Hedge Fund Activism and Corporate Innovation

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Abstract

This paper investigates the impact of hedge fund activism on corporate innovating activities. It finds that innovative firms, those in high-tech industries or with positive R&D, are as likely to be targeted by activist hedge funds as non-innovative firms. Activist hedge funds tend to target innovative firms with poor innovation efficiency. Hedge fund interventions are associated with significant improvements in innovation output in both high and low competitive industries. The improvement is more pronounced in active intervention events. Moreover, hedge fund activists deliver positive abnormal returns to shareholders of target innovative firms during the 5-year period following the intervention. Overall, our results suggest that activist hedge funds are not myopic investors and their interventions enhance innovative activities that benefit shareholders of innovative firms in the long term.

Key Words: Corporate Innovation; Corporate Governance; Hedge Fund Activism; Active Intervention

JEL Classification: G23, G34

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Abstract

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1. Introduction

Innovation is a key factor in determining a firm's competitive advantages and productivity growth. Schumpeter (1939) notes that innovation is a complex economic activity that is distinguished from invention − an act of intellectual creativity. The process of innovation involves interactions among various stakeholders inside and outside the firm who might have diverged interests in innovation. For example, a risk-averse manager might want to avoid innovation risk since his wealth is under-diversified and highly tied to firm performance, while a well-diversified long-term shareholder might have greater risk tolerance and encourage innovation. The fundamental reason for the conflict of stakeholders' interests in innovation lies in the unique features of innovation, which requires a prolonged period of commitment of resources that is associated with a high degree of uncertainty and information asymmetry, whereas the firm's stakeholders are heterogeneous and differ in their risk tolerance, monitoring capacity, and investment horizons. As a result, the composition and the changing balance of the power of stakeholders could have a significant bearing on a firm's incentive of innovation and its outcome.

In recent decades, the rising popularity of shareholder activism and its increased influence on corporate management has raised concerns among policy makers that activist shareholders, especially activist hedge funds, are myopic investors who could pose a major threat to a firm's long-term performance by pursing actions that are profitable in the short term but are harmful to the firm's long-term interest. In the mid-1980s, traditional institutional investors, particularly public and union pension funds, were the most frequent shareholder activists. In the

past decade, hedge funds have overtaken all other institutional investors as the most prevalent in the investor activism space (Gillan and Starks, 2007). The potential myopic actions pursued by activist hedge funds could aggravate managerial risk aversion, discourage creditors' willingness to provide long-term financing, and lower the enticement of employees' incentives to invest in firm-specific human capital, all of which could impede a firm's innovation effort. On the other hand, hedge fund investors are generally wealthy individuals whose assets are more diversified than average investors, allowing hedge funds to assume more risk and encourage innovation. More importantly, the monitoring of activist hedge funds could reduce the information asymmetry between managers and investors, lowering managers' career concerns and reducing managerial slack in innovation (Aghion, Reenen, and Zingales (2013). Despite the controversial role of activist hedge funds as an increasingly important corporate stakeholder and their potential impacts on firm innovations, little is known about whether hedge fund activism hinders or enhances firms' innovation activities.

In this paper, we provide a systematic empirical investigation on whether and how interventions by activist hedge funds impact innovation activities and the shareholder value of innovative firms. Our empirical analysis addresses the following questions: do activist hedge funds prefer or avoid innovative firms as targets? If hedge funds target innovative firms, in which types of innovative firms do they choose to intervene? How does the intervention of hedge funds affect targeted firms' innovation outcome? Do activist hedge funds benefit shareholders of target innovative firms in the long run?

We first investigate the tendency of hedge funds to target innovative firms. On the one

hand, as argued by Black (1990) and Kahn and Winton (1998), activist hedge funds, like typical institutional investors, might tend to avoid opaque businesses or industries such as innovative firms with high levels of R&D expenditures because their intervention may not be rapidly recognized by the market, making it difficult to sell ownership and exit targets. On the other hand, some attributes of innovative firms may make them attractive targets for hedge funds. For instance, the high volatility stock prices of innovative firms allow hedge funds to take positions at a lower cost during its down cycle. The active merger and acquisition market for innovative firms makes it easier for hedge funds to exit targets through selling the firms. More importantly, compared to other types of investments, innovation is a complex and costly process that might be associated with significant agency costs, creating opportunities for hedge funds to intervene and improve innovation outcome.

To investigate whether hedge funds avoid or prefer targeting innovative firms, we estimate the likelihood that hedge funds target innovate firms; i.e., those that are in the high tech industry or have positive R&D expenditure. Our results indicate that hedge funds do not avoid innovative firms when choosing their targets. Among firms targeted by hedge funds, 29.6% (40.3%) are in the high tech industry (have positive R&D). As a comparison, 28.6% (37.6%) firms in the Compustat universe are in the high tech industry (have positive R&D). To control for other firms' characteristics that could potentially affect the likelihood of being targeted, we use a Probit model to estimate the probability of a firm being targeted by hedge funds. We find that there is no significant difference between innovative firms and non-innovative firms in their likelihood of being targeted by activist hedge funds. The finding indicates that the high level of

business complexity and information asymmetry is not a formidable obstacle for hedge funds to target innovative firms.

We then investigate what types of innovative firms are more likely to attract hedge fund interventions. We find that innovative firms with smaller size and lower market-to-book ratio have higher probabilities to be targets, consistent with the previous finding on all firms targeted by hedge funds (e.g., Brav, Jiang, Partnoy, and Thomas, 2008; BJPT hereafter). We also find that innovation input (R&D expenditures) does not affect the probability of being targeted. However, we find that hedge funds are significantly more likely to target innovative firms that have low levels of innovation efficiency (i.e., a lower number of patent applications for given R&D expenditure). In other words, hedge funds appear to view the efficiency of R&D rather than the level of R&D as the key factor in choosing target innovative firms.

Next, we examine the impact of hedge fund inventions on the target firms' innovation outcome. We employ a difference-in-difference approach to compare the difference in the innovation outcome before and after interventions between target-innovative (i.e., treatment) firms and a group of matched but non-target-innovative (i.e. control) firms. We find that there is no evidence that hedge fund intervention is associated with a significant reduction in innovation input. Instead, we show that, after hedge fund intervention, there are significant improvements in the innovation output of target innovative firms. Hence, our results do not support the "myopic activist" claim that hedge funds purposely select high R&D firms and cut R&D expenditures upon intervention to achieve short-term benefits. Instead, it shows that hedge funds target innovative firms that exhibit a higher degree of inefficiency whose performances subsequently

increase after intervention. Our results are consistent with the findings of Brav, Jiang, and Kim (2013) that hedge fund intervention significantly improves the total factor productivity of targeted firms, suggesting that hedge fund interventions have a positive impact on target firms' real activities.

Our finding that innovative firms with lower innovation output are more likely to be targeted and their innovation output subsequently improves is consistent with two alternative explanations. One is that the improved innovation output is due to the active intervention of hedge funds. The other is that hedge funds passively select innovative firms that have lower present output which is expected to increase in the future. In other words, the observed improvement in innovation output is due to hedge funds' stock selection ability rather than the intervention of hedge funds. Brav, Jiang, and Kim (2013) note that changes in targeted firms' performance are unlikely to have occurred if activists simply take passive positions. This is because activists hold a concentrated equity stake in target firms, and their average holding period is around two years. It is difficult to argue that activists are passive investors who are willingly to hold long-term undiversified positions without specific goals.

Nevertheless, to distinguish between the active intervention and passive selection hypotheses, we investigate whether the change in innovation output is related to hedge funds having specific objectives and aggressive tactics in interventions. We use stated objectives that the activist funds provide when they announce activism in their target firms to classify events into two categories: passive and active intervention events. The passive intervention events are those in which the hedge fund views that the target to be undervalued and that it will only

communicate with the management to improve shareholder values without taking more aggressive tactics. Active intervention events are those for which the hedge fund has specific objectives and will take aggressive tactics to achieve. We find that active intervention events are associated with significant increases in innovation output. In contrast, there is no significant change in innovation output for passive intervention events. The empirical results do not support the stock selection explanation that hedge funds identify lower efficient target firms and passively wait for the improvement of their innovation output. Instead, the results show that the active intervention of hedge funds is necessary for the improvement in the innovation output of target firms.

We then investigate underlying mechanisms through which activists facilitate innovations. Aghion, Reenen, and Zingales (2013) point out two possible channels through which institutional investors could enhance innovations. One is that institutional investors could reduce the career concern of managers in innovation through frequent monitoring that helps identify whether the failure of innovation is due to luck or managerial ability (career concern channel). The other is that institutional monitoring can effectively discipline lazy managers and force them to work hard in innovative activities (discipline channel). The career concern channel predicts that hedge fund activists could benefit innovative activities for firms in high competitive industries, as managerial career concern is more severe in these industries, while discipline channel predicts that hedge funds could be beneficial for innovative firms in low competitive industries given managers are likely to have more slack in these industries. We find that hedge fund intervention enhances the innovations of target firms in both high and low competitive industries, suggesting

that hedge fund interventions could improve innovation through both career concern and discipline channels. The results indicate that effective monitoring provided by activist hedge funds is crucial to facilitate their positive impact on target firms' innovative activities.

