China Strategic Choices Tool

International Cost Estimating and Analysis Association, Washington, DC Chapter

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Jack Bianchi, Toshi Yoshihara, Harrison Schramm, Jacob Cohn, Lukas Autenried

CSBA
Center for Strategic and Budgetary Assessments

CSBA Mission, Vision, Values

- **CSBA is the world's premier center for understanding future international competition and conflict. Our mission is to develop innovative defense concepts, promote public debate, and spur action to advance U.S. and allied interests.**

- Our vision is to set the terms of debate for the future of national defense and drive change in concept development and force structure to prepare the U.S. and its allies to compete and win in an era characterized by great power competition and conflict.

- Independence   Integrity   Expertise

  Objectivity   Innovation   Quality

Our Team

**Jack Bianchi,
Senior Analyst**:
Asia-Pacific Strategy and
China's military

Jacob Cohn,
Research Fellow:
Defense Strategy, Resources,
Military Competitions

**Dr. Toshi Yoshihara,
Senior Fellow**:
Asian Security and
Chinese Strategy

**Lukas Autenried,
Analyst:**
Defense Budgeting and
Future Warfare

**Harrison Schramm,
Non-Resident Fellow**:
Applied Mathematics,
Statistics

Discussion & Feedback

- **Data**: Other potential data sources we should consider?

- **Methodology**: Strengths and weaknesses of the outlined methodologies? Other methodologies to consider?

- **Chinese Context**: How to adjust Western cost data for China?

- **Workshop**: How to structure upcoming workshop and propose questions for paper authors?

Agenda

- Project Background & Strategic Choices Tool Overview

- Literature Review

- Potential Cost Estimation Models

- Case Study: Fighter Aircraft

- Discussion

Project Background & Strategic Choices Overview

Project Goals

- Understand at the *strategic level* the feasible range of China's potential future force structures

- Gain policy-relevant insights into competitive dynamics between U.S. and China and analyze potential interactions in series of moves

- Aid U.S. competitive strategy development toward China

- Create an extensible methodology that can be used beyond project end date and applied to other countries/competitions

For this project, the **<u>relative</u>** effort that a country makes to produce systems is essential; the **<u>absolute</u>** cost is not.

What is the Strategic Choices Tool?

The **Strategic Choices Tool (SCT)** is

an **interactive** decision making tool in which

users can rapidly consider **alternative future force structures**

within a **real world budget constraint.**

Strategic Choices Tool opening page

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HOME

ADD/CUT SUMMARY

SELECTION DETAILS VIEW

FORCE STRUCTURE

FORCE STRUCTURE DETAILS

AIR

GROUND

LOGISTICS & BASING

MISSILE DEFENSE

MUNITIONS

NUCLEAR FORCES

PERSONNEL

R&D

READINESS

SEA

SOF

SPACE/CYBER/COMMS

PERSONNEL DEVIATIONS

UNLOCKED SELECTION

REFERENCE FILES

SEARCH

ASK FOR HELP

SIGN OUT

ITEM	MOVE 1 2019 – 2023	MOVE 2 2024 – 2028	Aircraft	Munitions	Ships	Active BCT	Reserve BCT	Active Personnel	Reserve Personnel
Running Total	$ –6.19 B	$ –32.6 B	6,744	0	292	31	27	1,314,000	814,200
			0	401	2	–3	–3	–35,300	–78,700
			6,744	401	294	28	24	1,278,700	735,500

Categories

Air >

Ground >

Logistics & Basing >

Missile Defense >

Munitions >

Nuclear Forces >

Personnel >

R&D >

Readiness >

Sea >

SOF >

Space/Cyber/Com... >

Lock Move 2

Running Total of Spending

Summary of User Choices

Categories of Spending Options

The SCT has a wide range of built-in options

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Air

| Airlift | - | Bomber | + | Fighter | + | ISR/C2 | + | Refueling | + |

C-130

C-130

Medium-size transport aircraft capable of performing a variety of combat delivery (tactical airlift) operations across a broad range of mission environments.
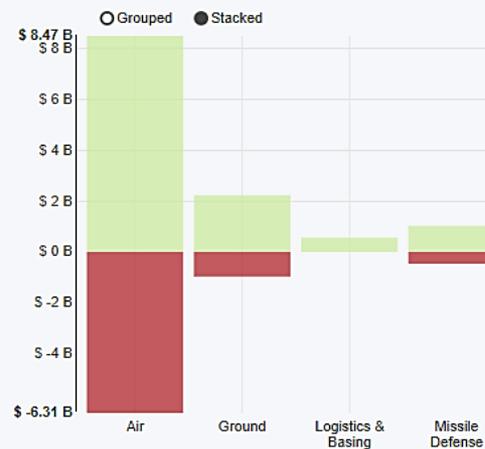
[Ok]

