Different Incentives in Government Contracting

Abstract:
This paper shows stock prices are used as the primary incentive for executives of publically traded government contractors rather than profit sharing contracts. Looking at the reaction of companies' stock prices to public and private sector news, this paper shows stock prices do not capture "bad news" for both the public and private sector customers compared to overall market indicators; and would make poor contract incentives. Finally, alternate methods of contract incentives will be explored.

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Introduction

Gross Domestic Product (GDP) is one of the most comprehensive and closely watched economic statistics. It is used by the White House and Congress to prepare the Federal budget, by the Federal Reserve to formulate monetary policy, by Wall Street as an indicator of economic activity, and by the business community to prepare forecasts of economic performance that provide the basis for production, investment, and employment planning (Bureau of Economic Anlaysis, 2014).

While discretionary spending is now on a path to its lowest level since just after World War II, non-discretionary funding is on a path to increase from 10% to 16% of total GDP by 2031 (Department of Treasury, 2012). As non-discretionary spending increases, it is increasingly more important that contracts for discretionary funds do not exceed their negotiated value to allow the government to develop a budget that will adequately account for expenditures so that those contracts do not overrun and cause other programs to lose scarce resources.

During the early 1960s, the Department of Defense (DOD) contracting process was overhauled by then Secretary of Defense, Robert McNamara, in order to ensure that the government did not waste money on cost overruns so that funds could be available to pursue as many projects as possible. One result of this overhaul was an examination of risk sharing between the government and contractor through the contract's fee structure; specifically the use of incentive fees rather than fixed fees in government contracting (Carlilse, 1964).

However, incentive fee contracts, originally believed to be a fundamental solution for the government's cost overrun problem, cannot be effectively implemented due to constantly changing requirements, weak incentives, and lack of negative consequences for contractors who do overrun the negotiated contract value. After a brief review of incentive fee contracts and their inability to motivate firms, this paper will examine other methods used to incentivize executives outside of the government contracting model, such as stock compensation. It will then go on to explore whether stock prices are sensitive to signals provided from customers by looking at two case studies, one for the public sector and one for the private sector. It will conclude by examining possible reasons to explain any disconnects between the stock price and customers' signals and potential ways to align those signals to contractor and executive incentives in order to prevent cost overruns to allow the government to maximize its return on discretionary funding.

Incentive Fee Contracts

When negotiating contracts between the government and a contractor, two considerations are the contract vehicle and the fee structure. During negotiations, the contractor's incentive is to maximize profit, while the government's incentive is to maximize the amount of possible programs (McCall, 1970). Two contract vehicles used in government contracting are fixed fee and cost reimbursable. Within those there are two fee structures: fixed fee and incentive fee. This gives a total of four contract types: Firm Fixed Price (FFP), Firm Price Incentive Fee (FPIF), Cost Plus Fixed Fee (CPFF), and Cost Plus Incentive Fee (CPIF).

It was theorized that CPIF contracting would lower cost overruns by sharing the risk of those overruns between the government and the contractor, while FFP contracts place all the risk on the contractor and CPFF place all the risk on the government (McCall, 1970). By sharing the risk, the contractor was given *incentive* to keep costs down while still meeting the technical requirements of the contract's specifications.

However, the following table shows government programs in the System Design and Development (SDD) phase still face extensive cost overruns (Edwards, 2003):

TABLE 1[1]

Program	Target Cost	Actual Cost	% Overrun	Type of Contract
Global Hawk Surveillance plan	$86M	$123M	143%	CPIF
V-22 Osprey	$36M	$93M	258%	CPIF
RAH-66 Comanche helicopter	$33M	$53M	161%	CPFF
SBIRS Satellite System	$825M	$1.6B	194%	CPFF
Patriot Advanced Missile	$5M	$10M	200%	CPIF
Littoral Combat Ship	$220M	$400M	182%	CPIF

However convincing this data may be, it does not prove that there are persistent cost overruns throughout government contracting. A study performed on 64 defense contracts (for the time period 1977-2000) shows that persistent cost overruns across services, phases of development, and contract vehicle exist (Christensen, 2002). The following table provides a top-level summary of this study:

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[1] The Global Hawk Surveillance Plan, V-22 Osprey, and RAH-66 are all helicopter programs. More specifically, Global Hawk is an Unmanned Air Vehicle (UAV), the V-22 Osprey is a tilt-rotor vertical take-off system, and the RAH-66 Comanche is a cargo helicopter. SBIRS stands for Space Based Infrared System and its primary mission is to provide early warning of a ballistic missile attack on the US, its deployed forces, or allies. The Patriot Advanced Missile is a mobile missile program using guided missiles to simultaneously engage and destroy multiple target types at varying ranges. The data for these programs was taken from the Cato Institute Study. The Littoral Combat Ship (LCS) is a new class of small, stealthy ships designed to support troops ashore and to conduct anti-mine, intelligence, and reconnaissance operations. The data for this program was taken from the Department of Defense Press Office.

<div align="center">TABLE 2</div>

		Contract Overrun ($M)			Contract Overrun (%)		
FINAL COST OVERRUN ON 64 COMPLETED CONTRACTS							
Contract Category	Number	Avg	Min	Max	Avg	Min	Max
All	64	36	-3	493	118%	97%	209%
Army	28	21	-3	46	120%	97%	146%
Air Force	18	49	-2	407	119%	99%	209%
Navy	18	47	0	493	113%	100%	146%
Air	43	45	-3	492	118%	97%	209%
Ground	13	23	7	42	121%	105%	145%
Sea	8	12	0	36	112%	100%	138%
Development	25	38	-2	407	121%	101%	209%
Production	39	35	-3	493	116%	97%	146%
Reimbursable	23	41	-2	493	114%	99%	146%
Fixed	41	34	-3	407	120%	97%	209%