Finally, we investigate if and how the stock market evaluates the intervention of hedge funds in innovative firms. Innovation is a complex process that could take a long period of time to reach commercialization stage. For instance, the process from the time that a new medicine is discovered to when it is available for treating patients is, on average, 10 to 15 years. Although active hedge funds improve the target's R&D output, the firm could still be far away from reaching the commercialization stage. One concern is that such an improvement in R&D output is short lived and might not help the firm's long-term innovation outcome. Moreover, if investors do not rapidly recognize the improvement in R&D output, it will be difficult for activists to exit targets given that the average time for their intervention is around 2 years.

To investigate the effect of hedge fund innovation on target firms' shareholder value, we estimate target firms' cumulative abnormal stock returns up to 60 months after the announcement of interventions. Our results show that innovative target firms experience significantly positive increases in stock returns in both the short (i.e., 1 month) and long terms (i.e., 60 months). The result indicates that the market rapidly recognizes the benefit of hedge fund intervention on target innovative firms. It also suggests that hedge funds are able to exit target firms through selling stock before the final outcome of innovations if they improve the innovation output of targets.

Our paper contributes to the recent literature on the impact of hedge fund activism on corporate performance (BJPT, 2008; Boyson and Mooradian, 2011; Clifford, 2008; Klein and Zur, 2009). Until the mid-1980s, institutional investors tended to follow the so-called "Wall Street Rule" that they either voted upon with the management of the firms in which they held stocks or sold stocks if they disagreed with management (Useem, 1993; Monks and Minow, 1995). As the ownership of institutional investors increased, it became more difficult to exit the firm by selling stock, as it could trigger drops in share prices. Therefore, institutional investors have increasingly used their voting power to actively influence firm management. However, a major concern of activism among institutional investors, particularly activist hedge funds, is that they might pursue short-term goals by sacrificing the firm's long-term value. Our paper uses hedge fund interventions on innovative firms as a unique setting to shed light on this issue. Our finding that activists improve innovative firms' innovation efficiency and deliver long-term returns to shareholders indicates that, although activists tend to have a short investment horizon, there is no evidence that they are pushed for myopic actions such as cutting R&D that hinders the long-run innovation ability. Instead, activist hedge funds focus on improving the innovation output and deliver positive long-term returns to the shareholders of innovative firms.

Our paper also adds to the literature on how institutional investors influence firm-innovative activities. The extant literature offers mixed evidence on the role of institutions in corporate innovation. For example, Graves (1988) argues that the short-term focus of institutional investors hinders innovation progress due to a lack of knowledge of innovative businesses. Mao, Tian, and Yu (2013) reveal that the interference and constraints imposed by

VCs make IPO firms less innovative. A recent important paper by Aghion, Reenen, and Zingales (2013) argues that the presence of institutional investors lowers the concern of managers that the failure of innovation due to unlucky draws could affect their future careers. Institutional monitoring helps identify whether the failure of innovation is due to luck or managerial ability. Empirically, Aghion, Reenen, and Zingales (2013) find only supportive evidence for the career concern channel in that institutional ownership is positively associated with a firm's patent counts, but only in high competitive industries. However, Aghion, Reenen, and Zingales (2013) do not distinguish the different types of institutional investors who could differ significantly in their risk preference, investment horizon, and incentives in monitoring. Indeed, earlier studies show that activist institutional investors such as mutual funds and pension funds do not add value to the firm (Black, 1990; Karpoff, 2001; Romano, 2001; Gillan and Starks, 2007). However, recent studies show that activist hedge funds bring significant benefits to shareholders (e.g., BJPT, 2008), suggesting that hedge funds are more effective than other institutional investors as informed monitors. Our paper focuses on hedge fund activists as a clearly defined group of institutional investors. The finding that hedge funds enhance innovation in both high and low competitive industries provides direct support to the theory by Aghion, Reenen, and Zingales (2013) that effective monitoring, through either career concern or discipline channels, could enhance a firm's innovation. Our new empirical findings suggest that institutional investors are heterogeneous and might affect innovation through different mechanisms.

The paper proceeds as follows. Section 2 describes the construction of the data and the sample used in the analysis. Section 3 analyzes the effects of hedge fund activism on corporate innovation. Section 4 summarizes and concludes.

2. Data

Our sample of hedge fund activism events is the same as that used in Brav, Jiang, and Kim (2010) which collected hedge fund activism events based mostly on Schedule 13D filings that hedge funds file with the SEC within 10 days of acquiring more than 5% of any class of securities of a publicly traded company.[2] The filing of a Schedule 13D signals to the market that the filer intends to seek control or influence the management of the target company. To mitigate the concern that the Schedule 13D-based sample may be biased toward smaller targets, Brav, Jiang, and Kim (2010) searched Thomson Financial Form 13F and news for more than 2% ownership by any hedge funds in public companies of over $1 billion market value. After excluding filings and news that involve risk arbitrage, distress financing, and closed-end funds, their final sample consists of 231 activist hedge funds, 976 targeted firms, and 1169 hedge fund-target pairs. The sample period is from 2001 to 2007 with target companies spanning 196 (59) three-digit (two-digit) SIC code industries.

To measure firms' innovating activities, we obtain data on firms' patenting activity from the National Bureau of Economics Research (NBER) Patent Citation database. This database contains annual information from 1976 to 2006 on patent and citation for U.S. publicly traded firms, including patent ID, patent assignee, number of citations made and the cited patent IDs, number of citations received and the citing patent IDs, patent application year, and patent granted year (see Hall, Jaffe, and Trajtenberg, 2001, for details).

[2] We are grateful to Jiang Wei for providing the data on hedge fund 13D filing date and target firm identity.

Following Sapra, Subramanian, and Subramanian (2013), we measure a firm's innovation input in year *t* as its *R&D Expenses/Sales* in a year *t*. Following Bena and Li (2013), we measure a firm's innovation output using *Patent Index/Sales. Patent Index* is constructed in three steps. First, for each technology class *j* and patent application year *t*, we calculate the median value of the number of granted patents in technology class *j* with application year *t* across all firms that were granted at least one patent in technology class *j* with application year *t*. [3] Second, we scale the number of granted patents to firm *i* in technology class *j* with application year *t* by the corresponding (technology class and application year) median value from the first step. Finally, for firm *i*, we sum the scaled number of granted patents from the second step across all technology classes with application year *t* and multiply the summation by 100. Since firms' patenting activities tend to cluster over technology classes and time, *Patent index* thus measures a firm's relative productivity in innovation by excluding those clustering effects. We use patent application year rather than patent granted year to measure a firm's patenting activities in a particular year because it may take several years for the firm to receive the patent grant after application. Hall, Jaffe, and Trajtenberg (2001) note that the patent application year captures the firm's innovative activities in that particular year more accurately than does patent granted year. To avoid the outlier effect, we winsorize all variables at the top and bottom 1% values.

We use two methods to identify innovative firms. The first one identifies innovative firms as those in the high tech industry based on three-digit SIC codes, following Kile and Phillip (2009).[4] We call this sample the high tech sample. The limitation of this classification is that some firms might engage in significant R&D activities but are not in the high tech industry. As

[3] The U.S. Patent Office classifies each patent into 421 technology classes.

[4] Specifically, three-digit SIC codes for high tech industries are 283 Drugs; 357 Computer and Office Equipment; 366 Communication Equipment; 367 Electronic Components and Accessories; 382 Laboratory, Optic, Measure, Control Instruments; 384 Surgical, Medical, and Dental Instruments; 481 Telephone Communications; 482 Miscellaneous Communication Services; 489 Communication Services, NEC; 737 Computer Programming, Data Processing, etc; and 873 Research, Development, and Testing Services.

such, our second sample identifies innovative firms as those with positive R&D expenditures in the past five years. We call this sample the positive R&D sample. We use these two samples, the high tech sample and the positive R&D sample, in all analyses to cross-verify the robustness of our empirical results.

Table 1 reports the summary statistics of the characteristics of target firms in the year before being targeted. The first three columns provide summary statistics of firm characteristics for the whole target sample, and the middle and last three columns report statistics for the high tech sample and positive R&D sample, respectively. For the whole target sample, the median target firm is quite small − the market value is l81 million, and most target firms have no innovation input and innovation output, as indicated by the zero median innovation input and innovation output. Compared to the whole sample of target firms, innovative target firms have a higher Tobin's q, lower leverage, higher cash-to-asset ratio, and higher innovation input and output. The median innovation input is about 10% for the high tech target sample, suggesting that most innovative target firms spend about 10% of sale revenue in their R&D.

