Presented at the 2007 ISPA/SCEA Joint Annual International Conference and Workshop - www.iceaaonline.com

Product, Sub-Market and Market Demand

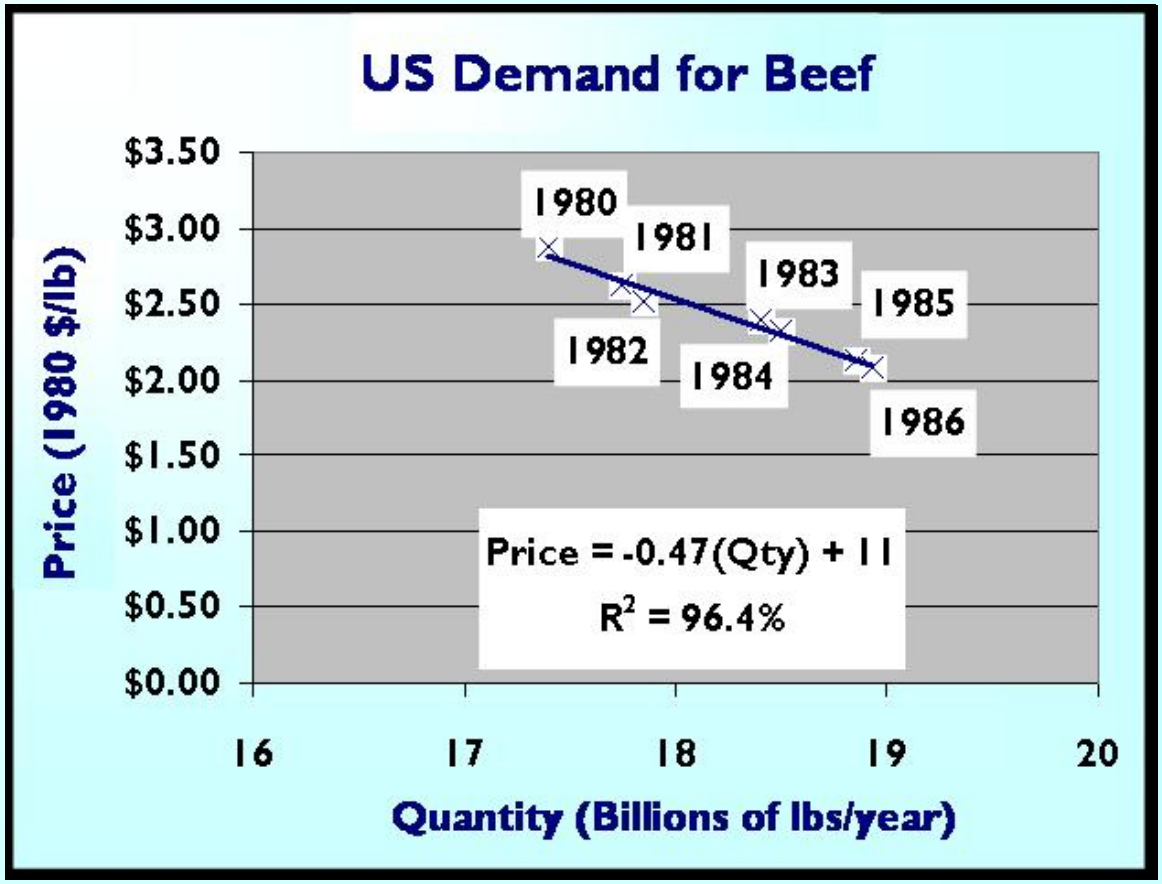
Doug Howarth
Lockheed Martin Aeronautics Company
Advanced Development Projects Palmdale, CA

Why are we Interested in Demand?

- Previous Government Procurement: Build the Lowest Cost Device that Meets our Criteria
- New Govt. Procurement Method (Ongoing Commercial Practice): Build the Best Device for Available Monies
  - Producers Decide Performance Criteria
  - Buyers Decide Price Based on Attributes
  - Buyers Decide Quantities Sold Based on Performance and Funds They Bring to Market

Classical View of Demand

Year	US Beef Consumption (Billions of lbs./year)	1980 Price ($/lb)
1980	17.4	$2.88
1981	17.7	$2.62
1982	17.8	$2.51
1983	18.4	$2.39
1984	18.5	$2.32
1985	18.8	$2.13
1986	18.9	$2.08



Classical Demand States that the More Something Costs, the Less we can Afford, and the More we Have, the Less we Want

Downward Sloping Demand is Borne out in the US Beef Market from 1980 to 1986, but Most Demand Curves are not Believed to be Linear

What About Demand for Non-Commodity Products Such As Aircraft?

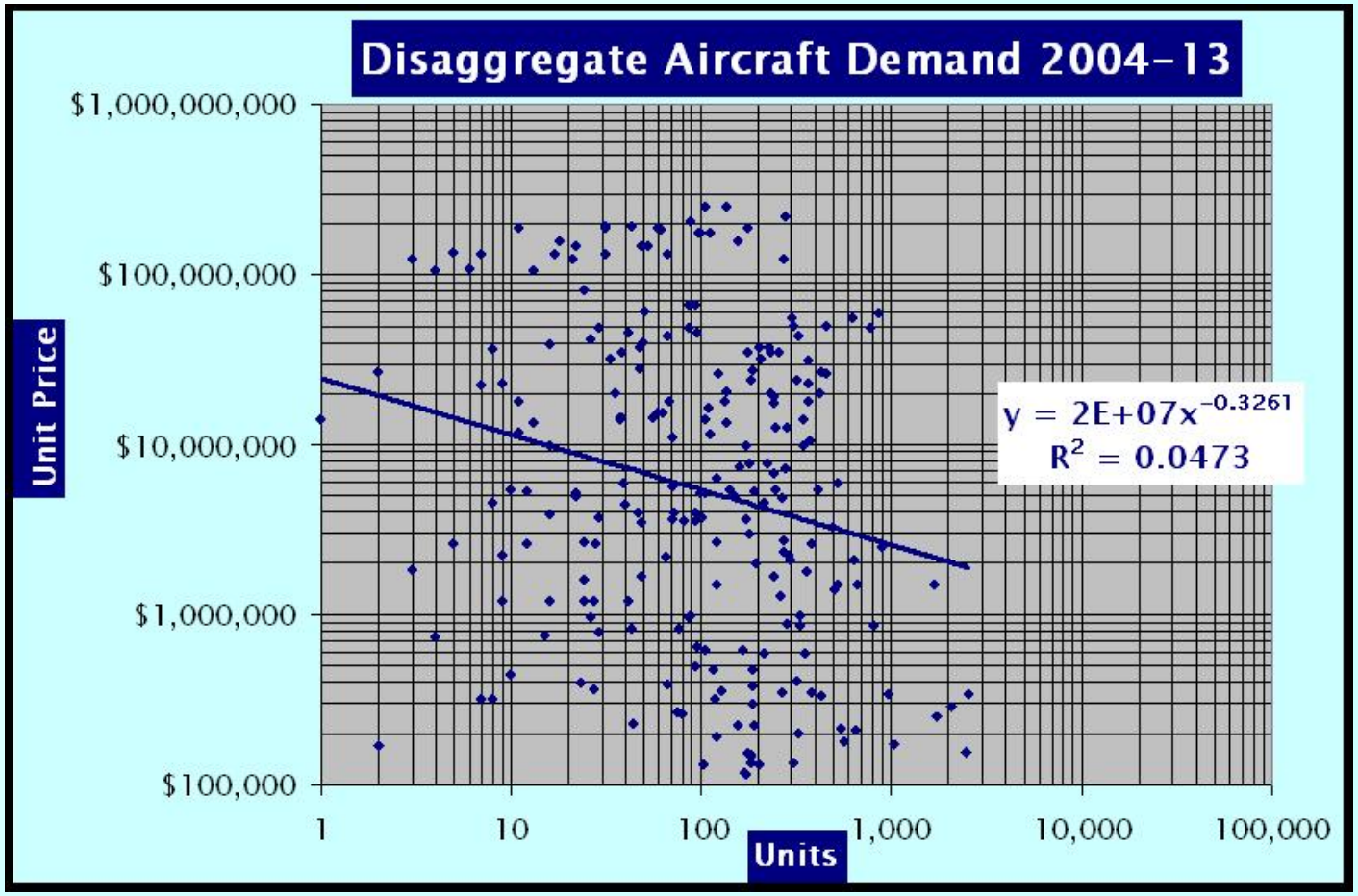
- There is More Variation in the World Aircraft Market than there is in the US Beef Market
- However, Several Groups Track and/or Forecast Aircraft Sales
  - Jane's Information Group
  - The Teal Group
  - Documental Solutions
  - Forecast International

How Can We Determine Aircraft Demand?

