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A Game-Theoretic Approach to Innovate Government Procurement: The Case for Non-Traditional Acquisitions

Eighteen months after the Build America, Buy America act took effect in May 2022, the federal government has obligated $18 billion to contractors.[i] As the costs from onshoring construction purchases continue to rise, now estimated to be equivalent to a 25 percent tariff and 5-10 percent increase to prices[ii], the application of game theory holds the potential to yield considerable savings for procurement professionals.

By: Ben Wilson

The government shoulders a significant responsibility in procuring products, a critical endeavor that propels agencies towards fulfilling their mandates and serving citizens. With the enactment of the Build America, Buy America Act, there is a renewed emphasis on onshoring spending within the United States, necessitating government agencies to allocate more funds to products and supplies that were traditionally offshored for cost savings.

Procurement officers are now tasked with the challenge of onshoring purchasing, a move that inevitably raises prices due to the premiums associated with domestic production and decreased supply for procurement. In light of these changes, the time is now for procurement offices to reevaluate their strategies as the conventional closed bid procurement process falls short in optimizing results for agencies. To address this, A&M has introduced a three-part series that delves into the application of game theory to government procurement.

Starting with ***A New Paradigm for Public Sector Procurement with Vickrey Second Price Acquisitions***, we dismantle the limitations of traditional closed bid acquisition formats and unveil the innovative potential of the Vickrey second price format to slash bid prices. In our second installment, ***The Power of Proposal Reduction with Combinatorial Clock Acquisitions***, we explore the innovative use of Combinatorial Clock Acquisitions (CCAs), showcasing their unparalleled ability to streamline government procurement processes and amplify efficiency. Culminating the series, ***Hidden Bias: Rate Discounting and Its Distorting Effect on Contract Award Equity*** offers a critical examination of the subtle interplay between game theory and behavioral decision-making, revealing the hidden cognitive biases that are inadvertently tilting the scales in government contract awards.

This series aims to equip procurement officers with innovative strategies to navigate this new terrain with a promise of curbing costs and amplifying contract allocation efficiency, providing agencies with a robust tool for stretching their budgets and ensuring they receive the greatest value for their investments.

A New Paradigm for Public Sector Procurement with Vickrey Second Price Acquisitions

Estimated Time to Read: 6-8 minutes

Closed Bid Auction Limitations

The closed bid acquisition is the predominant format for government bids due to its: 1) simplicity, 2) intuitiveness, and 3) adherence to the FAR. Bidders submit a proposal, and the contract is awarded based on the lowest price or with a weighted score card. This is optimal where the three constraints of project quality[iii] are equally balanced (see Figure 1) but **not optimal when cost is the primary factor.** In theory, the acquisition format should not matter (per the revenue equivalence theorem[vi]), yet this does not hold due to: 1) information assumptions, 2) bidder strategies, 3) risk aversion and 4) competition.

This leads to bidders being vulnerable to the "Winners Curse"[v] phenomena. Specifically, bidders use an aggressive bidding strategy and underprice the proposal, thus winning the bid yet losing money on the contract. This risk creates a significant delivery danger for the government, a key contributor to the 51,000 contracts terminated across the federal government from 2019-2023 (see Figure 2)[vi]. Apprehensions from the "Winners Curse" cause companies to adopt a cautious approach and build in large margins to safeguard against this phenomenon and against the government requesting a Best and Final Offer (BAFO) to receive more favorable terms. Consequently, the government receives a collection of conservative bids and pays a higher cost as a result. This situation is further exacerbated by the Build America, Buy America Act, as its mandate for onshoring products across 25 government agencies inherently drives up expenses due to higher domestic production costs.[vii] To overcome the perpetual overpricing, procurement professionals need to explore alternative acquisition formats that utilize procurement psychology and ultimately benefit both parties.