However, the overrun problem is not isolated to the DOD. The following is a sample of federal programs that saw overruns (Edwards, 2007):

<div align="center">TABLE 3[2]</div>

Program	Department/ Agency	Estimate Cost	Year of Estimate	Actual	Year of Actual	Percent Overrun
Kennedy Center Parking Lot	Transportation	$28M	1998	$88M	2003	214%
Denver International Airport	Transportation	$1.7B	1989	$4.8B	1995	182%
Yucca Mountain Radioactive waste	Energy	$6.3B	1992	$8.4B	2001	33%
Weldon Springs Remedial Action	Energy	$358M	1989	$905M	2001	153%
FBI Trilogy Computer System	Justice	$477M	2000	$600M	2004	26%
International Space Station	NASA	$17B	1995	$30B	2002	76%

According to one study[3], once a program is 15% complete and over budget, it is unlikely to recover (in other words it is unlikely to achieve its original target cost) (Christensen, 2002). In fact, it has been shown (statistically significant to a 95% Confidence Level) that cost overruns

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[2] All costs are in budget year dollars; "$M" indicate that the value is in millions of dollars and "$B" indicate that the value is in billions of dollars.

[3] This study did not address government overruns (or overruns due to increases in scope). However, regardless of the cause, it has been shown that cost overruns are persistent in government programs and that once they do occur, recovery from the overrun is improbable (Christensen, 2002).

are likely to increase as the program continues (Christensen, 2002). Another study showed that the DOD has paid out an estimated $8 billion in award fees on contracts, regardless of whether acquisition outcomes fell short of, met, or exceeded the contract expectations (Government Accountability Office, 2006). It was also shown that, despite these payouts, DOD did not compile data or developed performance measures to evaluate the validity of the generally accepted belief that award and incentive fees improve contractor performance or acquisition outcomes (Government Accountability Office, 2006).

It is theorized that one reason that incentive fee contracting is not effective in preventing cost overruns is because the gains from ensuring that the program does not overrun are insignificant compared to other gains the contractor receives. These other gains have a larger effect on what motivates a contractor's upper level management, and thus the contractor's business philosophy. The next section will discuss another incentive problem (that between the contractor and their program managers/executives) and examine how stock compensation is used to align their disparate interests.

Principal-Agent Problem and Stock Compensation

The misalignment of goals between the principal (contractor) and the agent (program managers/executives) is called the principal-agent problem; the problem being that the agent doesn't intrinsically want to do what their principals desire (Beggs, 2015). In other words, the incentives provided to the agents do not lead to an optimal level of effort from the principal's perspective (Beggs, 2015).

To fix the principal-agent problem, wage contracts are used to better align the incentives of the principal and the agent (Beggs, 2015). Principal-agent theory states that firms seek to design the most efficient compensation packages possible in order to attract, retain, and motivate executives and managers (Conyon, 2006). Firms typically use stock options, restricted stock, and long-term contracts, to create a contract to motivate executives to maximize the firm's value (Conyon, 2006).
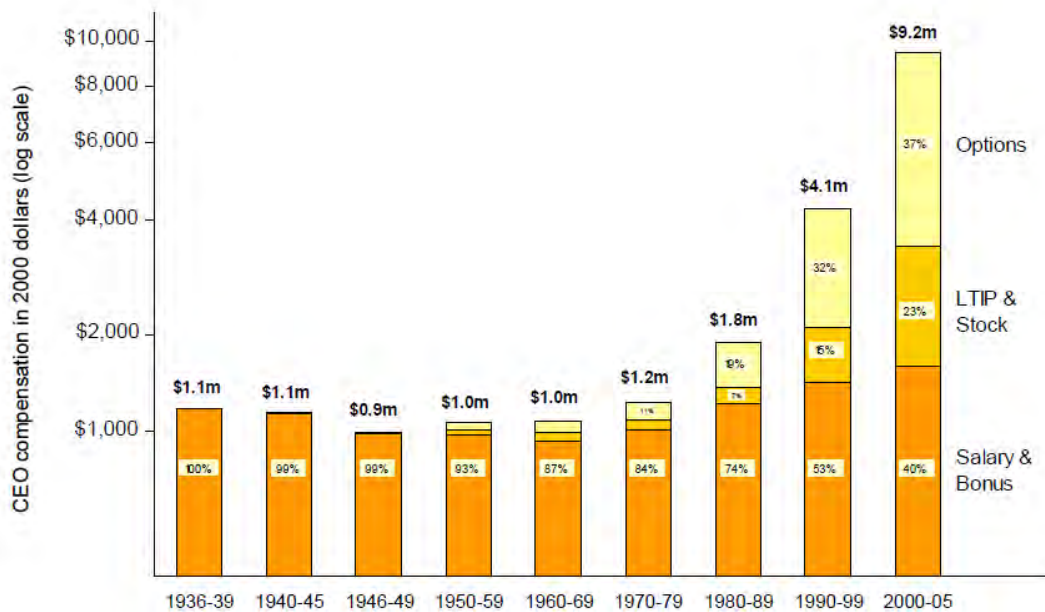
The manager's wage must be at least equal to the wage that he could earn by working elsewhere in the economy, or else the manager would reject the contract with the firm (Paul, 1992). Additionally, the firm sets the wage contract so as to maximize the ex-ante value of the firm while the manager sets their effort level in order to maximize his own utility (Paul, 1992). To provide optimal incentives in a principal-agent problem, we need to weigh information according to how well it informs the principal regarding the agent's contribution or value-added to their firm (Paul, 1992). The optimal weight to place on information about the i-th project will both maximize the firm's expected value and manager's salary while minimizing the manager's effort (Paul, 1992).

To provide optimal incentives in a principal-agent problem, weight information according to how well it informs the firm's owners regarding the executive's contribution or value added to the firm is needed (Paul, 1992). For the stock price (of an all-equity firm) to be an optimal aggregator of information for the incentive problem, it would have to measure the value-added of the manager, instead of the value of the firm's assets (Paul, 1992).

