Winning by Default: Why is There So Little Competition in Government Procurement?

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March 2017

Procurement and Little Competition

- Ubiquitous problem to find a suitable contractor from a small pool of contenders
  - Commercially unavailable goods or services
  - Negotiation of price and contract terms
- US federal procurement (FY 2013):
  - Median number of bids is one
  - $0.2 trillion (44%) paid for contracts with a single bidder
  - Most large, non-repetitive contracts are negotiated

Why Little Competition?

- Benefits and costs of attracting/considering another contractor
  - Lower contract price due to competition
  - Administration and search cost
  - Capture and corruption
- Contract negotiations during the selection process are relevant
- Goal: To quantify the factors determining competition under contract negotiation

What This Paper Does

- Develop a principal-agent model where the procurer
    1. Chooses the extent of competition
    2. Negotiates the contract terms
- Identify and estimate the model using the data on the Federal IT/telecommunications service procurement contracts of FY 2004-2012
- Conduct counter-factual analyses of the estimated model to quantify the factors determining competition

Preview of the Results

- Negotiations substantially reduce the informational asymmetry between a procurer and contractors:
  - $\mathbb{E}(\textit{price}|\textit{negotiation}, \textit{one bidder}) \approx \mathbb{E}(\textit{price}|\textit{auction}, \textit{two bidders})$
  - Cost savings from negotiations (as opposed to a standard first-price auction): $63,500 per $1-million contract
- Allowing discretion to contracting officers reduces government cost

Literature Review

- Nonstandard auctions: *Negotiations vs. auctions* - Bajari, McMillan, and Tadelis (2008); *Preference program* - Krasnokutskaya and Seim (2011), Athey, Coey, and Levin (2013); *Scoring* - Asker and Cantillon (2010); *Endogenous Entry* - Li and Zheng (2009)
- Corruption and regulatory capture: *Active vs. passive waste* - Bandiera, Prat, Valletti (2009); *Discretion* - Coviello, Guglielmo, and Spagnolo (2014)
- Auctioning incentive contracts: Laffont and Tirole (1987), McAfee and McMillan (1987), Riordan and Sappington (1987)
- Price adjustments and contract renegotiation: Bajari, Houghton, and Tadelis (2014), Kosmopoulou and Zhou (2014)
- Identification of adverse selection model: Perrigne and Vuong (2011)

Today's Talk

1. Institutional background and descriptive statistics
2. Model of procurement with negotiations
3. Nonparametric identification of the model given our data
4. Estimation results

Data

- Source: Federal Procurement Data System - Next Generation
- For each procurement project, we observe
  1. Competitive or noncompetitive (and why)
  2. Number of bids
  3. History of price and duration changes
  4. Product/service code, agency, and location
- IT/telecommunications service contracts of FY 2004-2012:
  1. With specified quantity and delivery schedule
  2. Of a large size ($300K–$5M) and commercially unavailable

Extent of Competition

Extent of competition	Number	Size ($M)
Limited/no competition	1,952	1.52
Unavailable for competition	925 (47%)	1.30
Set-asides for small business	215 (11%)	1.63
Not competed by discretion	812 (42%)	1.75
Full and open competition	753	1.30
One bid	274 (36%)	1.15
Two bids	121 (16%)	1.29
Three bids	197 (26%)	1.27
More than three bids	161 (21%)	1.61

Note: All definitive IT/telecommunications contracts for commercially unavailable services of FY 2004-2012, a large size ($0.3–5 million): 2,705 contracts, $3.8 billion (CPI-adjusted, 2010 dollars) in total.

Extent of Competition

- Reasons for no competition by discretion:
  - Only one source available (brand, patent, etc.; 56%), follow-on contract (17%), urgency (8%), other/unspecified (national security, public interest, etc.; 19%)
- Costly efforts for bids:
  - Information exchanges with potential contractors prior to issuing a RFP (pre-solicitation notices, industry conferences, public hearings, market research, one-on-one meetings)

Contract Negotiation

- A contract awarded using other than sealed bidding procedures is defined as a *negotiated* contract (FAR 15.000)
- Focus attention to the following two types of negotiated contracts
  1. Noncompetitive: Discretionary (42% of those noncompeted)
  2. Competitive: Negotiated proposal solicitation (56% of those competed)

