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Stock Buybacks and Innovation: An Analysis of the Effects of Share Repurchases on Research & Development Expenditures

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Abstract

Rates of stock buybacks have recently hit an all-time high, and have gained a lot of attention from both the business community and the mainstream media. A polarizing debate exists over whether or not stock buybacks are harmful to the economy, especially in the context of stagnant wages and rising income inequality throughout the United States. The primary goal of this research paper is to examine what effect stock buybacks have, if any, on the innovation of large multi-national corporations. The analytical framework uses logit regression and ordinary least squares regression analysis to add to the debate surrounding the effects of share repurchases. Results show that share repurchases are correlated with an increased likelihood that a given company will increase its research & development expenditure in the subsequent year following the repurchase. This can be likely attributed to correlation between large cash holdings and repurchases as well as between large cash holdings and the pursuit of new innovations. While results add to the literature by suggesting correlation between research & development increases and share repurchases, additional paths for future research are proposed.

Part 1: Introduction

In just 2018 there was over $1 trillion of stock buybacks, with over $460 billion of this concentrated in only 19 companies. Companies' use of stock buybacks as an addition or substitute to dividends is a trend that has been consistently increasing since the SEC's legalization of the practice in 1982. However, the profound increase in the use of stock buybacks, and its recent precipice in 2018, has led to a new height. This trend can be largely attributed to the large cash reserves of corporate behemoths, as well as the recent tax reforms. Furthermore, in an economy in which technological disruption has become more fast-paced and shareholder returns can be volatile, the use of buybacks as a vehicle for shareholder value that is more flexible than dividends has been gaining traction. The increased use of employee stock options as a compensation method has also been cited as a reason for the rise of the practice.

While there exists a vibrant debate regarding the causes of stock buybacks and the intentions of companies that carry them out, one thing is clear: the increasing use of the practice has elicited polarizing responses. There are two main schools of thought surrounding stock buybacks: one which posits that they impede real value creation, and another which claims that buybacks are simply a healthy way for companies to reward shareholders, signal undervalued share prices, and manage debt. Those that argue against stock buybacks claim that that their extreme use is a form of market manipulation that creates short-term profits for rich investors and executives while impeding long-term growth of innovation, wages, and real investment (Lazonick, 2015). However, others hail the trend as indicative of healthy growth following the great recession and argue that the flexibility of stock buybacks in conveying value back to shareholders allows for more liquid and efficient financing (Chan et al., 2001). This debate has become increasingly important in our increasingly globalized economic system, especially in the context of a United States in which tens of millions of jobs have been offshored, wages have been stagnant for decades, and inequality is climbing to century-long highs.

To contribute to the debate surrounding stock buybacks, my research objective is to examine the relationship between stock buybacks and innovation in the contemporary American economy. In order to do so, I will analyze the incentives for why companies engage in stock buybacks, as well as what the implications of the practice are for firms' investment and research. This research question will be empirically tested using research & development expenditures as an indicator of innovation, examining whether companies that repurchase shares decrease their

spending on research & development in periods following buybacks. In doing so, this paper will add to the literature by providing an analytical framework that helps inform the current debate surrounding the incentive structures around buybacks, as well as their practical implications for innovation in large multinational corporations. This paper is structured by first analyzing the current dialogue on the topic to contextualize the research question, and then setting up the empirical framework for an analysis between buybacks and R&D. Setting up and analyzing the empirical framework, results are analyzed and discussed. Study limitations and potential questions for future research are included in the conclusion.

Part 2: Literature Review

This literature review consists of several key sections, which serve to first introduce the reasons that companies have for buying back stock as the link between stock buybacks and R&D is examined. Sections 1 through 5 provide a background and analysis of the hypotheses surrounding company motivations, as well as an examination of the implications of these hypotheses for R&D expenditure. Section 6 then furthers the connection back to the main research question, and the conclusion of the literature review highlights next steps for my research, outlining how this paper will address the research question in light of the relevant literature.

Section 2.1: Why Repurchase Stock?

Within the two perspectives of buybacks being either destructive or constructive, there are many nuances informed by theoretical frameworks for why companies choose to repurchase shares in the first place. While there are legitimate reasons to buy back stock, there are also reasons that are illegitimate at best, and illegal at worst. Different sides of the debate surrounding the legitimacy of stock buybacks as a practice are informed by the credence to which economists give certain theories.

There are several legitimate reasons to repurchase shares. First off, stock buybacks are a way to compensate investors at a lower tax rate than dividends since they are taxed as capital gains instead of as income. Secondly, they provide management flexibility while rewarding investors because once a firm commits to paying a dividend, it must continue to do so since terminating dividend payments sends a negative signal to shareholders (Iyer & Rao, 2017).

However, this is not the case for buybacks since buybacks are not recurring; this flexibility that stock buybacks give managers is known as the flexibility hypothesis. Also, according to the signaling hypothesis buybacks show confidence of growth and future earnings, showing to investors that investment in a company's stock is better than any other asset the company could have invested in. They also allow a Company to increase its earnings per share if it can't actually generate more earnings, since it can simply reduce the number of shares outstanding (Stunda, 2014). Furthermore, if a company does not have positive net present value investment opportunities, it may be more efficient to invest retained earnings back into stock instead of into an unprofitable investment. It could be argued that this is an acceptable reason, but could also be argued that firms that are not innovating should not be allowed to boost their stock prices in this way. While innocuous reasons to repurchase stock may exist, there are undoubtedly several other reasons that are not legitimate and could be indicative of share repurchases being a corrupt practice. For example, companies may repurchase stock in order to simply boost stock prices in the short term at the expense of long-term growth and innovation (Tan et al., 2016). Additionally, buybacks may create moral hazard as they enrich company executives at the expense of long-term performance and innovation (Lamba & Miranda, 2010). Developing a solid understanding of the literature's consensus on these reasons for repurchasing stock is crucial to understanding the relationship between stock buybacks, innovation, and R&D investment.

Section 2.2: The Signaling Hypothesis

Findings in the literature provide important context for the signaling hypothesis-- the theory that firms repurchase shares because the market is currently undervaluing them. Evidence for the signaling hypothesis is important in informing the relationship between buybacks and R&D, because R&D expenditure does not immediately materialize as returns. Companies that invest in research experience time delays between R&D investment and the returns that are received from the new products that are the results of said R&D (Chan et. al., 2004). So, stock buybacks would then be a way to simultaneously provide shareholder returns during that interim and bring stock prices up to more appropriate levels that reflect the impending impact of the yields from R&D activities. Chan et. al. (2004) used cross-sectional differences in market reactions and long-run performance following stock buybacks to investigate three of the main economic motivations for engaging in them: mispricing, disgorging free cash flow, and

