

# **Hyperbolic Discounting & Defense Acquisitions**

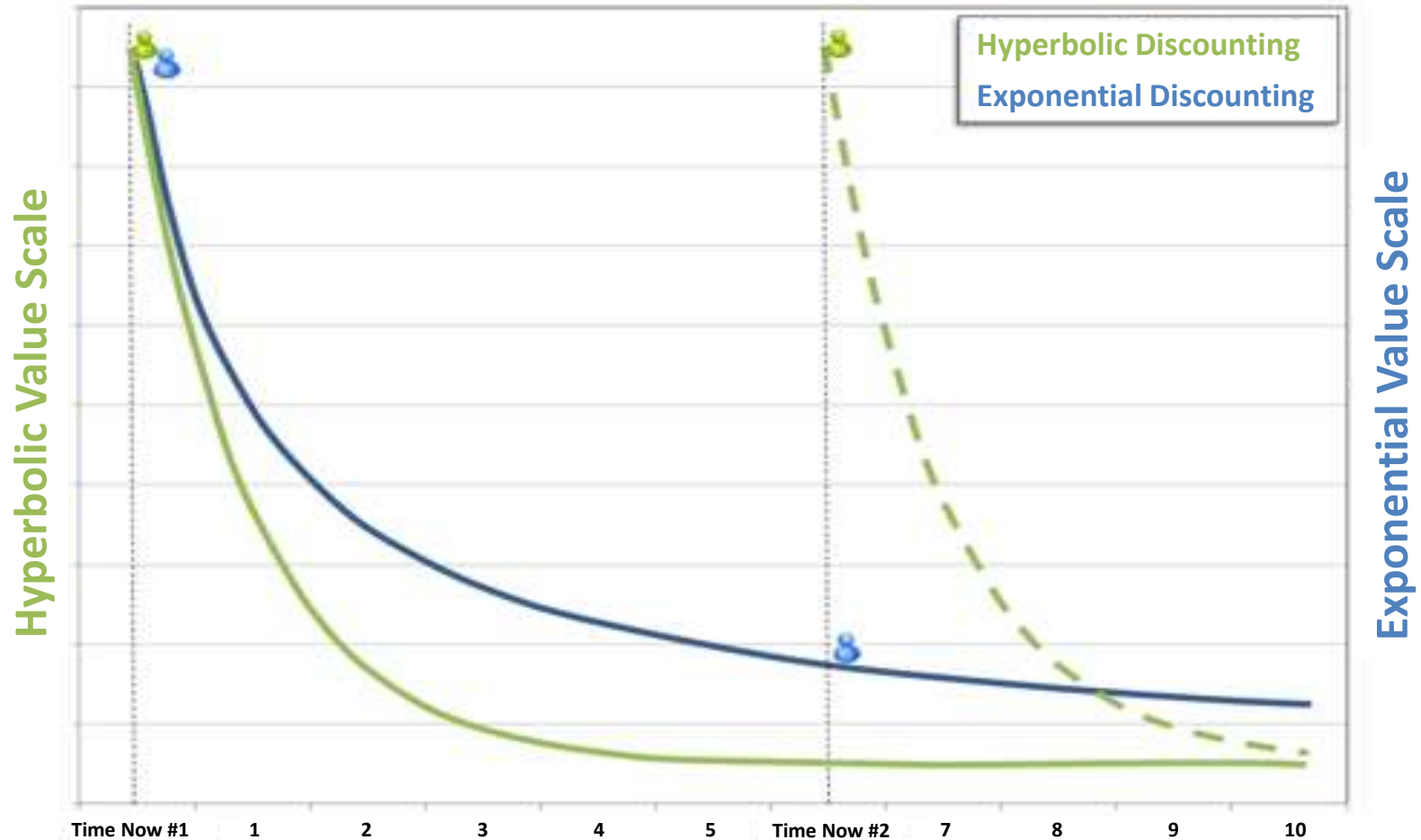
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ICEAA 2015, San Diego

