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journal homepage: www.elsevier.com/locate/jbfEquity compensation and the sensitivity of research and development to financial market frictions[☆]Matthew O'Connor^{a,1}, Matthew Rafferty^{b,*}, Aamer Sheikh^{c,2}^a Department of Finance, Quinnipiac University, Hamden, CT 06518, United States^b Department of Economics, Quinnipiac University, Hamden, CT 06518, United States^c Department of Accounting, Quinnipiac University, Hamden, CT 06518, United States

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ABSTRACT

When financial market frictions exist, executives may have to decide which investment activities to reduce when internal funds decrease. Expenditures on research and development (R&D) may be particularly vulnerable because of the long-term nature of innovative activity. We find that equity compensation is associated with lower levels of firm R&D expenditures. Rewarding executives to incur more risk has little effect on R&D expenditures, but rewarding executives for higher returns reduces R&D expenditures and makes R&D expenditures more sensitive to financial market frictions. In contrast, cash compensation reduces the sensitivity of R&D expenditures to financial market frictions.

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1. Introduction

This paper examines the incentive effects of equity compensation on firm-financed research and development (R&D) expenditures. In a world without any frictions, firms will pursue all investment projects that have a positive net present value so executive compensation should have no effect on the level of R&D activity. However, if asymmetric information, the financial friction we examine in this paper, exists in markets then firms may be unable or unwilling to pursue all positive net present value investment projects. We focus on agency problems caused by asymmetric information between shareholders and executives. However, we also discuss financial market frictions caused by asymmetric information between firms and creditors. In particular, we examine how the incentive effects imbedded in executive compensation packages influence financial market frictions.

Shareholders are often risk neutral because they hold a large portfolio of assets which allow them to diversify away firm specific risks. However, much of the executive's reputational and human capital is tied to the performance of the firm so executives are often risk averse. If it is difficult or costly to monitor executives then agency problems, exist which allow executives to pursue their own interests rather than the interests of the shareholders. One way executives may pursue their own interests at the expense of the shareholders is to reduce risky long-term investments such as R&D activity. Therefore, firms with agency problems may perform less R&D.

The agency problem may also affect R&D expenditures by magnifying the influence of financial market frictions. When a firm faces binding financial market constraints, the firm cannot pursue all profitable investment opportunities so executives at the firm must decide which investment activities to reduce. If agency problems exist then executives may be more likely to reduce R&D expenditures than other types of investment projects. Therefore, agency problems may influence the sensitivity of R&D expenditures to financial market frictions.

Equity compensation (both in the form of granted shares and stock options) may provide a solution to both financial market frictions and the agency problem. By making the executives part owner of the firm, equity compensation may align the interests of the executives with those of the owners. Therefore, equity compensation may make executives more willing to make R&D expenditures

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and, in addition, make executives less willing to reduce R&D expenditures when financial constraints bind. If equity compensation works as intended then an increased reliance on equity compensation should increase the average amount of R&D expenditures and reduce the sensitivity of R&D expenditures to financial market frictions.

Alternatively, equity compensation may have perverse effects. Executives may seek to maximize the short-term value of their shares and options. If markets have a short-term bias then this could lead executives to reduce the average amount of R&D expenditures and may increase the sensitivity of R&D expenditures to financial frictions. For example, with options vesting or expiring in the near future a management team might cut R&D (to manage earnings), initiate a stock buyback plan, or announce an increase in dividends. Rather than solving the agency problem by aligning incentives of the executives and the owners of the firm, stock options and other forms of equity compensation might create an even larger gap between the incentives of executives and the owners of the firm.

In this paper, we use delta (the sensitivity of executive compensation to stock price *returns*) and vega (the sensitivity of executive compensation to stock price *volatility*) to measure the incentive effects of executive compensation. We find essentially no relationship between vega and the level of R&D activity. However, we find that the greater the delta of the executive's compensation package, the lower the level of R&D expenditures and the more sensitive R&D expenditures become to financial market frictions. Finally, we find that cash compensation reduces the sensitivity of R&D expenditures to financial market frictions. We believe that our paper is the first to show that executive compensation packages influence financial market frictions. We also use an econometric technique that overcomes several sources of bias that influence the results in the current literature.

