Do Proprietary Costs Deter Insider Trading?

by

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ABSTRACT

Insider trading potentially reveals proprietary information, allowing rivals to compete more effectively against the insiders' firm. This paper examines whether proprietary costs are associated with insiders' trading decisions and the profitability of their trades. Using a variety of approaches to identify proprietary information risk, I find proprietary costs significantly deter insiders' trading activities. The deterrence effect is more pronounced when insider trading is likely to be more informative to rivals. Specifically, trades by top executives, non-routine trades, and trades at low complexity firms are curbed to a greater extent by proprietary costs. Examining the mechanisms of this deterrence effect, I find firms with higher proprietary costs are more likely to impose insider trading restrictions, and insiders' trading decisions are more sensitive to proprietary costs when they have higher share ownership of the company. These results suggest insiders reduce trading activities not only due to firm policies, but also due to incentive alignment. Finally, when insiders trade despite higher proprietary costs, they earn significantly higher abnormal profits from their purchase transactions. Overall, this study suggests product market considerations are an important factor associated with insiders' trading decisions and profitability of their trades. These findings are likely to be of interest to regulators and corporate boards in setting insider trading policies, and help investors make investment decisions using insider trading signals.

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CHAPTER 1

INTRODUCTION

Insider trading is an important source of information through which insiders' private information gets impounded into stock prices (Meulbroek, 1992; Damodaran and Liu, 1993; Aboody and Lev, 2000; Lakonishok and Lee, 2001; Brochet, 2010). Previous research has extensively explored the determinants and consequences of insider trading, largely focusing on the capital market implications of insider trading. On the other hand, the voluntary disclosure literature has focused on the trade-off between capital market benefits and product market costs of disclosure (e.g., Verrecchia, 1983, 2001; Dye, 1986; Li, 2010; Ali et al., 2014). One of the primary arguments for why firms do not fully disclose their private information is disclosures reveal proprietary information to rivals, who might use the information to compete more effectively in the product market against disclosing firms. In this paper, I argue insider trading conveys valuable information not only to capital market participants but also to rival firms, thereby potentially harming the firm's competitive position. Thus, I expect managers in firms with high proprietary costs limit their trading to avoid the risk of the firm being disadvantaged in the product market.

Although insider trading does not directly provide detailed proprietary information, such as the current status of a drug trial, it does convey insiders' view on the prospects of the firm. If specific inferences can be drawn from managers' trades, such information could prove valuable for rivals in setting product or marketing strategies. At a minimum, intensive insider trading may attract a competitor's attention, leading the rival to search for more detailed information about the firm. Such information transfers would be especially costly for firms that operate in an environment with a high level of corporate confidentiality.

For example, R&D intensive firms that operate in competitive industries frequently enter into an innovation race with many competitors. When a firm succeeds in a R&D project before its rivals, competitors frequently suspend or even abandon similar projects (Gu, 2016). In such an environment, reasonable inferences by competitors, such as the likely success of R&D investments or the progress of product development (e.g., FDA approval or clinical trials), may enable them to make more effective strategic adjustments.

To investigate the link between proprietary costs and insider trading intensity, I first examine whether managers trade less at firms with higher proprietary costs. I measure the intensity of insider trading as the total number of shares traded, purchased, or sold by insiders during the year, scaled by the total number of shares outstanding at the beginning of the year.[1] Since proprietary costs are not directly observable, I measure these costs using several approaches. First, following the suggestions of King et al. (1990), I use R&D intensity, the number of patent applications, SG&A intensity, product similarity, and a composite score of these four measures as proxies for proprietary costs. I find there is a strong negative association between proprietary costs and insider trading intensity. This negative effect is economically significant, as a one standard deviation increase in proprietary costs is associated with an 11% decrease in insider buys and a 10% decrease in insider sales.

As an alternative identification approach, I exploit event-driven variation in proprietary costs. Specifically, I examine insider trading behavior during the period before new product launches, when the proprietary information risk is particularly high. I define

[1] I also consider four alternative measures of insider trading intensity: i) dollar value of insider trading, ii) frequency of insider trading, iii) likelihood of the occurrence of insider trading, and iv) the number shares traded as the proportion of insider share ownership. The results are quantitatively similar.

proprietary periods as the year prior to a new product launch, and find insiders significantly reduce trading intensity during proprietary periods relative to other periods, consistent with proprietary concerns discouraging insider trading.[2]

Next, to establish a causal link between proprietary costs and insider trading intensity, I use large reductions in industry-specific U.S. import tariff rates as a source of exogenous shocks that increase proprietary costs through increased competition. I conduct a difference-in-differences analysis to compare the change in insider trading intensity in industries that experience large tariff cuts to that of industries that do not experience such a shock. The results show that relative to firms in unaffected industries, firms in industries that experience a large tariff reduction significantly reduce insider trading activities. In economic terms, insiders reduce purchases by 11% and sales by 13% after a large tariff reduction relative to control firms. In sum, the evidence from tariff rate reductions supports the causal nature of the deterrence effect of proprietary costs on insider trading intensity.

To shed more light on the results above, I examine how the relation between proprietary costs and insider trading intensity varies with informativeness of insider trading. I find top executives, who are most likely to possess proprietary information (Peress, 2010; Cheng et al., 2016), reduce trading activities significantly more than other insiders. Cohen et al. (2012) show non-routine insider trading has higher informational value than routine trading, which is normally associated with liquidity and diversification reasons. I find the presence of proprietary costs has a much larger deterrence effect on non-routine insider trading than on routine trading. Firm complexity also can be related to the usefulness of

[2] As alternative measures of proprietary periods, I use the two and three years prior to the product announcement, and obtain similar results.

information signals. Frankel et al. (2006) find analyst reports are less informative for firms with multiple segments because of high information processing costs. Similarly, insider trading provides less precise information signals for multi-segment or multi-product firms, whereas it may convey information that is easier to interpret for low complexity firms. Consistent with this reasoning, I find the deterrence effect of proprietary costs on insider trading is more pronounced in firms with low complexity. Overall, consistent with proprietary costs discouraging insider trading, the deterrence effect is stronger when insider trading is more informative to competitors.

The analysis thus far demonstrates proprietary costs are associated with reduced insider trading, but has not provided evidence on the specific mechanisms behind these relations. While financial gains from insider trading solely accrue to insiders, proprietary costs of revealing information are borne by the shareholders of the firm. There are potentially two reasons why insiders refrain from trading when proprietary costs are high. First, when firms have high proprietary costs, they may put in place insider trading restrictions to prevent information leakage. For instance, in addition to quarterly blackout periods around earnings announcements, many firms employ event-specific blackout periods such as prior to announcements of new products, clinical trials, or mergers and acquisitions. I provide evidence that firms with higher proprietary costs are more likely to employ insider trading restrictions. Second, independent from insider trading restrictions, managers may voluntarily refrain from trading if their incentives are closely aligned to those of the shareholders. My results show that insiders reduce trades significantly more when they have higher share ownership of the company.

Finally, I investigate the trade profitability for the insiders who trade despite the presence of high proprietary costs. Insiders face a trade-off between their own financial benefits and the firm's proprietary costs. For insiders to trade, the resulting benefits must be greater than the associated costs. Thus, if insiders in high proprietary cost firms decide to trade, I expect them to earn higher profits, *ceteris paribus*, than insiders in low proprietary cost firms. Results are consistent with this conjecture; I find when insiders in firms with high proprietary costs engage in purchase trades, they earn significantly higher returns. A one standard deviation increase in proprietary costs is associated with a 3.69% increase in annual returns from buy transactions. However, I do not find evidence of higher profits for sale transactions in firms with higher proprietary costs. One reason for this is that insider sales are likely driven by personal liquidity, diversification, or other motivations that are not related to private information. Overall, these findings indicate that, although insiders engage in less trading in the face of higher proprietary costs, when they do engage in purchase transactions, their trades are based on more valuable private information.

An alternative explanation for the negative relation between proprietary costs and insider trading is that higher proprietary costs are associated with higher litigation risk, and it is litigation risk that limits insider trading. However, there are several reasons limiting the plausibility of this alternative explanation. First, I include litigation risk, measured using the predicted litigation probability from Kim and Skinner (2012), as a control variable throughout the tests. Second, the correlation between the proprietary cost composite score measure and litigation risk is very low (0.9%), indicating these two measures capture different constructs. Third, the findings that insiders reduce *purchase*

transactions are unlikely to be explained by this alternative explanation because prior literature documents insiders are exposed to legal risk almost exclusively when they sell before bad news, but not when they buy before good news (Cheng and Lo, 2006; Johnson et al., 2007; Cohen et al., 2012; Billings and Cedergren, 2015). Fourth, to further ensure the results are not driven by litigation risk, I partition the sample into litigation risk quintiles and find the negative relation between proprietary costs and insider trading holds across all quintiles of litigation risk.

This study contributes to two strands of literature. First, this paper adds to the literature on the determinants of insider trading. Prior studies show that managers engage in insider trading to exploit private information (Ke et al., 2003; Piotroski and Roulstone, 2005; Dechow et al., 2016) and diversify personal wealth (Kallunki et al., 2009), but avoid insider trading to reduce personal tax burdens (Jin and Kothari, 2008) and legal risk (Cheng et al., 2016). I provide new evidence that product market considerations are also an important determinant of both insiders' trading decisions and trading profitability. These findings are likely to be of interest to regulators and corporate boards in setting insider trading policies, and help investors better interpret insider trading signals.

Second, this paper contributes to the literature on the proprietary costs of disclosure. Studies on voluntary disclosure document that proprietary costs are one of the primary reasons for non-disclosure. I view insider trading from the perspective of information disclosure and provide, to my knowledge, the first empirical study on insiders' strategic trading decisions in the presence of proprietary costs. This paper complements prior studies documenting that firms avoid disclosures about future earnings, profitable segments,

identity of customers, and financial constraints to maintain their competitive advantage (Botosan and Stanford, 2005; Ellis et al., 2012; Bernard, 2016; Huang et al., 2016).

CHAPTER 2

PRIOR LITERATURE AND HYPOTHESIS DEVELOPMENT

2.1. Related Literature on Insider Trading

2.1.1. Determinants of Insider Trading

Theory suggests that an insider's trading decision is driven by the insider's superior information about the firm (Grossman, 1976; Grossman and Stiglitz, 1980; Kyle, 1985). Consistent with this theoretical prediction, prior work shows that insiders take advantage of their private information in their trading. Ke et al. (2003) examine insider trading patterns prior to a break in quarterly earnings increases, and find insider net purchases decrease three to nine quarters before the break. This finding suggests insiders trade on upcoming earnings news, but do so far in advance to avoid the appearance of trading on private information. Similarly, Piotroski and Roulstone (2005) document the ratio of insider purchases to total insider trades is positively associated with the firm's future earnings performance. Huddart et al. (2007) document insider transactions are clustered immediately after the earnings announcements but before the 10-K/Q filing dates. They find insiders profit from this foreknowledge of price-relevant information in those filings. Other studies have found insiders appear to trade on information about relatively infrequent corporate events such as mergers and acquisitions, Chapter 11 bankruptcy filings, stock repurchases, dividend initiations, earnings restatements, and SEC comment letters. For example, Agrawal and Nasser (2012) find insiders increase net purchases before takeover announcements by reducing their purchases less than they reduce their sales. Dechow et al. (2016) document insider sales increase significantly prior to the public disclosure of SEC

comment letters on revenue recognition. Overall, prior literature suggests private information plays an important role in insider trading decisions.

In addition to exploiting private information, there could be other motives underlying insiders' decisions to trade. These motives include insiders' diversification and liquidity needs, tax considerations, and litigation concerns, with most of the motives pertaining to insider sales. Using data on Swedish insiders, Kallunki et al. (2009) find insiders with more concentrated portfolios toward their companies' stock sell their stock more intensively. Jin and Kothari (2008) report that the personal tax burden associated with the sale of vested stock discourages CEOs from selling their equity. Cheng et al. (2016) document a significant decrease in insider selling following actual shareholder litigation, indicating that legal concerns deter insider sales.