increasing leverage. In their analysis of open market repurchases from 1980 to 1990, supplemented with cases from Securities Data Corporation (SDC) from 1980 to 1996, they found evidence of positive abnormal returns following buybacks to provide support for the mispricing (signaling) hypothesis, and found very little evidence for the leverage and free cash flow hypotheses (Chan et. al., 2004). However, this study's sample period was over 20 years ago so it's results may be less relevant in the contemporary economy. While this short-term support for the signaling hypothesis exists, clear-cut evidence for the signaling hypothesis is not ubiquitous in the literature. For example, while performing inter-industry comparisons on a sample of open market common stock repurchase announcements reported in the Wall Street Journal Index from 1982 to 1997, Liano et al. (2003) show that long-term financial performance of companies that engage in stock buybacks varies by industry. Their analysis used a CRSP value-weighted index to reveal significant negative abnormal shareholder returns-- compared to non-repurchasing industry peers-- leading up to buyback announcements in the majority of industry groups, and found positive and significant excess returns over a one-year time horizon following buybacks (Liano et al., 2003). However, they found significant negative excess returns for two-year time horizons and insignificant positive returns along a three-year time horizon. They concluded that stock repurchasing firms may outperform the CRSP value-weighted index in the years following a repurchase announcement, they end up underperforming relative to their industry peers. The authors posit that this may be the case because firms announce buybacks when their industries are doing well, not necessarily when they themselves are doing well when benchmarked to industry peers. These results of diminishing long-term returns following stock buybacks suggest that firms may be signaling purely the short term and not the long term. To add to this, Chan et al. (1990) examined 167 announcements of plans to increase company-sponsored R&D expenditures from June 1979 to June 1985, matched up with announcement dates from the Dow Jones New Retrieval Service database. They found statistically significant short-term positive abnormal returns for firms after increasing R&D costs over a 248 day event window following R&D announcements, even while controlling for extraneous information and earnings declines. Additionally, they performed an analysis of cumulative abnormal returns by level of technology, a cross-sectional analysis off cumulative abnormal returns, and an analysis of managerial discretion and the possibility of limited dependent variable bias. They found that higher rates of R&D than the industry average leads to larger stock-price increases for high-technology firms,

but neutral or negative effects for low-technology firms. Overall, they concluded the results to indicate that investors see beyond the short term earnings impact when evaluating firms' stocks (Chan et al., 1990). This would indicate that investments in R&D would be better signals to the market than stock buybacks, which erodes support for the signaling theory. However, Chan et al. (1990) conducted their research on a sample from 1979 to 1985, when financialization and hyper-globalization were just beginning to pick up. Stock buybacks were illegal for half of their sample period, and, being made newly legal in 1982, they would not have seen widespread implementation after recently becoming legal.

The results of Liano et al. (2003) and Chan et al.(2004) suggest strong evidence that companies use stock buybacks to signal good news and imminent large returns in the short run, but do not indicate that the signaling hypothesis holds in the long run. Furthermore, the context of high immediate returns to R&D announcements shown by Chan et al. (1990) puts into question the validity of the signaling hypothesis, because it could be argued that if companies really wanted to signal that their stock price will increase they would invest in R&D and/or other investment opportunities, not in their own stock. The lack of evidence for a long-term signaling effect has implications for buybacks' relationship between R&D because the timeline for returns on R&D is long, so the fact that the signaling hypothesis only is suggested to hold in the short run means that companies may not be buying back stock to signal long-term growth from R&D. Therefore, this evidence from the literature suggests that since buybacks are not likely indicative of long-term returns from R&D expenditure, stock buybacks may be a substitute investment that leads companies to actually spend less cash on R&D for innovative projects.

Section 2.3: Option Funding (Manager Incentive) Hypothesis

The signaling hypothesis exists as a reason for carrying out stock buybacks that, if used as a long term signaling mechanism, could be correlated with heightened R&D activity. However, the option funding (manager incentive) hypothesis states that stock buybacks are used by managers to increase the value of stock options to enrich company insiders. If this hypothesis holds, and company executives are using buybacks to enrich themselves instead of as legitimate indicators of signaling, that would suggest that buybacks are unproductive uses of company cash that are coming at the expense of innovation through investment in R&D. This would suggest that buybacks would be negatively correlated with future R&D expenditure, as firms that buy

back shares are low on cash for innovative activities because they have spent so much cash on buying back stock. Indeed, several studies have suggested that manager incentives are a driving factor behind share buybacks. For example, in their 2010 study of 50 ASX-listed firms from 1997 to 2000, Lamba & Miranda (2010) concluded that firms with relatively higher proportions of executive stock options outstanding are more likely to engage in stock buybacks to a statistically significant degree (Lamba & Miranda, 2010). This contradicts most traditionally stated reasons for engaging in stock buybacks, and suggests that instead of returning cash to shareholders or signaling to the market that a stock is truly overvalued, managers want to neutralize the dilution of earnings per share caused by their exercising of stock options. Although, it is worth noting that a limitation of this study was its relatively small sample size and sample period. When taken by itself, the results obtained from Lamba & Miranda (2010) suggest that executives may be using buybacks as a way to siphon off company resources for their own gain. However, other papers have provided results that counter this conclusion. Chan, Ikenberry, Lee, & Wang (2012) examined the relationship between insider trading and share repurchases using two methods on a data set of 9,976 open-market repurchase announcements recorded by Securities Data Corporation from January 1990 to November 2010. They measured abnormal long-term stock performance for companies by calculating returns for a buyback company against its benchmark of industry, market cap, and stock exchange peers in addition to focusing on return performance of a value-weighted, calendar-time portfolios on 12 month investment horizons. Their study is very relevant because insiders' decisions to invest in a company and a company's decision to repurchase stock are made by similar sets of decision-makers: those in and/or connected to senior management. Their results showed that market undervaluation is actually a main motive in buying back stock, and that insider trading is not correlated to mispricing-driven buyback cases. One limitation of this study was that empirical analysis used more heavily weighted shares with lower trading costs, which skewed the sample towards select firms.

When contextualized together, the differing results obtained from Lamba & Miranda (2010) versus those obtained from Chan, Ikenberry, Lee, & Wang (2012) provide inconclusive evidence regarding the role that executive incentives play in the decision to buy back stock. The mixed evidence suggests that executive incentives may play a role in some cases, but is not necessarily a chief reason. This inconclusive evidence regarding the managerial incentive

hypothesis has implications for the relationship between stock buybacks and R&D because it indicates that innovation and R&D will not necessarily suffer from management diverting company resources towards stock buybacks, but there is a possibility that it might.

Section 2.4: Returns Following Buybacks

The relationship between executive stock compensation and stock buybacks has not been proven to have an indisputable link in the literature, but the effects of stock buybacks in return drift following buyback announcements add to that portion of the debate. Many previous studies have had conclusions suggesting that company financial performance declines over the long-term financial horizons that follow stock buybacks. This helps support the argument that stock buybacks are inefficient uses of resources that may be used to enrich company insiders in the short-term at the expense of R&D budgeting which would support long term growth. For instance, some authors have posited that some buybacks are deliberate attempts to mislead the market, instead of genuine and credible signals of confidence in and quality of the underlying stock. Chan, Ikenberry, Lee, & Wang (2005) specifically examined a subset of buybacks from companies who may have been trying to simply boost stock price despite no basis for improved confidence and quality. Their dataset consisted of a sample of open-market repurchase announcements from the Wall Street Journal Index from 1980-1990, in addition to announcements from Securities Data Corporation from 1985-2000. They separated firms by their earnings qualities, specifically focusing on firms that have lagging stock prices and high rates of discretionary accruals-- which indicates that executives may have been under pressure to provide a short-term boost to stock prices. Their results show that in the short term buybacks boost share prices because markets do not necessarily prioritize earnings as highly as they should when evaluating stocks. So, over long-term horizons firms with low earnings quality that repurchase stock suffer from poor operating performance and do not experience positive return drift. These results show that some buyback programs may be manipulative, and sheds light on why repurchase announcements are often met with skepticism from investors. In addition, Keasler & Bryerly (2015) used a multi-industry sample of 91 companies obtained from the University of Chicago Booth School of Business to show that the market capitalization of companies that engage in stock buybacks decline over long-run horizons of three, five, and ten years (Keasler & Bryerly, 2015). This corroborates the conclusions of Chan et al. (2005), by suggesting that stock

buybacks are correlated with decline of key financial metrics such as shareholder returns, earnings, and market capitalization.

