

Presented at the 2011 ISPA/SCEA Joint Annual Conference and Training Workshop - www.iceaaonline.com



CRITICAL THINKING.
SOLUTIONS DELIVERED.

Economic Elasticity of Tactical Missile Costs

presented by:

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Agenda

- **Introduction**
- **Definitions**
- **Finding the Dominant Theory**
- **Missile Cases**
- **Summary**
- **Conclusions**
- **Acronyms**
- **References**



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Introduction

- **A customer (unnamable by me) asked the following:**
 - “Do we buy more missiles because the price decreases or does the price of missiles decrease because we have bought more?”
- **It seems like a chicken and egg proposition, but after a little thought, it seemed like a good problem to solve**
- **Essentially, we are trying to prove which of the following two theories has the dominant effect on missile costs**
 - **Price elasticity of demand**
 - **Unit cost improvement**



Background Theories

- **Price elasticity of demand dictates [Ref. Frank]:**
 - “If like goods (e.g., missiles) are cheaper, we tend to buy more of them.”
 - Meaning that prices and demand are inversely proportional
- **Cost improvement curve theories, such as unit learning, explain the converse effect [Ref. Stewart]:**
 - “If we can buy a greater quantity of an item, its relative cost decreases between successive units.”
- **Which theory dominates in weapons system markets such as missiles?**
- **This presentation shows evidence concerning these two theories**



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Demand Issues

- **We cannot directly trace the effect of the change in the missile unit costs to the change in the total number of missiles demanded by the Government**
 - Presumably, the Government would buy fewer missiles if the costs exceeded the budget
 - Also, the government might buy more missiles if they could still meet their budget
 - The data available do not contain these details
- **Quantity Demanded, as used in this analysis, is measured as the number of missiles produced in a particular lot**



Cost Improvement Is More Than “Learning”*

- **Cost Improvement is the observed reduction of costs between successive units or projects**
- **The following factors affect cost improvement:**
 - **Nonrecurring and recurring *accounting standards affect measurement***
 - ***Reuse* of existing designs, materials, equipment, effort, or products**
 - ***Learning* or gained experience in value added effort**
 - ***Skill Mix* changes**
 - **Process *shortcuts* that eliminate effort or expenses**
 - ***Yield* improvements that reduce cost**
 - ***Production Rate* increases allowing for *amortization* of pooled costs and greater efficiency**
 - ***Technological advances* allowing greater yield and efficiency**
 - ***Inflation*, which measures the time variable cost of a “basket of goods”**
- **We should not call cost improvement “learning”**

*True “learning” is a subset of cost improvement, so cost improvement is more than “learning.”



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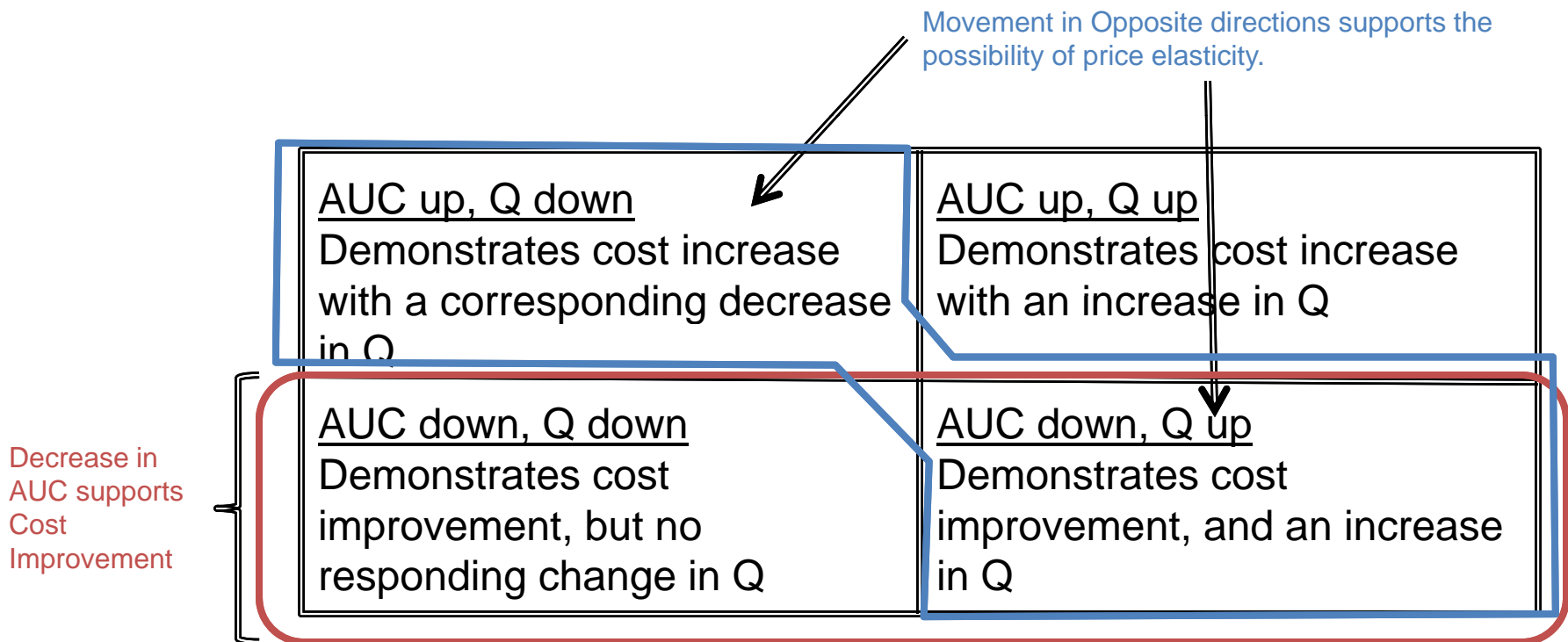
Finding the Dominant Theory