[Table 1 about here]

3. Empirical analysis

3.1 Do activist hedge funds avoid targeting innovative firms?

Kahn and Winton (1998) argue that, to attract a rapid appreciation of the intervention from the market, investors tend to avoid opaque businesses such as innovative firms with high levels of R&D expenditure but intervene in transparent firms or industries. In light of this view, BJPT (2008) find that higher R&D/total assets ratios are negatively (but insignificantly) associated with the likelihood of being targeted by hedge funds. However, hedge fund activism might not

necessarily be short-term focused. For example, Bebchuk, Brav, and Jiang (2013) show that the positive impact of hedge fund intervention on firm operational performance persists five years after the intervention. If the market is sufficiently efficient so as to recognize the long-term benefit of hedge fund intervention, both the short- and long-term stock price will incorporate the enhanced value. More importantly, compared to other types of investments, innovation is a complex and costly process, making it difficult to design contracts to reduce agency costs (e.g., Holmstrom, 1989; Francis and Smith, 1995), allowing hedge funds to create value through effective monitoring. Hence, the question of whether or not hedge funds prefer or avoid targeting innovative firms is an empirical one.

[Table 2 about here]

Table 2 reports the hedge fund activism events that target innovative companies each year. For the period of 2001-2007, 338 activism events took place in high tech firms, representing 29.6% of all events, and 459 activism events took place in positive R&D firms, representing 40.3% of the full sample. Over the same period, the percentage of activist events ranges from 25.8% to 37.6% in high tech firms and from 35.5% to 45.3% in positive R&D firms. To illustrate whether hedge funds are more likely to target innovative firms, we compare the percentage of activism events for innovative firms with the percentage of innovative firms in the CRSP/Compustat database. We find that the percentage of activist events for positive R&D firms (40.3%) is significantly higher than the percentage of positive R&D firms in the CRSP/Compustat database (37.6%). The percentage of activism events in the high tech firms (29.6%) is also higher (but insignificant) than that of the percentage of high tech firms in the

CRSP/Compustat database. These results show that activist hedge funds do not tend to avoid innovative companies.

[Table 3 about here]

In Table 3, we perform Probit regressions to further examine whether activist hedge funds tend to avoid innovative firms. The sample includes all firms in the CRSP/Compustat database from 2001 to 2007. The dependent variable is a dummy equal to one if a firm is targeted by activists during the following year and zero otherwise. The explanatory variables include a dummy indicating whether a firm is an innovative firm and other firm characteristics that have been used in extant literature on hedge fund activism. In Columns 1 and 2, the indicator for innovative firms, *High_Tech,* is a dummy that takes the value of one if a firm is a high tech firm and zero otherwise. In Columns 3 and 4, the indicator for innovative firms, *Positive_R&D,* is a dummy equal to one if a firm is a positive R&D firm and zero otherwise. An inspection of the results in Table 3 shows that coefficients on the *High_Tech* dummy and the *Positive_R&D* dummy are all positive but statistically insignificant, suggesting that the likelihood for innovative firms being targeted by activists is not significantly different from those of non-innovative firms. Among other control variables, we find that hedge funds tend to target firms with smaller size, lower Tobin's q, higher profitability, and lower dividend payouts, which are all consistent with those of BJPT (2008). The results do not support the view that hedge fund activists tend to avoid innovative firms. The complexity of innovative activity does not appear to prevent hedge funds from targeting firms in the high tech industry or firms with positive R&D.

3.2 What types of innovative firms are targeted by hedge funds?

If hedge funds do not avoid firms that engage in innovative activity, what type of innovative firms do hedge funds target? That is, compared to innovative firms that are not targeted by hedge funds, what particular characteristics of target innovative firms are attractive to hedge funds? To investigate this issue, we conduct a Probit analysis to identify firm characteristics that significantly affect the likelihood of innovative firms being targeted by hedge funds. The sample includes all innovative firms in the CRSP/Compustat database. Again, we use two samples of innovative firms: the high tech sample and the positive R&D sample. The dependent variable of the Probit regression is a dummy variable equal to one if an innovative firm is targeted by activist hedge funds and zero otherwise.

[Table 4 about here]

Table 4 reports the results from the Probit analysis. The first three columns report the results regarding the likelihood of being the target for high tech firms. Column 1 includes innovation input and other firm characteristics as explanatory variables. Following Sapra, Subramanian, and Subramanian (2013), we take the logarithm of one plus innovation variables; i.e., *Innovation input* and Innovation output equal *log*(*1+R&D/Sales*) and *log(1+Patent Index/Sales)*, respectively. The result shows that the coefficient on innovation input is negative but insignificant, consistent with the Probit result in BJPT (2008) that the level of R&D is not a significant predictor for being the target. Column 2 includes innovation output and other firm characteristics as explanatory variables. The coefficient on innovation output is significantly negative. A one-standard-deviation decrease in innovation output is associated with a 0.46 percentage point increase in the probability of being targeted when all variables stay at mean.

Considering that target innovative firms represent only 1.70% of all innovative firms, the marginal probability of innovation output is economically meaningful. Column 3 includes both innovation input and output as explanatory variables. This shows that the effect of innovation output is still significantly negative, while innovation input remains insignificant. These results show that hedge fund activists tend to target firms with low innovation output for a given level of innovation input, suggesting that innovation efficiency is the main factor when hedge funds choose target firms.

The last three columns of Table 4 report the results for the likelihood of being the target for positive R&D firms. The results are consistent with those for high tech firms and show that a positive R&D firm's innovation output is negatively related to the likelihood of being targeted when innovation input stays the same. We thus conclude from Table 4 that activist hedge funds do not simply target firms with low innovation input; instead, innovation efficiency is a primary factor in determining an innovative firm being targeted by activists. The fact that activist hedge funds tend to target innovative firms with low levels of innovation efficiency suggests that the hedge funds believe that there is greater potential to create value from innovation firms with greater inefficiency in their R&D investments.

3.3 Hedge fund activism and innovation outcome

In this section we answer the following question: How does the intervention of activists change the innovative activities of target firms? On the one hand, given that investments on innovative projects are typically long-term focused and exhibit high levels of business complexity and information asymmetry, the market may not fully appreciate the impact of activist intervention in

innovation intensive targets. As such, activist hedge funds might be incentivized to cut R&D expenditures to improve the short-term performance but hinder firms' innovation capacity in the long run. In fact, opponents of hedge fund activism often claim hedge fund activists to be short-term focused and financial engineering oriented and that their actions could hurt targets' long-term real performance. However, if the market does not reward myopic behavior, activist hedge funds might aim to create long-run value for shareholders by optimizing the resource reallocation of innovative activity and improve the efficient R&D expenditures of target firms. Holmstrom (1989) argues that it is costly to design contracts to promote inventive activity given the unique characteristics of innovation: long-term nature, high risk and unpredictability. Therefore, the success of innovation hinges greatly on the monitoring by shareholders. Extant literature has shown that hedge funds are more effective monitors as they are different than that of other institutional investors such as banks, insurance companies, mutual funds, pension funds, and endowment funds, which are all subject to regulatory and political restrictions, conflicts of interest, and liquidity constraints (e.g., Armour and Cheffins, 2009; Klein and Zur, 2009; Thompson, 2006). As such, hedge fund activists could be more effective than other institutional investors at spurring innovative activities.

We use the difference-in-difference method to examine the effects of hedge fund activism on firm innovation. We first construct a group of matched innovative (control) firms for actual target innovative (treatment) firms. Specifically, for each actual target innovative firm, we find 5 closely matched innovative firms that are in the same year, in the same industry based on the three-digit SIC code, and in the same 10*10 size and book-to-market sorted portfolios 2 years

before the events (BJPT, 2008). If the narrow criteria yield no match, we relax the industry group to the two-digit SIC code and 5*5 size and book-to-market sorted portfolios. For high tech target firms, we require that all matched firms belong to the high tech industry. For positive R&D target firms, we require that all matched firms have positive R&D. Both target and matched firms are required to have 5 consecutive years of Compustat data around the target year. By doing so, for a high tech sample, we construct a panel data set of 198 target firms and 198*5 matched firms formed from two years before the target year to 2006, which is the last year of our innovation output data. Similarly, for the positive R&D sample, we create a panel data set of 279 target firms and 279*5 matched firms from two years before the target year to 2006.