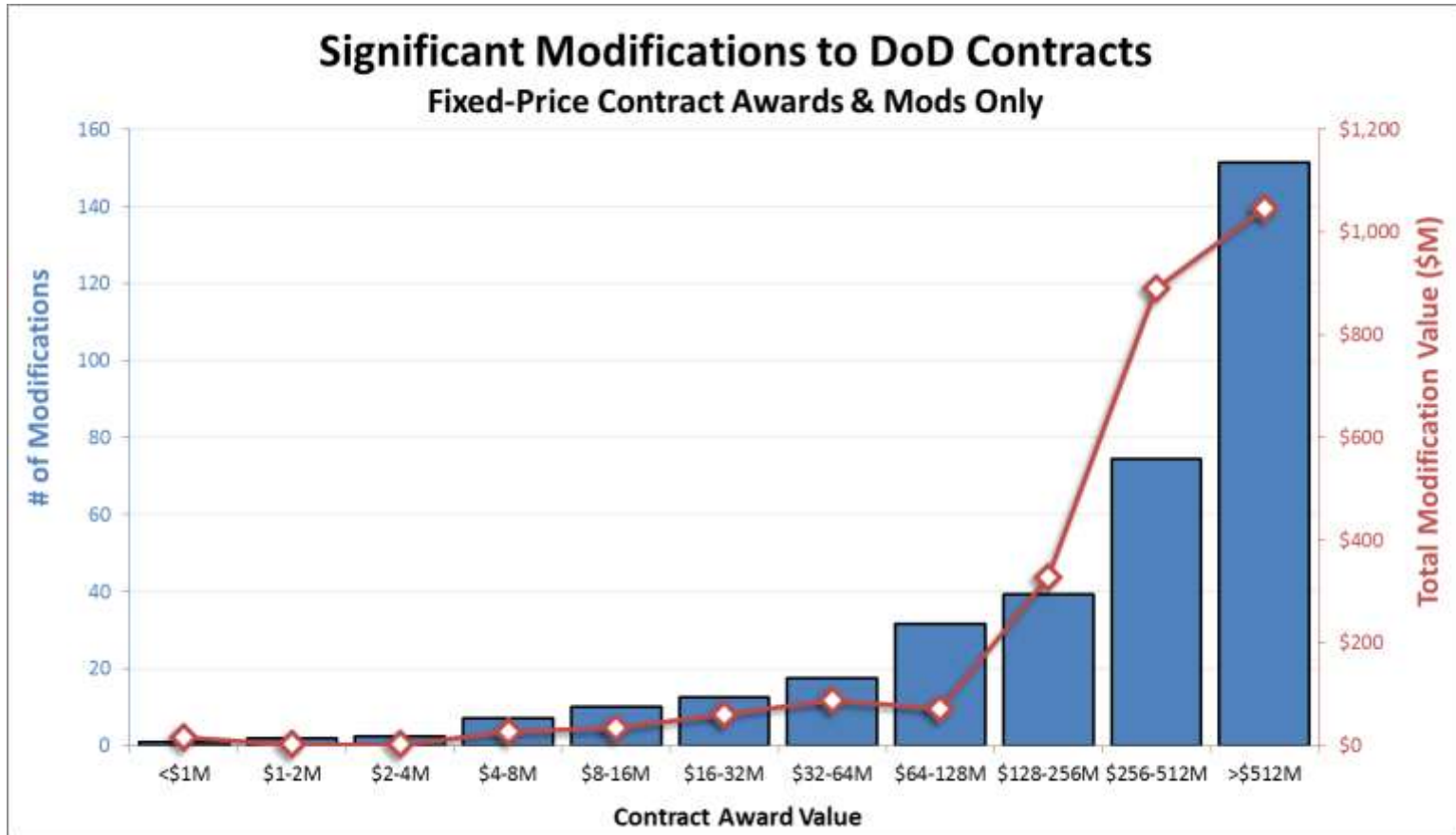
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# What is Hyperbolic Discounting?



- Exponential function is smooth with a constant unit discount rate regardless of timeframe
  - Mirrors expected growth of pecuniary investment opportunities
- Hyperbolic function is steep in the short-term and relatively flat thereafter
  - Reflects personal valuations
  - Continually reconsidered at each instance in time