Section 2.5: Flexibility Hypothesis

When considering reasons for companies to buy back shares from the open market, another important theory is the flexibility hypothesis. This states that companies are simply using buybacks as a way to reward shareholders as a substitute to dividends, instead of as additions to dividends. Companies may choose to use stock buybacks for two reasons. First off, stock sales from buybacks are taxed at the capital gains rate, which is lower than the income tax rate. Secondly, once a firm commits to paying out a certain amount in dividends, investors come to expect that fixed dividend payout-- which can become constraining for the firm. Hence, the flexibility provided by buybacks is an incentive to use stock buybacks instead. If the flexibility hypothesis holds, it would suggest that increases in stock buybacks should not adversely affect R&D expenditures because companies would be spending that excess cash on dividends if they weren't already spending that money on stock buybacks. Through an examination of 174 repurchasing companies on the Hong Kong Stock Exchange that engaged in 4,676 stock repurchases from 1991 to 1997, Firth and Yeung (2005) used a Tobit model to show that positive cash flows induce managers to buy back stock, and that the number of shares repurchased in a given quarter can be predicted through short-term historic and current cash flows (Firth and Yeung, 2005). The results of Firth and Yeung (2005) indicate that cash flows are key determinants of stock buybacks support the flexibility hypothesis due to the implication that firms are simply returning cash flows to shareholders with buybacks instead of via dividends. Furthermore, Howe & McFetridge (1976) studied the effects of depreciation on R&D across three major industry groups (Electrical, Chemical, Machinery) from 1967 to 1971 using 256 panel observations (Howe & McFetridge, 1976). While using sales and after-tax profits as proxies for cash flow, their results suggested cash flows to be a key determinant of R&D expenditures, which corroborates the conclusions of Firth & Yeung (2005) by suggesting that buybacks are simply a more flexible may of returning company value to shareholders.

Iyer & Rao (2017) used the 2008 financial crisis as a natural experiment for testing the flexibility hypothesis. Iyer & Rao (2017) examine this hypothesis through an analysis of how regular repurchasing and regular dividend-paying firms altered their payout policies in response

to the financial crisis. The financial crisis was used because it placed pressure on the liquidity of firms throughout the economy, so the flexibility hypothesis can be tested through a comparison of reduction in payout polices of firms that regularly repurchase stock versus those that regularly pay dividends. The sample consists of a timeline published by the St. Louis Federal Reserve Board from 2000 through 2011, and authors break up their sample into four periods: firm classification period, precrisis period, financial crisis period, and postcrisis period. Their analysis found that regularly-repurchasing firms were more likely to reduce payouts following the cash constraints of the recession's wake, and furthermore that regularly repurchasing firms tended to spend more on R&D than firms that regularly payed out dividends. This suggests that by giving companies more flexibility with and control over their capital, stock buybacks allow companies to spend more on R&D while also rewarding shareholders in a way that they couldn't necessarily be able to do with dividends. However, a limitation to this study is that is important to consider is the fact that stock repurchasing firms tend to be more high-tech firms that have a lot of cash, whereas older "low-tech" companies have lower proportions of liquid assets; this means that it is likely that the repurchasing firms in their study were spending more on R&D in the first place--so the relationship between buybacks and R&D could've been exogenous to the model. When put together, the conclusions of Howe & McFetridge (1976), Iyer & Rao (2017), and Firth & Yeung (2005) provide a case for stock buybacks as substitutes to dividends because the cash that companies spend on buybacks is simply cash that would have gone to shareholders via dividends if stock buybacks were not an option. This in theory significantly decreases the likelihood that buybacks would be substitutes to R&D.

Section 2.6: Buybacks and R&D

In the context of the hypotheses mentioned above, as well as the short- and long-term financial implications of engaging in stock buybacks, the literature has several interesting studies regarding the impact of buybacks, as well as other financing dynamics, on R&D. Much of the discourse in the literature surrounding stock buybacks focuses on the stagnating rates of R&D in the contemporary American economy. However, there are disagreements over whether stock buybacks cause slowdowns in innovation, or are simply sometimes correlated with them. Lev, Radhakrishnan, & Tong (2016) point out that as of 2014 R&D expenditures of large U.S. firms stagnated at 2.5 to 2.8% of GDP, despite non-financial firms having over $1.5 trillion dollars in

cash. They point out that many executives, board members, and investors have an “accounting mentality” that leads them to consider R&D as an expense that reduces earnings with risky prospects for long-term benefits (Lev et al., 2016). The authors perform an analysis of R&D uncertainty using three factors: product uncertainty, process-cost uncertainty, and technological disruption uncertainty. They measure product uncertainty using volatility of future sales, process-cost uncertainty measuring future cost of goods sold and technological disruption uncertainty using future special items volatility. Their analysis shows that product and process-cost uncertainties are lower than the uncertainty of tangible capital expenditures-- their benchmark-- and find that future special items volatility is significantly higher than volatility from capital expenditures. From this, they conclude that the major uncertainty from R&D is technological disruption, which leads them to suggest that firms should use cash to invest in R&D that will help them come out on top as their industries cope with technological disruption, and suggests that repurchases are short-sighted (Lev et al., 2016). Lazonick (2015) corroborates these claims as he gives a scathing critique of the very existence of stock buybacks as a practice. He argues that they are an integral part of the roots of financialization that has made American industry less competitive and has had extremely negative effects for American workers, leading to consistent periods of layoffs, along with economic decay in certain parts of the country, serious inequality, and terrible national divisions. Lazonick argues that "Old Economy" companies used to value career employees, and that these career employees' experience and proficiency in developing and using proprietary technologies (Lazonick, 2015). He notes that it used to be the case that research & development was the main source of intellectual property for most leading companies. He contrasts this with the large companies of today, that he argues are increasingly using financial investments and maneuvers-- such as stock buybacks-- to make up for declining research and real innovation by simply rewarding shareholders for cashing out on their shares. Lazonick concludes that the use of company retained earnings towards dividends and buybacks, instead of real investment, is indicative of a "failure of corporate executives" to develop strategies for "investing in the productive capabilities of the companies they manage" (Lazonick, 2015). Furthermore, he also argues that stock buybacks have essentially been added on top of dividends instead of replacing them, which implies that buybacks would be substitues to R&D. Additionally, Lazonick argues that not only are R & D expenditures declining, the actual research that is occurring for American companies itself is being outsourced to many other

countries. Lazonick cites the fact that large increases in immigrant H-1B and L-1 work visas in the United States throughout the late 1990s and early 2000s spurred hundreds of thousands of high-tech workers to accumulate work experience in the U.S. that they could take back to their home countries. Some of these areas-- which include basic research, along with chip design and engineering-- are integral to any form of advanced research in the 21st century. Lazonick continues to prove his point through the use of observations of specific companies that have rates of stock buybacks that are hard to justify by any metric. Drug companies are charging far higher drug prices in the U. S. than in anywhere else in the world, but many of the largest drug companies have been continuously allocating a vast majority, if not over 100%, of their profits to shareholders through a combination of buybacks and dividends (Lazonick, 2015). At the same time health insurance companies routinely spend the majority of their net income on stock buybacks, allowing their executives to gain tens of millions in stock-based pay while average Americans pay some of the highest premiums in the world. Stock buybacks are even so pervasive that they exist in the face of perverse government incentives, as GM spent over $5 billion on buybacks in 2015 and 2016 to acquiesce rich shareholders despite the fact that taxpayers lost $11 billion on the GM bailout only 7 years prior, and oil companies such as Exxon Mobil spend tens of billions of dollars on stock buybacks each year despite having government subsidies (Lazonick, 2015).