Consider the World Market for New Aircraft for a Decade

Aircraft	2004 2013 Qty	Price 04$
Model 1	281	$900,000
Model 2	295	$2,100,000
Model 3	71	$3,700,000
Model 4	92	$3,600,000
Model 5	81	$3,600,000
Model 6	191	$2,000,000
Model 7	11	$18,000,000

233 Models | 1-2500 Units | $95K-$250M

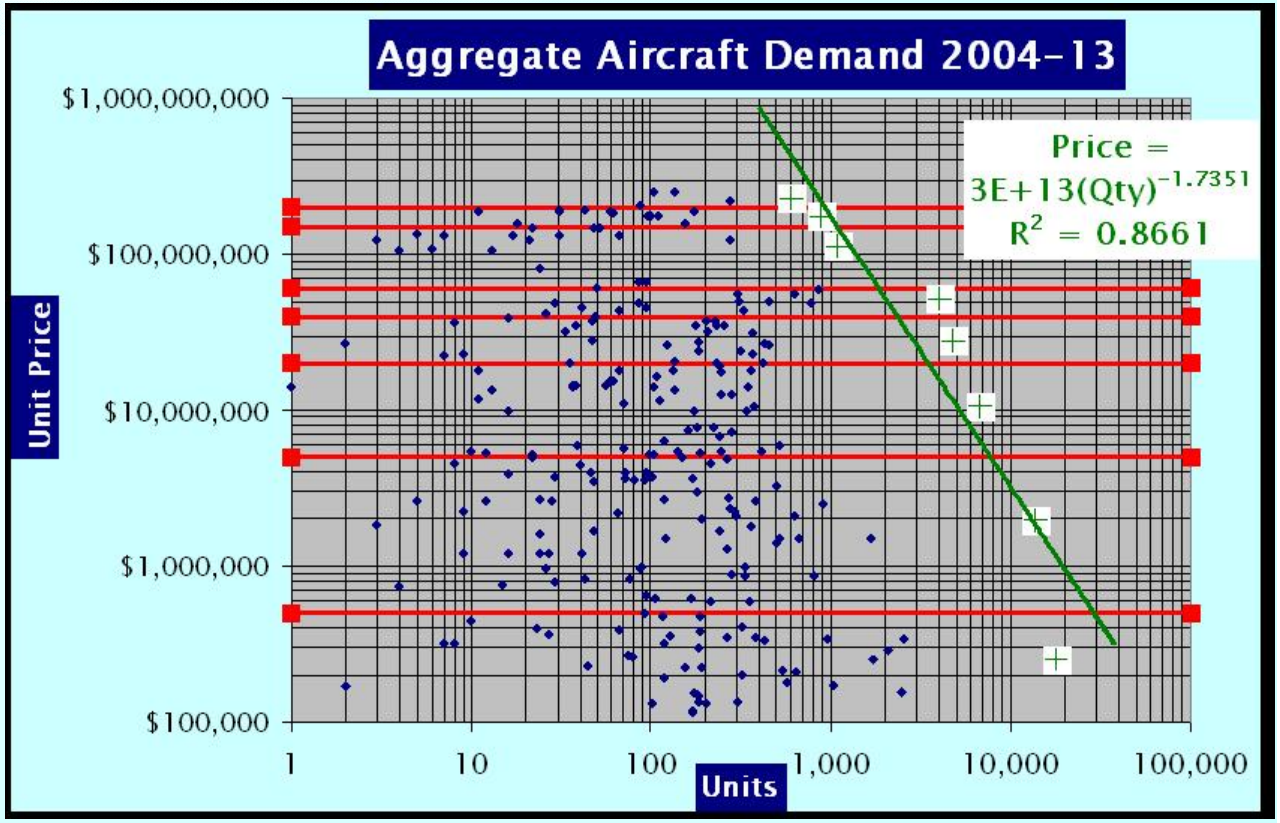


A Simple Log-Linear Regression Through the Data Reveals Nothing Statistically Significant – But We Have Not Aggregated the Data

Let's Examine Demand Differently

Price Range in 04$M	Qty	Ave 04$M
x <= $0.5	17,716	$0.26
$0.5 < x <= $5.0	13,571	$1.98
$5.0 < x <= $20.0	6,707	$10.49
$20.0 < x <= $40.0	4,770	$28.00
$40.0 < x <= $60.0	3,971	$51.74
$60.0 < x <= $150.0	1,091	$112.91
$150.0 < x <= $200.0	888	$175.94
x > $200.0	599	$228.39

Collecting Unit Sales by Price Ranges (Bins) allows us to Calculate Aggregate Demand



Examining All New Planes from Cessna 172's to Airbus A380's, the Demand for All Models may be Characterized Simultaneously

This Market Consists of Submarkets

- The Commercial Aircraft Market has within it
  - Airliners
    - Regional to Jumbo
    - Jet or Turboprops
  - Freighters (Jet or Turboprops)
  - Business Aircraft (Jet or Turboprops)
  - Personal Aircraft
  - Vertical Takeoff and Landing (VTOL) Aircraft
  - New and Used Aircraft (Note: Used Aircraft Not Addressed in this Analysis)
- All Maturing Markets form Submarkets, as Competitors Provide Alternatives to Established Products