- In the case of missiles, one way to determine which of the two theories (i.e., *price elasticity of demand* and *cost improvement of successive units*) dominates is to examine the lot quantity purchases of different lots for the same missiles
 - Since the average unit cost (AUC) of successive lots are presumably lower due to cost improvement, we should see a trend towards greater lot buys of successive lots
 - This does not prove whether either theory is dominant
 - If this effect is not evident (i.e., we buy consistently the same number of missiles or fewer in successive lots), then the cost improvement paradigm should dominate since we are still on the “learning curve”
 - This supports the hypothesis that cost improvement of successive units is the dominant theory



The Possible Outcomes

The potential year over year changes in Average Unit Cost (AUC) and Quantity Demanded (Q) are shown in the table below.



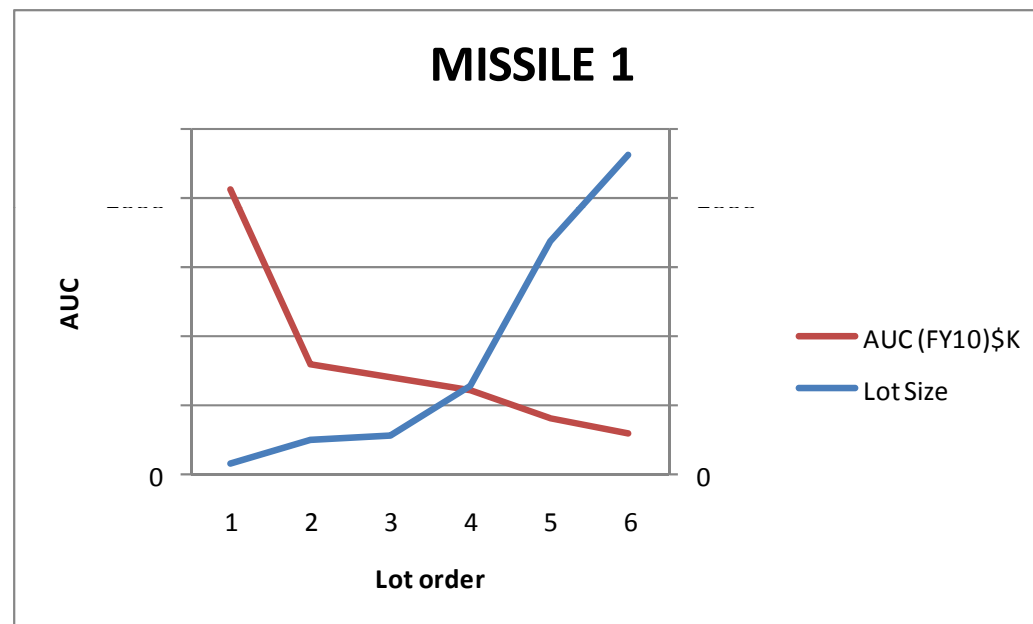


The Data

- **The data examined include the inflation-adjusted AUC (average unit production lot costs, in FY\$10k) for four missiles**
- **While the data do not constitute an exhaustive sample of all missile programs, they do provide a reasonable sample from which a pattern might emerge**
- **The names of the missile programs are labeled MISSILE 1, MISSILE 2, MISSILE 3, MISSILE 4**