2.1.2. Capital Market Participants and Insider Trading

Information about insider trading can be disseminated to capital markets through various channels. The SEC requires insiders to report their trading activities on Form 4 filings within two business days of the transaction date.[3] As of June 30, 2003, the SEC also mandates electronic filings through the EDGAR system. In addition, various newspapers, business magazines, and web sites disseminate insider trading reports obtained from the SEC, which enables outsiders to easily access information about insider trading activities (Dai et al., 2015).[4]

[3] Before August 29, 2002, insiders were required to file Form 4s to the SEC within ten days after the end of the month in which insider trades took place.

[4] The Wall Street Journal provides detailed information and analyses of insider trading activities via the "Insider Trading Spotlight" section on a daily basis. Moreover, numerous web sites are dedicated to collect insider trading activities from SEC filings (for example ww.secform4.com and www.insiderslab.com).

Prior studies examine whether investors and other capital market participants are aware that insiders trade on private information and react accordingly.[5] Brochet (2010) finds there are significantly positive (negative) abnormal returns around fillings of insider purchases (sales) in both the pre-SOX and post-SOX periods. Choi et al. (2017) examine abnormal stock returns around insider transaction and disclosure dates, and find returns are significantly higher around insider purchases compared to sales, indicating market participants immediately react to the information contained in insider trades. Sivakumar and Vijayakumar (2001) investigate analysts' revision of earnings forecasts following insider trading, and document analysts revise earnings upward (downward) following insider purchases (sales). Together, prior research indicates insider trading serves as a valuable source of private information to the capital markets, and market participants react to the information contained in insider trading.

2.2. Hypothesis Development

The information content of insider trading is not restricted to capital market participants, but is also available to competitors since trading information can be observed by rivals. There are at least two reasons why insider trading information is particularly relevant to rivals. First, compared to other sources of information, such as analyst reports, insider trading contains firm-specific information rather than industry- or macroeconomic-information (Piotroski and Roulstone, 2004), for which rivals can have the same degree of informational advantage. Second, compared to management forecasts, which are subject to

[5] See Bhattacharya (2014) for a review of various topics on insider trading.

"cheap talk" (Stocken, 2000), insider trading conveys a more credible signal because it involves managers' personal wealth.

Such informational benefits to rivals represent a potential cost to the insider's firm because competitors might use the information conveyed by insider trading in a manner that disadvantages the firm in the product market. Although insider trading does not provide specific examples of proprietary information, such as a proprietary formula of a drug, it does contain private information about the firm's financial status and the prospects of its investment projects. In an environment with a high level of corporate confidentiality, private and forward-looking information about the firm enables competitors to set their product and marketing strategies more effectively. Specifically, intensive insider purchases may signal a positive outlook of a product, and hence attract competitors to enter into similar product markets. These signals may also induce rivals to change their production schedules or mimic successful business strategies (e.g., Botosan and Stanford, 2005). On the other hand, intensive insider sales may indicate the vulnerability of the firm. When competitors observe the weakness of a rival, they engage in product market predation by lowering prices or increasing expenditures on non-price competition (e.g., advertising) with the goal of forcing a rival to exit (Bernard, 2016).[6]

To the extent insider trading may negatively affect their firms' competitive positions, insiders need to consider proprietary costs when making their trading decisions. In a similar vein, the voluntary disclosure literature (e.g., Verrecchia, 1983, 2001; Dye, 1986) argues in the presence of proprietary costs, firms may not fully disclose all their

[6] As noted in Bernard (2016), exit is not necessarily in a form of bankruptcy or liquidation. It can take other forms such as exiting a specific product market or being acquired by the predator.

private information in order to prevent revealing proprietary information to rivals. Consistent with the proprietary cost argument, Verrecchia and Weber (2006) find firms operating in more concentrated industries are less likely to redact information. Ellis et al. (2012) find firms with higher proprietary costs are more likely to conceal the identities of major customers. More recently, using large tariff reductions as an exogenous increase in competition, Huang et al. (2016) show that product market competition is negatively associated with management earnings forecasts. The authors interpret the results as consistent with competition reducing voluntary disclosure through higher proprietary costs. Finally, Bernard (2016) finds financially constrained private firms in Germany tend to avoid financial statement disclosures to mitigate the risk of product market predation. In a survey study, Graham et al. (2005) document three-fifths of surveyed CFOs agree or strongly agree that proprietary concerns are an important barrier to voluntary disclosure. Based on their interviews with CFOs, Graham et al. (2005) note "CFOs do not want to explicitly reveal sensitive proprietary information 'on a platter' to competitors, even if such information could be partially inferred by competitors from other sources." Thus, similar to managers withholding earnings forecasts to avoid proprietary costs (Bamber and Cheon, 1998; Ali et al., 2014; Huang et al., 2016), I expect managers in firms with high proprietary costs have incentives to abstain from insider trading to avoid revealing proprietary information. This leads to my first hypothesis:

H1: The intensity of insider trading is negatively associated with proprietary costs.

While financial benefits from insider trading accrue to individual insiders, proprietary costs of information transfer are borne by the firm's shareholders. There are potentially two reasons why insiders reduce trading activities in the face of high proprietary

costs. First, firms with high proprietary costs may impose insider trading restrictions to avoid information leakage. For instance, many firms employ event-specific blackout periods such as prior to announcements of new products, clinical trials, or mergers and acquisitions in conjunction with quarterly blackout periods around earnings announcements. Second, regardless of the existence of insider trading restrictions, managers may voluntarily refrain from trading if proprietary costs are passed on to managers through compensation contracts. If this is the case, then I expect insiders would reduce trading activities more when they have higher share ownership of the company. Accordingly, this leads to the following hypotheses:

H2a: The likelihood of imposing insider trading restrictions is positively associated with proprietary costs.

H2b: The negative association between the intensity of insider trading and proprietary costs is stronger for firms in which managers have higher share ownership.

Managers weigh the expected costs and benefits when they make trading decisions. While insiders obtain financial gains from their trading, insider trading incurs proprietary costs in addition to other litigation or regulatory costs. For insiders to trade, the expected benefits should be greater than the expected costs. Therefore, in order for insiders at high proprietary cost firms to be willing to trade, it must be that the expected benefits from insider trading are higher, *ceteris paribus*. Thus, I expect that when insiders at high proprietary cost firms decide to trade, they earn higher profits than insiders at low proprietary cost firms. This leads to my third hypothesis:

H3: Conditional on insider trading, the profitability of insider trading is positively associated with proprietary costs.

CHAPTER 3

SAMPLE AND MEASURES

3.1. Sample

The data in this study come from several sources. I obtain insider trading data from Thomson Reuters Insider Filings database, which provides transactions by corporate insiders, including directors, officers, and others (e.g., beneficial owners of more than 10% of a company's stock), who are subject to disclosure requirements under Section 16 of the Securities Exchange Act of 1934. In my analysis, I include open market stock purchases and sales made by insiders during the period from 1986 to 2014. Accordingly, stock option exercises and private transactions are excluded. Following prior literature on insider trading (Peress, 2010; Cheng et al., 2016), I focus on the top executives (CEO, CFO, COO, President, and Chairman of Board), as they are the most likely to possess proprietary information, and are likely to be sensitive to costs associated with information leakage. I also obtain financial data from Compustat, stock returns data from CRSP, analyst forecast data from I/B/E/S, institutional ownership data from Thomson Reuters' Institutional Holdings (13F), and executive share ownership information from ExecuComp. In addition, I gather product related announcement data from the database compiled by S&P Capital IQ. Finally, I obtain patent data from Noah Stoffman's website, product similarity scores from Hoberg-Phillips Data Library, and U.S. import data from Peter Schott's website.[7]

I employ two samples for my tests: i) a sample of firm-years for my primary analyses related to my hypothesis examining the effect of proprietary costs on insider

[7] https://iu.app.box.com/v/patents, http://hobergphillips.usc.edu, http://faculty.som.yale.edu/peterschott, respectively.

trading intensity, and ii) a sample of insider trades for the analyses related to the association between proprietary costs and insider trading profits. Because the data availability differs across tests, the sample period and size for each test vary. For example, when R&D intensity and SG&A intensity are used as proxies for proprietary costs, the sample period is from 1986 to 2014. With the number of patent applications, the sample spans from 1986 to 2011 because the patent data are only available up to 2010.[8] With product similarity, the sample period is from 1997 to 2014, as most 10-K filings are only available from 1996 on the SEC Edgar website. Hence, when a composite score of the above four measures is used, the sample is from 1997 to 2011. Finally, when I use import tariff reductions as exogenous shocks to proprietary costs, the sample spans from 1990 to 2014 because U.S. import data are available from 1989. I also require non-missing data on control variables. This results in 52,896 firm-years (8,047 distinct firms) for my main tests, which use the composite score of four measures as the proxy for proprietary costs.

For the sample of insider trades, I gather all insider transactions made by top five executives from 1986 to 2014. I then eliminate transactions without a sufficient level of accuracy and reasonableness, transactions completed outside of the open market, and transactions with missing numbers of shares traded.[9] I also require non-missing data on control variables including the composite score of proprietary costs, other firm characteristics, and past stock returns. The final sample of insider trades includes 800,349

[8] My sample covers one year ahead of data availability of independent variables because I use one-year lag independent variables.

[9] Following Dai et al., (2015), I eliminate transactions with Cleanse codes of "A" or "S". The Cleanse indicator denotes Thomson Reuters' level of confidence regarding the accuracy of the record. Cleanse code "A" indicates that numerous data elements were missing or invalid, and "S" indicates that the security does not meet the collection requirements.

transactions (107,273 purchases and 693,076 sales), covering 7,624 distinct firms. The sample selection procedures are summarized in Table 1.

3.2. Variable Measurement

3.2.1. Measures of Proprietary Cost

Proprietary costs represent the reduction in firm value resulting from proprietary information leakage. Because proprietary costs are not directly observable, I follow prior literature and approximate these costs using several firm characteristics. King et al. (1990) argue property rights associated with innovations are not perfectly enforceable, and hence are a primary source of proprietary costs. Along these lines, King et al. (1990) suggest several empirical measures of proprietary costs including R&D expenditures, the number of patent applications, and measures of product market competition. My empirical measures of proprietary information costs closely follow these suggestions.

The first measure of proprietary costs is R&D intensity. Given that R&D activities stimulate product innovation and technological change, a firm's resource allocation toward R&D represents how active the firm is in innovative activities, which arguably carry significant amount of proprietary information. Consequently, firms with higher R&D expenditures tend to face higher proprietary costs (Wang, 2007; Ellis et al., 2012; Albring et al., 2016). I measure R&D intensity, *R&D_Intensity,* by dividing R&D expenditures by total expenses, where total expenses are calculated by subtracting income before extraordinary items from revenues.[10]

[10] In alternative specifications, I scale R&D expenditures by either total assets or sales, and find qualitatively similar results.

My second proprietary cost measure is the number of patent applications filed in a given year. Firms with a greater number of patent filings likely possess higher degrees of secrecy, and thus face higher proprietary costs. This measure is widely used in the economics, finance, and accounting literature to capture the quantity of innovation (Aghion et al., 2005; He and Tian, 2013). I do not use the number of patent citations because the main purpose of the measure is to capture the amount, rather than the quality, of innovative activities and the firms' desires to receive patent protections. I use a patent's application year instead of its grant year because the former is superior in capturing the actual time of innovation (Griliches et al., 1987). Because the number of patent applications is right-skewed, I use the natural logarithm of one plus the number of patents filed, *NumPatents*.

Next, I use SG&A intensity as a measure of proprietary costs. Lev (2001) notes that innovation is mainly achieved by investment in intangible capital. R&D expenditures and the number of patent applications capture product innovation and development, but do so mostly for high tech companies (Faurel et al., 2016). Hence, to capture intellectual property associated with a broader set of innovative activities in a large set of firms, I use SG&A expense. The accounting treatment of intangible assets depends on whether the firm generates an intangible asset internally or purchases it externally. When a firm creates an intangible asset internally, the firm usually expenses it on the income statement as SG&A expense or R&D expenditure.[11] When an intangible asset is acquired, the firm typically capitalizes it on the balance sheet as Acquired Intangible Asset or Goodwill. Because the vast majority of the firm's intangible assets are missing from its balance sheet, I focus on

[11] There are a few exceptions where internally developed intangibles, for example legal costs, consulting fees, and registration fees associated with a patent or trademark registration, are capitalized, but the number is negligible (Peters and Taylor, 2016).