We then estimate the following difference-in-difference regression on the sample of target and matched innovative firms:

$$Y_{it}=\phi TargetAfter_{it}+\theta X_{it}+\alpha_i+\beta_t+\varepsilon_{it} \quad (1)$$

where Y_{it} is firm i's innovation input (*log(1+R&D/Sales)*) or innovation output (*log(1+ Patent Index /Sales)*) in year t. α_i denotes firm-fixed effect, β_t denotes year-fixed effect. Following the standard difference-in-difference approach, *TargetAfter* equals 1 for target firms from one year after the activist intervention to 2006 when the sample period ends and 0 otherwise. X_{it} denotes a set of firm characteristic variables that could affect innovation outcome, following Atanassov, Nanda, and Seru (2007) and Seru (2010). They include lagged total assets to control for firm size, current ROA to control for firm performance, lagged debt-to-asset ratio to control for the level of leverage, lagged Tobin's q to control for firm valuation, and firm age to control for the effect of different R&D life cycles on innovative activity. To tackle the serial correlation problem in

difference-in-difference regression, we use clustered standard errors at the firm level (Bertrand, Duflo, and Mullainathan 2004; Petersen, 2007). Given that a hedge fund intervention could happen in the middle of a year, we exclude observations in event year t in the difference-in-difference regressions to allow for a clean classification of observations into before and after interventions.[5]

[Table 5 about here]

Table 5 reports the impact of hedge fund activism on target firms' innovation outcome. Panels A and B present the results for the high tech and positive R&D firms, respectively. The first three columns examine the effect on innovation input. Column 1 includes only *TargetAfter*, firm-fixed effect, and year-fixed effect, while Column 2 adds a battery of firm characteristics as control variables. The coefficients on the *TargetAfter* are insignificant, indicating no significant change of innovation input after hedge fund intervention. The result does not support the view that hedge funds take myopic action by cutting R&D expenditures to improve the short-run performance.

Columns 4 to 5 of Table 5 report the regression results when innovation output is the dependent variable. First note that the coefficients on the control variables are largely consistent with previous findings in the literature (Atanassov, 2013). For example, innovation output is negatively related to firms' size and leverage and is not significantly related to profitability, Tobin's q and age. More importantly, we find that activist intervention results in a significant increase in innovation output for both the high tech and positive R&D firms. Specifically, in

[5] Including observations in event year yields similar results.

Panel A, the coefficient on *TargetAfter* in Column 5 is 0.175, showing that innovation output for the average target firm increases by 17.5% after the activist event.

We also examine the potentially dynamic effect of hedge fund intervention. In other words, we are interested in whether the effect of activist intervention on innovation reverted two years after the intervention, given that the hedge funds' holding period is about two years (Brav et al., 2008). We replace *TargetAfter* with two dummy variables: *TargetAfter1* equals 1 at one year after the firm is targeted by hedge funds (t+1) and 0 otherwise, and *TargetAfter2* equals 1 from two years after the firm is targeted by hedge funds to 2006 ($\geq$ t+2) and 0 otherwise. Columns 3 and 6 report the coefficients on *TargetAfter1* and *TargetAfter2* for innovation input and innovation output, respectively. The coefficient for *TargetAfter1* and *TargetAfter2* are insignificant for innovation input, while they are both significantly positive for innovation output. Specifically, Column 6 shows that the activist event enhances innovation output by 15.5% (*TargetAfter1*) one year after intervention, and by 16.9% (*TargetAfter2*) two years after targeting. This suggests that hedge fund activism continues to make a significantly positive impact on innovation output after two years of activist intervention. The results show that the impact of hedge fund intervention on innovation outcome didn't revert two years after innovation.

To summarize, we find that hedge fund activism does not change target firms' innovation input but increases innovation output, indicating that hedge fund intervention increases the efficiency of innovative activity in target-innovative firms. Our finding is consistent with the results of Brav, Jiang, and Kim (2013), who find that target firms' production efficiency increases after hedge fund interventions, suggesting that hedge fund intervention is associated

with a real change in target firms' fundamentals.

3.4 Passive versus Active Intervention Events

We have shown that innovative firms with lower innovation efficiency are more likely to be targeted by hedge funds, upon which their innovation output improves. The results are consistent with two alternative explanations. One is that the improvement in innovation output is due to the active intervention of hedge funds. The other is that hedge funds passively select innovative firms that have lower present output but are expected to increase their output in the future. In other words, the observed improvement in innovation output is due to hedge funds' passive stock selection ability.

Brav, Jiang, and Kim (2013) point out that changes in targeted firms' performance that are well documented in the literature are unlikely to happen if hedge funds simply take passive positions. Activists hold a concentrated equity stake in target firms, and their average holding period is around two years. It is unlikely that they are willing to hold long term undiversified positions without specific goals.

Nevertheless, to distinguish between active intervention and passive selection explanations, we investigate whether the change of innovation output is associated with hedge funds' intervention agenda. In particular, we classify activist events into two categories, passive intervention and active intervention events, according to the stated objectives that the activist funds provide when they announce activism. Passive intervention events are those in which hedge funds view targets as undervalued and will only communicate with the management to improve shareholder values without taking more aggressive tactics. Active intervention events

are those in which hedge funds have specific objectives and will take aggressive intervention tactics. If hedge fund intervention has a causal impact on the improvement of corporation innovation, we should expect that the improvement in output is more likely to exist for active intervention events. Conversely, if hedge funds only anticipate the improvement of innovation but play a passive role, we should expect that the improved output also exists in passive intervention events.

[Table 6 about here]

Table 6 shows the stated objectives and tactics that hedge funds provide when they announce activism. Passive intervention events represent 47.93% in the high tech sample and 46.84% in the positive R&D sample. All passive intervention events in this objective involve only communication with the management without active tactics. In active intervention events, hedge funds tend to launch more aggressive tactics to achieve their activism agenda, which are classified into six sub-categories: seeking board representation, making formal shareholder proposals or public letters, threatening to sue the firm or to launch proxy fight, launching proxy fight, suing the company, and intending to take control of the company (Brav, Jiang, and Kim, 2010).[6]

[Table 7 about here]

Table 7 provides the difference-in-difference regression on the impact of hedge fund intervention for passive and active intervention events, respectively. Columns 1 to 2 (3 to 4) in Panel A report the results for active (passive) intervention events in high tech firms. The results

[6] We manually collect this information using the hedge fund events information provided by Professor Jiang Wei.

show that active intervention is associated with a significant increase in target firms' innovation output. Most noticeably, the coefficient on *TargetAfter* in Column 2 indicates a 26.8% increase in innovation output. This size of output increase is 1.5 times that of the *TargetAfter* coefficient in the whole high tech event sample. Therefore, the regression results demonstrate a significant value enhancement in terms of target firms' innovation output when hedge funds intervene with an active agenda. On the contrary, all coefficients on *TargetAfter* are insignificant at the 5% level for passive intervention events. Panel B presents similar results for positive R&D firms.

The results from Table 7 show that hedge fund intervention is associated with an improvement on target firms' innovation output in active intervention events. In contrast, there is no significant difference in innovation output in passive intervention events. The results do not support the view that hedge funds passively select firms that have low present innovation output but are expected to improve in the future. Rather, it supports the notion that hedge funds need to get actively involved in corporate governance in order to improve the level of innovation output of target companies. Overall, the evidence is consistent with the active intervention explanation but not the passive selection explanation, suggesting that active involvement of hedge funds is crucial to effectively improve the innovation output.

3.4 Product market competition and hedge fund intervention

The results so far show that activist hedge funds have a positive effect on target firms' innovative activities. A naturally following question is thus: how do activists enhance innovations? Aghion, Reenen, and Zingales (2013) point out that there are two possible mechanisms. One is the career concern channel that a manager could hesitate to innovate because he is concerned about losing

jobs if an unlucky draw occurs when trying to innovate. The presence of institutional investors could increase the risk tolerance of managers and encourage innovation through frequent monitoring that helps identify if the failure of innovation is due to bad luck or low managerial ability. An empirical prediction of this channel is that institutional investors could ehance innovative activities for firms in high competitive industries given that the managerial career concerns are more severe in these industries. The other is a discipline channel in that institutional monitoring can effectively discipline lazy managers who desire to live a quiet life and can force them to work harder in innovations. The empirical implication is that institutional investors could enhance innovative activities for firms in low competitive industries given that managers are likely to have more slack in less competitive industries.

To identify channels through which hedge fund activism affects innovation, we investigate the role of product market competition in the impact of hedge fund activism on innovation. Specifically, we augment eq. (1) and estimate the following equation:

$$Y_{it}=\phi_1 TargetAfter_{it}+\phi_2 TargetAfter_{it}\times Low\ Competition_{it}+\theta X_{it}+\alpha_i+\beta_t+\varepsilon_{it} \quad (2)$$

The coefficient on $TargetAfter_{it}$ now presents the effects of hedge fund interventions on innovation in high competitive industries, while the coefficient on the interaction term $TargetAfter_{it}\times Low\ Competition_{it}$ captures the difference between high competitive industries and low competitive industries in activists' impact on innovation. We measure market competition using the sale-based Herfindahl index in the four-digit industry. To check the robustness of our results, we create two dummies to indicate if an observation is in low competitive industries: *Low Competition_P50* is a dummy variable equal to one if a firm-year has a herfindale index that

is above the median. *Low Competition_P25* is a dummy variable equal to one if a firm-year has a Herfindale index that is above the 25 percentile.