MISSILE 1

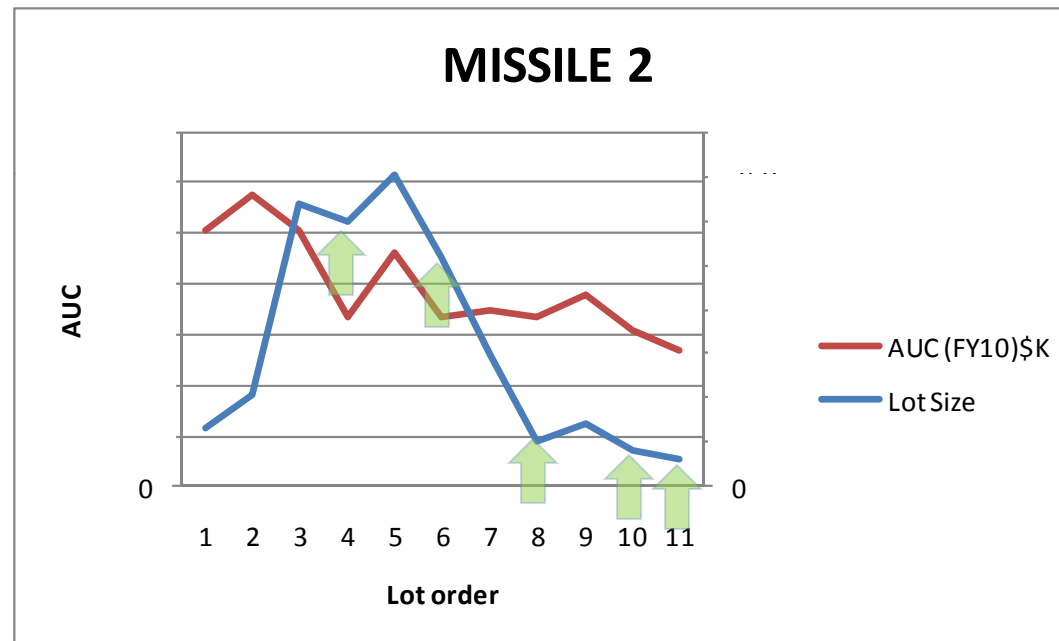
- **Missile 1 shows a trend toward increasing lot size with decreasing AUC**



- **This case does not prove whether either theory is dominant**

MISSILE 2

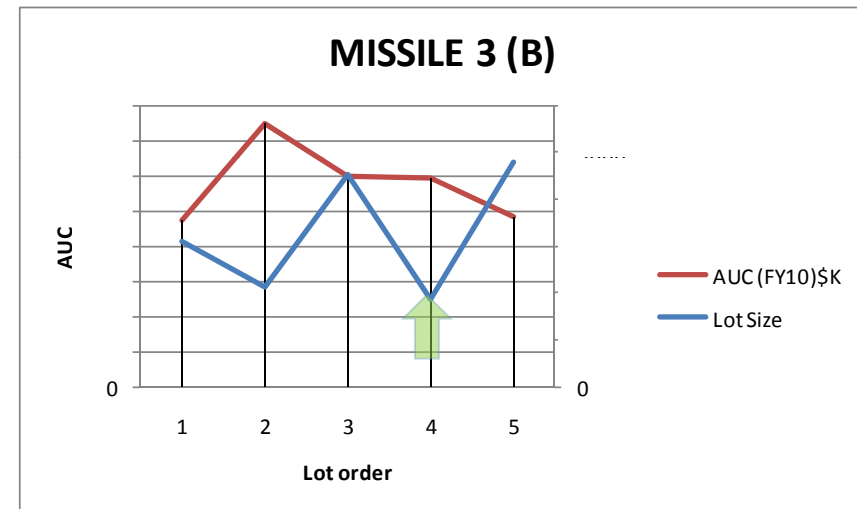
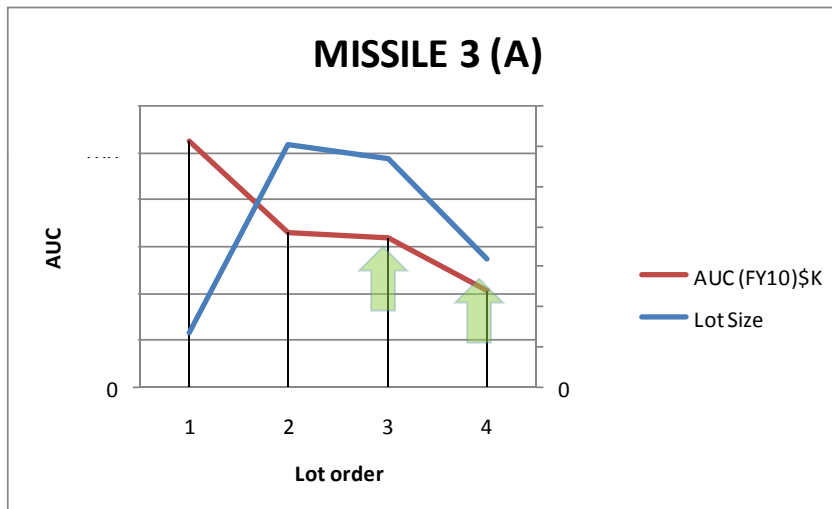
- **Missile 2 shows mixed lot size trends**
 - **Green arrows indicate where lot size decreased when AUC decreased**