Pop-up Box w/Platform Detail

User Makes Selection Here

↑ OPTION	PLANNED BUY	BASELINE	PLATFORM INFORMATION		SELECTION	PERSONNEL INFORMATION		RECOMMENDED	TOTAL COST	
			MOVE 1	MOVE 2		MOVE 1	MOVE 2		MOVE 1	MOVE 2
Increase Buy – Air Force C-130 J (A/C)	8	168	$1.24B	$0.68B	0 ↕	$0.01B	$0.02B	0 ↕	$0B	$0B
Reduce Buy – Air Force C-130 J (A/C)	8	168	$-0.99B	$-0.55B	☐	$-0.01B	$-0.02B	0 ↕	$0B	$0B
Retire – Air Force C-130 (R/C)	N/A	238	$-0.27B	$-0.68B	0 ↕	$0B	$0B	0 ↕	$0B	$0B

List of Add/Cut Options

Total Cost (Savings) of Selection by Move

10

Example SCT outputs

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Summary of Adds/Cuts: jcohn

○ Grouped ● Stacked

Chart y-axis: $8.47 B, $8 B, $6 B, $4 B, $2 B, $0 B, $-2 B, $-4 B, $-6.31 B

Categories: Air, Ground, Logistics & Basing, Missile Defense

Visual Display of Adds and Cuts by Category

Selection Details: jcohn

Air

		MOVE 1		MOVE 2
Subtotals:		$3.94B		$-1.76B
Add	**Quantity**			
Restart Production Line – Air Force C-17	1	$3.59B		$0.0B
Accelerate – Army Future Vertical Lift	0	$3.66B		$0.81B
Reconstitute – Air Force C-17 (R/C)	3	$0.12B		$0.3B
Cut	**Quantity**			
Cancel – Navy MQ-25 Stingray (A/C)	0	$-2.72B		$-1.02B
Retire – Air Force C-5 (A/C)	5	$-0.3B		$-0.78B
Retire – Air Force C-5 (R/C)	5	$-0.3B		$-0.78B
Retire – Air Force C-17 (A/C)	3	$-0.11B		$-0.29B

List of Each User Selection

Ground

Add	
Purchase – Marine Corps Artillery Battali...	
Cut	
Retire – Marine Corps Reserve Armored ...	
Retire – Marine Corps Reserve Artillery B...	

Visual Comparison of Baseline and User Platform #'s

Select Category: Air

Force Structures: Rotary | Fighter | Bomber | Airlift | Aerial Refueling | C2/ISR | Unmanned

● Move BaseLine ● Move Inventory

Year	Value
2019	3,868
2023	4,302
2023	4,302
2028	4,805
2028	4,805

x-axis: 0, 2,000, 4,000

The SCT Is a Strategic Level Tool

- Costs are **rough order of magnitude estimates** (precision not required)

- Since this is a trading tool, **correct relative cost relationships** are more important than correct absolute costs

- The SCT is <u>NOT</u> a budget building tool; users make adds/cuts to the existing baseline budget, primarily for major defense acquisition programs

China SCT: Project Stages

- **Phase I: Literature Review**

- **Phase II: Construct a force structure trading tool**
  - Part A: develop cost estimation models of PLA platforms and systems
  - Part B: develop a projected 2030 PLA force structure
  - Part C: estimate the annual PLA equipment budget for 2020-2030
  - Build model internally, then hold workshop with external participation

WE ARE HERE

- **Phase III: Exercises**
  - Conduct three exercises utilizing the China SCT and the existing U.S. SCT to examine competitive dynamics between the U.S. and China
  - Solicit feedback before launching

Literature Review

Literature Review: Process

- Reviewed existing literature on PLA budget and Chinese defense procurement over last 30+ years

- Consulted 50+ experts worldwide in Chinese military studies, defense analysis, and cost analysis

- Collected platform characteristic and cost data on U.S. and Chinese platforms and systems

Literature Review: Insights

- Limited Chinese Data Available
  - No official defense budget data, except total defense budget amount
  - Some data on arms exports, but prices may be distorted

- Unique Project
  - Western research efforts in this field are sparse, sporadic, and isolated
  - No organization—at least in public domain—has attempted to develop cost estimates of PLA platforms/systems in all warfighting domains