Contract Price and Duration Changes

- Two types of contract price and duration changes:

  1. *Unilateral*
     - No requirement for both parties' agreement; i.e., following the initial contract terms
     - Exercise an option, termination, administrative actions
  2. *Bilateral*
     - Requirement for both parties' agreement; i.e., renegotiation
     - Additional work, supplemental agreement for work within scope, change order

▸ More

Price and Duration by Competition

	Noncompetitive	Competitive	
		1 Bid	2+ Bids
Number of Observations	652	83	227
Total payment ($M)	1.20 (1.12)	1.20 (1.11)	1.45 (1.17)
Fraction of price changes			
Unilateral	0.58	0.60	0.54
Bilateral	0.38	0.35	0.35
Amount of price changes ($M)			
Unilateral	0.35 (0.63)	0.35 (0.62)	0.39 (0.74)
Bilateral	0.19 (0.51)	0.18 (0.45)	0.16 (0.53)
Total duration (years)	2.08 (1.74)	2.55 (1.92)	2.24 (1.80)
Length of duration changes (years)			
Unilateral	0.63 (1.23)	0.96 (1.48)	0.77 (1.39)
Bilateral	0.32 (0.85)	0.27 (0.73)	0.27 (0.90)

Note: Final sample of 962 obs.; standard deviations are in parentheses.

Competition and Military Contracts

	Noncompetitive	One Bid	Num. of Bids
Military agency	0.144***	0.120***	1.182
	(0.0417)	(0.0258)	(1.244)
Log(Duration, in days)		-0.0263**	0.764
		(0.0126)	(1.236)
Base price ($K)		0.711***	5.867
		(0.167)	(7.537)
Product/service code FE	Yes	Yes	Yes
State, year, month FE	Yes	Yes	Yes
N	962	962	310
R^2	0.182	0.193	0.319

Note: All contracts in the sample, except the last specification for competitive contracts only; standard errors are clustered at the product/service code level, and provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. *Military agencies* include the Departments of State, Defense, and Homeland Security.

Unilateral Price and Duration Changes

	Unilateral price change ($K)		
Unilateral duration change/Base duration	70.77***	81.19***	81.74***
	(15.61)	(18.78)	(18.41)
Base duration (days)		0.203**	0.208**
		(0.0805)	(0.0791)
Base price ($K)		0.0938*	0.0891
		(0.0549)	(0.0558)
Noncompetitive		-104.6	-6.546
		(175.6)	(125.8)
One bid		-63.77	
		(145.3)	
Log (number of bids)			143.6
			(90.94)
Product/service code FE	Yes	Yes	Yes
Agency, state, year, month FE	No	Yes	Yes
N	554	554	554
R^2	0.106	0.412	0.417

Note: Contracts with unilateral price changes in the sample; standard errors are clustered at the product/service code level, and provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Key Features of the Model

1. Procurer chooses whether to solicit bids or not
   - Cost reduction from competition, quality ("only one source"), administrative cost of formal solicitation process ("urgency"), corruption
2. She chooses the level of effort for attracting bidders
   - More effort (various exchanges of information prior to a RFP) leads to more bids, but at a higher cost
3. Given the bidders, she offers a menu of contracts
   - We model the individual, simultaneous negotiation as an adverse selection model with multiple agents

Timeline and Choices

1. Procurer chooses whether to solicit bids
2. If soliciting bids, she chooses the level of effort to attract bidders, determining the distribution of the number of bidders
3. Given the number of bidders, the procurer offers a menu of contracts
4. Bidders choose a contract from the menu
5. Given the contract choices, the procurer chooses a winner
6. Based on the project outcomes, the final payment is determined

Information

- A model of hidden information with two cost types of contractors
  - Contractors know their own cost type, while procurer does not
    - Low-cost contractor: $\alpha + \epsilon$
    - High-cost contractor: $\alpha + \beta + \epsilon$ with $\beta > 0$
- *Cost shock*(ϵ) and *signal*(s) are realized and observed by both parties
  - Cost shock is independent of cost type
  - Signal depends on contractors' cost type

Procurer's Choices and Payoff

- Procurer decides
  1. Whether to solicit bids
  2. Bidder arrival rate λ: Number of *extra* bidders $\sim$ *Poisson*(λ)
  3. Menu of contracts and the winner
- Procurer's total cost includes
  1. Payment to the contractors
  2. Bid processing cost $(\kappa\lambda)$
  3. Formal solicitation procedure cost (η)