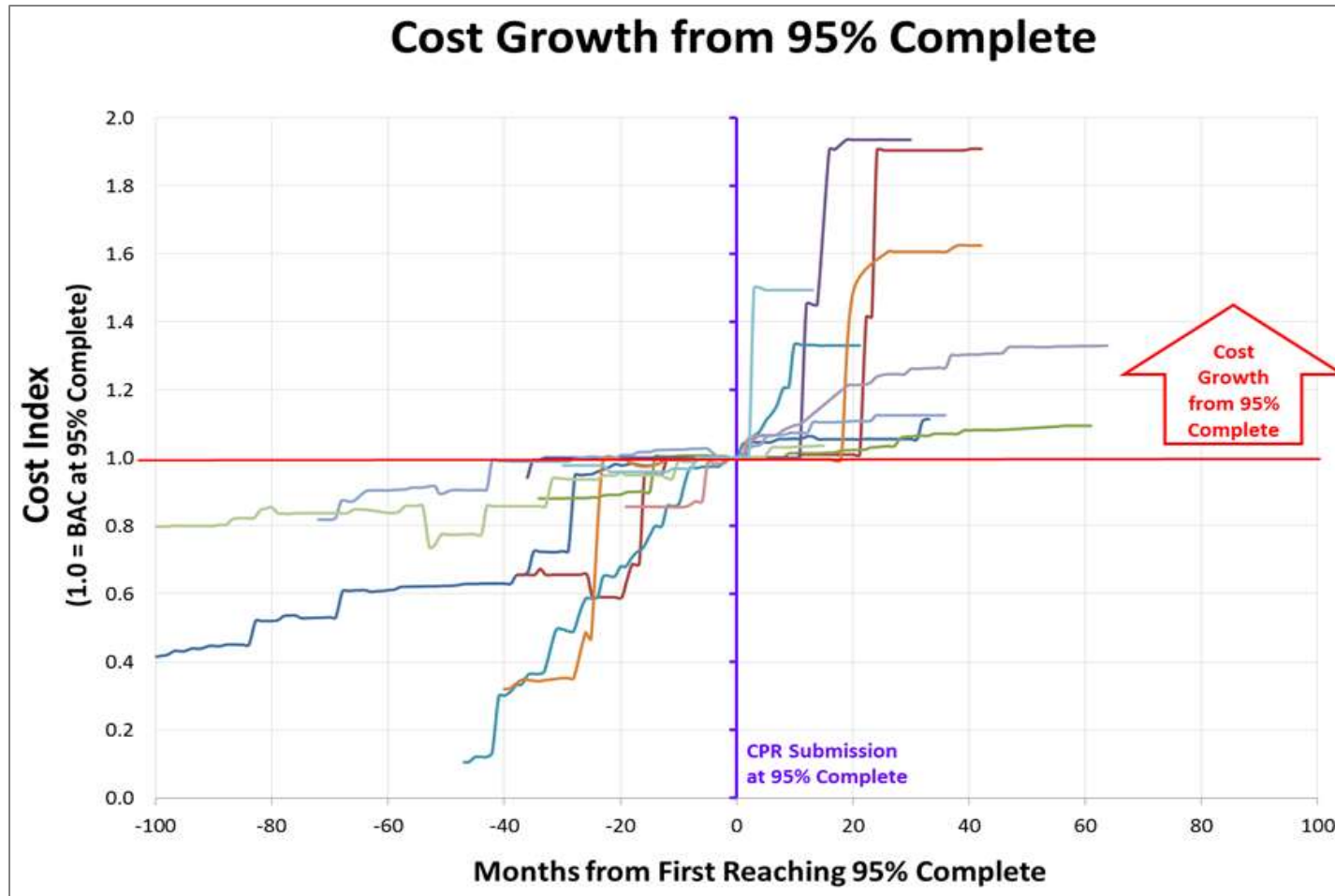
# Impacts of Incomplete Contracting



*Source: Air Force Cost Analysis Agency (AFCAA) Contracts Database (Publically Available). Includes 4,073 fixed-price contracts from across the military services dating back to Aug. 1991. Accessed November 11, 2014.*

- Extensive requirements documentation cannot offset the need for contract mods
  - **Coase:** contracting less desirable the longer the term or less specifiable the requirements
  - **Jensen and Meckling:** “collocation” of production knowledge and decision-rights
  - **Hayek:** gov’t retention of decision-rights necessitates planning on a similar scale as the contractor themselves and shrouds responsibility for poor performance

# Additional Avenue for Contract Mods

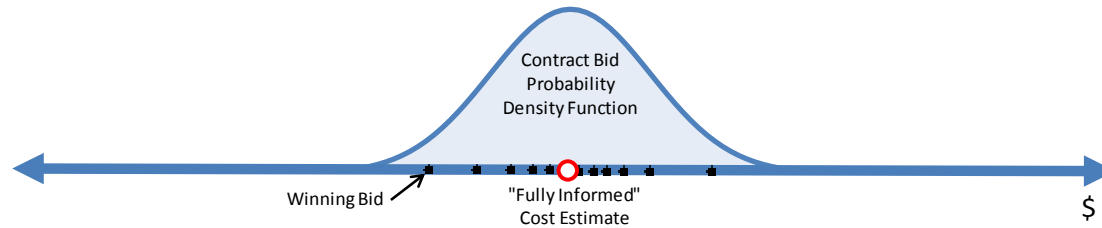


*Source: Earned Value Management Central Repository (EVM-CR). Sample includes 11 MDAP Contract Performance Reports (CPRs). BAC stands for Budget at Complete. See <http://dau.mil> for additional information.*

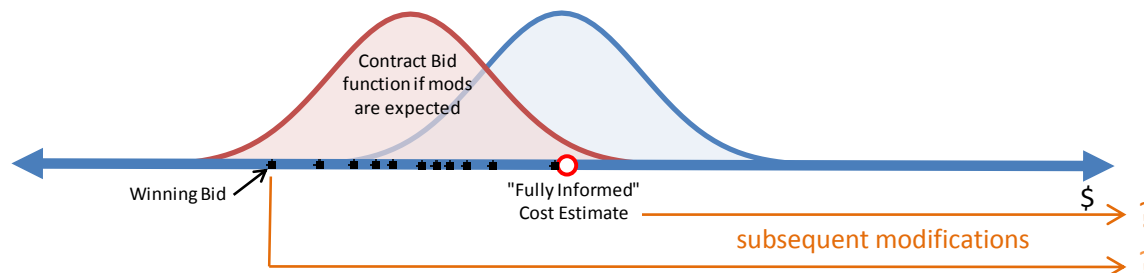
- Significant budget growth due to marginal new scope added to the existing contract vehicles
  - Consequence of “price aggressively, budget conservatively”