Table 8 reports estimated results for Equation (2). It shows that, in all cases, there is no significant change of innovation input after hedge fund intervention in either high or low competitive industries. However, we find that activist intervention results in a significant increase in innovation output in high competitive industries. The coefficients on $TargetAfter_{it}$ are all positive and significant in innovation output regressions. For example, the coefficient on *TargetAfter* in Column 3 is 0.132 and significant at 5%, showing that innovation output increases by 13.2% for target firms in the high competition industries. Moreover, the coefficients on *TargetAfter*×*Low Competition_P50* are insignificant, showing that there is no significant difference in the impact of hedge fund intervention between low and high competition industries. The results are similar using *Low Competition_P25* as the indicator for low competitive industries.

Hence, our results show that hedge fund intervention enhances innovations of target firms in both high and low competitive industries, suggesting that hedge fund interventions could improve innovation through both career concern and discipline channels. In other words, the intervention of activist hedge funds provides two functions that promote innovation: reducing managerial career concerns by lower information asymmetry between investors and managers and pushing managers to work harder in innovation. The results suggest that effective monitoring plays a crucial role in hedge funds' positive impacts on target firms' innovative activities.

It is important to note that our findings support the theoretical argument by Aghion,

Reenen, and Zingales (2013) but differ from their empirical findings that institutional investors enhance innovation through only the career concern but not the discipline channel. Their institutional investors include all institutional owners who file a Form 13-F with the SEC on a quarterly basis when they have greater than $100 million in equity assets under discretionary management. These institutional investors could include insurance companies, mutual funds, pension funds, and endowment funds. Activist hedge funds are different from typical institutional investors who are subject to regulatory and political restrictions, conflicts of interest, and liquidity constraints (e.g., Armour and Cheffins, 2009, Klein and Zur, 2009, Thompson, 2006). Moreover, traditional institutional investors typically focus on changing corporate governance *rules*, whereas hedge funds address specific governance issues as part of larger plans to improve target firm performance (Kahan and Rock, 2007; Gantchev and Jotikasthira, 2012; Gillan and Starks, 2007). As such, hedge fund activists could be more effective than other institutional investors in disciplining managers. Indeed, there is some evidence that institutional investors such as mutual funds and pension funds do not add value to the firm (Black, 1990; Karpoff, 2001; Romano, 2001 and Gillan and Starks, 2007). Taken together, the results suggest that it is important to distinguish different types of institutional investors who might differ in their risk preferences, monitoring capacities, and investor horizons and, as a result, could affect a firm's innovation in significantly different ways.

3.5. Stock market reaction

So far, we find that hedge fund intervention is associated with an improvement in innovations. This section examines how the market perceives the effect of hedge fund activism on innovative

target firms.

BJPT (2008) show that hedge fund intervention is associated with positive stock market reactions, suggesting that the market rapidly perceives the enhanced value that the activism brings to the firms. However, due to the opaque and complex business nature of innovative firms, hedge fund activism may experience delays in the resolution in the market price of the intervention's impact (Kahn and Winton, 1998). If so, target innovative firms may experience lower short-term abnormal returns than those non-innovative target firms. Moreover, if the market views that the improvement in innovation is temporary given the long-run nature of innovation, the increase in stock price, if any, is likely to be short lived.

[Figure 1 about here]

To investigate the stock market reaction to hedge fund intervention among innovative firms, Figure 1 plots the average buy-and-hold return in excess of the buy-and-hold return on the value-weighted NYSE/Amex/NASDAQ index for innovative targets and non-innovative targets from 12 months prior to the Schedule 13D filing month to 60 months afterward.[7] In Figure 1A, the diamond (triangle) line plots the abnormal cumulative returns for high tech (non-high tech) target firms. In Figure 1B, the diamond (triangle) line plots abnormal cumulative returns for positive R&D (zero R&D) target firms. We find that abnormal cumulative returns experience a sharp increase in the event month for all firms. The mean of the event month excess returns is 4.86% (5.04%) for high tech targets (non-high tech targets), and 4.84% (5.08%) for the positive

[7] For the activist events that are not filed in the Schedule 13 (those large-sized firms in which hedge fund investments are less than 5% or those events with missing Schedule 13 filing date), we use the first public announcement date of the activist events. There are 28 such events.

R&D (zero R&D) target firms, and the mean differences between innovative and non-innovative target firms are statistically insignificant. These results suggest that, despite the opaque and complex nature of innovative firms, the market rapidly recognizes the impact of hedge fund intervention to the same extent as for non-innovative firms.

In addition, Figure 1 further shows that the long-term abnormal cumulative returns of innovative firms continue to increase in the following 60 months after activist targeting. For example, the diamond line (high tech firms) in Figure 1A experiences a nearly monotonic increase after activist targeting and reaches the highest point of 35.7% at the end of the 60-month period. This is in contrast to the triangle line (non-high tech firms), which slowly increases and ends at the value of 21.5% at the end of the period. Figure 1B shows a similar pattern of long-term abnormal returns. In Table 9, we further report statistics on the cumulative abnormal returns associated with hedge fund activism 12 months before activist targeting, at the event month, and 12, 24, 36, 48, and 60 months after activist intervention. The main finding is that cumulative abnormal returns remain positive at the event month and in all months after and are significant in 36 months and 48 months after activist targeting.

To summarize, innovative targets experience the same level of abnormal returns as non-innovative targets at the event month. Moreover, there is no evidence that the rise of stock prices upon intervention reverts in the long run. The fact that the benefit of hedge fund intervention in innovative firms is indeed recognized by the market suggests that hedge funds bring long-term value enhancement for the shareholders of innovative firms.

4. Conclusion

Innovation is the main engine of economic growth and the key to the survival and success of individual firms. The rising popularity of activist hedge funds has raised the concern that activists could pursue short-term interest that is harmful to the firm's long-run performance and thus its value. In particular, the potential myopic behavior of hedge fund activists could be detrimental to innovation that requires a long-term commitment of resources. However, despite the increasing importance of activist hedge funds in the corporate governance domain and its potential impact on firm innovations, no extant study has examined whether activist hedge funds hinder or enhance corporate innovations.

This paper fills this gap and provides a comprehensive investigation on how hedge fund activism affects firm innovation. We find that activist hedge funds do not avoid targeting innovative firms despite their high business uncertainties. Instead, they tend to target innovative firms that have low levels of innovation efficiency. Furthermore, we find that activist hedge funds do not cut target firms' R&D but significantly increase their innovation output after interventions, and such an increase is more significant among target firms whose hedge funds have explicit objectives and aggressive tactics. Moreover, we show that the hedge fund activists improve innovation outputs for target firms in both high and low competitive industries, suggesting that activist hedge funds enhance innovation by reducing managerial career concerns and slack through effective monitoring. The stock market reacts positively to hedge fund activism on innovative firms, in both the short and long run. Overall, our results do not support the view that activist hedge funds are myopic and take short-term actions that hinder a firm's innovation. Rather, hedge funds improve the innovation efficiency of target innovative firms and

deliver long-term benefit to shareholders of innovative firms. Our findings echo the recent findings by Bebchuk, Brav and Jiang (2013) and Brav, Jiang and Kim (2013) that activist hedge funds have a long-run positive impact on a firm's real activities. Our results suggest that effective monitoring by activist investors could play a crucial role in enhancing firm innovations.

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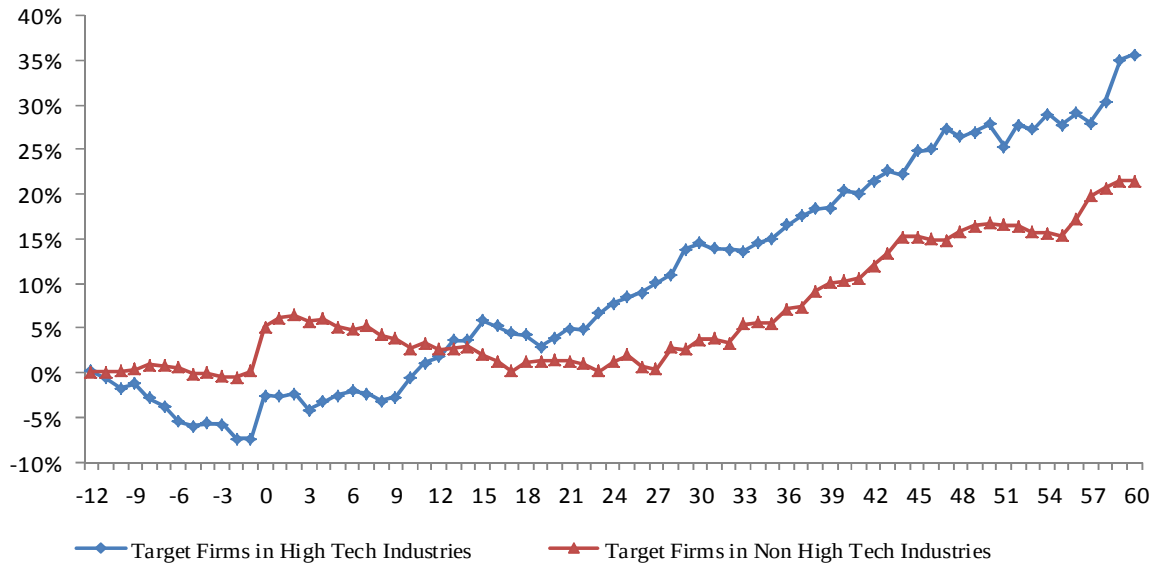
Figure 1. Abnormal Returns for Innovative Target Firms and Non-Innovative Target Firms

This figure depicts the abnormal cumulative returns for innovative target firms and non-innovative target firms around the Schedule 13D filing, from 12 months prior to the Schedule 13D filing to 60 months afterward. Abnormal cumulative return is the average buy-and-hold return, in excess of the buy-and-hold return on the value weighted NYSE/Amex/NASDAQ index during the event window. In Figure 1A, the diamond (triangle) line is the abnormal return for high (non-high) tech target firms over the event window. In Figure 1B, the diamond (triangle) line is the abnormal return for positive (zero) R&D target firms over the event window.