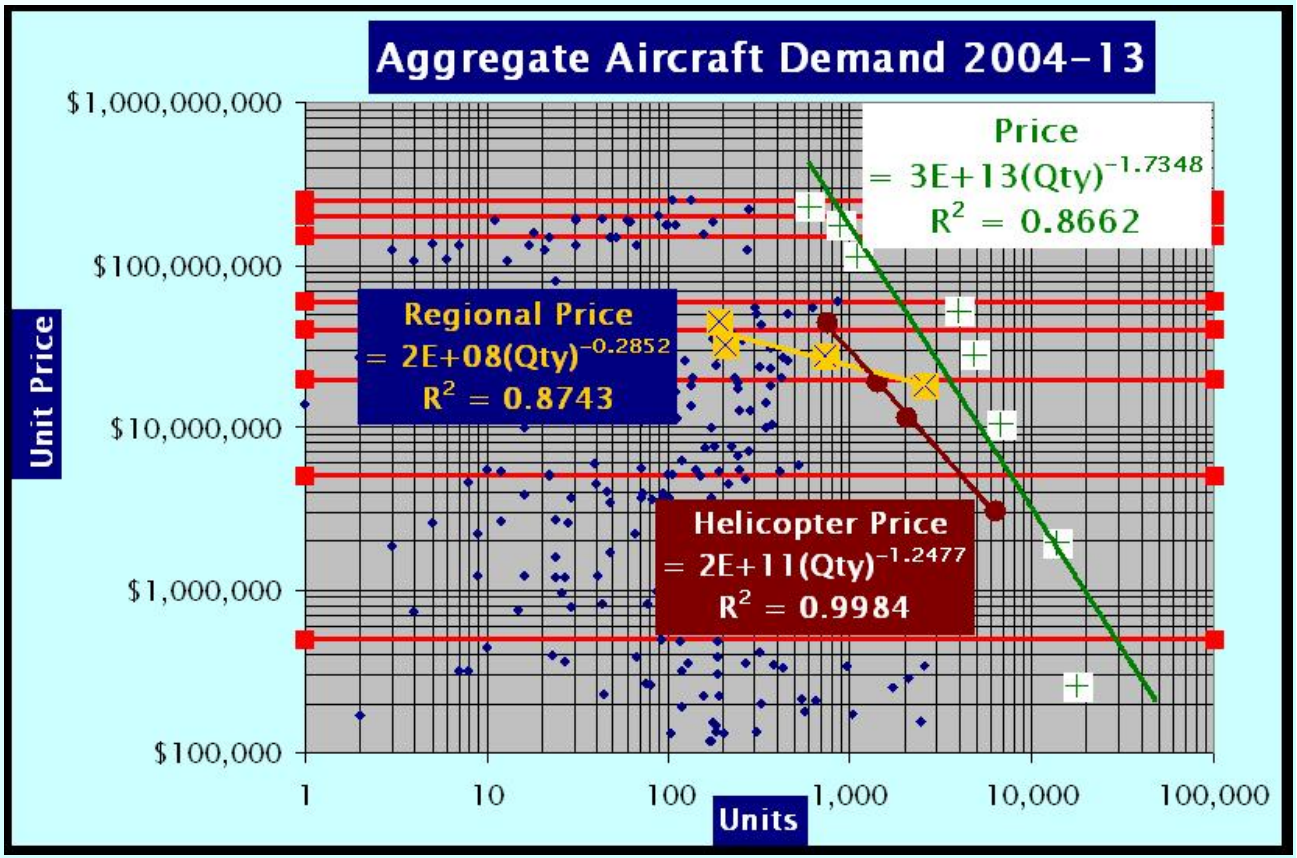
Consider the Total Aircraft Market Again

Using the Techniques Previously Presented, Within The Total Market, Regional Aircraft Demand is

Price Range in 04$M	Qty	Ave 04$M
x <= $25	2,532	$18.31
$25 < x <= $30	717	$27.43
$30 < x <= $40	204	$32.08
x > $40	191	$45.00

And Helicopter Demand is

Price Range in 04$M	Qty	Ave 04$M
x <= $7.5	6,373	$3.02
$7.5 < x <= $15	2,043	$11.39
$15 < x <= $25	1,424	$19.15
x > $25	751	$43.63



The Submarkets, Working by Themselves and in Concert with the Larger Market, Form Their Own Demand Curves

What are We Buying?

"Price is what you pay. Value is what you get."

Warren Buffet

Important Value Considerations Include:

- Capacity (Aircraft Payload, Computer Memory)
- Speed (Aircraft Cruise Speed, Computer Processing Speed)
- Portability (Aircraft Field Length, Laptop Size and Weight)
- Flexibility (Amphibious Aircraft, Waterproof Laptops)
- Saturation (Number of Aircraft or Computers in the Market)

What is Aircraft Value Given Platforms With Varying Capabilities?