Executive pay consists of a base salary (which is generally benchmarked against peer firms), an annual bonus plan (usually based on accounting performance measures), stock options (which represent the right, not obligation, to purchase shares in the future at some pre-specified exercise price), and additional compensation (including restricted stock, long-term incentive plans, and retirement plans) (Conyon, 2006).

The following graph shows the median level and average composition of CEO pay, over the time period 1936-2005, for a total of 101 firms, displayed in inflation-adjusted 2000 dollars (Jenter, 2010):

FIGURE 1

This figure shows that CEO pay and compensation have changed dramatically over time. The post-World War II era can be divided into two distinct time period. Prior to the 1970s, there are lower levels of pay and only moderate levels of stock and stock option compensation. From the mid-1970s to the end of the 1990s, all compensation components grew dramatically and there was a dramatic increase in executive compensation from stock and stock options. In fact, in the 1990s stock and stock compensation became the largest part of executive compensation at a total of approximately 60% of total compensation (37% from options and 23% from stocks) (Jenter, 2010).

Since stock price is mostly determined by consumer confidence and expected future earnings, the company would want to maximize these factors (Business Intelligence Program Performance Team, 2007). Theoretically, this would provide contractors with incentives not to have negative publicity (which could lower consumer confidence and then lower their stock price). The next

section examines whether customer signals (defined as negative news reports) impact stock prices for both public sector and private sector companies.

Case Studies: Public Sector and Private Sector

Stock price reflects the value of the firm's expected future revenue stream (see Appendix B for further details regarding stock pricing theory). This section examines whether customer signals, defined as negative news reports, provide a strong enough signal to the market that the firm's future revenue stream is endangered. If the signals impact the company's stock price, this could be a more effective motivational tool for government contractors than incentive contract fee structures.

Generally, in order for the news to impact the stock price it must provide a signal to an investor which resolves uncertainty regarding the firm's ultimate payoff (Paul, 1992). Although this paper primarily focuses on government contracting and incentives, two different types of customers were examined as signalers: the government (public sector) and the airline industry (private sector) in order to ascertain if either sector had a stronger signaling mechanism due to the crossover of revenue streams in the aerospace industry (see Appendix B for more information regarding how multiple customers/revenue streams can impact incentives).

First, look at Lockheed Martin as an example of the government customer signaling to the market their dissatisfaction regarding the Joint Strike Fighter (JSF) program. In September 2014, the Government Accountability Office (GAO) published a report that questioned how sustainable the JSF program was and provided eight recommendations to the DOD in order to improve the reliability of its cost estimates and to address the key risks to JSF's affordability and operational readiness (Government Accountability Office, 2014).

The following stock chart shows the six-month period (June 2014-December 2014) surrounding the release of the GAO report (Yahoo Finance):
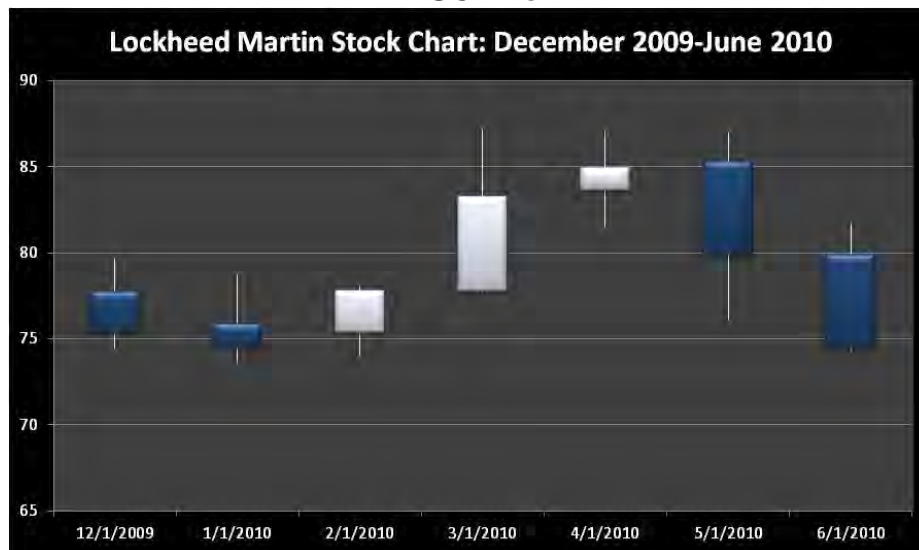
FIGURE 2

The white boxes indicate increasing stock price for that month and the green/blue indicate decreasing stock price for that month. The stock chart shows that, for September and October Lockheed's stock price actually increased. The stock price decreased for the month in June 2014 and December 2014 and was constant for November 2014.

However, conflicting signals were published one week after the GAO report was released; the Street updated Lockheed's stock rating from hold to buy (Schiavo, 2014). This upgrade was based on Lockheed's ability to continue to use its large dividend and buyback to return cash to its investors (Schiavo, 2014). The Street expects that Lockheed will outperform the majority of the stocks that they rate due to its solid performance, good cash flows from operations, growth in earnings per share, increase in net income, and notable return on equity (Schiavo, 2014). The data indicates that the signal from the customer was less important than the signal from a third party regarding the firm's future revenue streams.

