	0.93%***	2.74%	-10.29%	25.48%
	20.72	20.39			

Panel C: Trimmed Sample 2.5%, Period 1992-2008 (Obs=2,304)

Ranges for PDR	PDR ≤ 0	0 < PDR ≤ 0.5	0.5 < PDR ≤ 1	PDR > 1
PDR	-1.271	0.250	0.760	2.173
AR	3.89%	2.33%	0.86%	-1.57%
No of Obs	591	452	555	706

Table 5-5 presents summary statistics for the Euro price drop, the % price drop, the PDR and the AR on the ex-day, as well as t-tests on the theoretical values for PDR (=1) and AR (=0). Panel A shows statistics for the entire 100% sample and panel B for the 95% trimmed sample. Notably, the elimination of PDR outliers reduces remarkably the PDR standard deviation from 4.80 to 1.67 whereas it does not seriously impact on the measures of central tendency. The mean PDR is 0.57 (0.65) for the 95% (100%) sample, the mean AR on the ex-day is 1.18% (1.15%) for the 95% (100%) sample and their hypothetical values are rejected at 1% significance level. These findings agree with previous empirical research on the ex-day behaviour of Greek listed firms done by Milonas and Travlos (2001) for the 1994-1999 period and Dasilas (2009) for the 2000-2004 period. These results significantly contradict the hypothesized PDR (≥ 1) according to the tax hypothesis (Elton and Gruber (1970)). This conclusion is even more evident in Panel C that shows that 452 of all PDRs (20%) have values between "0" and "0.5" and 591 of all PDRs (25%) have values below "0", that are impossible to explain by any effective dividend tax rate for any particular tax clientele. Likewise, other international studies that find PDRs of less than one have been published by Liljeblom et al. (2001) for Finland, Lasfer (2008) for the UK and Germany markets, and Kadapakkam and Martinez (2008) for Mexico.

5.4.2 Microstructure Hypothesis - Bali and Hite (1998) and Frank and Jagannathan (1998)

The tick size hypothesis (Bali and Hite (1998)) rests its validity on the small amount of quarterly dividends in relation to the discrete pricing of stocks in the U.S. before decimalization took place. In Greece, dividends are paid annually with the exception of few stocks that also pay interim dividends before the end of fiscal year. According to the ATHEX Rulebooks, the tick size varies within different stock price ranges and changed after the introduction of Euro currency at the beginning of 2001.[117]

[117] Before April 2001, the stock price was being "manually" adjusted for the dividend at the ex-day. Namely, the closing price at the cum-day would be reduced by the full amount of the dividend by an exchange specialist. ATHEX rules required rounding to the closest tick whenever the stock price resulting from any corporate action fell in between two ticks. Therefore, an *a priori* downward rounding for the price drop with respect to the dividend is precluded due to this ATHEX rule. Since the beginning of April 2001, the ex-day has been free of this non-market intervention.

Table 5-6: Tick Size Analysis

According to the ATHEX Rulebooks, the tick size varies within different stock price ranges before and after the introduction of Euro currency at the beginning of 2001. This table shows the tick size, the mean dividend, the tick multiple per dividend and the % of dividends that are exact tick multiples for each stock price range before and after the Euro adoption. The tick size analysis refers to the 2.5% trimmed sample of 2,304 ex-days of stocks listed in ATHEX during the period 1992 - 2008. The tick multiple is calculated by dividing the mean dividend per stock price range by its respective tick size.

Trimmed Sample 2.5%, Period 1992-2008 (Obs=2,304)						
Before Euro adoption (in Greek Drachmas)				Dividend		Tick
Price Range	Tick	No of Obs.	Min	Max	Mean	Multiple
≤ 1,000 Drs	1	86	5	140	34	34
Exact Tick Multiple		79	7	140	35	
% of Obs		92%				
> 1,000 Drs	5	685	15	1,556	126	25
Exact Tick Multiple		550	5	1,200	132	
% of Obs		80%				
After Euro adoption				Dividend		Tick
Price Range	Tick	No of Obs.	Min	Max	Mean	Multiple
0.01 – 2.99 €	0.01	601	0.010	0.500	0.055	6
Exact Tick Multiple		592	0.010	0.500	0.053	
% of Obs		99%				
3.00 – 59.99 €	0.02	922	0.010	2.600	0.238	12
Exact Tick Multiple		498	0.020	2.600	0.236	
% of Obs		54%				
60.00 – ∞ €	0.05	10	2.200	3.230	2.740	55
Exact Tick Multiple		7	2.200	3.200	2.664	
		70%				

(Source: ATHEX Rulebooks)

Table 5-6 shows the tick size, the mean dividend, the tick multiple per dividend and the % of dividends that are exact tick multiples for each stock price range before and after the Euro adoption. The mean dividend is relatively large compared to its tick size, the smaller tick multiple per dividend equals "6" and the majority of dividends are exact tick multiples. Moreover, even within the 3.00 - 59.99 € stock price range where almost half of the dividends are not exact multiples, it is difficult to suggest that rounding the dividend to the lower tick can result in ex-day price drops that are such low as the ones found for. For example, let a stock has a price of 5 Euros on the cum-day and a reasonable dividend amount of 0.239 Euros. Then, provided that its price drop on the ex-day is downward rounded almost by the full tick size of 0.02, its PDR cannot fall below 0.92 which is much above the mean PDR found. Thus, it is evident that price discreteness, whenever present in the Greek stock market, cannot have any explanatory power for the ex-dividend day anomaly.

Table 5-7: Ex-Day Abnormal Returns and Price Drop Ratios Using Bid and Ask Prices

This table reports mean and median PDRs and ARs that have been calculated using Bid-Ask midpoints, Ask to Ask closing quotes and Bid to Bid closing quotes instead of transaction prices, for the 2.5% trimmed sample of ex-days of stocks listed in ATHEX during the period 1995 - 2008. Daily bid and ask closing quotes were provided by ATHEX and merged with the data file containing the ex-days and dividends that were extracted from Datastream. The number of observations drops below 2,304 due to lack of availability of the bid and ask quotes before December 1994. The PDR is defined as $(P_{cum} - P_{ex}^{adjusted})/Div$ and the AR is defined as $[(P_{ex}-P_{cum} + Div)/ P_{cum} - R^{normal}]$. P_{cum} is the bid-ask midpoint or ask closing quote or bid closing quote on the cum-dividend day, for the three alternative calculations respectively. $P_{ex}^{adjusted}$ is the bid-ask midpoint or ask closing quote or bid closing quote on the ex-dividend day adjusted for the market risk (R^{normal}) on that day, for the three alternative calculations respectively. Div. is the dividend amount. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. T-statistics and sample sizes are reported below estimated mean values. The Wilcoxon signed-rank test was used for testing median values. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Trimmed Sample 2.5%, Period 1995-2008				
	Ho : "AR= 0"		Ho : "PDR= 1"	
	Mean	Median	Mean	Median
Bid Ask Midpoints	1.12%***	0.92%***	0.603***	0.634***
t-stat. / z-stat	20.71	20.39	-10.45	-17.31
No of Obs.	2,181	2,181	2,181	2,181
Ask to Ask Quotes	1.05%***	0.88%***	0.653***	0.649***
t-stat. / z-stat	18.92	19.07	-9.13	-15.94
No of Obs.	2,202	2,202	2,202	2,202
Bid to Bid Quotes	1.22%***	0.93%***	0.544***	0.623***
t-stat. / z-stat	20.53	20.29	-10.17	-17.49
No of Obs.	2,220	2,220	2,220	2,220

In order to test the “bid-ask bounce” hypothesis PDRs and ARs are re-calculated using bid-ask midpoints, ask to ask closing quotes and bid to bid closing quotes instead of transaction prices and the test of equality to their theoretical values is repeated. According to the Frank and Jagannathan (1998) model, in the absence of discreteness and taxes impact, these “alternative prices” should drop by the exact amount of the dividend. Koski (1996) also points out that the use of bid and ask quotes can eliminate potential measurement errors that may bias returns. As shown in Table 5-7, the re-computed mean and median[118] values of PDR and AR do not deviate much from the ones derived from transaction closing prices in Table 5-5 and the

[118] The Wilcoxon signed-rank test was used for testing median values.

hypotheses "Ho: PDR = 1" and "Ho: AR = 0" are still rejected at the 1% significance level, providing evidence against the "bid-ask bounce" hypothesis.[119]

A final comment should be made on the Dubofsky (1992) paper that suggests that ex-day abnormal returns in the U.S. market for the period 1962 - 1987 are caused due to the NYSE Rule 118 and AMEX Rule 132 combined with price discreteness prevalent over that period. In specific, these two rules require an exchange specialist to reduce all "good till canceled" limit buy orders that are open at the beginning of the ex-dividend trade day by the cash dividend amount while not adjusting likewise open limit sell orders. Although no direct tests have been performed on this hypothesis, the presence of approximate decimalization and the very infrequent use of "good till canceled" orders in the Greek market renders this theory unlikely to apply in the Greek ex-dividend day.[120]

5.4.3 Short-Term Arbitrage and Transaction Cost Hypothesis - Kalay (1982)

The cash component of the transaction cost in ATHEX consists of the Brokerage commission and the Exchange & Transfer fees. Average Brokerage fees did not exceed 1.0%, Exchange fees varied from 0.015% to 0.04% and Transfer fees for registered stocks varied from 0.025% to 0.3% of the transaction value of a one-way executed order, throughout the period examined.[121] However, as quoted in Milonas and Travlos (2001) *"very large transactions of institutional investors are treated with even smaller broker fees of around 0.10% - 0.20%"*. Since 1998, transactions on the ATHEX are also subject to a transfer tax rate of 0.30% (reduced to 0.15% in 2005) on the value of the proceeds that are received when a stock is sold.[122] This tax is always

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[119] The number of observations drops below 2,304 due to lack of availability of the bid and ask quotes before December 1994.

[120] According to the ATHEX Rulebook, limit orders that do not have any special duration feature, such as "good till cancel" and "until expiration" are automatically canceled at the end of the (cum-) trade day, if not executed.

[121] For example, in 2008, a major Greek broker charged 1.0% for trades up to 3,000 Euros, 0.75% for trades from 3,000 up to 9,000 Euros and 0.50% for trades above 9,000 Euros on the transaction value of the trade of retail investors.

[122] The transfer tax rate 0.3% was imposed for the first time in February 1998 with the publication of the Greek Law 2579/1998 (article 8). According to Greek Law 2742/1999 (article 22) the tax rate

imposed to all individual, corporate and institutional investors (excluding market makers), irrespective of whether the sale was profitable or not and constitutes part of the transaction cost for traders.

The implied trading component of the transaction cost consists of the intra-day bid-ask spread and the daily volatility of each stock. Panel A of Table 5-8 reports both of these transaction cost components separately for stocks paying an above median (0.117€) dividend, stocks paying a below median dividend and the total sample.[123] The % bid-ask spread is the ratio of the difference of the ask minus the bid closing quotes to the midpoint of the ask and bid closing quotes on the ex-dividend day and the volatility is the standard deviation of daily returns over the estimation period. The sample average % bid-ask spread is 1.7% and the sample average volatility is 2.9% with stocks paying above median dividends having lower bid-ask spreads (1.4%) and lower volatility (2.6%) than those paying below median dividends (2.0% and 3.2% respectively).

If all transaction cost components are accounted, the total transaction cost is found to vary from 1.2% for large institutional investors investing in high dividend yield stocks to 3.0% for retail investors investing in low dividend yield stocks. Given that the average abnormal return on the ex-dividend day is 1.18%, it is concluded that short term arbitrage or dividend capturing around the ex-day will be unable to eliminate the positive abnormal ex-day return due to the substantial trading cost and exposure to idiosyncratic risk.

At the same time, significantly negative abnormal returns are found on the day after the ex-day (-0.20%) and two days after the ex-day (-0.14%), with the abnormal return on the day in between still being negative but insignificant.

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increased from 0.3% to 0.6% for the stock sales that occurred during the period October, 1999 until December, 2000. Then, according to Greek Law 2874/2000 (article 37), it fell back to 0.3% until December, 2004. Finally, after the Greek Law 3296/2004 (article 12), the rate was cut to 0.15% for the stock sales realized after January 1st, 2005. The pertinent tax is considered to be an indirect and not an income tax, given that it is imposed on the stock sale proceeds and not on the profit realized from the exchange transaction.

[123] The number of observations has dropped from 2,304 to 2,204 due to lack of availability of the bid and ask quotes before December 1994.

Table 5-8: Transaction Cost and Abnormal Returns around the Ex-Dividend Day

Panel A of this table presents the average intra-day % bid ask-spread and the mean daily volatility for the 2.5% trimmed sample of ex-days of stocks listed in ATHEX during the period 1995 - 2008. The number of observations has dropped from 2,304 to 2,204 due to lack of availability of the bid and ask quotes before December 1994. The % bid-ask spread is calculated as $[(P^{ask} - P^{bid}) / 0.5*(P^{ask} + P^{bid})]$ on the ex-day and the volatility is the sample mean standard deviation of daily returns over the estimation period [-130, -31] before the ex-day. Panel B reports abnormal returns (AR) for a window of [-5, +5] days around the ex-day for the 2.5% trimmed sample of 2,304 ex-days of stocks listed in ATHEX during the period 1992 - 2008. ARs are adjusted for market risk using the market model that is estimated over the period [-130, -31] before the ex-day. The AR on the ex-day is defined as $[(P_{ex}-P_{cum} + Div)/ P_{cum} - R^{normal}]$. P_{cum} is the closing price on the cum-dividend day, P_{ex} is the closing price on the ex-day and the expected return (R^{normal}) is adjusted for the market risk using the market model that is estimated over the period [-130, -31] before the ex-day. Both analysis are repeated separately for stocks paying an above median (0.117€) dividend and stocks paying a below median dividend. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Panel A: Trimmed Sample 2.5%, Period 1995-2008, Transaction cost

	All Sample	Div. ≥ €0.117	Div. < €0.117
% Bid Ask Spread	1.7%	1.4%	2.0%
Volatility	2.9%	2.6%	3.2%
No of Obs	2,204	1,106	1,098

Panel B: Trimmed Sample 2.5%, Period 1992-2008, Abnormal Returns

	All Sample (Obs =2,304)		Div. ≥ €0.117 (Obs =1,181)		Div. < €0.117 (Obs = 1,123)	
Day	ARs (%)	t-stat	ARs (%)	t-stat	ARs (%)	t-stat
-5	0.16%***	3.00	0.27%***	4.17	0.04%	0.47
-4	0.08%	1.45	0.17%***	2.47	-0.01%	-0.16
-3	0.04%	0.78	0.03%	0.46	0.06%	0.63
-2	0.22%***	4.34	0.34%***	5.24	0.09%	1.19
-1	0.21%***	4.08	0.38%***	5.63	0.03%	0.43
Ex-day	1.18%***	20.72	1.18%***	15.43	1.18%***	13.91
1	-0.20%***	-3.59	-0.35%***	-5.03	-0.04%	-0.42
2	-0.07%	-1.26	-0.13%*	-1.88	-0.01%	-0.07
3	-0.14%***	-2.66	-0.12%*	-1.73	-0.17%**	-2.02
4	-0.03%	-0.55	-0.11%	-1.58	0.05%	0.61
5	0.02%	0.38	-0.06%	-0.85	0.10%	1.13

The abnormal returns (both positive and negative) for the high dividend payout stocks are more significant than average on these days whereas for the low dividend payout stocks they become insignificant, except from the ex-day and the day "+3". This is clear evidence that there is dividend capturing activity, possibly tax induced by domestic corporations and / or institutional investors who mainly target high dividend yield stocks. Nevertheless, as suggested above, dividend capturing is not capable of eliminating positive abnormal returns on the ex-day. This is strongly confirmed by the fact both likely (high %DY) and unlikely (low %DY) candidates for dividend capture, exhibit exactly the same positive abnormal return on the ex-day (1.18%).[124]

This section has elaborated on the non-applicability of hypothesis previously stated in the literature on the Greek ex-day abnormal returns but nothing has been said as to what is the generating mechanism of the Greek ex-day anomaly. Moreover, there are positive abnormal returns on the ex-day that might be driven by unexpected intra-day buying pressure. The sections to follow will shed light to this issue.

[124] As a robustness test, the AR [-5, +5] window is also employed for the analysis, using the ex-day market return adjustment for the calculation of abnormal returns, resulting in identical results to one decimal.

5.5 Abnormal Buying Pressure on the Greek Ex-Dividend Day

5.5.1 Description of Abnormal Buying Pressure on the Ex-Dividend Day

Assuming that no new information is conveyed to the market, there can only be two cases describing the stock price behaviour on the ex-dividend day. Either the market is strongly efficient so that the price drop because of the dividend takes place at the opening and the open to close price change is driven by the normal stock return. Or the market is weakly efficient so that the individual stock price reaction to both the dividend adjustment and the market movement simultaneously take place throughout the entire ex-day. As a result, in a complete market, the absolute percentage price change on the ex-day for an individual stock, on a market adjusted basis, should equal its dividend yield. Furthermore, when an adjustment is made for the normal return, neither of the above cases can predict buying pressure that could drive the ex-day closing price P_{ex} above the hypothesized value of (P_{cum} - D). In order to isolate the possible buying pressure effect, the average daily price P^{averg} is employed to break down the ex-day price abnormal return in three components; the component from the P_{cum}^{close} to P_{ex}^{open}, the component from the P_{ex}^{open} to the P_{ex}^{averg} and the component from P_{ex}^{averg} to the P_{ex}^{close}. The last component constitutes the designated proxy variable for abnormal buy pressure (%BP). P^{averg} is the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to. Implicitly, it is assumed that the average daily price P^{averg} will serve as a "demarcation line" between the price drop due to the dividend and the buying pressure that might follow on the ex-day. In specific, the three components are:

(i) the % AR from cum-day to ex-day opening, adjusted for one third of the expected return on the ex-day:

$$\%AR_{cumtoopen} = \frac{P_{ex}^{open} - P_{cum}^{close}}{P_{cum}^{close}} - 0.33 * \hat{R}^{normal} \qquad (5.9)$$

(ii) the % AR from ex-day opening to ex-day average, adjusted for one third of the expected return on the ex-day:

$$\%AR_{opentoaverg} = \frac{P_{ex}^{averg} - P_{ex}^{open}}{P_{ex}^{open}} - 0.33 * \hat{R}^{normal} \quad (5.10)$$

and (iii) the abnormal buy pressure component (%BP) from ex-day average to ex-day closing, adjusted for one third of the expected return on the ex-day:

$$\%BP_{ex} = \frac{P_{ex}^{close} - P_{ex}^{averg}}{P_{ex}^{averg}} - 0.33 * \hat{R}^{normal} \quad (5.11)$$

where R^{normal} is estimated using the market model as in Equation 5.2. Graham et al. (2003), compute overnight U.S. abnormal returns ($\%AR_{cumtoopen}$) by subtracting one half of the expected ex-day return. Nevertheless, the one third adjustment that is employed is regarded more appropriate for the Greek case on the grounds that at the open, trading volume is not great, as already shown in Table 5-1 (1.6% and 2.2% of total daily trading volume for year 2007 and 2008 respectively). Alternatively, the abnormal return break down is performed in 2 components:

(i) the % AR from cum-day to ex-day average, adjusted for one half of the expected return on the ex-day:

$$\%AR_{cumtoaverg} = \frac{P_{ex}^{averg} - P_{cum}^{close}}{P_{cum}^{close}} - 0.5 * \hat{R}^{normal} \quad (5.12)$$

and (ii) the abnormal buy pressure component (%BP) from ex-day average to ex-day closing, adjusted for one half of the expected return on the ex-day:

$$\%BP_{ex} = \frac{P_{ex}^{close} - P_{ex}^{averg}}{P_{ex}^{averg}} - 0.5 * \hat{R}^{normal} \quad (5.13)$$

Table 5-9 shows means and t-statistics for the ex-day abnormal return individual components under both breakdown variations. The ex-day sample is reduced to 1,717 observations due to lack of availability of the average daily price P^{averg} for the period before November 1999. The accuracy of this analysis is verified by the fact that the sum of all individual abnormal return components and the dividend yield (defined as the implied abnormal return on the last row of Table 5-9) is equal to the actual abnormal return on the ex-day (+1.22%). As expected, all abnormal return components up to P^{averg} are significantly negative due to the dividend adjustment whilst the P_{ex}^{averg} to P_{ex}^{close} return component is significantly positive due to abnormal buying pressure on the ex-day. In effect, the downward move of the average price is followed by an upward move on the ex-day, hence, lending a convex shape to the intra-day price direction. To the extent that abnormal buying pressure is driving the ex-day stock price on average, the % price drop, in absolute terms, will be less than the average dividend yield, ceteris paribus.

Table 5-9: Ex-Day Return Break Down in % Price Change Components

This table shows the breakdown of the ex-day abnormal return into the price drop due to the dividend and the abnormal buying pressure (%BP) prevalent on that day, for the 2.5% trimmed sample of ex-days of stocks listed in ATHEX during the period 1999 - 2008. The number of observations has dropped from 2,304 to 1,717 due to lack of availability of the daily average price (P^{averg}) before November 1999. P^{averg} is the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to. The P_{cum}^{close} to P^{open} return component is equal to $[((P_{ex}^{open} - P_{cum}^{close}) / P_{cum}^{close}) - 0.33*R^{normal}]$. The P^{open} to P^{averg} return component is equal to $[((P_{ex}^{averg} - P_{ex}^{open}) / P_{ex}^{open}) - 0.33*R^{normal}]$. The P_{cum}^{close} to P^{averg} return component is equal to $[((P_{ex}^{averg} - P_{cum}^{close}) / P_{cum}^{close}) - 0.5*R^{normal}]$. The P^{averg} to P_{ex}^{close} return component is equal to $[((P_{ex}^{close} - P_{ex}^{averg}) / P_{ex}^{averg}) - 0.5*R^{normal}]$ that is used as a proxy variable for the abnormal buying pressure on the ex-day. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. The implied AR is the sum of all the individual ex-day abnormal return components and the dividend yield (DY(%)). The DY(%) is the dividend amount as a percentage of the price on the cum-day (P_{cum}^{close}) and constitutes the expected absolute % price drop on the ex-day. T-statistics are reported below estimated mean values. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Trimmed Sample 2.5%, Period 1999-2008 (Obs=1,717)			
Actual AR	1.22%***	Price Drop Ratio	0.519***
t-stat	19.35	t-stat (Ho: PDR= 1)	-12.45
Three AR Components		Two AR Components	
Exp (% Price Drop) = DY(%)	2.61%	Exp (% Price Drop) = DY(%)	2.61%
cumPclose to Popen	-1.39%***	cumPclose to Paverage	-1.63%***
t-stat	-22.59	t-stat	-27.61
Popen to Paverage	-0.19%***		
t-stat	-3.50		
Paverage to exPclose (%BP)	0.20%***	Paverage to exPclose (%BP)	0.24%***
t-stat	6.03	t-stat	6.67
Total return (excl. dividends)	-1.37%	Total Return (excl. dividends)	-1.39%
Implied AR	1.23%	Implied AR	1.22%

5.5.2 Abnormal Buying Pressure Explaining the Ex-Dividend Day Anomaly

So far it has been proved that none of the "traditional" hypothesis is valid in the ATHEX case and that there is a significant buying pressure on the Greek ex-day. These presumptions imply that the abnormal buying pressure must be the sole driver of ex-day abnormal returns. If this is true, the following should apply:

Hypothesis<5-1a>: Stocks with no abnormal pressure on their ex-day should have PDRs and ARs equal to their fundamental values.