Contractors' Payoff and Choice

- Contractors choose a contract from a given menu
- A typical contract consists of base price (p) and ex-post price adjustment (Δ)
- Contractors consider the expected profit from procurement:

$$\underbrace{p - (\alpha + \beta)}_{\text{deterministic payoff}} + \underbrace{\mathbb{E}[\psi(\Delta - \epsilon)]}_{\text{stochastic payoff}},$$

where $\psi' > 0, \psi'' < 0$, $\psi(0) = 0$, and $\psi'(0) = 1$

  – Liquidity concerns, or the cost of working capital, lead the winning contractor to discount the variable part of the payoff, and enlarge unanticipated cost adjustments ▸ More

Equilibrium Menu of Contracts

- We characterize a menu of two contracts (*fixed* vs. *variable*) that induces a truth-telling Bayesian Nash equilibrium

  1. Both contracts allow *bilateral* changes to insure cost shock
  2. Only variable contracts allow *unilateral* changes, contingent on signal

- When the number of bids is small, the expected transfer given this scheme is smaller than that of a standard auction

Equilibrium Menu of Contracts: A Cut-down Problem

- Given ex-ante symmetric n bidders, procurer minimizes

$$\underbrace{(1-(1-\pi)^n)}_{\substack{\text{Pr. of receiving} \\ \text{at least 1 eff. bid}}} \quad \underline{p}_n + (1-\pi)^n(\overline{p} + \int q(s)\overline{f}(s)ds)$$

subject to

$$\overline{p} + \int \psi[q(s)]\overline{f}(s)ds - (\alpha + \beta) \geq 0 \text{ (IR: High-cost)}$$

$$\underline{\phi}_n \left\{\underline{p}_n - \alpha\right\} \geq \overline{\phi}_n \left\{\overline{p} + \int \psi[q(s)]\underline{f}(s)ds - \alpha\right\} \text{ (IC: Low-cost)}$$

Equilibrium Menu of Contracts: Characterization

- Procurer offers a menu of two contracts that induces a truth-telling Bayesian Nash equilibrium

1. Fixed-price contract: $\underline{p}_n + \epsilon$, where

$$\underline{p}_n = \alpha + \frac{\pi(1-\pi)^{n-1}}{1-(1-\pi)^n}\left\{\beta - \int \psi[q(s)]\left[\overline{f}(s) - \underline{f}(s)\right] ds\right\}.$$

2. Variable-price contract: $\overline{p} + q(s) + \epsilon$, where

$$\overline{p} = \alpha + \beta - \int \psi[q(s)]\overline{f}(s) ds,$$

$$\psi'[q(s)]\left[1 - \pi\underline{f}(s)/\overline{f}(s)\right] = 1 - \pi.$$

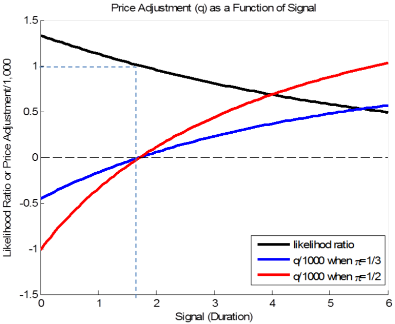
Comparative Statics: Variable-price Contracts

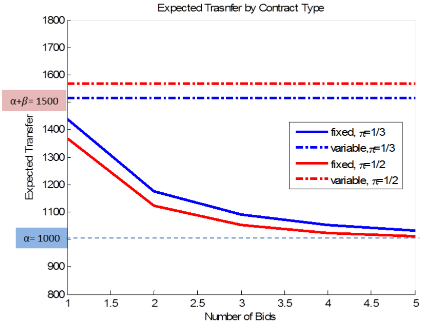
- There is a trade-off between *extracting more rents from the low-cost contractor* vs. *paying a higher risk premium to the high-cost contractor to maintain IR and IC*:

$$\psi'[q(s)]\left[1-\pi \underline{f}(s)/\overline{f}(s)\right]=1-\pi.$$

1. If $\underline{f}(s)=\overline{f}(s)$, then $\psi'[q(s)]=1$, or $q(s)=0$.
2. If $\underline{f}(s)<\overline{f}(s)$, then $\psi'[q(s)]<1$, or $q(s)>0$.
3. If $\underline{f}(s)>\overline{f}(s)$, then $\psi'[q(s)]>1$, or $q(s)<0$.