Airbus A380

Cessna Caravan Amphibian

Sikorsky S-92

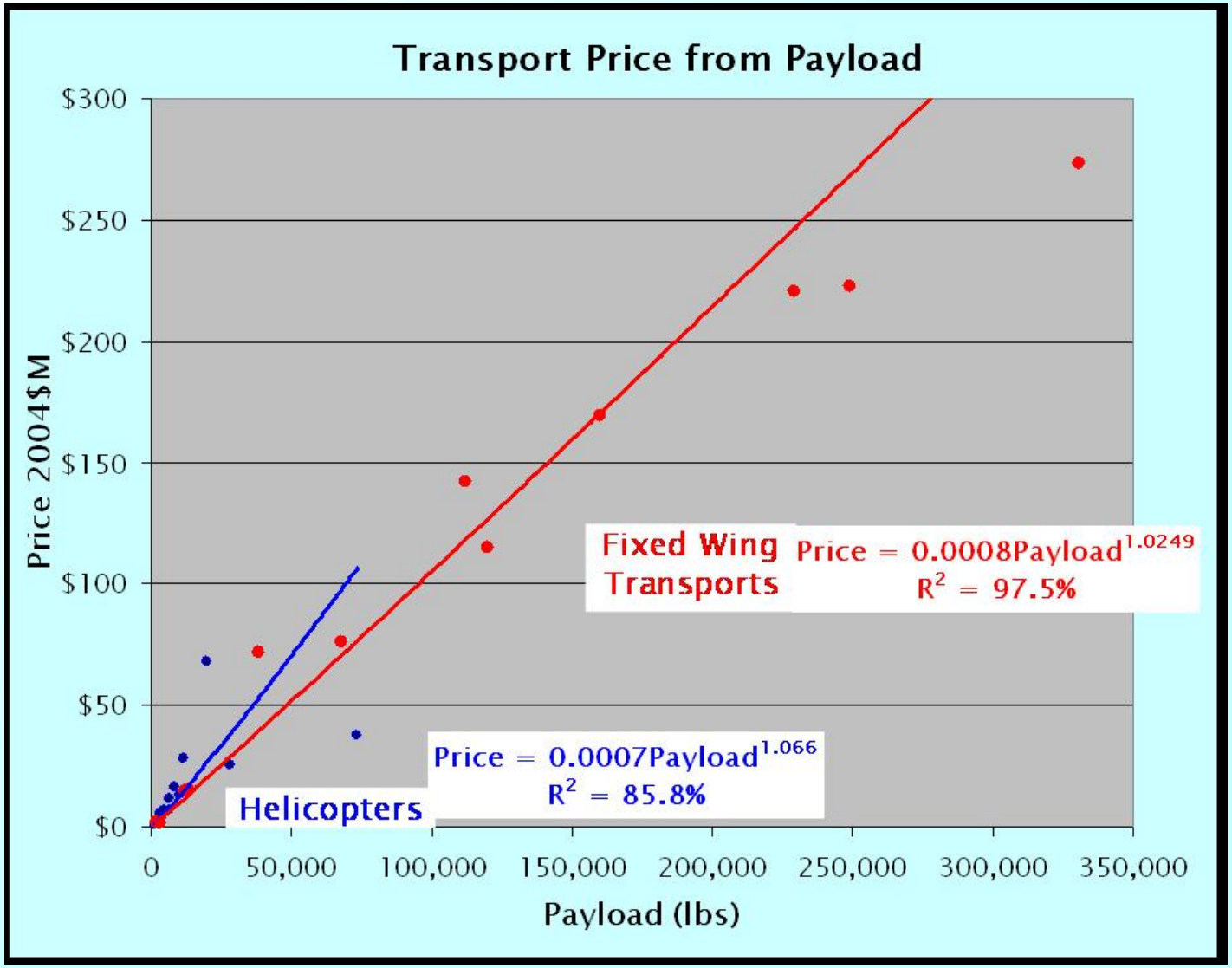
Bell Agusta BA609

Let's Consider Payload First

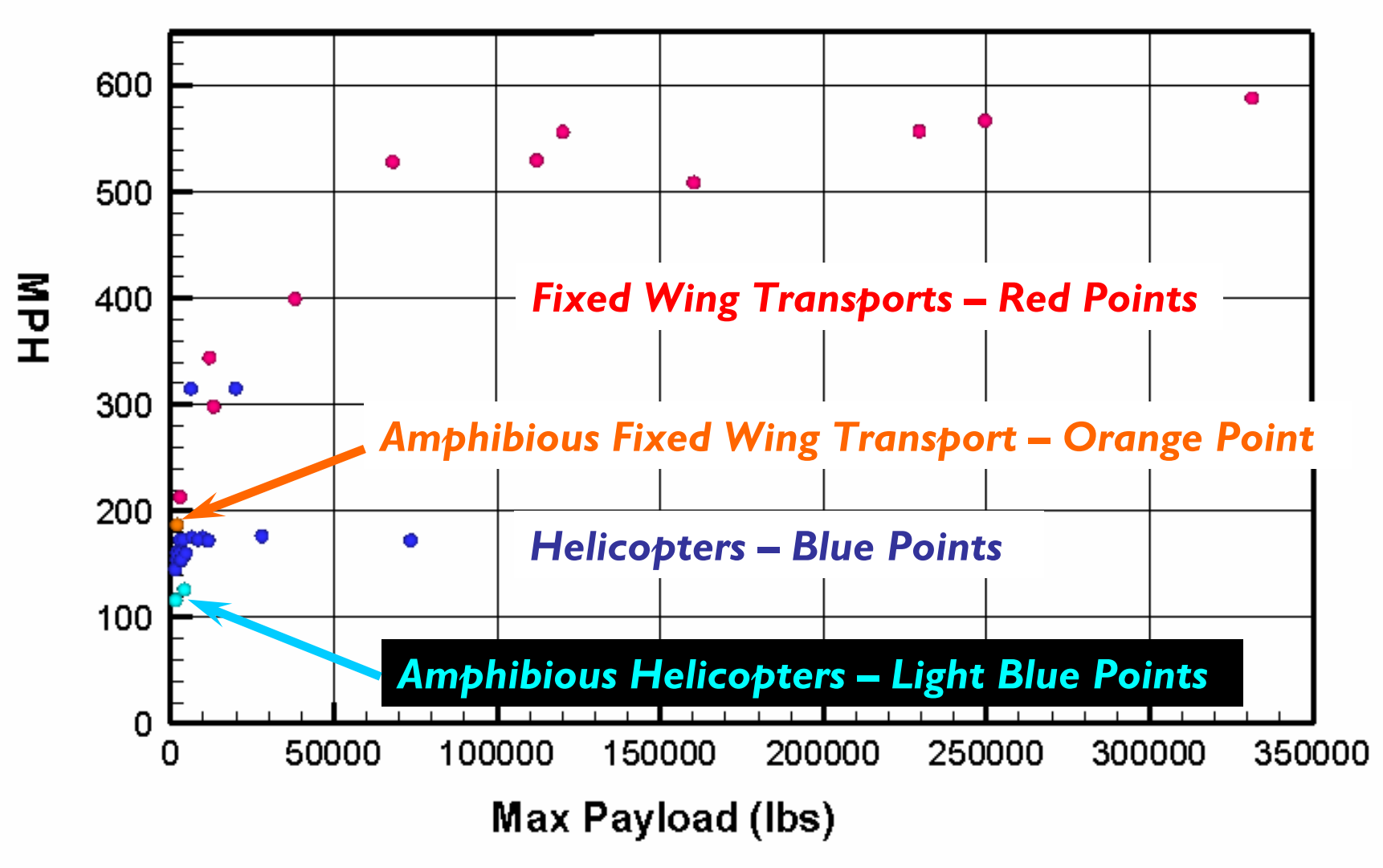
Helicopters Prices are Correlated to their Payloads

Fixed Wing Transport Prices are also Correlated to their Payloads

What Else Can We Say About the Relationship of Aircraft Attributes Relative to their Prices?