SG&A expenses as it reflect a firm's resource allocation towards intangible inputs such as human capital, brand, customer relationships, and information technology.[12] Following Srivastava (2014), I measure SG&A intensity, *SG&A_Intensity*, by dividing SG&A expense by total expenses, where total expenses are calculated by subtracting income before extraordinary items from revenues.

Prior research suggests that product market competition is related to the proprietary costs of disclosure. Theoretical models, in voluntary disclosure settings, suggest that whether competition encourages or discourages disclosure depends on whether the competitive threat comes from existing rivals or potential entrants. Theories of competition among existing rivals focus on the proprietary costs associated with disclosure, and generally conclude that competition discourages disclosure because it reduces the disclosing firm's competitive advantage (Verrecchia, 1983,1990). In contrast, models of entry game generally suggest potential competition encourages firms to disclose an increased amount of bad news, along with good news, to deter entry and increase capital market valuation (Darrough and Stoughton, 1990; Wagenhofer, 1990). Empirical studies that investigate the effect of competition on disclosure produce mixed results mainly because prior studies have used industry concentration to measure competition (Beyer et al., 2010; Lang and Sul, 2014; Huang et al., 2016). As noted in Lang and Sul (2014) and Huang et al. (2016), it is unclear whether a high level of industry concentration represents

[12] SG&A expense reported in Compustat includes R&D expense. From private communication with S&P and from randomly selected 10-K filings, Peters and Taylor (2016) document Compustat includes R&D in SG&A in 90 out of 100 cases.

more or less competition, and how is it linked to proprietary costs.[13] To more directly capture product market competition from existing competitors, I employ the product similarity score, *ProdSimilarity*, developed by Hoberg and Phillips (2016).[14] Hoberg and Phillips construct a text-based measure of product similarity, for which they analyze the product descriptions in 10-K filings, and calculate firm-by-firm pairwise similarity scores to quantify product similarity between any two firms. Then, the product similarity score at the firm level is calculated as the sum of pairwise similarities between the given firm and all other Compustat firms in the given year. The more similar the products of the firm to its peers, the more substitutable it is, and hence the greater competitive pressure the firm faces from existing competitors.

Finally, since each of the above measures capture different dimensions of proprietary costs, I also construct a composite score, *Composite*, using an approach similar to the one used in Dai et al. (2016). Specifically, I standardize each of the four variables, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, to have zero mean and unit variance, and then sum these standardized values to obtain the main composite score.

3.2.2. Measures of Insider Trading Intensity

I measure the intensity of insider trading as the total number of shares traded (*TotalTrades*), purchased (*Purchases*), or sold (*Sales*) by insiders during the year, scaled

[13] Verrecchia and Weber (2006), Li (2010), and Ellis et al. (2012), among others, associate higher level of industry concentration with lower level of competition, whereas Ali et al. (2014) predict greater competition in more concentrated industries due to greater product substitutability.

[14] Another advantage of using *ProdSimilarity* is that, unlike industry concentration (e.g., HHI or four-firm concentration ratio), it is a firm-level measure that captures firm-specific proprietary costs. Moreover, Hoberg and Phillips show that firms with higher product similarity score are more likely to cite high-competition-related words in the MD&A section of their 10-Ks.

by the total number of shares outstanding at the beginning of the year. This measure is similar to those employed by prior research (Beneish and Vargus, 2002; Piotroski and Roulstone, 2005; Jagolinzer et al., 2011). Since *TotalTrades* (*Purchases*, *Sales*) is the ratio of the shares traded by insiders to the total number of shares outstanding, the range of the variable is a small interval around zero. Therefore, to preserve significant digits of the coefficient estimates on the independent variables, I multiply *TotalTrades*, *Purchases* and *Sales* by 1,000.

I also consider three alternative measures of insider trading intensity: i) dollar value of insider trading scaled by the market capitalization at the beginning of the year, ii) the number of transactions scaled by the number of active insiders, where active insiders are defined as insiders who have reported at least one insider stock transaction during my sample period (Ke et al., 2003; Peress, 2010), iii) the likelihood of the occurrence of insider trading (Massa et al., 2015), and iv) the number shares traded scaled by their share ownership (Massa et al., 2015).

3.2.3. Measures of Insider Trading Profits

To capture profits gained from purchases or potential losses avoided from sales, I use the following three methods. First, following recent literature on insider trading (Jagolinzer et al., 2011; Gao et al., 2014; Dai et al., 2015, 2016), I use daily alpha, *Alpha*, an intercept from the Carhart (1997) four-factor model estimates over the 180 calendar days subsequent to insider transaction dates. Second, similar to Ravina and Sapienza (2010) and Dai et al. (2016), I use six-month size-adjusted buy-and-hold abnormal returns, *BHAR*, which is calculated as buy-and-hold raw returns over the 180 calendar days following the

transaction date minus buy-and-hold returns for the CRSP value-weighted size decile portfolio. The third measure of insider trading profit is buy-and-hold raw returns, *BHRAW*, which is defined as buy-and-hold raw returns over the 180 calendar days following the transaction date. Profits are multiplied by -1 for insider sale transactions to ease the interpretation.

Consistent with prior studies, I measure insider trading profits over a six-month period (e.g., Jagolinzer et al., 2011; Gao et al., 2014). The six-month window is a reasonable period over which to measure an insider's profit because Section 16(b) of the Securities and Exchange Act of 1934 requires insiders to disgorge "short-swing profits". Insiders are required to return profits made from the purchase and sale of company stock if both transactions occur within a six-month period. I also consider a 12-month period as an alternative window. The results are similar and conclusions are unaffected if returns are computed over 12 months.

CHAPTER 4

PROPRIETARY COSTS AND INSIDER TRADING INTENSITY

In this section, I present analyses of whether insiders reduce trades of their company stocks in the face of high proprietary costs, how the association varies with informativeness of insider trading, and the potential mechanisms through which proprietary costs discourage insider trading activities.

4.1. Proprietary Cost Measures and Insider Trading Intensity

To analyze whether proprietary costs affect insiders' decisions to trade, I estimate following tobit regression model for firm *i* in year *t*:

$$TotalTrades\ (Purchases, Sales)_{i,t} = \beta\ PropCost_{i,t-1} + \gamma \sum Controls_{i,t-1} + \alpha_j + \alpha_t + \varepsilon_{i,t} \quad (1)$$

where the subscript *i, j*, and *t* refer to firm, Fama and French 48 industry, and year, respectively. *TotalTrades, Purchases,* and *Sales* are defined in Section 3.2.2, and are the dependent variables in separate tests. The main variable of interest is *PropCost,* which is measured using four individual proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, and a composite score, *CompScore*.

I include a series of firm characteristics that have been shown to affect insider trading decisions by prior literature. Insider trading activity is associated with firm size (Seyhun, 1986). Insiders in larger firms make fewer purchases relative to sales because managers in large firms are more likely to receive stock-based compensation than in small firms (Lakonishok and Lee, 2001; Roulstone, 2008). Therefore, I include firm size, *Size*, defined as the natural logarithm of the market value of equity at the beginning of the year. Prior studies also document insiders sell more actively in growth firms, and are contrarian

investors who buy (sell) stocks with low (high) past returns (Lakonishok and Lee, 2001; Ke et al., 2003; Piotroski and Roulstone, 2005). Accordingly, I include book-to-market ratio, *BM*, defined as the book value of equity divided by the market value of equity at the beginning of the year, and past stock returns, *PreRet*, defined as buy-and-hold stock returns over the prior year.

Insiders' information advantage is likely to motivate insiders to trade and enables insiders to earn higher profits (Aboody and Lev, 2000; Frankel and Li, 2004; Huddart et al., 2007). Hence, to control for information asymmetry between insiders and outsiders, I include analyst coverage and institutional ownership. Analyst coverage, *Analysts*, is defined as the natural logarithm of one plus the number of analyst who issued earnings forecasts in the prior year. Institutional ownership, *InstOwn*, is defined as the percentage of institutional ownership at the beginning of the year. In addition, following Ravina and Sapienza (2010) and Gao et al. (2014), I include stock return volatility, *Volatility*, defined as the variance of daily stock returns over the prior year, and share turnover, *Turnover*, defined as the natural logarithm of the ratio of the number of shares traded during the prior year divided by the number of shares outstanding at the beginning of the prior year. Finally, prior research connects insider trading with legal liability (Cheng and Lo, 2006; Billings and Cedergren, 2015; Cheng et al., 2016). I include ex-ante litigation risk, *LitigationRisk*, defined as the predicted litigation probability using Model (3) of Kim and Skinner (2012). Finally, I include industry and year dummies to control for systematic variation in insider trading both across industries and over time due to regulatory changes, and I cluster standard errors by firm and year (Petersen, 2009).

I use a tobit model because a significant fraction of the dependent variables (i.e., *TotalTrades*, *Purchases*, *Sales*) have zero values,[15] which corresponds to the corner solution tobit model or type I tobit model (Wooldridge, 2010). The tobit model relies on stricter assumptions of the functional form of the error term, and is less flexible to include fixed effects. Therefore, I also use OLS regression models for robustness. Additionally, when the likelihood of the occurrence of insider trading is used as the alternative measure of insider trading intensity, I employ logit regression models.

Table 3 presents the results from estimating Equation (1). Panel A reports the results for the effects of proprietary costs on total insider trading intensity. *CompScore* is used as the proxy of proprietary costs in the first column, and four individual measures are used as the proprietary cost measures in the subsequent four columns. Referring to the first column of results, *b* is negative and significant (-0.401, *t*-statistic=-8.20), consistent with insiders reducing trade activities in high proprietary firms. In economic terms, for a one standard deviation increase in proprietary costs, there is a 0.672 share decrease in the predicted value of *TotalTrades*, which is a 23.41 % decrease relative to the mean total trades.[16] This form of marginal effects describes how the *unobserved* latent trading incentives change, with respect to changes in proprietary costs. Alternatively, one might be interested in the marginal effect of the *observed* trading activities, namely how the expected value of the observed *TotalTrades* changes as proprietary costs change. The estimated marginal effect is -0.180, which is a 10.51% decrease relative to the mean total

[15] *TotalTrades*(*Purchases*, *Sales*) contains 44.20% (73.55%, 63.20%) of zero values when *CompScore* is used as the proxy of proprietary costs.
[16] The standard deviation of *PropCost* is 1.675, the mean of *TotalTrades* (*Puchases*, *Sales*) is 2.869 (0.575, 2.016), for the sample used in Column (1) of Table 3.

shares traded by insiders. Turning to the results in Columns (2) to (5), the coefficient on *PropCost* is negative and significant across each of the four estimations (*t*-statistics ranging from -2.31 to -5.92), consistent with insiders trading less actively in firms with higher proprietary costs.

Panel B of Table 3 presents the results of insider purchase intensity across each of the five measures of proprietary costs. The coefficient on *PropCost* is negative and significant (coefficients ranging from -0.015 to -1.576, *t*-statistics ranging from -2.00 to -3.96). The economic significance is large as well; a one standard deviation increase in *CompScore* is associated with an 11.07% decrease in *observed* insider buy transactions, relative to the mean shares purchased by insiders. Panel C of Table 3 presents the results of insider sales transactions. The coefficients on *PropCost* are negative in all of the five regression estimations (coefficients ranging from -0.007 to -4.199), but significant in three out of five specifications (*t*-statistics ranging from -1.01 to -7.11). A one standard deviation increase in *CompScore* is associated with a 9.97% decrease in *observed* insider sales transactions, relative to the mean shares sold by insiders.

For the sake of brevity, the coefficients on control variables are not reported in Panels B and C, and are generally consistent with prior literature. Insiders trade less actively in large firms, sell (buy) more in growth (value) firms, and sell (buy) more when past returns are high (low). The number of analysts, institutional ownership, and stock turnover are positively associated with both insider purchases and sales, whereas litigation risk is negatively associated with insider sale intensity. In sum, the results are consistent with my hypothesis that insiders trade less actively in firms with higher proprietary costs.