# Are Contract Bids Biased Downwards?

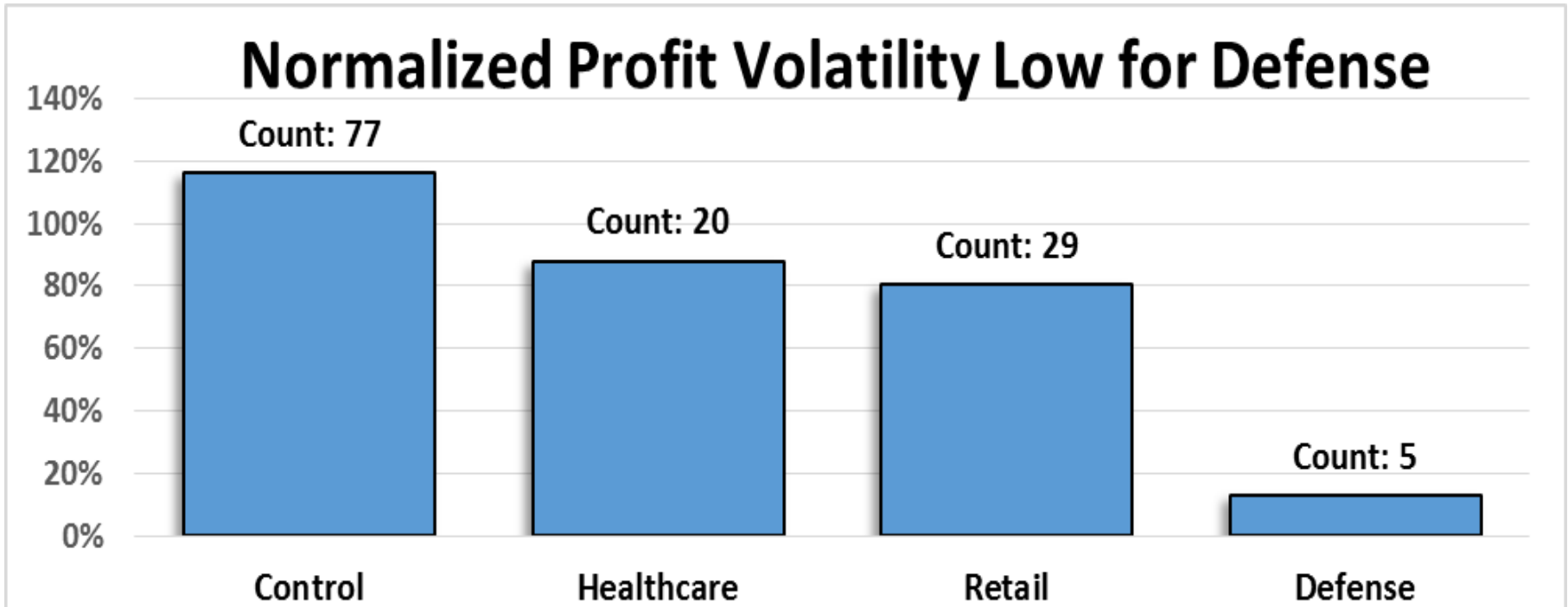
- The government awards contracts using a procurement, or reverse, auction whereby the lowest bidder wins the work
  - Each contractor, with equal efficiency assumed for analytical traction, has a “signal” to the potential contract costs
  - Signal errors are also assumed to be approximately NIID $\sim[0, \sigma^2]$
  - **“Winner’s Curse”**: the winning bid is biased downward and the contractor is expected to make a loss



- What if contractors anticipate contract modifications which partially alleviates the expected loss of an underestimate?
  - Market Feedback Problem: firm’s speculation is not disciplined by endogenous profit/loss feedback
  - Too Big to Fail Problem: firm may believe the project or company itself will be bailed out of poor performance – *see also hiding hand principle*
  - How might this effect the winner’s curse problem? (**Winner’s Blessing**)