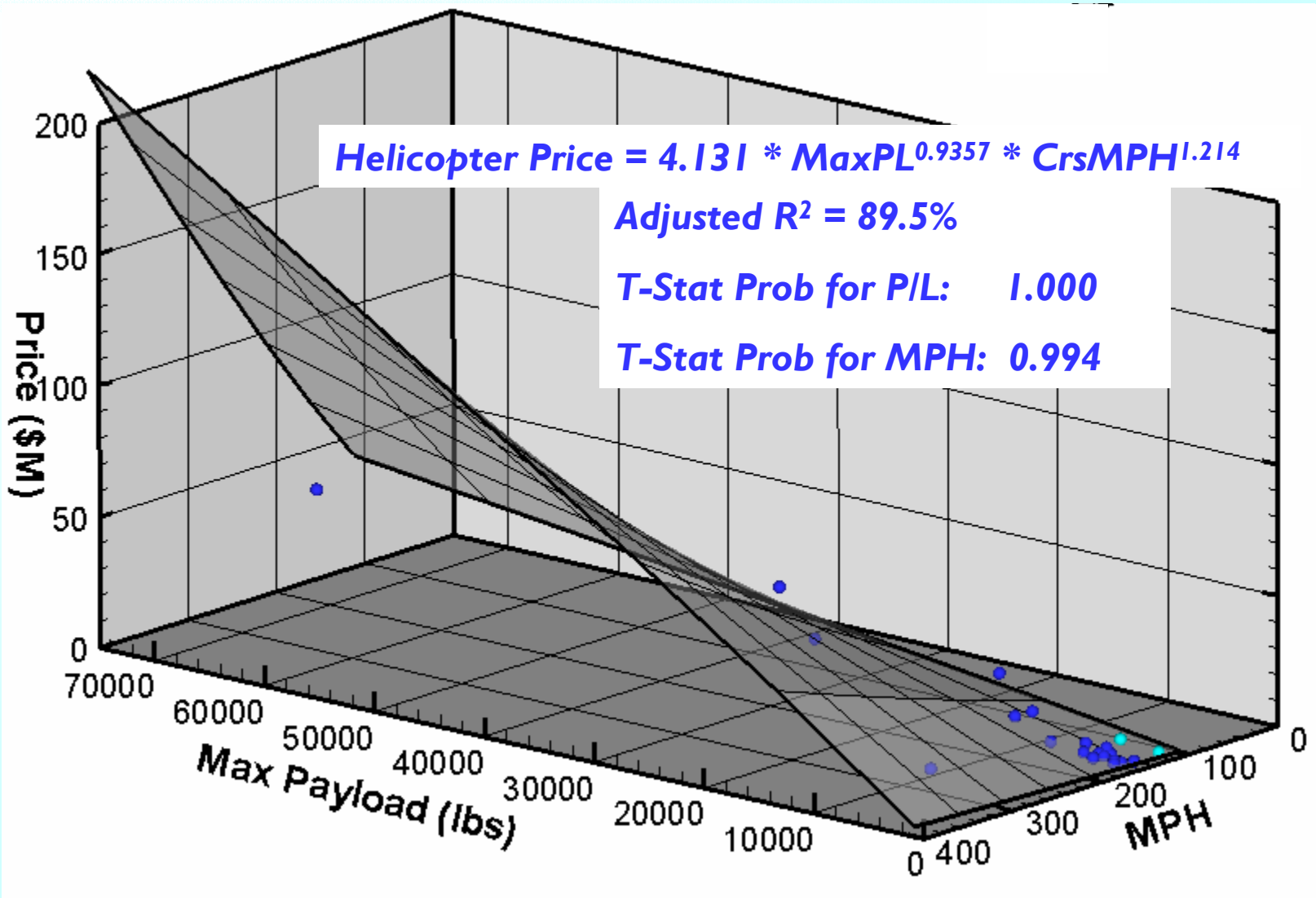


Let's Examine Payload & Speed



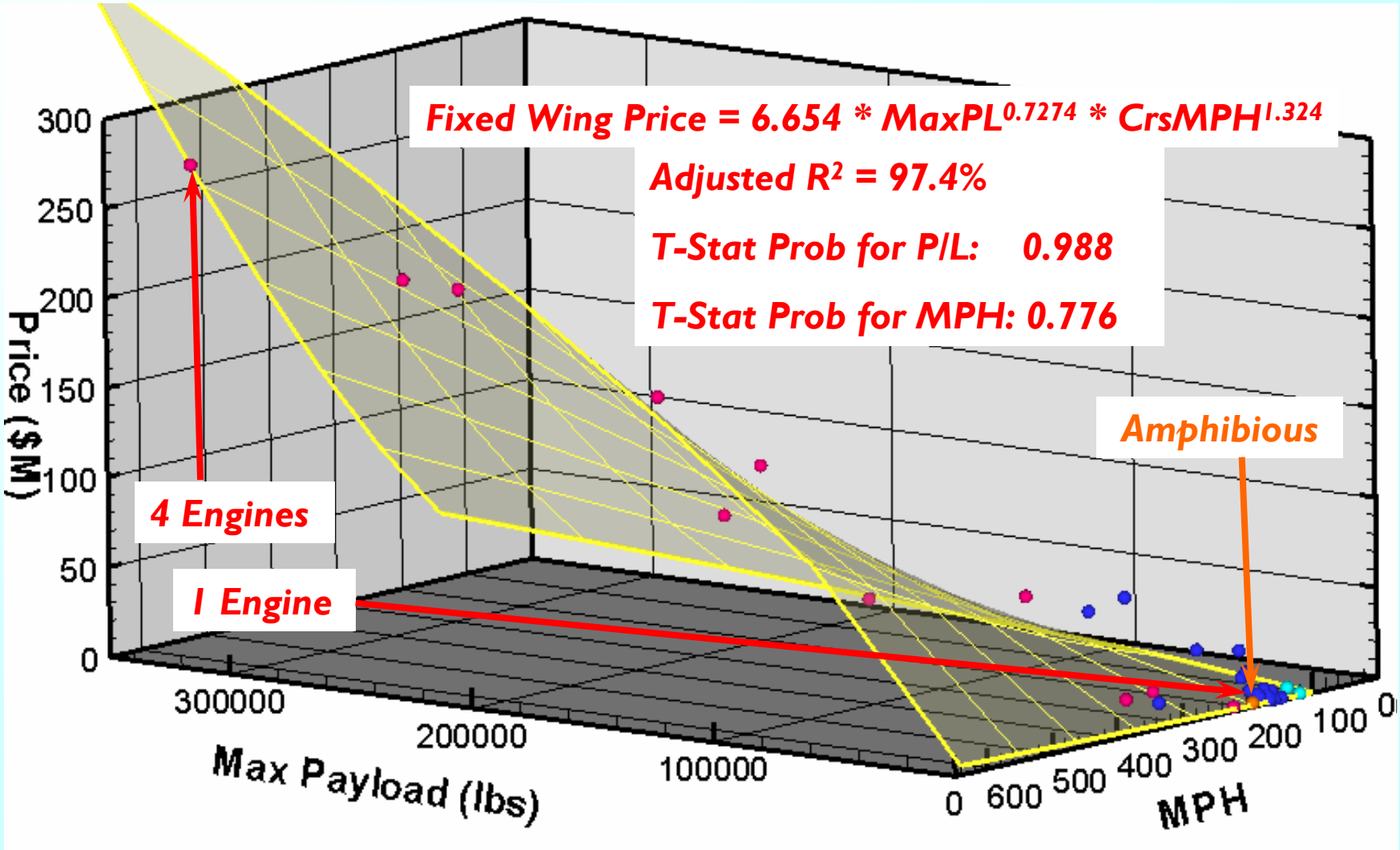
How Do Payload Capacity & Speed Combine to Support Vehicle Prices?

Effect of Payload & Speed for Helicopters



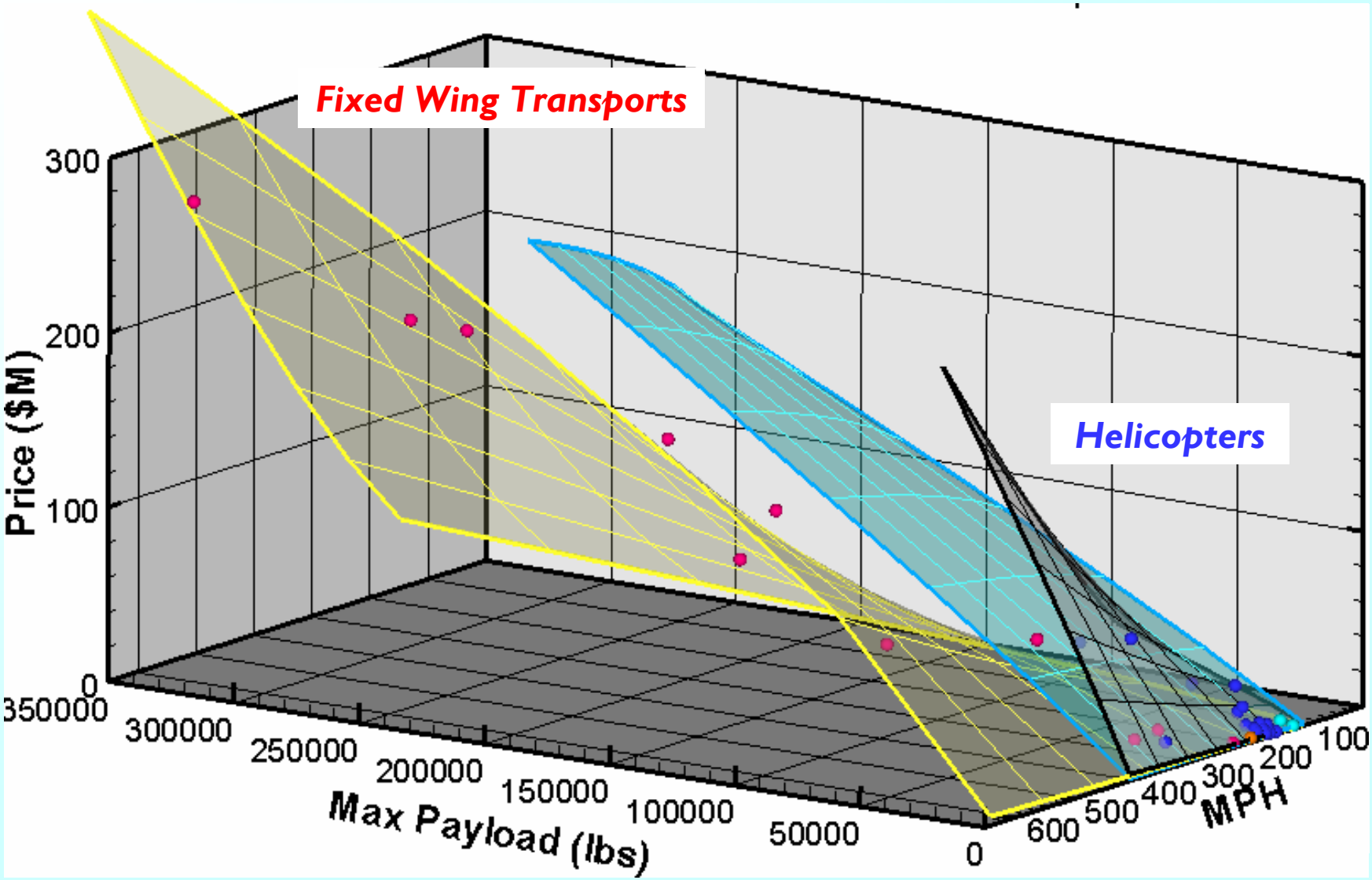
Multiple Stepwise Regression offers Better Price Predictor Using More Variables

Same Effect for Fixed Wing Transports



What if Other Terms Were Important to Value: Should We Consider Them?

What if We Account Only for Payload & MPH?