4.2. Insider Trading Intensity Prior to Product Launch

In this section, I examine event-driven variation in proprietary costs. Proprietary information risk would be especially high prior to the launch of new products because insider trading may reveal to rival firms the progress and the likely success of product development. Consistent with this, in most firms, insider trading policies explicitly state that insiders are not allowed to trade based on information about the timelines or the results of product development. Moreover, besides quarterly blackout periods prior to earnings announcements, firms employ event-specific blackout periods such as periods prior to the announcements of new product development, clinical trials or mergers and acquisitions. Therefore, I expect insiders will refrain from trading during product development periods, when proprietary costs of information transfer are especially high.

I gather product related announcements for the period from 2002 to 2014 from the database compiled by S&P Capital IQ. The coverage of this database starts in 2002 and includes mostly unscheduled corporate information events from newswires, newspapers, and disclosure wires such as Reuters, Dow Jones, Comtex, Regulatory News Service, Bloomberg Business News, CNN, and CBS. To ensure the product announcements are related to new products, I restrict the press releases to include either "introduce" and "new" or "launch" and "new" in the headlines. To account for the possibility that Capital IQ covers selected firms, I restrict firms with at least one product announcement during the sample periods. In addition, firm-year observations that cannot be clearly classified as product development periods (proprietary periods) or post-product development periods (non-proprietary periods) are excluded from the analysis. This procedure results in 1,319 new product announcements in 1,029 firm-years in my sample.

To test whether insiders reduce trading activities during proprietary periods, I estimate the following tobit regression model for firm *i* in year *t*:

$$TotalTrades\ (Purchases, Sales)_{i,t} = \beta\ PropPeriod_{i,t} + \gamma \sum Controls_{i,t-1} + \alpha_j + \alpha_t + \varepsilon_{i,t} \quad (2)$$

where the subscript *i, j*, and *t* refer to firm, Fama and French 48 industry, and year, respectively. The dependent variables, *TotalTrades*, *Purchases*, and *Sales*, are defined in Section 3.2.2. The main variable of interest is *PropPeriod*, which is an indicator variable equal to one if the firm-year is in a proprietary period, zero otherwise. Proprietary periods are defined as firm-year observations that have at least one product announcement in the subsequent year but no announcement in the current or prior year. As alternative measures of proprietary period, I use the two years prior and the three years prior to product announcements, and obtain quantitatively similar results.

Table 4 presents the results from estimating Equation (2). *TotalTrades* is the dependent variable in the first column, and *Purchases* and *Sales* are the dependent variables in the subsequent columns. The coefficients on *PropPeriod* are negative and significant in each of the three regression estimations (t-statistics ranging from -1.99 to -3.79). Overall, the results are consistent with insiders significantly reducing trade activities prior to new product announcements to minimize the risk of information leakage.

4.3. Tariff Reductions and Insider Trading Intensity: Exogenous Shocks in Proprietary Costs

The evidence so far is consistent with proprietary costs discouraging insider trading activities. However, proprietary cost measures could be related to other unobservable firm characteristics which also drive insider trading decisions. To alleviate potential concerns

about endogeneity, I use large reductions in U.S. import tariff rates as a source of exogenous shocks that increase proprietary costs through increased competition. I conduct a difference-in-differences analysis that compares the change in insider trading intensity in industries that experience large tariff cuts to the change in insider trading intensity in industries that do not experience such a shock.

Tariff rate reductions significantly increase competition, and hence increase proprietary costs for U.S. domestic firms. Valta (2012) documents that over his sample period, the average tariff rates drop from 3 percent to below 1.5 percent, and import penetration rose from 19.5 percent to 24.1 percent. Xu (2012) reports a significant decrease of profit margins for U.S. domestic firms following large tariff rate reductions, consistent with tariff rate reductions intensifying competition for U.S. domestic firms. As discussed in Section 3.2.1, competition from existing rivals discourages disclosure, whereas competition from potential entrants encourages disclosure. Huang et al. (2016) argue tariff rate reductions mainly increase competition from existing foreign rivals rather than from potential foreign entrants. This is because foreign rivals were already actively participating in the domestic product market even before the tariff cuts. They also observe that the amount of imports increases by 36 percent in the tariff reduction years, but increases only by 3 percent and 8 percent in the subsequent two years, indicating that the competitive threat from foreign entrants that begin importing in future years is relatively low. Therefore, insider trading in domestic firms is likely to incur higher proprietary costs after tariff reductions, which reduces managers' incentives to trade.

Tariff cuts provide a well-suited setting for examining the link between proprietary costs and insider trading intensity. First, tariff cuts satisfy the relevance condition. As

discussed above, tariff rate reductions have been shown to significantly increase competition (Fresard, 2010; Valta, 2012; Xu, 2012), and hence increase proprietary costs faced by U.S. domestic firms (Huang et al., 2016). Second, tariff rate reductions satisfy the exclusion condition because these reductions are likely exogenous to managers' trading decisions. In recent decades, tariff rate reductions in the U.S. are mainly enacted as part of a trade agreement with other countries. While firms make efforts to influence trade policies through participating in Trade Advisory Committees, making political contributions and lobbying congress members, these efforts are unlikely to be related to insider trading incentives.[17] Third, due to the staggered nature of tariff cuts, firms can be either treatment or control firms at different points in time, which mitigates the potential problem of systematic differences between treatment and control firms. Moreover, the staggered cuts in tariff rates alleviate the concerns that the results are confounded by other concurrent events.

I follow prior literature (Fresard, 2010; Valta, 2012; Huang et al., 2016) and focus on large reductions in import tariff rates. To do so, I gather U.S. import data for the period from 1989 to 2014, and compute the tariff rate for each industry-year (at the three-digit SIC level). Tariff rates are calculated as the duties collected at U.S. Customs divided by the Free-On-Board custom value of imports. Then, I compute for each industry the largest and the median tariff rate changes. I identify industry-years that experience the most

[17] The identifying assumption may be violated if the managers who want to benefit from trading their company stocks make efforts to prevent tariff rate reductions. However, Gaspar and Massa (2005) and Irvine and Pontiff (2009) document higher competition leads to more volatile idiosyncratic returns and increase uncertainty about the firm's future performance, which increases insiders' informational advantage. Therefore, insiders who want to profit more from their trading would make more of an effort, if any, to increase competition rather than to lower competition, which is likely to bias my tests against finding a negative relation between tariff reductions and insider trading intensity.

significant tariff cuts that is larger than three times the median reduction in that industry. To ensure that these reductions reflect non-transitory changes in the competitive landscape, I exclude reductions that are followed by equivalently large increases in tariff rates. This procedure results in 60 industries with a large tariff reduction from 1990 to 2014.[18]

To investigate the effect of large shifts in import tariff rates on insider trading intensity, I follow Bertrand and Mullainathan (2003), Bertrand et al. (2004), Valta (2012), and Huang et al. (2016), and estimate the following regression model:

$$TotalTrades\ (Purchases, Sales)_{i,t} = \beta\ PostReduction_{i,t} + \gamma \sum Controls_{i,t-1} + \alpha_j + \alpha_t + \varepsilon_{i,t} \quad (3)$$

where the subscript *i*, *j*, and *t* refer to firm, SIC three-digit industry, and year, respectively. The dependent variables, *TotalTrades*, *Purchases*, and *Sales*, are defined in Section 3.2.2. The main variable of interest is *PostReduction*, which is an indicator variable equal to one if industry *j* experiences a significant tariff reduction by year *t*-1, and zero otherwise. As noted by Bertrand et al. (2004), Equation (3) is a difference-in-differences specification because this model controls for fixed differences between the treatment and the control group via industry fixed effects. β captures changes in insider trading intensity in industries that experience large tariff reductions relative to changes in insider trading intensity in industries that do not experience a similar shock.

Table 5 presents the estimation results from Equation (3). Columns (1), (2), and (3) show the effects of large import tariff cuts on total insider trades, purchases, and sales, respectively. Across each of the three columns, the coefficient on *PostReduction* is negative and significant (coefficients ranging from -0.313 to -0.926, *t*-statistics ranging

[18] This is comparable to the number of large tariff rate reductions reported in Valta (2012), in which he identifies 54 events between 1992 and 2005.

from -1.91 to -3.45), indicating that relative to control firms, firms in industries that experience a large tariff reduction significantly reduce insider trading activities. In economic terms, insiders reduce total trades by 13.77%, purchases by 10.82%, and sales by 13.04%, after a large tariff reduction relative to control firms. Overall, difference-in-differences estimations support the causal nature of the deterrence effect of proprietary costs on insider trading intensity.

4.4. Proprietary Costs and Insider Trading Intensity by Informativeness of Insider Trading

To shed more light on the results above, I investigate how the association between proprietary costs and insiders' decision to trade varies with the informativeness of insider trading. In particular, I ask whether insiders are more sensitive to proprietary costs when their trades are more likely to be informative to their rivals.

4.4.1. Top 5 Versus Non-Top 5 Officers and Directors

First, I examine whether top-level executives tend to reduce their trades more than lower-level insiders do. Top executives are the most likely to possess proprietary information (Peress, 2010; Cheng et al., 2016), and hence competitors would consider insider trading by top executives more informative. Therefore, I expect a stronger deterrence effect of proprietary costs on top executives' trading than on non-top directors' and officers' trading. To test this prediction, I classify each insider trade transaction by top 5 (CEO, CFO, COO, President, and Chairman of Board) or non-top 5 officers and directors, then separately estimate Equation (1). The results are reported in Panel A of Table 6. While

both top- and non-top-level insiders reduce trading activities in the face of high proprietary costs, top executives are more sensitive to proprietary costs. The coefficients on *PropCost* are statistically different between these two types of insiders (*p*-values ranging from less than 0.01 to 0.06).

4.4.2. Opportunistic Versus Routine Trading

Cohen et al. (2012) document that opportunistic (non-routine) insider trading has higher informational value in terms of predicting future firm returns, news, and events, compared to routine insider trading. If managers are concerned about the revelation of information through their trades, they will reduce non-routine trades, which are likely to attract greater attention from outsiders, including rivals.

To test this prediction, I classify each insider transaction into an opportunistic or a routine trade. Following Cohen et al. (2012), if an insider trades a stock in the same month for three consecutive years, then all subsequent trades that she makes in the same month are classified as routine trades. The trades completed in a different month are classified as opportunistic trades. If an insider trades for three consecutive years but no trades are made in the same month, then subsequent trades are classified as opportunistic. Panel B of Table 6 presents the results from estimating Equation (1) in separate tests for opportunistic and routine trades. The results indicate that proprietary costs have a significantly negative association with opportunistic trades, purchases, and sales, but not with routine trades, purchases, and sales. More specifically, in terms of purchase transactions, insiders tend to significantly reduce opportunistic trading but not routine trading. In terms of sale transactions, insiders reduce opportunistic trades but increase routine ones, suggesting that

they shift their trades to a routine basis. To further examine this trading pattern, in untabulated tests, I regress the percentage of opportunistic trades to the total trades on *PropCost*, and find significantly negative associations between percentage of opportunistic trading and proprietary costs for both purchases and sales. These results suggest that when proprietary costs are high, insiders reduce trades mainly by reducing opportunistic trading. However, when insiders need to sell, they shift their transactions to a routine basis to avoid attention.

4.4.3. Low Versus High Firm Complexity

Firm complexity can be associated with usefulness of various information signals. Frankel et al. (2006) find analyst reports are less informative for firms with multiple segments because of high information processing costs. Similarly, insider trading in a complex firm (e.g., a firm with multiple segments or products) provides abstract and vague signals about the company's future prospects, making it difficult and costly for competitors to interpret. In contrast, insider trades in a low-complexity firm convey clearer and more specific information about the prospects of the firm and its products, and therefore competitors would find it easier to process the information revealed by insider trading. Thus, I expect the deterrence effect of proprietary costs on insider trading to be more pronounced in firms with low complexity.

