LIMITED ARBITRAGE AND PROFITABLE TRADING: EVIDENCE FROM INSIDER AND FIRM TRANSACTIONS

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ABSTRACT

We conduct a test of limited arbitrage theories by studying the trading patterns of insiders and firms in the presence of arbitrage risk. If idiosyncratic risk discourages arbitrage activity, insiders and firms (as informed traders) should earn more on their trades when idiosyncratic risk is high relative to when it is low. Consistent with this prediction, we find that the magnitude of the returns that insiders and firms earn on their trades is correlated with the degree of idiosyncratic risk. This is partially due to insiders and firms initiating buys (sells) following lower (higher) returns when idiosyncratic risk is high than when it is low, i.e., insiders and firms time the market better when arbitrage is limited. Further, the use of private information in insider purchases is related to the extent to which arbitrage is limited. Overall, the evidence suggests that insiders' and firms' ability to exploit trading opportunities increases with idiosyncratic risk, consistent with idiosyncratic risk limiting outsider arbitrage activity.

JEL Classification: G11, G12, G14, G32, G35
Key Words: Limits of Arbitrage, Insider Trading, Abnormal Returns

I. Introduction

Several papers argue that markets are not fully efficient because rational traders are sometimes reluctant to engage in arbitrage trades (Barberis and Thaler 2003). In some models of trading, arbitrageurs have short horizons and cannot wait for the market to correct mispricing especially if "noise traders" make mispricing worse in the short term (DeLong, Shleifer, Summers, and Waldmann 1990, Liu and Longstaff 2004). In other models, arbitrageurs are disinclined to initiate arbitrage trades if it is likely that the information conveyed by their trade will not be quickly reflected in the price (Dow and Gorton 1994, Abreu and Brunnermeier 2002, Froot, Scharfstein, and Stein 1992). Finally, arbitrageurs who take a position in a mispriced stock may be exposed to idiosyncratic price movements which they cannot perfectly hedge, i.e., "fundamental risk" (Shleifer and Vishny 1997, Wurgler and Zhuravskaya 2002, Pontiff 2005).

Studies of limits to arbitrage are prompted by research documenting apparent stock market anomalies.[1] A key feature of these anomalies is that trading signals identified with publicly available information are associated with future returns. Research on limited arbitrage offers a potential explanation for these anomalies based on the inability of arbitrageurs to perfectly hedge the fundamental risk in their trades. Consider the accrual anomaly: Sloan (1996) documents that firms in the highest decile ranked on accruals underperform firms in the lowest decile ranked on accruals in the year following the portfolio

[1]Ball and Brown (1968) were the first to document post-earnings announcement drift. Other market anomalies that have received attention are the index-inclusion effect (Shleifer 1986), the discount on closed-end funds (Lee, Shleifer, and Thaler 1991), the book-to-market effect (Fama and French 1993), the long-term abnormal returns to SEOs and IPOs (Loughran and Ritter 1995), and the accrual anomaly (Sloan 1996).

formation. Further, these return differences are robust to common risk adjustments and are concentrated around subsequent earnings announcements, consistent with investor mispricing. To capitalize on this mispricing, arbitrageurs should purchase firms with low accruals and sell short firms with high accruals. To hedge against the fundamental risk in such a strategy (the risk that news about the mispriced firms' fundamental values moves price in the "wrong" direction before the arbitrageur can close out his/her position) the arbitrageur can take an opposing position in a stock that is a close substitute for the mispriced stock. Hence, the need to guard against fundamental risk suggests one reason why arbitrage opportunities are not eliminated by the strategy just described: if a mispriced stock has few close substitutes (i.e., is highly idiosyncratic), then it will be difficult to engage in arbitrage trades that are free from fundamental risk. As long as arbitrageurs are risk-averse and insufficiently diversified, the inability to perfectly hedge fundamental risk implies arbitrage will be limited (Barberis and Thaler 2003, Shleifer 2000).[2]

Pursuing this line of inquiry, a large literature has used idiosyncratic risk (a proxy for the inability to hedge fundamental risk)[3] to explain the existence of apparent arbitrage opportunities. Returning to our example of the accrual anomaly, Mashruwala, Rajgopal, and Shevlin (2005) show that returns to the accrual anomaly are concentrated among idiosyncratic firms with few close substitutes. Other papers that show similar results are Wurgler and Zhuravskaya (2002) (index-inclusion anomaly), Pontiff (1997) (closed-end fund

[2]Even if a mispriced stock has close substitutes, noise trader risk (DeLong, Shleifer, Summers, and Waldmann 1990) combined with risk aversion and short horizons limits arbitrage activity as do excessive costs to learn about the mispricing (Barberis and Thaler 2003).

[3]See Pontiff (2005) for a discussion of the critical role of idiosyncratic risk in limiting arbitrage.

discounts), Ali, Hwang, and Trombley (2003) (book to market effect), and Mendenhall (2004) (post-earnings announcement drift).

All of these papers provide indirect evidence of fundamental risk as a limit to arbitrage. These studies assume that the association between idiosyncratic risk and returns to mispricing results from the lack of action by arbitrageurs: if arbitrageurs were able to hedge fundamental risk, they would engage in arbitrage trades that would eliminate the mispricing. Our paper extends this approach by analyzing the actual trades of two classes of informed traders – insiders who trade for their own account and managers who issue and repurchase firm equity – whose trading should be affected by impediments to arbitrage. While insiders and corporate decision makers are unlikely to be directly affected by fundamental risk, they can exploit trading opportunities better when outsiders have limited capacity to arbitrage the security.

In our study, we examine the returns following trades to investigate whether insiders and firms earn higher returns when outside arbitrage activity is limited. We document that the magnitude of post-trade returns is increasing in idiosyncratic risk: insider purchases and share repurchases precede higher (lower) returns when idiosyncratic risk is high (low), while insider sales and SEOs precede lower (higher) returns when idiosyncratic risk is high (low). However, the results for SEOs are sensitive to our methodology for estimating abnormal returns. We then examine determinants of insider and firm trading and how the effects of these determinants vary with idiosyncratic risk. Prior research has shown that insiders and firms trade on public information such as past returns and the market

to book ratio ((Rozeff and Zaman 1998),[4] Loughran and Ritter (1995),[5] and Graham and Harvey (2001)[6]) and private information such as future earnings innovations (Piotroski and Roulstone 2005). We find that returns prior to insider and firm trades are more extreme for high idiosyncratic risk stocks than for stocks with lower idiosyncratic risk although the results for repurchases are sensitive to controls for endogeneity. This is consistent with idiosyncratic risk limiting outside arbitrageurs' ability to profit from past returns (a public signal of possible mispricing), allowing insiders and firms to time the market more profitably. We also find that insider purchases make greater use of private information when limits to arbitrage are low than when limits to arbitrage are high. This is consistent with insiders exploiting their comparative advantage (private information) when competition from outside traders is high.

To ensure our results are compatible with a limited arbitrage story, we examine alternative explanations for our findings. In particular, we discuss whether the trading behavior we observe could result from aversion to total risk, from portfolio re-balancing, from corporate insiders' concerns about hedging fundamental risk, or from idiosyncratic risk proxying for information asymmetry. We believe none of these alternative stories can explain the entire set of empirical results. First, if observed trading patterns are motivated by general risk aversion, then insiders and firms should be agnostic to whether the source of risk is idiosyn-

[4]Rozeff and Zaman (1998) present evidence that corporate insiders trade on past returns and that these trades are motivated by perceived mispricing, i.e., insiders are "contrarians". Insiders buy after price decreases and sell after price increases and these trades are presumably made to take advantage of price reversals.

[5]Loughran and Ritter (1995) report a mean, one-year return prior to SEOs of 72%. Further discussion of SEOs and repurchases appears in Baker, Ruback, and Wurgler (2005).

[6]Graham and Harvey (2001) report that 62% of CFOs they survey list "If our stock price has recently risen, the price at which we can sell is 'high"' as important or very important in their decision to issue equity.

cratic or systematic. Contrary to this idea we find that idiosyncratic risk is associated with greater market timing ability while systematic risk is associated with lesser market timing ability. Second, if insiders simply re-balance their portfolios as a response to past returns, then their trades should not be followed by abnormal returns as we find. Further, while a re-balancing story may be valid in explaining personal behavior, it cannot explain the behavior of firms repurchasing shares and making seasoned equity offerings. Third, given insiders' superior knowledge of firm fundamentals and activities, we doubt that insiders and corporate decision makers are explicitly concerned about hedging fundamental risk when they initiate personal and firm trades. Rather, we believe the relations we observe among trades, trading signals, and post-trade returns derive from idiosyncratic risk limiting arbitrage by non-insiders, enabling insiders to better time the market with their own trades. Finally, we control for several firm characteristics associated with information asymmetry (e.g., firm size and analyst following) as well as future earnings innovations.

The closest paper to our study is Pontiff and Schill (2003) who show that 3-year abnormal returns following seasoned equity offerings (SEOs) are lower when stocks have greater idiosyncratic risk. In our paper, we repeat their setting with regards to treating specific corporate events that exploit mispricing and private information. We extend their work by examining stock repurchases and insider trades. In addition, we study the determinants of the decision to trade in order to identify the types of trading signals most affected by limits to arbitrage. Another related paper is Ali, Hwang, and Trombley (2003) who show that returns to a book-to-market strategy are increasing in arbitrage risk, consistent with

book-to-market capturing mispricing. Similarly, we show that returns to insider trades increase in arbitrage risk, consistent with insiders profiting from mispricing.

The study proceeds as following. In Section II we describe the data we use. In Section III we describe the empirical tests and their results. In Section IV we discuss our results and explore alternative explanations. We conclude and discuss future research avenues in Section V.

II. Data

A. Data Sources

We employ data from the Compustat, CRSP, I/B/E/S, SDC Platinum, Thomson Financial Insider Trading Data Feed and Thomson Financial 13F databases. The sample covers the years 1986 to 2003 which is the period covered by the Thomson Financial Insider Trading Data Feed database and for which we have full CRSP data available.

The basic unit of our dataset is a firm-month. To be included in the data set, each firm-month must have at least 24 valid monthly observations in CRSP and 8 quarterly financial reports in the Compustat Quarterly file in the preceding 4 years. For each firm-month we assign indicator variables to whether any of the following transactions took place: stock purchase by a manager or director ($INDBUY$), stock sale by a manager or director ($INDSAL$), stock repurchase by the firm ($INDREP$) and seasoned equity offering by the firm ($INDSEO$).

We follow the insider trading literature regarding the definition of purchases and sales by insiders (Rozeff and Zaman 1998, for example). We limit the population of insiders to officers and directors and consider only open-market purchases and sales with a size of more than 100 shares and a reported stock price of below $1,000. In the final sample, we have 70,542 firm-months with purchases by insiders, and 79,373 firm-months with sales by insiders.

The repurchase and SEO data are provided by Compustat and SDC Platinum, respectively. From Compustat, we prepare a list of all firms that repurchased between 1% and 15% of their shares outstanding during any quarter between the years 1986 and 2003.[7] Repurchases are defined as Compustat data item 93. From SDC Platinum, we generate a list of all firms that conducted seasoned equity offerings between the years 1986 and 2003. Overall, the sample includes 90,485 firm-months that conducted repurchases and 2,808 firm-months that conducted SEOs. Note that while we have the exact date of SEOs, we know only the fiscal quarter in which firms conducted their repurchases. Hence, in our analysis we assume that all repurchases took place in the last month of the fiscal quarter.

In addition, we compute several control variables from the CRSP, Compustat, I/B/E/S, and Thomson Financial 13F databases. From CRSP, we calculate for each firm-month t the one-month lagged market value of equity (MVE), six and twelve-month cumulative, market-adjusted returns from $t+1$ to $t+6$ or $t+12$ ($FUTRET6$, $FUTRET12$), and six and twelve-month cumulative, market-adjusted returns from $t-6$ or $t-12$ to $t-1$ ($PASTRET6$,

[7]Small repurchases are likely be related to the use of stock compensation rather than mispricing or private information while the limitation on the maximum size of repurchases follows from Lie (2002) who finds that large repurchases are likely to be defensive in nature.

$PASTRET12$). Using Compustat, we compute the market-to-book ratio (M/B) as the market value of equity scaled by the book value of equity (Compustat quarterly data item 60). We compute the future change in operating performance, $FDROA$, as the difference between the next quarter's operating income before depreciation (Compustat quarterly data item 21) and the same data item four quarters before, all scaled by total assets (Compustat quarterly data item 44). From I/B/E/S, we computed the number of analysts issuing one-quarter ahead earnings forecast in each month ($ANALYST$). From the Thomson Financial 13F database, we computed for each firm-quarter the percentage of aggregate institutional shareholding ($INST$) and applied that percentage to each month in the quarter.

To keep our results robust to extreme values and skewed distributions we transform the data in several ways. First, we exclude from the analysis all firm-months with a negative market-to-book ratio. Second, we winsorize all variables used in our regressions at the 1% level. Third, we log variables that have a skewed distribution (MVE and $ANALYST$).