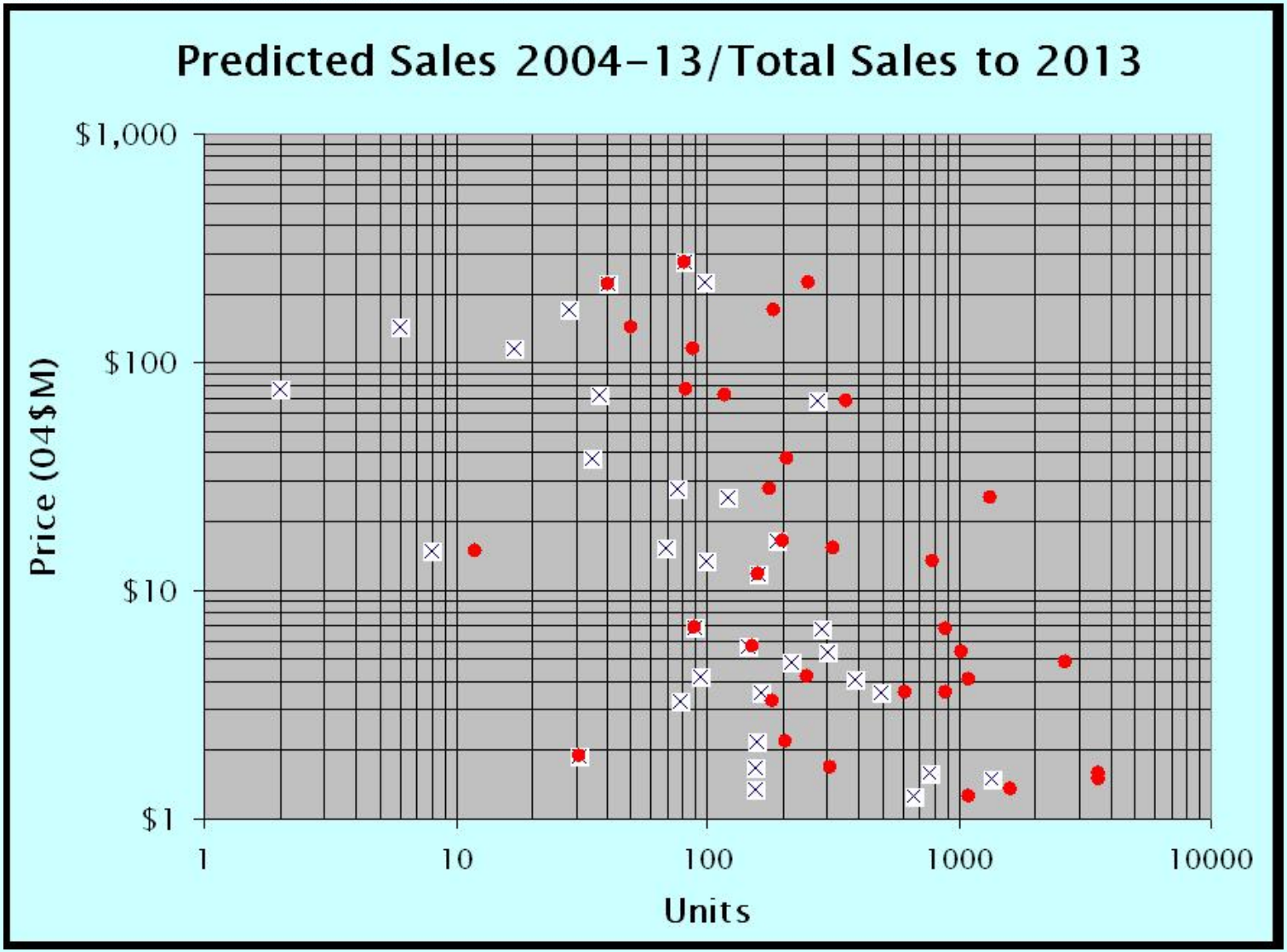


A Regression Using Only Payload and Cruise Speed as Independent Variables (the Light Blue Surface) Misses Many Points by Wide Margins

How Might We Get Better Answers?

- Helicopters have Added Value Compared to Same Capacity Fixed Wing Transports (Dummy Variable for Helicopters)
- Amphibious Vehicles have More Value than Comparable Aircraft without this Ability (Dummy Variable for Amphibians)
- Added Engines Provide an Added Measure of Safety (Use Number of Engines as an Independent Value Variable)
- For any Given Model, more Vehicles of it in the Market adds to Market Saturation (Take the Number of the Vehicle predicted for sale in the next 10 years, add that to the number already Manufactured as an Independent Value Variable)

Units in the Market

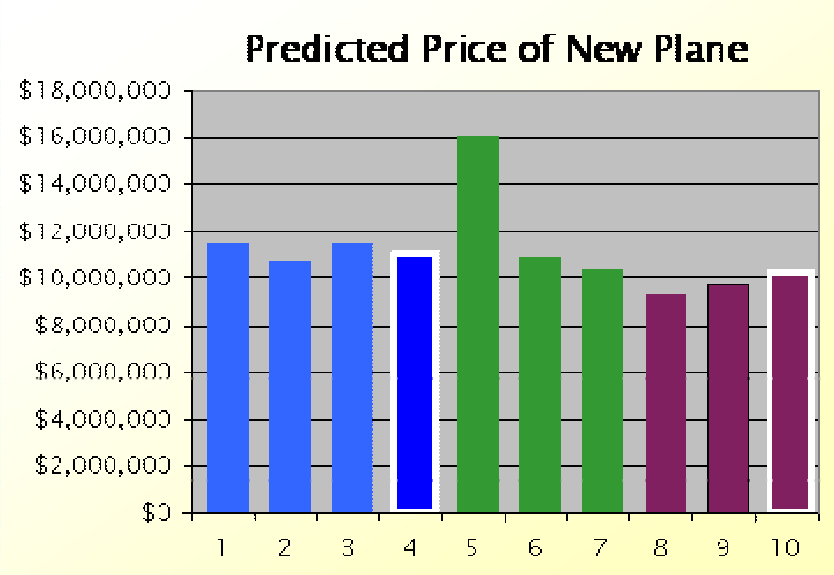


The Number of Units that Will be Sold…Add to the Units Already Sold

Parallel Multiple Regressions for Bounding

Variable	Value
Payload (lbs)	9,000
Cabin Volume (ft^3)	400
Normal Cruise (MPH)	350
Max Cruise (MPH)	363
Max Dash Speed (MPH)	180
First Flight Year (Year)	2010
Commercial =1, Mil = 2	1
Not Helo = 1, Helo = 2	1.5
No H2O Land=1, Use 2	1
Maximum Ton-Miles	3,000
Number of Engines	1
Max Range (Miles)	2,880
Max Ton Mile MPH	22,730,000
Units in the Market	180