Figure 1 - Triple Constraints of Project Quality

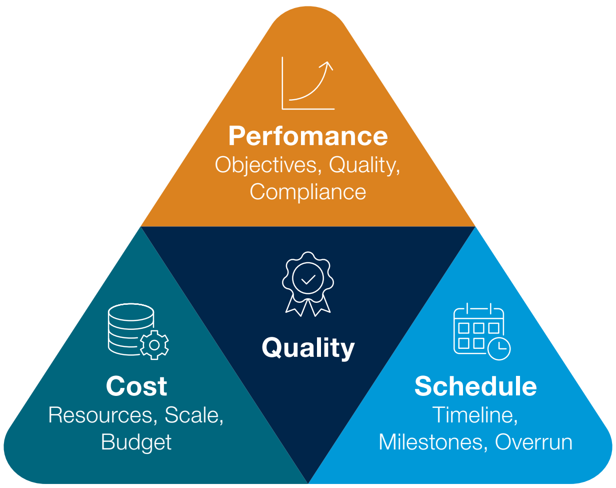
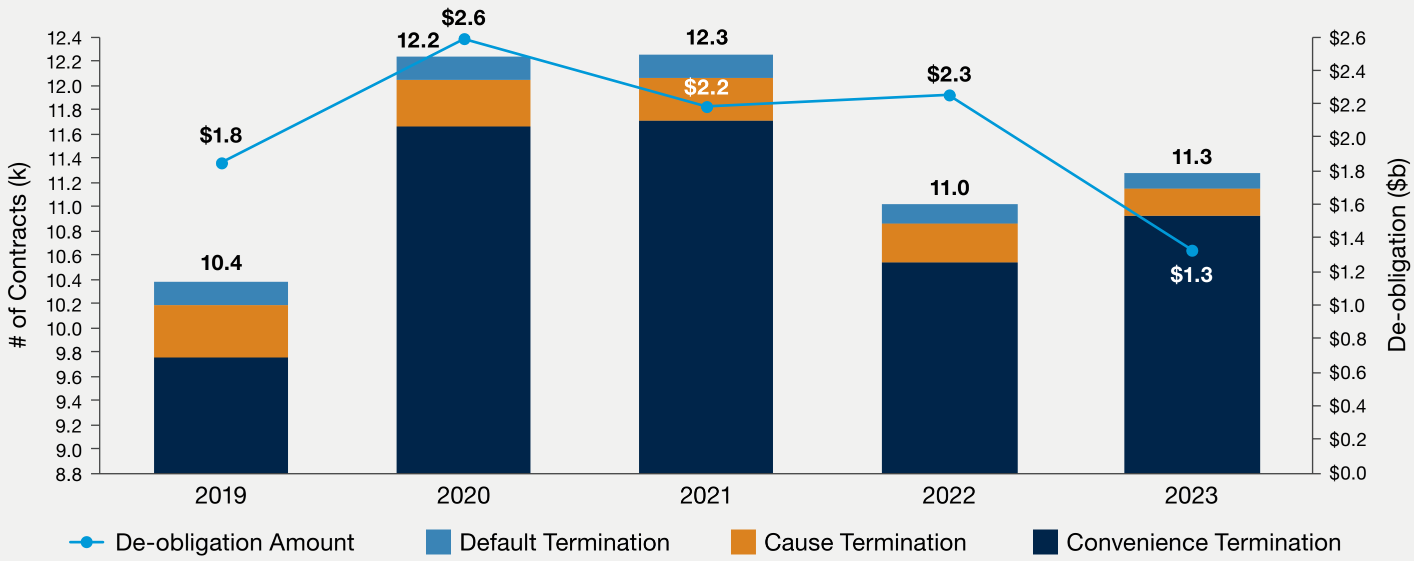


Figure 2 - Federal Government Contracts Terminated (k) & De-Obligation Amount ($b)