Hypothesis<5-1b>: If the abnormal returns (including dividends) are regressed against the abnormal buying pressure proxy variable on the ex-day, the estimated intercept should be equal to zero and the estimated beta coefficient should be equal to one.

The sample is split into stocks with positive %BP ("Buy pressure") and stocks with negative %BP ("No Buy pressure") and mean PDRs and ARs are estimated with their 95% confidence intervals and median PDRs and ARs, separately for each group and for the whole sample. Panel A of Table 5-10 gives descriptive statistics for the %BP variable for both sub-samples. Panel B of Table 5-10 shows that the mean (median) AR for the "Buy pressure" stocks is equal to 2.17% (1.78%), whereas the mean (median) AR for the "No buy pressure" stocks is 0.04% (0.04%) that is not significantly different from zero, at the 1% significance level. Panel C of Table 5-10 indicates that the mean PDR is significantly less than one (equal to zero!) for the "Buy pressure" stocks and significantly more than one (1.155) for the "No buy pressure" stocks.[125] The median PDR for the "Buy pressure" stocks is equal to 0.184, whereas for the "No buy pressure" stocks it equals 0.985 that is not significantly different from one, at the 1% significance level. Finally, all differences on the mean and median PDRs and ARs between the positive %BP and negative %BP stocks are

[125] As presented in Table 5-4, a PDR greater than 1 is predicted by the tax preferences of corporations and / or institutional investors.

statistically different from zero.[126] These results corroborate the validity of Hypothesis 5-1a.

Next, the ARs on the ex-day are regressed against the %BP variable, also using %DY as a control variable. The regression is repeated with three additional variables controlling for liquidity (mean turnover), idiosyncratic risk[127] (the ratio of individual stock standard deviation by the market standard deviation of daily returns over the estimation period) and firm size (natural log of individual stock market value on the cum-day).[128] As a proxy for the market return, the % change of the daily value of the ATHEX Composite Share Price index is employed. T-statistics are computed either with heteroscedasticity consistent standard errors, according to the White (1980) correction or with event clustering adjusted standard errors. Table 5-11 reports the estimated intercept and beta coefficients as well as F-statistics for the two models.[129] The intercept is found to be not significantly different from zero and the beta coefficient on the %BP is not significantly different from one for both models, hence, confirming Hypothesis 5-1b.

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[126] The non-parametric Wilcoxon signed-rank test and two-sample Wilcoxon rank-sum test was used for testing median values and the equality of medians, respectively.

[127] Michaely and Vila (1995) and Zhang et al. (2008) adopt this measure of non systematic risk.

[128] Following Naranjo et al. (2000), Lasfer (2008) and Zhang et al. (2008).

[129] F-statistics in parentheses refer to the regression that adjusts for event clustering.

Table 5-10: Ex-Day Buying Pressure Analysis for Abnormal Return and Price Drop Ratio

The 2.5% trimmed sample of 1,717 ex-days of stocks listed in ATHEX during the period 1999 - 2008 is split into stocks with positive abnormal buying pressure (“Buy pressure”) and stocks with negative abnormal buying pressure (“No Buy pressure”). The proxy for abnormal buying pressure (%BP) is defined as $[((P_{ex}^{close} - P_{ex}^{averg}) / P_{ex}^{averg}) - 0.5*R^{normal}]$. P^{averg} is the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to. Panel A gives descriptive statistics for the %BP variable for both sub-samples and the whole sample. Panel B reports means, medians and 95% confidence intervals for the mean of the abnormal ex-day return (AR) for both sub-samples and the whole sample. Panel C reports means, medians and 95% confidence intervals for the mean of the price drop ratio on the ex-day (PDR) for both sub-samples and the whole sample. The AR is defined as $[(P_{ex}-P_{cum} + Div)/ P_{cum} - R^{normal}]$ and the PDR is defined as $(P_{cum} - P_{ex}^{adjusted})/Div$ on the ex-day. $P_{ex}^{adjusted}$ is the closing price on the ex-dividend day adjusted for the market risk (R^{normal}) on that day and Div is the dividend amount. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. The last column in Panels B and C presents tests on the differences of the mean and median PDRs and ARs between the sub-samples of the positive %BP and negative %BP ex-days. The Wilcoxon signed-rank test was used for testing median values. The non parametric two-sample Wilcoxon rank-sum test is used for testing the difference between medians. T-statistics (z-statistics) are reported below estimated mean (median) values. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Panel A: Period 1999-2008 (Obs=1,717), Buy Pressure on the ex-day

Variable / Statistic	Total	Buy Press.	No Buy Press.
Buy Pressure	0.24%	1.18%	-0.92%
Std. Error	0.04%	0.04%	0.03%
No of Obs.	1,717	945	772
	[95% Confidence Interval for the mean]		
95% C.I. Lower	0.167%	1.109%	-0.983%
95% C.I. Upper	0.306%	1.255%	-0.859%

Panel B: Period 1999-2008 (Obs=1,717), Abnormal Return on the ex-day

Variable / Statistic	Total	Buy Press.	No Buy Press.	Difference
AR mean	1.22%***	2.17%***	0.04%	2.13%***
t-stat	19.35	26.75	0.56	18.66
AR median	0.93%***	1.78%***	0.04%	1.73%***
z-stat	19.04	22.99	0.01	19.45
	[95% Confidence Interval for the mean]			
95% C.I. Lower	1.094%	2.015%	-0.113%	
95% C.I. Upper	1.340%	2.334%	0.202%	

Panel C: Period 1999-2008 (Obs=1,717), Price Drop ratio on the ex-day

Variable / Statistic	Total	Buy Press.	No Buy Press.	Difference
Ho: mean PDR=1	0.519***	-0.0004***	1.155***	-1.155***
t-stat	-12.45	-20.66	2.86	-15.92
Ho: median PDR=1	0.574***	0.184***	0.985	-0.801***
z-stat	-16.73	-20.85	0.62	-18.73
	[95% Confidence Interval for the mean]			
95% C.I. Lower	0.443	-0.095	1.049	
95% C.I. Upper	0.595	0.095	1.261	

Table 5-11: Relationship between Abnormal Return and Buying Pressure on the Ex-Day

This table relates abnormal returns (AR) to the abnormal buying pressure (%BP) on the ex-day and several control variables, for the 2.5% trimmed sample of 1,717 ex-days of stocks listed in ATHEX during the period 1999 - 2008. Two equations are specified as:

$AR = \alpha + \beta_1(\%BP) + \beta_2(DY\%) + \varepsilon$
$AR = \alpha + \beta_1(\%BP) + \beta_2(DY\%) + \beta_3(Turnover) + \beta_4(IdiosyncVol) + \beta_5(Size) + \varepsilon$

AR is calculated as $[(P_{ex}-P_{cum} + Div)/ P_{cum} - R^{normal}]$ and %BP is calculated as $[((P_{ex}^{close} - P_{ex}^{averg}) / P_{ex}^{averg}) - 0.5*R^{normal}]$. P^{averg} is the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. DY(%) is the dividend amount as a % of the price on the cum-day (P_{cum}^{close}). *Turnover* is the mean ratio of (Volume / No of outstanding shares) over the estimation period [-130, -31] before the ex-day. Idiosyncratic risk (*IdiosyncVol*) is the ratio of (individual stock standard deviation / market standard deviation) of daily returns over the estimation period [-130, -31] before the ex-day. As a proxy for the market return, the % change of the daily value of the ATHEX Composite Share Price index is employed. Firm size (*Size*) is calculated as the natural log of individual stock market capitalization on the cum-day. Tests on the hypothesized values for the intercept (α) and β_1 coefficient of the estimated regressions are reported. T-statistics are computed either with heteroscedasticity consistent standard errors, according to the White (1980) correction or with event clustering adjusted standard errors. F-statistics in parentheses refer to the regression that adjusts for event clustering. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Period 1999-2008 (Obs=1,717), OLS Regression								
Ex-day AR	Intercept	Buy Press.	DY(%)	Turnover	IdiosyncVol.	Size		
	Ho:"α=0"	Ho:"β=1"					F-stat	Adj. R^2
Model 1	0.002	0.980	0.316***				190	0.36
(Heterosc. adj.)	1.11	-0.37	5.50				210	
(Cluster adj.)	1.05	-0.38	5.45					
Model 2	0.006	0.971	0.307***	-0.089	0.002**	-0.001**	92	0.38
(Heterosc. adj.)	1.06	-0.56	5.11	-0.54	2.52	-2.37	105	
(Cluster adj.)	1.09	-0.58	5.06	-0.50	2.52	-2.32		

5.6 The “Investor Unawareness” Hypothesis

5.6.1 Investor Unawareness Explaining Abnormal Buying Pressure on the Ex-Dividend Day

The notion of “investor awareness” has been widely documented in the literature of index additions and deletions. According to Chen et al. (2004), after a stock is added to an index, it is possible that investors, who become more aware of the stock, will rush to buy the stock generating positive abnormal returns after the announcement of the stock inclusion to the index. In a similar vein, it is argued that if a significant group of investors are “unaware” that the price falls on the ex-day because of the deprivation of the right to the dividend, they might wrongly interpret the stock as undervalued. Subsequently, the ex-day price drop occurring at (or short after) the opening of the ex-day will trigger significant buy orders that will result in the abnormal price appreciation that is evident on the ex-day of several Greek stocks. In essence, these “unaware investors” are assumed to follow the intra-ex-day price fluctuation but are ignorant of the dividend adjustment.

Quantifying investor awareness is not an easy task given that there is no direct measure. Following Chen et al. (2004), firm size and listing age are employed as proxy variables for investor awareness and turnover is also added. Implicitly, it is assumed that large firms with a long listing life will be better known than small, young stocks. Turnover can be related to investor awareness in the sense that a high turnover could reflect a wide ownership base monitoring the corporation and hence, following its dividend payout policy. *Log(RelSize)* is the natural logarithm of the individual stock market value scaled by the market capitalization of the ATHEX Composite Index on the cum-day.[130] *Log(Age)* is the natural logarithm of the number of months being listed on ATHEX and mean Turnover is calculated over the estimation period. The “Investor Unawareness” hypothesis suggests that:

Hypothesis<5-2>: Large, old firms with a high trade turnover should bear a lower buying pressure on the ex-day than small, young firms with a low trade turnover.

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[130] This controls for the impact that the equity market cycles will have on the individual stock’s market capitalization.

Table 5-12: Quintile And Regression Analysis For Abnormal Buying Pressure on The Ex-Day

First, the 2.5% trimmed sample of 1,717 ex-days of stocks listed in ATHEX during the period 1999 - 2008 is sorted into relative firm size, listing age and mean turnover quintiles. Firm size, listing age and turnover serve as proxy variables for the degree of "investor awareness" of the stock that distributes the dividend. Then, abnormal buying pressure (%BP) is calculated for each quintile in Panels A, B and C, respectively. %BP is calculated as $[((P_{ex}^{close} - P_{ex}^{averg}) / P_{ex}^{averg}) - 0.5*R^{normal}]$. P^{averg} is the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. *Log(RelSize)* is the natural logarithm of the individual stock market value scaled by the market capitalization of the ATHEX Composite Index on the cum-day. *Age* is the number of years that each stock has been listed on ATHEX, until the ex-day. *Turnover* is the mean ratio of (Volume / No of outstanding shares) over the estimation period [-130, -31] before the ex-day. Panel D reports estimated beta coefficients for the regression model that relates abnormal buying pressure (%BP) to the three proxy variables of the degree of "investor awareness" and one control variable, specified as:

$\%BP = \alpha + \beta_1 Log(RelSize) + \beta_2 (Turnover) + \beta_3 Log(Age) + \beta_4 (DY\%) + \varepsilon$

Log(Age) is the natural logarithm of the number of months being listed on ATHEX. Control variable *DY(%)* is the dividend amount as a % of the price on the cum-day (P_{cum}^{close}). T-statistics are computed either with heteroscedasticity consistent standard errors or with event clustering adjusted standard errors. F-statistics in parentheses refer to the regression that adjusts for event clustering. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Panel A: Period 1999-2008 (Obs=1,717), Buying Pressure per Relative Size Quintile

Quintile	No of Obs	log(RelSize)	BuyPress.
1 (Low)	344	-15.4	0.47%
2	343	-14.3	0.33%
3	344	-13.5	0.21%
4	343	-12.6	0.10%
5 (High)	343	-10.9	0.06%
Total	1,717	-13.4	0.24%

Panel B: Period 1999-2008 (Obs=1,717), Buying Pressure per Listing Age Quintile

Quintile	No of Obs	Age (years)	BuyPress.
1 (Low)	351	1.7	0.43%
2	347	4.4	0.30%
3	336	7.1	0.08%
4	340	10.6	0.18%
5 (High)	343	41.1	0.18%
Total	1,717	12.9	0.24%

Panel C: Period 1999-2008 (Obs=1,717), Buying Pressure per Turnover Quintile

Quintile	No of Obs	Turnover	BuyPress.
1 (Low)	344	0.04%	0.41%
2	343	0.09%	0.35%
3	344	0.16%	0.25%
4	343	0.28%	0.11%
5 (High)	343	0.79%	0.05%
Total	1,717	0.27%	0.24%

Panel D: Period 1999-2008 (Obs=1,717), OLS Regression					
Variables	Intercept	log(RelSize)	Turnover	Log(Age)	DY(%)
Exp(sign)		(-)	(-)	(-)	
Buy Press.	-0.004	-0.001***	-0.454***	-0.001***	-0.006
(Heterosc. adj.)	-1.34	-4.36	-4.22	-3.07	-0.35
(Cluster adj.)	-1.28	-4.01	-3.80	-2.93	-0.36
F statistic	10.95 (9.21)				
Adj. R^2	0.03				

First, the sample is sorted into relative size, listing age (in years) and mean turnover quintiles and % buying pressure is calculated for each quintile. Panel A and Panel C of Table 5-12 indicate that % BP falls monotonically with size and turnover. Panel B reports that % BP is higher for the lower two age quintiles, lowest for the middle age quintile and moderate for the higher two age quintiles indicating a weak negative relationship. Second, % BP is regressed against the three variables that serve as proxies for stock recognition and dividend yield as a control variable. Panel D depicts the significantly negative relationship between % buying pressure and all three explanatory variables, at the 1% significance level.[131] T-statistics are computed either with heteroscedasticity consistent standard errors or with event clustering adjusted standard errors.[132] The dividend yield is statistically insignificant. Overall, these findings give strong support to Hypothesis 5-2.

5.6.2 Investor Unawareness Explaining the Ex-Dividend Day Abnormal Returns

According to theory, stocks that are widely recognized by investors should have no abnormal ex-day returns given than no buying pressure will be exerted by investors who are not informed of the dividend. In order to examine this, the ex-day sample is alternatively grouped into three firm size quantiles, three listing age quantiles and three turnover quantiles. Then, observations that simultaneously belong to the upper quantile of firm size, listing age and turnover are marked as “High awareness ex-

[131] As a robustness check, both the quintile and the regression analysis were repeated using % buying pressure adjusted with one third of the normal daily return and almost identical results were found.

[132] F-statistics in parentheses refer to the regression that adjusts for event clustering.

days". Similarly, observations that simultaneously belong to the lowest quantile of firm size, listing age and turnover are marked as "Low awareness ex-days". Then, the mean % buy pressure, PDR and AR are calculated for each respective sub sample.

Table 5-13: Abnormal Return and Price Drop Ratio on the Ex-Day for High and Low Awareness Ex-Days

First, the 2.5% trimmed sample of 1,717 ex-days of stocks listed in ATHEX during the period 1999 - 2008 is alternatively grouped into three firm size quantiles, three listing age quantiles and three turnover quantiles. Firm size, listing age and turnover serve as proxy variables for the degree of "investor awareness" of the stock that distributes the dividend. Then, observations that simultaneously belong to the upper quantile of firm size, listing age and turnover are marked as "High awareness ex-days". Similarly, observations that simultaneously belong to the lowest quantile of firm size, listing age and turnover are marked as "Low awareness ex-days". Panel A and Panel B show the mean abnormal buying pressure (% BP), price drop ratio (PDR) and abnormal return (AR) on the ex-day, for each respective "High / Low awareness" sub sample of ex-days. AR is calculated as $[(P_{ex}-P_{cum} + Div)/ P_{cum} - R^{normal}]$ and %BP is calculated as $[((P_{ex}^{close} - P_{ex}^{averg}) / P_{ex}^{averg}) - 0.5*R^{normal}]$. P^{averg} is the weighted average price of all transactions that took place within a day where each intra-day price is weighted by the trading volume of the transaction it refers to. PDR is defined as $(P_{cum} - P_{ex}^{adjusted})$/Div on the ex-day where $P_{ex}^{adjusted}$ is the closing price on the ex-dividend day adjusted for the market risk (R^{normal}) on that day and Div is the dividend amount. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. T-statistics and p-values are reported on the hypothesized values for the mean % BP, PDR and AR of each "High / Low awareness" sub sample of ex-days. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Panel A: High Awareness ex-days (Obs. = 62)			
	Ho: "Buy Press. = 0"	Ho: "AR = 0"	Ho: "PDR = 1"
Mean	-0.05%	0.30%	0.878
t-stat	-0.30	1.39	-0.62
Conclude:	*Cannot Reject Ho*	*Cannot Reject Ho*	*Cannot Reject Ho*
Panel B: Low Awareness ex-days (Obs. = 64)			
	Ho: "Buy Press. = 0"	Ho: "AR = 0"	Ho: "PDR = 1"
Mean	1.23%	2.16%	0.291
t-stat	4.83***	5.01***	4.83***
Conclude:	*Reject Ho*	*Reject Ho*	*Reject Ho*

As reported in Panel A of Table 5-13, the highly recognized stocks have a mean AR insignificantly different from zero and a mean PDR insignificantly different from one, at the 1% significance level. One could reasonably argue that an alternative indicator of the degree of recognition for a stock is whether it is, or has been, included in a widely known exchange index. Thus, the names of these "high awareness" stocks were traced to confirm that more than two thirds of these are being or have been included in either the FTSE/ATHEX 20 (Large Cap) or the FTSE/ATHEX Mid 40 index. In contrast, from the stocks pertaining to the "Low awareness" group (see

Panel B of Table 5-13 for estimated AR and PDR) of ex-days, there was only one stock belonging to the FTSE/ATHEX Mid 40 index.

With view to "completing the jigsaw", a direct test of the relationship between the ex-day price AR and PDR and the three proxies for "investor awareness" is attempted, as following:

Hypothesis<5-3>: Small, young, illiquid stocks whose ex-days are "overlooked" by "unaware" investors should have a higher AR (lower PDR) on the ex-dividend day.

The OLS regression that is estimated employs ex-day AR (or PDR) as the dependent variable, the firm size, age and mean turnover as explanatory variables, and the dividend yield and idiosyncratic volatility as control variables. T-statistics are computed either with heteroscedasticity consistent standard errors or with event clustering adjusted standard errors.[133] The results for the whole period 1992-2008 (Obs. = 2,304) are presented in Table 5-14. In the AR regression, all explanatory variables have the hypothesized signs, size is significant at the 1% significance level and age and turnover are significant at the 10% significance.[134] Dividend yield is significantly positively related to AR because in essence, it constitutes a component of the AR on the ex-day. In the PDR regression, as expected, the opposite signs with the same significance levels are found for size, turnover and age. Furthermore, the PDR regression intercept (α=1.04) confirms the argument that after controlling for the "investor unawareness" effect, PDR should converge to its hypothesized value (PDR$\geq$1).[135]

It is well known in Greece that during the years 1999 and 2000, stocks listed in ATHEX suffered from great volatility. In 1999, the price of the ATHEX General Composite Index doubled whereas in 2000 it dropped almost by 40%. The mean stock standard deviation of daily returns for the sample climbed to 4.14% and 4.57% for year 1999 and 2000 respectively, while it was equal to 2.93% for the whole 1992-2008 period. As a result, it is likely for PDR extreme values to appear in these years. As a robustness check, the two regressions were re-estimated excluding 305

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[133] F-statistics in parentheses refer to the regression that adjusts for event clustering.

[134] The absence of the % buy pressure variable from this model lifts the limitation of the sample previously caused by the lack of average price data before November 1999.

[135] The null hypothesis that "PDR = 1" cannot be rejected at the 1% significance level.

observations from the 95% trimmed sample that fall within these two years (Obs. = 1,999). Table 5-14 indicates that size remains significant at the 1% level, turnover significance rises to 5% for both PDR and AR regressions and age significance rises to 5% for the PDR regression.[136] Overall, the regression results support Hypothesis 5-3 that postulates that stocks recognizable by their size, listing age and trading volume will exhibit AR and PDR values that are consistent with the fair valuation of the dividend on their ex-days.

[136] The AR and PDR regressions are repeated just for the 1999 - 2008 period sample of 1,717 observations and all size, turnover and age are estimated significant at the 1% level in the AR regression. In the PDR regression, size becomes less significant (t-statistic = 1.7), but age becomes more significant (t-statistic=3.2) in comparison to the 1992 - 2008 period.