Perhaps these signals from the government customer were too general and did not pose a credible threat to the firm's future revenue stream. Indeed, JSF did not take major cuts due to the government sequester in 2013 (Chandrasekaran, 2013). To account for this, another time period with a stronger signal from the customer was examined. In March 2010, the JSF breached its Nunn-McCurdy limits (that is, it exceeded by more than 50 percent its original 2001 baseline) (Reed, 2010). The following stock chart shows the six-month period (December 2009 through June 2010) surrounding the news of the JSF Nunn-McCurdy breach (Yahoo Finance):
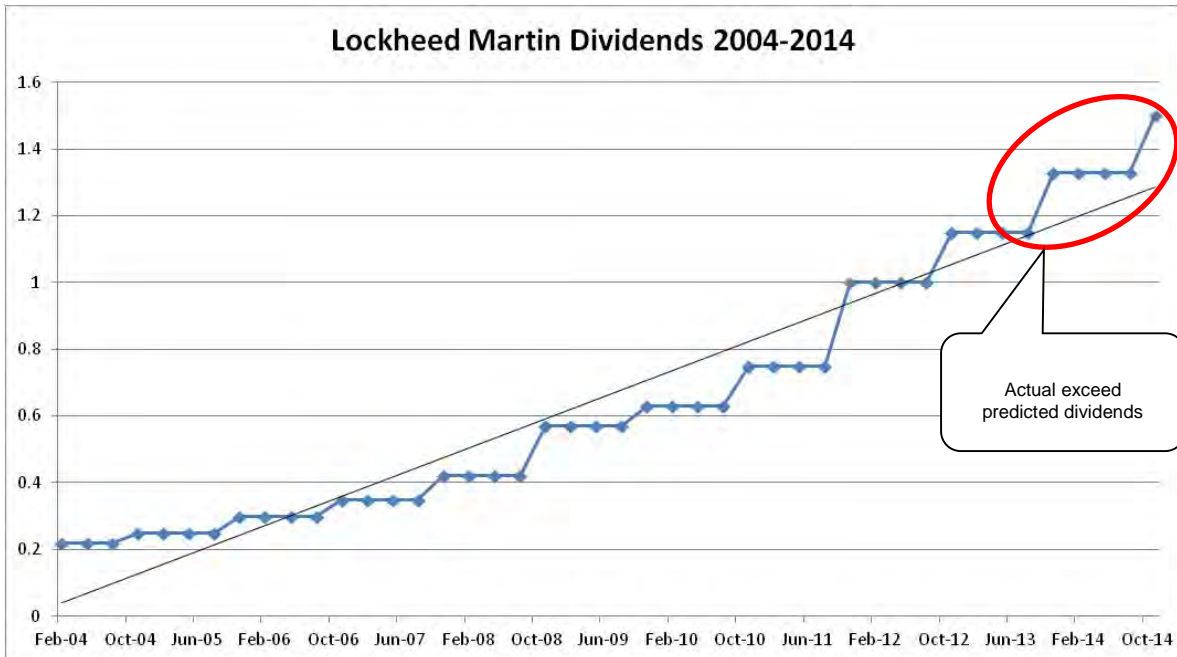
FIGURE 3

Instead of decreasing when the news was announced in March 2010, Lockheed Martin's stock price increased for that month. This could indicate that shareholders expect negative news from the government to translate to additional funding and cash flows for the contractor rather than potential program cancellation.

Next, with respect to the dividend payout method of stock pricing (see Appendix B), the firm's dividend history was reviewed. The following graph shows Lockheed's dividends pay-out per share for the 10-year period of 2004-2014 (Yahoo Finance):

FIGURE 4

The trend line shows that the dividends are growing linearly and that Lockheed Martin's dividends exceeded the predicted value starting in October 2013 (as indicated on the graph). Assuming that the dividend payouts are the firm's signal to the market regarding their future revenue stream, this indicates that dividend payouts are a stronger signal to the stock market than negative signals from customers regarding a product's performance.

Perhaps the signals from the government customer were not strong enough due to the public's perception that poorly managed government programs will not be cancelled, but in fact gain additional funding. To account for that perception and how it might skew these observations of the customer's signals on the stock price, signals from a private sector customer in the same industry were also examined.

In January 2013, it was reported that that Boeing's fleet of 787 Dreamliners was grounded due to a series of incidents that included a battery fire, a cracked windshield, two fuel leaks, and a braking system problem (Riley, 2013). Boeing's stock declined as much as 7% over the weeks following the initial news reports (Vella, 2013). The news also reported that the Federal Aviation Administration (FAA) planned to probe the design and manufacture of the 787s in order to assure their safety (Isidore, 2013). Additionally, the head of Boeing's commercial airplane unit appeared at a news conference confident in the aircraft's safety (Isidore, 2013).

The following graph shows a monthly stock chart for the six-month time period (October 2012 through April 2013) surrounding the initial report of the 787's problems (Yahoo Finance):
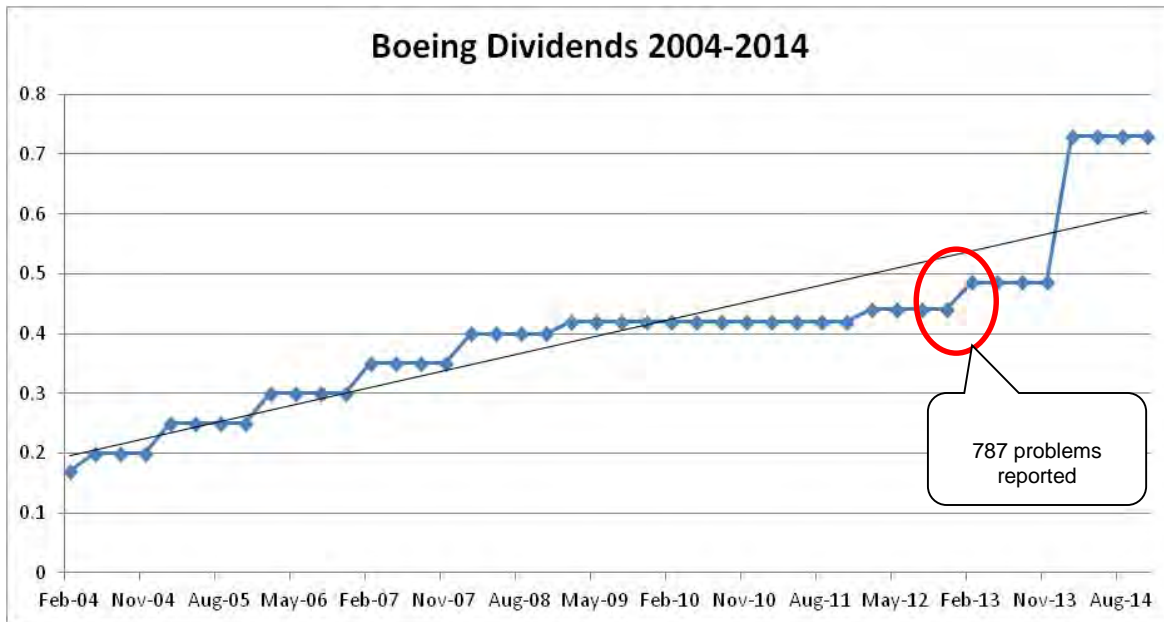
FIGURE 5