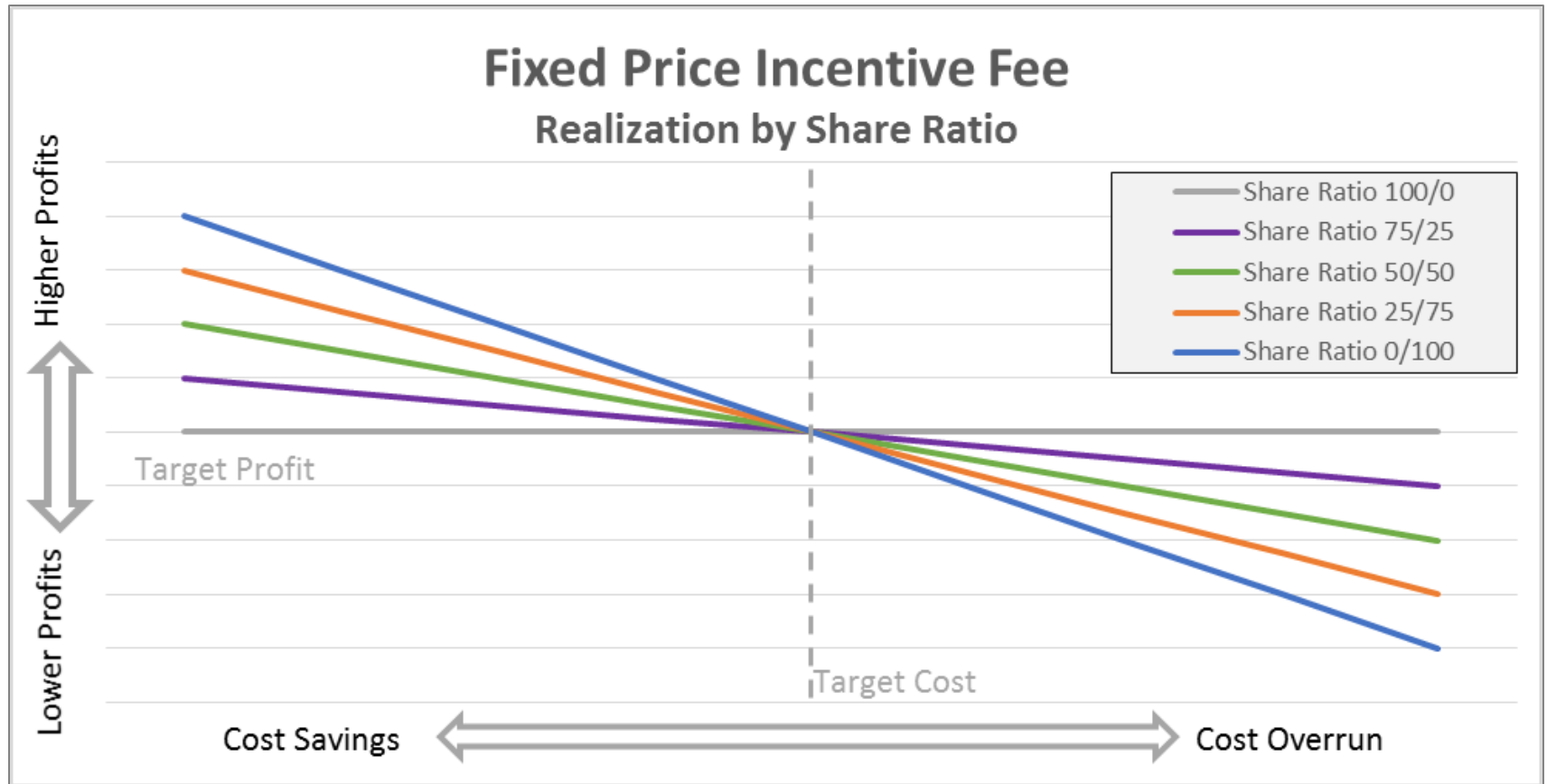
# Aggregate Financial Effect of Mods



*Source: Google finance accessed through 'R' quantmod package. 20 healthcare companies from the NYQ list under Yahoo Biotechnology, Drug Manufactures – Major, and Hospitals. 29 retail companies in NYQ list under Yahoo category names Restaurants, Grocery Stores, and Department Stores. Defense firms include Lockheed Martin, General Dynamics, Boeing, Northrop Grumman, and Raytheon. Second tier defense firms not used because they tend to receive a majority of their revenue from defense primes as opposed to the government itself. Control group of 77 companies from a simple random sample of other company names. Gross Profits as percent of Total Revenues over four years (2010-2013) used to determine mean and standard deviation for each sector, the latter being divided by the former to derive the metric used in the chart.*

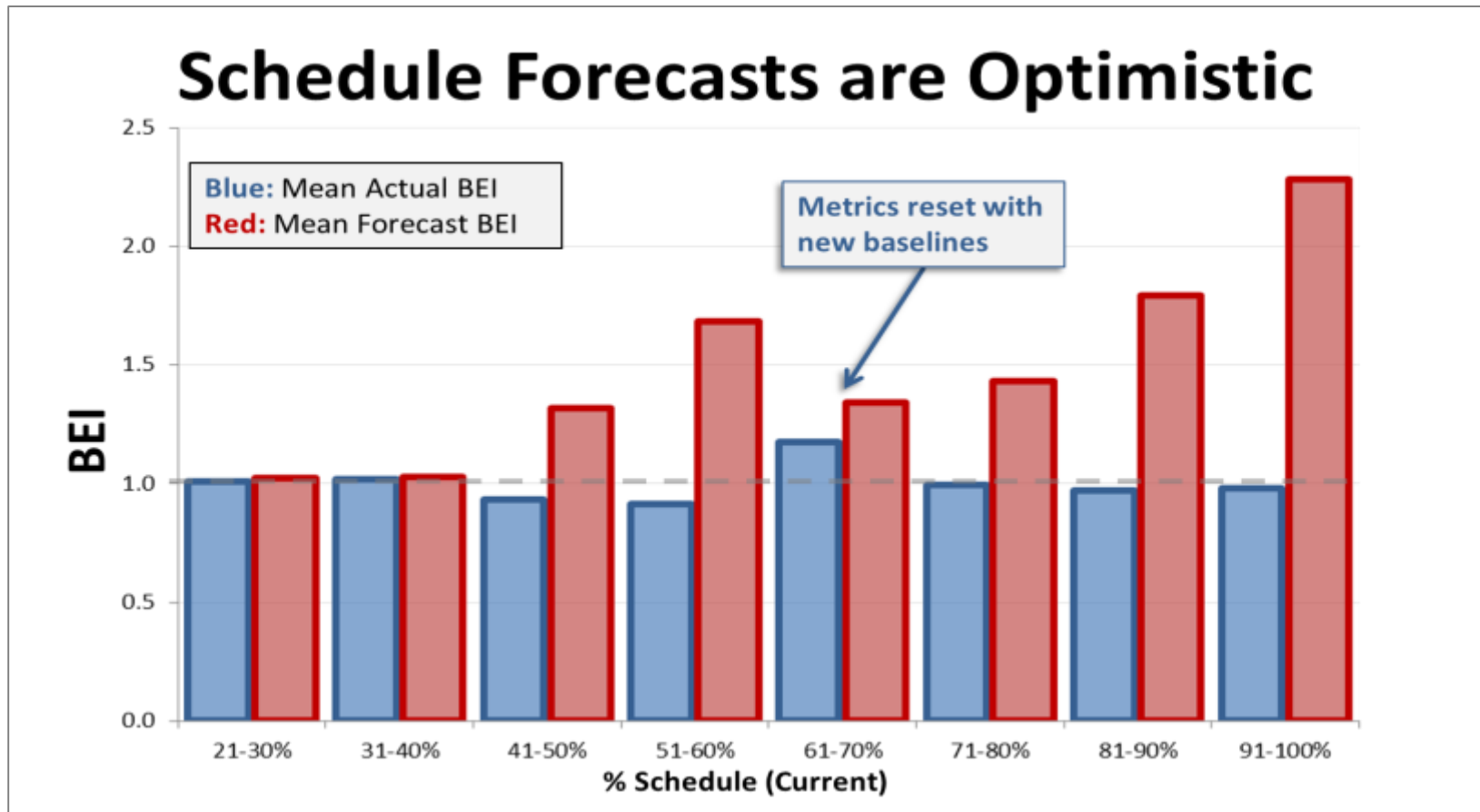
- DellaVigna and Malmendier (2004): profit-maximizing firms price investment goods below marginal cost for consumers who are overconfident about future self-control
  - Back-load fees and transaction costs (e.g. credit cards, health clubs, life insurance, etc.)
- Overpriced new scope translates to high profitability on that work – or the ability to cover overruns on baseline scope
  - Defense contractors also may expect to recoup costs through follow-on work