B. Measures of Arbitrage Risk

As noted in the introduction, studies of limited arbitrage focus on the inability of traders to hedge fundamental risk in their trades. Wurgler and Zhuravskaya (2002) present a model in which arbitrageurs are sensitive to the risk of the hedge portfolio they form when engaging in arbitrage. They measure the risk of this hedge portfolio as the variance of the residuals from a regression of a firm's stock returns on the returns of the market portfolio. They show that using the market portfolio as the hedge portfolio works as well as using

individual stocks matched to the mispriced stock on industry and market-to-book ratio. Several studies use similar measures of idiosyncratic risk. Ali, Hwang, and Trombley (2003) use the variance of residuals from a regression of one year of daily returns on the value-weighted market portfolio. Mashruwala, Rajgopal, and Shevlin (2005) use the variance of residuals from a regression of four years of monthly firm returns on the equally-weighted market portfolio. Pontiff and Schill (2003) use the standard deviation of residuals from regressions of three years of monthly firm returns on industry, market, and Fama-French factor-mimicking portfolios.

We proxy for arbitrage risk ($IRISK$) with the variance of residuals from a regression of monthly returns on a four-factor model (MKT, SMB, HML and UMD). We measure idiosyncratic risk with respect to size, book-to-market, and momentum factors (in addition to the market factor) to exclude idiosyncratic risk that is correlated with the trading strategy of insiders and firms.[8] Our proxy is constructed as follows: for each firm-month t we collect monthly excess returns from months $t-54$ through $t-6$ and regress these excess returns on the four factors. We then compute the variance of the residuals from each monthly firm-specific regression. This variance has high skewness and kurtosis; a logarithmic transformation results in a relatively normal variable (skewness near zero and kurtosis of 2.9). We use the log-transformed version of $IRISK$ in all of our tests; results are similar using the standard deviation of the residuals (without the log transformation) instead of the variance or creating fractional ranks of the raw variance. Our proxy for systematic risk ($SYSRISK$) is the total variance of monthly returns over months $t-54$ through $t-6$,

[8]For example, Rozeff and Zaman (1998), Jenter (2005), and Piotroski and Roulstone (2005) show that insiders are value investors.

minus $IRISK$. To ease interpretation of our regression output, we center both $IRISK$ and $SYSRISK$ so that they have means of zero.

Our proxy for arbitrage risk, $IRISK$, may be endogenous with respect to insider and firm trading, and thus, requires further econometric treatment to achieve valid identification. Arbitrage risk makes arbitrageurs reluctant to trade in securities that have few close substitutes. Their reluctance to trade exacerbates mispricing in the stock and, thus, increases the idiosyncratic component of the firm's returns, i.e., $IRISK$. We resolve the endogeneity problem by instrumenting $IRISK$ with the idiosyncratic component of accounting return ($ACCRISK$).[9] We compute $ACCRISK$ for each firm-month as follows: First, we compute the quarterly return on assets of firm i at quarter t, ROA_{it}, calculated as operating income before depreciation (data item 21 from Quarterly Compustat) divided by lagged total assets (data item 44). Then, for each firm i in quarter q, we computed a quarterly index of the 2-digit SIC industry accounting return, $ROAIND_{iq}$, which is weighted by lagged total assets and excludes firm i. Each firm-quarter, we regress up to 16 quarters, (from $t-3$ through $t-48$ months) of firm-level ROA on aggregate industry $ROAIND$. Finally, we calculate the variance of the residuals of these regressions, $ACCRISK$, as the proxy for the idiosyncratic risk from operating income. As with $IRISK$, we use the centered, log-transformed version of $ACCRISK$ in our tests. From the correlation coefficients in Table II, it is evident that the idiosyncratic risk in stock returns is highly correlated with the idiosyncratic risk of operating income ($\rho = 0.577$).

[9] Irvine and Pontiff (2005) show that idiosyncratic variance in cash flows is highly correlated with idiosyncratic variance in stock returns.

C. Returns

Market-adjusted cumulative returns serve in our analysis both as explanatory variables and as dependent variables. In the first part of the work we document the link between idiosyncratic risk and returns following the trades of insiders and firms. In this analysis, future returns are the dependent variable; we use six-month and twelve-month market adjusted returns. In the second half of our analysis we investigate the decision to trade. We follow previous studies which have identified past returns as an important trigger for insider and firm trades (Rozeff and Zaman 1998, Piotroski and Roulstone 2005, Graham and Harvey 2001, Loughran and Ritter 1995, Jenter 2005). As noted in Section II.A, we denote the returns over the six (twelve) months preceding a trade as $PASTRET6$ ($PASTRET12$), and the future returns over the following six (twelve) months as $FUTRET6$ ($FUTRET12$).

III. Empirical Tests

A. Descriptive Statistics

Table I presents descriptive statistics for the firm-months in our sample. Insider buys (insider sells, share repurchases, SEOs) occur in 9.6% (10.9%, 16.1%, 0.39%) of our firm-months. The mean past (future) six-month, market-adjusted return is 1.3% (1.5%), while the mean firm has market value of equity of $1.6 billion, has a market-to-book ratio of 2.6, is followed by 4.2 analysts and has 27.4% of its shares held by institutions. Raw idiosyncratic risk has a mean (median) value of 0.024 (0.012); raw systematic risk has a mean (median)

value of 0.007 (0.004), and raw, idiosyncratic cash flow volatility has a mean (median) value of 0.002 (0.0002). (By construction, the centered, log-transformed values of these three variables have means of zero.)

Table II presents correlation coefficients for our main variables. Idiosyncratic and systematic risk are highly correlated as are idiosyncratic risk and its instrument $ACCRISK$. Insider buys and share repurchases occur after negative returns and prior to positive returns, while insider sales and SEOs occur after positive returns and prior to negative returns (although the latter correlation for SEOs is not statistically significant).

B. Arbitrage Risk and Returns from Trade

B.1. Pooled Regressions

To test whether firms and insiders earn returns that are positively correlated with the fundamental risk of arbitrage, we regress market-adjusted returns accumulated over six and twelve months following the trades of insiders and firms on indicator variables for type of trade, $IRISK$, and the interaction between the trade indicator variables and $IRISK$, along with control variables for systematic risk ($SYSRISK$), size (MVE), market-to-book (M/B), analyst following ($ANALYST$), institutional ownership ($INST$), and future earnings information ($FDROA$). We control for market and industry shocks by adding fixed effects for time (indicator variables for each calendar month from 1986 to 2003) and industry (defined by two-digit SIC codes). Statistical significance is assessed with standard errors that are robust to heteroscedasticity and allow for correlation across firms within

two-digit SIC industries. By adding the interactions to the regression, we assess whether the future returns following a trade by an insider or a firm are more extreme for high idiosyncratic risk stocks:

$$
\begin{aligned}
&FUTRET6/12_{it} = \beta_0 + \beta_1 IRISK_{it} + \beta_2 SYSRISK_{it} \\
&+\beta_3 INDBUY_{it} + \beta_4 INDBUY_{it} * IRISK_{it} + \beta_5 INDBUY_{it} * SYSRISK_{it} \\
&+\beta_6 INDSAL_{it} + \beta_7 INDSAL_{it} * IRISK_{it} + \beta_8 INDSAL_{it} * SYSRISK_{it} \\
&+\beta_9 INDREP_{it} + \beta_{10} INDREP_{it} * IRISK_{it} + \beta_{11} INDREP_{it} * SYSRISK_{it} \\
&+\beta_{12} INDSEO_{it} + \beta_{13} INDSEO_{it} * IRISK_{it} + \beta_{14} INDSEO_{it} * SYSRISK_{it} \\
&+\beta_{15} FDROA_{it} + \beta_{16} PASTRET6/12_{it} + \beta_{17} M/B_{it} \\
&+\beta_{18} LN(MVE)_{it} + \beta_{19} LN(ANALYST)_{it} + \beta_{20} LN(INST)_{it} \\
&+Industry\ Fixed\ Effects + Time\ Fixed\ Effects + \epsilon_t
\end{aligned}
$$

The results in Table III (2SLS regressions only; results are similar when we do not instrument for $IRISK$) suggest that insider purchases and firm trades earn higher returns when idiosyncratic risk is high: the interaction variables are all statistically significant and with the expected signs. In terms of economic significance, the results in Table III column (3) indicate that insider purchases are followed by six-month, market-adjusted returns of approximately 4% when $IRISK$ is at its mean; these returns increase (decrease) to approximately 7% (1%) when $IRISK$ is one-standard deviation above (below) its mean. With share repurchases, six-month, market-adjusted returns following the repurchase are roughly 5.0% (1.5%) when $IRISK$ is one-standard deviation above (below) its mean. For SEOs,

subsequent six-month returns are roughly -5.5% (1.5%) when $IRISK$ is one-standard deviation above (below) its mean. Twelve-month returns (column (4) of Table III) show a similar spread in returns across the level of $IRISK$ for insider purchases, share repurchases, and SEOs.

Results for insider sales are less clear. Although idiosyncratic risk is negatively related to post-insider sales returns in columns (1) and (2), this relation weakens when time and industry fixed effects are included. In column (3) the interaction between insider sales and idiosyncratic risk is insignificant and in column (4), with 12-month returns, the interaction is only marginally significant (one-tailed p-value of 0.075). In a sensitivity analysis, we find this appears to be due to the correlation between the $IRISK$ interactions and the $SYSRISK$ interactions: when the interaction between $SYSRISK$ and $INDSAL$ is removed from the full model, the coefficient on the interaction between $IRISK$ and $INDSAL$ is negative and significant. As systematic and idiosyncratic risk are highly correlated (correlation coefficient of 0.68 in our sample) this may indicate a multi-collinearity problem.[10] To summarize: insider and firm purchases (sales) are followed by larger (smaller) returns as idiosyncratic risk increases although the results for insider sales are sensitive to model specification.

[10]We provide more evidence related to insider sales in the next section (where we calculate calendar-time portfolio returns) and in Section III.C where we report sensitivity analysis using a measure of systematic risk orthoganalized with respect to idiosyncratic risk.

B.2. Calendar-Time Portfolios

As a robustness check of the results in the previous subsection, we conform to Fama (1998) who advocates the use of the calendar-time method to measure the abnormal returns from a trading strategy. With the calendar-time method, one tests a trading strategy by regressing excess returns (returns minus the risk free rate) generated by the trading strategy on the contemporaneous returns of risk factor portfolios. If the intercept of these regressions is significantly different from zero, the trading strategy produces abnormal returns, i.e., returns which cannot be subsumed by the known risk factors. As a matter of practice, most researchers use three- or four-factor models where the factors are the market excess return (MKT), small minus big (SMB), high book-to-market minus low book-to-market (HML) and a momentum factor (UMD).[11]

To illustrate the calendar-time methodology, we describe the process for assessing abnormal returns in the six months following insider purchases. For each calendar month in our sample, we form a portfolio of all firms that experienced an insider purchase in the preceding six months and did not experience an insider sale during that time. Within each monthly portfolio we then form four sub-portfolios based on the rank of $IRISK$ at the beginning of the month. We then compute the equally-weighted return for each sub-portfolio and subtract the risk-free rate to give a monthly portfolio excess return.[12] This calculation gives us four time-series of monthly observations, one for each level of $IRISK$. The excess returns to these monthly portfolios are then regressed on the contemporaneous returns to

[11] For further details on the calendar-time portfolios technique, see Mitchell and Stafford (2000).

[12] Value-weighting the portfolio return yields similar results.

the factor-mimicking portfolios with the intercepts in these regressions representing the average monthly return in the six-months following the specified transaction:[13]

$$R_{pt} - R_{ft} = \beta_0 + \beta_1 MKTRF_t + \beta_2 HML_t + \beta_3 SMB_T + \beta_4 UMD_t + \epsilon_t$$

Similar procedures are carried out for insider sales, repurchases, and SEOs.

The results are presented in Table IV. In Table IV Panel A we present the results for purchases by insiders. The average abnormal, monthly return in the six months following an insider purchase is 97 basis points for high $IRISK$ firms versus 41 basis points for low $IRISK$ firms, a difference significant at the 1% level. Similar results are evident for insider sales (Panel B) and stock repurchases (Panel C): insider sales at high (low) $IRISK$ firms earn monthly returns of -71 (8) basis points; while monthly returns following stock repurchases by high (low) $IRISK$ firms earn returns of 67 (22) basis points. The exception is SEOs which show insignificant abnormal returns across all levels of $IRISK$.[14]

Results for twelve-month returns are similar to the six-month results although significance levels are sometimes lower. For example, the difference between $IRISK$ portfolios in twelve-month returns following insider purchases is only 17 basis points per month and this difference is only marginally significant (one-tailed significance at the 10% level). Re-

[13]The dependent variable in these regressions is a mean value calculated using varying numbers of firms from month to month. This can result in heteroscedastic residuals; we deal with this by weighting each monthly portfolio return by the square root of the number of firms used to calculate the portfolio return.