Chan, Ikenberry, & Wang (2001), on the other hand, take a very different position than Lazonick. They argue that repurchases can simply be viewed as "an investment alternative among all investment projects" (Chan et al., 2001). They reason that when managers' sense market prices are too low compared to true value, they enhance long-term shareholder interests by buying back stock, and they proceed to compare the benefit that shareholders receive from buybacks to the benefits that shareholders receive from any other profitable project that increases stock prices and long-term prospects for a company. Through this reasoning, they figure that repurchases themselves do not directly affect economic value, but are simply a response to the underlying economic inconsistencies between market value and a stock's "correct" value. They also figure that companies use stock buybacks instead of dividends due to the lower taxes associated with them. Kahle (2002) corroborates these ideas in a study that simultaneously tests the flexibility hypothesis and the option-funding hypothesis. The option-funding hypothesis is the idea that managers chose to buy back stock because buybacks do not dilute the per-share

value of firm stock because cash outflows are complemented by shares outstanding. Through a sample of open market repurchase ranging from 1993-1996, Kahle (2002) examines the effects of several different stock option types, as well as many different control variables including capital expenditures and R&D. The results suggest that stock buybacks have become an increasingly popular form of compensation due to the increase in stock options as compensation for not only manager but other employees as well. These results for buybacks visa-vi managerial incentives may partially corroborate those of other authors who claim that managerial incentives are the chief reasons for buybacks, and that buybacks are a drag on long-term growth, investment, and research. However, Kahle also found that for the entire sample capital expenditures and R&D actually increase from the year before to the year after the repurchase at a statistically significant level. Because of this positive relationship between R&D and stock buybacks, Kahle concludes that repurchases are not signals of decreased growth opportunities (Kahle, 2002). It's also important to note that results suggested a negative relationship between announcement returns and stock-options, which is consistent with the option-funding hypothesis and suggests that markets know when managers may be using buybacks to simply boost the value of their options, and respond accordingly. This relationship between buyback announcements and share returns is highly contested in the literature as most papers that examine post-buyback returns, including Chan et al (2005) as well as Keasler & Bryerly (2015), find that stock prices increase in the short-term following buyback announcements.

Tan, Yu, & Ma (2018) examined the impact of internal capital markets on business group efficiency through an analysis of private versus state-owned enterprises in China. Their methods included a panel data set of 7,836 firm-year observations analyzed through a regression that estimated the effect of the ease of financing on over-investment and R&D underinvestment. Overall, the authors included that the functioning internal capital markets of privately owned enterprises allowed for financing flows that prevented underinvestment in R&D and increased overall investment efficiency. They contrast this with state-owned companies that did not have the same easy financing flows tended to have much lower returns on their investments. In relation to stock buybacks, it may be the case that stock buybacks are part of functioning financial markets that allow for companies to signal when they are investing productively in R&D and think that those investments will pay off, instead of being substitutes for R&D investment. While several empirical papers do not conclude that buybacks adversely affect R&D

expenditures, this is not a ubiquitous result as the observed correlation between stock buybacks and subsequent increased, or unaffected, research & development expenditures contradicts some previous findings. For example, Hwan, Han, & Yoo (2012) conducted an analysis of the effects of stock buybacks and other financialization on R&D investment of non-financial Korean firms from 1994 to 2009. Their analysis used over 6,200 observations of panel data to estimate both the joint and separate effects of buybacks and dividends on research & development expenditures, as well as the effect of crowding-out effects-- in other words, the effect of relatively higher financial investment opportunities relative to non-financial investment opportunities-- on managers' decision-making. Results showed that when viewed separately, buybacks and dividends each do have negative effects on R&D investment for firms; the crowding-out effect was also shown to have a negative correlation with R&D investment. Put together, these results would suggest that the presence of a buyback would lead to a heightened chance that R&D investment decreases in the subsequent year. However, one main limitation of this study was that significant results were only obtained for years after the Asian Financial Crisis (2001-2009) while years 1994-1998 did not yield significant results one way or another. This suggests that the results obtained from this paper may not be very conclusive because the decreases R&D investment and planning horizons could be due to the fact that firms were cash-strapped, needed to cut costs, and had few net present investment opportunities for the years that the negative relationship was suggested.

Results obtained by Li (2011) corroborate results obtained by Kahle (2002), and put doubt towards the school of thought that argues that stock buybacks necessarily dampen innovation. While examining the relationship between financial constraints and R&D investments, Li (2011) used a sample of 1,333 firm-year combinations from 1975 to 2007 to estimate the effect of financial constraints on both intensity of R&D and returns to R&D. Li found that less financially constrained firms, as measured through surplus equity as well as higher earnings and cash flow, were more likely to have higher returns to R&D and tended to invest more in R&D than firms that were more financially constrained. However, this sheds light on the relationship between stock buybacks and R&D, as results obtained by authors such as Firth and Yeung (2005) indicate that the same metrics indicating lack of financial constraints and higher propensity to invest in R&D are correlated with the decision to engage in stock buybacks. Furthermore, the investment opportunities hypothesis-- the notion that R&D reactions are

positive for high-tech firms and negative for low-tech firms-- was tested by Szeqcyk et al. (1996) using a inter-industry sample of 252 R&D increase announcements from 1979 to 1992. Through time series analyses, authors' results suggested a significant positive response for high-tech firms and a significantly negative response for low-tech firms. This has important implications for managerial decisions to either allocate funds towards buybacks or R&D, because it suggests that high-tech firms may be more likely to invest in R&D over buybacks because they have more of a market financial incentive to do so. These results also suggest that older, less high-tech companies would be less inclined to invest in R&D because markets may perceive that as an unproductive allocation of resources. So, this may mean that low-tech companies may be more inclined to buy back stock because there is a lower opportunity cost compared to spending the same fund on R&D. Although work done by Szeqcyk et al. (1996) has important implications regarding the opportunity costs of investing in R&D versus investing in stock buybacks, one serous limitation of the study is its small sample size of only 252 R&D increase announcements. Brown, Fazzari, and Peterson (2009) examined the relationship between financing and R&D throughout the 1990's. They corroborate the conclusions of Szeqcyk et al. (1996) as they find a positive effect of financing in the form of cash flow and external equity for young, and especially high-tech firms, but not for mature companies. Their conclusion is that the impact of financing on R&D for small, start-up firms is large enough to have a significant impact on the U.S. economy. However, for small firms the use of financing for R&D is imperative, because they are disrupting industries and by the nature of their companies' sizes a lot of financing for R&D is required to fulfill rapid growth. The impact that net stock issuance and financing has on large companies, however, is more contentiously debated. However, if financing for R&D is less imperative for large companies, then that may suggest that the choice between investing in R&D and putting cash towards stock buybacks may not necessarily be a tradeoff. This would contradict the substitution hypothesis, and would go against the arguments of Lazonick (2015) and Lev et al (2016).