Table 5-14: Testing the "Investor Unawereness" Hypothesis

This table relates the abnormal return (AR) or the price drop ratio (PDR) on the ex-day to the three proxy variables for "investor unawareness" and two control variables, for the 2.5% trimmed sample of 2,304 ex-days of stocks listed in ATHEX for the period 1992 - 2008, with the following specification:
$AR / PDR= \alpha + \beta_1 Log(RelSize) + \beta_2(Turnover) + \beta_3 Log(Age) + \beta_4(DY\%) + \beta_5(IdiosyncVol) + \varepsilon$
The same models are re-estimated excluding the 1999 and 2000 years (Obs.=1,999) with view to alleviating the impact of the PDR outliers created by excess volatility during these two years. AR is defined as $[(P_{ex}-P_{cum} + Div)/ P_{cum} - R^{normal}]$ and PDR is defined as $(P_{cum} - P_{ex}^{adjusted})/Div$ on the ex-day. $P_{ex}^{adjusted}$ is the closing price on the ex-dividend day adjusted for the market risk (R^{normal}) on that day and Div is the dividend amount. R^{normal} is the expected return on the ex-day adjusted with the market model that is estimated over the period [-130, -31] before the ex-day. *Log(RelSize)* is the natural logarithm of the individual stock market value scaled by the market capitalization of the ATHEX Composite Index on the cum-day. *Log(Age)* is the natural logarithm of the number of months being listed on ATHEX. *Turnover* is the mean ratio of (Volume / No of outstanding shares) over the estimation period [-130, -31] before the ex-day. Control variable *DY(%)* is the dividend amount as a % of the price on the cum-day (P_{cum}^{close}). Control variable *IdiosyncVol* is the ratio of (individual stock standard deviation / market standard deviation) of daily returns over the estimation period [-130, -31] before the ex-day. As a proxy for the market return, the % change of the daily value of the ATHEX Composite Share Price index is employed. T-statistics are computed either with heteroscedasticity consistent standard errors or with event clustering adjusted standard errors. F-statistics in parentheses refer to the regression that adjusts for event clustering. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Period 1992-2008 with (Obs=2,304) and without 1999 and 2000 years (Obs=1,999)						
		Obs=2,304	Obs=1,999		Obs=2,304	Obs=1,999
Variable	E(sign)	AR	AR	E(sign)	PDR	PDR
Constant		-0.021***	-0.024***		1.040***	1.151***
(Heterosc. adj.)		-3.86	-3.84		3.07	3.85
(Cluster adj.)		-3.71	-3.73		2.90	3.75
Relative size	(-)	-0.002***	-0.002***	(+)	0.060***	0.073***
(Heterosc. adj.)		-5.68	-6.00		2.78	3.69
(Cluster adj.)		-5.47	-5.82		2.59	3.44
Turnover	(-)	-0.057*	-0.075**	(+)	3.707*	3.313**
(Heterosc. adj.)		-1.95	-2.18		1.84	2.18
(Cluster adj.)		-1.90	-2.13		1.75	2.13
Age	(-)	-0.001*	-0.001*	(+)	0.056*	0.061**
(Heterosc. adj.)		-1.81	-1.77		1.74	2.22
(Cluster adj.)		-1.84	-1.79		1.74	2.20
Dividend Yield	(+)	0.283***	0.259***		0.750	2.541
(Heterosc. adj.)		6.29	5.20		0.47	1.64
(Cluster adj.)		6.15	5.12		0.39	1.58
Idiosync.Vol.		0.001	0.001		0.019	0.000
(Heterosc. adj.)		0.72	1.09		0.41	-0.01
(Cluster adj.)		0.59	0.92		0.32	0.00
F statistic		21.93 (19.34)	19.56 (17.97)		3.98 (3.25)	6.63 (5.46)
Adj. R^2		0.07	0.07		0.005	0.013

5.6.3 Investor Unawareness Affecting Abnormal Volume on the Ex-Dividend Day

Michaely and Vila (1995) prove that one of the primary determinants of the volume on the ex-dividend day is the degree of heterogeneity among investors in the relative valuation of the dividends. In specific, they state that if investors with differential (opposing) tax preferences trade on the same ex-day they will drive the PDR closer to its equilibrium value but mostly, they will significantly increase abnormal volume.[137] As explained in Section 5.4.1, tax preferences in Greece are relatively homogeneous given that almost all investors are either neutral or in favor of the dividend from a tax perspective. For this reason, insignificant or even negative abnormal volumes for ex-day trading are anticipated. By the same rationale though, there can be heterogeneous expectations as to the valuation of the stock on the ex-day. According to the "Unawareness hypothesis", the ex-days of "unaware" stocks are overwhelmed by investors who have the mistaken perception that these are undervalued. Their buying trades will make ex-day prices significantly diverge from their fundamental values to the extent that these are not offset by investors who correctly incorporate the elimination of the right of the dividend on the ex-day into their stock valuation. In effect, this postulated mispricing results from homogeneous "wrong" expectations on the ex-day from "unaware" investors. As a result, the following is hypothesized:

Hypothesis<5-4>: Buying pressure on the ex-day of "unaware" stocks should be accompanied with lower trading abnormal volume compared to stocks that are fairly valued and exhibit no buying pressure on the ex-day.

In order to test Hypothesis 5-4, abnormal volume (%AV), abnormal turnover (%ATO) and abnormal number of transactions (%ATR) on the ex-day are estimated for the "unaware stocks - with buy pressure" versus the "no buy pressure" sub samples. In their ex-day analysis for the Norwegian market, Dai and Rydqvist (2009) explicitly state that thinly traded markets are characterized by extremely positively skewed volumes. As shown in Panel A of Table 5-15 this is also true for the observed and abnormal volume, turnover and number of transaction figures on the Greek ex-

[137] They define this as the weighted average effective tax rate on dividends of all traders on the ex day where the weight reflects each trader's tax adjusted risk tolerance.

day. Notably, mean values for abnormal % volume (+14.1%) and abnormal % turnover (+13.5%) are highly positive whereas their respective median values are highly negative (-47.1% and -47.3%). For this reason, the non-parametric Wilcoxon rank-sum test is adopted for testing the equality of medians of the two sub-samples. Panel B shows that the median abnormal % volume, % turnover and % number of transactions for the "unaware stocks - with buy pressure" group are significantly lower (more negative) than their respective values for the "no buy pressure" group of stocks, at the 1% significance level. As a robustness test, this test of median differences is repeated using standardized abnormal volume (SAV), standardized abnormal turnover (SATO) and standardized abnormal number of transactions (SATR) as described in Section 5.3.2 and almost identical results are found (unreported). Dai and Rydqvist (2009) use observed rather than abnormal ex-day turnover to tackle the impact of skewness. Likewise, the test of median differences is repeated using observed ex-day volume,[138] turnover and number of transaction and even higher z-statistics are found (unreported) than the ones presented in Panel B. In short, Hypothesis 5-4 proves to be consistent with this study's findings on the ex-day trading volume.

[138] The volume figures are adjusted for stock splits and stock dividends.

Table 5-15: Buying Pressure Affecting Volume, Turnover and Number of Transactions on the Ex-Day

Panel A presents descriptive statistics for the observed volume (V), observed turnover (TO), observed number of transaction (TR), abnormal volume (%AV), abnormal turnover (%ATO) and abnormal number of transactions (%ATR) on the ex-day. V on the ex-day is adjusted for stock splits and stock dividends. TO is defined as (Volume / No of outstanding shares) on the ex-day. %AV is defined as %[(V - V^{averg}) / V^{averg}] on the ex-day where V^{averg} is the mean volume over the estimation [-130, 30] period. %ATO is defined as %[(TO - TO^{averg}) / TO^{averg}] on the ex-day where TO^{averg} is the mean turnover over the estimation [-130, 30] period. %ATR is defined as %[(TR - TR^{averg}) / TR^{averg}] on the ex-day where TR^{averg} is the mean number of transaction over the estimation [-130, 30] period. In addition, the 2.5% trimmed sample of 1,717 ex-days of stocks listed in ATHEX during the period 1999 - 2008 is split into ex-days with positive abnormal buying pressure ("Buy pressure") and ex-days with negative abnormal buying pressure ("No Buy pressure"). Panel B reports tests on the equality of the median %AV, median %ATO and median %ATR on the ex-day calculated for these two sub-samples. The non-parametric Wilcoxon rank-sum test is used for testing the difference of the medians of the two sub-samples. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Panel A: Period 1999-2008 (Obs. = 1,717), Descriptive Statistics

Statistic	Volume	Turnover	Transact.	%AVolume	%ATurnover	%ATransact.
Mean	109,922	0.21%	169	14.1%	13.5%	-1.4%
Median	26,380	0.09%	69	-47.1%	-47.3%	-29.4%
Stand. Deviation	379,633	0.75%	300	595%	594%	109%
Skewness	20.4	19.2	4.0	32.0	32.1	6.1

Panel B: Period 1999-2008 (Obs. = 1,717), Difference of medians

Variable	Buy Press.	No Buy Press.	Diff.	z-stat.	p-val
% AVolume	-52.2%	-39.9%	-12.4%***	3.39	0.00
% ATurnover	-52.3%	-40.1%	-12.2%***	3.45	0.00
% ATransactions	-34.8%	-24.6%	-10.2%***	3.17	0.00

5.7 Conclusions and Further Insights

According to the ex-dividend day literature, in a capital market with no taxes for dividends and capital gains and no microstructure distortions, the stock price should fall by the exact dividend amount on the ex-day. Although the Greek stock exchange represents one such trading environment, the average ratio of the price drop on the ex-day to the dividend amount is surprisingly less than one. In this study, none of the "traditional" tax, short-term arbitrage and microstructure hypothesis is applicable to the Greek ex-day case. Therefore, the key objective of this Chapter is to identify the driver of Greek ex-day abnormal returns.

In this pursuit, it is acknowledged that for more than a few investors, the ex-day of particular stocks can be indistinguishable from a non ex-trading day due to inadequate information concerning their dividend payouts. This will result in abnormal buying pressure on the ex-day that will prevent the stock price from decreasing by the full dividend amount, on a market adjusted basis. The main contribution of this Chapter is that it introduces a new "investor unawareness" hypothesis, outside the context of complete - rational markets, that is capable of explaining the empirical evidence found in the Greek ex-day which cannot be otherwise interpreted.

CHAPTER 6: CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Two of the studies presented in this thesis show clear evidence in support of irrational trading around the ex-dividend day induced by behavioral biases such as the disposition effect (NYSE and AMEX) or the investor awareness phenomenon (ATHEX) that cannot be fully explained by the traditional neoclassical finance paradigms. Moreover, the third study presents empirical evidence of abnormal returns at the close of the ex-dividend day (NYSE, AMEX and NASDAQ) that do not conform to the existing microstructure hypotheses previously stated in the ex-dividend bibliography. However, it remains for future research in other stock markets and other time periods to fully verify this conjecture. Overall, the main conclusion after compiling the stylized facts about trading around the ex-dividend day is that theoreticians are going to be challenged. Although much of the documented distinct empirical evidence can be explained by separate theoretical models, researchers will have to come up with better models than those that currently exist to explain these stylized facts in combination with one another.

The next concluding sections aim to briefly summarize the main inferences and implications that are deduced from the empirical results presented in the thesis, as well as indicate opportunities for further research that should attempt to reconcile both neoclassical and behavioral finance theories into a common objective; find the natural causes and influences of trading around the ex-dividend day by all marginal investors.

6.1 The Price Impact of the Disposition Effect on the Ex-Dividend Day

Since Shefrin and Statman (1985) introduced the notion of the disposition effect, a growing body of literature has examined whether and why the disposition effect is prevalent in the trading behavior of both individual and professional investors. However, little has been documented about whether this effect has a significant impact on stock prices, which is of primary importance in the finance literature. Inspired by the empirical study of Frazzini (2006), and Grinblatt and Han (2005), this thesis adds to the literature by examining the degree to which the tendency to sell winners more readily than losers facilitates or hinders the downward price adjustment of the stock price on the ex-dividend day.

The capital gains overhang proxy, as computed by Grinblatt and Han (2005), is employed to measure the accrued gain or loss for individual stocks just before the ex-day based on market-wide data on stock prices and turnovers. Consistent with the disposition effect, stocks with a positive capital gains overhang are found to have a higher price drop ratio than stocks with a negative capital gains overhang on the ex-day. Moreover, the market-adjusted price drop ratio is positively related to the level of the capital gains overhang. These results are attributed to the fact that active (limited) selling by holders of winning (losing) stocks accelerates (restrains) the downward price adjustment on the ex-day. Overall, results remain robust to numerous ex-day normal return specifications, panel data models adjusting for clusters along stock and time dimensions or fixed effects, different holding period length assumptions and the use of opening prices instead of closing prices on the ex-day.

Lastly, a test is performed on whether empirical results are driven by evident buy-sell order imbalances prior to the ex-day that are unrelated to the disposition effect. Abnormal buying (selling) pressure for winners (losers) prior to the ex-day seems to affect ex-day abnormal returns in the opposite direction of the disposition effect, providing no support for an alternative hypothesis. Furthermore, the thesis contributes to the ex-dividend day literature in that it nominates the disposition effect as a reason why the ex-dividend day price drop ratio might vary over time at the individual stock level. Specifically, it is shown that the price drop ratio referring to the same stock will be higher in good times than in bad times, in accordance with the predicted hypothesis.

This study has important implications for the ongoing discussion about whether behavioral biases identified during trading are capable of influencing asset prices. Admittedly, one of the most widely acknowledged biases, namely, the disposition effect, may create significant asymmetries in the valuation of common stocks on the ex-dividend day.

6.2 Intra-Day Analysis of the Limit Order Bias at the Ex-Dividend Day of U.S. Common stocks

Recent research by Jakob and Ma (2004, 2005) suggests that Dubofsky's (1992), "limit order adjustment" hypothesis prevails over Bali and Hite's (1998) "tick size" in the context of the competition among microstructure theories for providing a plausible explanation of the abnormal returns evident at the ex-dividend of U.S. markets. Chapter 4 of this thesis, performs an intraday analysis of the stock price and quote movement during the ex-dividend days with the view to specifying the conditions under which the "limit order adjustment" hypothesis has indeed relevant implications for the ex-dividend day anomaly. In this respect, the limit order bias evident at the ex-day open is found to cause a substantial widening of the bid-ask spread at the ex-day open, which translates into significant overnight abnormal returns for the ex-dividend day. Nevertheless, in the course of active trading by all market participants in between the open and close of the ex-day any limit order bias incurred at the open is reversed resulting in a break in the hypothesized link between the ex-day close valuation of the dividend and the "limit order adjustment" hypothesis.

In this context, several studies have deployed the cum-day close to ex-day open rather than the cum-day close to ex-day close price drops in their pursuit of confirming the validity of alternative hypotheses in explaining the ex-day anomaly, on the grounds that overnight price drops are less noisy, thereby, producing more robust results (Lakonishok and Vermaelen (1986), Graham, Michaely and Roberts (2003), and Jakob and Ma (2004)). In relation to this, empirical results reported in Chapter 4 imply that this is not advisable, as the price drops at the ex-day opening are due to be afflicted with the open limit order bias. Nevertheless, price drops calculated at the ex-day close are not equally affected and thus, serve as a safer methodological ground for future research in what drives the ex-day price drop discrepancy.

The drawing of the aforementioned inferences would not have been made possible if a time stamped minute-by-minute price and quote dataset had not been utilized in empirical analysis. In parallel, microstructure researchers traditionally opted for analyzing high frequency data in order for their empirical results to be more specific and robust. As a result, for future research related in particular to the impact of microstructure effects on the ex-dividend day, the examination of intraday, rather than daily, data seems to be the right path.

6.3 Abnormal Buying Pressure on the Ex-Dividend Day of the Greek Stock Market

The Greek stock market provides a rather simple case for the stock price movement on the ex-dividend day, free of the complexities that arise due to differential taxation, price discreteness, and trading by a variety of investor clienteles around the ex-day. Assuming that no significant information unrelated to the dividend is transmitted to the market on the ex-day, one should expect the price drop to equal the dividend amount, on average. Still, the price of Greek common stocks drops significantly less than the dividend, a puzzle that remains unresolved in the international literature until today. Empirical evidence is supporting the argument that ex-day buying pressure is so pervasive that it does not allow the stock price drop by the full amount of the dividend for a particular group of stocks, hence, generating significant positive abnormal returns on the ex-dividend day.

Prior empirical studies, unconditionally assume that investors are fully informed that the dividend goes ex on the particular date that has been previously announced by the distributing corporation. Thus, investors will time their trade before or after the ex-day on the basis of their preferences towards the dividend. At the same time, positing that all investors are fully aware of the ex-days of all stocks traded on the exchange can be questionable in a realistic framework and remains a subject for empirical investigation. Within this reasoning, if a group of investors who are uninformed of the dividend observe an initial price drop on the ex-day that cannot be predicted by their incomplete information set, they will be prone to believe that the stock is undervalued. Consequently, they will place buy orders for this stock with view to exploiting the seemingly trade opportunity, hence, exerting buying pressure on the ex-day. In addition, firm size, listing duration and trading activity constitute reasonable indicators of the degree of recognition of particular stocks by the investing population. In fact, Chen et al. (2004), in their study of index additions and deletions, use firm size and listing age as proxy variables for “investor awareness” of the stocks that are included in an index. Thus, if there are Greek stocks whose corporate actions such as the dividend payout are inadequately followed by a big group of investors, these stocks will most likely belong to small, young firms with low trading turnover. Therefore, stocks with these characteristics will be probable candidates for evident abnormal buying pressure and abnormal positive returns on their ex-days.

The empirical results of Chapter 5 corroborate this "investor unawareness" hypothesis since it is shown that small cap stocks with short listing life and low trading turnover are characterized by excess buying pressure on their ex-days leading to price drops that are remarkably smaller than their dividends. On the other hand, large cap, liquid stocks with a long listing history have price drops and abnormal returns on the ex-day that are not different from the dividend amount and zero, respectively, in the statistical sense.

Furthermore, although research concerning the stock price behaviour on the ex-dividend day has been extensive, disproportionate weight has been put to the cross-sectional and microstructure-related investigation of the sources of the ex-day premium. Further research on the time variation of the ex-day returns might bring new hypotheses as to how the relative pricing of the dividend on the ex-day reflects investor preferences that change according to their dynamic behavioural characteristics.

REFERENCES

Ajinkya, Bipin B., and Prem C. Jain, 1989, The behavior of daily stock market trading volume, *Journal of Accounting and Economics* 11, 331-359.

Bali, Rakesh, and Gailen L. Hite, 1998, Ex-dividend day stock price behavior: Discreteness or tax-induced clienteles? *Journal of Financial Economics* 47, 127-159.

Balasubramaniam, Vyas, William Bertin, Thomas Henker, and Laurie Prather, 2010, Dividend drop rations and tax theory: An intraday analysis under different tax and price quoting regimes, *Working Paper*.

Barber, Brad M., Yi-Tsung Lee, Yu-Jane Liu, and Terrance Odean, 2007, Is the aggregate investor reluctant to realise losses? Evidence from Taiwan, *European Financial Management* 13, 423-447.

Barberis, Nicholas, and Wei Xiong, 2009, What drives the disposition effect? An analysis of a long-standing preference-based explanation, *Journal of Finance* 64, 751-784.

Barclay, Michael J., 1987, Dividends, taxes and common stock prices: The ex-dividend day behavior of common stock prices before the income tax, *Journal of Financial Economics* 19, 31-44.

Bell, Leonie, and Tim Jenkinson, 2002, New evidence of the impact of dividend taxation and on the identity of the marginal investor, *Journal of Finance* 57, 1321-1346.

Booth, L.D., Johnston, D.J., 1984. The ex-dividend day behavior of Canadian stock prices: Tax changes and clientele effects. *Journal of Finance* 39, 457-476.

Boyd, John H., and Ravi Jagannathan, 1994, Ex-dividend price behavior of common stocks, *Review of Financial Studies* 7, 711-741.

Brock, A. William, and Allan W. Kleidon, 1992, Periodic market closure and trading volume: A model of intraday bids and asks, *Journal of Economic Dynamics and Control* 16, 451-489.

Cameron, Colin, Jonah Gelbach, and Douglas Miller, 2011, Robust inference with multiway clustering, *Journal of Business and Economic Statistics* 29, 238-249.

Campbell, Cynthia J., and Charles E. Wasley, 1996, Measuring abnormal daily trading volume for samples of NYSE/ASE and NASDAQ securities using parametric and nonparametric test statistics, *Review of Quantitative Finance and Accounting* 6, 309-326.

Carhart, Mark M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57-82.

Chan, K.C., W.G. Christie, and P.H. Schultz, 1995, Market structure and the intraday pattern of bid-ask spreads for NASDAQ securities, *Journal of Business* 68, 35-60.

Chen, H., Noronha, G., Singal, V., 2004. The price response to S&P index additions and deletions: Evidence of asymmetry and a new explanation. *Journal of Finance* 59, 1901–1929.

Chetty, Raj, Joseph Rosenberg, and Emmanuel Saez, 2007, The effects of taxes on market responses to dividend announcements and payments: What can we learn from the 2003 dividend tax cut? in Alan J. Auerbach, James R. Hines, Jr., and Joel Slemrod, ed.: *Taxing Corporate Income in the 21st Century* (Cambridge University Press).

Conrad, S. Jennifer, and Robert Conroy, 1994, Market microstructure and the ex-date return, *Journal of Finance* 49, 1507-1519.

Coval, Joshua D., and Tyler Shumway, 2005, Do behavioral biases affect prices? *Journal of Finance* 60, 1-34.

D'Agostino, Ralph B., Albert Belanger, and Ralph B. D'Agostino, Jr., 1990, A suggestion for using powerful and informative tests of normality, *American Statistician* 44, 316-321.

Dai, Q., Rydqvist, K., 2009. Investigation of the costly-arbitrage model of price formation around the ex-dividend day in Norway. *Journal of Empirical Finance* 16, 582–596.

Dasilas, A., 2009. The ex-dividend day stock price anomaly: Evidence from the Greek stock market. *Financial Markets and Portfolio Management* 23, 59–91.

Dhar, Ravi, and Ning Zhu, 2006, Up close and personal: Investor sophistication and the disposition effect, *Management Science* 52, 726-740.

Dubofsky, D., 1992. A market microstructure explanation of ex-day abnormal returns. *Financial Management*, 21, 32–43.

Eades, Kenneth M., Patrick J. Hess, and E. Han Kim, 1994, Time-series variation in dividend pricing, *Journal of Finance* 49, 1617-1638.

Elton, Edwin J., and Martin J. Gruber, 1970, Marginal stockholder tax rates and the clientele effect, *Review of Economics and Statistics* 52, 68-74.

Elton, Edwin J., Martin J. Gruber, and Christopher R. Blake, 2005, Marginal stockholder tax effects and ex-dividend-day price behavior: Evidence from taxable versus nontaxable closed-end funds, *Review of Economics and Statistics* 87, 579-586.

Elton, Edwin J., Martin J. Gruber, and Joel Rentzler, 1984, The ex-dividend day behavior of stock prices; A re-examination of the clientele effect: A comment, *Journal of Finance* 39, 551-556.

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3-56.

Fama, Eugene F., and James D. MacBeth, 1973, Risk, return and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607-636.

Foster, F.D., and S. Viswanathan, 1993, Variations in trading volume, return volatility and trading costs: Evidence on recent price formation models, *Journal of Finance* 48, 187-211.

Frank, Murray, and Ravi Jagannathan, 1998, Why do stock prices drop by less than the value of the dividend? Evidence from a country without taxes, *Journal of Financial Economics* 47, 161-188.

Frazzini, Andrea, 2006, The disposition effect and underreaction to news, *Journal of Finance* 61, 2017-2046.