Source: Deltek FPDS Report

Introducing Vickrey Auctions

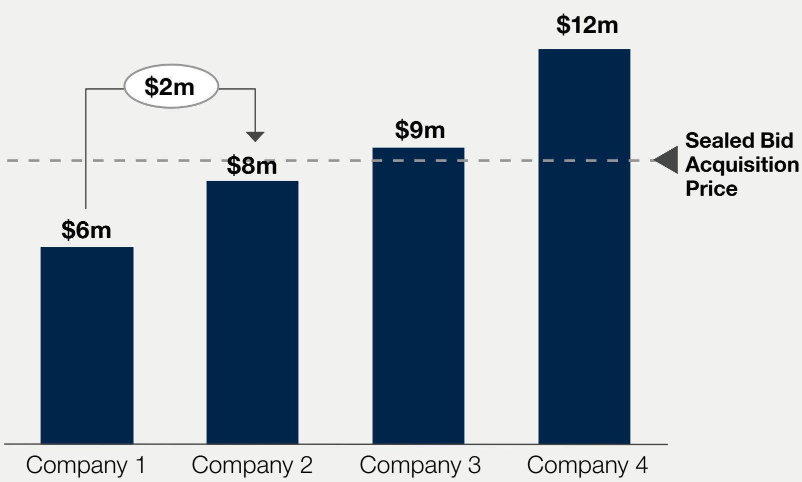
A **solution to the overpricing is the Vickrey second price acquisition format**, a reverse acquisition format regulated in the FAR, section 15.407-90. In the Vickrey model for public sector, the lowest bidder is declared the winner, yet is compensated based on the second-lowest bid. This dynamic creates an incentive for participants to bid their true value, as there is no additional advantage in exceeding this value (see 'Game Theory in Vickrey Acquisitions note for further detail). The notion of true value is a company's bid price formed by a range of project factors, such as cost estimate, risk assessment, resource allocation and opportunity cost. The winner receives a contract surpassing their bid value, thus mitigating the risk of losing money on the contract. Concurrently, this contributes to the government receiving lower average bid values, aligning more closely with the objective of paying prices that are fair and reasonable, as emphasized in FAR section 15.404-1.

Game Theory in Vickrey Auctions

For Vickrey format acquisitions, the participant's *dominant strategy* (ensures bidder receives the optimal payoff, regardless of fellow bidder strategies) is to bid their true value. When all participants bid their true value, it creates a *Nash equilibrium* where changing bids is not advantageous for any participant.

For example, four companies bid on a contract with an expected $9 million price. Company 1 bids (V) $6 million and Company 2 bids (B) $8 million. Company 1 wins and, in Vickrey format acquisitions, is awarded the second-highest bid of $8 million, a $2 million surplus. Therefore, companies bid when B – V > 0 (contract is profitable). The government saves $1 million compared to the estimated closed bid acquisition price of $9 million.

Figure 3 – Ex. Public Sector Vickrey Auction



The benefits of the Vickrey format have resonated across markets:

- **Mutual transparency:** Vickrey format enhances insight by revealing bidders' willingness to spend (demand revealing) while improving participants' value estimations. Meta and eBay each employ Vickrey formats, with eBay using a proxy method for price setting[viii], and Meta optimizing ad placement to enhance platform value[ix].
- **Reduced manipulation:** Participants frequently shade[x] bids to increase their probability of winning, inflating costs up to 20 percent[xi]. Although collusion is present in all acquisition formats, it is more complex in a Vickrey format where bidders do not directly impact the final price, reducing vulnerability. After transitioning away from a second price format in 2019, Google saw an increase in shading tactics for AdWords.[xii]
- **Enhanced efficiency:** Vickrey format optimizes resource allocation by selecting the most efficient bidder for the contract, confirmed by research from McAfee and McMillan[xiii]. Second price formats can also incorporate additional attributes, such as quality, as Google did with 'Ad Rank' to blend quality and price[xiv].