[14]Note that our calendar-time analyses may understate the returns to insider and firm trades if these trades are based on mispricing related to the market-to-book ratio. This is particularly important in our regressions as insiders tend to buy "value" stocks and sell "glamor" stocks (Rozeff and Zaman 1998). For a discussion of this issue, see Daniel, Hirshleifer, and Subrahmanyam (2005) and Ben-David and Roulstone (2005).

sults for insider sales are similar across the two cumulation periods while share repurchases, like insider purchases, show a much smaller spread across $IRISK$ levels. For SEOs, the difference in 12-month abnormal returns between high and low $IRISK$ is 28 basis points and this difference has one-tailed significance at the 10% level. Thus, the calendar-time regressions provide weak evidence supporting the Table III results for the effect of $IRISK$ on returns following SEOs.

The intercepts in Table IV provide the average monthly abnormal return following insider and firm transactions but do not indicate how quickly these returns occur. Figure 1 graphs the cumulative monthly intercepts from our four-factor regressions for the 12 months following insider and firm transactions, stratified by $IRISK$. Consistent with the average monthly results, cumulative monthly returns to insider trades and repurchases are greater in magnitude across the quartiles of $IRISK$. Further, the returns do not occur immediately following the trades; abnormal returns continue to increase (for insider buys and share repurchases) and decrease (for insider sales and SEOs) for up to a year following the trade event. Of particular note, SEOs show under-performance one-year after the issuance, with this under-performance most severe for the highest idiosyncratic risk quartiles.

In sorting firms by $IRISK$ there is a concern that we are implicitly sorting by firm size which is highly correlated with $IRISK$. To alleviate this concern we perform a double-sort where we first sort firms on the one-year lagged market value of equity, and then, within these size quartiles, sort firms into quartiles of $IRISK$. Thus, our portfolio assignments control for size. Results with this double-sort are similar to those presented: returns to insider purchases and share repurchases (insider sales) increase (decrease) across the

quartiles of idiosyncratic risk. Results for SEOs continue to be weak with differences in twelve-month returns marginally significant across the high and low $IRISK$ quartiles.[15]

Past studies have shown that idiosyncratic risk may be associated with future abnormal returns (Goyal and Santa-Clara 2003). Such an association between abnormal returns and idiosyncratic risk should not explain our results as we document a positive relation between idiosyncratic risk and returns for purchase events and a negative relation between idiosyncratic risk and returns for sales events. In contrast, the idiosyncratic risk literature generally documents a monotonic relation between idiosyncratic risk and returns (Pontiff 2005 also makes this point). For robustness, we investigate this issue in two ways. First, we form calendar-time portfolios of all firms stratified by the level of $IRISK$. Regressions of excess portfolio returns on the four-factor model provide estimates of the average abnormal return each month to firms stratified by idiosyncratic risk. Table V presents these results and shows that with the four-factor model idiosyncratic risk does not appear to be priced by the market: only the intercept for the lowest level of $IRISK$ is significantly different from zero and the significance is marginal. Intercepts for the top-three quartiles of $IRISK$ are not significantly different from zero. This result provides some comfort that our measure of idiosyncratic risk is not, in our sample, capturing unspecified risk factors that drive our return results.

Second, we construct a factor based on $IRISK$, and include this factor in our calendar-time analysis. We construct this factor in a manner similar to the Fama-French HML

[15](Pontiff and Schill 2003) find decreasing 36-month returns to SEOs as idiosyncratic risk increases. When we examine calendar-time returns in the 36-months following an SEO we find similar results: average monthly returns (after controlling for Fama-French and four-factor returns) are significantly lower for high-$IRISK$ firms than for low-$IRISK$ firms.

(value/glamor) factor: using all firms, we measure each month the mean return to large and small firms with a high (above the median) level of $IRISK$, as well as the mean return to large and small firms with a low (below or equal to the median) level of $IRISK$. The difference of these returns is our $IRISK$ factor (I_FACTOR). Table V presents our universal calendar-time regressions with this factor included in the second column of each $IRISK$ quartile's results:

$$R_{pt} - R_{ft} = \beta_0 + \beta_1 MKTRF_t + \beta_2 HML_t + \beta_3 SMB_T + \beta_4 UMD_t + \beta_5 I\_FACTOR_t + \epsilon_t$$

intercepts for all levels of $IRISK$ are now insignificantly different from zero.

Table V, panel B assesses the effects of including I_FACTOR in our calendar-time estimations of returns to insider and firm trades. As can be seen in the table, the inclusion of I_FACTOR does not significantly alter our inferences: abnormal returns following insider buys, insider sales, and share repurchases still have greater magnitudes when $IRISK$ is high than when $IRISK$ is low. In fact, the 12-month results for insider purchases and share repurchases are stronger with I_FACTOR included in the regressions: the spread between the top and bottom quartiles of $IRISK$ is now significant at the 1% level for both.

These robustness tests support our hypothesis that insiders and firms are better able to exploit profitable trading opportunities when idiosyncratic risk is high rather than low. First, our measure of idiosyncratic risk is not proxying for firm size. Second, the abnormal returns in the $IRISK$-based portfolios are not subsumed by the return difference between high and low idiosyncratic risk firms. Rather, controlling for this return difference, trades

occurring at high-$IRISK$ firms are followed by more extreme returns than trades occurring at low-$IRISK$ firms.

C. The Decision to Trade

Given that returns following insider and firm trades appear to be correlated with arbitrage risk, we examine the source of this correlation by testing the hypothesis that insiders and firms can more easily exploit public information about mispricing and private information about firm prospects when arbitrage risk is high. We do this by studying the determinants of trading by insiders and firms. Results are presented in Table VI, Panels A (insider purchases), B (insider sales), C (repurchases) and D (SEOs). The dependent variable in all the regressions is an indicator variable for whether the event in question took place in a particular firm-month. The variables of interest are the proxy for arbitrage risk ($IRISK$) and its interactions with (1) past returns ($PASTRET6$ or $PASTRET12$); (2) the market-to-book ratio (M/B); and (3) the one-quarter ahead change in ROA ($FDROA$):

$$
\begin{aligned}
&INDBUY/SAL/REP/SEO_{it} = \beta_0 + \beta_1 IRISK_{it} + \beta_2 SYSRISK_{it} \\
&+\beta_3 PASTRET6_{it} + \beta_4 PASTRET6_{it} * IRISK_{it} + \beta_5 PASTRET6_{it} * SYSRISK_{it} \\
&+\beta_6 M/B_{it} + \beta_7 M/B_{it} * IRISK_{it} + \beta_8 M/B_{it} * SYSRISK_{it} \\
&+\beta_9 FDROA_{it} + \beta_{10} FDROA_{it} * IRISK_{it} + \beta_{11} FDROA_{it} * SYSRISK_{it} \\
&+\beta_{12} LN(MVE)_{it} + \beta_{13} LN(ANALYST)_{it} + \beta_{14} LN(INST)_{it} \\
&+Industry\ Fixed\ Effects + Time\ Fixed\ Effects + \epsilon_t
\end{aligned}
$$

We do not predict the sign of the coefficient on $IRISK$, however, we can make a prediction regarding the coefficient on the interaction between $IRISK$ and the trade signals. As $IRISK$ increases, insiders and firms will initiate buys (sells) after lower (higher) past returns and when the firm has a lower (higher) market-to-book ratio: i.e., when $IRISK$ is high insiders and firms will trade when public signals of mispricing are more pronounced. This is because higher $IRISK$ discourages outside arbitrage activity and allows insiders and firms to be more patient in timing the market. Thus, for insider purchases and share repurchases, the sign on the interaction between $IRISK$ and, $PASTRET6/12$ or M/B, should be positive: low returns and low market-to-book ratios lead to insider purchases and share repurchases but stronger signals are needed as the risk of arbitrage increases. For insider sales and SEOs the sign on the coefficient of the interaction term will be negative: high returns and high market-to-book ratios lead to insider sales and SEOs but stronger signals are needed as the risk of arbitrage increases. Put another way, a larger decrease (increase) in price and a lower (higher) valuation will occur before initiation of purchases (sales) when $IRISK$ is high. These relations occur because high $IRISK$ prevents outside arbitrageurs from capitalizing on public signals such as past returns and the market-to-book ratio.

The relation between $IRISK$ and the private signal of future earnings changes ($FDROA$) is not so clear. Unlike public signals such as past returns, insiders have a clear advantage in using knowledge of future earnings changes relative to outside arbitrageurs. At the same time, trading on private information about earnings carries with it litigation concerns not attached to trading on public signals of mispricing. Litigation concerns imply that high

idiosyncratic risk will decrease the use of earnings news because idiosyncratic risk prevents outsiders from trading on public signals, allowing insiders to trade on those signals (which carry less litigation risk than private information). Alternatively, if idiosyncratic risk prevents outsiders from trading on public signals *and* private signals such as earnings news, we would expect the weight on $FDROA$ to increase with idiosyncratic risk.

While the arbitrage literature has focused on idiosyncratic risk as an impediment to arbitrage, Shleifer and Vishny (1997) suggest that both idiosyncratic and systematic risk may deter arbitrage activity. To investigate whether the source of stock return volatility is important for arbitrage activity (and thus, to the activities of insiders), we include systematic risk ($SYSRISK$) and its interaction with the trading signals in our regressions. If all types of volatility deter arbitrage then we expect that the signs on the coefficient of the interaction between $SYSRISK$ and the trading signals would follow the signs of the coefficient on the interaction between $IRISK$ and the trading signals. However, when $IRISK$ is held constant, greater $SYSRISK$ implies a stock's returns are closer to those of the market, providing an arbitrageur greater ability to hedge the fundamental risk in a trade. This outcome then implies that the sign of the coefficient on the interaction between $SYSRISK$ and the trading signals will be opposite to the sign on the coefficient on the interaction between $IRISK$ and the trading signals. Thus, including $SYSRISK$ and its interaction in our regressions provides an additional test of our prediction that idiosyncratic risk increases the risks of arbitrage by limiting the hedging of fundamental risk.

To identify the determinants of trading by insiders and firms we estimate a linear probability model. In such models, the variance of the error term is always heteroscedastic

(Wooldridge 2002). As mentioned earlier, we assess significance with standard errors that are robust to heteroscedasticity. To mitigate concerns that the increase over time in idiosyncratic volatility (Campbell, Lettau, Malkiel, and Xu 2001) is correlated with changes in trading patterns we include time fixed effects. Similarly, we include fixed effects for industry membership to control for the possibility that idiosyncratic industries make heavy use of stock-based compensation resulting in increased insider trading and stock repurchases. Finally, we add firm size (MVE), analyst following ($ANALYST$), and institutional ownership ($INST$) to control for information asymmetry between insiders and shareholders.

Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS) regressions of the determinants of trading are presented in Table VI. In column (1) we regress the transaction indicator on $IRISK$, $PASTRET6$, M/B, $FDROA$, and the control variables. In column (2) we add interactions between $IRISK$ and the trading signals along with the fixed effects. In column (3), we present results where we instrument for $IRISK$ using $ACCRISK$. Finally, column (4) repeats the analysis in column (3) with $PASTRET12$ instead of $PASTRET6$. Table VI confirms the findings of previous studies (Rozeff and Zaman 1998, Piotroski and Roulstone 2005) that past returns predict transactions of insiders and firms: insider purchases and share repurchases follow negative returns while insider sales and SEOs follow positive returns. As predicted, the interaction between $IRISK$ and $PASTRET6$ is positive for purchases and repurchases and negative for sales and SEOs suggesting that in the presence of arbitrage risk, insiders trade after greater past mispricing.

Results with the market-to-book ratio (M/B) are not as clear. Insider purchases occur when the ratio is low (i.e., insiders are value investors) but this relation is unaffected by idiosyncratic or systematic risk. On the other hand, insider sales occur when the ratio is high and higher values are needed to induce sales as idiosyncratic risk increases (with the opposite result for systematic risk). Finally, share repurchases and SEOs show little variation in their relation with market-to-book ratios as idiosyncratic risk varies. Overall, only insiders sales support the hypothesis that misvaluation (as proxied by the market-to-book ratio) is greater at trade initiation when idiosyncratic risk is high relative to when it is low.

The final trading signal is future earnings changes ($FDROA$). Insider purchases occur when future earnings changes are positive; however, this relation decreases as idiosyncratic risk increases and this decrease is significant in the 2SLS regression. Combined with the results for past returns, this suggests than when idiosyncratic risk is high, insiders purchase after price declines but not necessarily before positive earnings surprises, i.e., at idiosyncratic firms, insider purchases are driven by public information about mispricing and not private information about firm performance. Conversely, when idiosyncratic risk is low and systematic risk is high, insider purchases occur after smaller price declines but before larger earnings surprises, i.e., at systematic firms insider purchases are driven by private earnings news, not public mispricing. These results are consistent with insiders trading on public information when idiosyncratic risk prevents non-insiders from using this information, and trading on private information when non-insiders can make use of public signals.