- **This indicates cost improvement of successive units is the dominant theory**

MISSILE 3

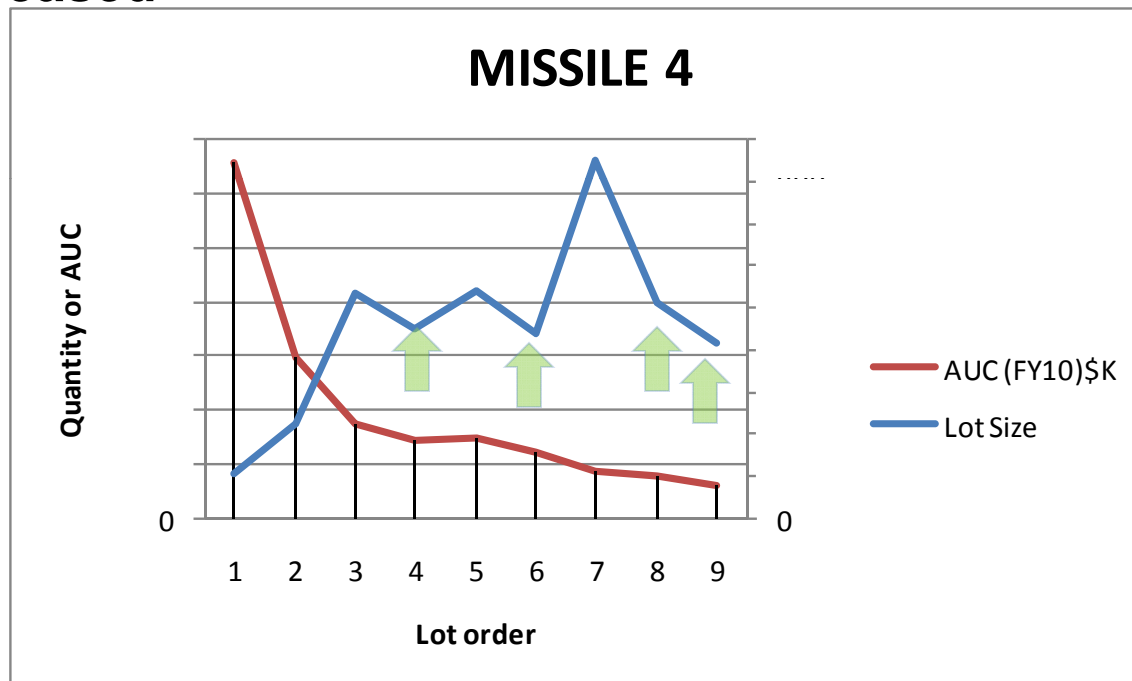
- **Missile 3 was produced by two vendors (A and B)**
 - **Green arrows indicate where lot size decreased when AUC decreased**



- **This indicates cost improvement of successive units is the dominant theory**

MISSILE 4

- **Missile 4 shows mixed lot size trends**
 - **Green arrows indicate where lot size decreased when AUC decreased**