To test this prediction, I classify firm-year observations into low or high firm complexity groups based on the industry-year median complexity, where complexity is defined as the total number of business and geographic segments. Panel C of Table 6 reports the results from estimating Equation (1) in separate tests for firms with high versus

low complexity.[19] Consistent with the idea that trades are easier to interpret by peer firms, insiders are more sensitive to proprietary costs in less complex firms. The difference in coefficients on *PropCost* between these two groups of firms is statistically significant for total trades (*p*-value = 0.06) and purchases (*p*-value = 0.02), but not significant for sale transactions (*p*-value = 0.33).

4.5. Why Do Insiders Reduce Trades?

4.5.1. Insider Trading Restrictions

To further dissect the nature of the above results, I explore potential mechanisms through which proprietary costs limit insider trading activities. First, firms that face high proprietary costs could limit the information flow from insider trading by imposing insider trading restrictions. Corporate insider trading policies typically specify trading windows during which insiders are allowed to trade their stocks (Bettis et al., 2000; Roulstone, 2003; Jagolinzer et al., 2011). During blackout periods, companies prohibit insiders from trading. The most commonly-used blackout periods are prior to quarterly earnings announcements. I follow Roulstone (2003) and infer that a firm restricts insider trading if the firm's insiders disproportionally execute their trades during the short period after earnings announcements.[20]

[19] While this test can be done using an interaction of *PropCost* and complexity, for the consistency with other tests, I estimate the effects on proprietary costs on insider trading intensity in separate tests for firms with high versus low complexity, and compare the coefficients on *PropCost.* In addition, Ai and Norton (2003) note that, in nonlinear models, the coefficient and the statistical significance of the interaction term cannot be translated into the marginal effect of the interaction, and sometimes the coefficient can be of opposite sign to the actual marginal effect.

[20] Firms also employ other types of insider trading restrictions. For instance, a large percentage of firms that employ trading window restrictions also require insiders to get pre-approvals from their general counsels. Jagolinzer et al. (2011) document 80% of their 260 sample firms with insider trading policies require insider trades to be pre-approved by the general counsels. Hence, I use trading window restrictions as a proxy for insider trading policies.

To examine whether firms with higher proprietary costs are indeed more likely to impose insider trading restrictions, I estimate the following logit model:

$$Pr(\text{Insider Trading Restrictions}_{i,t}=1) = F(\beta\ PropCost_{i,t-1}+\gamma\sum\text{Controls}_{i,t-1}+ \alpha_j + \alpha_t + \varepsilon_{i,t} \quad (4)$$

where the subscript *i, j,* and *t* refer to firm, Fama and French 48 industry, and year, respectively. The dependent variable is an indicator variable equal to one if the firm imposes a blackout period restriction, zero otherwise. I use a three-year rolling window to calculate the percentage of safe trades, which are defined as trades within a month following quarterly earnings announcements. A firm is considered as imposing a blackout period from the beginning year of the rolling window when the percentage of safe trades is greater than or equal to 75%. The 75% cutoff is based on the survey findings in Bettis et al. (2000), who show that insiders are three times more likely to trade in allowed trading periods than during blackout periods.[21] The main variable of interest is *PropCost*, which is a composite score of proprietary costs. I include industry and year dummies, and cluster standard errors by firm and year.

Panel A of Table 7 reports the results from estimating Equation (4), with a logit regression model in Column (1) and a linear likelihood model in Column (2). As shown in the table, firms with higher proprietary cost are significantly more likely to impose insider trading restrictions that are not required by law (coefficients ranging from 0.014 to 0.079, *t*-statistics ranging from 3.57 to 3.94). In economic terms, a one standard deviation increase in proprietary costs is associated with a 3.20% increase in the probability of imposing

[21]Similarly, Jagolinzer et al. (2011) find 24% of insider trades in their sample occur during blackout periods.

insider trading restrictions, which corresponds to a 5.42% increase relative to the unconditional mean probability (59.07%).

In untabulated results, I also conduct a path analysis using a structural equation model. In this model, proprietary costs are modeled as having both direct and indirect (through insider trading restrictions) effects on insider trading intensity, and insider trading restrictions are modeled as having a direct effect on insider trading intensity. The results show that insider trading restrictions directly reduce total insider trades and sales, but do not have a significant direct effect on insider purchases. In addition, total trades and sales are both directly and indirectly affected by proprietary costs, whereas purchase activities are solely directly affected by proprietary costs. Overall, the results suggest that firms with high proprietary costs are more likely to employ insider trading restrictions, which in turn reduce insiders' total trade and sale transactions. Moreover, the significant direct effects suggest that insiders reduce both purchase and sale activities voluntarily when proprietary cost are high.

4.5.2. Executives' Incentive Alignment

Another mechanism through which insiders alter their trading behavior in the face of high proprietary costs is managers' incentive alignment with shareholders. Potential loss of competitive advantage caused by intensive insider trading could be detrimental to managers if their wealth is closely linked to their firms' performance. In this case, managers may voluntarily reduce trading activities even in the absence of insider trading restrictions. Therefore, I predict the effect of proprietary costs on insider trading intensity is more pronounced when executives hold greater ownership of their company. To examine

this prediction, I classify firm-year observations as High or Low Ownership group based on the industry-year median share ownership held by top five executives, and then estimate Equation (1) for these groups separately.

The results are presented in Panel B of Table 7. Consistent with managers' self-disciplining of insider trading, managers' tendency to reduce trades in the face of proprietary costs are significantly stronger when they hold larger fractions of corporate ownership. The difference in coefficients on *PropCost* between high and low ownership groups is statistically significant (*p*-values < 0.01). In an untabulated test, I examine whether executive officers (CEOs and CFOs) and independent directors (non-officer directors) behave differently in facing proprietary costs. Arguably, the incentives of CEOs and CFOs are more tightly linked to firm performance compared to independent directors. Consistent with the constraining effects being stronger to insiders whose incentives are more aligned to those of shareholders, I find executive officers reduce both purchase and sale activities significantly more relative to independent directors.

In sum, the results suggest that, when proprietary costs of information transfer are likely to be higher, firms are more likely to impose insider trading restrictions. In addition, managers also self-discipline their trading behavior especially if their interests are aligned with shareholders. These are potential and non-mutually exclusive reasons why insiders reduce trading activities when proprietary costs are high.

CHAPTER 5

PROPRIETARY COSTS AND INSIDER TRADING PROFITS

In this section, I examine whether insiders who trade despite high proprietary costs earn higher abnormal profits than insiders in firms with low proprietary costs. Managers weigh proprietary costs and financial benefits when they make trading decisions; they trade only when the expected benefits are greater than the expected costs. Therefore, I expect insiders in firms with higher proprietary costs, *ceteris paribus*, earn higher profits from their trades when they decide to trade.

To examine whether insider trades are more profitable when proprietary costs are higher, I estimate the following OLS regression at the insider transaction level:

$$Profit_{i,k,t} = \beta\ PropCost_{i,t-1} + \gamma \sum \text{Controls}_{i,k,t} + \alpha_j + \alpha_t + \varepsilon_{i,k,t} \quad (5)$$

where the subscript *i*, *k*, and *t* refer to firm, transaction, and year, respectively. The dependent variable is insider trading profits, *Profit*, which is measured using daily alpha (*Alpha*), buy-and-hold size-adjusted abnormal returns *(BHAR*), and buy-and-hold size-adjusted abnormal returns *(BHRAW*) over the 180 calendar days subsequent to transaction dates. Profits are multiplied by -1 for insider sale transactions. The main variable of interest is *PropCost*, which is a composite score of proprietary cost.

Following Brochet (2010), Ravina and Sapienza (2010), and Gao et al. (2014), I include a set of control variables at the firm and transaction levels. Firm-level controls are firm size (*Size)*, book-to-market ratio (*BM*), analyst following (*Analysts*), and institutional ownership (*InstOwn*), and are defined in Section 4.1. Insider-transaction-level controls are momentum ($PreRet_{[-380,-20]}$), share turnover ($Turnover_{[-380,-20]}$), stock return volatility

(*Volatility*$_{[-380,-20]}$), and trade size (*TradeSize*). Momentum, share turnover, and stock return volatility are measured over the period between 380 and 20 days prior to the transaction date. *PreRet*$_{[-380,-20]}$ is included to control for insiders' contrarian behavior, and is defined as the buy-and-hold stock returns. *Turnover*$_{[-380,-20]}$ controls for the intensity of investors' interest in the stock, and is calculated as the natural logarithm of the sum of daily trading volume, where daily trading volume is the number of shares traded scaled by number of shares outstanding. *Volatility*$_{[-380,-20]}$ is included because insider trades are likely to be more informative in firms with higher uncertainty, and is computed as the standard deviation of daily stock returns. *TradeSize* controls for the link between the importance of private information and trade size, and is defined as the dollar value of the trade scaled by the natural logarithm of the market value of equity. I also add industry and year fixed effects to control for heterogeneity of insider trading profits across industries and time, and I cluster standard errors by firm and year.

Panel A of Table 8 reports the results from estimating Equation (5), with profitability from purchases in Columns (1) to (3) and from sales in Columns (4) and (5). The results indicate that insiders of firms with higher proprietary costs earn significantly higher profits from their buy transactions (coefficients ranging from 0.010 to 0.013, *t*-statistics ranging from 2.02 to 2.30). In economic terms, when daily alpha is used as the measure of profitability, a one standard deviation increase in proprietary costs is associated with a 1.464 basis points increase of daily abnormal returns, which corresponds to a 3.69% increase in annual returns. The marginal effects are similar when buy-and-hold size-adjusted abnormal returns and buy-and-hold raw returns are used as measures of insider trading profits; insiders earn 3.80% higher returns annually. In contrast, the coefficients on

PropCost are not significant for insider sales (*t*-statistics ranging from -0.85 to -1.22), indicating that insiders do not earn significantly higher profits from their sales transactions when proprietary costs are higher.[22] In addition, I rerun these tests using a 360-calendar-day profitability window and obtain quantitatively similar results (untabulated). Overall, these findings suggest that even though managers engage in less intensive insider trading in the face of higher proprietary costs, when they do engage in purchases, their trades are based on more valuable information.

Cohen et al. (2012) suggest that the profitability of insider trades is derived mainly from opportunistic trading. Accordingly, I examine whether greater insider trading profits in firms with higher proprietary costs are driven by opportunistic trading. I estimate Equation (5) separately for opportunistic trades and routine trades, and the results for *Alpha* are presented in Panel B of Table 8.[23] Consistent with insiders primarily profiting from non-routine trading, insiders in firms with higher proprietary costs earn significantly higher profits from opportunistic purchases (*t*-statistic = 3.23), but not from routine purchases (*t*-statistic = -1.64). A one standard deviation increase in proprietary costs is associated with an 8.85% increase in annual abnormal returns, suggesting that insiders in firms with higher proprietary costs make substantially higher profits from their non-routine purchases. In addition, I continue to find insignificant insider trading profits for both opportunistic and routine sales. This result might be due to noise in the classification of opportunistic and routine sales.

[22] Prior works that examine insider trading profits generally report insignificant returns for sales because insider sales are likely driven by personal liquidity, diversification, and other motivations that are not necessarily related to private information (e.g., Jeng et al., 2003; Lakonishok and Lee, 2001; Seyhun, 1986).
[23] I also investigate buy-and-hold size-adjusted abnormal returns and buy-and-hold raw returns and find quantitatively similar results.

CHAPTER 6

ADDITIONAL TESTS

6.1. Litigation Risk as an Alternative Explanation

An alternative explanation for the negative association between proprietary costs and insider trading intensity is that the proprietary cost measures also proxy for litigation risk, and it is the litigation risk that affects insider trading decisions. However, this plausible alternative explanation does not alter my main conclusion for the following reasons. First, I include litigation risk, the predicted litigation probability from Kim and Skinner (2012), as a control variable throughout the tests. Second, the correlation between the composite measure of proprietary costs and litigation risk is very low (0.9%), indicating that these two measures capture different constructs. Third, the findings that insiders reduce *purchase* transactions are unlikely to be explained by litigation risk because extant literature documents insiders are exposed to legal risk almost exclusively when they sell before bad news, but not when they buy before good news. For example, Johnson et al. (2007) find litigation increases after abnormal insider sales, especially after the Private Securities Litigation Reform Act of 1995, and Billings and Cedergren (2015) find the probability of being sued significantly increases when insiders engage in sales prior to the announcement of negative earnings news and fail to provide prior warnings. In addition, Cohen et al. (2012) find the number of opportunistic sale transactions significantly increases the probability of being investigated by the SEC, but the number of opportunistic buys does not, suggesting that insiders face very limited legal risk when they exploit positive private information. Fourth, the findings that the negative relation between proprietary costs and insider trading intensity is more pronounced in less complex firms

and when managers' interests are more aligned with those of shareholders are consistent with the deterrence effect of proprietary costs on insider trading. However, these findings are less consistent with litigation risk explanations because there are no clear reasons to believe that firm complexity and incentive alignment are associated with legal risk.