Surprisingly, insider sales occur before positive earnings surprises; however, this relation is unaffected by idiosyncratic and systematic risk. This may be due to litigation worries as insider sales ahead of bad earnings news are likely to draw regulatory scrutiny.[16] In addition, many insider sales are made for liquidity reasons and the prior literature has concluded that insider sales contain little private information (Lakonishok and Lee 2001). Strangely, share repurchases are also more likely as earnings decrease with this relation decreasing (increasing) in idiosyncratic (systematic) risk. Finally, SEOs are unaffected by short-term earnings changes.

Table VI suggests that idiosyncratic risk has a statistically significant effect on the probability of trading. The economic significance of this effect can be assessed as follows using the data from column (2) of Table VI Panel A: $IRISK$ has a mean of zero (by construction) and a standard deviation of 1.1251. When $IRISK$ is one-standard deviation above zero, a ten percent decrease in price over the past six months increases the probability of an insider purchase by 0.19% ($= 10\% * (-0.047 + (1.1251 * 0.0251))$). When $IRISK$ is one-standard deviation below zero, a ten percent decrease in price over the past six months increases the probability of an insider purchase by 0.78% ($= 10\% * (-0.047 + (-1.1251 * 0.0251))$). Thus, the effect of past returns (a public signal of mispricing) on insider purchases is four times as strong when arbitrage risk is low (one-standard deviation below its mean) relative to when it is high (one-standard deviation above its mean). Put differently, to achieve a 1% increase in the probability of an insider purchase would require a price drop of roughly 58% at a high arbitrage risk firm, but a drop of only 13% at a low arbitrage risk firm. Results

[16]See Ke, Huddart, and Petroni (2003) for a discussion of this issue and evidence that insiders prefer to sell several quarters ahead of negative earnings news.

are similar for insider sales and repurchases but weaker for SEOs. The causality of the associations documented in columns (1) and (2) of Table VI depends on the exogeneity of the relation between trading decisions and idiosyncratic risk. If insiders at some firms are very quick to act on perceived mispricing, returns at these firms are likely to display smaller idiosyncratic volatility, implying a smaller value of $IRISK$. Thus, high values of $IRISK$ will be correlated with insiders initiating trades only after considerable perceived mispricing; i.e., the same association as in Table VI but with causality reversed. To control for this endogeneity, we instrument the returns-based measure $IRISK$ with an accounting-based proxy for idiosyncratic risk $ACCRISK$. The results of the 2SLS regressions are presented in columns (3) and (4) in each panel of Table VI. The coefficient on the interaction of arbitrage risk and past returns is similar to the OLS coefficient (in fact, it is larger than the OLS coefficient for all regressions) suggesting that insiders and firms respond to arbitrage risk by trading less on mispricing. However, for shares repurchases and SEOs, the coefficient on the interaction is just barely statistically insignificant for six-month returns (two-tailed p-values of 0.12 and 0.11, respectively), suggesting that firms that engage in repurchases and SEOs also engage in other activities that increase idiosyncratic risk (e.g., poor disclosure) but that these other activities are unrelated to their operating results. Alternatively, our instrument for idiosyncratic risk ($ACCRISK$) is simply a noisy measure of idiosyncratic operating results. Given the increase in coefficient magnitude from the OLS to the 2SLS estimation, the lack of statistical significance appears to come from an increase in the standard error of the coefficient.

Overall, the results in Table VI imply that insiders at high idiosyncratic risk firms take advantage of more favorable price movements before initiating trades than insiders at low arbitrage risk firms; i.e., when idiosyncratic risk is high, insiders and firms are better able to time the market. Similarly, insiders at idiosyncratic firms sell when the firm is more over-valued (as measured by the market-to-book ratio) than insiders at systematic firms. Private information about earnings changes is used by insiders at systematic, not idiosyncratic, firms when making purchase decisions. However, the use of earnings news for insider sales and SEOs is unrelated to idiosyncratic risk (and the main effect is of the opposite sign for insider sales), while the use of earnings news in share repurchase decisions is contrary to expectations. Overall, the consistent driver of trading decisions is past returns with trades occurring after more extreme past returns as idiosyncratic risk increases. This is consistent with insiders and firms attempting to time the market and being more successful when idiosyncratic risk is high.

D. Returns Prior To Trades

We provide more evidence on the relation between past returns and trading by regressing past returns on indicator variables for trade occurrence and interactions of these indicator variables with $IRISK$. Table VII presents these results; column (1) presents the base regression; column (2) adds control variables; column (3) adds fixed effects for industry and time; column (4) repeats the model of column (3) substituting $PASTRET12$ for $PASTRET6$ as the dependent variable (for brevity, we only report 2SLS regressions in which we instrument for $IRISK$). For insider sales the results are as implied by the Ta-

ble VI regressions: six-month returns before sales are positive and past-return magnitudes increase as $IRISK$ increases. In economic terms, insider sales are preceded on average by a share price increase of 9.6%; when $IRISK$ is one-standard deviation above (below) its mean, the six-month return before insider sales is roughly 16% (2%).

For firm transactions, our results indicate that equity is issued following high returns and, the greater the value of $IRISK$, the greater the past returns observed. In contrast, repurchases occur after price declines and, as $IRISK$ increases, smaller past declines are observed. The result for repurchases may be due to repurchases which occur for reasons other than undervaluation. For example, stock options are more valuable at idiosyncratic firms. These firms may repurchase shares to avoid EPS dilution following option exercises; these repurchases will tend to follow the positive returns associated with option exercises. However, these results must be interpreted cautiously however, as the Table III results indicate that the relation between repurchases and SEOs and idiosyncratic risk is sensitive to controls for endogeneity.

The results in Table VII for insider purchases are weaker than the results for insider sales: as expected the coefficient on the interaction term is negative; this result suggests that insider purchases are preceded by lower returns when idiosyncratic risk is high. However, the interaction term loses significance in column (3). Similar to the Table III result for returns following insider sales we find that the coefficient on the interaction term is negative and significant in column (3) if the interaction between $INDBUY$ and $SYSRISK$ is not included in the regression; i.e., this result appears to be driven by multi-collinearity.

To deal with this collinearity issue, we have re-estimated the Table III and Table VII regressions after orthogonalizing systematic risk with respect to idiosyncratic risk. Results for regressions with this specification (not tabulated) are that returns following insiders sales are significantly decreasing in $IRISK$ while returns prior to insider purchases are significantly decreasing in $IRISK$. However, even with the orthogonalized measure of systematic risk, the results for share repurchases continue to be contrary to expectations with the interaction between $INDREP$ and $IRISK$ positive and significantly different from zero.

Thus, our cross-sectional regressions indicate that, with the exception of returns preceding share repurchases, returns before insider and firm trades are greater in magnitude when idiosyncratic risk is high. This result is consistent with idiosyncratic risk limiting the activities of non-insider arbitrageurs and allowing insider arbitrageurs more freedom to exploit profitable trading opportunities associated with past return movements.

E. Other Proxies for Arbitrage Risk

So far in this paper, we have used idiosyncratic risk as our proxy for impediments to arbitrage trades. As noted earlier however, arbitrage will also be limited by transactions costs and the extent of noise trading (see footnote 2). To support our contention that limits to arbitrage increase returns to insider and firm trades we replicate our analysis in Table III using other proxies for arbitrage risk. The proxies we use are drawn from Ali, Hwang, and

Trombley (2003) who examine the relation between arbitrage risk and the returns to a trading strategy based on the book-to-market ratio.

Ali, Hwang, and Trombley (2003) examine several measures of limits to arbitrage including idiosyncratic volatility, share price, firm size, analyst following, and institutional ownership. They find the returns to a book-to-market strategy are increasing in idiosyncratic volatility, consistent with book-to-market capturing mispricing that is exacerbated by limits to arbitrage. They also find an association between book-to-market returns and share price and institutional ownership consistent with these proxies representing transaction costs (share price) and investor sophistication (institutional ownership). In unreported results we run our Table III regressions including interactions between the trade indicators and share price, firm size, analyst following, and institutional ownership. This analysis reveals two main points: first, the relations between idiosyncratic volatility and the trade indicators are robust to including these additional arbitrage risk proxies. Second, the returns to insider trades are generally increasing in the additional proxies for limits to arbitrage. As share prices, firm size, analyst following, and institutional ownership decrease, returns to insider trades increase. However, as in Ali, Hwang, and Trombley (2003) these relations are generally subsumed by the idiosyncratic risk relation: when the trade indicators are interacted with both idiosyncratic risk and the other proxies, only the interaction with idiosyncratic risk is significant. Overall, this analysis indicates that the relation between insider trading profits and limits to arbitrage is robust to multiple proxies for limits to arbitrage; however, idiosyncratic risk is the strongest example of this relation.

IV. Discussion

A. Insiders' and Firms' Timing Ability

The results from the previous section indicate that insiders and firms modify their trading behavior with respect to trading signals and with respect to the degree of idiosyncratic risk. With the exception of insider purchases, idiosyncratic risk has little effect on the relation between trades and private information. However, when insiders and firms trade on public information, they trade as if they time the troughs and peaks of mispriced stocks.

We find that in order to initiate a purchase (sale), insiders and firms require a greater decline (a greater increase) in price when idiosyncratic risk is high relative to when it is low (Table VI). Further, the magnitude of post-trade returns is more extreme in high idiosyncratic risk stocks (Table III). This is consistent with a world in which idiosyncratic risk limits the ability of outside arbitrageurs to exploit mispricing: given these limits, insiders (who face fewer barriers to arbitrage activity than outsiders) are better able to time their trades and thus, we observe them trading after greater mispricing, i.e., after more extreme returns (all trades) and after greater market valuation relative to book value (insider sales).

While insider sales, share repurchases, and SEOs are primarily driven by past returns, insider purchases are also affected by private information about future earnings news. However, this relation exists largely for systematic stocks: when idiosyncratic risk is high, insider purchases show little correlation with future earnings news; when idiosyncratic risk

is low, insider purchases are positively correlated with future earnings news (Table VI). Combined with the results regarding the relation among insider purchases, past returns, and idiosyncratic risk, this implies insider purchases at high idiosyncratic risk firms will largely be based on overreaction in past returns, while at low idiosyncratic risk firms, insider purchases will largely be based on private information about future firm performance. Figure 2, documenting cumulative, monthly, calendar-time returns over the 12 months prior to and following insider purchases, supports these predictions: For high idiosyncratic risk firms, returns prior to trades are negative, while returns following the trade are just positive enough to cancel out the past decline by roughly 2%. In contrast, at low idiosyncratic risk firms, returns prior to insider purchases are largely flat, but the purchases are followed by positive returns of approximately 5.5%.

These results bring to mind the discussion in Seyhun (1998) of "active" versus "passive" insider trading. Seyhun defines active insider trading as trading motivated by future news rather than past price changes. In contrast, passive insider trading occurs when insiders trade after price changes (e.g., a contrarian response to mispricing). Seyhun shows that insider purchases made after flat return periods (i.e., active purchases) are more profitable than insider purchases which follow steep price declines (i.e., passive purchases). One contribution of our paper is to show how opportunities for active and passive purchases relate to barriers to arbitrage activity. In high idiosyncratic risk firms, outsiders face difficulty arbitraging away temporary mispricing and, as a result, prices may fall too much relative to fundamentals. This provides insiders with opportunities to buy an undervalued asset. In contrast, at low idiosyncratic risk firms, outsiders are more likely to arbitrage

away mispricing leaving only private information as a source of profitable purchases by insiders.

Results for sales transactions demonstrate a smaller role for private information. Positive returns before insider sales and SEOs and negative returns after insider sales and SEOs increase with idiosyncratic risk. This is consistent with insiders and firms locking in gains from past performance and being able to do so more profitably when idiosyncratic risk is high. However, the price declines after insider sales and SEOs are modest compared to the price increases before the trades suggesting that private information about future negative news plays only small role in these trading decisions, a finding that is consistent with the Table VI results.

B. Alternative Explanations

Our findings imply that insiders and firms are sensitive to indicators of mispricing and this sensitivity depends on the level of idiosyncratic risk. The effect of idiosyncratic risk is not proxying for total volatility: consistent with a limited arbitrage story, systematic risk affects trading in a manner opposite to idiosyncratic risk. The relation between past returns and trades may reflect portfolio re-balancing: as the price of their company's stock rises, insiders will sell shares and invest in outside assets in order to keep their firm from becoming too large a portion of their portfolio and maintain diversification. Similarly, as the price drops, insiders may buy shares in order to maintain a minimum level of investment in their firm.

We believe that a portfolio re-balancing explanation for the relation between past returns and trades cannot explain our findings. If insiders are merely re-balancing their portfolios following price changes, then we would not expect this re-balancing to be decreased by idiosyncratic risk; in fact, we would expect idiosyncratic risk to increase the desire for re-balancing (because, as idiosyncratic risk rises, the costs of a sub-optimal portfolio increase). Further, if insider trades are motivated by re-balancing and not exploitation of mispricing, insider trades should not be followed by significant abnormal returns.