Frino, Alex, David Johnstone, and Hui Zheng, 2004, The propensity for local traders in futures markets to ride losses: Evidence of irrational or rational behavior? *Journal of Banking and Finance* 28, 353-372.

Garvey, Ryan, and Anthony Murphy, 2004, Are professional traders too slow to realize their losses? *Financial Analysts Journal* 60, 35-43.

Gerety, M.S., and J.H. Mulherin, 1992, Trading halts and market activity: an analysis of volume at the open and the close, *Journal of Finance* 47, 1765-1784.

Graham, John R., and Alok Kumar, 2006, Do dividend clienteles exist? Evidence on dividend preferences of retail investors, *Journal of Finance* 61, 1305-1336.

Graham, John R., Roni Michaely, and Michael R. Roberts, 2003, Do price discreteness and transaction costs affect stock returns? Comparing ex-dividend pricing before and after decimalization, *Journal of Finance* 58, 2611-2635.

Green, Richard C., and Kristian Rydqvist, 1999, Ex-day behavior with dividend preference and limitations to short-term arbitrage: The case of Swedish lottery bonds, *Journal of Financial Economics* 53, 145-187.

Grinblatt, Mark, and Bing Han, 2005, Prospect theory, mental accounting, and momentum, *Journal of Financial Economics* 78, 311-339.

Grinblatt, Mark, and Matti Keloharju, 2001, What makes investors trade? *Journal of Finance* 56, 589-616.

Harris, Lawrence, 1988, Predicting contemporary volume with historic volume at differential price levels: Evidence supporting the disposition effect: Discussion, *Journal of Finance* 43, 698-699.

Hayashi, Fumio, and Ravi Jagannathan, 1990, Ex-day behavior of Japanese stock prices: New insights from new methodology, *Journal of the Japanese and International Economies* 4, 401-427.

Jain, P.C., and G.H. Joh, 1988, The dependence between hourly prices and trading volume, *Journal of Financial and Quantitative Analysis* 23, 269-83.

Jakob, Keith, and Tongshu Ma, 2004, Tick size, NYSE rule 118, and ex-dividend day stock price behavior, *Journal of Financial Economics* 72, 605-625.

Jakob, Keith, and Tongshu Ma, 2005, Limit Order Adjustment Mechanisms and Ex-Dividend Day Stock Price Behavior, *Financial Management* 34, 89-101.

Jin, Li, 2006, Capital gain tax overhang and price pressure, *Journal of Finance* 61, 1399-1431.

Kadapakkam, Palani-Rajan, 2000, Reduction of constraints on arbitrage trading and market efficiency: An examination of ex-day returns in Hong Kong after introduction of electronic settlement, *Journal of Finance* 55, 2841-2861.

Kadapakkam R.P., Martinez V., 2008. Ex-dividend returns: The Mexican puzzle. *Journal of Banking and Finance* 32, 2453–2461.

Kahneman, Daniel, and Amos Tversky, 1979, Prospect theory: An analysis of decision under risk, *Econometrica* 47, 263-291.

Kalay, Avner, 1982, The ex-dividend day behavior of stock prices: A re-examination of the clientele effect, *Journal of Finance* 37, 1059-1070.

Kalay, Avner, 1984, The ex-dividend day behavior of stock prices; A re-examination of the clientele effect: A reply, *Journal of Finance* 39, 557-561.

Kalay, Avner, and Marti G. Subrahmanyam, 1984, The ex-dividend day behavior of option prices, *Journal of Business* 57, 113-128.

Karpoff, J.M., Walkling, R.A., 1988. Short-term trading around ex-days: additional evidence. *Journal of Financial Economics* 21, 291–298.

Koski, Jennifer Lynch, 1996, A microstructure analysis of ex-dividend stock price behavior before and after the 1984 and 1986 tax reform acts, *Journal of Business* 69, 313-338.

Koski, J.L., Scruggs J.L., 1998. Who trades around the ex dividend day? Evidence from NYSE Audit file data. *Financial Management* 27, 58–72.

Lakonishok, Josef, and Seymour Smidt, 1986, Volume for winners and losers: Taxation and other motives for stock trading, *Journal of Finance* 41, 951-974.

Lakonishok, J., Vermaelen, T., 1986. Tax-induced trading around ex-dividend dates. *Journal of Financial Economics* 16, 287–319.

Lamdin, Douglas J., and Craig Hiemstra, 1993, Ex-dividend day share price behavior: Effects of the tax reform act of 1986, *Review of Economics and Statistics* 75, 778-783.

Lasfer, M. Ameziane, 1995, Ex-day behavior: Tax or short-term trading effects, *Journal of Finance* 50, 875-897.

Lasfer, M. Ameziane, 2008, Taxes and Ex–day returns: Evidence from Germany and the U.K., *National Tax Journal* 61, 721–742.

Lee, M. C. Charles, Belinda Mucklow, and Mark J. Ready, 1993, Depths, and the impact of earnings information: An intraday analysis, *Review of Financial Studies* 6, 345-374.

Liljeblom, E., Löflund, A., Hedvall, K., 2001. Foreign and domestic investors and tax induced ex-dividend day trading. *Journal of Banking and Finance* 25, 1687–1716.

Locke, Peter R., and Steven C Mann, 2005, Professional trader discipline and trade disposition, *Journal of Financial Economics* 76, 401-444.

Locke, Peter R., and Zhan Onayev, 2005, Trade duration: Information and trade disposition, *Financial Review* 40, 113-129.

Lynch, Anthony W., and Richard R. Mendenhall, 1997, New evidence on stock price effects associated with changes in the S&P 500 index, *Journal of Business* 70, 351-383.

McInish, T.H., and R.A. Wood, 1990, An analysis of transactions data for the Toronto Stock Exchange, *Journal of Banking and Finance* 14, 441-458.

McInish, T.H., and R.A. Wood, 1992, An analysis of intraday patterns in bid/ask spreads for NYSE stocks, *Journal of Finance* 47, 753-764.

Michaely, R., 1991, Ex-dividend day stock price behavior: the case of the 1986 Tax reform Act. *Journal of Finance* 46, 845-860.

Michaely, Roni, and Jean-Luc Vila, 1995, Investors' heterogeneity, prices, and volume around the ex-dividend day, *Journal of Financial and Quantitative Analysis* 30, 171-198.

Miller, Merton H., and Franco Modigliani, 1961, Dividend policy, growth, and the valuation of shares, *Journal of Business* 34, 411-433.

Milonas, T.N., Travlos, G.N., 2001. The ex-dividend day stock price behaviour in the Athens stock market. *Working Paper*.

Milonas, Nikolaos T., Nickolaos G. Travlos, Jason Zezhong Xiao, and Cunkai Tan, 2006, The ex-dividend day stock price behavior in the Chinese stock market, *Pacific-Basin Finance Journal* 14, 155-174.

Naranjo, Andy, M. Nimalendran, and Mike Ryngaert, 2000, Time variation of ex-dividend day stock returns and corporate dividend capture: A reexamination, *Journal of Finance* 55, 2357-2372.

Odean, Terrance, 1998, Are investors reluctant to realize their losses? *Journal of Finance* 53, 1775-1798.

Poterba, James M., and Lawrence H. Summers, 1984, New evidence that taxes affect the valuation of dividends, *Journal of Finance* 39, 1397-1415.

Rantapuska, Elias, 2008, Ex-dividend day trading: Who, how, and why? Evidence from the Finnish market, *Journal of Financial Economics* 88, 355-374.

Robin, Ashok J., 1991, The impact of the 1986 tax reform act on ex-dividend day returns, *Financial Management* 20, 60-70.

Roll, Richard, 1977, An analytic valuation formula for unprotected American call options on stocks with known dividends, *Journal of Financial Economics* 5, 251-258.

Shapira, Zur, and Itzhak Venezia, 2001, Patterns of behavior of professionally managed and independent investors, *Journal of Banking and Finance* 25, 1573-1587.

Shefrin, Hersh, and Meir Statman, 1985, The disposition to sell winners too early and ride losers too long: Theory and evidence, *Journal of Finance* 40, 777-790.

Stoll, H., and R. Whaley, 1990, Stock market structure and volatility, *Review of Financial Studies* 3, 37-71.

Thaler, Richard, 1985, Mental accounting and consumer choice, *Marketing Science* 4, 199-214.

Thompson, Samuel B., 2011, Simple formulas for standard errors that cluster by both firm and time, *Journal of Financial Economics* 99, 1-10.

White, Halbert, 1980, A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity, *Econometrica* 48, 817-838.

Zhang, Yi, Kathleen A. Farrell, and Todd A. Brown, 2008, Ex-dividend day price and volume: The case of 2003 dividend tax cut, *National Tax Journal* 61, 105-127.

APPENDIX

A-1 US Tax Reforms / Acts from 1969 to 2010 and their Effect on Taxation of Dividends and Capital Gains

1969 Tax reform Act (TRA)

The 1969 TRA reduced income tax rates for individuals and private entities. In specific, top tax bracket rates for individuals fell from 77% in 1969 to 71% in 1970.

1981 Economic recovery Act ("Reagan Act")

The 1981 Economic recovery Act featured a 25% reduction in individual tax brackets which were indexed for inflation thereafter. This resulted in decrease of the (income) dividend tax rate from 70% to 50%.

1984 Tax reform Act (TRA)

The 1984 TRA did not impose any change on the individual tax rates. However, it lengthened the minimum holding period for stocks held by corporations to be eligible for the inter-corporate dividend exclusion. Overall, it seems that it increased corporate taxation.

1986 Tax Reform Act (TRA)

The 1986 TRA was enacted in October 22, 1986 to simplify the income tax code, broaden the tax base and eliminate many tax shelters and other preferences. It was designed to be revenue neutral, given that individual taxes were decreased while corporate taxes were increased. The 1986 TRA ultimately consolidated tax brackets from fifteen levels of income to four levels of income. The highest income tax rate decreased from 50% to 38.5% in 1987 and to 28% in 1988 while the bottom rate was raised from 11% to 15% since many lower level tax brackets were consolidated. Dividend income remained taxable at the prevailing income tax rates per individual income tax bracket. However, the dividend exclusion that applied for part of the dividend amount prior to the 1986 TRA was eliminated. Due to the 1986 TRA, for the period 1988-1990, all capital gains, irrespective of holding period, were taxed at rates equal to the income tax rates, in all tax brackets. Finally, the corporate tax rate was reduced from 50% to 35%.

1990 Omnibus Budget Reconciliation Act

The 1990 Omnibus Budget Reconciliation Act was signed into law by President George H.W. Bush on November 5, 1990. It was enacted pursuant to the budget reconciliation process to reduce the United States federal budget deficit. It increased income taxes by creating a new 31 percent individual income tax rate. It discriminated between short term (for stocks held for less than 1 year) and long term (for stocks held for more than 1 year) but capped the long term capital gains rate at 28 percent. Previously, (years 1988 – 1989) all capital gains (namely, no distinction between short and long term was made) were taxed at the prevailing income tax rates.

1993 Omnibus Budget Reconciliation Act

President Clinton signed the 1993 Omnibus Budget Reconciliation Act on August 10, 1993. It created two higher income tax brackets of 36 percent and 39.6 percent for individuals. Hence, short term capital gains within these income tax brackets were equally taxed. There was no change on the tax rates of the long term capital gains (15% for the lowest income tax bracket of 15% and 28% for the higher income tax bracket of 28%, 31%, 36% and 39.6%. Dividend income remained taxable at the prevailing income tax rates per individual income tax bracket. The income tax brackets resulting from this Act (15%, 28%, 31%, 36%, 39.6%) remained unchanged thereafter until 2000, included. Finally, it created a 35% percent income tax rate for corporations.

1997 Tax-payer Relief Act

The 1997 Tax-payer Relief Act was signed into law by President Bill Clinton on August 5, 1997. It significantly reduced all long term (for stocks held for more than a year) capital gain tax rates compared to the period before May7, 1997. In specific the long term capital gain tax rate for the lowest income tax bracket (less or equal 15%)

was reduced from 15% to 10% and the long term capital gain tax rate for the higher income tax bracket (28% - 39.6%) was reduced from 28% to 20%. Dividend income remained taxable at the prevailing income tax rates per individual income tax bracket.

1998 Internal Revenue Service Restructuring and Reform Act

The 1998 Internal Revenue Service Restructuring and Reform Act, also known as Taxpayer Bill of Rights III, was enacted in July 22, 1998. It changed the holding period for long-term capital gain treatment from eighteen months to twelve months, effective for tax years that would begin after December 31, 1997.

2001 Economic Growth and Tax Relief Reconciliation Act (EGTRRA)

The 2001 EGTRRA was published in June 7th, 2001. Many of the tax reductions in EGTRRA were designed to be phased in over a period of up to 9 years. Many of these slow phase-ins were accelerated by the Jobs and Growth Tax Relief Reconciliation Act of 2003 (JGTRRA). The 2001 EGTRRA significantly reduced the individual income tax rates for all tax brackets by enforcing the following amendments; a new 10% bracket was created for single filers with taxable income up to $6,000, the 15% bracket's lower threshold was indexed to the new 10% bracket, the 28% bracket would be lowered to 25% by 2006, the 31% bracket would be lowered to 28% by 2006, the 36% bracket would be lowered to 33% by 2006, and the 39.6% bracket would be lowered to 35% by 2006. Accordingly, all tax rates for short term (for stocks held for less than 1 year) capital gains and long term (for stocks held for more than 1 year) capital gains were lowered in absolute terms. On the other hand, the relative taxation of capital gains with respect to taxable (dividend) income, namely, within each income tax bracket remained pretty much the same as before the 2001 EGTRRA; In specific, its level was 10% for the low tax brackets (10% and 15% marginal income tax rates), and 20% for the high tax brackets (27% - 39% marginal income tax rates) for both short term and long term capital gains. The only minor variation was the reduction of the capital gain tax rate of stock held for more than 5 years for the lowest 10% income tax bracket from 10% to 8%. The 2001 EGTRRA, also, postulated a dividend tax rate of 5% for the low tax brackets (less or equal to 15%) and a dividend tax rate for all other tax brackets (25%-39%), namely, becoming independent of the respective income tax bracket of the individual taxpayer. However, this was due to be effective from 2003 onwards, as it eventually did.

2003 Jobs & Growth Tax Relief Reconciliation Act (JAGTRRA)

The 2003 JAGTRRA is finalized by Congress and signed by President Bush within the May 22th – May 28th day period, 2003. It featured a significant reduction in the long-term capital gains (for stocks held for more than 1 year). In specific, for the low tax brackets (10% and 15% marginal income tax rates), capital gains tax rate decreased from 10% to 5% and for the high tax brackets (25% - 38% marginal income tax rates), capital gains tax rate decreased from 20% to 15%. At the same time, the dividend was thereafter taxed at a “fixed” 15% rate, irrespective of the individual tax-payer tax bracket. As a conclusion, the 2003 JAGTRRA, in effect, equalized personal tax rates on dividends and long term (for stocks held for more than 1 year) capital gains on the high tax brackets investors.

2006 Tax Increase Prevention and Reconciliation Act of 2005 (TIPRA)

The 2005 TIPRA was enacted on May 17, 2006 in order to extend the reduced tax rates on capital gains and dividends. Under the amended law, long-term capital gains (held beyond 1 year) and dividend income were taxed at a maximum rate of 15 percent through 2008. For taxpayers in the 10 and 15 percent tax brackets, the tax rate would be 5 percent through 2007 and zero in 2008. The bill also extended the two investor-friendly tax provisions for two years beyond their scheduled expiration at the end of 2008. As a result, the long-term capital gains rate would remain at 15 percent until December 31, 2010, for taxpayers in all except the 10-percent and 15-percent brackets. For those in the 10 percent and 15 percent brackets, long-term capital gains would be taxed at 5 percent for the 2006 and 2007 tax years and at 0 percent for the 2008-2010 period. In addition, dividends would continue to receive the same tax treatment as capital gains through the end of 2010. Without action, these rates would have increased after 2008.

Note

The required holding period had its lowest value (6 months) from 1942 to 1976 – a period which also saw some of the largest differentials between dividend and effective capital gains tax rates. For the period 1988-1990, after the Tax Reform of 1986, a minimum holding period was not applicable, as this is two year window is the only period in U.S. history when capital gains were taxed as ordinary income. In all other years from 1991 onwards, assets held in the long term (beyond 6 or 18 months) were favored with a lower rate compared to the respective income tax bracket tax rate.

A-2 Robustness Tests: The Price Impact of the Disposition Effect on the Ex-Dividend Day

A-2.1 Difference of Mean and Median PDR/AR^{ex} between Losers and Winners with Different Holding Periods for the Capital Gain Overhang (CGOH). PDR/AR^{ex} per CGOH Quantile with Different Holding Periods for the CGOH.

Table A-2.1.1: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} Per CGOH Quantile for CGOH Window of [-360, -1] days.

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 360 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between winners and losers

	PDR			AR^{ex}		
Status (CGOH360)	Obs	Mean	Median	Obs	Mean	Median
Losers	9,918	0.592	0.714	9,670	0.200%	0.180%
Winners	15,768	0.835	0.900	16,016	0.079%	0.055%
Diff.		-0.243***	-0.187***		0.122%***	0.124%***
t-stat / z-stat		-4.57	-6.09		6.91	7.08
Total	25,686	0.741	0.832	25,686	0.124%	0.097%

Panel B: PDR per CGOH360 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-26.5%	-7.5%	-2.1%	2.7%	7.9%	16.2%	Total
Median	0.686	0.679	0.765	0.875	0.895	0.951	0.832
Mean	0.531***	0.566***	0.679***	0.760***	0.787***	0.960	0.741***
t-stat (PDR=1)	-6.04	-6.09	-4.70	-4.59	-3.96	-0.62	-9.97
Obs	3,306	3,306	3,306	5,256	5,256	5,256	25,686

Panel C: AR^{ex} per CGOH360 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
Median	0.237%	0.189%	0.135%	0.069%	0.060%	0.031%	0.097%
Mean	0.259%***	0.204%***	0.139%***	0.108%***	0.084%***	0.045%***	0.124%***
t-stat (AR^{ex}=0)	8.99	8.38	6.16	6.58	5.08	2.49	15.13
Obs	3,223	3,223	3,224	5,339	5,339	5,338	25,686

Table A-2.1.2: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} Per CGOH Quantile for CGOH Window of [-250, -1] days.

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 250 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between winners and losers

	PDR			AR^{ex}		
Status (CGOH250)	Obs	Mean	Median	Obs	Mean	Median
Losers	10,186	0.565	0.701	9,950	0.209%	0.184%
Winners	15,500	0.858	0.914	15,736	0.071%	0.051%
Diff.		-0.293***	-0.213***		0.137%***	0.133%***
t-stat / z-stat		-5.51	-7.08		7.90	8.08
Total	25,686	0.741	0.832	25,686	0.124%	0.097%

Panel B: PDR per CGOH250 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-23.5%	-6.7%	-1.8%	2.3%	6.9%	14.3%	Total
Median	0.656	0.694	0.746	0.872	0.896	1.005	0.832
Mean	0.496***	0.597***	0.602***	0.762***	0.795***	1.016	0.741***
t-stat (PDR=1)	-6.46	-5.74	-5.98	-4.60	-3.75	0.24	-9.97
Obs	3,395	3,395	3,396	5,167	5,167	5,166	25,686

Panel C: AR^{ex} per CGOH250 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
Median	0.241%	0.174%	0.150%	0.079%	0.060%	0.003%	0.097%
Mean	0.262%***	0.193%***	0.171%***	0.117%***	0.066%***	0.031%*	0.124%***
t-stat (AR^{ex}=0)	9.24	8.11	7.89	7.15	3.94	1.67	15.13
Obs	3,316	3,317	3,317	5,246	5,245	5,245	25,686

Table A-2.1.3: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} Per CGOH Quantile for CGOH Window of [-150, -1] days.

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 150 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between winners and losers

	PDR			AR^{ex}		
Status (CGOH150)	Obs	Mean	Median	Obs	Mean	Median
Losers	10,558	0.542	0.700	10,353	0.208%	0.178%
Winners	15,128	0.881	0.919	15,333	0.068%	0.051%
Diff.		-0.338***	-0.219***		0.140%***	0.127%***
t-stat / z-stat		-6.41	-7.66		8.16	8.24
Total	25,686	0.741	0.832	25,686	0.124%	0.097%

Panel B: PDR per CGOH150 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-19.0%	-5.5%	-1.5%	1.9%	5.7%	12.0%	Total
Median	0.661	0.662	0.779	0.880	0.909	0.991	0.832
Mean	0.476***	0.520***	0.630***	0.833***	0.817***	0.992	0.741***
t-stat (PDR=1)	-6.72	-7.17	-5.57	-3.27	-3.26	-0.12	-9.97
Obs	3,519	3,519	3,520	5,043	5,043	5,042	25,686

Panel C: AR^{ex} per CGOH150 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
Median	0.224%	0.193%	0.117%	0.072%	0.059%	0.011%	0.097%
Mean	0.246%***	0.227%***	0.152%***	0.096%***	0.064%***	0.044%**	0.124%***
t-stat (AR^{ex}=0)	8.85	10.04	7.07	5.79	3.84	2.33	15.13
Obs	3,451	3,451	3,451	5,111	5,111	5,111	25,686

Table A-2.1.4: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} Per CGOH Quantile for CGOH Window of [-60, -1] days.

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 60 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between winners and losers

	PDR			AR^{ex}		
Status (CGOH60)	Obs	Mean	Median	Obs	Mean	Median
Losers	10,774	0.579	0.732	10,630	0.184%	0.154%
Winners	14,912	0.859	0.899	15,056	0.083%	0.060%
Diff.		-0.281***	-0.167***		0.101%***	0.094%***
t-stat / z-stat		-5.32	-6.16		5.97	6.03
Total	25,686	0.741	0.832	25,686	0.124%	0.097%

Panel B: PDR per CGOH60 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-11.6%	-3.6%	-1.0%	1.2%	3.7%	8.3%	Total
Median	0.606	0.727	0.846	0.801	0.918	1.006	0.832
Mean	0.381***	0.586***	0.768***	0.669***	0.843***	1.066	0.741***
t-stat (PDR=1)	-7.99	-5.95	-3.69	-6.49	-2.79	0.99	-9.97
Obs	3,591	3,591	3,592	4,971	4,971	4,970	25,686

Panel C: AR^{ex} per CGOH60 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
Median	0.261%	0.145%	0.085%	0.113%	0.058%	0.011%	0.097%
Mean	0.270%***	0.168%***	0.113%***	0.134%***	0.076%***	0.038%*	0.124%***
t-stat (AR^{ex}=0)	10.10	7.47	5.52	8.20	4.43	1.91	15.13
Obs	3,543	3,543	3,544	5,019	5,019	5,018	25,686

Table A-2.1.5: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} Per CGOH Quantile for CGOH Window of [-30, -1] days.