To further examine whether the results hold in firms with different degrees of litigation risk, I investigate the effects of proprietary costs on insider trading intensity across litigation risk quintiles. Firm-year observations are classified into lowest to highest litigation risk quintiles based on industry-year cutoff points. The results for total trades, purchases, and sales are presented in Panel A, B, and C of Table 9, respectively. As shown in the table, across each quintile of litigation risk, the effect of proprietary costs on total trades, purchases, and sales is negative and significant (*t*-statistics ranging from -1.73 to -5.89). Overall, these results further suggest that the relation is not driven by litigation risk.

6.2. Additional Robustness Tests

I conduct a battery of additional robustness tests (untabulated). First, I consider four alternative measures of insider trading intensity: i) the dollar value of insider trading scaled by the firm's market capitalization at the beginning of the year, ii) the number of transactions scaled by the number of active insiders, where active insiders are defined as insiders who have reported at least one insider stock transaction during my sample period, iii) the likelihood of the occurrence of insider trading, and iv) the number shares traded scaled by their share ownership. The results are quantitatively and qualitatively similar to those tabulated in Table 3 and the inferences remain unchanged. For example, when the dollar value of insider trades (purchases, sales) is used as the measure of insider trading

intensity, the coefficient on *PropCost* is -0.491 (-0.150, -0.524) with a *t*-statistic of -7.88 (-3.49, -7.07).

Second, the results are robust to alternative model specifications. Since the tobit model requires stricter assumptions on the functional form of error terms, I check the robustness of the results using OLS regression models. In addition, when the likelihood of the occurrence of insider trading is used as the insider trading intensity measure, I employ logit regression models. The results are similar to those tabulated in Table 3. For example, the coefficient on *PropCost* is -0.246 (-0.017, -0.204) with a *t*-statistic of -8.86 (-1.52, -8.65) when using an OLS model and -0.040 (-0.062, -0.032) with a *t*-statistic of -3.90 (-4.71, -2.54) when using a logit model.

CHAPTER 7

CONCLUSION

Previous studies have extensively investigated the potential determinants and consequences of insider trading, with most of them focusing on capital market implications of insider trading. On the other hand, studies on voluntary disclosure have long examined the trade-off between capital market benefits and product market costs of disclosure. In this paper, I argue insider trading can reveal proprietary information, allowing rivals to compete more effectively against the insiders' firm.

I use a variety of approaches to identify proprietary costs. First, I employ four proxies of proprietary costs suggested by King et al. (1990), and find a negative association between proprietary costs and insiders' trading activities. Second, I examine insider trading intensity prior to new product launches, when the proprietary information risk is particularly high, and find insiders significantly reduce trading intensity during this period. In addition, using large reductions in U.S. import tariff rates as a source of exogenous variation in proprietary costs, I conduct a difference-in-differences analysis. The results show that insiders in industries that have experienced a large tariff reduction significantly reduce trading activities, compared to insiders in unaffected industries. Consistent with proprietary concerns driving the results, the deterrence effect is stronger when insider trading is potentially more informative to rivals. Further analysis shows that firms with higher proprietary costs are more likely to employ insider trading policies, and that insiders are more sensitive to proprietary costs when their wealth is more closely linked to that of shareholders. These results suggest that insiders reduce trading activities not only due to

firm policies but also due to incentive alignment. Finally, when insiders trade despite higher proprietary costs, they earn significantly higher abnormal profits.

Overall, this study suggests that product market considerations are an important factor associated with insiders' trading decisions and profitability of their trades. These findings are likely to be of interest to regulators and corporate boards in setting insider trading policies, and help investors make investment decisions using insider trading signals.

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APPENDIX A

VARIABLE DEFINITIONS

Proprietary Cost Measures

CompScore	Sum of the values of four individual proxies below, where each proxy is standardized to have zero mean and unit variance
R&D_Intensity	R&D expenditures scaled by total expenses, where total expenses are calculated by subtracting income before extraordinary items from revenues
NumPatents	The natural logarithm of one plus the number of patents filed
SG&A_Intensity	SG&A expense scaled by total expenses, where total expenses are calculated by subtracting income before extraordinary items from revenues
ProdSimilarity	Product similarity score from Hoberg and Phillips data library
PostReduction	An indicator variable equal to one if the industry experiences a tariff rate reduction by year t-1 that is larger than three times the median tariff rate reduction in that industry, zero otherwise
PropPeriod	An indicator variable indicating the year prior to a new product launch

Insider Trading Intensity Measures

TotalTrades	The total number of shares traded by insiders during the year, scaled by the total number of shares outstanding at the beginning of the year, multiplied by 1,000
Purchases	The total number of shares purchased by insiders during the year, scaled by the total number of shares outstanding at the beginning of the year, multiplied by 1,000
Sales	The total number of shares sold by insiders during the year, scaled by the total number of shares outstanding at the beginning of the year, multiplied by 1,000

Firm Characteristics

Size	The natural logarithm of the market value of the equity at the beginning of the year
BM	Book value of equity divided by the market value of equity at the beginning of the year
PreRet	Buy-and-hold stock returns over the prior year
Coverage	The natural logarithm of one plus the number of analysts who issued earnings forecasts in the prior year
InstOwn	Percentage of institutional ownership at the beginning of the year

Turnover	The natural logarithm of the ratio of the number of shares traded during the prior year divided by number of shares outstanding at the beginning of the prior year
Litigation	Predicted litigation probability using Model (3) of Kim and Skinner (2012)
Volatility	Variance of daily stock returns over the prior year

APPENDIX B

TABLES

Table 1
Sample Selection

Sample Selection Criteria	Number of firm-years	Number of distinct firms
All firm-year observations from Compustat with fiscal year ends December 31, 1986 - December 31, 2014	264,412	27,523
Less missing required data to construct control variables	(136,638)	(13,493)
Samples for the tests when:		
PropCost = R&D_Intensity	127,774	14,030
PropCost = NumPatents	116,032	13,560
PropCost = SG&A_Intensity	104,768	12,196
PropCost = ProdSiimilarity	73,981	9,685
PropCost = CompScore	52,896	8,047

Sample Selection Criteria	Number of transactions	Number of distinct firms
All insider trading transactions completed by top 5 executives (i.e., CEO, CFO, COO, President, and Chairman of Board) during sample period January 1, 1986 - December 31, 2014	3,225,958	24,320
Less transactions completed outside of the open market	(1,652,030)	(4,507)
Less transactions without sufficient level of accuracy and reasonableness (i.e., TFN Cleanse Indicator is not 'S' or 'A')	(205,601)	(877)
Less transactions without required data to construct control variables and *PropCost*	(557,710)	(11,282)
Less transactions with missing stock return data to compute *Alpha*	(10,268)	(30)
Final sample	800,349	7,624

Table2
Descriptive Statistics and Correlation Coefficients

Panel A: Descriptive Statistics

	Mean	Q1	Median	Q3	Std.Dev.
Proprietary Cost Measures					
CompScore	0.251	-0.930	-0.662	1.024	1.672
R&D_Intensity	0.049	0.000	0.000	0.032	0.123
NumPatents	0.449	0.000	0.000	0.000	1.075
SG&A_Intensity	0.297	0.149	0.255	0.391	0.203
ProdSimilarity	9.039	1.323	2.397	6.356	17.471
Insider Trading Intensity Measures					
TotalTrades	2.266	0.000	0.000	1.001	7.229
Purchases	0.474	0.000	0.000	0.000	2.322
Sales	1.560	0.000	0.000	0.224	5.341
Firm Characteristics					
Size	5.438	3.761	5.345	7.018	2.283
BM	0.693	0.314	0.556	0.884	0.659
PreRet	0.155	-0.213	0.062	0.354	0.670
Analysts	1.159	0.000	1.099	2.197	1.187
InstOwn	0.345	0.042	0.281	0.603	0.308
Turnover	-0.235	-0.977	-0.185	0.576	1.136
Volatility	0.036	0.020	0.029	0.045	0.022
Litigation	0.291	0.068	0.175	0.433	0.288

Panel B: Pearson Correlations (Below the Diagonal) and Spearman Correlations (Above the Diagonal)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) *CompScore*	**1.000**	**0.388**	**0.720**	**0.237**	**0.548**	**0.006**	**-0.001**	**0.034**	**0.149**	**-0.139**	**0.010**	**0.164**	**0.010**	**0.027**	**-0.114**	**0.017**
(2) *R&D_Intensity*	**0.458**	**1.000**	**0.499**	**0.437**	**-0.039**	**0.041**	**-0.027**	**0.058**	**-0.015**	**-0.249**	**-0.036**	**0.022**	**0.079**	**0.247**	**0.238**	**0.185**
(3) *NumPatents*	**0.599**	**0.224**	**1.000**	**0.095**	**-0.056**	**0.024**	**-0.054**	**0.075**	**0.253**	**-0.170**	**0.017**	**0.234**	**0.205**	**0.187**	**-0.046**	**0.127**
(4) *SG&A_Intensity*	**0.432**	**0.586**	**0.041**	**1.000**	**0.189**	**0.029**	**0.019**	**0.017**	**-0.149**	**-0.179**	**-0.031**	**-0.112**	**-0.071**	**0.035**	**0.180**	**0.025**
(5) *ProdSimilarity*	**0.562**	**0.044**	**-0.108**	**0.041**	**1.000**	**-0.004**	**0.037**	**-0.010**	**0.075**	**0.028**	0.004	**0.121**	**-0.085**	**-0.013**	**-0.107**	**0.011**
(6) *TotalTrades*	**-0.068**	-0.004	**-0.040**	**0.017**	**-0.049**	**1.000**	**0.510**	**0.775**	**0.078**	**-0.124**	**0.066**	**0.145**	**0.268**	**0.175**	0.001	**0.036**
(7) *Purchases*	**-0.059**	**-0.014**	**-0.054**	**0.007**	**-0.012**	**0.507**	**1.000**	**-0.045**	**-0.127**	**0.067**	**-0.095**	**-0.086**	**-0.010**	**-0.035**	**0.075**	**-0.046**
(8) *Sales*	**-0.049**	**0.006**	**-0.018**	**0.017**	**-0.054**	**0.837**	**0.042**	**1.000**	**0.222**	**-0.202**	**0.138**	**0.260**	**0.335**	**0.234**	**-0.082**	**0.076**
(9) *Size*	**0.240**	**-0.030**	**0.348**	**-0.139**	**-0.081**	**-0.079**	**-0.152**	**-0.010**	**1.000**	**-0.318**	**0.037**	**0.709**	**0.429**	**0.431**	**-0.556**	**0.250**
(10) *BM*	**-0.119**	**-0.164**	**-0.129**	**-0.135**	**0.041**	**-0.035**	**0.061**	**-0.080**	**-0.326**	**1.000**	**0.110**	**-0.234**	**-0.142**	**-0.275**	**0.033**	**-0.154**
(11) *PreRet*	0.003	**0.019**	**0.011**	**0.013**	**-0.012**	**0.094**	**-0.014**	**0.122**	**-0.074**	**0.131**	**1.000**	**0.093**	**0.088**	**-0.074**	**-0.067**	**-0.031**
(12) *Analysts*	**0.198**	0.004	**0.289**	**-0.114**	**-0.051**	**-0.012**	**-0.115**	**0.053**	**0.697**	**-0.225**	**0.026**	**1.000**	**0.527**	**0.433**	**-0.342**	**0.241**
(13) *InstOwn*	**0.030**	**0.030**	**0.194**	**-0.096**	**-0.173**	**0.047**	**-0.097**	**0.121**	**0.467**	**-0.167**	**0.043**	**0.568**	**1.000**	**0.376**	**-0.208**	**0.131**
(14) *Turnover*	**0.009**	**0.213**	**0.177**	**0.061**	**-0.242**	**0.054**	**-0.042**	**0.098**	**0.411**	**-0.217**	**-0.046**	**0.434**	**0.423**	**1.000**	**0.137**	**0.453**
(15) *Volatility*	**-0.151**	**0.198**	**-0.102**	**0.193**	**-0.135**	**0.079**	**0.115**	**0.029**	**-0.528**	**0.151**	**0.104**	**-0.340**	**-0.274**	**0.077**	**1.000**	**0.292**
(16) *Litigation*	**0.009**	**0.186**	**0.111**	**0.079**	**-0.142**	**0.025**	**-0.008**	**0.034**	**0.124**	**-0.071**	**0.022**	**0.132**	**0.069**	**0.376**	**0.313**	**1.000**