Trade-off: *Informational rents* vs. *Risk premium*





- Likelihood ratio: Likelihood that a contractor is the low-cost type given signal
- q: Ex-post price adjustment due to signal
- π: Proportion of low-cost contractors
- α: Expected project cost for low-cost contractors
- β: Expected *extra* project cost for high-cost contractors

Identification

- We observe the joint distribution of (entry restrictions, number of bids, contract type, base price, price adjustment, and signals).
- We treat π (the proportion of low-cost contractors) as an unobserved heterogeneity and allow other primitives of the model to vary with π.
    1. Project costs: $\alpha(\pi)$ (for low-cost contractors) and $\beta(\pi)$ (extra costs for high-cost contractors)
    2. Bid cost: $\kappa(\pi)$
    3. We assume that π, signals (s), and direct cost of entry restriction (η) are mutually independent.
- We identify (i) the distribution of π, signal, and η; (ii) project costs and bid cost as functions of π; and (iii) liquidity cost function.

Identification

- In this talk, we focus on the case that the ex-post price adjustment ($q(s;\pi)$) for any given (s,π) is an interior solution.
- For identification, we exploit the following monotone relationship between π and contracts:
  1. If $q(s;\pi)$ is an interior solution, then $\partial \left|q(s;\pi)\right| / \partial\pi > 0$.
  2. With project costs non-increasing in π, $\partial \underline{p}_n(\pi) / \partial\pi < 0$.
  3. With a further assumption on $\partial(\alpha+\beta)/\partial\pi$, $\partial \overline{p}(\pi) / \partial\pi < 0$.

Identification: Sketch of the Proof (1/4)

- Given the separating equilibrium, the signal distribution of fixed contracts is $\underline{f}(s)$, and that of variable contracts is $\overline{f}(s)$.
- By monotonicity, there exists a one-to-one mapping between the likelihood ratio $l(s) \equiv \underline{f}(s)/\overline{f}(s)$ and $(\overline{p}, q)$, denoted by $l^*(\overline{p}, q)$.

$$\psi''(q) = \left[\frac{1 - \psi'(q)}{1 - l^*(q, \overline{p})}\right] \psi'(q) \frac{\partial l^*(q, \overline{p})}{\partial q}.$$

  - This first-order ODE is derived from the FOC wrt q.
  - We can solve $\psi(\cdot)$ uniquely using $\psi'(0) = 1$ and $\psi(0) = 0$.

Identification: Sketch of the Proof (2/4)

- Since $\psi(\cdot)$ is identified, so is π corresponding to each variable contract $(\overline{p}, q, s)$ defined through the FOC by:

$$\pi_{q,s} \equiv \frac{1 - \psi'[q(s)]}{1 - l(s)\psi'[q(s)]}.$$

- Given the above equation, we identify the distribution of π for variable contracts conditional on number of bids (n) and competition (c), $f_{\pi|v,n,c}(\pi|1, n, c)$.

- Using the theoretical prediction on the probability of having a fixed-contract conditional on (π, n), ▸ More

$$f_{\pi|v,n,c}(\pi|0, n, c) = \frac{[1 - (1 - \pi)^n]\Pr(v = 1|n, c)}{(1 - \pi)^n \Pr(v = 0|n, c)} f_{\pi|v,n,c}(\pi|1, n, c).$$

Identification: Sketch of the Proof (3/4)

- Using the monotonicity between the fixed-price ($\underline{p}$) and π:

$$\underline{p}_n^*(\pi, c) = G^{-1}_{\underline{p}_n|c}\left(\int_{\pi}^{\pi_{\max}} f_{\pi|c,n,v}(x\,|c, n, 0)\,dx\middle|c\right).$$

- Project costs are identified from the equilibrium characterization.

$$\alpha(\pi) = \frac{1-(1-\pi)^n}{1-(1-\pi)^{n-1}}\underline{p}_n^*(\pi, c) - \frac{\pi(1-\pi)^{n-1}}{1-(1-\pi)^{n-1}}\underline{p}_1^*(\pi, c),$$

$$\beta(\pi) = \overline{p}^*\left(h\left[\frac{1-\pi}{1-\pi l(s)}\right], s\right) + \int \psi\left(h\left[\frac{1-\pi}{1-\pi l(t)}\right]\right)\overline{f}(t)\,dt - \alpha(\pi),$$

where $\overline{p}^*(q, s)$ is identified directly from data.