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 30 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between winners and losers

	PDR				AR^{ex}		
Status (CGOH30)	Obs	Mean	Median		Obs	Mean	Median
Losers	11,140	0.536	0.700		11,048	0.198%	0.167%
Winners	14,546	0.899	0.922		14,638	0.069%	0.051%
Diff.		-0.363***	-0.223***			0.129%***	0.116%***
t-stat / z-stat		-6.92	-8.08			7.71	7.75
Total	25,686	0.741	0.832		25,686	0.124%	0.097%

Panel B: PDR per CGOH30 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-7.6%	-2.4%	-0.7%	0.8%	2.6%	6.1%	Total
Median	0.604	0.689	0.805	0.845	0.917	1.028	0.832
Mean	0.391***	0.605***	0.611***	0.773***	0.876**	1.047	0.741***
t-stat (PDR=1)	-7.89	-6.04	-5.99	-4.33	-2.27	0.69	-9.97
Obs	3,713	3,713	3,714	4,849	4,849	4,848	25,686

Panel C: AR^{ex} per CGOH30 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
Median	0.241%	0.180%	0.103%	0.099%	0.048%	-0.001%	0.097%
Mean	0.255%***	0.176%***	0.163%***	0.115%***	0.063%***	0.028%	0.124%***
t-stat (AR^{ex}=0)	9.86	8.20	8.11	6.87	3.65	1.39	15.13
Obs	3,682	3,683	3,683	4,880	4,879	4,879	25,686

Table A-2.1.6: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners, and PDR/AR^{ex} Per CGOH Quantile for CGOH Window of [-15, -1] days.

Panel A tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Panels B and C report the mean and median PDR/AR^{ex} per six CGOH quantiles as well as t-statistics from testing whether the mean PDR/AR^{ex} is equal to its hypothesized value (PDR=1 or AR^{ex}=0). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of 15 calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A: Difference of mean and median PDR/AR^{ex} between winners and losers

	PDR			AR^{ex}		
Status (CGOH15)	Obs	Mean	Median	Obs	Mean	Median
Losers	11,619	0.595	0.711	11,570	0.185%	0.158%
Winners	14,067	0.863	0.921	14,116	0.075%	0.053%
Diff.		-0.268***	-0.209***		0.111%***	0.105%***
t-stat / z-stat		-5.15	-6.74		6.66	6.90
Total	25,686	0.741	0.832	25,686	0.124%	0.097%

Panel B: PDR per CGOH15 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
CGOH90	-5.0%	-1.6%	-0.5%	0.5%	1.7%	4.3%	Total
Median	0.578	0.709	0.841	0.802	0.925	1.065	0.832
Mean	0.360***	0.635***	0.788***	0.636***	0.869**	1.083	0.741***
t-stat (PDR=1)	-8.48	-5.69	-3.49	-6.70	-2.32	1.20	-9.97
Obs	3,872	3,872	3,872	4,689	4,689	4,689	25,683

Panel C: AR^{ex} per CGOH15 Quantile

	Losers			Winners			
Quantile	3	2	1	1	2	3	
Median	0.229%	0.159%	0.106%	0.129%	0.048%	-0.029%	0.097%
Mean	0.248%***	0.192%***	0.116%***	0.154%***	0.057%***	0.013%	0.124%***
t-stat (AR^{ex}=0)	9.84	9.28	6.05	8.98	3.18	0.64	15.13
Obs	3,855	3,856	3,856	4,706	4,705	4,705	25,683

A-2.2 Hypothesis 3.1: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners with Different Estimation Models and Different Holding Periods for the CGOH.

Table A-2.2.1: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Market Model Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,918	0.592	0.714	9,670	0.200%	0.180%
Winners (CGOH360)	15,768	0.835	0.900	16,016	0.079%	0.055%
Diff.		-0.243***	-0.187***		0.122%***	0.124%***
t-stat / z-stat		-4.57	-6.09		6.91	7.08
Losers (CGOH250)	10,186	0.565	0.701	9,950	0.209%	0.184%
Winners (CGOH250)	15,500	0.858	0.914	15,736	0.071%	0.051%
Diff.		-0.293***	-0.213***		0.137%***	0.133%***
t-stat / z-stat		-5.51	-7.08		7.90	8.08
Losers (CGOH150)	10,558	0.542	0.700	10,353	0.208%	0.178%
Winners (CGOH150)	15,128	0.881	0.919	15,333	0.068%	0.051%
Diff.		-0.338***	-0.219***		0.140%***	0.127%***
t-stat / z-stat		-6.41	-7.66		8.16	8.24
Losers (CGOH90)	10,752	0.539	0.684	10,570	0.202%	0.184%
Winners (CGOH90)	14,934	0.887	0.928	15,116	0.071%	0.046%
Diff.		-0.348***	-0.244***		0.131%***	0.138%***
t-stat / z-stat		-6.62	-8.09		7.70	8.19
Losers (CGOH60)	10,774	0.579	0.732	10,630	0.184%	0.154%
Winners (CGOH60)	14,912	0.859	0.899	15,056	0.083%	0.060%
Diff.		-0.281***	-0.167***		0.101%***	0.094%***
t-stat / z-stat		-5.32	-6.16		5.97	6.03
Losers (CGOH30)	11,140	0.536	0.700	11,048	0.198%	0.167%
Winners (CGOH30)	14,546	0.899	0.922	14,638	0.069%	0.051%
Diff.		-0.363***	-0.223***		0.129%***	0.116%***
t-stat / z-stat		-6.92	-8.08		7.71	7.75
Losers (CGOH15)	11,619	0.595	0.711	11,570	0.185%	0.158%
Winners (CGOH15)	14,067	0.863	0.921	14,116	0.075%	0.053%
Diff.		-0.268***	-0.209***		0.111%***	0.105%***
t-stat / z-stat		-5.15	-6.74		6.66	6.90

Table A-2.2.2: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Value Weight Index Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP value-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,922	0.696	0.755	9,678	0.158%	0.156%
Winners (CGOH360)	15,764	0.846	0.889	16,008	0.079%	0.065%
Diff.		-0.149***	-0.134***		0.079%***	0.091%***
t-stat / z-stat		-2.81	-4.62		4.52	5.04
Losers (CGOH250)	10,199	0.678	0.750	9,953	0.163%	0.158%
Winners (CGOH250)	15,487	0.860	0.898	15,733	0.074%	0.061%
Diff.		-0.182***	-0.148***		0.089%***	0.096%***
t-stat / z-stat		-3.43	-5.10		5.15	5.55
Losers (CGOH150)	10,563	0.681	0.764	10,355	0.153%	0.138%
Winners (CGOH150)	15,123	0.863	0.885	15,331	0.079%	0.068%
Diff.		-0.182***	-0.121***		0.075%***	0.071%***
t-stat / z-stat		-3.45	-4.65		4.37	4.65
Losers (CGOH90)	10,757	0.707	0.766	10,575	0.141%	0.134%
Winners (CGOH90)	14,929	0.846	0.884	15,111	0.086%	0.069%
Diff.		-0.139***	-0.119***		0.055%***	0.064%***
t-stat / z-stat		-2.64	-4.04		3.26	3.79
Losers (CGOH60)	10,780	0.751	0.808	10,636	0.117%	0.108%
Winners (CGOH60)	14,906	0.815	0.862	15,050	0.103%	0.083%
Diff.		-0.064	-0.054*		0.014%	0.026%
t-stat / z-stat		-1.22	-1.89		0.80	1.07
Losers (CGOH30)	11,148	0.699	0.780	11,057	0.135%	0.120%
Winners (CGOH30)	14,538	0.856	0.884	14,629	0.089%	0.074%
Diff.		-0.158***	-0.104***		0.047%***	0.045%***
t-stat / z-stat		-3.01	-3.57		2.79	2.77
Losers (CGOH15)	11,627	0.773	0.801	11,559	0.122%	0.106%
Winners (CGOH15)	14,059	0.800	0.871	14,127	0.098%	0.081%
Diff.		-0.027	-0.070		0.023%	0.024%
t-stat / z-stat		-0.52	-1.61		1.40	1.51

Table A-2.2.3: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Stock Mean Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day that is the arithmetic mean stock return over the estimation window of [(–130, –31) & (+31, +130)] days window around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,898	0.577	0.676	9,581	0.197%	0.201%
Winners (CGOH360)	15,788	0.900	0.867	16,105	0.066%	0.080%
Diff.		-0.322***	-0.191***		0.132%***	0.120%***
t-stat / z-stat		-5.00	-6.11		6.19	6.50
Losers (CGOH250)	10,170	0.559	0.660	9,861	0.201%	0.204%
Winners (CGOH250)	15,516	0.917	0.876	15,825	0.061%	0.078%
Diff.		-0.359***	-0.216***		0.139%***	0.126%***
t-stat / z-stat		-5.59	-6.82		6.62	6.99
Losers (CGOH150)	10,536	0.606	0.696	10,254	0.183%	0.185%
Winners (CGOH150)	15,150	0.893	0.858	15,432	0.070%	0.085%
Diff.		-0.287***	-0.163***		0.113%***	0.100%***
t-stat / z-stat		-4.49	-5.61		5.46	5.73
Losers (CGOH90)	10,729	0.643	0.710	10,467	0.161%	0.168%
Winners (CGOH90)	14,957	0.870	0.848	15,219	0.083%	0.092%
Diff.		-0.227***	-0.138***		0.078%***	0.076%***
t-stat / z-stat		-3.56	-4.56		3.82	4.38
Losers (CGOH60)	10,757	0.711	0.766	10,548	0.143%	0.138%
Winners (CGOH60)	14,929	0.822	0.816	15,138	0.095%	0.109%
Diff.		-0.111*	-0.050***		0.048%***	0.028%***
t-stat / z-stat		-1.74	-2.39		2.34	2.50
Losers (CGOH30)	11,121	0.647	0.721	10,981	0.153%	0.151%
Winners (CGOH30)	14,565	0.874	0.843	14,705	0.087%	0.098%
Diff.		-0.227***	-0.123***		0.066%***	0.053%***
t-stat / z-stat		-3.58	-4.37		3.27	3.58
Losers (CGOH15)	11,621	0.696	0.732	11,510	0.145%	0.147%
Winners (CGOH15)	14,065	0.841	0.843	14,176	0.090%	0.100%
Diff.		-0.144***	-0.111***		0.055%***	0.047%***
t-stat / z-stat		-2.30	-3.29		2.76	3.01

Table A-2.2.4: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Fama and French (1997) Model Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the Fama and French (1997) model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,926	0.693	0.754	9,672	0.169%	0.160%
Winners (CGOH360)	15,760	0.843	0.897	16,014	0.079%	0.059%
Diff.		-0.150***	-0.143***		0.090%***	0.101%***
t-stat / z-stat		-2.85	-4.68		5.24	5.51
Losers (CGOH250)	10,194	0.675	0.753	9,956	0.174%	0.157%
Winners (CGOH250)	15,492	0.858	0.900	15,730	0.074%	0.056%
Diff.		-0.183***	-0.147***		0.100%***	0.100%***
t-stat / z-stat		-3.50	-5.20		5.89	6.04
Losers (CGOH150)	10,560	0.653	0.764	10,355	0.169%	0.142%
Winners (CGOH150)	15,126	0.878	0.897	15,331	0.075%	0.061%
Diff.		-0.225***	-0.133***		0.095%***	0.080%***
t-stat / z-stat		-4.32	-5.29		5.62	5.57
Losers (CGOH90)	10,754	0.670	0.759	10,573	0.162%	0.144%
Winners (CGOH90)	14,932	0.868	0.897	15,113	0.078%	0.061%
Diff.		-0.198***	-0.138***		0.083%***	0.083%***
t-stat / z-stat		-3.82	-4.98		4.99	5.25
Losers (CGOH60)	10,780	0.697	0.794	10,624	0.144%	0.118%
Winners (CGOH60)	14,906	0.849	0.876	15,062	0.090%	0.074%
Diff.		-0.152***	-0.082***		0.054%***	0.045%***
t-stat / z-stat		-2.92	-3.48		3.25	3.14
Losers (CGOH30)	11,154	0.686	0.771	11,048	0.157%	0.126%
Winners (CGOH30)	14,532	0.861	0.890	14,638	0.079%	0.067%
Diff.		-0.176***	-0.119***		0.078%***	0.059%***
t-stat / z-stat		-3.39	-4.61		4.75	4.56
Losers (CGOH15)	11,622	0.755	0.801	11,557	0.141%	0.107%
Winners (CGOH15)	14,064	0.810	0.877	14,129	0.090%	0.075%
Diff.		-0.056	-0.077***		0.051%***	0.032%***
t-stat / z-stat		-1.08	-2.64		3.11	3.02

Table A-2.2.5: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Carhart (1997) Model Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as [(P^{cum} – (P^{ex}/(1 + R^{norm}))) / Div] and the AR^{ex} is defined as [((P^{ex} – P^{cum} + Div) / P^{cum}) – R^{norm}]. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the four-factor Carhart (1997) model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,916	0.680	0.751	9,655	0.177%	0.164%
Winners (CGOH360)	15,770	0.853	0.907	16,031	0.072%	0.054%
Diff.		-0.173***	-0.156***		0.104%***	0.109%***
t-stat / z-stat		-3.30	-4.98		6.08	6.35
Losers (CGOH250)	10,188	0.665	0.747	9,941	0.180%	0.162%
Winners (CGOH250)	15,498	0.866	0.909	15,745	0.068%	0.052%
Diff.		-0.201***	-0.163***		0.112%***	0.109%***
t-stat / z-stat		-3.85	-5.57		6.61	6.88
Losers (CGOH150)	10,554	0.655	0.757	10,333	0.173%	0.145%
Winners (CGOH150)	15,132	0.878	0.904	15,353	0.070%	0.057%
Diff.		-0.224***	-0.147***		0.102%***	0.088%***
t-stat / z-stat		-4.31	-5.37		6.12	6.18
Losers (CGOH90)	10,754	0.684	0.758	10,553	0.163%	0.142%
Winners (CGOH90)	14,932	0.860	0.900	15,133	0.076%	0.057%
Diff.		-0.175***	-0.143***		0.087%***	0.085%***
t-stat / z-stat		-3.39	-4.72		5.25	5.51
Losers (CGOH60)	10,779	0.716	0.790	10,615	0.144%	0.119%
Winners (CGOH60)	14,907	0.837	0.880	15,071	0.089%	0.073%
Diff.		-0.121***	-0.090***		0.055%***	0.046%***
t-stat / z-stat		-2.34	-3.09		3.33	3.28
Losers (CGOH30)	11,153	0.697	0.765	11,042	0.151%	0.126%
Winners (CGOH30)	14,533	0.855	0.894	14,644	0.082%	0.067%
Diff.		-0.158***	-0.129***		0.069%***	0.058%***
t-stat / z-stat		-3.07	-4.15		4.23	4.12
Losers (CGOH15)	11,633	0.765	0.808	11,555	0.135%	0.106%
Winners (CGOH15)	14,053	0.804	0.879	14,131	0.093%	0.079%
Diff.		-0.038	-0.071***		0.042%***	0.027%***
t-stat / z-stat		-0.75	-2.12		2.61	2.55

Table A-2.2.6: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Market Model (One Half) Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as [(P^{cum} – (P^{ex}/(1 + R^{norm}))) / Div] and the AR^{ex} is defined as [((P^{ex} – P^{cum} + Div) / P^{cum}) – R^{norm}]. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the opening price on the ex-dividend day adjusted for one half of the market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,878	0.646	0.677	9,607	0.226%	0.202%
Winners (CGOH360)	15,750	0.829	0.864	16,021	0.100%	0.072%
Diff.		-0.183***	-0.187***		0.126%***	0.130%***
t-stat / z-stat		-7.07	-9.91		14.29	14.26
Losers (CGOH250)	10,149	0.637	0.672	9,902	0.221%	0.198%
Winners (CGOH250)	15,479	0.838	0.869	15,726	0.100%	0.070%
Diff.		-0.201***	-0.197***		0.121%***	0.128%***
t-stat / z-stat		-7.78	-10.65		13.95	13.95
Losers (CGOH150)	10,523	0.629	0.676	10,292	0.218%	0.188%
Winners (CGOH150)	15,105	0.849	0.870	15,336	0.100%	0.070%
Diff.		-0.219***	-0.194***		0.118%***	0.118%***
t-stat / z-stat		-8.53	-10.78		13.77	13.69
Losers (CGOH90)	10,702	0.651	0.690	10,501	0.209%	0.179%
Winners (CGOH90)	14,926	0.836	0.860	15,127	0.104%	0.075%
Diff.		-0.184***	-0.170***		0.105%***	0.104%***
t-stat / z-stat		-7.18	-9.46		12.31	12.25
Losers (CGOH60)	10,731	0.647	0.691	10,571	0.203%	0.175%
Winners (CGOH60)	14,897	0.839	0.858	15,057	0.108%	0.078%
Diff.		-0.192***	-0.167***		0.095%***	0.097%***
t-stat / z-stat		-7.47	-9.45		11.23	11.33
Losers (CGOH30)	11,111	0.652	0.697	11,012	0.196%	0.165%
Winners (CGOH30)	14,517	0.840	0.860	14,616	0.110%	0.080%
Diff.		-0.189***	-0.163***		0.086%***	0.085%***
t-stat / z-stat		-7.38	-9.32		10.29	10.26
Losers (CGOH15)	11,616	0.675	0.733	11,546	0.182%	0.149%
Winners (CGOH15)	14,012	0.828	0.842	14,082	0.119%	0.090%
Diff.		-0.152***	-0.109***		0.063%***	0.059%***
t-stat / z-stat		-6.00	-6.81		7.59	7.40

Table A-2.2.7: Difference of Mean and Median PDR/AR^{ex} between Losers and Winners per CGOH Window: Market Model (One Third) Adjust.

This table tests the significance of the difference of the mean and median PDR/AR^{ex} between stocks with a negative CGOH (losers) and stocks with a positive CGOH (winners). Means and medians have been calculated after trimming the top and bottom 2.5 percentiles separately for the PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the opening price on the ex-dividend day adjusted for one third of the market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(–130, –31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T [=360, 250, 150, 90, 60, 30, 15] calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data, and described in Section 3.2.5. The Wilcoxon rank-sum test is used for testing the difference of median values. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR			AR^{ex}		
	Obs	Mean	Median	Obs	Mean	Median
Losers (CGOH360)	9,883	0.651	0.674	9,628	0.222%	0.197%
Winners (CGOH360)	15,745	0.795	0.831	16,000	0.112%	0.087%
Diff.		-0.144***	-0.157***		0.111%***	0.110%***
t-stat / z-stat		-6.28	-9.63		13.94	14.20
Losers (CGOH250)	10,152	0.642	0.671	9,917	0.220%	0.194%
Winners (CGOH250)	15,476	0.804	0.836	15,711	0.111%	0.086%
Diff.		-0.161***	-0.165***		0.108%***	0.108%***
t-stat / z-stat		-7.08	-10.39		13.85	14.03
Losers (CGOH150)	10,521	0.640	0.677	10,310	0.216%	0.190%
Winners (CGOH150)	15,107	0.809	0.836	15,318	0.111%	0.085%
Diff.		-0.169***	-0.159***		0.105%***	0.105%***
t-stat / z-stat		-7.43	-10.14		13.64	13.73
Losers (CGOH90)	10,704	0.657	0.689	10,525	0.207%	0.183%
Winners (CGOH90)	14,924	0.799	0.831	15,103	0.116%	0.088%
Diff.		-0.142***	-0.141***		0.091%***	0.095%***
t-stat / z-stat		-6.28	-8.98		12.01	12.13
Losers (CGOH60)	10,737	0.648	0.690	10,604	0.202%	0.178%
Winners (CGOH60)	14,891	0.806	0.831	15,024	0.119%	0.089%
Diff.		-0.158***	-0.141***		0.083%***	0.089%***
t-stat / z-stat		-6.96	-9.36		10.89	11.28
Losers (CGOH30)	11,121	0.643	0.694	11,024	0.198%	0.171%
Winners (CGOH30)	14,507	0.814	0.831	14,604	0.120%	0.092%
Diff.		-0.171***	-0.137***		0.078%***	0.079%***
t-stat / z-stat		-7.54	-9.49		10.38	10.53
Losers (CGOH15)	11,621	0.673	0.723	11,559	0.184%	0.156%
Winners (CGOH15)	14,007	0.795	0.816	14,069	0.128%	0.100%
Diff.		-0.122***	-0.094***		0.056%***	0.057%***
t-stat / z-stat		-5.45	-6.87		7.44	7.56

A-2.3 Hypothesis 3.2: Examining the Relationship between PDR/AR^{ex} and the Capital Gain Overhang (CGOH) with Estimation Different Models and Different Holding Periods for the CGOH.