- Reception Varied by Field
  - PLA experts are particularly skeptical about estimating costs
  - Analysts in defense industry, civilian industrial sectors, and consulting more open minded

- Wealth of U.S. Data Available

Potential Cost Estimation Models

Cost Models: Procurement (1)

Comprehensive Cost Estimation Models

1. ***Single Characteristic Ratio Model**
   – Apply ratio of key characteristics, such as weight or power, to cost of known Western platforms to generate price of similar Chinese platforms
2. **"Walk-down" Approach**
   – Apply cost from U.S. platform to similar Chinese platform, then adjust major subsystem costs based on research on China's defense S&T industry
3. ***Parametric Model**
   – Both Frequentist and Bayesian versions: develop Cost Estimating Relationships (CERs) for US/Western aircraft and apply to Chinese platforms
4. **Existing Off-the-Shelf Cost Estimation Software**

Limited Cost Estimation Model

1. Calculate per platform cost based off of financial data of subsidiary companies

All methods can include a PPP or other factor to adjust for Chinese labor costs

* Denotes ongoing CSBA effort

The qualities of 'good' estimates of Chinese costs:
internally consistent, **scalable**, and **minimum variance**

Cost Models: Procurement (2)

Overall Checks

1. Create cost ratios from complex civilian platforms (e.g. ships, aircraft) or construction processes (e.g. hotels) and apply to defense goods and production:

   – Data can be from U.S. and China, or from U.S. and a developing country with factor costs similar to China (e.g. Brazil)

2. Estimate procurement budget and production for previous five years, then compare these historical estimates to our budget and production forecasts for future five-year period (serves as a top-down check on bottom-up data)

3. Chinese prices:

   – Use existing commercial database of Chinese "prices" for defense goods

   – Check uncorroborated Chinese prices on blogs and press reports

   – Calculate prices from defense export deals

Cost Models: O&M

Comprehensive Cost Estimation Models

1. *Single Characteristic Ratio Model:
   - Apply ratio of key characteristics (e.g. tonnage or days at sea) to cost of known U.S. platform to generate price of similar Chinese platform

2. Parametric Model:
   - Develop parametric model from U.S. cost and specification data; apply to China

3. Use existing parametric model cost estimation software

Cost Estimation Model Limited to Particular Platforms

1. Find official sources (e.g. PLA field manuals) with O&M guidance and procedures

All methods can include a PPP or other factor to adjust for Chinese labor costs

* Denotes ongoing CSBA effort

Cost Model: Personnel

1. ***Single-factor model:** Apply a simple per person cost

2. **Multi-factor model:** Create a detailed model with personnel costs from job postings, articles, and blogs