Boeing Stock Chart October 2012-April 2013

While Boeing's price did decline in January 2013 (presumably as a result of the negative news regarding the 787 Dreamliner), the decline was only temporary. In fact, Boeing's stock saw significant increases in March and April 2013. There was news provided by Boeing at the time of the Dreamliner incident that signaled there would be no long term problems with the company's revenue stream despite the previously reported problems. In fact, two news articles suggested that Boeing's problems were exaggerated (Riley, 2013) and (Vella, 2013). Additionally, later in January 2013 it was reported that there was doubt that any airline would cancel its order for the 787 (Riley, 2013). The data shows that, in the long term, Boeing's price was unaffected and their dividend stream was uninterrupted.

Again, with respect to the dividend payout method of stock pricing, the firm's dividend history was reviewed. The following graph shows Boeing's dividends pay-out per share for the 10-year period of 2004-2014 (Yahoo Finance):

FIGURE 6

The graph shows that the dividend stream increased slightly each year from February 2004 through February 2008 and remained fairly constant until there was a slightly larger increase in June 2013 and a significant increase from November 2013 to February 2014. Until June 2014, Boeing following a linear trend line with a fairly flat slope when paying its dividends. The June 2014 increase represented an observable and significant increase in Boeing's dividend pay-outs compared to the previous nine years of dividend payments. There was also an increase in dividend payouts in February 2013, directly after the 787 performance problems were reported. This indicates that the stock market is more responsive to news regarding a stock's dividend price rather than news of one specific contract.

Both examples show that the market treats signals from both the public and private sector customers the same way; that is to say, they are largely ignored when determining stock prices. These signals are primarily the "noise" in the model rather than a weight on a complex stock pricing equation. Intuitively investors are interested in a signal to the extent that it resolves uncertainty about the firm's ultimate payoffs (Paul, 1992). The more uncertainty a signal resolves, the more weight the signal receives in the stock price (Paul, 1992); implying signals from customers resolve minimal uncertainty about stock price for the aerospace industry.

This illustrates that the stock price and therefore stock incentives are an ineffective incentive for government contracts. It may be that stock compensation subjects the manager to additional risk by making his compensation a function of industry-specific and economy-wide shocks that are beyond his control (Paul, 1992).

Appendix 1 compares the Boeing and Lockheed stock prices to general market indicators. This analysis shows that the Boeing and Lockheed's stock prices have a positive relationship with overall market and industry indicators and an inverse relationship with the 10-year real interest rate. This implies that the companies' stock prices follow market forces; that executive

compensation depends more on luck (from market increases outside of their control) rather than executive performance and skill when stock is used as the majority of the executive compensation formula.

Furthermore, the stock price can only reflect information available to the stock market. If the market's information is inferior to the manager's, actions that maximize the current stock price will not, in general, be the ones that lead to efficient operation of the firm. Therefore, a rational, efficient market will lead to inefficient operation of the firm when the manager's objective function contains the current stock price (Paul, 1992). In other words, it can be argued that, based on the examination of the stock price shock based on customer signals, the weights on projects are insignificant compared to the weights on overall market information[4].

Alternate Contract Incentives

Since the government's current signals (negative news reports) have minimal to no impact on a contractor's stock price (i.e. investors do not regard these signals to influence the firm's future revenue streams), this section examines other methods the government can use to motivate the contractor. As discussed in Appendix B, a potentially lost revenue stream from one program does not provide enough of a "credible threat" to interrupt a firm's dividend payouts since many large, publically traded companies typically have business in both the private and public sector and multiple streams of revenue in each; negative news for one program may not be seen to impact the future revenues of the overall company[5].

This adds a third dimension to the principal-agent problem; the question becomes how to incentive managers to expend more effort to ensure the success of the programs that the government is interested in and how the firm can maintain as many revenue streams as possible. It has been theorized that only once the federal government can credibly commit to cancelling poorly managed programs will the government be able to decrease the prevalence of cost overruns. However, if there are no other firms that are able to complete a specific program, the government's threat of cancellation will never be credible.

An alternative to cancellation is to align interests between the government (customer) and the principal (firm) and to use incentives to influence agents (executives) to act in those interests. It was shown previously that contract vehicle incentives are not adequate to align the government and firm's interests. It was also shown that the stock price does not adequately capture negative customer signals and, as such, stock cannot be used as a reliable incentive for executives in order to solve this problem. An alternative method could be to place a high value on customer

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[4] An example of this is the increasing demand for military equipment and weaponry due to ongoing global conflicts against the Islamic State and al-Qaeda extremists, Russia's annex of Crimea, and China's dispute over the South China Sea islands (Clough, 2014). Investors see this increase in demand as an increase in future revenues and as a result, three of the Pentagon's largest contractors saw increases of approximately 19% from January through September 2014 (Clough, 2014).