Table A-2.3.1: Relationship between PDR and CGOH: Weighted Least Squares - Market Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Closing Ex-day Prices - Weighted Least Squares - Market Model Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.1600***	1.1618***	1.1628***	1.1558***	1.1494***	1.1475***	1.1534***
	(10.38)	(10.40)	(10.41)	(10.34)	(10.29)	(10.27)	(10.33)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.8577***	1.0717***	1.3625***	1.8028***	2.4219***	4.0600***	6.4276***
	(6.09)	(6.81)	(7.13)	(7.49)	(7.92)	(8.91)	(9.68)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	1.4492**	1.4698**	1.4823**	1.4637**	1.4489**	1.4198**	1.2638*
	(2.01)	(2.04)	(2.06)	(2.03)	(2.01)	(1.97)	(1.76)
	0.04	0.04	0.04	0.04	0.04	0.05	0.08
MCap	0.0156	0.0154	0.0163	0.0169	0.0179	0.0192	0.0197
	(1.21)	(1.19)	(1.26)	(1.31)	(1.39)	(1.49)	(1.53)
	0.23	0.23	0.21	0.19	0.16	0.14	0.13
TO	0.0832***	0.0842***	0.0821***	0.0789***	0.0760***	0.0721***	0.0702***
	(2.99)	(3.03)	(2.96)	(2.86)	(2.75)	(2.62)	(2.55)
	0.00	0.00	0.00	0.00	0.01	0.01	0.01
IVol	-0.0669***	-0.0678***	-0.0677***	-0.0668***	-0.0651***	-0.0637***	-0.0639***
	(-2.85)	(-2.89)	(-2.89)	(-2.85)	(-2.78)	(-2.72)	(-2.73)
	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Tax03	-0.0439	-0.0418	-0.0342	-0.0256	-0.0188	-0.0168	-0.0171
	(-0.90)	(-0.86)	(-0.70)	(-0.53)	(-0.39)	(-0.34)	(-0.35)
	0.37	0.39	0.48	0.60	0.70	0.73	0.73
Adj R^2	0.002	0.003	0.003	0.003	0.003	0.004	0.004
F stat	10.39	11.96	12.70	13.56	14.66	17.46	19.83
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.2: Relationship between AR^{ex} and CGOH: Ordinary Least Squares - Market Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Closing Ex-day Prices - Ordinary Least Squares - Market Model Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0016***	-0.0016***	-0.0016***	-0.0016***	-0.0015***	-0.0015***	-0.0016***
	(-3.35)	(-3.39)	(-3.41)	(-3.35)	(-3.30)	(-3.30)	(-3.36)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	-0.0050***	-0.0058***	-0.0066***	-0.0083***	-0.0106***	-0.0171***	-0.0266***
	(-6.6)	(-6.72)	(-6.43)	(-6.43)	(-6.72)	(-7.49)	(-7.85)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0197**	0.0200**	0.0208**	0.0217**	0.0224**	0.0233***	0.0243***
	(2.13)	(2.16)	(2.24)	(2.34)	(2.42)	(2.52)	(2.64)
	0.03	0.03	0.03	0.02	0.02	0.01	0.01
MCap	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-3.95)	(-3.99)	(-4.11)	(-4.17)	(-4.25)	(-4.32)	(-4.34)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0003***	-0.0003***	-0.0003***
	(-3.56)	(-3.48)	(-3.27)	(-3.11)	(-2.99)	(-2.88)	(-2.86)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IVol	0.0002*	0.0002*	0.0002*	0.0002*	0.0002	0.0002	0.0002
	(1.66)	(1.71)	(1.70)	(1.65)	(1.58)	(1.53)	(1.53)
	0.10	0.09	0.09	0.10	0.11	0.13	0.13
Tax03	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.68)	(0.55)	(0.28)	(0.07)	(-0.08)	(-0.14)	(-0.15)
	0.50	0.58	0.78	0.95	0.93	0.89	0.88
Adj R^2	0.005	0.006	0.005	0.005	0.006	0.006	0.007
F stat	17.59	17.92	17.35	17.44	18.05	19.93	20.76
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.3: Relationship between PDR and CGOH: Weighted Least Squares - Value Weight Index Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP value-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Closing Ex-day Prices - Weighted Least Squares - Value Weight Index Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.1228***	1.1245***	1.1270***	1.1251***	1.1246***	1.1245***	1.1274***
	(10.39)	(10.40)	(10.43)	(10.41)	(10.40)	(10.40)	(10.43)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.6690***	0.7822***	0.8211***	0.9221***	1.0462***	1.6822***	2.5213***
	(4.76)	(4.98)	(4.31)	(3.84)	(3.42)	(3.70)	(3.80)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	1.2155*	1.2268*	1.2227*	1.2039*	1.1911*	1.1776*	1.1156
	(1.69)	(1.71)	(1.70)	(1.68)	(1.66)	(1.64)	(1.55)
	0.09	0.09	0.09	0.09	0.10	0.10	0.12
MCap	0.0165	0.0168	0.0183	0.0192	0.0200	0.0206	0.0209
	(1.27)	(1.30)	(1.41)	(1.48)	(1.55)	(1.60)	(1.62)
	0.20	0.19	0.16	0.14	0.12	0.11	0.11
TO	0.0899***	0.0891***	0.0840***	0.0800***	0.0769***	0.0749***	0.0738***
	(3.23)	(3.21)	(3.03)	(2.90)	(2.79)	(2.72)	(2.68)
	0.00	0.00	0.00	0.00	0.01	0.01	0.01
IVol	-0.0421	-0.0423	-0.0417	-0.0409	-0.0400	-0.0392	-0.0395
	(-1.55)	(-1.56)	(-1.53)	(-1.51)	(-1.47)	(-1.44)	(-1.46)
	0.12	0.12	0.12	0.13	0.14	0.15	0.15
Tax03	-0.0279	-0.0250	-0.0182	-0.0130	-0.0102	-0.0098	-0.0098
	(-0.57)	(-0.51)	(-0.37)	(-0.27)	(-0.21)	(-0.20)	(-0.20)
	0.57	0.61	0.71	0.79	0.83	0.84	0.84
Adj R^2	0.002	0.002	0.001	0.001	0.001	0.001	0.001
F stat	7.23	7.60	6.55	5.91	5.42	5.74	5.87
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.4: Relationship between AR^{ex} and CGOH: Ordinary Least Squares - Value Weight Index Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP value-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Closing Ex-day Prices - Ordinary Least Squares - Value Weight Index Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0011***	-0.0011***	-0.0011***	-0.0011***	-0.0011***	-0.0011***	-0.0011***
	(-2.41)	(-2.44)	(-2.48)	(-2.48)	(-2.48)	(-2.46)	(-2.48)
	0.02	0.01	0.01	0.01	0.01	0.01	0.01
CGOH	-0.0031***	-0.0033***	-0.0029***	-0.0028**	-0.0031*	-0.0060***	-0.0094***
	(-3.94)	(-3.79)	(-2.79)	(-2.17)	(-1.92)	(-2.57)	(-2.76)
	0.00	0.00	0.01	0.03	0.06	0.01	0.01
DY	0.0143	0.0146	0.0156*	0.0162*	0.0166*	0.0168*	0.0171*
	(1.58)	(1.61)	(1.72)	(1.80)	(1.84)	(1.86)	(1.90)
	0.12	0.11	0.09	0.07	0.07	0.06	0.06
MCap	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-3.67)	(-3.71)	(-3.83)	(-3.89)	(-3.93)	(-3.93)	(-3.94)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0003***
	(-3.53)	(-3.45)	(-3.22)	(-3.09)	(-3.02)	(-3.02)	(-3.00)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IVol	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.43)	(0.45)	(0.44)	(0.42)	(0.40)	(0.38)	(0.39)
	0.67	0.65	0.66	0.67	0.69	0.70	0.70
Tax03	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(-0.19)	(-0.29)	(-0.49)	(-0.59)	(-0.64)	(-0.66)	(-0.67)
	0.85	0.77	0.63	0.55	0.52	0.51	0.51
Adj R^2	0.003	0.003	0.003	0.003	0.003	0.003	0.003
F stat	11.28	11.12	10.01	9.50	9.32	9.84	9.96
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.5: Relationship between PDR and CGOH: Weighted Least Squares - Stock Mean Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is the arithmetic mean stock return over the estimation window of [(−130, −31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR using Closing Ex-day Prices - Weighted Least Squares - Stock Mean Adjust.						
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.1130***	1.1181***	1.1237***	1.1204***	1.1204***	1.1207***	1.1226***
	(8.30)	(8.34)	(8.38)	(8.35)	(8.35)	(8.35)	(8.37)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH (T)	1.2947***	1.4919***	1.6357***	1.8434***	2.0020***	3.1542***	5.6163***
	(7.67)	(7.93)	(7.16)	(6.4)	(5.49)	(5.80)	(7.06)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	1.2571	1.2790	1.2765	1.2391	1.2105	1.1837	1.0494
	(1.45)	(1.48)	(1.48)	(1.43)	(1.40)	(1.37)	(1.21)
	0.15	0.14	0.14	0.15	0.16	0.17	0.23
MCap	0.0317**	0.0323**	0.0346**	0.0364**	0.0382***	0.0393***	0.0395***
	(2.04)	(2.08)	(2.23)	(2.35)	(2.46)	(2.54)	(2.55)
	0.04	0.04	0.03	0.02	0.01	0.01	0.01
TO	0.0387	0.0369	0.0289	0.0211	0.0143	0.0104	0.0103
	(1.16)	(1.11)	(0.87)	(0.64)	(0.43)	(0.31)	(0.31)
	0.25	0.27	0.38	0.52	0.67	0.75	0.75
IVol	0.0240	0.0229	0.0230	0.0239	0.0250	0.0259	0.0262
	(0.86)	(0.82)	(0.82)	(0.85)	(0.89)	(0.92)	(0.93)
	0.39	0.41	0.41	0.39	0.37	0.36	0.35
Tax03	-0.1216**	-0.1161**	-0.1035*	-0.0925	-0.0861	-0.0846	-0.0843
	(-2.07)	(-1.98)	(-1.77)	(-1.58)	(-1.47)	(-1.44)	(-1.44)
	0.04	0.05	0.08	0.11	0.14	0.15	0.15
Adj R^2	0.003	0.003	0.002	0.002	0.001	0.002	0.002
F stat	11.87	12.54	10.59	8.89	7.08	7.65	10.35
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.6: Relationship between AR^{ex} and CGOH: Ordinary Least Squares - Stock Mean Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is the arithmetic mean stock return over the estimation window of [(−130, −31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	AR^{ex} using Closing Ex-day Prices - Ordinary Least Squares - Stock Mean Adjust.						
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0017***	-0.0017***	-0.0017***	-0.0017***	-0.0017***	-0.0017***	-0.0018***
	(-3.04)	(-3.07)	(-3.12)	(-3.13)	(-3.15)	(-3.17)	(-3.20)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	-0.0058***	-0.0067***	-0.0069***	-0.0074***	-0.0076***	-0.0114***	-0.0194***
	(-6.07)	(-6.21)	(-5.34)	(-4.54)	(-3.86)	(-4.09)	(-4.72)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0259***	0.0261***	0.0274***	0.0287***	0.0295***	0.0301***	0.0306***
	(2.57)	(2.59)	(2.70)	(2.82)	(2.90)	(2.95)	(3.01)
	0.01	0.01	0.01	0.00	0.00	0.00	0.00
MCap	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(-4.07)	(-4.13)	(-4.29)	(-4.39)	(-4.47)	(-4.52)	(-4.53)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0002*	-0.0002*	-0.0002	-0.0002	-0.0001	-0.0001	-0.0001
	(-1.73)	(-1.64)	(-1.36)	(-1.14)	(-0.99)	(-0.91)	(-0.91)
	0.08	0.10	0.17	0.26	0.32	0.36	0.36
IVol	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(-0.66)	(-0.63)	(-0.64)	(-0.67)	(-0.69)	(-0.70)	(-0.69)
	0.51	0.53	0.52	0.50	0.49	0.48	0.49
Tax03	0.0007***	0.0007***	0.0006***	0.0006***	0.0006**	0.0005**	0.0005**
	(3.07)	(2.95)	(2.66)	(2.47)	(2.36)	(2.33)	(2.32)
	0.00	0.00	0.01	0.01	0.02	0.02	0.02
Adj R^2	0.004	0.005	0.004	0.003	0.003	0.003	0.003
F stat	14.26	14.58	12.79	11.42	10.46	10.76	11.52
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.7: Relationship between PDR and CGOH: Weighted Least Squares - Market Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is the return of the CRSP equal-weighted NYSE/AMEX index on the ex-day. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR using Closing Ex-day Prices - Weighted Least Squares - Market Adjust.						
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.1474***	1.1471***	1.1455***	1.1366***	1.1291***	1.1275***	1.1331***
	(10.02)	(10.02)	(10.01)	(9.93)	(9.86)	(9.85)	(9.91)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.5918***	0.8075***	1.1756***	1.7383***	2.4013***	3.9609***	6.2651***
	(4.13)	(5.05)	(6.06)	(7.11)	(7.75)	(8.56)	(9.26)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	1.3378*	1.3580*	1.3785*	1.3711*	1.3593*	1.3289*	1.1752
	(1.81)	(1.84)	(1.87)	(1.86)	(1.84)	(1.80)	(1.59)
	0.07	0.07	0.06	0.06	0.07	0.07	0.11
MCap	0.0312**	0.0306**	0.0306**	0.0307**	0.0315**	0.0328***	0.0333***
	(2.35)	(2.31)	(2.32)	(2.32)	(2.39)	(2.48)	(2.52)
	0.02	0.02	0.02	0.02	0.02	0.01	0.01
TO	0.0625**	0.0650**	0.0663**	0.0659**	0.0636**	0.0595**	0.0576**
	(2.19)	(2.28)	(2.33)	(2.33)	(2.25)	(2.11)	(2.05)
	0.03	0.02	0.02	0.02	0.02	0.04	0.04
IVol	-0.0236	-0.0240	-0.0238	-0.0228	-0.0209	-0.0196	-0.0198
	(-0.98)	(-1.00)	(-1.00)	(-0.95)	(-0.87)	(-0.82)	(-0.83)
	0.33	0.32	0.32	0.34	0.38	0.41	0.41
Tax03	0.0093	0.0095	0.0137	0.0206	0.0272	0.0292	0.0291
	(0.19)	(0.19)	(0.27)	(0.41)	(0.54)	(0.58)	(0.58)
	0.85	0.85	0.78	0.68	0.59	0.56	0.56
Adj R^2	0.001	0.002	0.002	0.003	0.003	0.004	0.004
F stat	6.65	8.06	9.93	12.24	13.83	16.03	18.12
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.8: Relationship between AR^{ex} and CGOH: Ordinary Least Squares – Market Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is the return of the CRSP equal-weighted NYSE/AMEX index on the ex-day. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	AR^{ex} using Closing Ex-day Prices - Ordinary Least Squares - Market Adjust.						
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0014***	-0.0014***	-0.0013***	-0.0013***	-0.0013***	-0.0013***	-0.0013***
	(-2.82)	(-2.83)	(-2.81)	(-2.75)	(-2.70)	(-2.70)	(-2.75)
	0.00	0.00	0.00	0.01	0.01	0.01	0.01
CGOH	-0.0028***	-0.0036***	-0.0050***	-0.0071***	-0.0094***	-0.0151***	-0.0239***
	(-3.53)	(-4.05)	(-4.65)	(-5.19)	(-5.66)	(-6.30)	(-6.84)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0139	0.0137	0.0138	0.0143	0.0148	0.0155	0.0164*
	(1.42)	(1.40)	(1.41)	(1.46)	(1.52)	(1.59)	(1.69)
	0.16	0.16	0.16	0.14	0.13	0.11	0.09
MCap	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(-4.57)	(-4.56)	(-4.60)	(-4.62)	(-4.68)	(-4.74)	(-4.75)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(-2.72)	(-2.75)	(-2.73)	(-2.67)	(-2.59)	(-2.48)	(-2.45)
	0.01	0.01	0.01	0.01	0.01	0.01	0.01
IVol	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(-0.05)	(-0.03)	(-0.04)	(-0.07)	(-0.13)	(-0.17)	(-0.15)
	0.96	0.98	0.97	0.94	0.90	0.87	0.88
Tax03	0.0000	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001
	(-0.07)	(-0.10)	(-0.22)	(-0.36)	(-0.49)	(-0.55)	(-0.57)
	0.95	0.92	0.83	0.72	0.62	0.59	0.57
Adj R^2	0.003	0.003	0.004	0.004	0.004	0.005	0.005
F stat	11.08	11.80	12.74	13.69	14.52	15.71	16.74
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.9: Relationship between PDR and CGOH: Weighted Least Squares - Fama and French (1997) Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:
$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$
where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the three-factor Fama and French (1997) model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Closing Ex-day Prices - Weighted Least Squares - 3 factor F&F Model Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.1233***	1.1252***	1.1272***	1.1238***	1.1218***	1.1222***	1.1273***
	(10.21)	(10.23)	(10.24)	(10.21)	(10.19)	(10.20)	(10.24)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.7080***	0.8675***	1.0203***	1.2270***	1.4723***	2.2907***	3.2197***
	(5.10)	(5.60)	(5.42)	(5.17)	(4.89)	(5.11)	(4.92)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	1.2041*	1.2196*	1.2238*	1.2045*	1.1896*	1.1703*	1.0902
	(1.70)	(1.72)	(1.73)	(1.70)	(1.68)	(1.65)	(1.54)
	0.09	0.09	0.08	0.09	0.09	0.10	0.12
MCap	0.0168	0.0167	0.0178	0.0186	0.0196	0.0205	0.0210
	(1.32)	(1.32)	(1.40)	(1.46)	(1.54)	(1.61)	(1.65)
	0.19	0.19	0.16	0.14	0.12	0.11	0.10
TO	0.0836***	0.0840***	0.0807***	0.0769***	0.0734***	0.0704***	0.0684***
	(3.05)	(3.07)	(2.96)	(2.82)	(2.70)	(2.60)	(2.52)
	0.00	0.00	0.00	0.00	0.01	0.01	0.01
IVol	-0.0409*	-0.0416*	-0.0416*	-0.0410*	-0.0400*	-0.0394*	-0.0397*
	(-1.78)	(-1.81)	(-1.81)	(-1.78)	(-1.74)	(-1.71)	(-1.72)
	0.08	0.07	0.07	0.08	0.08	0.09	0.09
Tax03	-0.0250	-0.0230	-0.0161	-0.0094	-0.0050	-0.0040	-0.0044
	(-0.52)	(-0.48)	(-0.33)	(-0.20)	(-0.10)	(-0.08)	(-0.09)
	0.60	0.63	0.74	0.85	0.92	0.93	0.93
Adj R^2	0.002	0.002	0.002	0.002	0.002	0.002	0.002
F stat	7.82	8.71	8.38	7.95	7.47	7.84	7.52
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.10: Relationship between AR^{ex} and CGOH: Ordinary Least Squares – Fama and French (1997) Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the three-factor Fama and French (1997) model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Closing Ex-day Prices - Ordinary Least Squares - 3 factor F&F Model Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0014***	-0.0014***	-0.0014***	-0.0014***	-0.0014***	-0.0014***	-0.0014***
	(-3.06)	(-3.08)	(-3.10)	(-3.07)	(-3.04)	(-3.03)	(-3.10)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	-0.0036***	-0.0042***	-0.0045***	-0.0053***	-0.0067***	-0.0113***	-0.0148***
	(-4.78)	(-4.90)	(-4.43)	(-4.17)	(-4.32)	(-5.03)	(-4.52)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0206**	0.0208**	0.0215**	0.0223**	0.0228***	0.0233***	0.0239***
	(2.24)	(2.26)	(2.33)	(2.42)	(2.47)	(2.53)	(2.60)
	0.02	0.02	0.02	0.02	0.01	0.01	0.01
MCap	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-3.79)	(-3.81)	(-3.92)	(-3.98)	(-4.04)	(-4.08)	(-4.11)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003**
	(-2.99)	(-2.94)	(-2.75)	(-2.62)	(-2.53)	(-2.47)	(-2.40)
	0.00	0.00	0.01	0.01	0.01	0.01	0.02
IVol	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
	(1.56)	(1.59)	(1.57)	(1.54)	(1.48)	(1.44)	(1.45)
	0.12	0.11	0.12	0.12	0.14	0.15	0.15
Tax03	0.0000	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001
	(0.08)	(-0.02)	(-0.23)	(-0.38)	(-0.47)	(-0.50)	(-0.50)
	0.94	0.99	0.82	0.70	0.64	0.61	0.62
Adj R^2	0.004	0.004	0.004	0.004	0.004	0.004	0.004
F stat	12.73	12.92	12.24	11.95	12.20	13.35	12.40
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.11: Relationship between PDR and CGOH: Weighted Least Squares – Carhart (1997) Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the four-factor Carhart (1997) model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Closing Ex-day Prices - Weighted Least Squares - 4 factor Carhart Model Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.2056***	1.2076***	1.2098***	1.2074***	1.2061***	1.2072***	1.2111***
	(11.02)	(11.04)	(11.06)	(11.04)	(11.02)	(11.03)	(11.07)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.6610***	0.7940***	0.9101***	1.0503***	1.2370***	1.8294***	2.5895***
	(4.79)	(5.16)	(4.86)	(4.45)	(4.13)	(4.11)	(3.98)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	1.2125*	1.2258*	1.2279*	1.2086*	1.1951*	1.1778*	1.1129
	(1.72)	(1.74)	(1.74)	(1.71)	(1.70)	(1.67)	(1.58)
	0.09	0.08	0.08	0.09	0.09	0.09	0.11
MCap	0.0198	0.0199	0.0209*	0.0218*	0.0227*	0.0235*	0.0239*
	(1.57)	(1.57)	(1.66)	(1.73)	(1.80)	(1.86)	(1.89)
	0.12	0.12	0.10	0.08	0.07	0.06	0.06
TO	0.0772***	0.0771***	0.0737***	0.0696***	0.0665***	0.0637**	0.0622**
	(2.84)	(2.84)	(2.72)	(2.58)	(2.46)	(2.36)	(2.31)
	0.00	0.00	0.01	0.01	0.01	0.02	0.02
IVol	-0.0600***	-0.0606***	-0.0606***	-0.0600***	-0.0592***	-0.0587***	-0.0589***
	(-2.61)	(-2.64)	(-2.64)	(-2.62)	(-2.58)	(-2.56)	(-2.57)
	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tax03	-0.0403	-0.0381	-0.0316	-0.0256	-0.0219	-0.0212	-0.0216
	(-0.84)	(-0.80)	(-0.66)	(-0.54)	(-0.46)	(-0.44)	(-0.45)
	0.40	0.43	0.51	0.59	0.65	0.66	0.65
Adj R^2	0.002	0.002	0.002	0.002	0.001	0.001	0.001
F stat	8.05	8.66	8.17	7.54	7.07	7.04	6.87
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.12: Relationship between AR^{ex} and CGOH: Ordinary Least Squares – Carhart (1997) Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the four-factor Carhart (1997) model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Closing Ex-day Prices - Ordinary Least Squares - 4 factor Carhart Model Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0016***	-0.0016***	-0.0016***	-0.0016***	-0.0016***	-0.0016***	-0.0016***
	(-3.46)	(-3.49)	(-3.52)	(-3.50)	(-3.47)	(-3.48)	(-3.52)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	-0.0039***	-0.0044***	-0.0046***	-0.0050***	-0.0062***	-0.0098***	-0.0137***
	(-5.08)	(-5.16)	(-4.49)	(-4.00)	(-3.99)	(-4.35)	(-4.15)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0251***	0.0253***	0.0262***	0.0270***	0.0275***	0.0280***	0.0286***
	(2.97)	(2.99)	(3.09)	(3.18)	(3.24)	(3.30)	(3.37)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MCap	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-3.63)	(-3.67)	(-3.79)	(-3.86)	(-3.91)	(-3.96)	(-3.98)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0004***	-0.0004***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(-3.34)	(-3.28)	(-3.06)	(-2.90)	(-2.81)	(-2.75)	(-2.70)
	0.00	0.00	0.00	0.00	0.00	0.01	0.01
IVol	0.0002**	0.0002**	0.0002**	0.0002**	0.0002**	0.0002**	0.0002**
	(2.12)	(2.14)	(2.12)	(2.09)	(2.05)	(2.02)	(2.02)
	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Tax03	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.40)	(0.30)	(0.07)	(-0.09)	(-0.18)	(-0.21)	(-0.21)
	0.69	0.76	0.95	0.93	0.85	0.83	0.83
Adj R^2	0.004	0.005	0.004	0.004	0.004	0.004	0.004
F stat	14.63	14.77	13.77	13.15	13.13	13.70	13.32
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.13: Relationship between PDR and CGOH: Double Clustered Standard Errors - Market Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Clustered SE-method is estimated to adjust standard errors for both ex-day and stock clusters, as per Thompson (2011), and Cameron, Gelbach, and Miller (2011). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Closing Ex-day Prices - Double Cluster Standard Errors (Stocks & Ex-days)							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	0.9878***	0.9891***	0.9900***	0.9830***	0.9755***	0.9762***	0.9853***
	(6.09)	(6.10)	(6.11)	(6.08)	(6.04)	(6.04)	(6.11)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH (T)	0.9776***	1.2165***	1.5278***	2.0335***	2.7826***	4.6436***	7.1742***
	(4.75)	(5.19)	(5.17)	(5.42)	(5.94)	(6.49)	(6.78)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	3.7840***	3.8231***	3.7156***	3.5508***	3.4105***	3.1584***	2.8438***
	(3.43)	(3.46)	(3.42)	(3.33)	(3.24)	(3.08)	(2.84)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MCap	-0.0025	-0.0026	-0.0018	-0.0012	-0.0002	0.0010	0.0015
	(-0.14)	(-0.15)	(-0.10)	(-0.07)	(-0.01)	(0.06)	(0.09)
	0.89	0.88	0.92	0.94	0.99	0.95	0.93
TO	0.0987**	0.0994**	0.0966**	0.0931**	0.0902**	0.0860**	0.0838**
	(2.30)	(2.33)	(2.26)	(2.19)	(2.12)	(2.04)	(1.99)
	0.02	0.02	0.02	0.03	0.03	0.04	0.05
IVol	-0.0596*	-0.0606*	-0.0608*	-0.0600*	-0.0577*	-0.0563*	-0.0574*
	(-1.70)	(-1.73)	(-1.74)	(-1.72)	(-1.66)	(-1.63)	(-1.67)
	0.09	0.08	0.08	0.09	0.10	0.10	0.10
Tax03	-0.0786	-0.0751	-0.0655	-0.0558	-0.0484	-0.0467	-0.0467
	(-1.05)	(-1.01)	(-0.89)	(-0.76)	(-0.66)	(-0.64)	(-0.64)
	0.29	0.31	0.38	0.45	0.51	0.52	0.52
Adj R^2	0.002	0.002	0.002	0.002	0.003	0.003	0.004
F stat	7.28	8.19	8.39	9.02	9.94	11.31	12.37
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.14: Relationship between AR^{ex} and CGOH: Double Cluster Standard Errors - Market Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Clustered SE-method is estimated to adjust standard errors for both ex-day and stock clusters, as per Thompson (2011), and Cameron, Gelbach, and Miller (2011). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Closing Ex-day Prices - Double Cluster Standard Errors (Stocks & Ex-days)							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0016***	-0.0016***	-0.0016***	-0.0016***	-0.0015***	-0.0015***	-0.0016***
	(-2.83)	(-2.86)	(-2.88)	(-2.84)	(-2.80)	(-2.80)	(-2.86)
	0.00	0.00	0.00	0.00	0.01	0.01	0.00
CGOH	-0.0050***	-0.0058***	-0.0066***	-0.0083***	-0.0106***	-0.0171***	-0.0266***
	(-5.73)	(-5.81)	(-5.55)	(-5.63)	(-6.11)	(-6.79)	(-6.96)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0197**	0.0200**	0.0208**	0.0217**	0.0224***	0.0233***	0.0243***
	(2.15)	(2.18)	(2.26)	(2.36)	(2.44)	(2.54)	(2.66)
	0.03	0.03	0.02	0.02	0.01	0.01	0.01
MCap	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-3.46)	(-3.49)	(-3.59)	(-3.64)	(-3.71)	(-3.77)	(-3.80)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TO	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0003***	-0.0003***	-0.0003***
	(-3.20)	(-3.12)	(-2.93)	(-2.80)	(-2.69)	(-2.61)	(-2.59)
	0.00	0.00	0.00	0.01	0.01	0.01	0.01
IVol	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	(1.52)	(1.55)	(1.54)	(1.51)	(1.44)	(1.41)	(1.42)
	0.13	0.12	0.12	0.13	0.15	0.16	0.16
Tax03	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.55)	(0.44)	(0.23)	(0.06)	(-0.07)	(-0.11)	(-0.13)
	0.58	0.66	0.82	0.96	0.94	0.91	0.90
Adj R^2	0.005	0.006	0.005	0.005	0.006	0.006	0.007
F stat	17.59	17.92	17.35	17.44	18.05	19.93	20.76
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.15: Relationship between PDR and CGOH: Fixed Effects - Market Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Fixed Effects estimation includes year and stock dummies to the panel data regression equation above. The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	PDR using Closing Ex-day Prices - Fixed Effects (Stocks & Years)						
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	1.1233	1.2859	1.4421*	1.4438*	1.4073*	1.3646*	1.3929*
	(1.41)	(1.62)	(1.82)	(1.82)	(1.77)	(1.72)	(1.75)
	0.16	0.11	0.07	0.07	0.08	0.09	0.08
CGOH	1.3009***	1.4874***	1.7191***	2.1089***	2.8684***	4.8755***	7.5525***
	(6.60)	(6.95)	(6.82)	(6.81)	(7.44)	(8.66)	(9.23)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	-0.5678	-0.5300	-0.6939	-0.9106	-1.0757	-1.5043	-1.8490
	(-0.18)	(-0.17)	(-0.22)	(-0.29)	(-0.34)	(-0.48)	(-0.58)
	0.86	0.87	0.83	0.77	0.73	0.63	0.56
MCap	0.0733	0.0900	0.1078	0.1097	0.1077	0.1019	0.1035
	(0.81)	(0.99)	(1.19)	(1.21)	(1.19)	(1.13)	(1.14)
	0.42	0.32	0.23	0.23	0.23	0.26	0.25
TO	-0.0784	-0.0777	-0.0863	-0.0948	-0.1006	-0.1016	-0.1017
	(-0.89)	(-0.89)	(-0.98)	(-1.08)	(-1.15)	(-1.16)	(-1.16)
	0.37	0.38	0.33	0.28	0.25	0.25	0.25
IVol	-0.0084	-0.0099	-0.0108	-0.0109	-0.0091	-0.0114	-0.0153
	(-0.20)	(-0.24)	(-0.26)	(-0.26)	(-0.22)	(-0.27)	(-0.37)
	0.84	0.81	0.80	0.80	0.83	0.79	0.71
Tax03	-0.5582***	-0.5221***	-0.4813***	-0.4536***	-0.4406***	-0.4220***	-0.4047***
	(-3.56)	(-3.36)	(-3.11)	(-2.94)	(-2.86)	(-2.74)	(-2.63)
	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Adj R^2	0.013	0.014	0.014	0.014	0.014	0.015	0.015
F stat	4.65	5.03	4.89	4.88	5.57	7.07	7.86
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.16: Relationship between AR^{ex} and CGOH: Fixed Effects - Market Model Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using closing prices on the ex-day and adjusted for the expected ex-day return that is estimated with the market model. The estimation window is [(−130, −31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Fixed Effects estimation includes year and stock dummies to the panel data regression equation above. The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