Overall, several authors such as Kahle (2002) and Chan et al. (2001) do find results to be consistent with the hypothesis that managers may use stock buybacks to the advantage of long-term shareholders. So, the results of these authors stand in contrast to those of Lazonick (2015) and Lev et al. (2016) because these authors' results imply that the companies that choose to engage in buybacks are making a rational investment decision, and that company executives are

making this decision with the interests of their shareholders in mind and this decision would not lead to long-term declines in research & development. On the other hand, anti-buyback authors argue that stock buybacks are shortsighted decisions to enrich company executives at the expense of shareholders' long-term interest, and that they come at the expense of research & development. Chan et al. (2001) and Kahle (2002) seem to be different schools of thought than Lazonick (2015), and uses a much more robust empirical models, who generally makes points through examples and situational analysis instead of empiricism. Because of this, there is a lot of room for error in Lazonick's argument due to the fact that it is possible for companies to amass huge amounts of corporate surplus, while not having any net present value investment activities in which to invest all of the cash and other liquid assets that they have. Under this scenario, Lazonick's argument becomes much weaker because he assumes that stock buybacks are perfect substitutes for R&D expenditures, wages, and other investments, which may not be the case.

The literature contains mixed results regarding the reasons that companies have for buying back stock: signaling, options-funding, and flexibility hypotheses. The relationship between buybacks and R&D is also contested, as the two main schools of thought in the debate over stock buybacks as harmful or harmless use different methodologies. Papers such as Lazonick (2015) and Lev et al. (2016) present buybacks as harmful to innovation through an examination of the business realities, but may not provide robust enough empirical models and accompanying reasons for any sort of causal relationship between stock buybacks and decreased R&D spending. On the other hand, many of the papers that do provide empirical frameworks and suggest that buybacks are not harmful to R&D have significant limitations. While Kahle (2002) found a complementary relationship between buybacks and R&D, and Lev et al. (2016) supported the notion that efficient two-way financing helps mitigate the risk of R&D underinvestment, results still do not completely take into account the effect that increased earnings and returns might have on the effects between stock buybacks and R&D. My paper seeks to contribute to the literature by using controlling for several important variables including returns, cash levels, and metrics of whether firms are high-tech or low-tech.

Part 3: Data Extraction & Cleaning with Python Scripting

Data was obtained through *Mergent Online*'s database of company financial information, as well as *Market Watch*'s list of historic stock buybacks. Income statement and business ratio data from 455 Fortune 500 companies was obtained from *Mergent Online*, and a complete list of historical share repurchase agreements was obtained through *Market Watch*. Data from both of these sources were integrated and cleaned via a Python script to convert the data into usable tabular formats, and to structure the data set in. Python's "Pandas" module was used for this script because this module combines the detail-oriented nature of the Python programming language with the user-friendly nature of the R programming language, allowing for the use of "DataFrames" for relatively convenient data organization.

The Python script scrapes buyback information and R&D information, with several control variables are included. The program iterates through a text file of raw company financial information to append Income Statement items representing Research & Development expenses to a DataFrame. Firm symbol, report date, various business ratios, as well as SIC and NAISC codes, are also appended to each respective observation of R & D expenses. This process builds a data set that only consists of firms with line items that specifically represent R & D expenditure. Then, buyback data from *Market Watch* is integrated by using firm symbol and report date as a unique identifier, matching stock buyback information for a given year to its appropriate firm. Note that buyback data, along with control variables, are shifted up by one year. Change in R&D is calculated as the difference in R&D expenditures from the previous year to the current year. This structures the data such that a buyback, along with various control variables, in one year is predicting the change in R&D expenditures from the end-of-year reporting period of the buyback year to the end-of-year reporting period of the year after the buyback. In addition to the creation of change in R&D, a dummy variable for change in R&D is created in preparation for the logit regressions-- this variable tracks whether R & D expenditures increase or decrease from the end-of-year reporting period of the buyback year to the end-of-year reporting period following the buyback year (1 or 0). Note that every last row (formerly representing values from 2009) for each firm is dropped because independent and control variables were all shifted up from that row.

Part 4: Data and Variables

The final, cleaned data set contains 702 observations from 81 firms over a period of 2009 through 2018. There are 239 buybacks present in the data throughout this period. The "buyback" independent variable is a dummy variable in the data set, where a value of 1 signifies a buyback in a given year and a buyback of 0 signifies the lack of a buyback in a given year. The dependent variable in the logit regression of change in R&D expenditures (RDDum) is also a dummy variable, where 1 means that R&D spending increased throughout the time period and a 0 means that R & D spending decreased throughout the time period. $RDDUM_{it}$ is the movement in R & D (up and down signified by 1 and 0, respectively) for firm *i* from the end of year *t-1* to the end of year *t*, and BB_{it} represents whether (1 or 0) there was a buyback for firm *i* in year *t-1*. The dependent variable in the OLS regression is the percentage change in R&D— common sized with revenue—as opposed to the logit regression where the dependent variable is revenue.

Control variables include Return on Assets (ROA), EBITDA, Quick Ratio (QR), Property, Plant, & Equipment Turnover (PPET), Total Asset Turnover (TAT), and Cash Flow per Share (CFPS). ROA_{it} is return on assets (net income/total assets) for firm *i* in year *t*, and $EBITDA_{it}$ is earnings before income taxes, depreciation, and amortization for firm *i* in year *t*. QR_{it} is the quick ratio (liquid assets/current liabilities) for firm *i* in year *t*, and $PPET_{it}$ is property, plant, and equipment turnover (net sales/fixed assets - Accumulated depreciation) for firm *i* in year *t*. Finally, TAT_{it} is total asset turnover (total sales/((beginning assets + ending assets)/2)) for firm *i* in year *t*. $CFPS_{it}$ is cash flow per share for firm *i* in year *t*.

Previous literature informs the selection of the various control variables that will be jointly used to predict the impact that stock buybacks have on R&D. This section delves into the literary findings regarding these variables, and informs why they are being used in this model. Firstly, Return on Assets (ROA) for companies is included as a control variable because previous work has shown there to be a feedback loop between R&D expenditure and return on assets (ROA). Results from an inter-industry study of R&D "leaders" and "peers" throughout 1976-2012 conducted by Jiang et al. (2015) suggested that R&D successes from "leaders" spill over across companies in the same industries. Following these R&D successes, R&D "peers" experience higher returns on assets as they must simultaneously increase their R&D budgets to keep up with the increased rate of innovation in the industry. As ROA increases with this intra-industy R&D intensity, this creates a dynamic where R&D and ROA have are likely

complementary metrics. Shust (2014) corroborates this positive correlation between discretionary accruals and R&D, while also noting that EBITDA and cash flow have been shown to be positively correlated with R&D expenditures, by suggesting that they are variables inextricably tied to return on assets and discretionary accruals. Furthermore Firth and Yeung (2005) suggest that positive cash flows induce managers to buy back stock as they show that cash flows may be an important control for factors co-occurring with repurchase decisions that affect R&D. Additionally, Howe & McFetridge (1976) studied the effects of depreciation on R&D across three major industry groups (Electrical, Chemical, Machinery) from 1967 to 1971 using 256 panel observations (Howe & McFetridge, 1976). While using sales and after-tax profits as proxies for cash flow, their results suggested cash flows to be a key determinant of R&D expenditures. When contextualized with the works of previous authors such as Jiang et al.(2015), Shust (2014), and Howe & McFetridge (1976), cash flow is an important control metric because it captures information related to impacts on both the dependent variable and most important control variable. Additionally, results obtained by Li (2011) indicated that sales and earnings growth are important determinants of financial-constraint reduction that serve to incentivize investment in R&D; this provides further suggestions that control variables for earnings, such as EBITDA and cash flow, are important to the model.