If insiders and firms are viewed as exercising options to trade, then our results may simply document a positive relation between option value and volatility: greater volatility in prices implies greater movement away from fundamentals leading to more opportunities for insider and firms to buy at peaks and sell during troughs. However, outside arbitrageurs also have an option to trade in a firm and would be expected to compete with insiders in trading on price swings. Only when one considers the unique role of idiosyncratic risk in deterring outside arbitrageurs (by making it difficult for them to hedge the fundamental risk in their trades) can one explain our results regarding the relation between past returns and insider and firm decision making: idiosyncratic risk deters outside investors and allows insiders and firms to better time the market.

A third alternative explanation for our results is that insiders and firms themselves are deterred from trading by the difficulty of hedging fundamental risk. This deterrence effect leads to insiders at high idiosyncratic risk firms trading only after mispricing becomes strong enough to compensate them for the risk involved in the trade, a prediction consistent with our results in Tables VI and VII. However, it is unlikely that managers making decisions

about SEOs and share repurchases are sensitive to idiosyncratic risk in the manner depicted in the limits to arbitrage literature. For example, firms are unlikely to hedge themselves against the risk involved in issuing equity or repurchasing shares. Further, of all possible arbitrageurs, insiders and firms are the least susceptible to worries about fundamental risk.

Finally, idiosyncratic risk may proxy for information asymmetry between corporate insiders and outside market participants. Such information asymmetry would lead to profitable trading opportunities for insiders and corporate decision makers. Our tests control for several proxies for information asymmetry (firm size, analyst following, institutional ownership, and future earnings innovations). Thus, we believe the results documented in Tables VI and VII most likely indicate that corporate insiders have the best market timing ability when idiosyncratic risk deters non-insider arbitrageurs from trading in the firm's shares.

V. Conclusion

In this paper we provide evidence that idiosyncratic risk affects arbitrage activities with subsequent effects on stock returns. Consistent with idiosyncratic risk limiting arbitrage trades by non-insiders, we show that insiders and firms trade more profitably in firms with high idiosyncratic risk than in firms with low idiosyncratic risk. Specifically, trades of insiders and firms capitalize on proxies for mispricing, and are followed by higher returns, when idiosyncratic risk is high than when it is low. Our results imply that when arbitrage

risk is high the price of a stock may deviate from its fundamental value to a greater extent than if arbitrage risk is low, due to the lack of trades intended to profit from this mispricing.

We discount several alternative explanations for our work. First, our results are not driven by a general aversion to risk by arbitrageurs. Specifically, we show that systematic risk affects insider and firm trading in a manner opposite to idiosyncratic risk. This is consistent with systematic risk proxying for the ability of non-insider arbitrageurs to hedge their fundamental risk, i.e., systematic risk is not an impediment to arbitrage. Second, portfolio re-balancing does not explain the effect of idiosyncratic risk on the relation between trading and past returns, nor does it explain returns following trades. Third, we recognize that our results our consistent with insiders and firms viewing idiosyncratic risk as an impediment to their arbitrage activities. However, we view this explanation as unlikely given that insiders have superior knowledge of fundamental value relative to non-insiders and firms are unlikely to worry about hedging themselves when issuing equity or repurchasing shares. Finally, we control for measures of information asymmetry, reducing concerns that idiosyncratic risk proxies for information asymmetry and thus, provides insiders with profitable trading opportunities.

Our results point to several future research ideas. First, we have concentrated on a limited set of trading signals that arbitrageurs may act on: past returns, market to book, and future earnings changes. If insiders exploit other mispricing indicators such as accruals (Core, Guay, Richardson, and Verdi 2005), do they also trade more profitably on that signal as arbitrage risk increases? Second, we have focused on arbitrageurs' inability to eliminate fundamental risk due to a lack of substitute stocks. The risks of arbitrage also increase

with the presence of noise traders (DeLong, Shleifer, Summers, and Waldmann 1990), transactions costs, and implementation costs (Barberis and Thaler 2003). How insiders and firms profit in the presence of these risks is an open question. Third, our results imply that $IRISK$ is informative about the extent of mispricing. Many other corporate finance actions are potentially associated with the degree of arbitrage risk and an investigation of how the risks of arbitrage affect these items may prove useful in documenting how corporate finance decisions are made. For example, Ben-David and Roulstone (2005) investigate whether merger acquirers and targets (which are presumably over and under-valued at the time of the merger) tend to be high arbitrage risk firms, while Polk and Sapienza (2003) investigate whether managers invest more when their firm is overvalued.

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Appendix: Variable Definitions

Variable	Definition
$IRISK$	Centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample
$SYSRISK$	Centered log of the total variance of monthly returns minus the variance of residuals used to calculate $IRISK$
$ACCRISK$	Centered log of the variance of residuals from a regression of quarterly return on assets on value-weighted industry index of return on assets; data from months $t-3$ through $t-48$
$INDBUY(SAL)$	Indicator variable equal to one if at least one insider purchase (insider sale) occurred during the month
$INDREP(SEO)$	Indicator variable equal to one if a share repurchase (SEO) occurred during the month
$PASTRET6(12)$	Six-month (12-month) market adjusted, buy and hold return over month $t-1$ through $t-6$ $(t-12)$
$FUTRET6(12)$	Six-month (12-month) market adjusted, buy and hold return over month $t+1$ through $t+6$ $(t+12)$
MVE	The market value of equity at the end of month t
M/B	Market value of equity scaled by the book value of equity
$ANALYST$	The number of analysts issuing a one-quarter ahead earnings forecast for the firm in month t
$INST$	The percentage of shares outstanding owned by institutional investors
$FDROA$	One-quarter ahead seasonal change in quarterly return on assets
R_f	Risk-free rate of return in month t, proxied by one-month treasury bill rate
$MKTRF$	Excess return on the market defined as the value-weighted monthly return to all stocks on CRSP less the one-month treasury bill rate
SMB	Mean monthly return on portfolio of small firms less mean monthly return on portfolio of large firms
HML	Mean monthly return on portfolio of value firms less mean monthly return on portfolio of glamor firms
UMD	Mean monthly return on portfolio of winners less mean monthly return on portfolio of losers
I_FACTOR	Mean monthly return on portfolio of high $IRISK$ firms less mean monthly return on portfolio of low $IRISK$ firms

Table I
Descriptive Statistics

The table presents descriptive statistics of the sample used. The sample consists of all firms with: Complete data from Compustat, CRSP, I/B/E/S, CDA/Spectrum, Thomson Financial's Insider Trading Data Feed for 1986-2003. For the monthly Fama-French variables (R_f, $MKTRF$, HML, SMB, and UMD) statistics are based on 215 monthly observations. $IRISK$ is a centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. $SYSRISK$ is a centered log of the total variance of monthly returns minus the variance of residuals used to calculate $IRISK$. $ACCRISK$ is a centered log of the variance of residuals from a regression of quarterly return on assets on value-weighted industry index of return on assets; data from months $t-3$ through $t-48$. $INDBUY(SAL)$ is an indicator variable equal to one if at least one insider purchase (insider sale) occurred during the month. $INDREP(SEO)$ is an indicator variable equal to one if a share repurchase (SEO) occurred during the month. $PASTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t-1$ through $t-6$ ($t-12$). $FUTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t+1$ through $t+6$ ($t+12$). MVE is the market value of equity at the end of month t. M/B is the market value of equity scaled by the book value of equity. $ANALYST$ is the number of analysts issuing a one-quarter ahead earnings forecast for the firm in month t. $INST$ is the percentage of shares outstanding owned by institutional investors. $FDROA$ is one-quarter ahead seasonal change in quarterly return on assets. R_f is the risk-free rate of return in month t, proxied by one-month treasury bill rate. $MKTRF$ is the excess return on the market defined as the value-weighted monthly return to all stocks on CRSP less the one-month treasury bill rate. SMB is the mean monthly return on portfolio of small firms less mean monthly return on portfolio of large firms. HML is the mean monthly return on portfolio of value firms less mean monthly return on portfolio of glamor firms. UMD is the mean monthly return on portfolio of winners less mean monthly return on portfolio of losers. I_FACTOR is the mean monthly return on portfolio of high $IRISK$ firms less mean monthly return on portfolio of low $IRISK$ firms.

Variable	Mean	Standard Deviation	Q1	Median	Q3
$IRISK$ (unlogged, uncentered)	0.0240	0.0771	0.0052	0.0118	0.0262
$IRISK$	0.0000	1.1251	-0.8242	-0.0168	0.7806
$SYSRISK$ (unlogged, uncentered)	0.0070	0.0398	0.0015	0.0036	0.0074
$SYSRISK$	0.0000	1.2359	-0.7753	0.0676	0.7950
$ACCRISK$ (unlogged, uncentered)	0.0016	0.0053	0.0001	0.0002	0.0008
$ACCRISK$	0.0000	2.4840	-1.1930	0.1796	1.5368
$INDBUY$	0.0964	0.2951	0.0000	0.0000	0.0000
$INDSAL$	0.1090	0.3116	0.0000	0.0000	0.0000
$INDREP$	0.1608	0.3673	0.0000	0.0000	0.0000
$INDSEO$	0.0039	0.0622	0.0000	0.0000	0.0000
$PASTRET6$	0.0133	0.3875	-0.2112	-0.0321	0.1591
$PASTRET12$	0.0157	0.5908	-0.3431	-0.0727	0.2257
$FUTRET6$	0.0148	0.3911	-0.2100	-0.0297	0.1635
$FUTRET12$	0.0340	0.6034	-0.3273	-0.0590	0.2412
MVE ($millions)	1620.0	9940.0	27.5	115.0	593.0
M/B	2.5851	3.3563	1.0274	1.6127	2.7435
$ANALYST$	4.1886	6.7011	0.0000	1.0000	6.0000
$INST$	0.2740	0.2690	0.0137	0.1990	0.4760
$FDROA$	-0.0002	0.0213	-0.0006	0.0000	0.0001
R_f	0.0040	0.0016	0.0030	0.0042	0.0049
$MKTRF$	0.0064	0.0464	-0.0217	0.0111	0.0380
HML	0.0030	0.0336	-0.0158	0.0030	0.0193
SMB	0.0005	0.0362	-0.0209	-0.0013	0.0197
UMD	0.0087	0.0468	-0.0055	0.0108	0.0287
I_FACTOR	-0.0004	0.0534	-0.0233	-0.0003	0.0207

Table II
Correlation Table

The table presents the correlation table of the variables in the sample used. The sample consists of all firms with: Complete data from Compustat, CRSP, I/B/E/S, CDA/Spectrum, Thomson Financial's Insider Trading Data Feed for 1986-2003. $IRISK$ is a centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. $SYSRISK$ is a centered log of the total variance of monthly returns minus the variance of residuals used to calculate $IRISK$. $ACCRISK$ is a centered log of the variance of residuals from a regression of quarterly return on assets on value-weighted industry index of return on assets; data from months $t-3$ through $t-48$. $INDBUY(SAL)$ is an indicator variable equal to one if at least one insider purchase (insider sale) occurred during the month. $INDREP(SEO)$ is an indicator variable equal to one if a share repurchase (SEO) occurred during the month. $PASTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t-1$ through $t-6$ $(t-12)$. $FUTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t+1$ through $t+6$ $(t+12)$. Bolded coefficients are significant at the 1% level.

	$IRISK$	SYS $RISK$	ACC $RISK$	IND BUY	IND SAL	IND REP	IND SEO	$PAST$ $RET6$	FUT $RET6$
$IRISK$	1								
$SYSRISK$	**0.687**	1							
$ACCRISK$	**0.577**	**0.419**	1						
$INDBUY$	**-0.045**	**-0.038**	**-0.069**	1					
$INDSAL$	**-0.037**	**0.021**	**-0.035**	**0.033**	1				
$INDREP$	**-0.095**	**-0.039**	**-0.009**	**0.010**	**0.024**	1			
$INDSEO$	0.000	**0.005**	0.000	**0.009**	**0.024**	**-0.016**	1		
$PASTRET6$	**0.059**	**0.030**	**-0.012**	**-0.051**	**0.098**	**-0.032**	**0.049**	1	
$FUTRET6$	**0.026**	**0.033**	**-0.019**	**0.030**	**-0.014**	**0.025**	-0.002	**0.049**	1

Table III
Returns *Following* Trades

The table presents results from 2SLS regressions of 6- and 12-month returns following all firms with: Complete data from Compustat, CRSP, I/B/E/S, CDA/Spectrum, Thomson Financial's Insider Trading Data Feed for 1986-2003. $IRISK$ is a centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. $SYSRISK$ is a centered log of the total variance of monthly returns minus the variance of residuals used to calculate $IRISK$. $ACCRISK$ is a centered log of the variance of residuals from a regression of quarterly return on assets on value-weighted industry index of return on assets; data from months $t-3$ through $t-48$. $INDBUY(SAL)$ is an indicator variable equal to one if at least one insider purchase (insider sale) occurred during the month. $INDREP(SEO)$ is an indicator variable equal to one if a share repurchase (SEO) occurred during the month. $PASTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t-1$ through $t-6$ ($t-12$). $FUTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t+1$ through $t+6$ ($t+12$). MVE is the market value of equity at the end of month t. M/B is the market value of equity scaled by the book value of equity. $ANALYST$ is the number of analysts issuing a one-quarter ahead earnings forecast for the firm in month t. $INST$ is the percentage of shares outstanding owned by institutional investors. $FDROA$ is one-quarter ahead seasonal change in quarterly return on assets. *, **, *** denote two-tailed significance at the 10%, 5%, and 1% level respectively. Standard errors are robust to heteroscedasticity and dependence across observations in the same industry (defined by two-digit SIC). $IRISK$ is instrumented by $ACCRISK$.