Identification: Sketch of the Proof (4/4)

- Bid solicitation costs, $\kappa(\pi)$, are identified from the FOC regarding the extra bid arrival rate, $\lambda(\pi)$:

$$\lambda(\pi) = \sum_{n=0}^{\infty} \frac{n f_{\pi,n|c}(\pi, n+1|1)}{f_{\pi|c}(\pi|1)},$$

  If $\lambda(\pi) > 0$,

$$\kappa(\pi) = \pi\Gamma(\pi)\exp[-\pi\lambda(\pi)],$$

  where $\Gamma(\cdot)$ is an identified function of π.

- Probability of entry restrictions conditional on π help identify the distribution of η. The optimal entry restriction rule is

$$\eta \leq \frac{\kappa(\pi)}{\pi}\left\{1 + \ln(\pi) + \ln[\Gamma(\pi)] - \ln[\kappa(\pi)]\right\} - \Gamma(\pi).$$

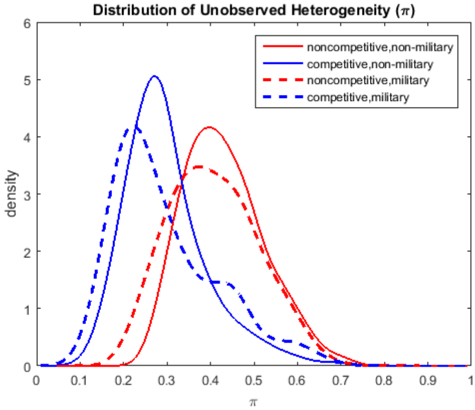
Estimation

- Since the number of observations is 962 (which is small for a nonparametric analysis), we estimate a parametric model using a simulated GMM estimator.
- Moment conditions are motivated by the identification arguments:
- In our estimated model,
  1. Signals: Duration changes *NOT* attributed to bilateral modifications
  2. Cost shocks: Price changes attributed to bilateral modifications

Model Fit

	Observed	Predicted
Probability of		
Entry restriction	0.6778	0.7374
One bid conditioning on competition	0.2677	0.3062
Up to two bids conditioning on competition	0.4258	0.5209
Up to five bids conditioning on competition	0.8516	0.9162
Fixed contracts conditioning on entry restriction	0.4156	0.4307
Fixed contracts conditioning on one bid	0.3976	0.4254
Fixed contracts conditioning on up to two bids	0.4091	0.4561
Fixed contracts conditioning on up to five bids	0.4621	0.5594
Average transfer ($M) of fixed contracts		
Conditioning on entry restriction	0.8256	0.7578
Conditioning on competition	1.1869	1.0863
Average transfer ($M) of variable contracts		
Conditioning on entry restriction	1.1397	1.0951
Conditioning on competition	1.2322	1.0153

Estimated Endogenous π Distribution



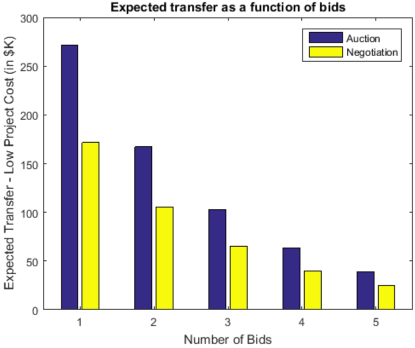
Why So Little Competition? (1/3)

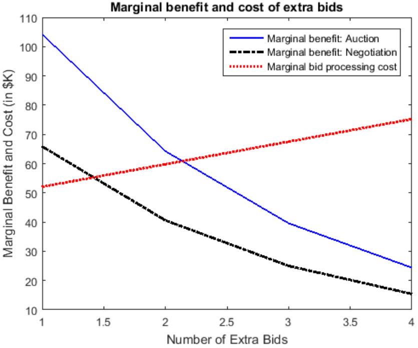
- For a project with $\pi = 0.35$,

(in $K)	Non-military Estimate	Non-military SE	Military Estimate	Military SE
Low project cost (α)	958.33	40.44	985.03	46.59
Project cost difference (β)	294.11	33.86	254.48	33.95
Per-bidder bid cost (κ)	46.49	8.09	46.49	8.09
Entry restriction benefit ($\mathbb{E}(\eta)$)	20.50	4.77	33.60	7.56