In addition to metrics that track returns in earnings such as return on assets (ROA), EBITDA, cash flow, and the quick ratio (QR), it was necessary to include indicators for how "high-tech" or "low-tech" a company is; I chose to do this using Total Asset Turnover (TAT) and Property, Plant, & Equipment Turnover (PPET). Previously mentioned, Howe & McFetridge (1976) also used depreciation as a control variable while predicting R&D expenditures across electrical, chemical, and machinery industries. Depreciation had a statistically significant positive effect on rates of R&D in the machinery industry, but did not have significant results for the other two industries. Nevertheless, intuitively the more a company innovates the more its innovations will eventually depreciate and amortize. So, I found it to be necessary to include Property, Plant, & Equipment Turnover (PPET) as a control variable in the model. Additionally, there needed to be a control variable that takes into account how high-tech or low-tech a firm is. Work conducted by Szeqcyk et al. (1996) indicates the clear importance of taking into account the level at which a firm is overvalued, as well as the level at which a firm is using its assets and depreciating it's current assets, as these factors are all critical in determining the amount of R&D

that a firm decides to invest in. While Szeqcyk et al. (1996) chose to use Tobin's q for this, I chose to use a few other business metrics to control for similar effects of Tobin's q. Whereas Tobin's q uses the ratio of market value to book value of a firm to track how "high tech" a firm is, I chose to do so through the use of turnover metrics such as Total Asset Turnover (TAT) and Property, Plant, & Equipment Turnover (PPET). The reasoning behind this is that firms in the sample that are "higher tech", such as technology companies and pharmaceutical companies, will have a higher ratios of earnings to both total assets and property, plant, & equipment.

Part 5: Discussion

Two models were conducted: a logit model to estimate the effect that stock buybacks have on the chances that a company increases R&D expenditures in the following year, and an OLS regression for estimating the effect of stock buybacks on the percentage increase in R&D throughout the subsequent year. The logit regression consists of the following form:

$$RDDUM_{it} = \beta_0 + \beta_1 BB_{it} + \beta_n C_{it}$$

Where $RDDUM_{it}$ is a dummy variable for the direction of change in R & D (up and down signified by 1 and 0, respectively) for firm *i* from the end of year *t-1* to the end of year *t*, and BB_{it} represents whether or not (BB = {0, 1}) there was a buyback for firm *i* in year *t-1*. C_{it} represents the various control variables used in regressions 1 through 11, each of which was mentioned in part 3. Additionally, an OLS regression is used to predict the estimated effect (%) of the presence of a stock buyback from one period to the next. This takes the probit regression a step further to provide a more precise estimation of change in R&D, and uses dependent variable of the actual percentage change of R&D expenditure in the subsequent year following a buyback. The OLS regression consists of the following form:

$$RD_{it} = \beta_0 + \beta_1 BB_{it} + \beta_n C_{it}$$

Where RD_{it} is percentage change in R&D, and the independent variable BB_{it} as well as all other control variables represented by C_{it} are the same as in the logit regression.

The results of the logit model regression using random effects are shown in table 4. Results for the OLS model are shown in Table 5, with each regression using the same variables as its respective regression in the logit models. Regressions 1 and 2 respectively estimate the

impact of buybacks and return on assets (ROA), as well as buybacks and EBITDA, on the probability of R&D spending increasing (decreasing) throughout the next period. Regressions 3 and 4 include the Quick Ratio (QR) as an additional control variable, and regressions 5 and 6 include property, plant, and equipment turnover (PPET) as an additional control variable on top of the variables in regressions 3 and 4. Regressions 7 and 8 interchange PPE turnover for total asset turnover (TAT) to include intangible assets. Regression 9 includes cash flow per share (CFPS), the quick ratio (QR), and ROA as control variables, and regression 10 mirrors regression 9 but interchanges ROA for EBITDA. Regression 11 only uses cash flow per share (CFPS) as a control variable.

Section 5.1: Robustness Checks

Pearson R values were calculated to test for multi-collinearity. Python can do this quite easily by creating a Pearson's R correlation plot, which shows the Pearson's R values for each pair of variables in the data set. Table 1 below shows the Pearson's R correlation matrix for the data set. As shown, the only variable pairs that have significant multi-collinearity are ROA and EBITDA, as well as PPET and TAT. Correlation between ROA and EBITDA is clearly shown through their Pearson R of .778, and correlation between PPET and TAT is shown through their Pearson R value of .636. I was sure to not use either of these two variable pairs in the same regressions with one another.

VIF results were also calculated to test for collinearity-- these results are shown in Table 2. In order to do this, a single OLS regression using all independent variables was run, and VIF statistics for all variables were calculated. As shown in the table, EBITDA and ROA have high VIF values of 3.39 and 3.24 respectively, so they are likely correlated with other independent variables in the model-- namely, each other. This corroborates the Pearson R results from the correlation plot. TAT and PPET have relatively high VIF statistics as well, which makes sense due to their high Pearson R calculation of .636. Although these variable pairs both have high Pearson R values and higher-than-average VIF results, their VIF results do not give strong evidence that they should be excluded from the model, but as previously stated the R values for both of the pairs indicate that they should not be used in the same regression. Overall, there does not seem to be rampant multi-collinearity between multiple variables in the model.

When comparing the fixed effects model to the random effects model, the Hausman test coefficients yield values of .38, .19, .1, .15, .17, .26, .6, .1, .05, .007, and .25 respectively. These results are shown in Table 3, and show that by and large, the vast majority of tests cannot reject the null hypothesis that there is no correlation between unique errors and the variables in the model, which thereby rejects the idea that the fixed effects model is the best estimator. Therefore, these results indicate that the random effects model is most appropriate and this is the model that will be analyzed.

Section 5.1: Discussion of Results

The results for the random effects logit model are in Table 4. Results for the independent variable, the presence of a stock buyback, estimate that the presence of a stock buyback are correlated with an increase in the likelihood of R&D expenditures increasing over the next year. The magnitude of this effect is an approximate 50-60% in the chance of an increase for R&D expenditures depending on the control variables used, and these results are statistically significant at the 95% level for all regressions in the table. ROA is also significant at the 95% level and predicts that a 1 percent increase for return on assets leads to an expected 2.8 to 3.0% increase in the chance of R & D increasing in the year following the buyback. Furthermore, EBITDA is also significant at the 95% level and predicts that a 1 percent increase for return on assets leads to an expected 1.4 to 1.7% increase in the chance of R&D increasing in the year following the buyback. None of the other control variables that are used are significant in this model. The quick ratio yielded a negative sign for its coefficient, which was unexpected given the previous findings of the literature, and cash flow per share yielded a positive sign for its coefficient, which was expected given the previous findings of the literature. OLS regression results are shown in Table 5. The independent variable, the presence of a stock buyback, is not significant at any level below 20%. Furthermore, none of the control variables are statistically significant either. The most statistically significant variable is EBITDA, which is consistently significant across all regression specifications. Total Asset Turnover does also appear to be significant in regression 8. This partly corroborates work previously done throughout the literature because total assets is correlated with higher liquid assets-- liquid assets are what cause companies to buy back stock as they attempt to convey that liquidity to investors.