Figure 1A: High Tech Sample



Panel 1B: Positive R&D Sample

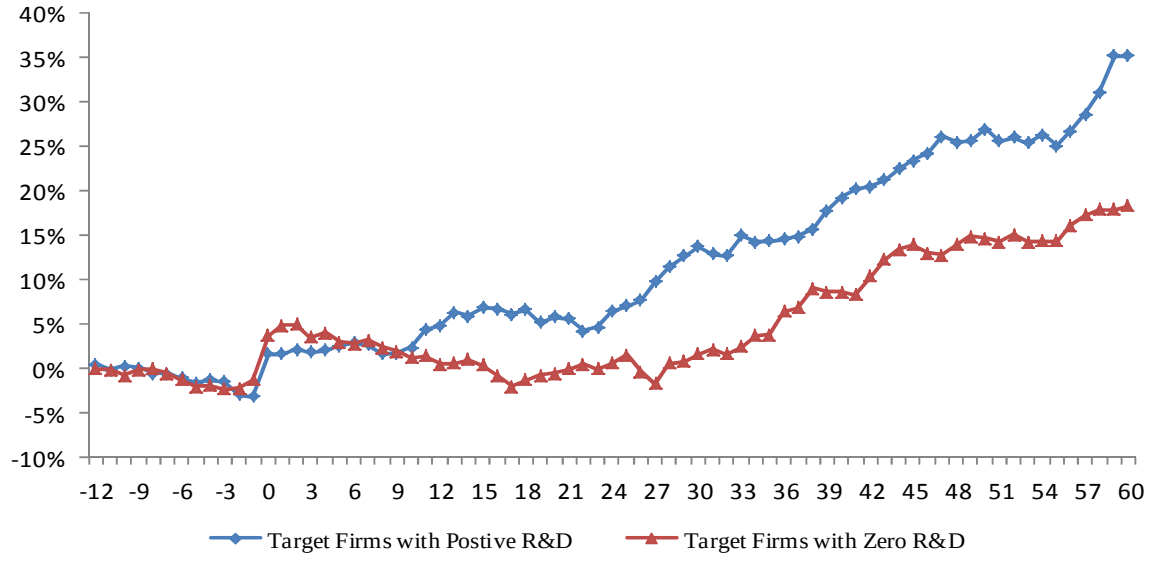


Table 1

Characteristics of Target Firms

This table reports the characteristics of target firms. The first three columns present summary statistics for the whole target firms. The middle three columns present summary statistics for high tech firms which are defined by 3 digit SIC code (Kile and Phillip, 2009). The last three columns present summary statistics for positive R&D firms that have positive R&D expenditures in the past five years. All the financial variables are defined in the Appendix, and winsorized at the 1% level.

	Total Sample			High Tech Sample			Positive R&D Sample		
	mean	median	n	mean	median	n	mean	median	n
MV	837.541	181.25	1036	600.451	161.478	316	811.613	177.992	429
BM	0.103	0.573	1035	0.119	0.413	315	0.299	0.485	428
Tobin's q	1.654	1.291	1035	2.077	1.685	315	1.906	1.55	428
Sales Growth	0.986	0.052	944	0.846	0.051	286	1.399	0.066	393
Profitability	0.17	0.083	945	0.074	0.044	290	0.147	0.068	398
Cash Flow	0.035	0.051	944	-0.043	0.036	290	-0.022	0.045	398
Leverage	0.243	0.193	1053	0.18	0.054	318	0.175	0.08	433
Cash	0.194	0.102	970	0.347	0.315	297	0.304	0.246	404
Dividend	0.011	0	1032	0.006	0	314	0.007	0	427
Inno. Input	0.115	0	1035	0.331	0.109	310	0.28	0.074	424
Inno. Output	0.154	0	1035	0.384	0	310	0.349	0	424

Table 2

Summary of Activist Events

This table reports the number of activist events across years, and the percentage of events for innovative firms as compared to the percentage of innovative firms in the whole CRSP/Compustat database. The first column reports the number of events in each year. Columns 2 and 3 report the percentage of events for high tech firms and the percentage of high tech firms in the CRSP/Compustat database. High tech firms are defined by 3 digit SIC code (Kile and Phillip, 2009). Columns 4 and 5 report the percentage of events for positive R&D firms and the percentage of positive R&D firms in the CRSP/Compustat database. Positive R&D firms are firms have positive R&D expenditures in the past five years.

	Activist Events	High Tech Sample		Positive R&D Sample	
		Targeted	CRSP/Compustat	Targeted	CRSP/Compustat
2001	85	27.1%	30.0%	37.6%	39.0%
2002	114	30.7%	29.6%	42.1%	38.7%
2003	117	37.6%	29.1%	45.3%	38.3%
2004	141	27.7%	29.1%	35.5%	37.0%
2005	229	25.8%	28.4%	37.6%	37.2%
2006	246	30.9%	27.4%	39.8%	36.7%
2007	208	29.8%	26.3%	44.2%	35.7%
Total number of events	1140	29.6%	28.6%	40.3%**	37.6%

Table 3

Probit Analysis of Targeting Probability for Innovative Firms

This table reports the effects of covariates on the probability of being targeted by activist hedge funds. The dependent variable is a dummy variable equal to one if there is hedge fund activism targeting the company during the following year (that is ,all covariates are lagged by 1 year). *High_Tech* is a dummy variable that takes 1 if a firm belongs to the high tech industry according its three-digit SIC code, and 0 otherwise. *Positive_R&D* is a dummy variable that takes 1 if a firm has positive R&D expenditures in the past five years, and 0 otherwise. Other financial variables are defined in the Appendix, and winsorized at the 1% level. For each independent variable, we report probit coefficients, t-statistics (in parentheses), and the marginal probability change induced by one-standard deviation change in the values of the covariates from their respective sample averages (in brackets). The sample includes all target firms from 2001 to 2007. *, ** and *** indicate statistical significance at the10%, 5%, and 1% levels.

	Full Sample			
	(1)	(2)	(3)	(4)
High_Tech	0.014	0.033		
	(0.50)	(1.10)		
	[0.03%]	[0.07%]		
Positive_R&D			0.011	0.0041
			(0.42)	(0.15)
			[0.03%]	[0.01%]
MV	-0.016***	-0.020***	-0.016***	-0.020***
	(-5.29)	(-5.93)	(-5.31)	(-5.92)
	[-0.57%]	[-0.69%]	[-0.57%]	[-0.69%]
Tobin's q	-0.040***	-0.033***	-0.040***	-0.032***
	(-6.08)	(-4.66)	(-6.08)	(-4.57)
	[-0.76%]	[-0.61%]	[-0.76%]	[-0.59%]
Leverage		0.069		0.064
		(1.55)		(1.42)
		[0.11%]		[0.10%]
Dividend		-2.12***		-2.19***
		(-3.76)		(-3.86)
		[-0.28%]		[-0.29%]
Profitability		0.13***		0.13***
		(3.06)		(2.95)
		[0.32%]		[0.31%]
Age		0.0072***		0.0070***
		(5.47)		(5.37)
		[0.33%]		[0.32%]
N	51087	48711	51087	48711
Pseudo R-sq	0.010	0.016	0.010	0.016
Percent Targeted	1.87%	1.85%	1.87%	1.85%

Table 4

Probit Analysis of Targeting Innovative Firms

This table reports the effects of innovation characteristics on the probability of being targeted by activist hedge funds. The left three columns report results that define innovative firms as high tech firms which are defined by their three-digit SIC codes, and the right three columns report results that define innovative firms as positive R&D firms that have positive R&D expenditures in the past five years. The dependent variable is 1 if a firm is targeted by hedge funds in the next fiscal year, and 0 otherwise. All the independent variables (firm characteristics) are defined in the Appendix and winsorized at the 1% level. For each independent variable, we report probit coefficients, t-statistics (in parentheses), and the marginal probability change induced by one-standard deviation change in the values of the covariates from their respective sample averages (in brackets). The sample includes all target firms from 2001 to 2007. *, ** and *** indicate statistical significance at the10%, 5%, and 1% levels.