# Linear FPIF Schemes



- When system attributes are proven and stable, performance parameters do not need to be incentivized so much as overall cost reductions through efficiency gains
  - e.g. 25:75 share ratio means that for every dollar the contractor completes the order less than the target cost and within the range of incentive effectiveness, 25 cents is returned to the government and the contractor receives 75 cents in addition to the target profit

# Evidence of CAM Time-Inconsistency

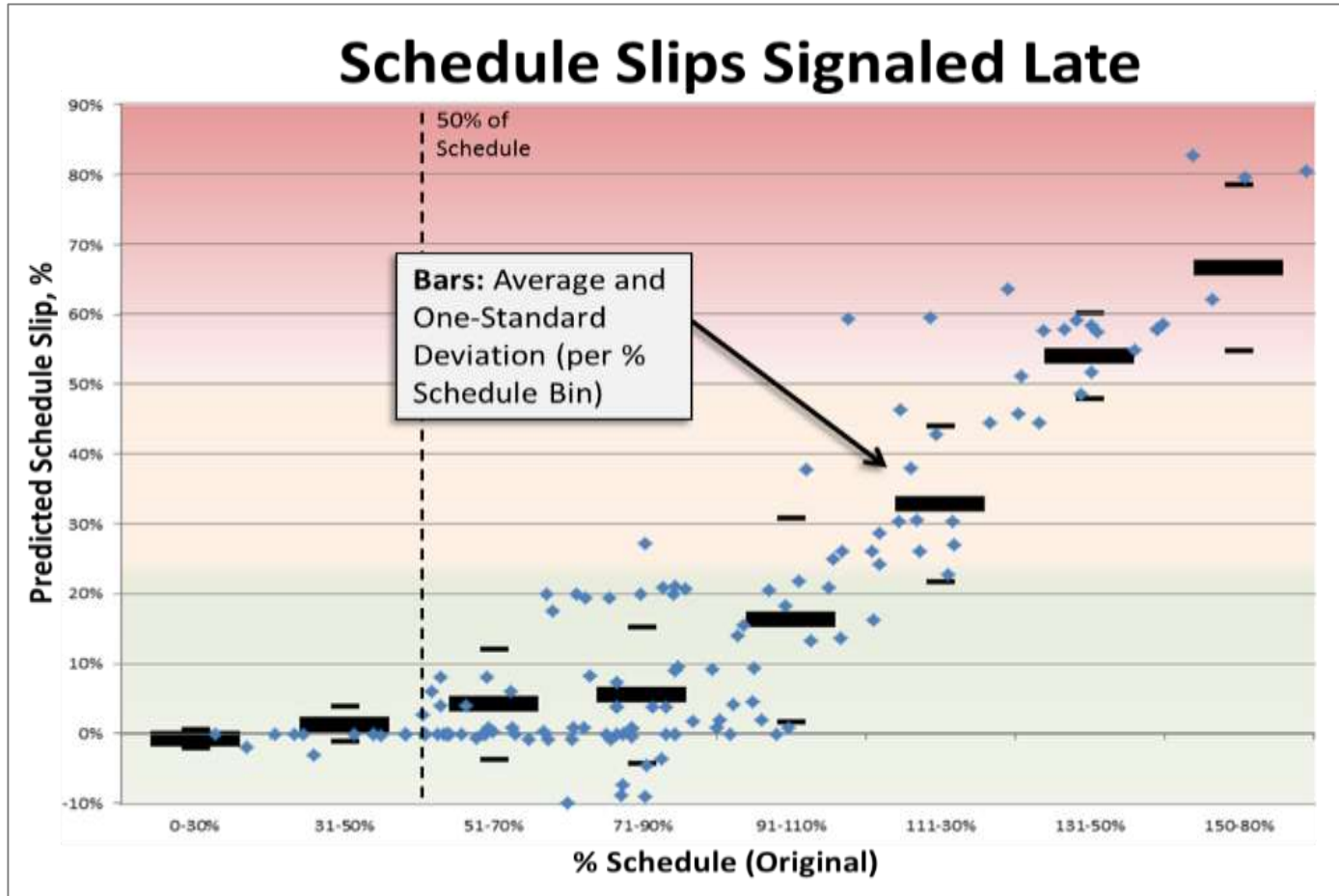


Source: Lofgren, Eric. "Trust, but Verify – An Improved Estimating Technique Using the Integrated Master Schedule." ICEAA 2014.

- The Baseline Execution Index (BEI) indicates the efficiency with which tasks have been accomplished when measured against the baseline
  - Despite actual performance (blue) staying flat or falling, the forecast task performance (red) climbs to implausibly high levels
  - CAMs within the sample overestimate their ability to execute in the future