Results from the logit regressions suggest that stock buybacks are actually positively correlated with increases in R&D expenditure, as well with high earnings and returns on assets. OLS regression results yield similar signs for variables, but it is hard to draw any meaningful conclusions from them due to statistical insignificance. This suggests that stock buybacks are being conducted on behalf of innovative and successful companies that are rewarding and compensating investors through buybacks. This observed correlation between stock buybacks and R&D increases corroborates results found by Kahle (2002), Tan et al. (2011, and Li (2011) which found that the same factors that typically contribute to high rates of dividends and buybacks are also highly correlated with R&D expenditures. This implies that companies are not necessarily substituting R&D expenditures for stock buybacks, contradicting the work done by Lazonick (2015), Lev et al. (2016), and Hwan et. al (2012). However, it is important to note that this study's sample size is occurring during a period of economic growth, which likely increased the rates of both buybacks and R&D increases. This is one potential reason as to why the results obtained differ from those of Hwan et al (2012), because the results obtained by Hwan et al. (2012) that showed slowdowns in R&D due to financialization were only significant for years after the Asian financial crisis. Cash flow per share was not a significant variable, corroborating the results of Chan et al. (2004) which did not find any evidence to support the free cash flow hypothesis. This negation of the free cash flow hypothesis provides some support for the theory of stock buybacks as a signaling tool for undervalued stocks, instead of a method for returning excess cash to shareholders. Additionally, since buybacks are correlated with high return on assets as well as high earnings, results provide support for the signaling hypothesis as they support the notion that companies with high returns on assets as well as earnings are using stock buybacks as a tool to indicate that their stocks are undervalued. This evidence is in line with results obtained by Chan et. al. (2004) in a short-term analysis providing support for the theory, but contradict results obtained by Lamba and Miranda (2010). Additionally, these results suggest support for the signaling hypothesis for long-term planning horizons since buybacks are correlated with increased R&D; in doing so these results contradict the work of Liano et. al. (2003). No significant conclusions regarding the leveraging or stock-option hypotheses can be made from these results.

Section 5.2: Limitations

First off, there were very few variables with negative coefficients in both the OLS and Logit models, which means that much of the negative effects that were present were likely lumped into the error term and/or some of the positive coefficients. This could likely explain the reason as to why the quick ratio had an expected negative coefficient, despite the fact that it high ratios of liquid assets to liabilities had been found to increase R & D rates in the literature. Secondly, there are likely other variables that it would be useful to include that would be helpful in predicting Research & Development expenditures. An example of one of these is Tobin's Q, which tracks whether a firm is high-tech or low-tech based on the ratio of its market value to its book value. Furthermore, Cash flow is measured through cash flow per share, and there is no standard benchmark for the number of shares outstanding. Therefore, firms that have fewer (more) shares would have disproportionately higher (lower) cash flows per share-- which may not be completely representative of actual cash flow.

Another limitation-- possibly the biggest overall limitation-- is that buybacks may be endogenous to the model. All of the 80 firms examined in this research are firms that specifically have R&D listed as a line item on their Income Statements, which means that it is not a true inter-industry analysis. From the onset, this means that these companies are more high tech than other large multinational corporations that do not have R&D listed as an individual line item. High tech companies typically are faster growing companies, with relatively high levels of cash, which must spend ever-increasing amounts of that cash on research & development from year-to-year in order to stay afloat in industries where technological disruption is constant. Furthermore, these companies typically have high returns on assets because they are growing so rapidly, and investors expect to have some of these gains transferred to them largely through the use of stock buybacks. So it would make sense that these high tech companies would, in times of excess cash, simultaneously use that cash on the research that is required to stay relevant while also conveying some of that cash to shareholder through the use of stock buybacks.

Part 6: Conclusions

This study set out to determine whether or not stock buybacks have a significant impact on rates of innovation for large Fortune 500 companies, as measured through their R&D expenditures. Using logit regression analysis, the model finds stock buybacks to be correlated

with increases in R&D expenditure for subsequent years following buybacks. OLS regression results also find repurchases to be correlated with increased R&D expenditures in subsequent years, but do not appear to yield statistically significant results. These findings may be partially due to joint correlations whereby firms that have excess cash to spend on stock buybacks also have excess cash with which to pursue new and innovative opportunities. Further research is necessary to gain a better understanding of the effects that stock buybacks have on R&D. First off, future studies could expand analysis to encompass more indicators of innovation than just the Income Statement line item of R&D. This would allow for a more comprehensive analysis of how stock buybacks affect innovation across industries that span the spectrum of innovation intensity. Additionally, while this paper seeks to estimate the immediate effect of share repurchases on R&D, it does not consider the longer-term implications of repurchases.
A study tracking innovation over multi-year time horizons would provide more insight into the longer-term effects that stock buybacks have on innovation.

Appendices

Table 1: Pearson's R Correlation Plot for All Variable Pairs

Correlation Plot: Pearson's R								
	RD	bb	ROA	EBITDA	QR	TAT	PPET	CFPS
RD	1	0.017613	-0.07387	0.053359	0.386648	-0.31362	-0.05514	-0.15757
bb	0.017613	1	0.188677	0.059032	0.018743	0.140569	0.13861	0.022479
ROA	-0.07387	0.188677	1	0.778054	0.264217	0.028074	0.016008	0.242039
EBITDA	0.053359	0.059032	0.778054	1	0.354445	-0.24277	-0.04663	0.147812
QR	0.386648	0.018743	0.264217	0.354445	1	-0.24735	-0.06805	0.090308
TAT	-0.31362	0.140569	0.028074	-0.24277	-0.24735	1	0.636249	0.134933
PPET	-0.05514	0.13861	0.016008	-0.04663	-0.06805	0.636249	1	0.056763
CFPS	-0.15757	0.022479	0.242039	0.147812	0.090308	0.134933	0.056763	1

Table 2: VIF Robustness Test

Variable	VIF	1/VIF
EBITDA	3.39	0.295
ROA	3.24	0.309
TAT	2.3	0.435
PPET	1.83	0.545
QR	1.2	0.834
CFPS	1.09	0.917
bb	1.08	0.928
Mean VIF	2.02	

Table 3: Hausman Test Results for Logit Regressions 1-11

Hausman Test Results											
Regression Number	1	2	3	4	5	6	7	8	9	10	11
Hausman Result	0.38	0.19	0.1	0.15	0.17	0.26	0.6	0.1	0.05	0.007	0.25

Table 4: Random-Effects Logit Predictors for R&D Movements

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D	Change in R&D
Buyback = 1	0.514***	0.579***	0.511***	0.577***	0.509***	0.573***	0.507***	0.553***	0.516***	0.577***	0.602***
	(0.173)	(0.170)	(0.173)	(0.170)	(0.174)	(0.171)	(0.174)	(0.172)	(0.174)	(0.171)	(0.171)
	[2.974]	[3.399]	[2.950]	[3.391]	[2.924]	[3.342]	[2.913]	[3.206]	[2.970]	[3.376]	[3.524]
Return on Assets (%)	0.028***		0.030***		0.030***		0.030***		0.028**		
	(0.010)		(0.011)		(0.011)		(0.011)		(0.011)		
	[2.718]		[2.738]		[2.737]		[2.708]		[2.508]		
EBITDA (%)		0.014***		0.016***		0.016***		0.017***		0.015***	
		(0.005)		(0.006)		(0.006)		(0.006)		(0.006)	
		[2.735]		[2.808]		[2.809]		[2.903]		[2.592]	
Quick Ratio (%)			-0.031	-0.052	-0.031	-0.051	-0.027	-0.040	-0.031	-0.051	
			(0.063)	(0.065)	(0.063)	(0.065)	(0.065)	(0.066)	(0.063)	(0.065)	
			[-0.495]	[-0.796]	[-0.488]	[-0.784]	[-0.413]	[-0.599]	[-0.495]	[-0.788]	
Property, Plant, & Equipment Turnover (%)					0.001	0.001					
					(0.007)	(0.007)					
					[0.081]	[0.209]					
Total Asset Turnover (%)							0.042	0.199			
							(0.177)	(0.185)			
							[0.236]	[1.077]			
Cash Flow Per Share (%)									0.011	0.015	0.021
									(0.017)	(0.016)	(0.017)
									[0.685]	[0.943]	[1.276]
Number of firms	80	80	80	80	80	80	80	80	80	80	80