	High Tech Sample			Positive R&D Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Innovation Input	-0.063		-0.023	-0.028		0.014
	(-1.23)		(-0.45)	(-0.59)		(0.3)
	[-0.18%]		[-0.06%]	[-0.07%]		[0.03%]
Innovation Output		-0.12***	-0.11***		-0.13***	-0.14***
		(-3.20)	(-3.06)		(-3.91)	(-3.92)
		[-0.46%]	[-0.45%]		[-0.49%]	[-0.49%]
MV	-0.017***	-0.016***	-0.016***	-0.013***	-0.012***	-0.012***
	(-3.03)	(-2.99)	(-2.99)	(-3.56)	(-3.53)	(-3.53)
	[-0.70%]	[-0.68%]	[-0.68%]	[-0.56%]	[-0.54%]	[-0.54%]
Tobin's q	-0.047***	-0.045***	-0.045***	-0.064***	-0.061***	-0.062***
	(-3.65)	(-3.57)	(-3.52)	(-4.74)	(-4.60)	(-4.60)
	[-0.83%]	[-0.79%]	[-0.78%]	[-1.12%]	[-1.05%]	[-1.06%]
Profitability	0.058	0.069	0.059	0.039	0.036	0.042
	(0.96)	(1.21)	(0.99)	(0.68)	(0.68)	(0.73)
	[0.17%]	[0.20%]	[0.17%]	[0.10%]	[0.09%]	[0.11%]
Sales Growth	-0.015	-0.014	-0.014	-0.0018	-0.00021	-0.00018
	(-0.76)	(-0.71)	(-0.71)	(-0.10)	(-0.01)	(-0.01)
	[-0.10%]	[-0.09%]	[-0.09%]	[-0.01%]	[0.00%]	[0.00%]
Leverage	0.11	0.1	0.1	-0.004	-0.012	-0.01
	(1.63)	(1.55)	(1.52)	(-0.05)	(-0.16)	(-0.14)
	[0.20%]	[0.19%]	[0.19%]	[-0.01%]	[-0.02%]	[-0.02%]
Dividend	-1.09	-1.22	-1.25	-2.11**	-2.28**	-2.26**
	(-1.03)	(-1.15)	(-1.17)	(-2.04)	(-2.19)	(-2.18)
	[-0.12%]	[-0.14%]	[-0.14%]	[-0.22%]	[-0.23%]	[-0.23%]
Age	0.007**	0.007**	0.007**	0.0075***	0.0072***	0.0072***
	(2.39)	(2.35)	(2.31)	(3.64)	(3.49)	(3.5)
	[0.25%]	[0.24%]	[0.24%]	[0.32%]	[0.30%]	[0.30%]
N	15019	15019	15019	20663	20663	20663
pseudo R-sq	0.02	0.023	0.023	0.022	0.026	0.026
Per targeted	1.74%	1.70%	1.70%	1.69%	1.65%	1.65%

Table 5

Effects of Hedge Fund Activism on Innovation Outcome

This table presents regression results for the impact of hedge fund activism on innovation input, innovation output of target firms. Panel A reports results for high tech firms that are defined by three-digit SIC codes, and Panel B reports results for positive R&D firms that have positive R&D expenditures in the past five years. For each target company, we have 5 matched firms which are formed from other innovative companies in the same industry plus a best possible match along the size and book-to-market dimensions. *TargetAfter* is a dummy variable that equals to 1 for firms from one year after activist targeting to 2006 which is the end of the data sample ($\geq$ t+1), and 0 for other years. *TargetAfter1* is a dummy variable that equals to 1 for firms at the year one year after activist targeting (t+1), and 0 for other years. *TargetAfter2* is a dummy variable that equals to 1 for firms from two years after activist targeting to 2006 ($\geq$ t+2), and 0 for other years. All the control variables (firm characteristics) are defined in the Appendix and winsorized at the 1% level. Heteroskedasticity-robust t-statistics adjusted for clustering within companies are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by*, ** and ***, respectively.

	Innovation Input			Innovation Output		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High Tech Sample						
TargetAfter	-0.039	-0.047		0.175***	0.162***	
	(-1.171)	(-1.421)		(2.760)	(2.601)	
TargetAfter1			-0.041			0.155**
			(-1.589)			(2.101)
TargetAfter2			-0.054			0.169**
			(-1.217)			(2.017)
log(Lagged AT)		0.024	0.024		-0.093**	-0.093**
		(1.143)	(1.144)		(-2.314)	(-2.314)
Profitability		-0.105**	-0.105**		0.039	0.039
		(-2.186)	(-2.186)		(0.545)	(0.545)
Lagged q		-0.005	-0.005		0.004	0.004
		(-0.953)	(-0.951)		(0.470)	(0.469)
Lagged Leverage		-0.076*	-0.077*		-0.221*	-0.221*
		(-1.869)	(-1.872)		(-1.714)	(-1.713)
Age		0.002	0.001		-0.009	-0.009
		(0.130)	(0.081)		(-0.141)	(-0.131)
Constant	-0.126	-0.234	-0.231	0.589**	1.077*	1.074*
	(-0.427)	(-0.750)	(-0.743)	(2.034)	(1.857)	(1.855)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes
N	3002	2976	2976	3002	2976	2976
adj. R-sq	0.794	0.798	0.798	0.355	0.363	0.363
Panel B: Positive R&D Sample						
TargetAfter	-0.044	-0.041		0.185***	0.163***	
	(-1.480)	(-1.543)		(3.467)	(3.092)	
TargetAfter1			-0.042*			0.141**
			(-1.795)			(2.398)
TargetAfter2			-0.040			0.188***
			(-1.219)			(2.693)
log(Lagged AT)		0.068***	0.068***		-0.055	-0.055
		(2.850)	(2.855)		(-1.426)	(-1.420)
Profitability		-0.223**	-0.223**		-0.078	-0.078
		(-2.256)	(-2.256)		(-0.559)	(-0.561)
Lagged q		-0.005	-0.005		-0.003	-0.003
		(-0.794)	(-0.794)		(-0.433)	(-0.437)
Lagged Leverage		-0.092	-0.092		-0.278**	-0.277**
		(-1.483)	(-1.483)		(-2.290)	(-2.286)
Age		-0.024**	-0.024**		-0.049	-0.049
		(-1.980)	(-1.971)		(-1.092)	(-1.075)
Constant	0.164***	0.108	0.108	0.682***	1.506***	1.502***
	(3.312)	(0.751)	(0.752)	(2.715)	(2.934)	(2.920)

Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes
N	4049	4024	4024	4051	4026	4026
adj. R-sq	0.774	0.780	0.780	0.385	0.390	0.390

Table 6

Summary of Hedge Funds' Stated Tactics and Objectives

This table reports the summary of activist events in the innovative firms sorted by hedge funds' stated objectives and tactics. Columns 1-2 define the innovative sample by three-digit SIC codes and report the number of events, the percentage among all events of each category. Columns 3-4 define the innovative sample by positive R&D expenditures in the past five years. Percentages sum up to more than 100% since one event may have multiple objectives. However, the first category and the other second category are mutually exclusive.

Objective Categories	High Tech Sample		Positive R&D Sample	
	Num of Events	% of Sample	Num of Events	% of Sample
1.Passive Intervention/General objectives Events	162	47.93%	215	46.84%
2.Active Intervention/Explicitly objective Events	176	52.07%	244	53.16%
-Seek board representation	39	11.54%	48	10.46%
-Shareholder proposal/public letters	119	35.21%	164	35.73%
-Threat to sue/proxy fight	28	8.28%	19	4.14%
-Proxy contest	42	12.43%	62	13.51%
-Lawsuits	19	5.62%	19	4.14%
-Takeover bid	14	4.14%	19	4.14%

Table 7

Effects of Hedge Fund Activism on Innovation Outcome: Active versus Passive Intervention Events

This table presents regression results for the impact of hedge fund activism on innovation input and innovation output for active and passive intervention events separately. Passive intervention events are those that hedge funds viewed that targets are undervalued and they will communicate with the management to improve shareholder values without taking more aggressive tactics. Active intervention events are those that hedge funds have specific objectives and plan to take aggressive tactics. Panel A reports results for target high tech firms. Panel B reports results for target positive R&D firms. For each target company, we have 5 matched firms which are formed from other innovative companies in the same industry plus a best possible match along the size and book-to-market dimensions. *TargetAfter* is a dummy variable that equals to 1 for firms from one year after activist targeting to 2006 which is the end of the data sample, and 0 for otherwise. All control variables (firm characteristics) are defined in the Appendix and winsorized at the 1% level. Heteroskedasticity-robust t-statistics adjusted for clustering within companies are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by*, ** and ***, respectively.