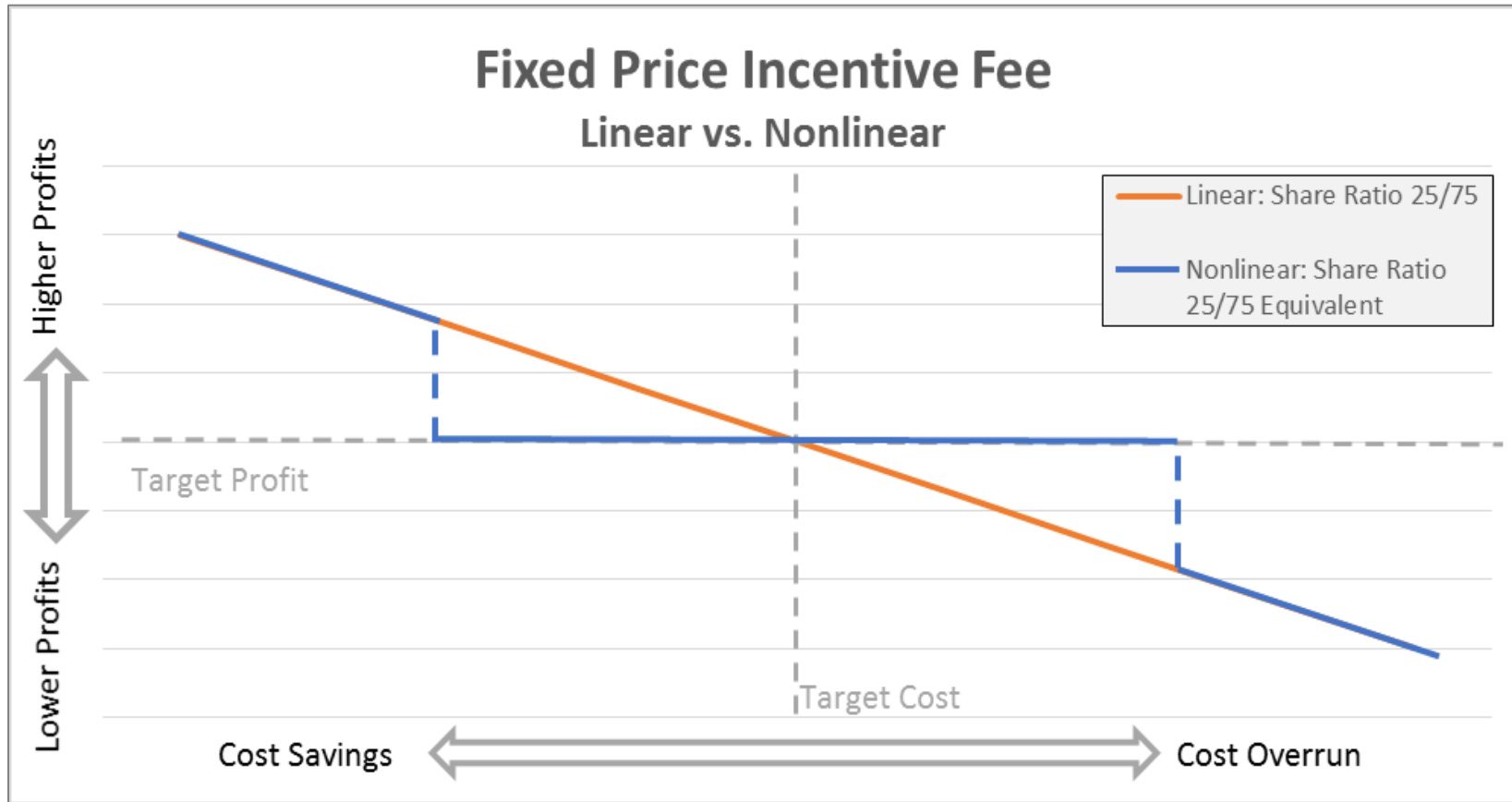
# Evidence Continued...



Source: Lofgren, Eric. "Trust, but Verify – An Improved Estimating Technique Using the Integrated Master Schedule." ICEAA 2014.

- The result of CAMs optimism is that the IMS does not alert management to likely schedule slips until relatively late
  - Exhibits the constant repudiation of past plans
  - We would expect forecast performance to reflect actual performance and schedule slips to be reported earlier if CAMs acknowledged their tendency to discount hyperbolically

# Incentivized Commitment Scheme



- For production with long time horizons, lags between work output and subsequent revenues generate suboptimal effort in the early stages
  - Kaur, Kremer, and Mullainathan find that nonlinear contract incentives can induce up-front productivity