[5] The ratio of a company's public and private sector revenue streams was not considered as part of this analysis. However, the amount of public sector revenue vs. private sector revenue and whether this has an impact on how customer signals influence that company's stock price is an area for future study.

(government) feedback so that the feedback will be applied to future acquisitions in order to impact the firm's revenue streams. Or, the customer (government) could tie that feedback to executive bonuses (provided those bonuses are a meaningful percentage of their pay).

However, the use of customer feedback to determine executive's bonuses may be hard to implement in the cases where the principal's interests are different or even contrary to the interests of their customers. In that case, customers can ignore the principal-agent problem and use other market forces to incentivize their contractors. The United States Citizenship and Immigration Services (USCIS) Flexible Agile Development Services (FADS) contract is one example how the government used innovative contracting methods to incentivize their desired performance from contractors.

The FADS contract was initially awarded to four contractors with a 6-month base period and additional 6-month follow on options. Each of the four contractors were awarded two agile software development teams. High performers could be awarded more teams during the option periods while low performers would not have their options picked up. This contract structure aligns the government and contractor goals; where the government receives high performing teams and contractors receive additional revenue streams (more teams) based on that performance. In this case, the government used market forces (limited competition) to achieve this result. Additionally this could help solve the principal-agent problem faced by the firm since owners find it more difficult to monitor managers in larger firms and are more likely to use equity incentives as a substitute for monitoring (Conyon, 2006). However, this method of contracting might not be feasible for industries where limited competition is not available, as is the case in the aerospace industry where high barriers to entry create natural oligopolies.

Alternatively, the customer could seek to align their interests with executives rather than the firm. This could mean excluding the principal (firm) from the incentive scheme and potentially shift the executive's incentive to align with the government rather than the firm. For example, the government could personally reward executives a percentage of cost savings realized on a program by program basis. However, these types of personal incentives may not be realistic for many reasons, one of which is the ability of the government to fairly implement this practice across all its programs.

Conclusion

There are many competing incentives in the contracting process. Customers and contractors often do not have the same interests and incentive fee contracting has shown to be ineffective to align these interests. Furthermore, as shown in the Lockheed Martin and Boeing case studies, customer signals has proved an ineffective mechanism for customers to influence stock price; and thus motivate executives paid in stock and stock options to act in a way desired by the customer. In fact, customer signals have negligible impact on stock prices; which are more closely related to overall market news and trends.

This paper proposes several methods to better align these conflicting interests. First, the government could provide a credible threat to program cancellation for poorly performing programs in order to threaten their future revenue streams. However, this may not be effective if

the firm has multiple other revenue streams. Additionally, if there are no other firms that are able to complete the program, the government's threat of cancellation will never be credible. Second, align executive pay, specifically bonuses or a significant allotment of total compensation, with customer feedback. This may be unrealistic to implement if firms and their customers have competing and contradictory interests. Finally, use innovative short term contracts to create competition between firms for future revenue streams. This aligns customer and firm purposes and incentivizes executives to a higher performance, however, it may be difficult to implement for those industries that have significant barriers to entry.
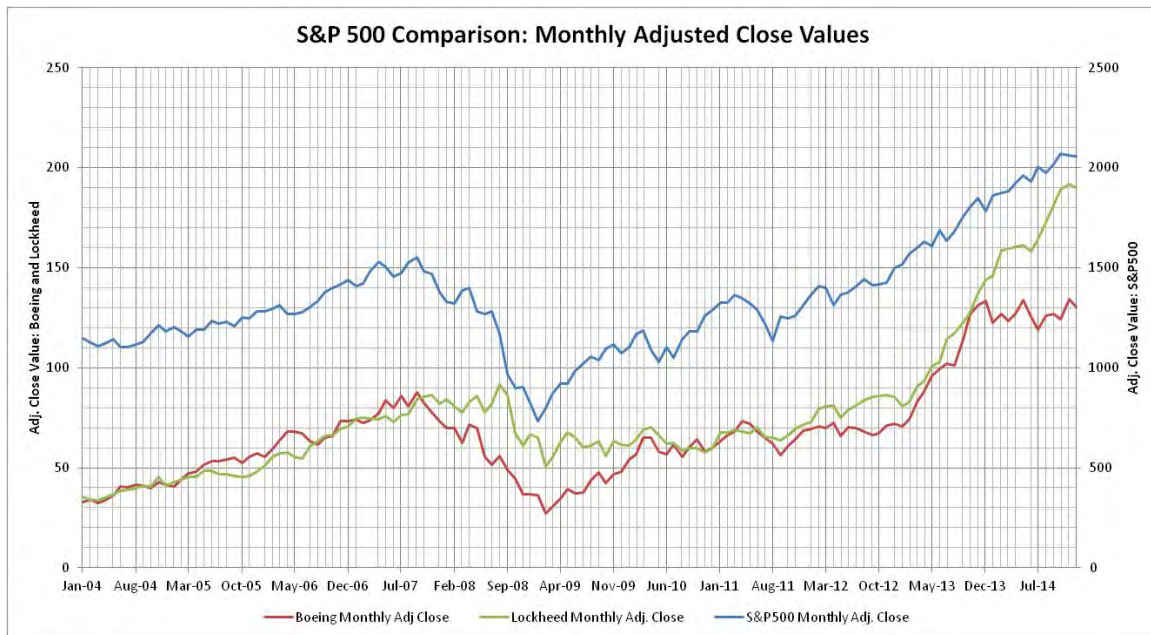
This paper also mentions several areas of additional study that can be explored to better understand contract incentives. One is to examine the firm's ratio of public vs. private sector work to determine if differences in the source of revenue streams indicate that customer signals would have more impact on companies with less public sector revenue than private sector revenue (or vice versa). Another is to look at the impact program cancellation has had on the stock prices of companies in the past to determine if there are different impacts for industries with different degrees of barriers to entry in order to ascertain whether program cancellation provides a strong signal to the stock market and stock prices for certain industries.