The paper proceeds as follows. In Section 2 we review the literature on R&D activity and the incentive effects of executive compensation. In Section 3 we modify a Tobin's q model to allow for the possibility that executive compensation influences both the average level of R&D expenditures and the sensitivity of R&D to financial frictions. We also explain our empirical approach in this section. Section 4 describes the data and presents the major findings of the paper. We present results from a variety of estimation techniques in this section from ordinary least squares to generalized method of moments. We conclude in Section 5 and offer some policy recommendations to boards of directors.

2. Equity compensation and R&D investment

2.1. Tobin's q and market frictions

Ever since Tobin (1969) researchers have used the ratio of the market value of the firm's assets to the book value of those assets, known as Tobin's q , to explain investment behavior. The intuition for Tobin's q is straightforward. If Tobin's q is greater than one then the market values capital at the firm more than it costs the firm to accumulate capital so the market is sending the firm a signal that it is profitable for the firm to expand its capital stock. In this case you would expect investment expenditures to increase so you would expect a positive relationship between Tobin's q and the level of investment activity. In the absence of market imperfections, Tobin's q should completely summarize the firm's investment opportunities and no other variables should be correlated with investment activity.

Fazzari et al. (1988) spawned a huge literature by showing how to modify Tobin's q models to allow for the possibility of financial market frictions. Financial market frictions arise due to asymmetric information when the firm has better information about the

expected payoff from an investment project than potential outside investors. In such a situation, potential investors cannot monitor the investment project so investors cannot ensure that executives maximize the expected payoff. Therefore, external financing is often more costly than internal financing of investment projects. If financial markets are perfect then there should be no relationship between the level of investment and measures of internal funds such as cash flow. However, Fazzari et al. (1988) found a strong positive relationship between cash flow and investment activity and interpret this as evidence that financial market frictions have an important effect on investment activity. Some firms cannot afford costly external financing so when financial constraints bind, firms cannot pursue all profitable investment activities and are forced to reduce investment activity.

Asymmetric information is likely to be more severe for R&D projects than other types of projects which makes external funds even more expensive for R&D projects. R&D expenditures are immediately expensed in the United States so financial reports provide little systematic evidence on the quality of current or past R&D projects. Consistent with this view, Leland and Pyle (1977) point out that it is more difficult for investors to distinguish between good and bad projects when the investment projects are associated with long-term risky R&D expenditures. The market does work to partially eliminate the information asymmetries. Barth et al. (2001) find that R&D intensive firms have more analyst coverage than non-R&D intensive firms. In addition, Tasker (1998a) finds that R&D intensive companies conduct more conference calls and Tasker (1998b) shows that most analyst questions during those conference calls relate to innovative activity. Informational asymmetries are almost certainly more severe for R&D than other types of investments and the market does try to eliminate these asymmetries.

Markets work to eliminate the information asymmetries, but they are unlikely that the market will ever completely eliminate them. Aboody and Lev (2000) point out that it is difficult for markets to obtain information about R&D projects. First, US accounting rules do not require much disclosure about R&D projects since R&D expenditures are immediately expensed. As a result, firms do not have to reveal much information about their research projects. Second, R&D projects are unique to the firm so there is little information to be gained by examining R&D projects at similar firms. Third, R&D assets are intangible and not regularly traded in markets so it is nearly impossible to determine the value of R&D projects. Fourth, much of the output from R&D projects is in the mind of the scientists and engineers working on the project. Finally, firms find it in their self-interest to keep the results of R&D projects secret as pointed out by Bhattacharya and Ritter (1983) and Anton and Yao (2002). This means that firms are often unwilling to send clear signals about the quality of their research. These points suggest that the cost of external funds is often especially high for R&D projects. Therefore, we would expect that R&D expenditures are especially sensitive to fluctuations in measures of internal funds.

Consistent with the view that the cost of external funds is especially high for R&D expenditures, Hall (1992) along with Himmelberg and Petersen (1994) both find a strong positive relationship between R&D expenditures and internal funds. Much like Fazzari et al. (1988) they interpret this as evidence that financial market frictions increase the cost of external funds for investment activity. Therefore, when internal funds increase firms engage in more R&D activity. Hall (2002, 2009) provides a useful overview of how financial frictions affect R&D expenditures as well as some of the agency problems we discuss next.

2.2. Agency problems and R&D expenditures

Agency problems create an inefficiency which can reduce the value of the firm. The theoretical foundations of agency problems

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