	Predicted Sign	$FUTRET6$	$FUTRET6$	$FUTRET6$	$FUTRET12$
$IRISK$	-	-0.0443***	-0.0577**	-0.0311***	-0.0460**
		(0.013)	(0.023)	(0.009)	(0.019)
$INDBUY$	+	0.0505***	0.0500***	0.0466***	0.0588***
		(0.003)	(0.003)	(0.003)	(0.004)
$INDBUY * IRISK$	+	0.0426***	0.0394***	0.0410***	0.0345***
		(0.009)	(0.010)	(0.007)	(0.008)
$INDSAL$	-	-0.0353***	-0.0208***	-0.0170***	-0.0185***
		(0.003)	(0.002)	(0.003)	(0.006)
$INDSAL * IRISK$	-	-0.0234***	-0.0161**	-0.0078	-0.0215
		(0.005)	(0.003)	(0.007)	(0.015)
$INDREP$	+	0.0370***	0.0388***	0.0345***	0.0596***
		(0.005)	(0.005)	(0.004)	(0.009)
$INDREP * IRISK$	+	0.0506***	0.0372***	0.0211**	0.0297*
		(0.014)	(0.014)	(0.009)	(0.016)
$INDSEO$	-	-0.0274***	-0.0264***	-0.0193**	-0.0426**
		(0.007)	(0.008)	(0.010)	(0.019)
$INDSEO * IRISK$	-	-0.0225	-0.0237	-0.0363*	-0.0862*
		(0.019)	(0.021)	(0.021)	(0.044)
$SYSRISK$	?	0.0361***	0.0408***	0.0136***	0.0234**
		(0.006)	(0.011)	(0.005)	(0.009)
$FDROA$	+	-	0.7304***	0.8294***	1.1409***
			(0.057)	(0.083)	(0.110)
$PASTRET6/12$	+	-	0.0737***	0.0617***	-0.0034
			(0.009)	(0.005)	(0.007)
M/B	-	-	-0.0061***	-0.0063**	-0.0073***
			(0.001)	(0.001)	(0.001)
$LN(MVE)$	?	-	-0.0143***	-0.0157***	-0.0348***
			(0.003)	(0.002)	(0.006)
$LN(ANALYST)$	?	-	0.0084***	0.0176***	0.0345***
			(0.002)	(0.003)	(0.005)
$INST$	?	-	0.0557***	-0.0068	-0.0507***
			(0.009)	(0.008)	(0.017)
Industry Fixed Effects		NO	NO	YES	YES
Time Fixed Effects		NO	NO	YES	YES
$SYSRISK$ Interactions		YES	YES	YES	YES
N		731387	731387	731387	697268

Table IV
Calendar-Time Portfolio Returns By $IRISK$ Quartiles

The table presents results of regressions calendar-time portfolios of firm-months that went through the studied events, stratified by $IRISK$ quartiles, on factor-mimicking portfolios. Each regression is based on 215 monthly observations. $IRISK$ is a centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. R_f is the risk-free rate of return in month t, proxied by one-month treasury bill rate. $MKTRF$ is the excess return on the market defined as the value-weighted monthly return to all stocks on CRSP less the one-month treasury bill rate. SMB is the mean monthly return on portfolio of small firms less mean monthly return on portfolio of large firms. HML is the mean monthly return on portfolio of value firms less mean monthly return on portfolio of glamor firms. UMD is the mean monthly return on portfolio of winners less mean monthly return on portfolio of losers. Observations are weighted by the square root of the number of observations in the portfolios created. *, **, *** denote two-tailed significance at the 10%, 5%, and 1% level respectively.

$$\mathrm{R}_{pt} - R_{ft} = \beta_0 + \beta_1 MKTRF_t + \beta_2 HML_t + \beta_3 SMB_T + \beta_4 UMD_t + \epsilon_t$$

Panel A: OLS Coefficients for Returns Following Insider Purchases

	$IRISK$	Intercept	$MKTRF$	HML	SMB	UMD	Adj. R^2
Six-Month	1	0.0041***	0.6804***	0.5637***	0.2538***	-0.0660***	0.813
Returns	2	0.0049***	0.9302***	0.6886***	0.5227***	-0.1879***	0.885
	3	0.0083***	0.9875***	0.3869***	1.0022***	-0.3580***	0.849
	4	0.0097***	0.9433***	-0.1463	1.3016***	-0.6065***	0.751
	4 – 1	0.0056***					
Twelve-Month	1	0.0035***	0.6394***	0.5420***	0.2444***	-0.0555***	0.821
Returns	2	0.0031***	0.9016***	0.6886***	0.5693***	-0.1633***	0.882
	3	0.0053***	0.9768***	0.4302***	1.0224***	-0.3101***	0.836
	4	0.0052	0.9553***	-0.0581	1.3193***	-0.5875***	0.733
	4 – 1	0.0017					

Panel B: OLS coefficients for returns following Insider Sales

	$IRISK$	Intercept	$MKTRF$	HML	SMB	UMD	Adj. R^2
Six-Month	1	-0.0008	0.8509***	0.5196***	0.1414***	0.0453**	0.836
Returns	2	-0.0024**	1.0009***	0.4977***	0.4728***	0.0052	0.889
	3	-0.0021*	1.1164***	0.1574***	0.9298***	-0.0691***	0.933
	4	-0.0071***	1.1542***	-0.3734***	1.3192***	-0.3105***	0.872
	4 – 1	-0.0063***					
Twelve-Month	1	-0.0001	0.8135***	0.5018***	0.1591***	0.03142	0.826
Returns	2	-0.0019*	0.9776***	0.4959***	0.4754***	-0.0067	0.886
	3	-0.0023*	1.0820***	0.1292***	0.8942***	-0.1139	0.928
	4	-0.0060**	1.1096***	-0.4092***	1.3111***	-0.4031***	0.855
	4 – 1	-0.0059***					

Table IV: Calendar-Time Portfolio Returns By $IRISK$ Quartiles (Cont.)

Panel C: OLS coefficients for returns following Share Repurchases

	$IRISK$	Intercept	$MKTRF$	HML	SMB	UMD	Adj. R^2
Six-Month	1	0.0022**	0.8569***	0.5236***	0.1530***	-0.0575***	0.829
Returns	2	0.0023**	0.9263***	0.5843***	0.4608***	-0.1498***	0.877
	3	0.0053***	0.9803***	0.3181***	0.8266***	-0.2960***	0.897
	4	0.0067**	0.9911***	-0.0940	1.1256***	-0.4556***	0.784
	4 – 1	0.0045**					
Twelve-Month	1	0.0035***	0.6394***	0.5420***	0.2444***	-0.0555***	0.821
Returns	2	0.0031***	0.9016***	0.6886***	0.5693***	-0.1633***	0.882
	3	0.0053***	0.9768***	0.4302***	1.0224***	-0.3101***	0.836
	4	0.0052	0.9553***	-0.0581	1.3193***	-0.5875***	0.733
	4 – 1	0.0017					

Panel D: OLS coefficients for returns following SEOs

	$IRISK$	Intercept	$MKTRF$	HML	SMB	UMD	Adj. R^2
Six-Month	1	0.0010	0.7570***	0.5138***	0.2796***	0.1476***	0.682
Returns	2	-0.0021	1.0778***	0.4814***	0.4421***	0.0708*	0.768
	3	-0.0006	1.3289***	0.7080	0.8938***	0.2364***	0.814
	4	-0.0005	1.2808***	-0.2920**	1.1556***	0.1511**	0.744
	4 – 1	-0.0015					
Twelve-Month	1	0.0001	0.7477***	0.4991***	0.1874***	0.0775***	0.721
Returns	2	-0.0029*	1.0882***	0.4602***	0.4188***	0.0383	0.809
	3	-0.0023	1.2447***	0.0203	0.8683***	0.0370	0.839
	4	-0.0027	1.2948***	-0.3778***	1.1258***	-0.0129	0.805
	4 – 1	-0.0028					

Table V
Calendar-Time Portfolio Returns By $IRISK$ Quartiles on 4 Factors and I_FACTOR

The table presents results of regressions calendar-time portfolios of firm-months. Panel A presents the results of portfolios based on the universe of firm-months, stratified by $IRISK$ quartiles. Panel B presents intercepts from regressions of calendar-time portfolios based on event firm-months. Regressors in Panel B are 4-factors ($MKTRF$, SMB, HML, and UMD), and I_FACTOR. Each regression is based on 215 monthly observations. $IRISK$ is centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. R_p is the time-series of mean monthly return of a portfolio which includes all firm-months (in Panel A) or event-firm-months (in Panel B), stratified by $IRISK$ quartile. R_f is the risk-free rate of return in month t, proxied by one-month treasury bill rate. $MKTRF$ is the excess return on the market defined as the value-weighted monthly return to all stocks on CRSP less the one-month treasury bill rate. SMB is the mean monthly return on portfolio of small firms less mean monthly return on portfolio of large firms. HML is the mean monthly return on portfolio of value firms less mean monthly return on portfolio of glamor firms. UMD is the mean monthly return on portfolio of winners less mean monthly return on portfolio of losers. I_FACTOR is the mean monthly return on portfolio of high $IRISK$ firms less mean monthly return on portfolio of low $IRISK$ firms. Observations are weighted by the square root of the number of observations in the portfolios created. *, **, *** denote two-tailed significance at the 10%, 5%, and 1% level respectively.

$$\mathrm{R}_{pt} - R_{ft} = \beta_0 + \beta_1 MKTRF_t + \beta_2 HML_t + \beta_3 SMB_T + \beta_4 UMD_t + \beta_5 I\_FACTOR_t + \epsilon_t$$

Panel A: Full-Sample regressions of calendar-time based on $IRISK$ quartiles

	$IRISK=1$		$IRISK=2$		$IRISK=3$		$IRISK=4$	
Intercept	0.0017*	0.0010	0.0000	-0.0003	-0.0002	0.0011	-0.0044	-0.0007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
$MKTRF$	0.6920***	0.7672***	0.9364***	0.9769***	1.0184***	0.8745***	0.9846***	0.5640***
	(0.021)	(0.019)	(0.021)	(0.022)	(0.032)	(0.027)	(0.072)	(0.040)
HML	0.4919***	0.3618***	0.5785***	0.5085***	0.3112***	0.5602***	-0.1471	0.5806***
	(0.031)	(0.030)	(0.031)	(0.034)	(0.049)	(0.041)	(0.108)	(0.061)
SMB	0.1907***	0.3727***	0.5226***	0.6206***	0.9439***	0.5954***	1.3449***	0.3267***
	(0.025)	(0.029)	(0.025)	(0.033)	(0.039)	(0.040)	(0.087)	(0.060)
UMD	-0.0106*	-0.0715***	-0.1152***	-0.1480***	-0.2399***	-0.1233***	-0.4666***	-0.1257***
	(0.018)	(0.016)	(0.018)	(0.019)	(0.027)	(0.023)	(0.061)	(0.034)
I_FACTOR	-	-0.2576***	-	-0.1387***	-	0.4933***	-	1.4414***
		(0.028)		(0.032)		(0.039)		(0.057)
Adj. R^2	0.848	0.889	0.925	0.931	0.908	0.948	0.780	0.945
N (months)	215	215	215	215	215	215	215	215

Panel B: Intercepts of regressions of calendar-time portfolios on 4 factors and I_FACTOR

Intercept for:	Returns	$IRISK=1$	$IRISK=2$	$IRISK=3$	$IRISK=4$	4 – 1
Insider Purchases	6-month	0.0036***	0.0046***	0.0095***	0.0123***	0.0087***
	12-month	0.0031***	0.0030***	0.0065***	0.0079***	0.0048***
Insider Sales	6-month	-0.0017*	-0.0030**	-0.0016	-0.0047***	-0.0030**
	12-month	-0.0010	-0.0025**	-0.0016	-0.00345***	-0.0025*
Repurchases	6-month	0.0014	0.0021*	0.0061***	0.0094***	0.0080***
	12-month	0.0031***	0.0030***	0.0065***	0.0079***	0.0048***
SEOs	6-month	-0.0002	-0.0028	-0.0003	0.0008	0.0010
	12-month	-0.0008	-0.0038**	-0.0019	-0.0012	-0.0004

Table VI
Cross-Sectional Regressions of the Decision to Trade

The table presents results from OLS and 2SLS regressions of event-indicator variables for all firms with: Complete data from Compustat, CRSP, I/B/E/S, CDA/Spectrum, Thomson Financial's Insider Trading Data Feed for 1986-2003. $IRISK$ is a centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. $SYSRISK$ is a centered log of the total variance of monthly returns minus the variance of residuals used to calculate $IRISK$. $ACCRISK$ is a centered log of the variance of residuals from a regression of quarterly return on assets on value-weighted industry index of return on assets; data from months $t-3$ through $t-48$. $INDBUY(SAL)$ is an indicator variable equal to one if at least one insider purchase (insider sale) occurred during the month. $INDREP(SEO)$ is an indicator variable equal to one if a share repurchase (SEO) occurred during the month. $PASTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t-1$ through $t-6$ $(t-12)$. MVE is the market value of equity at the end of month t. M/B is the market value of equity scaled by the book value of equity. $ANALYST$ is the number of analysts issuing a one-quarter ahead earnings forecast for the firm in month t. $INST$ is the percentage of shares outstanding owned by institutional investors. $FDROA$ is one-quarter ahead seasonal change in quarterly return on assets. *, **, *** denote two-tailed significance at the 10%, 5%, and 1% level respectively. Standard errors are robust to heteroscedasticity and dependence across observations in the same industry (defined by two-digit SIC). In 2SLS regressions, $IRISK$ is instrumented by $ACCRISK$.