Appendix A: Additional Market Analysis

This Appendix examines, at a top level, the relationship exhibited between Lockheed Martin and Boeing stock prices and leading market indicators. First, the Standard and Poor's 500 (S&P500) index[6] is examined as a representation of the overall economy. Next, the Aerospace Standard and Poor's Depositary Receipt (SPDR)[7] account (XAR) is examined as a representation of the aerospace industry. Finally, the 10-year treasury yield rate was examined as a representation of the rate of return used in the dividend discount model (see equation 1).

The following graph shows the S&P 500 Index monthly adjusted close values compared to Boeing and Lockheed Martin's monthly adjusted close values from 2004-2014:
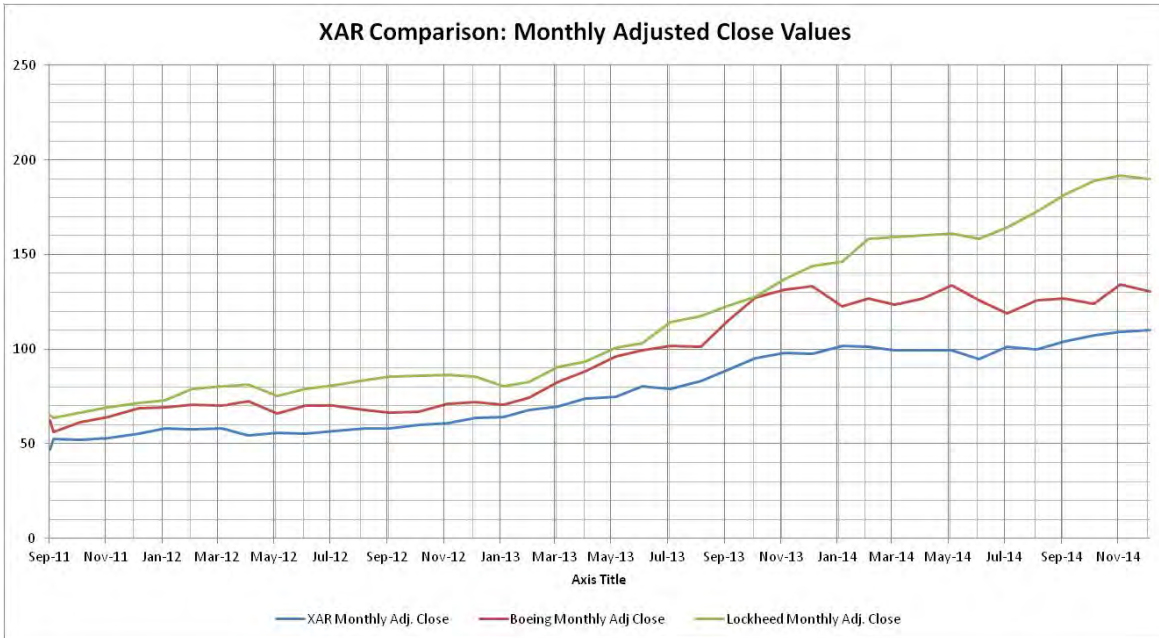
GRAPH A1

The following shows the XAR monthly adjusted close values compared to Boeing and Lockheed Martin's monthly adjusted close values from September 2011-December 2014:

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[6] The S&P500 is a stock market index based on the market capitalizations of 500 large companies having common stock listed on the New York Stock Exchange (NYSE) or the National Association of Securities Dealer Automated Quotation (NASDAQ) system. S&P 500 stocks are chosen for market size, liquidity, and industry grouping and the index is considered the leading indicator of US equities. The S&P500 was developed in order to reflect the risk/return characterization of the large capital universe (Investopedia Dictionary).
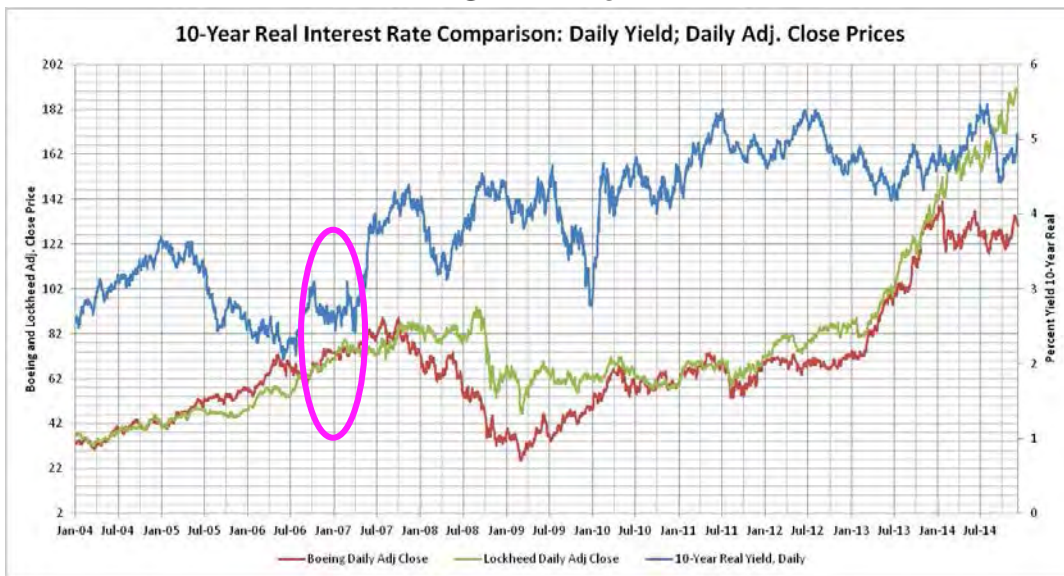
[7] A SPDR (called a "spider"); is an exchange traded fund (EFT) and generally track specific industries or sectors. For example, ticker symbol "XLU" is a SPDR that tracks utilities and ticker symbol "XLE" tracks the energy sector (State Street Global Advisors).