- **This indicates cost improvement of successive units is the dominant theory**



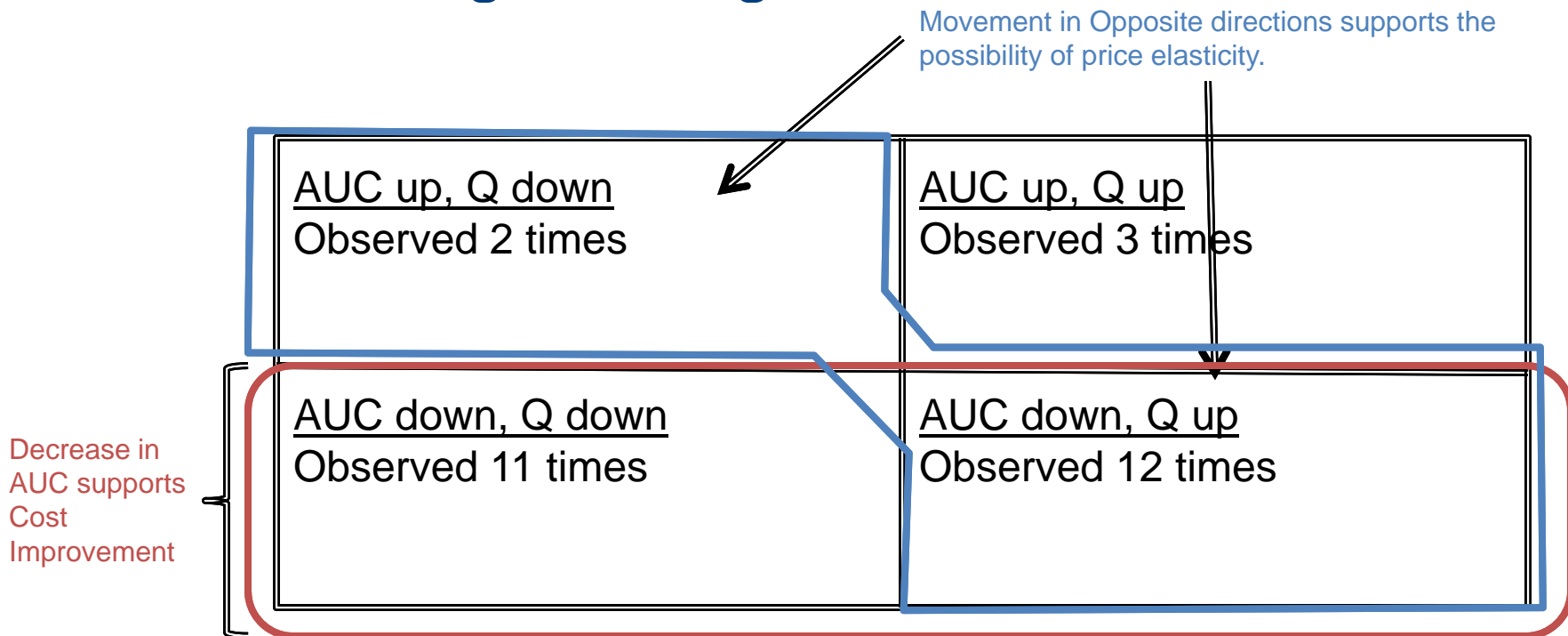
Summary

- **The summary of the four cases shows that unit cost improvement theory is more dominant than price elasticity of demand**

Case	Dominant Theory
MISSILE 1	Inconclusive
MISSILE 2	Unit Cost Improvement
MISSILE 3	Unit Cost Improvement
MISSILE 4	Unit Cost Improvement

The Quantitative Results

- The observed year over year changes in Average Unit Cost (AUC) and Quantity Demanded (Q) are shown in the table below
- There were 30 observed year over year changes with two showing no change in AUC





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Conclusions

- **While this isn't an exhaustive analysis, it does indicate a general cost improvement trend rather than an elastic effect**
- **We do not have sufficient data to conclusively identify the magnitude of the demand effect**
 - **We cannot segregate the effect of price elasticity of demand from the annual change of demand, which results in a shift in scheduled purchases**
 - **We do not know the effect of price reductions on the total number of missiles purchased in the program, only the yearly change in lot quantities purchased**
 - **This would only reinforce the conclusion that cost improvement is the dominant effect**
- **The answer to the customer's question is:**
 - **“The price of missiles decreases because we have bought more. We cannot conclude that we buy more missiles because the cost of missiles decreases”**



Acronyms

- **AUC** **Lot average unit cost**
- **FY** **Fiscal Year**
- **Q** **Quantity Demanded**



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References

- **Stewart, R. and Wyskida, J., *Cost Estimator's Reference Manual*, 2nd Ed., J. Wiley and Sons, New York, 1995.**
- **Frank, R., and Bernanke, B., *Principles of Microeconomics*, 4th Ed., McGraw Hill, Boston, 2009.**