Panel A: Insider Purchases

	Predicted Sign	OLS $INDBUY$	OLS $INDBUY$	2SLS $INDBUY$	2SLS $INDBUY$
$IRISK$	-	-0.0044	-0.0027	-0.0046	-0.0015
		(0.005)	(0.002)	(0.005)	(0.005)
$SYSRISK$	?	-0.0044**	0.0003	0.0014	0.0000
		(0.002)	(0.002)	(0.003)	(0.003)
$PASTRET6$	-	-0.0334***	-0.0470***	-0.0537***	-0.0315***
		(0.002)	(0.003)	(0.003)	(0.003)
$PASTRET6 * IRISK$	+	-	0.0251***	0.0411***	0.0169***
			(0.003)	(0.005)	(0.002)
$PASTRET6 * SYSRISK$	-	-	-0.0068***	-0.0153***	-0.0071***
			(0.001)	(0.003)	(0.001)
M/B	-	-0.0020***	-0.0015***	-0.0016***	-0.0014***
		(0.001)	(0.000)	(0.000)	(0.000)
$M/B * IRISK$	+	-	-0.0001	0.0002	0.0000
			(0.000)	(0.001)	(0.001)
$M/B * SYSRISK$	?	-	-0.0001	-0.0003	-0.0002
			(0.000)	(0.001)	(0.001)
$FDROA$	+	0.0545***	0.0646***	0.1186***	0.1192***
		(0.011)	(0.017)	(0.028)	(0.029)
$FDROA * IRISK$	-	-	-0.0225	-0.1267***	-0.1303***
			(0.018)	(0.046)	(0.003)
$FDROA * SYSRISK$	?	-	0.0011	0.0611*	0.0637***
			(0.013)	(0.032)	(0.033)
$LN(MVE)$	?	0.0019**	0.0007	0.0005	0.0009
		(0.001)	(0.001)	(0.002)	(0.002)
$LN(ANALYST)$	?	0.0092**	0.0081***	0.0081***	0.0035***
		(0.004)	(0.002)	(0.002)	(0.001)
$INST$	?	-0.0369	-0.0297***	-0.0295***	-0.0001***
		(0.025)	(0.010)	(0.010)	(0.000)
Industry Fixed-Effects		NO	YES	YES	YES
Time Fixed-Effects		NO	YES	YES	YES
Adj. R^2		0.005	0.025	-	-
N		731387	731387	731387	730198

Table VI: Cross-Sectional Regressions of the Decision to Trade (Cont.)

Panel B: Insider Sales

	Predicted Sign	OLS $INDSAL$	OLS $INDSAL$	2SLS $INDSAL$	2SLS $INDSAL$
$IRISK$	-	0.0008	0.0148***	0.0293***	0.0226**
		(0.003)	(0.003)	(0.010)	(0.009)
$SYSRISK$	?	0.0063**	-0.0035	-0.0128***	-0.0095**
		(0.002)	(0.002)	(0.004)	(0.005)
$PASTRET6$	+	0.0600***	0.0742***	0.0786***	0.0585***
		(0.003)	(0.004)	(0.006)	(0.004)
$PASTRET6 * IRISK$	-	-	-0.0275***	-0.0352***	-0.0169***
			(0.003)	(0.011)	(0.005)
$PASTRET6 * SYSRISK$	+	-	0.0073***	0.0103*	0.0067**
			(0.002)	(0.006)	(0.003)
M/B	+	0.0045***	0.0046***	0.0070***	0.0061***
		(0.001)	(0.001)	(0.001)	(0.001)
$M/B * IRISK$	?	-	-0.0026***	-0.0100***	-0.0087***
			(0.001)	(0.002)	(0.002)
$M/B * SYSRISK$	?	-	0.0018***	0.0065***	0.0059***
			(0.001)	(0.002)	(0.002)
$FDROA$	-	0.0341**	0.0612***	0.07738**	0.0769**
		(0.016)	(0.020)	(0.038)	(0.037)
$FDROA * IRISK$	?	-	-0.0408**	-0.0677	-0.0552
			(0.018)	(0.055)	(0.054)
$FDROA * SYSRISK$	?	-	-0.0005	0.015	0.0083
			(0.012)	(0.029)	(0.029)
$LN(MVE)$	?	0.0132***	0.0182***	0.0173***	0.0160***
		(0.001)	(0.002)	(0.003)	(0.003)
$LN(ANALYST)$	?	0.0156***	0.0102***	0.0089***	0.0187***
		(0.003)	(0.003)	(0.003)	(0.003)
$INST$	?	0.0420***	0.0559***	0.0574***	0.0000*
		(0.013)	(0.010)	(0.011)	(0.000)
Industry Fixed Effects		NO	YES	YES	YES
Time Fixed Effects		NO	YES	YES	YES
Adj. R^2		0.040	0.058	-	-
N		731387	731387	731387	730198

Table VI: Cross-Sectional Regressions of the Decision to Trade (Cont.)

Panel C: Share Repurchases

	Predicted Sign	OLS $INDREP$	OLS $INDREP$	2SLS $INDREP$	2SLS $INDREP$
$IRISK$	-	-0.0042	-0.0201***	-0.0494**	-0.0546**
		(0.010)	(0.006)	(0.022)	(0.022)
$SYSRISK$	?	-0.0044	-0.0112***	0.0026	0.0047
		(0.004)	(0.003)	(0.011)	(0.011)
$PASTRET6$	-	-0.0454***	-0.0484***	-0.0460***	-0.0326***
		(0.005)	(0.007)	(0.012)	(0.011)
$PASTRET6 * IRISK$	+	-	0.0281***	0.0351	0.0174
			(0.004)	(0.022)	(0.013)
$PASTRET6 * SYSRISK$	-	-	-0.0101***	-0.0151	-0.0072
			(0.002)	(0.011)	(0.005)
M/B	-	-0.0012	-0.001	0.0012	0.0016
		(0.001)	(0.001)	(0.001)	(0.001)
$M/B * IRISK$	+	-	-0.0017***	-0.0047*	-0.0049*
			(0.001)	(0.003)	(0.003)
$M/B * SYSRISK$	?	-	-0.0002	0.0019	0.002
			(0.001)	(0.002)	(0.003)
$FDROA$	+	-0.0616***	-0.1153***	-0.1925***	-0.1956***
		(0.020)	(0.027)	(0.053)	(0.053)
$FDROA * IRISK$	-	-	0.1022***	0.2436***	0.2429***
			(0.019)	(0.075)	(0.073)
$FDROA * SYSRISK$	?	-	-0.0245*	-0.1082**	-0.1070**
			(0.014)	(0.042)	(0.041)
$LN(MVE)$	?	0.0105***	0.0130	0.0049	0.0049
		(0.003)	(0.002) ***	(0.005)	(0.005)
$LN(ANALYST)$	?	-0.0138***	-0.0050*	-0.0048	0.002
		(0.005)	(0.003)	(0.003)	(0.003)
$INST$	?	0.1534***	0.0573***	0.0471***	-0.0001
		(0.031)	(0.014)	(0.015)	(0.000)
Industry Fixed Effects		NO	YES	YES	YES
Time Fixed Effects		NO	YES	YES	YES
Adj. R^2		0.024	0.084	-	-
N		731387	731387	731387	730198

Table VI: Cross-Sectional Regressions of the Decision to Trade (Cont.)

Panel D: SEOs

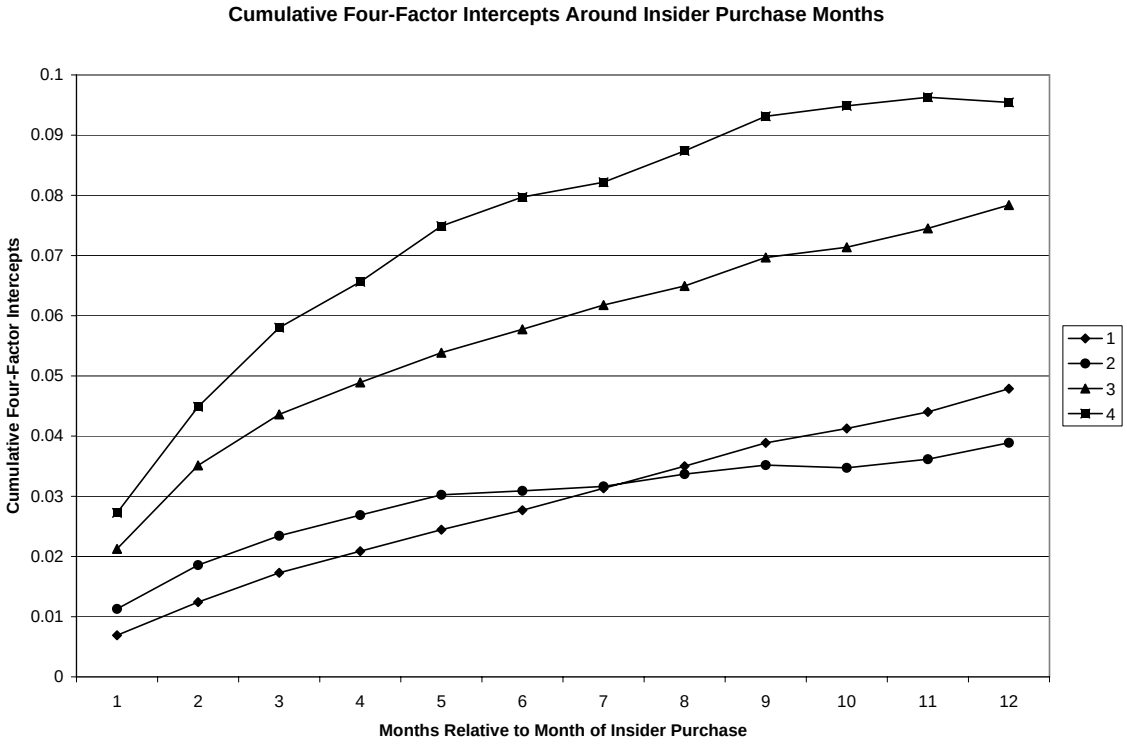
	Predicted Sign	OLS $INDSEO$	OLS $INDSEO$	2SLS $INDSEO$	2SLS $INDSEO$
$IRISK$	-	0.0011***	0.0016***	0.0042**	0.0024
		(0.000)	(0.000)	(0.002)	(0.002)
$SYSRISK$	?	-0.0004**	-0.0002	-0.0015*	-0.0007
		(0.000)	(0.000)	(0.001)	(0.001)
$PASTRET6$	+	0.0073***	0.0090***	0.0087***	0.0075***
		(0.001)	(0.001)	(0.001)	(0.001)
$PASTRET6 * IRISK$	-	-	-0.0035***	-0.0038	-0.0029**
			(0.000)	(0.002)	(0.001)
$PASTRET6 * SYSRISK$	+	-	0.0015***	0.0018	0.0019***
			(0.000)	(0.001)	(0.001)
M/B	+	-0.0001***	-0.0002***	-0.0004***	-0.0005***
		(0.000)	(0.000)	(0.000)	(0.000)
$M/B * IRISK$	-	-	0.0001**	0.0002	0.0003***
			(0.000)	(0.000)	(0.000)
$M/B * SYSRISK$	?	-	0.0000	-0.0001	-0.0002**
			(0.000)	(0.000)	(0.000)
$FDROA$	-	0.0086**	0.0081*	0.003	0.0034
		(0.004)	(0.004)	(0.005)	(0.005)
$FDROA * IRISK$	?	-	-0.0037*	0.0069	0.0065
			(0.002)	(0.009)	(0.008)
$FDROA * SYSRISK$	?	-	0.0052***	-0.0009	-0.0006
			(0.002)	(0.005)	(0.005)
$LN(MVE)$	?	0.0004***	0.0004***	0.0010**	0.0008**
		(0.000)	(0.000)	(0.000)	(0.000)
$LN(ANALYST)$	?	-0.0003	-0.0005	-0.0005	0.0020***
		(0.000)	(0.000)	(0.000)	(0.000)
$INST$	?	0.0117***	0.0149***	0.0157***	0.0000
		(0.001)	(0.001)	(0.001)	(0.000)
Industry Fixed Effects		NO	YES	YES	YES
Time Fixed Effects		NO	YES	YES	YES
Adj. R^2		0.005	0.008	-	-
N		731387	731387	731387	730198