	A: High Tech Sample				B: Positive R&D Sample			
	Active Intervention Events		Passive Intervention Events		Active Intervention Events		Passive Intervention Events	
	Inno. Input	Inno. Output	Inno. Input	Inno. Output	Inno. Input	Inno. Output	Inno. Input	Inno. Output
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
TargetAfter	-0.021	0.268***	-0.068	0.085	-0.032	0.200***	-0.031	0.131*
	(-0.387)	(2.770)	(-1.538)	(0.996)	(-0.742)	(2.599)	(-1.079)	(1.836)
log(Lagged AT)	0.052*	-0.101	0.002	-0.088*	0.090***	-0.078	0.039*	-0.041
	(1.691)	(-1.638)	(0.083)	(-1.707)	(2.600)	(-1.327)	(1.672)	(-0.856)
Profitability	-0.097	0.048	-0.106**	0.029	-0.275**	-0.072	-0.142	-0.072
	(-1.374)	(0.543)	(-2.138)	(0.276)	(-2.404)	(-0.324)	(-1.102)	(-0.561)
Lagged q	-0.002	0.008	-0.008	-0.001	-0.006	-0.010	-0.004	0.002
	(-0.283)	(0.770)	(-1.513)	(-0.066)	(-0.729)	(-0.789)	(-0.542)	(0.221)
Lagged Leverage	0.002	-0.177	-0.135**	-0.272	-0.058	-0.277	-0.075	-0.262
	(0.023)	(-1.198)	(-2.348)	(-1.481)	(-0.664)	(-1.594)	(-1.160)	(-1.605)
Age	-0.002	0.046	0.008	-0.134**	-0.028	-0.043	-0.019	-0.074
	(-0.156)	(0.811)	(0.281)	(-2.003)	(-1.488)	(-0.648)	(-1.645)	(-1.295)
Constant	0.019	0.774	-0.239	2.092***	0.095	1.644**	0.161	1.619***
	(0.085)	(1.316)	(-0.609)	(3.067)	(0.393)	(2.096)	(1.069)	(2.714)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1269	1269	1707	1707	1783	1783	2243	2243
Adj. R-sq	0.804	0.364	0.786	0.350	0.781	0.370	0.788	0.391

Table 8

Product Market Competition and Effects of Hedge Fund Activism on Innovation Outcome

This table presents regression results on the interaction between product market competition and the impact of hedge fund activism on innovation input and innovation output. Panel A report results for high tech firms that are defined by three-digit SIC codes, and Panel B report results for positive R&D firms that have positive R&D expenditures in the past five years. For each target company, we have 5 matched firms which are formed from other innovative companies in the same industry plus a best possible match along the size and book-to-market dimensions. *TargetAfter* is a dummy variable that equals to 1 for firms from one year after activist targeting to 2006 which is the end of the data sample (≥ t+1), and 0 for other years. *Low Competition_P50* is a dummy variable equal to one if a firm is in an industry whose Herfindahl index is above the sample median and zero otherwise. *Low Competition_P25* is a dummy variable equal to one if a firm is in an industry whose Herfindahl index is above the 25 percentile of the sample and zero otherwise. All control variables (firm characteristics) are defined in the Appendix and winsorized at the 1% level. Heteroskedasticity-robust t-statistics adjusted for clustering within companies are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by*, ** and ***, respectively.

	A: High Tech Sample				B: Positive R&D Sample			
	Inno. Input		Inno. Output		Inno. Input		Inno. Output	
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
TargetAfter	-0.024	-0.042	0.132**	0.158**	-0.059	-0.047	0.139**	0.152**
	(-0.680)	(-1.156)	(2.009)	(2.355)	(-1.484)	(-1.461)	(2.053)	(2.554)
TargetAfter×Low Competition_P50	-0.043		0.022		0.051		0.018	
	(-0.987)		(0.303)		(1.097)		(0.235)	
TargetAfter×Low Competition_P25		-0.020		-0.055		0.049		-0.017
		(-0.423)		(-0.470)		(1.544)		(-0.296)
log(Lagged AT)	0.024	0.025	-0.032	-0.032	0.063***	0.062***	0.009	0.009
	(1.160)	(1.165)	(-0.681)	(-0.688)	(2.946)	(2.943)	(0.212)	(0.212)
Profitability	-0.106**	-0.106**	-0.018	-0.018	-0.207**	-0.208**	0.020	0.020
	(-2.196)	(-2.196)	(-0.316)	(-0.316)	(-2.390)	(-2.391)	(0.200)	(0.201)
Lagged q	-0.005	-0.005	0.013**	0.013**	-0.005	-0.005	0.013**	0.013**
	(-0.948)	(-0.949)	(2.115)	(2.116)	(-0.990)	(-0.984)	(2.153)	(2.159)
Lagged Leverage	-0.077*	-0.077*	-0.172*	-0.172*	-0.073	-0.074	-0.184**	-0.183**
	(-1.888)	(-1.871)	(-1.815)	(-1.821)	(-1.361)	(-1.371)	(-2.052)	(-2.046)

Age	0.001	0.001	0.002	-0.000	-0.020*	-0.021**	-0.079**	-0.081**
	(0.073)	(0.044)	(0.040)	(-0.003)	(-1.904)	(-2.036)	(-2.320)	(-2.401)
Constant	-0.226	-0.228	0.494	0.516	0.078	0.086	1.433***	1.457***
	(-0.720)	(-0.723)	(0.877)	(0.911)	(0.625)	(0.691)	(3.359)	(3.440)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2976	2976	2976	2976	4026	4026	4026	4026
adj. R-sq	0.798	0.798	0.510	0.510	0.788	0.788	0.535	0.535

Table 9

Target Innovative Firm Cumulative Abnormal Returns Analysis

The table reports statistics on the cumulative abnormal returns associated with hedge fund activism. Abnormal cumulative return is the average buy-and-hold return, in excess of the buy-and-hold return on the value weighted NYSE/Amex/NASDAQ index during each window Months. We provide both the median and average abnormal cumulative return during each Window Months. "Window Months" indicates the buying time relative to the activist hedge fund event and the holding period in months. The first five columns report results for high tech target firms and the last five columns report results for positive R&D target firms.

Window	High Tech Sample					Positive R&D sample				
Months	mean	median	std	t	n	mean	median	std	t	n
[-12,-1]	-6.07%	-12.81%	0.567	-1.88	308	-2.80%	-7.25%	0.54	-1.07	426
event	4.63%	3.05%	0.148	5.37	296	4.32%	2.70%	0.145	6.00	408
[+1,+12]	4.22%	0.87%	0.545	1.34	299	2.20%	-0.34%	0.506	0.87	405
[+13,24]	4.36%	2.80%	0.582	1.16	239	0.99%	0.88%	0.561	0.33	341
[+25,+36]	9.97%	5.96%	0.551	2.57	201	8.31%	6.17%	0.572	2.49	294
[+37,+48]	9.15%	5.68%	0.554	2.25	185	9.89%	6.00%	0.525	3.08	268
[+49,+60]	7.80%	4.64%	0.635	1.60	169	7.75%	4.64%	0.558	2.18	247

Appendix: Definition of Variables

Variable Name	Variable Definition and Corresponding Compustat Data Items
AT	Total Asset =Data6.
MV	Market value of equity = data25*data 199.
Tobin's q	(Book value of debt + market value of equity)/total asset =(data6-data60+data25*data199)/data6
BM	Book value of equity/market value of equity = data60/data25*data 199
Sales Growth	Growth rate of sales over the previous year=sale-lag(sale)/ lag(sale) = data12-lag(data12)/lag(data12)
Profitability	Earnings Before Interest divided by total assets = data13/lag(data6)
Cash Flow (CF)	(Net income + depreciation and amortization)/lag(assets) = (data172 + data14)/lag(data6)
Dividend	(Common dividend + preferred dividends)/(Market value of equity + book value of preferred) = (data 21+data19)/(data25 * data 199+data130)
Leverage	(Long term debt + debt in current liabilities) /total assets = (data9+data34)/data6.
Debt	(Long term debt + debt in current liabilities) / (Firm market capitalization+ Long term debt + debt in current liabilities) = (data9+data34)/(data25*data 199+ data9+data34)
Age	The age of the firm is the number of years between the observation date and its first date on the Compustat data.
Innovation Input	R&D /total sales = data46/ data12
InnovationOutput	-Patent Index/ total sales
TargetAfter	A dummy variable that equals one for firms from one year after activist targeting to 2006 which is the end of the data sample for patent (≥t+1).
TargetAfter1	A dummy variable that equals one for firms at the year one year after activist targeting (t+1).
TargetAfter2	A dummy variable that equals one for firms from one year after activist targeting to 2006 which is the end of the data sample for patent (≥t+2).
High_Tech	A dummy variable that equals one if the firm is in the high tech industry according to the three-digit SIC code.
Positive_R&D	A dummy variable that equals one if the firm has positive R&D in the past five years
Low Competition_P25	A dummy variable equal to one if a firm is in an industry whose Herfindahl index is above the 25 percentile of the sample and zero otherwise.
Low Competition_P50	A dummy variable equal to one if a firm is in an industry whose Herfindahl index is above the 50 percentile of the sample and zero otherwise.