	AR^{ex} using Closing Ex-day Prices - Fixed Effects (Stocks & Years)						
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	-0.0029	-0.0036	-0.0043*	-0.0044*	-0.0043*	-0.0042*	-0.0043*
	(-1.14)	(-1.44)	(-1.71)	(-1.74)	(-1.71)	(-1.68)	(-1.72)
	0.25	0.15	0.09	0.08	0.09	0.09	0.09
CGOH	-0.0061***	-0.0066***	-0.0072***	-0.0084***	-0.0107***	-0.0172***	-0.0270***
	(-8.86)	(-8.86)	(-8.19)	(-7.85)	(-8.17)	(-9.22)	(-9.89)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0427***	0.0429***	0.0439***	0.0450***	0.0458***	0.0472***	0.0481***
	(4.07)	(4.09)	(4.19)	(4.30)	(4.38)	(4.52)	(4.61)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MCap	-0.0005*	-0.0006**	-0.0007**	-0.0007**	-0.0007**	-0.0007**	-0.0007**
	(-1.81)	(-2.08)	(-2.34)	(-2.39)	(-2.37)	(-2.32)	(-2.34)
	0.07	0.04	0.02	0.02	0.02	0.02	0.02
TO	-0.0002	-0.0002	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(-0.59)	(-0.56)	(-0.39)	(-0.25)	(-0.20)	(-0.21)	(-0.26)
	0.56	0.58	0.70	0.80	0.84	0.84	0.80
IVol	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	(-0.49)	(-0.40)	(-0.35)	(-0.32)	(-0.31)	(-0.22)	(-0.14)
	0.62	0.69	0.73	0.75	0.76	0.83	0.89
Tax03	0.0015***	0.0013***	0.0011**	0.0010**	0.0009*	0.0008*	0.0008
	(3.10)	(2.72)	(2.30)	(2.05)	(1.90)	(1.74)	(1.62)
	0.00	0.01	0.02	0.04	0.06	0.08	0.11
Adj R^2	0.018	0.018	0.018	0.018	0.018	0.019	0.019
F stat	9.43	9.43	8.55	8.13	8.53	9.94	10.92
Obs	25,686	25,686	25,686	25,686	25,686	25,686	25,686

Table A-2.3.17: Relationship between PDR and CGOH Using Opening Ex-Day Prices: Weighted Least Squares – Market Model (One Half) Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using opening prices on the ex-day and adjusted for one half of the expected ex-day return that is estimated with the market model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Opening Ex-day Prices - Weighted Least Squares - Market Model (One Half) Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	0.7092***	0.7107***	0.7116***	0.7098***	0.7073***	0.7089***	0.7131***
	(12.95)	(12.98)	(13.00)	(12.96)	(12.91)	(12.94)	(13.02)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.4566***	0.5379***	0.6469***	0.7643***	1.0148***	1.4411***	1.8637***
	(6.64)	(7.02)	(6.95)	(6.51)	(6.82)	(6.48)	(5.73)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.6554*	0.6639*	0.6673*	0.6544*	0.6480*	0.6331*	0.5841*
	(1.86)	(1.89)	(1.90)	(1.86)	(1.84)	(1.80)	(1.66)
	0.06	0.06	0.06	0.06	0.07	0.07	0.10
MCap	-0.0063	-0.0061	-0.0056	-0.0050	-0.0045	-0.0038	-0.0034
	(-0.99)	(-0.97)	(-0.88)	(-0.79)	(-0.72)	(-0.60)	(-0.54)
	0.32	0.33	0.38	0.43	0.47	0.55	0.59
TO	-0.0589***	-0.0593***	-0.0610***	-0.0637***	-0.0650***	-0.0677***	-0.0693***
	(-4.34)	(-4.37)	(-4.52)	(-4.72)	(-4.83)	(-5.04)	(-5.16)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IVol	-0.0249**	-0.0253**	-0.0252**	-0.0248**	-0.0240**	-0.0237**	-0.0240**
	(-2.17)	(-2.21)	(-2.2)	(-2.16)	(-2.10)	(-2.07)	(-2.09)
	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Tax03	-0.0201	-0.0184	-0.0144	-0.0103	-0.0075	-0.0071	-0.0075
	(-0.84)	(-0.77)	(-0.61)	(-0.43)	(-0.32)	(-0.30)	(-0.31)
	0.40	0.44	0.55	0.67	0.75	0.77	0.75
Adj R^2	0.004	0.004	0.004	0.004	0.004	0.004	0.003
F stat	17.26	18.13	17.96	16.96	17.65	16.91	15.37
Obs	25,628	25,628	25,628	25,628	25,628	25,628	25,628

Table A-2.3.18: Relationship between AR^{ex} and CGOH Using Opening Ex-Day Prices: Ordinary Least Squares - Market Model (One Half) Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using opening prices on the ex-day and adjusted for one half of the expected ex-day return that is estimated with the market model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Opening Ex-day Prices - Ordinary Least Squares - Market Model (One Half) Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	0.0014***	0.0014***	0.0014***	0.0014***	0.0014***	0.0013***	0.0013***
	(5.79)	(5.71)	(5.65)	(5.68)	(5.67)	(5.51)	(5.34)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	-0.0052***	-0.0057***	-0.0065***	-0.0074***	-0.0081***	-0.0098***	-0.0109***
	(-13.11)	(-13.08)	(-12.39)	(-11.35)	(-10.43)	(-8.92)	(-6.72)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0336***	0.0341***	0.0350***	0.0362***	0.0370***	0.0379***	0.0386***
	(3.62)	(3.61)	(3.61)	(3.66)	(3.69)	(3.71)	(3.74)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MCap	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000*
	(-0.68)	(-0.82)	(-1.06)	(-1.23)	(-1.41)	(-1.57)	(-1.65)
	0.49	0.41	0.29	0.22	0.16	0.12	0.10
TO	0.0002***	0.0002***	0.0002***	0.0003***	0.0003***	0.0003***	0.0003***
	(3.60)	(3.88)	(4.36)	(4.83)	(5.19)	(5.51)	(5.67)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IVol	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001*	-0.0001	-0.0001
	(-1.47)	(-1.42)	(-1.47)	(-1.55)	(-1.63)	(-1.60)	(-1.51)
	0.14	0.15	0.14	0.12	0.10	0.11	0.13
Tax03	0.0002***	0.0002*	0.0001	0.0001	0.0001	0.0001	0.0001
	(2.19)	(1.89)	(1.38)	(0.94)	(0.66)	(0.60)	(0.58)
	0.03	0.06	0.17	0.35	0.51	0.55	0.56
Adj R^2	0.016	0.016	0.015	0.014	0.012	0.008	0.007
F stat	39.78	38.88	35.03	30.55	27.10	16.40	16.40
Obs	25,628	25,628	25,628	25,628	25,628	25,628	25,628

Table A-2.3.19: Relationship between PDR and CGOH Using Opening Ex-Day Prices: Weighted Least Squares – Market Model (One Third) Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of PDR of the 2.5% trimmed sample against CGOH and a group of control variables as:

$PDR_{it} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. PDR is computed using opening prices on the ex-day and adjusted for one third of the expected ex-day return that is estimated with the market model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The Weighted Least Squares method (WLS) is utilized for the PDR pooled regression with the weight being equal to the squared ratio of (DY to stock return standard deviation). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

PDR using Opening Ex-day Prices - Weighted Least Squares - Market Model (One Third) Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	0.7422***	0.7435***	0.7441***	0.7418***	0.7394***	0.7410***	0.7449***
	(15.27)	(15.30)	(15.32)	(15.27)	(15.21)	(15.25)	(15.33)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	0.3886***	0.4536***	0.5544***	0.6976***	0.9318***	1.3066***	1.6694***
	(6.34)	(6.64)	(6.69)	(6.68)	(7.05)	(6.63)	(5.80)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.7859***	0.7927***	0.7961***	0.7869***	0.7812***	0.7674***	0.7237**
	(2.52)	(2.54)	(2.56)	(2.53)	(2.51)	(2.46)	(2.32)
	0.01	0.01	0.01	0.01	0.01	0.01	0.02
MCap	-0.0024	-0.0023	-0.0018	-0.0015	-0.0011	-0.0004	0.0000
	(-0.43)	(-0.41)	(-0.33)	(-0.26)	(-0.19)	(-0.07)	(0.00)
	0.67	0.68	0.74	0.79	0.85	0.94	1.00
TO	-0.0578***	-0.0582***	-0.0596***	-0.0613***	-0.0624***	-0.0650***	-0.0664***
	(-4.80)	(-4.84)	(-4.97)	(-5.12)	(-5.23)	(-5.45)	(-5.58)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IVol	-0.0263***	-0.0266***	-0.0265***	-0.0261***	-0.0254***	-0.0251***	-0.0254***
	(-2.59)	(-2.62)	(-2.61)	(-2.57)	(-2.50)	(-2.47)	(-2.50)
	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tax03	-0.0340	-0.0325	-0.0292	-0.0258	-0.0232	-0.0228	-0.0232
	(-1.61)	(-1.54)	(-1.38)	(-1.22)	(-1.10)	(-1.08)	(-1.10)
	0.11	0.12	0.17	0.22	0.27	0.28	0.27
Adj R^2	0.004	0.004	0.004	0.004	0.005	0.004	0.004
F stat	18.92	19.58	19.68	19.65	20.51	19.56	17.83
Obs	25,628	25,628	25,628	25,628	25,628	25,628	25,628

Table A-2.3.20: Relationship between AR^{ex} and CGOH Using Opening Ex-Day Prices: Ordinary Least Squares - Market Model (One Third) Adjust.

This table reports the estimated coefficients and their t-statistics of the regressions of AR^{ex} of the 2.5% trimmed sample against CGOH and a group of control variables as:

$AR_{it}^{ex} = \alpha + \beta_1 CGOH_{it} + \beta_2 DY_{it} + \beta_3 MCap_{it} + \beta_4 TO_{it} + \beta_5 IVol_{it} + \beta_6 Tax03_{it} + \varepsilon_{it}$

where CGOH is the capital gains overhang of stock *i* for an assumed investor holding period of T calendar days before the ex-dividend day *t*. DY is the dividend yield equal to the dividend amount over the closing price on the cum-day. MCap is the mean stock relative size equal to the average natural log (individual stock capitalization to market capitalization) over the estimation window. TO is the average stock turnover over the estimation window. IVol measures the idiosyncratic volatility as the ratio of (individual stock standard deviation to market standard deviation) of daily returns over the estimation window. Tax03 is a dummy variable that takes the value of 1 if the ex-day is located after the May 22, 2003 Tax Act and 0 otherwise. AR^{ex} is computed using opening prices on the ex-day and adjusted for one third of the expected ex-day return that is estimated with the market model. The estimation window is [(–130, –31) & (+31, +130)] trade days around the ex-day and the CRSP equal-weighted NYSE/AMEX index is employed as a proxy for the market portfolio. The CGOH is defined as the percentage deviation of the closing trade price on the cum-day from the aggregate cost basis proxy over an assumed holding period of T calendar days that is computed as in Grinblatt and Han (2005) using daily price and turnover data. The AR^{ex} pooled regression estimated with the Ordinary Least Squares (OLS) method reports t-statistics corrected for heteroscedasticity (White (1980)). The number in parentheses below the coefficient is the t-statistic and the p-value is reported below the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

AR^{ex} using Opening Ex-day Prices - Ordinary Least Squares - Market Model (One Third) Adjust.							
Variables	T = 360	T = 250	T = 150	T = 90	T = 60	T = 30	T = 15
Intercept	0.0013***	0.0012***	0.0012***	0.0012***	0.0012***	0.0012***	0.0012***
	(5.55)	(5.49)	(5.44)	(5.47)	(5.47)	(5.33)	(5.19)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CGOH	-0.0040***	-0.0046***	-0.0053***	-0.0061***	-0.0068***	-0.0082***	-0.0095***
	(-10.60)	(-10.98)	(-10.93)	(-10.35)	(-9.74)	(-8.31)	(-6.63)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DY	0.0342***	0.0345***	0.0352***	0.0361***	0.0368***	0.0376***	0.0382***
	(3.60)	(3.59)	(3.59)	(3.63)	(3.65)	(3.67)	(3.69)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MCap	0.0000*	-0.0001**	-0.0001**	-0.0001**	-0.0001***	-0.0001***	-0.0001***
	(-1.86)	(-1.96)	(-2.16)	(-2.31)	(-2.48)	(-2.63)	(-2.69)
	0.06	0.05	0.03	0.02	0.01	0.01	0.01
TO	0.0003***	0.0003***	0.0003***	0.0003***	0.0004***	0.0004***	0.0004***
	(5.68)	(5.91)	(6.31)	(6.72)	(7.05)	(7.37)	(7.51)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IVol	-0.0001*	-0.0001*	-0.0001*	-0.0001**	-0.0001**	-0.0001**	-0.0001**
	(-1.84)	(-1.81)	(-1.85)	(-1.93)	(-2.03)	(-2.01)	(-1.93)
	0.07	0.07	0.06	0.05	0.04	0.04	0.05
Tax03	0.0003***	0.0003***	0.0002***	0.0002**	0.0002*	0.0002*	0.0002*
	(3.12)	(2.89)	(2.46)	(2.08)	(1.83)	(1.78)	(1.76)
	0.00	0.00	0.01	0.04	0.07	0.08	0.08
Adj R^2	0.016	0.017	0.016	0.015	0.014	0.012	0.011
F stat	34.95	35.62	34.66	32.30	30.23	25.80	21.69
Obs	25,628	25,628	25,628	25,628	25,628	25,628	25,628

A-2.4 Mean and Median Difference of PDR/AR^{ex} between Losing and Winning Ex-Dividend Days with Different Holding Periods for the CGOH.

Table A-2.4.1: Mean and Median Difference of PDR/AR^{ex} between Losing and Winning Ex-Dividend Days for all CGOH windows

This table reports the significance of the mean and median difference of paired values of PDR/AR^{ex}, where each pair refers to one ex-dividend day with a negative CGOH (loser) and another ex-dividend day with a positive CGOH (winner) of the same stock, over an investor horizon of T calendar days before the ex-day. Losing and winning ex-days of the same stock are paired on the basis of equal dividend amount and time proximity. The ex-days have been matched after trimming the top and bottom 2.5 percentiles of the initial PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The tests presented in this table refer to the entire series of matched ex-days, irrespective of the length of the duration between losing and winning ex-dividend days. The Wilcoxon signed-rank test is used for testing the median difference of the PDR/AR^{ex} paired values. *** denotes statistical significance at the 1% level, using a two-tailed test.

CGOH (360)	Loser(PDR) - Winner(PDR)		Loser(AR^{ex}) - Winner(AR^{ex})	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.280***	-0.211***	0.102%***	0.124%***
t-stat/z-stat	-3.79	-4.57	4.31	4.76
p-val	0.00	0.00	0.00	0.00
Obs	6,485	6,485	6,467	6,467
CGOH (250)	**Loser(PDR) - Winner(PDR)**		**Loser(AR^{ex}) - Winner(AR^{ex})**	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.302***	-0.250***	0.128%***	0.125%***
t-stat/z-stat	-4.30	-5.50	5.66	5.79
p-val	0.00	0.00	0.00	0.00
Obs	6,969	6,969	6,954	6,954
CGOH (150)	**Loser(PDR) - Winner(PDR)**		**Loser(AR^{ex}) - Winner(AR^{ex})**	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.324***	-0.244***	0.121%***	0.127%***
t-stat/z-stat	-4.83	-6.04	5.60	5.87
p-val	0.00	0.00	0.00	0.00
Obs	7,521	7,521	7,514	7,514
CGOH (90)	**Loser(PDR) - Winner(PDR)**		**Loser(AR^{ex}) - Winner(AR^{ex})**	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.286***	-0.222***	0.097%***	0.105%***
t-stat/z-stat	-4.32	-4.92	4.58	4.77
p-val	0.00	0.00	0.00	0.00
Obs	7,893	7,893	7,874	7,874

CGOH (60)	Loser(PDR) - Winner(PDR)		Loser(AR^{ex}) - Winner(AR^{ex})	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.207***	-0.103***	0.065%***	0.045%***
t-stat/z-stat	-3.10	-3.28	3.08	2.95
p-val	0.00	0.00	0.00	0.00
Obs	7,906	7,906	7,883	7,883

CGOH (30)	Loser(PDR) - Winner(PDR)		Loser(AR^{ex}) - Winner(AR^{ex})	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.296***	-0.194***	0.098%***	0.071%***
t-stat/z-stat	-4.48	-5.24	4.68	4.81
p-val	0.00	0.00	0.00	0.00
Obs	7,970	7,970	7,982	7,982

Table A-2.4.2: Mean and Median Difference of PDR/AR^{ex} for a Subsample of Matched Ex-Days with Duration between Losing and Winning Ex-Dividend Days of Less than or Equal to 182 Calendar Days.