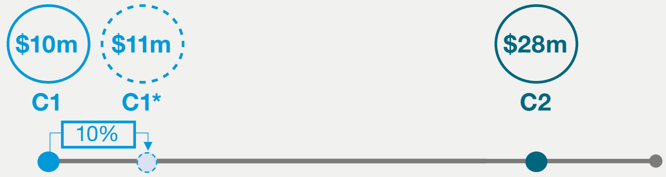
It is worth clarifying that the intention of adopting a Vickrey format is not to undermine the business of participating firms, but rather to empower procurement officers to strategically navigate the acquisition process, utilizing innovative formats to neutralize the negative externalities from the Build America, Buy America Act and ensure the government secures equitable and cost-effective terms for the products it procures.

Navigating Potential Pitfalls

Vickrey format acquisitions experience **two drawbacks** that procurement professionals need to understand (see Figure 4 examples). First, reduced bidder participation at the outset may occur from perceived complexity or risk aversion to the new format. Nevertheless, in situations where participation is limited, a viable solution is to adopt a percentage of the winning bid as the final price. For instance, including a rule that a 10 percent markup is applied to the lowest bid (i.e., the winning bid) if fewer than three bids are submitted. Second, a Vickrey format is susceptible to shill bids, or deceptive bids, intended to alter the price. For example, multiple companies collude to insert bids that increase their chances of winning or reducing the winner's earnings. By creating transparency in revealing the proposal price of all bidders, procurement officers can reduce the risk of shill bids.

Figure 4 - Vickrey auction drawback scenarios

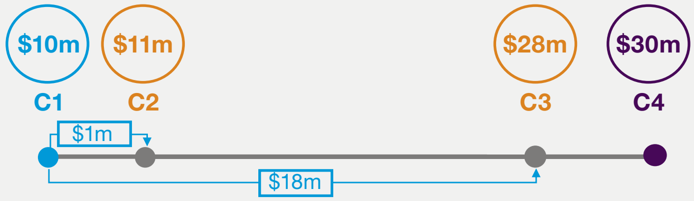
Scenario 1: Fewer Bidders



The following Vickrey auction example has two bidders:

- Company 1 and Company 2 each bid on the contract
- The proposal stipulates that if fewer than two bidders submit prices, a 10 percent markup will be used on the first price
- Company 1 wins the auction with a bid of $10 million, receiving a 10 percent markup to $11 million

Scenario 2: Shill Bid



The following Vickrey auction example has four bidders:

- Company 1 can perform the work for $10 million, so bids true value of $10 million
- Company 4 is inefficient at the work so must bid higher at $30 million
- Company 2 and 3 collude for Company 2 to use a shill bid
- Company 1 wins with a bid of $10 million, but rather than receiving the second-price of $28 million from Company 3, the shill bid from Company 2 reduces Company 1 to $11 million

Note of caution: there are distinct scenarios where a Vickrey format should be avoided, including where: 1) specialized products are required, 2) the outcome creates controversy, 3) a weighted scorecard is required, and 4) historical bids have an asymmetrical pattern (i.e., a wide margin exists between bids). This final point is underscored from the 1990s during a spectrum auction conducted by the New Zealand government where a projected NZ$250 million fell to NZ$36 million due to subpar execution.[xv]

Striking The Balance

Despite the inherent advantages to the Vickrey format, adoption in the global government context remains infrequent. This encourages the question, **'Where is the opportunity for the Vickrey acquisition format within government?'** A wider application emerges for government procurement of commoditized products, where the winner is chosen using the lowest price. As an example, the Federal Highway Administration construction contracts offer an ideal scenario where the lowest contractor is awarded the contract, clear symmetry in bid prices is evident, and the difference between many bidders is immaterial (see Figure 5 example)[xvi]. This approach minimizes expenses for tasks where disparities among bidders are predominantly trivial and eliminates instances where the Vickrey format is not suitable.

Figure 5 - US DOT Federal Highway Administration Construction Contracting Example

Contract Awarded to: [illegible] Award Date: 12/23/2020

Contractor	Bid Amount
[illegible]	$5,190,133.70
[illegible]	$5,283,308.00
[illegible]	$5,533,389.50
[illegible]	$5,559,094.50
Engineer's Estimate	$4,070,000.00

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