- Average direct benefits from restricting entry: [$30,160,$30,929] per noncompetitive contract
- Average bid costs: [$60,271,$63,052] per competitive contract

Why So Little Competition? (2/3)





Why So Little Competition? (3/3)

1. 50% decrease in the the per-bidder cost of attracting bids
2. 50% decrease in the benefits from imposing entry restrictions
3. Competition is required for all contracts
4. At least two bids are mandatory
5. First-price sealed-bid auction

	Base	(1)	(2)	(3)	(4)	(5)
Probability of restricting entry	0.74	-0.30	-0.39	-0.74	-0.74	-0.29
Average number of bids	1.48	+1.18	+0.22	+0.31	+1.31	+0.67
Probability of fixed contracts	0.47	+0.14	+0.04	+0.06	+0.25	+0.53
Average costs ($K)						
Transfer	1027.38	-46.20	-11.85	-16.76	-63.27	+32.08
Bid costs	16.19	+21.95	+9.89	+14.31	+74.94	+31.44
Entry restriction costs	-22.52	+7.50	+16.82	+22.52	+22.52	+6.69
Efficiency loss costs	3.37	-1.20	-0.34	-0.47	-1.54	-3.37
Average *total* costs ($K)						
private	1043.57	-24.24	-1.97	-2.45	+11.68	+63.52
public	1021.04	-16.74	+14.85	+20.08	+34.20	+70.21

Conclusion

- We study the procurement with negotiations
  - Develop, identify, and estimate a multiple-agent adverse selection model using the IT/telecommunications procurement contract data
  - Distinguish unilateral vs. bilateral ex-post changes in the contract price and duration
- Key findings:
  1. Negotiations effectively substitute for one extra bidder
  2. Government waste is relatively small
  3. Less competition for military contracts than nonmilitary ones is driven by the supply side

Contract Price Changes and Contract Type

- Price changes occur *regardless of contract type*

Fraction of price changes	Firm-fixed	Other
In number of contracts		
Unilateral	0.54	0.65
Bilateral	0.34	0.43
In total price (conditional on changes)		
Unilateral	0.46 (0.35)	0.45 (0.36)
Bilateral	0.29 (0.28)	0.32 (0.31)

Note: Final sample of 962 obs.; standard deviations are in parentheses.

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Derivation of π Distribution for Fixed Contracts

- Joint probability that a contract is fixed and $\pi \leq \pi^*$:

$$\begin{aligned}\Pr\{\pi \leq \pi^*, v = 0 \,|\, n\} &= F_{\pi|v,n}(\pi^* \,|0, n) \Pr(v = 0 \,|\, n) \\ &= \int_{\pi=\underline{\pi}}^{\pi^*} f_{\pi|n}(\pi \,|\, n)\left[1 - (1-\pi)^n\right] d\pi.\end{aligned}$$

- By taking the first order derivative with respect to π^*:

$$f_{\pi|v,n}(\pi^* \,|0, n) \Pr(v = 0 \,|\, n) = f_{\pi|n}(\pi^*|n)\left[1 - (1-\pi^*)^n\right].$$

- Note that

$$\Pr(v = 1|\pi^*, n) = (1-\pi^*)^n = \frac{f_{\pi|v,n}(\pi^*|1, n)\Pr(v = 1|n)}{f_{\pi|n}(\pi^*|n)}$$

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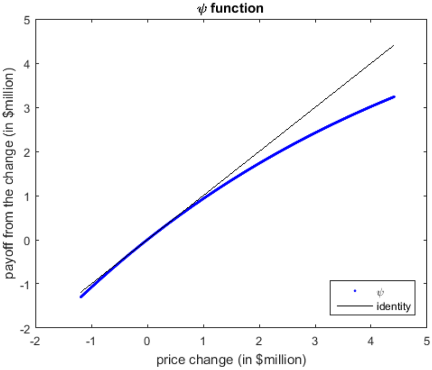
Estimates: Liquidity Cost Function



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