This table reports the significance of the mean and median difference of paired values of PDR/AR^{ex}, where each pair refers to one ex-dividend day with a negative CGOH (loser) and another ex-dividend day with a positive CGOH (winner) of the same stock, over an investor horizon of T calendar days before the ex-day. Losing and winning ex-days of the same stock are paired on the basis of equal dividend amount and time proximity. The ex-days have been matched after trimming the top and bottom 2.5 percentiles of the initial PDR/AR^{ex} samples. The PDR is defined as $[(P^{cum} - (P^{ex}/(1 + R^{norm}))) / Div]$ and the AR^{ex} is defined as $[((P^{ex} - P^{cum} + Div) / P^{cum}) - R^{norm}]$. P^{cum} is the closing price on the cum-dividend day, P^{ex} is the closing price on the ex-dividend day adjusted for market risk (R^{norm}) on that day and Div is the dividend amount. R^{norm} is the expected return on the ex-day calculated using the market model that is estimated over the [(−130, −31) & (+31, +130)] days window around the ex-day with the CRSP equal-weighted NYSE/AMEX index as the market proxy. The tests presented in this table refer to a subsample of matched ex-days, with duration between losing and winning ex-dividend days of less than or equal to 182 calendar days. The Wilcoxon signed-rank test is used for testing the median difference of the PDR/ARex paired values. *** denotes statistical significance at the 1% level, using a two-tailed test.

CGOH (90)	Loser(PDR) - Winner(PDR)		Loser(AR^{ex}) - Winner(AR^{ex})	
	Mean	Median	Mean	Median
Paired ex-days diff.	-0.387***	-0.257***	0.125%***	0.132%***
t-stat/z-stat	-4.47	-4.80	4.44	4.58
p-val	0.00	0.00	0.00	0.00
Obs	4,440	4,440	4,376	4,376

A-3 Microstructure Rules for NYSE, AMEX and NASDAQ

A-3.1 Rules of (Open) Limit Order Adjustment on the Ex-Dividend Day: NYSE, AMEX and NASDAQ

NYSE: Rule 118. Orders to Be Reduced and Increased on Ex-Date

When a security is quoted ex-dividend, ex-distribution, ex-rights or ex-interest, the following kinds of orders shall be reduced by the value of the payment or rights, and increased in shares in the case of stock dividends and stock distributions which result in round-lots, on the day the security sells ex:

(1) Open buying orders;

(2) Open stop orders to sell.

The following shall not be reduced:

(1) Open stop orders to buy;

(2) Open selling orders.

Reduction of orders—Odd amounts.—When the amount of a cash dividend is not equivalent to or is not a multiple of the fraction of a dollar in which bids and offers are made in the particular stock, orders shall be reduced by the next higher variation.

AMEX: Rule 132. Price Adjustment of Open Orders on "Ex-Date"

(a) When a security is quoted ex-dividend, ex-distribution, ex-rights or ex-interest, the following kinds of orders shall be reduced by the cash value of the payment or rights, except where the security is quoted "ex" a stock dividend or stock distribution in which case the provisions of paragraph (b) below shall apply, on the day the security sells ex:

(1) Open buying orders;

(2) Open stop orders to sell. (With open stop limit orders to sell, the limit, as well as the stop price, shall be reduced.)

The following shall not be reduced:

(1) Open stop orders to buy;

(2) Open selling orders.

NASDAQ: 3220. Adjustment of Open Orders

(a) A member holding an open order from a customer or another broker/dealer shall, prior to executing or permitting the order to be executed, reduce, increase or adjust the price and/or number of shares of such order by an amount equal to the dividend, payment or distribution, on the day that the security is quoted ex-dividend, ex-rights, ex-distribution or ex-interest, except where a cash dividend or distribution is less than one cent ($.01), as follows:

(1) In the case of a cash dividend or distribution, the price of the order shall be reduced by subtracting the dollar amount of the dividend or distribution from the price of the order and rounding the result to the next lower minimum quotation variation used in the primary market.

…………………………………………………………………………………………

(d) The term "open order" means an order to buy or an open stop order to sell, including but not limited to "good `till cancelled," "limit" or "stop limit" orders which remain in effect for a definite or indefinite period until executed, cancelled or expired.

(e) The provisions of this Rule shall not apply to:

…………………………………………………………………………………………

(4) Open stop orders to buy;

(5) Open sell orders;

A-3.2 Rules for Minimum Price/Quote Variations: NYSE, AMEX and NASDAQ

NYSE: Rule 62. Variations

…………………………………………………………………………………………

The minimum price variation (MPV) for quoting and entry of orders in equity securities admitted to dealings on the Exchange shall be as follows:

Price of Order or Interest	Minimum Price Variation
Less Than $1.00	$.0001
$1.00 or greater	$.01

AMEX: Rule 127. Minimum Price Variations

The minimum price variation for dealings in equity securities shall be one cent ($.01)

NASDAQ: 4613. Market Maker Obligations

…………………………………………………………………………………………

The minimum quotation increment for quotations of $1.00 or above in all System Securities shall be $0.01. The minimum quotation increment in the System for quotations below $1.00 in System Securities shall be $0.0001.

A-4 Proof of the Approximation of the Trade Return to the Sum of the Bid Return and the Order Flow Bias:

$$TR_{im} = \frac{\left(T_{im} - T_{im-1}\right)}{T_{im-1}}$$

$$which\ \ for\ T_{im-1} \approx B_{im-1},$$

$$= \frac{\left(T_{im} - T_{im-1}\right)}{B_{im-1}} = \frac{\left(T_{im} - T_{im-1}\right) + \left(B_{im} - B_{im-1}\right) - \left(B_{im} - B_{im-1}\right)}{B_{im-1}}$$

$$= \frac{\left(B_{im} - B_{im-1}\right)}{B_{im-1}} + \frac{\left(T_{im} - B_{im}\right) - \left(T_{im-1} - B_{im-1}\right)}{B_{im-1}}$$

$$= \frac{\left(B_{im} - B_{im-1}\right)}{B_{im-1}} + \left\{ \frac{\left(T_{im} - B_{im}\right)}{B_{im-1}} * \frac{\left(A_{im} - B_{im}\right)}{\left(A_{im} - B_{im}\right)} - \frac{\left(T_{im-1} - B_{im-1}\right)}{B_{im-1}} * \frac{\left(A_{im-1} - B_{im-1}\right)}{\left(A_{im-1} - B_{im-1}\right)} \right\}$$

$$which\ \ for\ B_{im} \approx B_{im-1},$$

$$= \frac{\left(B_{im} - B_{im-1}\right)}{B_{im-1}} + \left\{ \frac{\left(T_{im} - B_{im}\right)}{\left(A_{im} - B_{im}\right)} * \frac{\left(A_{im} - B_{im}\right)}{B_{im}} - \frac{\left(T_{im-1} - B_{im-1}\right)}{\left(A_{im-1} - B_{im-1}\right)} * \frac{\left(A_{im-1} - B_{im-1}\right)}{B_{im-1}} \right\}$$

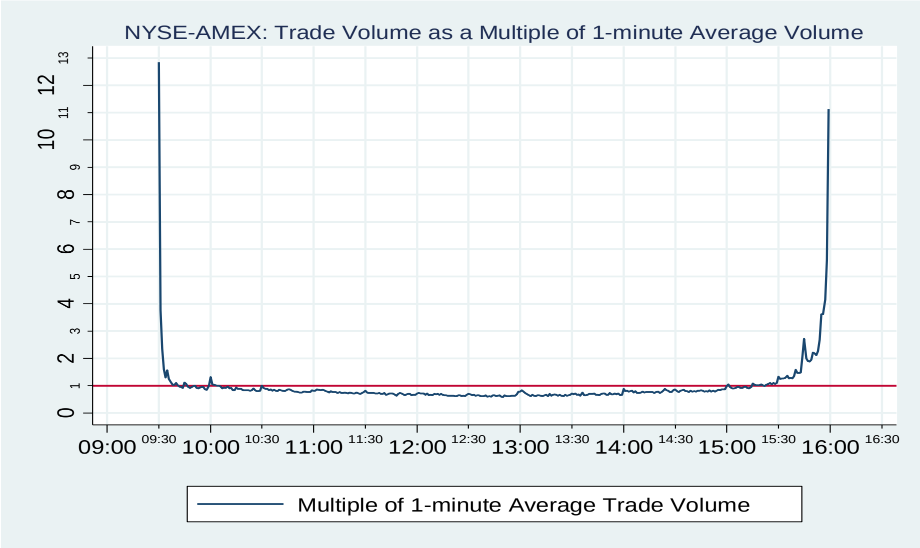
$$= BR_{im} + \left(Loc_{im} * BAS_{im}\right) - \left(Loc_{im-1} * BAS_{im-1}\right)$$

$$= BR_{im} + OFbias_{im}$$

A-5 Robustness Tests: Intraday Analysis of the Limit Order Bias at the Ex-Dividend Day of U.S. Common Stocks

Figure A-5.1 Intra Ex-Dividend Day Evolution of Trading Volume: As a multiple of Ex-day Minute Average Trade Volume

This figure illustrates the evolution of trade volume in minute intervals during the ex-dividend day separately for stocks listed on the NYSE and AMEX and stocks listed on the NASDAQ. Trade volume per minute is expressed as a multiple of the ex-dividend day minute average trade volume which is subsequently averaged across the sample of ex-dividend days for each minute.



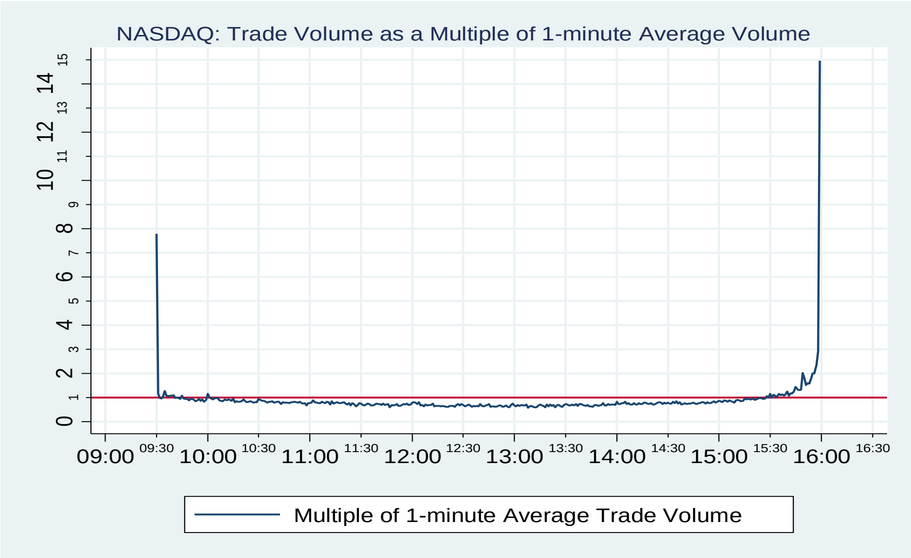


Figure A-5.2 Intra Ex-Dividend Day Evolution of the Relative Trade Price, Ask & Bid Quotes – Medians

This figure illustrates the evolution of the relative trade price, ask quote and bid quote averaged over 15 minute intervals during the ex-dividend day separately for stocks listed on the NYSE and AMEX and stocks listed on the NASDAQ. The relative trade price is the ratio of ($P^{ex,m}/P^{cum}$) where $P^{ex,m}$ is the intra-day trade price at each *m* minute during the ex-dividend day and P^{cum} is the closing trade price at the cum-dividend day. The relative ask quote is the ratio of ($A^{ex,m}/A^{cum}$) where $A^{ex,m}$ is the intra-day best ask quote at each *m* minute during the ex-dividend day and A^{cum} is the closing best ask quote at the cum-dividend day. The relative bid quote is the ratio of ($B^{ex,m}/B^{cum}$) where $B^{ex,m}$ is the intra-day best bid quote at each *m* minute during the ex-dividend day and B^{cum} is the closing best bid quote at the cum-dividend day. The minute-by-minute relative trade price, ask quote and bid quote are first averaged over 15 minute intervals during each ex-dividend day, and the 15 minute interval medians of the relative trade price, ask quote and bid quote are subsequently computed across the sample of ex-dividend days.

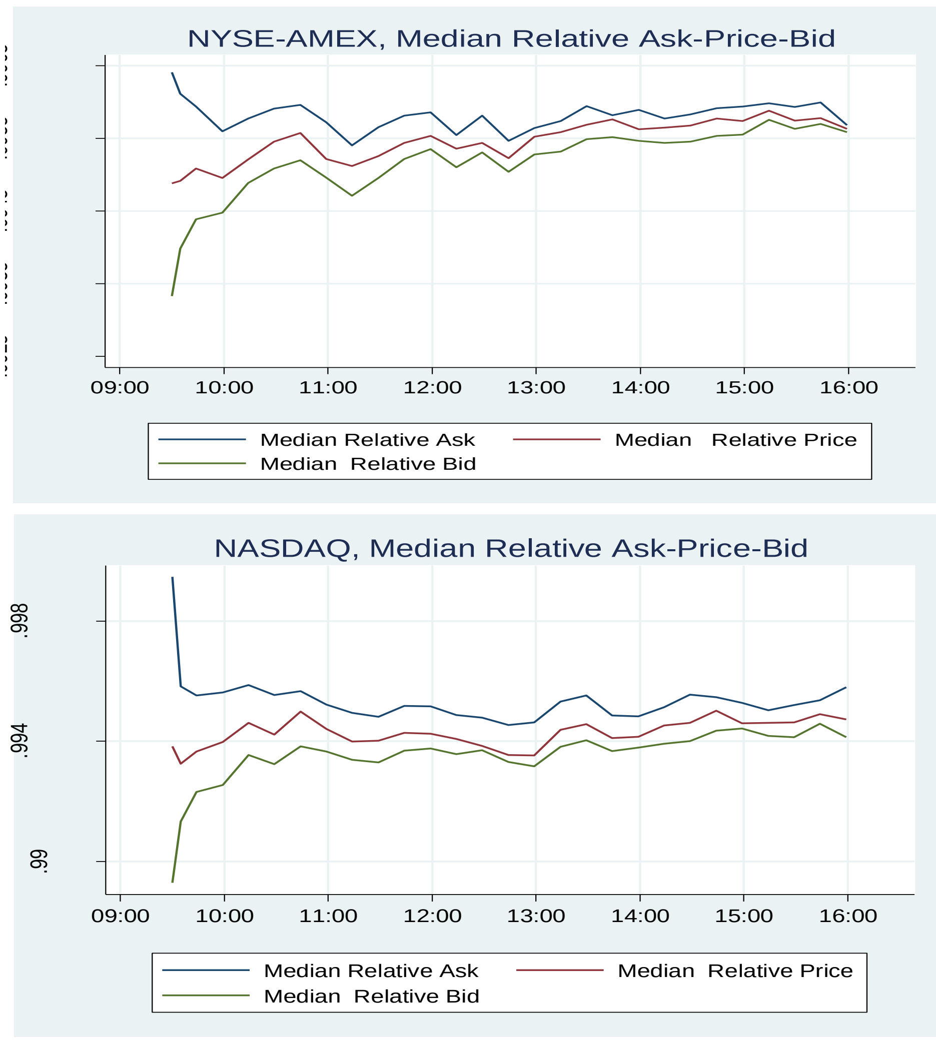


Table A-5.3: Median Trade Return, Bid Return and Order Flow Bias: At the Open, Close and during the Ex-Dividend Day

This table presents the breakdown of the median total return (TR) into the median bid return (BR) and the median order flow bias (OFbias), at the opening, at the closing and in the interim minutes of the ex-dividend day, separately for NYSE and AMEX stocks and NASDAQ stocks, as well as for all stocks listed on all exchanges. TR is the minute-by-minute percentage change of the trade price and BR is the minute-by-minute percentage change of the bid quote. The OFbias is equal to $[(Loc_m*BAS_m) - (Loc_{m-1}*BAS_{m-1})]$ where Loc_m is the within spread location of the trade and BAS_m is the proportional bid-ask spread at each minute *m* of the ex-dividend day. Loc is equal to [(P – B) / (A – B)] and BAS is equal to [(A – B) / B] where P is the trade price, B is the best bid quote and A is the best ask quote at each minute of the ex-dividend day. For the intra-day period between the opening and the closing of the ex-dividend day, minute-by-minute TR, BR and OFbias are first summed over the interim minutes for each ex-dividend day, and then their median is calculated across the sample of ex-dividend days. The number below the median values is the z-statistic computed on the basis of the Wilcoxon signed-rank test for medians. [a] denotes statistical significance at the 1% level, using a two-tailed test.

	NYSE & AMEX			NASDAQ			All Exchanges		
Period/Var.	TR	BR	OFbias	TR	BR	OFbias	TR	BR	OFbias
Open	-0.49% [a]	-0.64% [a]	0.09% [a]	-0.59% [a]	-1.02% [a]	0.27% [a]	-0.52% [a]	-0.76% [a]	0.12% [a]
	-32.21	-37.92	35.16	-28.84	-34.56	27.07	-43.05	-51.42	43.84
Interim	0.02%	0.17% [a]	-0.08% [a]	0.13% [a]	0.50% [a]	-0.26% [a]	0.06% [a]	0.26% [a]	-0.11% [a]
	1.17	8.22	-36.29	3.41	14.83	-25.89	3.08	15.78	-43.85
Close	0.01% [a]	0.01% [a]	0.00%	0.00%	-0.06% [a]	0.06% [a]	0.00% [a]	-0.01% [a]	0.00% [a]
	6.88	8.78	-0.99	-0.74	-20.14	19.93	4.50	-8.13	13.63
All	-0.45% [a]	-0.47% [a]	0.00%	-0.51% [a]	-0.70% [a]	0.06% [a]	-0.47% [a]	-0.54% [a]	0.00% [a]
	-18.35	-18.40	-0.42	-13.46	-18.32	20.13	-22.71	-25.77	13.63
Obs	3,738	3,738	3,738	1,985	1,985	1,985	5,723	5,723	5,723

Table A-5.4: Relationship between PDR/AR^{ex} and OFbias at the Open and at the Close of the Ex-Dividend Day: Non-Orthogonal Regressors

This table reports the estimated coefficients and their t-statistics of the regressions of PDR/AR^{ex} of the 95% trimmed samples against OFbias and a group of control variables separately for NYSE and AMEX stocks and NASDAQ stocks, as well as for all stocks listed on all exchanges. The estimated equation is:

$$PDR_{it} / AR_{it}^{ex} = \alpha + \beta_1 OFbias_i^{open} + \beta_2 BAS_{it} + \beta_3 Loc_{it} + \beta_4 TVol_{it} + \beta_5 DY_i + \varepsilon_{it}$$

where, $OFbias^{open}$ is the order flow bias at the opening of the *i* ex-dividend day for a particular stock, BAS is the proportional bid-ask spread, Loc is the within spread location of the trade, TVol is the natural logarithm of the trading volume over the relevant minute, and DY is the stock dividend yield equal to the dividend amount over the closing price on the cum-day. The subscript *t* refers to the time when the regression model is estimated, namely to either the opening or the closing of the ex-dividend day. The OLS coefficients are computed with heteroscedasticity consistent standard errors, according to the White (1980) correction. The number in parentheses below the coefficient is the t-statistic. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, using a two-tailed test.

Panel A	NYSE & AMEX		NASDAQ		All Exchanges	
PDR	Open	Close	Open	Close	Open	Close
Intercept	1.1226***	1.0126***	1.5429***	0.9614**	1.4538***	0.9006***
	3.34	2.59	4.39	2.24	6.23	3.28
OFbias	-79.8212***	12.8165	-22.4495***	-5.3179	-33.1814***	-2.0272
	-4.40	0.89	-2.64	-0.79	-4.20	-0.33
BAS	38.0782***	-31.2208	7.1366	0.5356	13.4806***	0.5873
	3.54	-1.21	1.56	0.54	3.12	0.60
Loc	0.0041	-0.1882**	-0.4284***	-0.4914***	-0.1981***	-0.2168***
	0.06	-2.34	-2.95	-2.61	-3.25	-2.77
TVol	-0.0432	0.0095	-0.0366	0.0439	-0.0562**	0.0249
	-1.14	0.23	-0.93	0.95	-2.14	0.83
DY	5.2185	-5.0594	-1.7991***	-1.5243*	-0.9473	-1.8246
	1.10	-1.05	-2.95	-1.67	-0.93	-1.65
Adj. R^2	0.007	0.004	0.025	0.004	0.011	0.003
F-stat	5.78	1.80	6.93	2.51	11.55	2.41
Obs	3,738	3,738	1,984	1,984	5,722	5,722

Panel B	NYSE & AMEX		NASDAQ		All Exchanges	
AR^{ex}	Open	Close	Open	Close	Open	Close
Intercept	0.0000	0.0013	-0.0008	0.0024	-0.0010	0.0022**
	-0.04	0.88	-0.78	1.38	-1.41	2.01
OFbias	0.4304***	-0.0016	0.1097***	0.0119	0.1609***	0.0148
	4.39	-0.02	2.92	0.31	4.10	0.45
BAS	-0.2225***	0.1269	-0.0450**	-0.0079	-0.0704***	-0.0073
	-3.59	0.77	-2.40	-1.46	-3.61	-1.36
Loc	0.0001	0.0007**	0.0018***	0.0020***	0.0010***	0.0008**
	0.45	2.03	5.52	2.89	4.69	2.44
TVol	0.0002	-0.0001	0.0000	-0.0004*	0.0002**	-0.0003**
	1.35	-0.85	0.33	-1.95	2.07	-2.20
DY	-0.0227	-0.0092	0.0263	0.0616**	0.0040	0.0372*
	-0.99	-0.27	0.85	2.37	0.19	1.83
Adj. R^2	0.027	0.004	0.048	0.011	0.029	0.005
F-stat	10.42	1.27	15.36	4.26	19.22	3.48
Obs	3,764	3,764	1,959	1,959	5,723	5,723