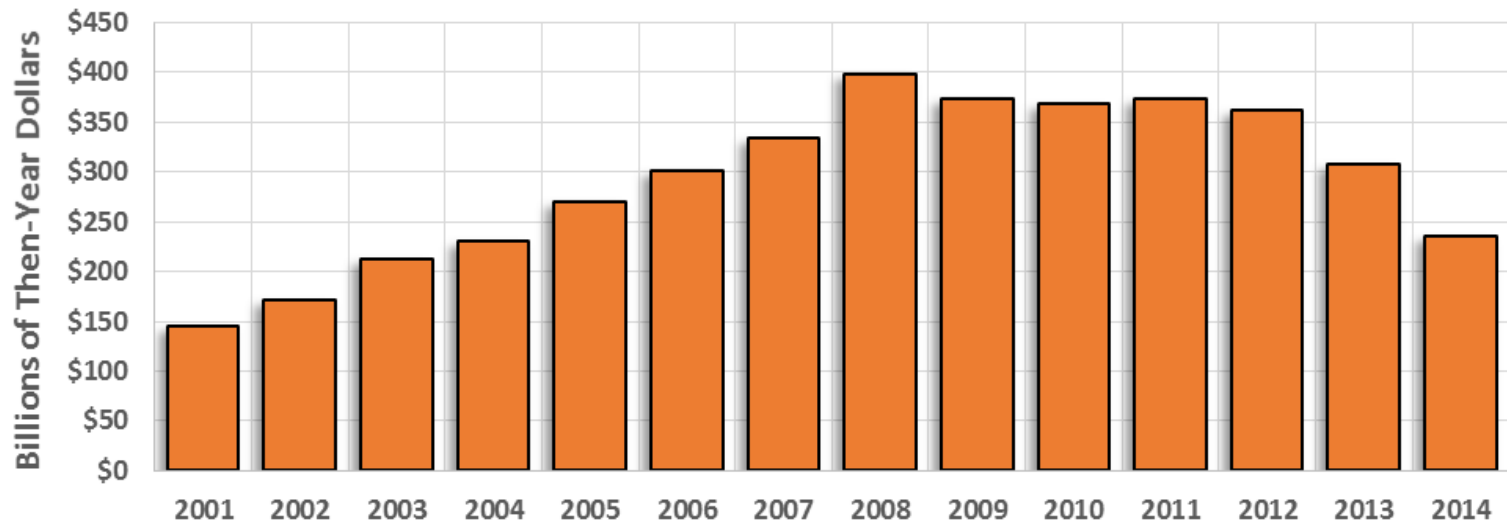
# Conclusion

- Reasonable justification provided that both government agents and contractor management portray time-inconsistent behavior
  - May lead to poor contract performance and cost growth
- Importance of institutional arrangements and human behavior in cost outcomes
  - e.g. commitment mechanisms to overcoming time-inconsistency

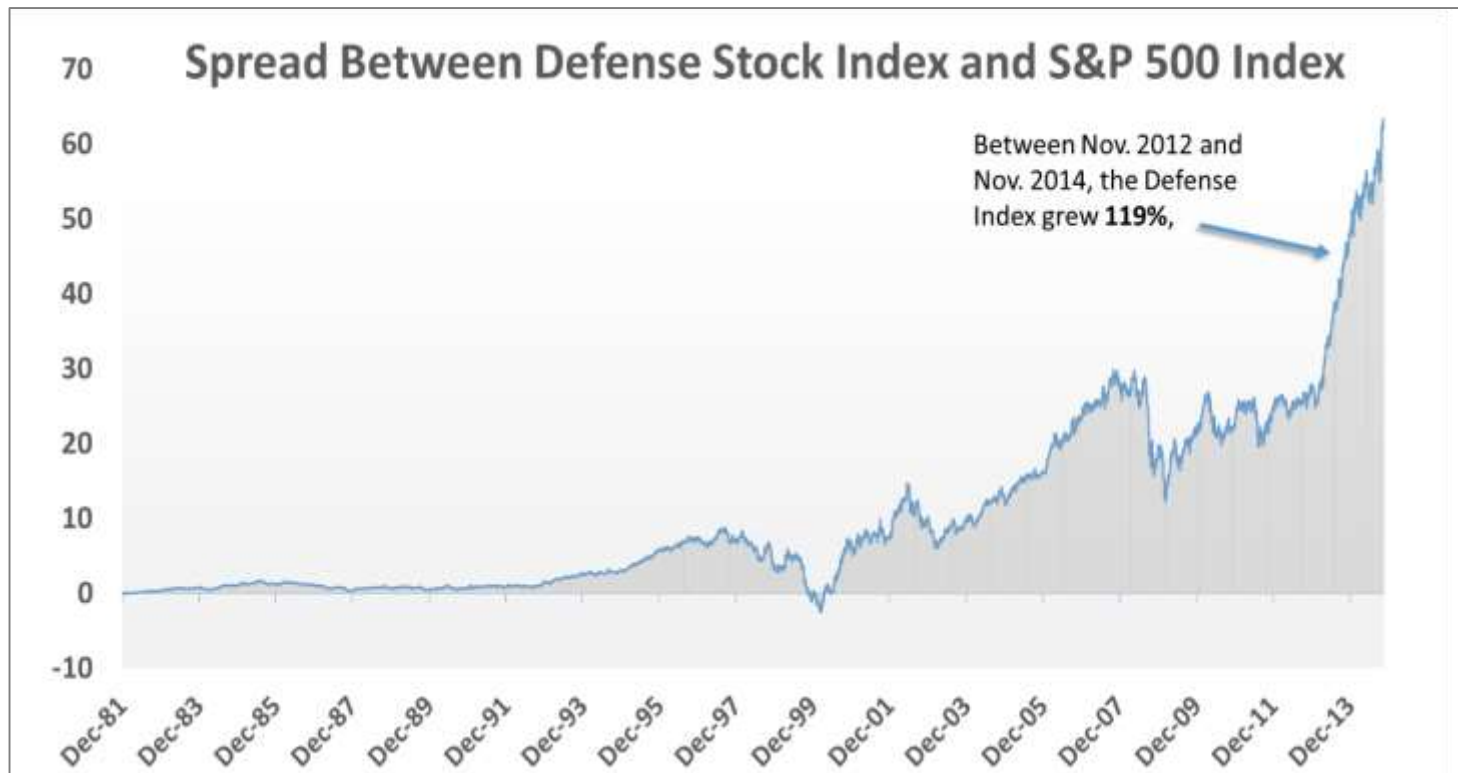
# Questions & Answers

# BACK-UP

## Total DOD Contract Obligations by Fiscal Year



**Source:** Office of Management and Budget (OMB), USASpending.gov.



**Source:** Yahoo! Finance datasets. Defense Stock Index includes equal weights Lockheed Martin, General Dynamics, Boeing, Northrop Grumman, and Raytheon. Spread calculated as Defense Index (1.0 = Dec. 31, 1981) minus the S&P 500 Index (1.0 = Dec. 31, 1981). Accessed Nov. 22, 2014.