* Denotes ongoing CSBA effort

Case Study: Fighter Aircraft

Fundamentals Still Hold
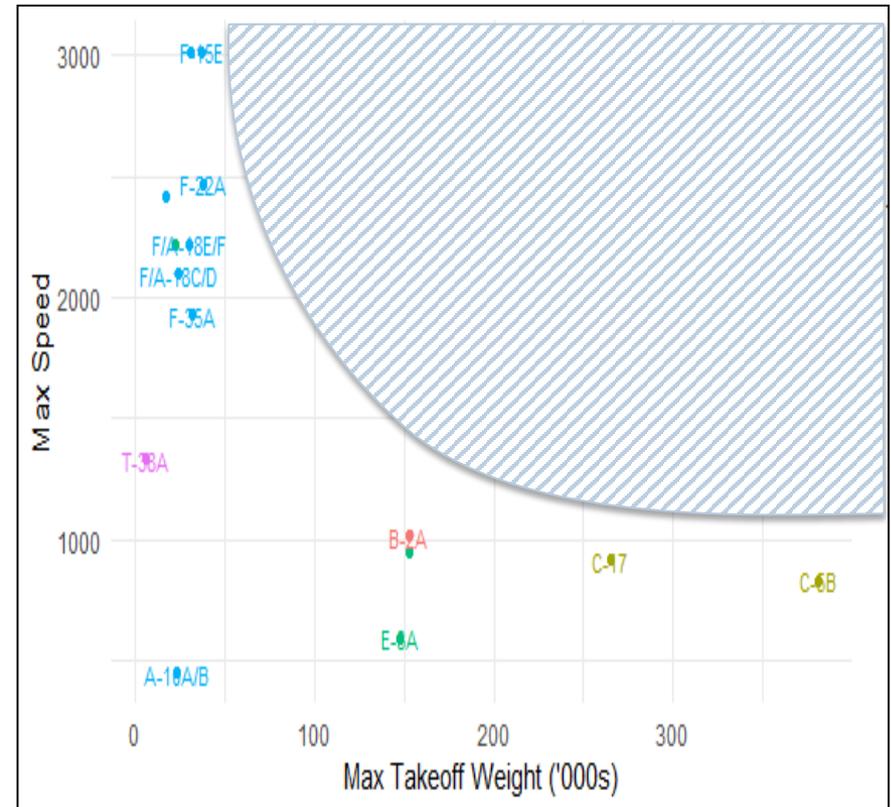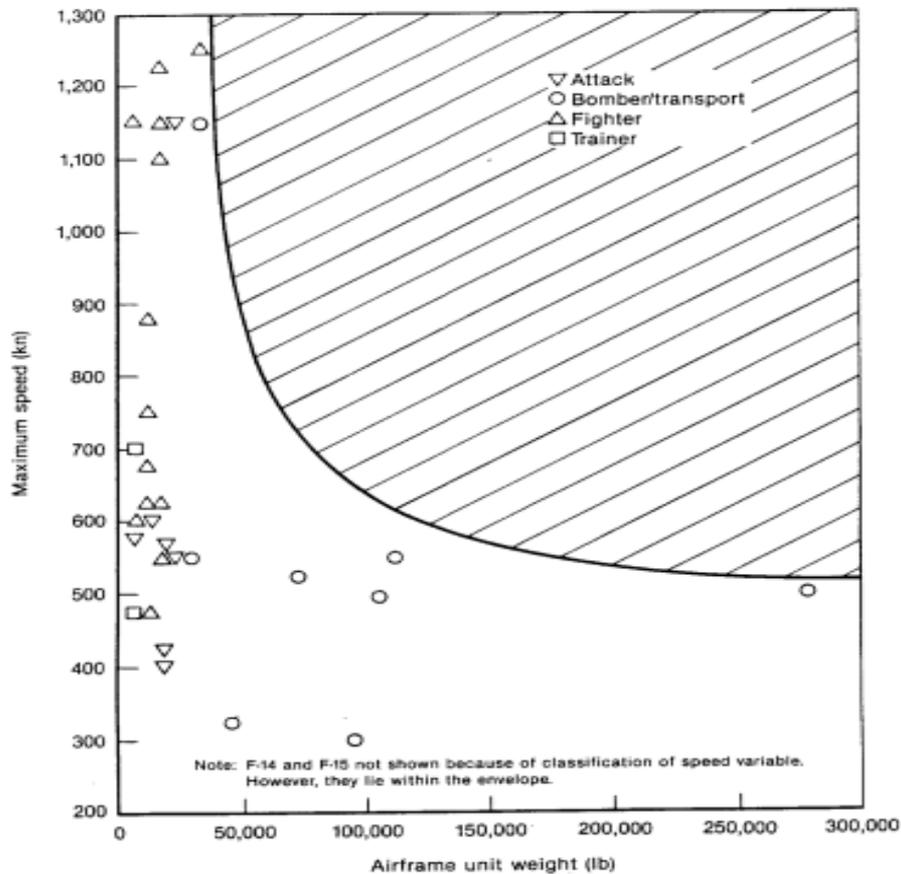
Example: Aircraft Speed-Weight Relationship
Comparison of 1987 RAND Study (Left) vs. Modern Data (Right)

Sample Single Characteristic Model

- **F-15A/B/C/D**
  - MTOW: 31,700 lbs
  - APUC: US $65.6m (2018 dollars)
  - Annual O&M: $15.1m (2018 dollars)
  - Directly Associated Personnel: 100

- **J-11D Fighter**
  - MTOW: 25,300 lbs
  - APUC: 25300/31700 X 65.6 = **US $52.4m**
  - O&M: 25300/31700 X 15.1 = **US $12m**
  - Personnel: 100*0.021 = **US 2.1m**

- **Example SCT Option:**

Platform	Planned Buy	User Selection	APUC	O&M Cost	Personnel Cost	Move 1 Cost	Move 2 Cost
J-11D - Increase Buy	42	8	52.4	12.0	2.1	701	564

  - Assuming Move 1 planned buy of 42 platforms, max selection # = 42

Sources: CSBA Estimates, DoD Budget Documents, IHS Jane's

- Sample parametric model developed from U.S. fighter aircraft (Blue) and applied to current/future Chinese aircraft (Red)

- Model generates a cost estimate in U.S. dollars for a hypothetical identical aircraft produced in the U.S.