Max Payload Equations
Max Ton-Mile Equations
Cabin Volume Equations



Regressed Equations for Transport Market Price

Equation	MAD	StdEr	FStat	AdR²	ob	Eq	06$
$ = 44.7 * MaxPL^{0.7141} * CrsMPH^{0.0413} * NotHelo^{0.0003} * Engs^{2.9535} * MaxR^{0.00020}	23.64%	0.318	182.2	96.48%	34	1	$11,500,000
$ = 11.1 * MaxPL^{0.693} * CrsMPH^{1.15} * NotHelo^{1.08} * Engs^{0.000} * MaxR^{0.036} * WorLand^{0.15}	22.26%	0.304	167.0	96.76%	34	2	$10,800,000
$ = 9.52e-023 * MaxPL^{0.7174} * CrsMPH^{1.034} * NotHelo^{1.002} * Engs^{0.6914} * MaxR^{0.00347} * WaterLand^{0.0003} * FFYear^{7.043}	22.40%	0.308	139.9	96.72%	34	3	$11,500,000
$ = 16.26 * MaxPL^{0.7166} * CrsMPH^{1.148} * NotHelo12^{1.22} * Engs^{0.6341} * WaterLand12^{0.195} * To2015^{-0.00578}	29.52%	0.295	177.4	96.98%	34	4	$11,100,000
$ = 5525 * MaxTnM^{0.0187} * CrsMPH^{0.4004} * NotHelo^{1.711}	32.08%	0.402	177.9	94.82%	30	5	$16,100,000
$ = 9208 * MaxTnM^{0.1993} * CrsMPH^{0.3008} * NotHelo^{1.377} * Engs^{0.6013}	25.87%	0.362	166.2	95.80%	30	6	$10,900,000
$ = 514.8 * MaxTnM^{0.0340} * CrsMPH^{0.0994} * NotHelo^{1.94} * Engs^{0.4004} * WaterLand^{0.2771}	25.03%	0.332	159.2	96.46%	30	7	$10,395,420
$ = 5.416 * CabVol^{0.7186} * CrsMPH^{1.468} * NotHelo^{2.475} * Engs^{0.3748}	25.87%	0.333	207.1	96.38%	32	9	$9,300,000
$ = 1.784 * CabVol^{0.7303} * CrsMPH^{1.722} * NotHelo^{2.198} * WaterLand^{0.4198} * Engs^{0.5004}	26.56%	0.333	166.0	96.38%	32	10	$9,700,000
$ = 1.97 * CabVol^{0.722} * CrsMPH^{1.76} * NtHlo^{2.73} * WorLnd^{0.467} * Engs^{0.496} * Units^{-0.0168}	26.14%	0.335	136.4	96.32%	32	11	$10,300,000

11 Equations Address 3 Capacity Terms: Payload, Ton-Miles & Cabin Volume

Multiple Stepwise Regression Provides Insight into the Value Proposition

Variable	Value
Max Payload (lbs)	9,000
Cablin Volume (ft^3)	300
Normal Cruise (MPH)	400
Not Helo = 1, Helo = 2	2
No Water Land=1, Else 2	2
Number of Engines	2
Units in the Market	160

Regressed Equation for Transport Market Price

$= 16.26 * MaxPL^{0.719} * CrsMPH^{1.15} * Helo^{1.22} * Engs^{0.635} * WtrLnd^{0.705} * Units^{(-0.067)}$

Equation Statistics & Estimate					
MAD	FStat	$Prsn^2$	ob	Eq	04$M
29.52%	177.4	93.39%	34	1	$46.30

Where:

- ***MAD = Mean Abs. Deviation***
- ***FStat = F Statistic***
- ***$Prsn^2$ = Pearson's Squared***
- ***Ob = Observations***
- ***Eq = Equation Number***

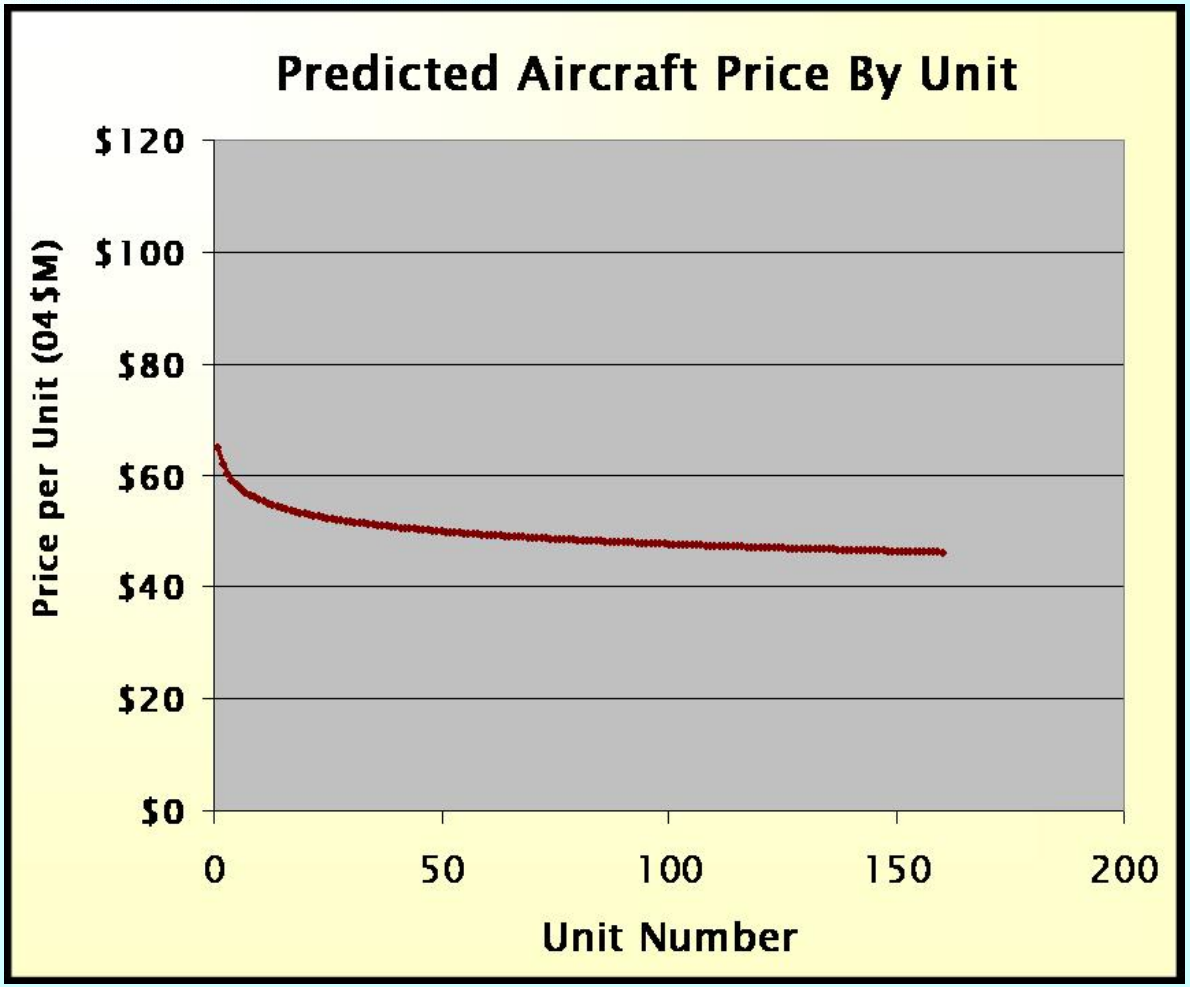
The Market Responds to	***T-Statistic***
•Capacity – Max Payload	1.000
•Speed - Cruise Speed	0.999
•Portability – VTOL Landing	0.999
-Water Landing	0.961
•Safety – No. of Engines	0.995
•Units in Market – Saturation	0.796