Standard errors in parentheses
Z-scores in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 5: OLS Predictors for R&D Movements

VARIABLES	(1) Change in R&D (%)	(2) Change in R&D (%)	(3) Change in R&D (%)	(4) Change in R&D (%)	(5) Change in R&D (%)	(6) Change in R&D (%)	(7) Change in R&D (%)	(8) Change in R&D (%)	(9) Change in R&D (%)	(10) Change in R&D (%)	(11) Change in R&D (%)
Buyback = 1	0.351	0.306	0.352	0.305	0.341	0.287	0.301	0.202	0.360	0.320	0.391
	(0.324)	(0.316)	(0.325)	(0.316)	(0.328)	(0.319)	(0.328)	(0.319)	(0.330)	(0.320)	(0.323)
	[1.082]	[0.969]	[1.085]	[0.966]	[1.038]	[0.899]	[0.919]	[0.634]	[1.093]	[0.999]	[1.208]
Return on Assets (%)	0.008		0.007		0.007		0.006		0.009		
	(0.018)		(0.018)		(0.018)		(0.018)		(0.019)		
	[0.441]		[0.393]		[0.391]		[0.306]		[0.468]		
EBITDA (%)		0.033***		0.037***		0.037***		0.040***		0.038***	
		(0.009)		(0.009)		(0.009)		(0.009)		(0.009)	
		[3.870]		[4.051]		[4.059]		[4.353]		[4.066]	
Quick Ratio (%)			0.013	-0.141	0.016	-0.138	0.050	-0.099	0.020	-0.132	
			(0.114)	(0.116)	(0.114)	(0.116)	(0.118)	(0.117)	(0.115)	(0.117)	
			[0.118]	[-1.216]	[0.137]	[-1.191]	[0.421]	[-0.842]	[0.170]	[-1.123]	
Property, Plant, & Equipment Turnover (%)					0.003	0.005					
					(0.012)	(0.012)					
					[0.262]	[0.400]					
Total Asset Turnover (%)							0.365	0.620**			
							(0.312)	(0.312)			
							[1.170]	[1.983]			
Cash Flow Per Share (%)									-0.019	-0.031	-0.015
									(0.031)	(0.030)	(0.030)
									[-0.613]	[-1.024]	[-0.496]
R-squared	0.002	0.023	0.002	0.025	0.002	0.025	0.004	0.031	0.003	0.026	0.002

Standard errors in parentheses
Z-scores in brackets
*** p<0.01, ** p<0.05, * p<0.1

References

Brown, J., Fazzari, S., & Peterson, B. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *The Journal of Finance, 64*(1), 151-185.

Chan, K., Ikenberry, D., & Lee, I. (2004). Economic sources of gain in stock repurchases. *Journal of Financial and Quantitative Analysis, 39*(3), 461-479.

Chan, K., Ikenberry, D., Lee, I., & Wang, Y. (2012). Informed traders: Linking legal insider trading and share repurchases. *Financial Analysts Journal, 68*(1), 60-73.

Chan, S. H., Martin, J. D., & Kensinger, J. W. (1990). Corporate research and development expenditures and share value *Journal of Financial Economics,*

Chen, S., Chen, Y., & Wang, Y. (2015). Does labor power affect the likelihood of a share repurchases? *Financial Management,* , 623-653.

Chen, S., Ho, K., & Ho, P. (2014). CEO overconfidence and long-term performance following R&D increases. *Financial Management,* , 245-269.

Chung, K. H., & Pruitt, S. W. (1994). A simple approximation of tobin's q.*23*(3), 70-74.

Eberhart, A. C., Maxwell, W. F., & Siddique, A. R. (2004). An examination of long-term abnormal stock returns and operating performance. *American Finance Association, 59*(2), 623-650.

Eberhart, A. C., & Siddique, A. R. (2004). Why are stock buyback announcements good news?

Firth, M., & Yeung, C. S. F. (2005). An empirical investigation of share buybacks in Hong Kong. *Journal of Emerging Market Finance, 4*(3), 207-225. doi:10.1177/097265270500400301

Hecht, J. (2014). Is net stock issuance relevant to capital formation? comparing heterodox models of firm-level capital expenditures across the advanced and largest developing economies. *Cambridge Journal of Economics,* , 1171-1206.

Howe, J. D., & McFetridge, D. G. (1976). The determinants of R & D expenditures. *The Canadian journal of economics, 9*(1), 57-71. Retrieved from http://www.econis.eu/PPNSET?PPN=493503846

Hwan, J. S., Han, S. K., & Yoo, C. K. (2012). Financialization and the slowdown in korean firms' R&D investment. *Asian Economic Papers,*

Iyer, S. R., & Rao, R. P. (2017). Share repurchases and the flexibility hypothesis. *Journal of Financial Research, 40*(3), 287-313. doi:10.1111/jfir.12125

Keasler, T., & Byerly, R. (2015). An examination of corporate stock buybacks: Do they really create value? *Economics, Management, and Financial Markets, 10*(4), 11-28.

Kim, J., & Oh, K. (2015). Introduction of shareholder-friendly behaviors after governance reform in korean firms: Is it a proactive response? *Emerging Markets Finance & Trade,*

Kulchania, M. (2016). Cost structure and payout policy. *Financial Management, 45*(4), 981-1009. doi:10.1111/fima.12133

Lamba, A., & Miranda, V. (2010). The role of executive stock options in on-market share buybacks *International Review of Finance,* , 339-363.

Lazonick, W. (December 20, 2015). How stock buybacks make Americans vulnerable to globalization. Paper presented at the *Mega-Regionalism - New Challenges for Trade and Innovation,*

Lev, B., Radhakrishnan, S., & Tong, J. Y. (2016). R&D volatility drivers.

Li, D. (2011). Financial constraints, R&D investment, and stock returns. *Society for Financial Studies,*

Liano, K., Huang, G., & Manakyan, H.Market reaction to open market stock repurchases and industry affiliation. *Quarterly Journal of Business & Economics, 42*(1), 97-120.

Schaub, M. (2010). Short-term wealth effects from debt buyback announcements., 1351-1354.

Stunda, R.*Corporate stock buybacks-do they enhance or worsen company performance over time?* Unpublished manuscript.

Szewczyk, S. H., Tsetsekos, G. P., & Zantout, Z. (1996). The valuation of corporate r&D expenditures: Evidence from investment opportunities and free cash flow. *Financial Management, 25*(1), 105-110.

Zantout, Z. Z., & Tsetsekos, G. P.The wealth effects of announcements of R&D expenditure increases. *The Journal of Financial Research, 17*(2)