Table VII
Returns *Prior* to Trades

The table presents results from 2SLS regressions of $PASTRET6(12)$ for all firms with: Complete data from Compustat, CRSP, I/B/E/S, CDA/Spectrum, Thomson Financial's Insider Trading Data Feed for 1986-2003. $IRISK$ is a centered log of the variance of residuals from a regression of monthly returns on the monthly Fama-French factors plus a momentum factor; data from month $t-6$ through $t-54$, minimum 24 months of returns to be in sample. $SYSRISK$ is a centered log of the total variance of monthly returns minus the variance of residuals used to calculate $IRISK$. $ACCRISK$ is a centered log of the variance of residuals from a regression of quarterly return on assets on value-weighted industry index of return on assets; data from months $t-3$ through $t-48$. $INDBUY(SAL)$ is an indicator variable equal to one if at least one insider purchase (insider sale) occurred during the month. $INDREP(SEO)$ is an indicator variable equal to one if a share repurchase (SEO) occurred during the month. $PASTRET6(12)$ is a six-month (12-month) market adjusted, buy and hold return over month $t-1$ through $t-6$ $(t-12)$. MVE is the market value of equity at the end of month t. M/B is the market value of equity scaled by the book value of equity. $ANALYST$ is the number of analysts issuing a one-quarter ahead earnings forecast for the firm in month t. $INST$ is the percentage of shares outstanding owned by institutional investors. $FDROA$ is one-quarter ahead seasonal change in quarterly return on assets. *, **, *** denote two-tailed significance at the 10%, 5%, and 1% level respectively. Standard errors are robust to heteroscedasticity and dependence across observations in the same industry (defined by two-digit SIC). In all regressions, $IRISK$ is instrumented by $ACCRISK$.

	Predicted Sign	$PASTRET6$	$PASTRET6$	$PASTRET6$	$PASTRET12$
$IRISK$	-	-0.0531***	-0.0831***	-0.0313*	-0.0713*
		(0.012)	(0.026)	(0.017)	(0.037)
$INDBUY$	-	-0.0720***	-0.0636***	-0.0572***	-0.0760***
		(0.003)	(0.003)	(0.002)	(0.004)
$INDBUY * IRISK$	-	-0.0177***	-0.0130*	-0.0084	-0.007
		(0.006)	(0.007)	(0.007)	(0.011)
$INDSAL$	+	0.1272***	0.1000***	0.0886***	0.1690***
		(0.006)	(0.006)	(0.004)	(0.010)
$INDSAL * IRISK$	+	0.0785***	0.0603***	0.0426***	0.1295***
		(0.013)	(0.014)	(0.004)	(0.022)
$INDREP$	-	-0.0475***	-0.0517***	-0.0421***	-0.0916***
		(0.006)	(0.007)	(0.005)	(0.012)
$INDREP * IRISK$	-	0.0197	0.0504**	0.0225*	0.0423*
		(0.014)	(0.014)	(0.011)	(0.022)
$INDSEO$	+	0.2951***	0.2775***	0.2401***	0.4524***
		(0.019)	(0.017)	(0.014)	(0.032)
$INDSEO * IRISK$	+	0.2105***	0.2075***	0.0862***	0.3144***
		(0.038)	(0.035)	(0.015)	(0.054)
$SYSRISK$	?	0.0400***	0.0561***	0.0168*	0.0456**
		(0.005)	(0.012)	(0.009)	(0.018)
$FDROA$	?	-	-0.1679***	-0.1486***	-0.3291***
			(0.051)	(0.055)	(0.077)
M/B	?	-	0.0179***	0.0146***	0.0353***
			(0.002)	(0.002)	(0.004)
$LN(MVE)$	?	-	0.0405***	0.0417***	0.0496***
			(0.004)	(0.005)	(0.012)
$LN(ANALYST)$	?	-	-0.0658***	-0.0612***	-0.1096
			(0.008)	(0.008)	(0.015) ***
$INST$	?	-	0.1409***	0.1236***	0.2121***
			(0.018)	(0.016)	(0.038)
Industry Fixed Effects		NO	NO	YES	YES
Time Fixed Effects		NO	NO	YES	YES
$SYSRISK$ Interactions		YES	YES	YES	YES
N		749593	749593	749593	730198

Figure 1. Cumulative Four-Factor Intercepts Following Trade Events



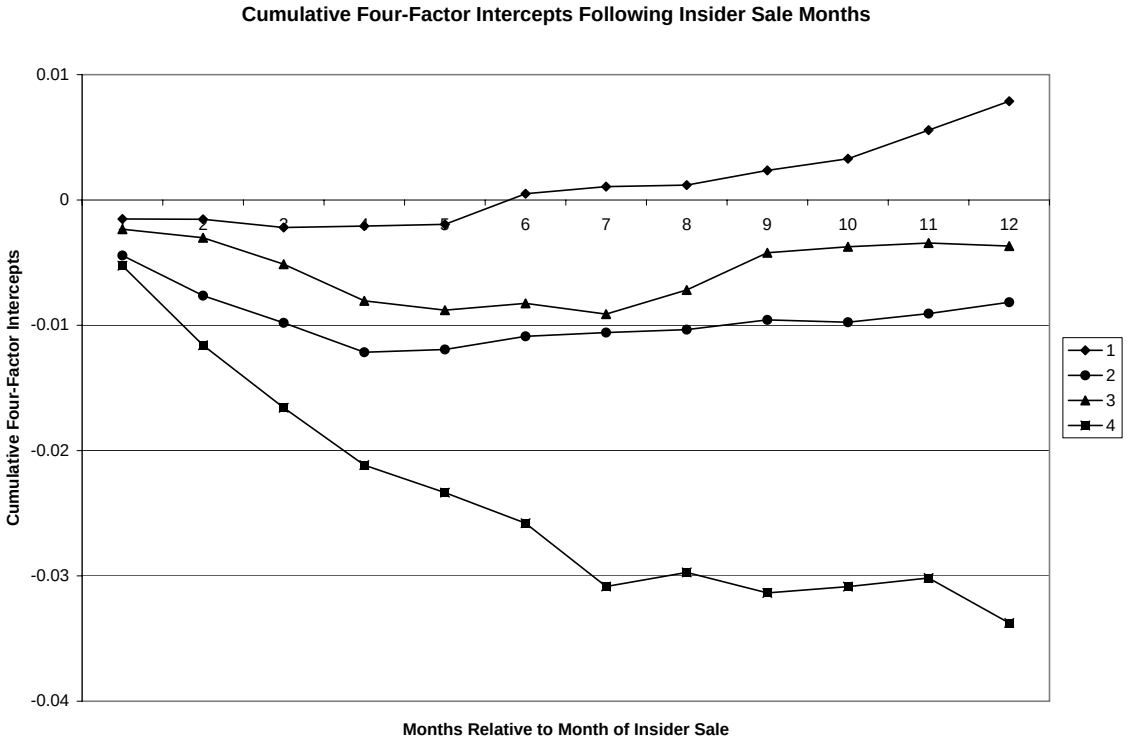
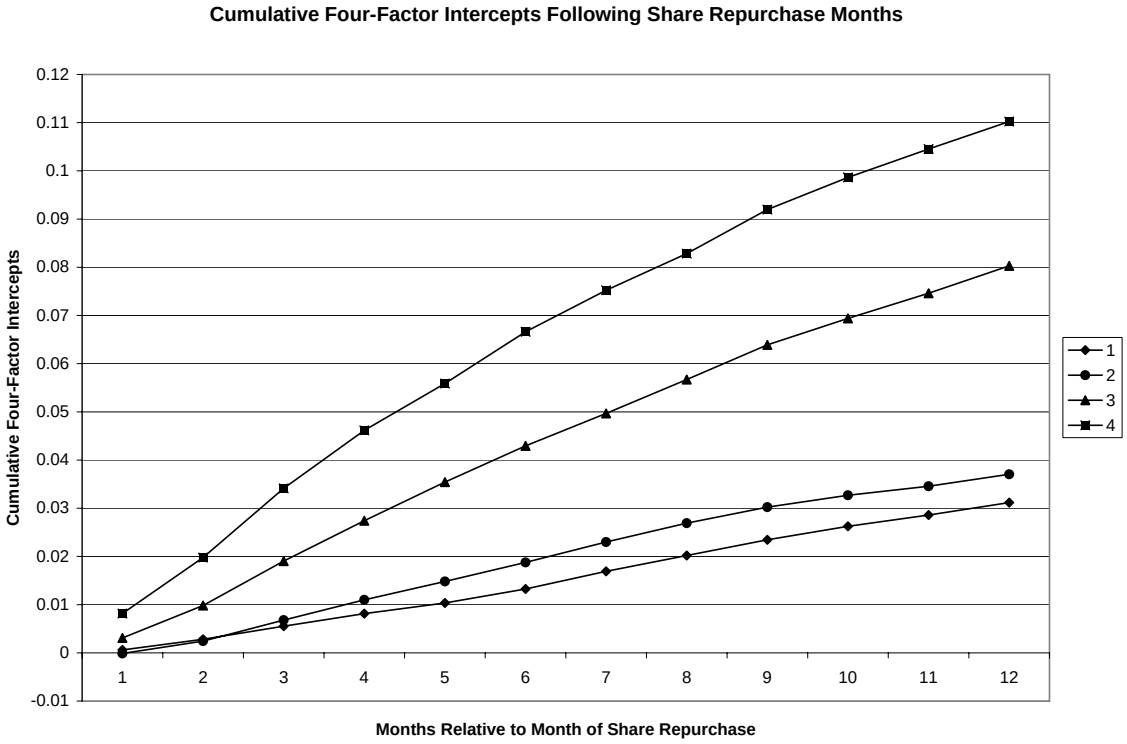


Figure 1. Cumulative Four-Factor Intercepts Following Trade Events (Cont.)



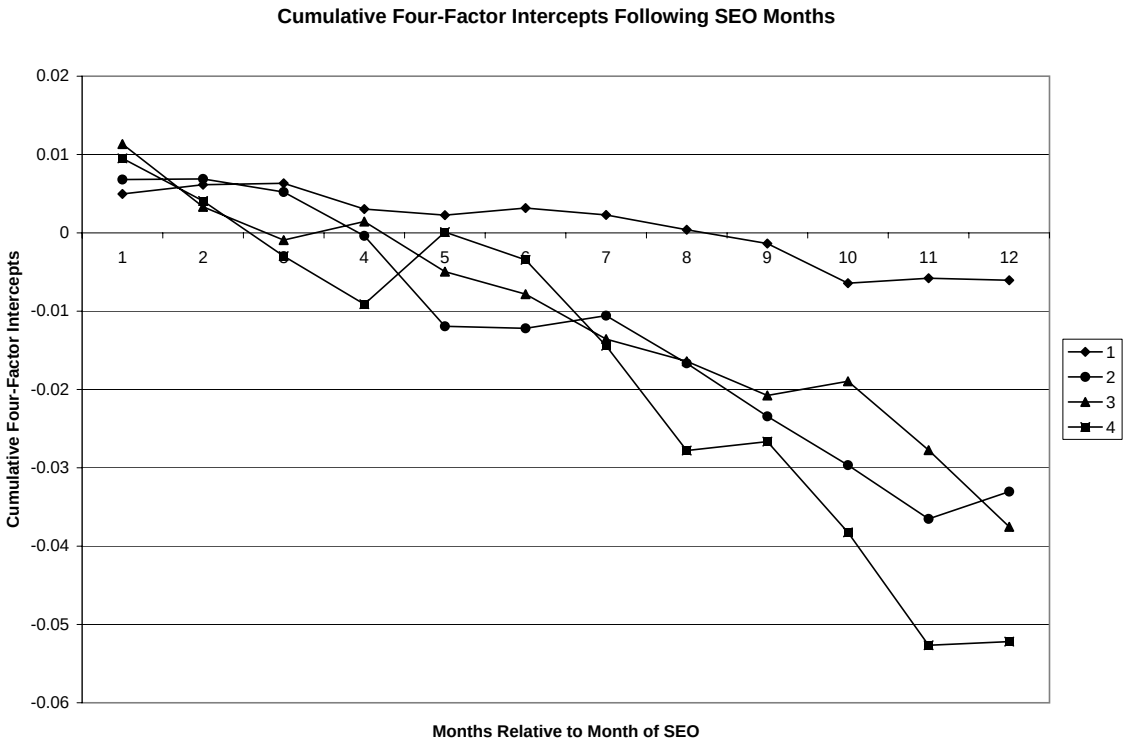


Figure 2. Cumulative Four-Factor Intercepts Around Insider Purchases