Sources: DoD Budget Documents, IHS Jane's

Summary
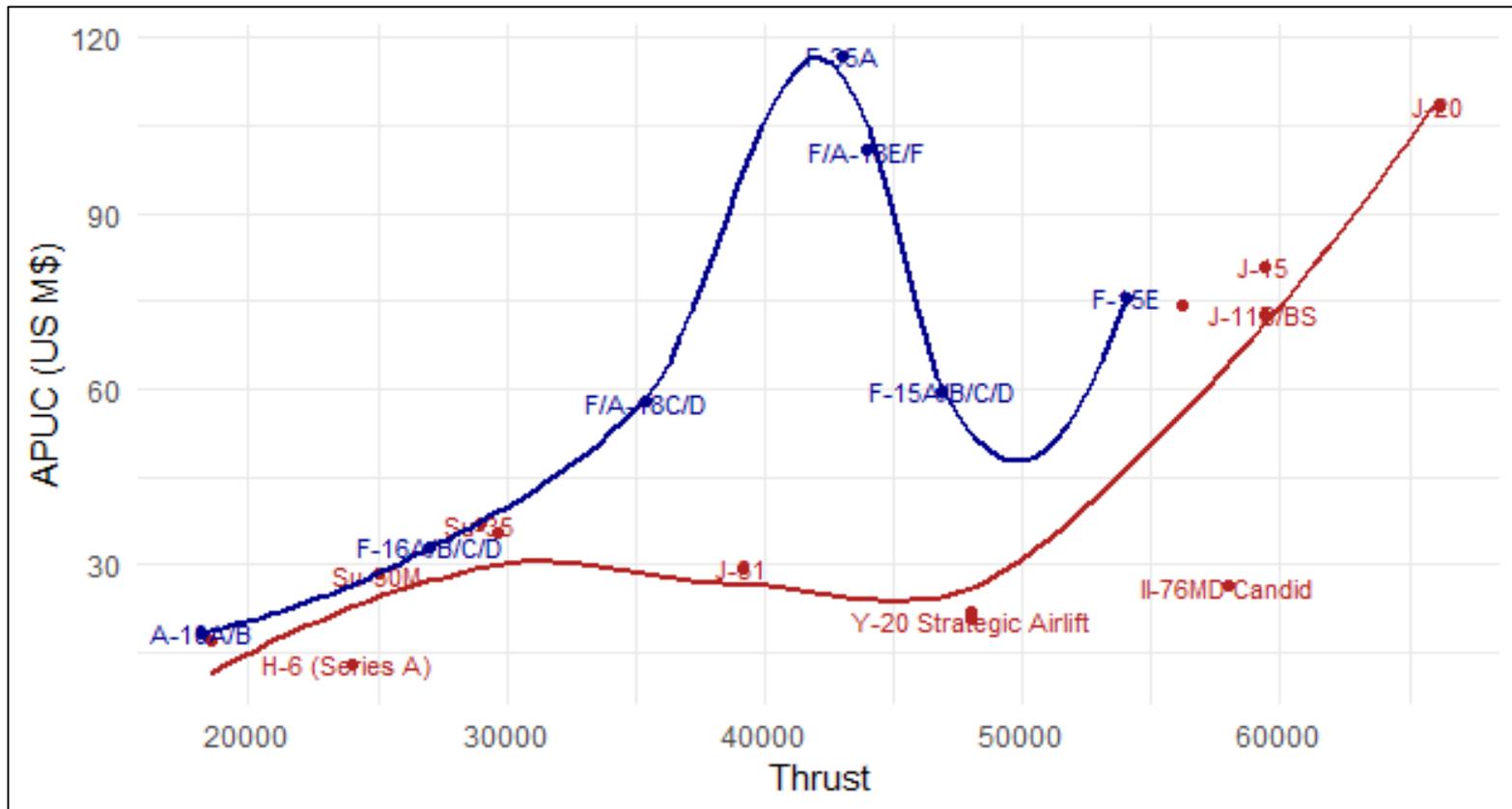
- This is a **Hard Problem**, but worth the effort!

- No single approach is likely to yield a definitive 'answer'
    - Many approaches in concert will help discern the feasible regions
    - Chinese themselves likely don't know the costs of these platforms

- Next steps:
    - With more U.S./Allied data, may attempt Recursive Partitioning, Neural Nets, or other 'Machine Learning' approaches
    - Create platform cost and production estimates for all domains
    - Organize workshop and invite experts to author papers on key questions

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Thank you!

Technical Lead: Jack Bianchi, bianchi@csbaonline.org, 202-719-1345

Contracting: Ilana Esterrich, esterrich@csbaonline.org, 202-719-1340

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