Notes: Panel A presents selected descriptive statistics. Panel B presents Pearson (Spearman) correlation coefficients below (above) the diagonal. The sample covers the period 1986 to 2014. Proprietary costs are measured using four individual proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, and a composite score, *CompScore*. *CompScore* is the sum of the values of the four individual proxies, where each proxy is standardized to have zero mean and unit variance. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 3
Proprietary Costs and Insider Trading Intensity

$$TotalTrades\ (Purchases, Sales)_{i,t} = \beta\ PropCost_{i,t-1} + \gamma \sum Controls_{i,t-1} + \alpha_j + \alpha_t + \varepsilon_{i,t}$$

Panel A: Total Insider Trades

	Dependent Variable: *TotalTrades*				
	(1)	(2)	(3)	(4)	(5)
PropCost:	*CompScore*	*R&D_Intensity*	*NumPatents*	*SG&A_Intensity*	*ProdSimilarity*
PropCost	-0.401 ***	-4.589 ***	-0.285 ***	-1.073 **	-0.021 ***
	(-8.20)	*(-5.92)*	*(-4.01)*	*(-2.31)*	*(-3.15)*
Size	-0.487 ***	-1.332 ***	-1.366 ***	-1.302 ***	-0.513 ***
	(-6.05)	*(-11.33)*	*(-12.13)*	*(-10.38)*	*(-6.79)*
BM	-1.666 ***	-2.101 ***	-2.028 ***	-2.275 ***	-1.523 ***
	(-5.48)	*(-8.84)*	*(-8.22)*	*(-8.32)*	*(-6.38)*
PreRet	1.846 ***	1.546 ***	1.550 ***	1.678 ***	1.697 ***
	(6.34)	*(6.66)*	*(6.14)*	*(6.51)*	*(6.64)*
Analysts	0.571 ***	1.012 ***	1.111 ***	0.955 ***	0.464 ***
	(5.83)	*(8.96)*	*(9.87)*	*(7.76)*	*(5.41)*
InstOwn	2.591 ***	7.808 ***	8.092 ***	8.339 ***	2.222 ***
	(5.03)	*(13.67)*	*(13.43)*	*(13.74)*	*(5.46)*
Turnover	1.007 ***	0.958 ***	0.966 ***	0.866 ***	0.992 ***
	(6.12)	*(7.30)*	*(7.12)*	*(5.91)*	*(6.57)*
Volatility	-7.349	-6.449	-7.663	-0.211	-14.450 *
	(-0.88)	*(-1.22)*	*(-1.39)*	*(-0.04)*	*(-1.93)*
LitigationRisk	-0.125	-0.939 ***	-0.866 ***	-0.824 ***	-0.556 **
	(-0.40)	*(-3.27)*	*(-2.74)*	*(-2.76)*	*(-2.04)*
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes
Observations	52,896	127,774	116,032	104,768	73,981
Pseudo R^2(%)	0.94	2.22	2.18	2.17	0.91

Panel B: Insider Purchases

	Dependent Variable: *Purchases*				
	(1)	(2)	(3)	(4)	(5)
PropCost:	*CompScore*	*R&D_Intensity*	*NumPatents*	*SG&A_Intensity*	*ProdSimilarity*
PropCost	-0.174 ***	-1.576 ***	-0.110 **	-0.766 ***	-0.015 ***
	(-3.96)	*(-3.64)*	*(-2.00)*	*(-2.94)*	*(-3.15)*
Control variables	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes
Observations	52,896	127,774	116,032	104,768	73,981
Pseudo R^2(%)	3.07	3.17	3.00	3.16	3.23

Panel C: Insider Sales

	Dependent Variable: *Sales*				
	(1)	(2)	(3)	(4)	(5)
PropCost:	*CompScore*	*R&D_Intensity*	*NumPatents*	*SG&A_Intensity*	*ProdSimilarity*
PropCost	-0.398 ***	-4.199 ***	-0.407 ***	-0.765	-0.007
	(-7.11)	*(-4.69)*	*(-5.26)*	*(-1.38)*	*(-1.01)*
Control variables	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes
Observations	52,896	127,774	116,032	104,768	73,981
Pseudo R^2(%)	3.77	4.97	4.90	4.90	3.75

Notes: This table presents the results from tobit regressions of insider trading intensity on proprietary costs. Standard errors are clustered by firm and year. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers the period 1986 to 2014. The dependent variables are the number of shares traded (*TotalTrades*), purchased (*Purchases*), and sold (*Sales*) by insiders during the year scaled by total number of shares outstanding at the beginning of the year, in Panels A, B, and C, respectively. Insiders are defined as top 5 officers and directors: chief executive officers, chief finance officers, chairman of the board, chief operating officers, and presidents. Proprietary costs are measured using four individual proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, and a composite score, *CompScore*. *CompScore* is the sum of the values of the four individual proxies, where each proxy is standardized to have zero mean and unit variance. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 4
Insider Trading Intensity before Product Launch

$$TotalTrades\ (Purchases, Sales)_{i,t} = \beta\ PropPeriod_{i,t} + \gamma \sum Controls_{i,t-1} + \alpha_j + \alpha_t + \varepsilon_{i,t}$$

	(1)	(2)	(3)
Dependent Variable:	*TotalTrades*	*Purchases*	*Sales*
PropPeriod	-0.744 ***	-0.275 **	-0.559 ***
	(-3.79)	*(-1.99)*	*(-2.69)*
Size	-0.584 ***	-0.354 ***	-0.278
	(-2.90)	*(-4.83)*	*(-1.21)*
BM	-2.061 ***	-0.061	-2.696 ***
	(-4.99)	*(-0.39)*	*(-4.68)*
PreRet	2.252 ***	-0.278	3.035 ***
	(3.51)	*(-1.54)*	*(3.93)*
Analysts	-0.040	-0.138	0.092
	(-0.15)	*(-1.14)*	*(0.33)*
InstOwn	1.169	-0.652 **	2.905 ***
	(1.21)	*(-2.04)*	*(2.67)*
Turnover	1.158 ***	0.145	1.395 ***
	(2.65)	*(0.79)*	*(3.33)*
Volatility	-65.029 ***	2.524	-83.268 ***
	(-2.71)	*(0.33)*	*(-2.77)*
Litigation	-0.905	-0.193	-1.370 *
	(-1.22)	*(-0.67)*	*(-1.86)*
Ind. and year dummies	Yes	Yes	Yes
Observations	4,315	4,315	4,315
Pseudo R^2(%)	2.02	6.17	3.45

Notes: This table presents the results from tobit regressions of insider trading intensity on proprietary periods. Standard errors are clustered by firm and year. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers the period 2002 to 2014. The dependent variables are the number of shares traded (*TotalTrades*), purchased (*Purchases*), and sold (*Sales*) by insiders during the year scaled by total number of shares outstanding at the beginning of the year, in Columns (1), (2), and (3), respectively. Insiders are defined as top 5 officers and directors: chief executive officers, chief finance officers, chairman of the board, chief operating officers, and presidents. *PropPeriod* is an indicator variable equal to one if the firm-year is in a proprietary period, zero otherwise. Proprietary periods are firm-year observations that have at least one product announcement in the subsequent year but no announcement in the current or prior year. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 5
Reductions of Import Tariff Rates and Insider Trading Intensity

$$TotalTrades\ (Purchases, Sales)_{i,t} = \beta\ PostReduction_{i,t} + \gamma \sum Controls_{i,t-1} + \alpha_j + \alpha_t + \varepsilon_{i,t}$$

	(1)	(2)	(3)
Dependent Variable:	*TotalTrades*	*Purchases*	*Sales*
PostReduction	-0.908 ***	-0.313 *	-0.926 ***
	(-3.45)	*(-1.91)*	*(-3.30)*
Size	-1.319 ***	-0.912 ***	-0.611 ***
	(-11.23)	*(-14.56)*	*(-5.70)*
BM	-2.046 ***	0.081	-3.915 ***
	(-8.49)	*(1.13)*	*(-9.77)*
PreRet	1.480 ***	-0.746 ***	2.831 ***
	(6.32)	*(-5.95)*	*(8.60)*
Analysts	1.028 ***	0.192 ***	1.000 ***
	(9.37)	*(4.13)*	*(7.28)*
InstOwn	8.055 ***	0.861 ***	9.479 ***
	(13.08)	*(4.98)*	*(12.98)*
Turnover	0.849 ***	0.149 ***	1.218 ***
	(6.34)	*(2.65)*	*(8.64)*
Volatility	-7.919	-1.625	-27.836 ***
	(-1.42)	*(-0.52)*	*(-3.20)*
Litigation	-0.929 ***	0.109	-1.535 ***
	(-3.12)	*(0.74)*	*(-4.57)*
Ind. and year dummies	Yes	Yes	Yes
Observations	116,610	116,610	116,610
Pseudo R^2(%)	2.14	3.47	4.88

Notes: This table presents results of difference-in-differences tobit regressions examining the effect of tariff rate reductions on insider trading intensity. Standard errors are clustered by firm. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers calendar years 1990 to 2014. The dependent variables are the number of shares traded (*TotalTrades*), purchased (*Purchases*), and sold (*Sales*) by insiders during the year scaled by total number of shares outstanding at the beginning of the year, in Columns (1), (2), and (3), respectively. *PostReduction* is an indicator variable equal to one if the industry experiences a tariff rate reduction by year *t*-1 that is larger than three times the median tariff rate reduction in that industry, zero otherwise. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 6
Proprietary Costs and Insider Trading Intensity by Informativeness of Insider Trading

Panel A: Top 5 Versus Non-Top 5 Officers and Directors

Dependent Variable:	*TotalTrades*		*Purchases*		*Sales*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Top 5	Non-Top 5	Top 5	Non-Top 5	Top 5	Non-Top 5
PropCost	-0.401 ***	-0.252 ***	-0.174 ***	-0.037	-0.398 ***	-0.286 ***
	(-8.20)	*(-3.77)*	*(-3.96)*	*(-1.00)*	*(-7.11)*	*(-5.84)*
<u>*p*-value for the test of equal coefficients on *PropCost:* Top5 vs. non-top5 officers and directors</u>						
TotalTrades:	0.02					
Purchases:	< 0.01					
Sales:	0.06					
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	52,896	52,896	52,896	52,896	52,896	52,896
Pseudo R^2(%)	0.94	0.54	3.07	1.52	3.77	2.22

Panel B: Opportunistic Versus Routine Trading

Dependent Variable:	*TotalTrades*		*Purchases*		*Sales*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Opportunistic	Routine	Opportunistic	Routine	Opportunistic	Routine
PropCost	-0.182 ***	0.079 ***	-0.159 ***	-0.006	-0.154 ***	0.070 ***
	(-3.77)	*(2.77)*	*(-4.41)*	*(-1.12)*	*(-2.70)*	*(2.84)*
<u>*p*-value for the test of equal coefficients on *PropCost:* Opportunistic vs. routine trades</u>						
TotalTrades:	< 0.01					
Purchases:	< 0.01					
Sales:	< 0.01					
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	52,896	52,896	52,896	52,896	52,896	52,896
Pseudo R^2(%)	2.29	3.68	3.38	3.46	6.15	8.19