For a Give Model, Saturation is Not the Strongest Force on Value

With the Market Response to the Units Within it, We can Derive Product Demand

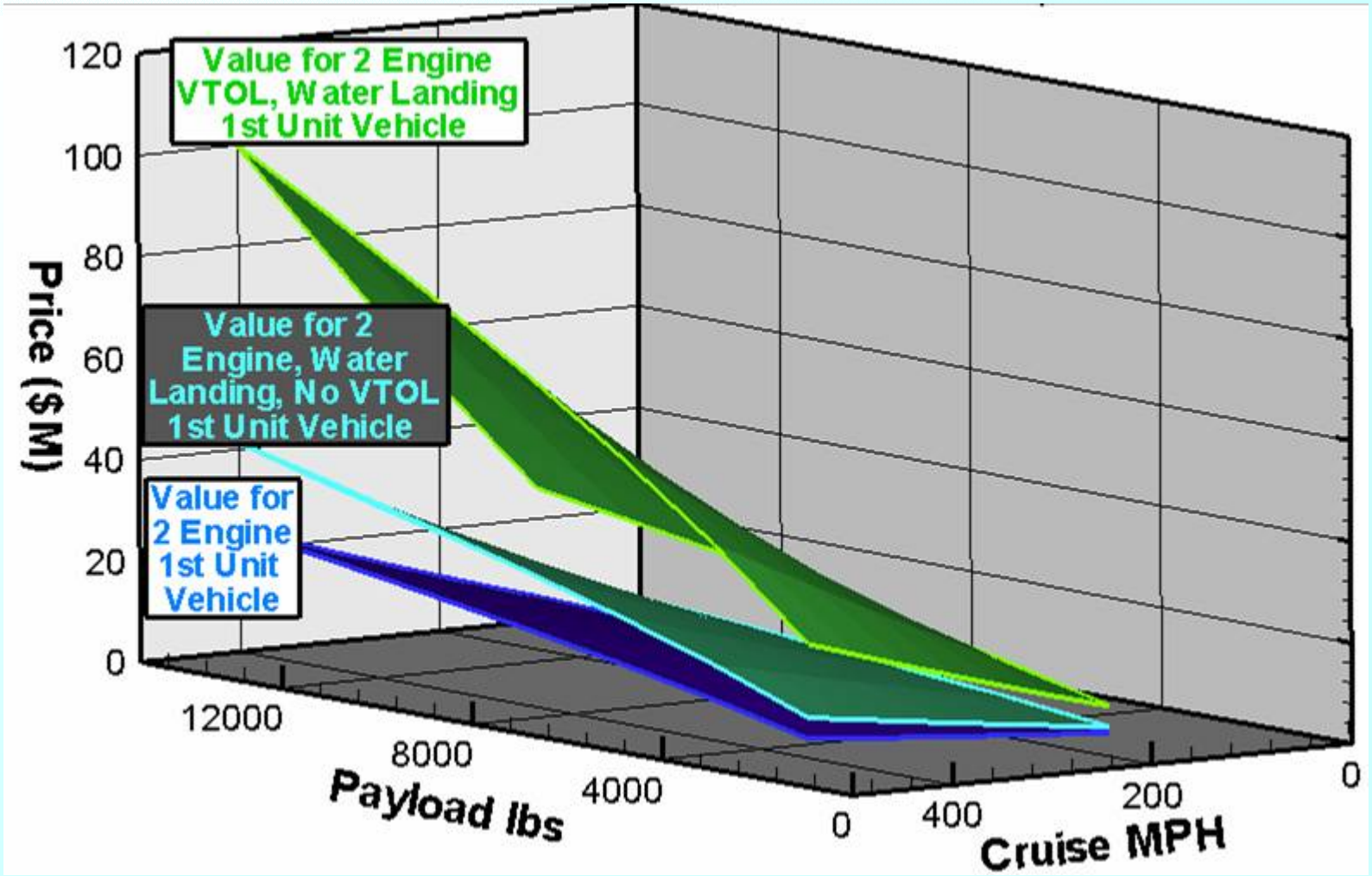
Unit	Unit Value Curve	Unit Expo-nent
1	$64.98	1.0000
2	$62.04	0.9548
3	$60.38	0.9293
4	$59.24	0.9116
5	$58.36	0.8981

To 160 Units



An Individual Vehicle, Selling Relatively Few Units, Does Not Impact Demand Greatly: However, the Market Responds as Anticipated

Value Effects on Sustainable Price

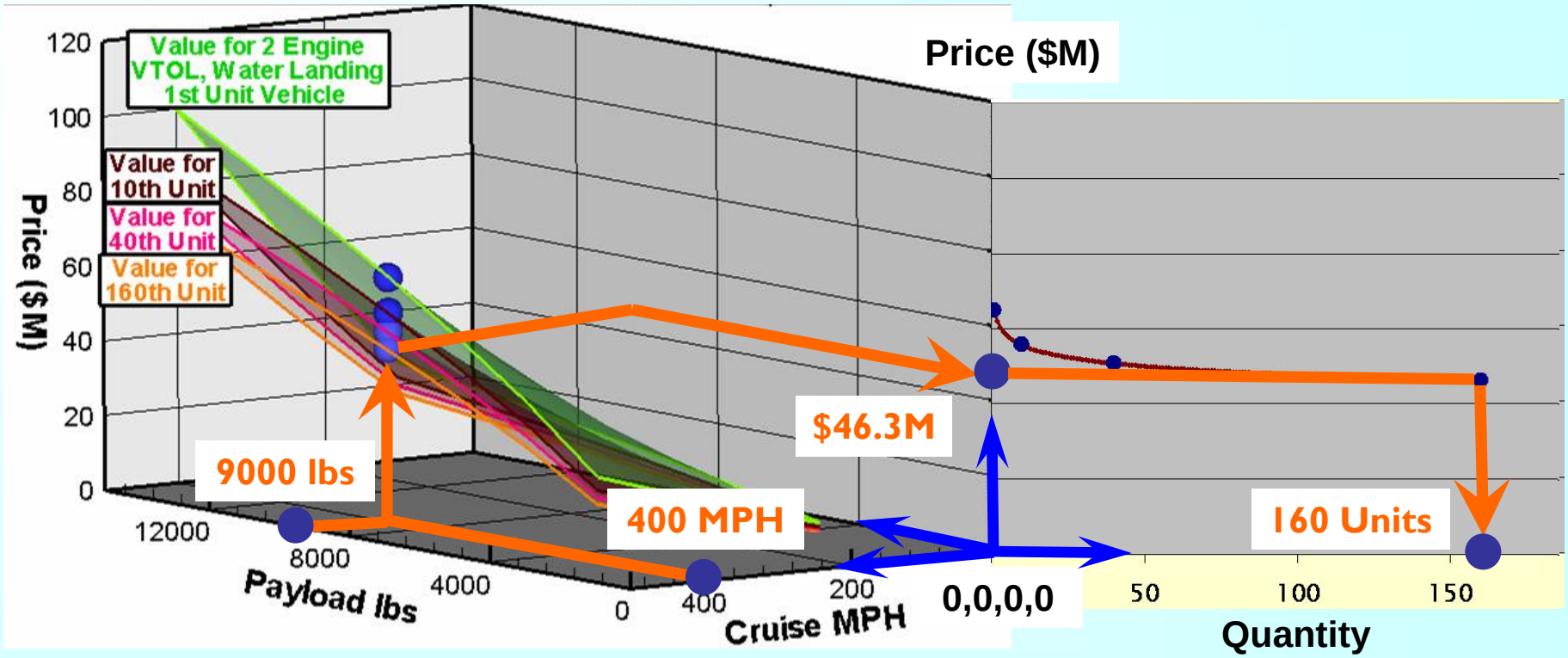


Our Baseline Vehicle Starts as the Green Surface

We Lose Value if we Give up VTOL and Move to the Light Blue Surface

More Value Lost if we Lose Water Landings & Move to Dark Blue Surface

The Law of Value and Demand



The Value Space on the Left and the Demand Plane on the Right Share the Currency Axis

The Law of Value and Demand:

Attributes Determine Value

Value Determines Price

Price Determines Quantity Demanded

Markets Operate in 4 Positive Dimensions – a 4D+ Coordinate System

Conclusions

- Aggregating Products within Price Groups Allows Demand Curve Calculation
  - Sub Markets Exist within Larger Markets, and Demonstrate Their Own Demand Curve
  - Products within Markets Demonstrate Their Own Demand Curves as Well, Based on Market Values
- Many Attributes Combine to form Value Propositions for Markets
- Attributes Determine Value Which Determines Price Which Determines Quantity Demanded