GRAPH A2

The following graph shows the 10-year treasury daily yield interest rate compared to the Boeing and Lockheed Martin daily adjusted close price from 2004-2014:

GRAPH A3

Graph A1 shows that, for the most part, both Boeing and Lockheed stocks' mimic the S&P500. Likewise, Graph A2 shows that both the Boeing and Lockheed stocks follow the same path as the XAR. However, Graph A3 shows that there is an inverse relationship between the stock prices (Boeing and Lockheed) and the bond yield rate (10-year real treasury rate). For example, in the circled part of the graph, the 10-year daily yield is decreasing but both stock prices are increasing. This is expected based on the inverse relationship between the risk free rate of return

and stock price in the dividend discount model (see Appendix B, equation B1). That is, the price to earnings ratio of a company is the inverse of the risk-free rate of return available from treasury bonds (Carr, 2004). In other words, as interest rates increase, earnings yields must also increase to attract investor demand (Carr, 2004).

Graphs A1, A2, and A3 show Boeing and Lockheed's adjusted close prices follow expected market trends; that is, they have a positive relationship with those funds used to measure the overall market and their specific industry (S&P500 and XAR, respectively) while showing an inverse relationship with the 10-year treasury yield rate. This indicates that stock prices for these companies are responsive to shifts in the overall market economy.

Appendix B: Stock Pricing Theory

This appendix provides an examination of stock pricing theory at a high level in order to better understand the underlying components of a company's stock price. By understanding the theory behind how a stock price is calculated, its effectiveness as an incentive in the firm's principal-agent problem can be observed. Additionally, stock pricing theory can help illuminate what impacts a company's stock price and how the government can potentially use those variables to motivate the agent and/or their principals.

In general, stock prices fluctuate due to market forces (Investopedia Staff). For example, if more people want to buy a stock (demand) than sell it (supply), then the price moves up; conversely, if more people wanted to sell a stock than buy it, there would be greater supply than demand, and the price would fall (Investopedia Staff). While this theory is straightforward, the underlying principal regarding what makes people like one stock over another is difficult to understand (Investopedia Staff). Specifically, this comes down to figuring out what signals are positive for a company and what signals are negative (Investopedia Staff).

However, the driving force behind this theory is that the price movement of a stock indicates what investors feel a company is worth and the growth that investors expect in the future (Investopedia Staff). The reason behind this is that analysts base their future value of a company on their earnings projection (Investopedia Staff). If a company's results surprise (are better than expected), the price jumps up; if a company's results disappoint (are worse than expected), then the price will fall (Investopedia Staff).

One concern investors in the stock market look at is how to predict the firm's future payoffs. Thus, the stock market weighs each signal according to how much of the uncertainty about the firm's future profits it resolves (Paul, 1992). One signal of the firm's future revenue stream is their dividend pay-outs. In fact, there are many theories that use dividend prices to predict future stock prices.

One of these theories, the dividend discount model, states that stocks are worth the present value of the firm's future stream of dividends. That is (Schroy, 2003-2005):

$$\textbf{Stock Value = D / (I – G)} \qquad \textit{(equation B1)}$$

Where
D= the current dividend
G= the dividend's growth rate (assuming that the dividend grows at a constant annual rate)
I = the expected interest rate

This model is also called the constant growth dividend discount model and uses the dividends (also called income) to generate the stock's intrinsic value (Lan, 2014)[8]. In other words, the

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[8] Note that the dividend discount model cannot be used to determine the stock price for companies that do not pay a dividend. Generally, smaller companies in high-growth phases do not pay dividends, as most earnings are retrained in order to fund expansion and even some mature companies do not pay dividends and choose to return cash to

formula takes the expected future dividend stream of a company and discounts it back to its present value (Lan, 2014). This model is best used for large, stable companies that have consistent earnings and dividends; however, it can also be used for small and medium sized firms that are growing their earnings and dividends steadily (Lan, 2014). As with any model, the output generated is only as good as the quality of the factors going into the calculation. Dividends and earnings information is widely available, but the required rate of return and growth rate of dividends require assumptions to be made (Lan, 2014).

It has been shown that when the market can observe each program's rate of return with equal precision, stock compensation adheres to the following principals (Paul, 1992):

i. The weight on any given project in managerial compensation is independent of the marginal productivity of the effort in the project
ii. The projects that are noisiest indicators of managerial effort receive the most weight in compensation
iii. Investors have the greatest incentive to collect information about projects that are the noisiest indicators of marginal effort

The more uncertainty that the signal resolves about firm payoffs, the more weight the signal receives in the stock price (Paul, 1992). However, if the signals cannot be directly contracted upon, the firm may have no choice but to include the stock price in management compensation, but it cannot rely on the stock market to aggregate information optimally for the principal-agent problem (Paul, 1992). In other words, stock compensation (a key element used to incentivize executives) could skew performance due to outside market forces.

Additionally, the desire to increase the stock price could also create incentives for agents to bid unrealistically in order to win the contract and secure future revenue streams. This would, theoretically, increase the firm's stock price regardless of whether the contract is successfully executed or not. However, if the government contractor has a significant amount of business from the private sector for their fully developed products that are already in production (e.g. commercial aircraft), then they have little incentive to complete the government contract after they've won it. It would be enough to win the contract, which would increase expected future revenue and thus increase the stock price. Then, the contractor could use the reimbursable contract to further research and development while earning profits from programs/systems already in production[9].

Moreover, it is assumed that negative news regarding future cash flows will have a negative impact on a company's stock price. However, due to the firm's many streams of revenue, how long these customer signals will impact the stock price is uncertain.

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investors through share repurchases (Lan, 2014). For that reason, this paper uses companies that do provide dividend payouts for all examples.

[9] In the terms of the principal-agent problem, the government would be the customer.

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