Panel C: Low Versus High Complexity

Dependent Variable:	*TotalTrades*		*Purchases*		*Sales*	
	(1) Low Complexity	(2) High Complexity	(3) Low Complexity	(4) High Complexity	(5) Low Complexity	(6) High Complexity
PropCost	-0.472 ***	-0.287 ***	-0.247 ***	-0.096 *	-0.411 ***	-0.302 ***
	(-6.49)	*(-3.98)*	*(-4.72)*	*(-1.87)*	*(-4.47)*	*(-3.74)*
p-value for the test of equal coefficient on *PropCost:* Low vs. high complexity						
TotalTrades:	0.06					
Purchases:	0.02					
Sales:	0.33					
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	33,821	19,075	33,821	19,075	33,821	19,075
Pseudo R^2(%)	1.05	0.95	2.64	4.16	4.27	3.01

Notes: This table presents the results from cross-sectional tobit regressions of insider trading intensity on proprietary costs. Standard errors are clustered by firm and year. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers the period 1986 to 2014. The dependent variables are the number of shares traded (*TotalTrades*), purchased (*Purchases*), or sold (*Sales*) by insiders during the year, scaled by total number of shares outstanding at the beginning of the year. In Panel A, each insider transaction is classified as top 5 or non-top 5 officers and directors. In Panel B, each insider transaction is classified as opportunistic or routine trade. If an insider trades a stock in the same month in three consecutive years, then all subsequent trades that she makes in the same month are classified as routine trades and the trades completed in a different month are classified as opportunistic trades. If an insider trades in three consecutive years but no trades are made in the same month, then subsequent trades are classified as opportunistic trades. In Panel C, firm-year observations are classified as low or high firm complexity based on the industry-year median complexity, where complexity is defined as the total number of business and geographic segments. The results for the test of equal coefficients are presented toward the bottom of each panel. *PropCost* is a composite score of proprietary cost, defined as the sum of the values of four individual proprietary costs proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, where each proxy is standardized to have zero mean and unit variance. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 7
Mechanisms: Insider Trading Restrictions and Executives' Incentive Alignment

Panel A: Likelihood of Imposing Insider Trading Restrictions

$$Pr(\text{Insider Trading Restrictions}_{i,t}=1) = F(\beta PropCost_{i,t-1}+\gamma\sum Controls_{i,t-1}+ \alpha_j + \alpha_t + \varepsilon_{i,t})$$

Dependent Variable:	*Pr* (Insider Trading Restrictions = 1)	
	(1)	(2)
	Logit	Linear Likelihood
PropCost	0.079 ***	0.014 ***
	(3.94)	*(3.57)*
Control variables	Yes	Yes
Ind. and year dummies	Yes	Yes
Observations	42,445	42,445
Pseudo/Adjusted R^2 (%)	12.62	15.79

Panel B: Incentive Alignment — High Versus Low Ownership

Dependent Variable:	*TotalTrades*		*Purchases*		*Sales*	
	(1)	(2)	(3)	(4)	(5)	(6)
	High Ownership	Low Ownership	High Ownership	Low Ownership	High Ownership	Low Ownership
PropCost	-0.570 ***	-0.095 *	-0.111 ***	-0.026	-0.589 ***	-0.119 **
	(-4.74)	*(-1.86)*	*(-9.87)*	*(-0.79)*	*(-4.06)*	*(-2.12)*
p-value for the test of equal coefficients on *PropCost:* High vs. low ownership						
TotalTrades:	< 0.01					
Purchases:	< 0.01					
Sales:	< 0.01					
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,588	3,855	3,588	3,855	3,588	3,855
Pseudo R^2(%)	2.01	2.64	5.67	9.52	3.55	4.81

Notes: This table presents results from the analyses of potential channels through which proprietary costs reduce insider trading activities. Standard errors are clustered by firm and year. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers the period 1986 to 2014. Panel A reports the results from the regressions of likelihood of imposing insider trading restrictions on proprietary costs. The dependent variable is an indicator variable equal to one if the firm employs blackout periods, zero otherwise. *Safe trades* are defined as insider trades within a month following quarterly earnings announcements, and calculated using a three-year rolling window. A firm is considered as imposing a blackout period from the beginning year of the rolling window when the percentage of *safe trades* is greater than or equal to 75%. The result from a logit regression is reported in Column (1) and from a linear likelihood model is reported in Column (2). Panel B presents the results from cross-sectional tobit regressions of insider trading intensity on proprietary costs. Firm-year observations are classified into high or low ownership based on the industry-year median share ownership held by executives. The results for the test of equal coefficients are presented toward the bottom of Panel B. *PropCost* is a composite score of proprietary cost, defined as the sum of the values of four individual proprietary costs proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, where each proxy is standardized to have zero mean and unit variance. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 8
Proprietary Costs and Insider Trading Profits

$$Profit_{i,k,t} = \beta\ PropCost_{i,t-1} + \gamma \sum Controls_{i,k,t} + \alpha_j + \alpha_t + \varepsilon_{i,k,t}$$

Panel A: Insider Trading Profits – All Trades

	Dependent Variable: *Profit*					
	Purchases			Sales		
	(1) *Alpha*	(2) *BHAR*	(3) *BHRAW*	(4) *Alpha*	(5) *BHAR*	(6) *BHRAW*
PropCost	0.010 **	0.013 **	0.013 **	-0.004	-0.007	-0.005
	(2.30)	*(2.28)*	*(2.02)*	*(-0.85)*	*(-1.22)*	*(-0.91)*
Size	-0.021 **	-0.013	-0.019 *	-0.002	0.004	0.004
	(-2.08)	*(-1.50)*	*(-1.80)*	*(-0.42)*	*(0.57)*	*(0.32)*
BM	0.025 **	0.045 **	0.046 *	-0.014	-0.012	-0.018
	(2.23)	*(2.13)*	*(1.91)*	*(-0.80)*	*(-0.74)*	*(-0.95)*
Analysts	0.031 ***	0.027 **	0.037 ***	-0.008	-0.013	-0.014
	(3.57)	*(2.46)*	*(3.20)*	*(-1.10)*	*(-1.35)*	*(-1.32)*
InstOwn	0.126 ***	0.217 ***	0.226 ***	-0.062 **	-0.071 **	-0.061 *
	(3.83)	*(3.64)*	*(3.78)*	*(-2.27)*	*(-2.40)*	*(-1.89)*
$PreRet_{[-380,-20]}$	-0.033 ***	-0.013	-0.004	0.005	0.012	0.018
	(-3.80)	*(-0.83)*	*(-0.25)*	*(0.47)*	*(1.22)*	*(1.43)*
$Turnover_{[-380,-20]}$	-0.027 ***	-0.007	-0.016	0.006	0.002	0.001
	(-3.62)	*(-0.61)*	*(-1.35)*	*(0.59)*	*(0.19)*	*(0.07)*
$Volatility_{[-380,-20]}$	4.053 ***	1.819	2.725 *	0.016	2.390 **	2.274
	(5.18)	*(1.60)*	*(1.90)*	*(0.02)*	*(2.11)*	*(1.64)*
Trade Size	0.005	0.002	-0.064	-0.015	0.015	0.044
	(0.13)	*(0.03)*	*(-1.16)*	*(-0.51)*	*(0.46)*	*(1.16)*
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	107,273	107,882	107,882	693,076	693,601	693,601
Adjusted R^2(%)	11.88	5.49	13.30	4.40	6.95	15.43

Panel B: Insider Trading Profits – Opportunistic Versus Routine Trades

	Dependent Variable: *Profit_Alpha*			
	Purchases		Sales	
	(1) Opportunistic	(2) Routine	(3) Opportunistic	(4) Routine
PropCost	0.024 ***	-0.010	-0.003	-0.004
	(3.23)	*(-1.64)*	*(-1.15)*	*(-0.41)*
Control variables	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes
Observations	25,724	6,848	183,645	61,495
Adjusted R^2(%)	19.03	38.60	8.00	19.39

Notes: This table presents the results from OLS regressions of insider trading profits on proprietary costs conducted at the insider-transaction level. Standard errors are clustered by firm and year. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers calendar years 1986 to 2014. Panel A reports insider trading profits for all

insider trades. Insider trading profits are measured by daily alpha (*Alpha*), the intercept from the Carhart (1997) four-factor model estimated over the 180 calendar days following the transaction date, in Columns (1) and (4), six-month size decile portfolio adjusted buy-and-hold abnormal returns (*BHAR*) in Columns (2) and (5), and raw buy-and-hold returns (*BHRAW*) in Columns (3) and (6). Panel B reports insider trading profits (*Alpha*) from opportunistic or routine trades. If an insider trades a stock in the same month in three consecutive years, then all subsequent trades that she makes in the same month are classified as routine trades and the trades completed in a different month are classified as opportunistic trades. If an insider trades in three consecutive years but no trades are made in the same month, then subsequent trades are classified as opportunistic trades. Profits are multiplied by -1 for insider sale transactions. Insiders are defined as top 5 officers and directors: chief executive officers, chief finance officers, chairman of the board, chief operating officers, and presidents. *PropCost* is a composite score of proprietary cost, defined as the sum of the values of four individual proprietary costs proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, where each proxy is standardized to have zero mean and unit variance. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.

Table 9
Proprietary Costs and Insider Trading Intensity by Litigation Risk

Panel A: Total Insider Trades

	Dependent Variable: *TotalTrades*				
	Litigation Risk				
	(1) Lowest	(2)	(3)	(4)	(5) Highest
PropCost	-0.876 ***	-0.399 ***	-0.363 ***	-0.300 ***	-0.359 ***
	(-5.89)	*(-4.31)*	*(-3.66)*	*(-3.69)*	*(-3.77)*
Control variables	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes
Observations	10,874	10,584	10,569	10,587	10,282
Pseudo R^2(%)	1.35	1.00	0.83	1.08	1.13

Panel B: Insider Purchases

	Dependent Variable: *Purchases*				
	Litigation Risk				
	(1) Lowest	(2)	(3)	(4)	(5) Highest
PropCost	-0.273 ***	-0.257 ***	-0.128 *	-0.091 *	-0.161 **
	(-3.32)	*(-2.88)*	*(-1.83)*	*(-1.73)*	*(-2.53)*
Control variables	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes
Observations	10,874	10,584	10,569	10,587	10,282
Pseudo R^2(%)	2.77	3.62	3.99	4.12	2.90

Panel C: Insider Sales

	Dependent Variable: *Sales*				
	Litigation Risk				
	(1) Lowest	(2)	(3)	(4)	(5) Highest
PropCost	-0.825 ***	-0.295 ***	-0.365 ***	-0.354 ***	-0.416 ***
	(-3.91)	*(-2.71)*	*(-4.45)*	*(-3.91)*	*(-4.22)*
Control variables	Yes	Yes	Yes	Yes	Yes
Ind. and year dummies	Yes	Yes	Yes	Yes	Yes
Observations	10,874	10,584	10,569	10,587	10,282
Pseudo R^2(%)	4.66	4.02	3.30	3.66	4.03

Notes: This table presents the results from tobit regressions of insider trading intensity on proprietary costs by litigation risk quintiles. Standard errors are clustered by firm. *t*-statistics are reported in parenthesis. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample covers calendar years 1986 to 2014. Firm-year observations are classified into low to high litigation risk quintiles based on industry-year cutoff points. Litigation risk is predicted using the litigation probability estimated using the Model (3) of Kim and Skinner (2012). The dependent variables are the number of shares traded (*TotalTrades*), purchased (*Purchases*), and sold (*Sales*) by insiders during the year scaled by total number of shares outstanding at the beginning of the year, in Panels A, B, and C, respectively. *PropCost* is a composite score of proprietary cost, defined as the sum of the values of four individual proprietary costs proxies, *R&D_Intensity*, *NumPatents*, *SG&A_Intensity*, and *ProdSimilarity*, where each proxy is standardized to have zero mean and unit variance. See Appendix A for additional variable definitions. All continuous variables are winsorized at 1% and 99%.