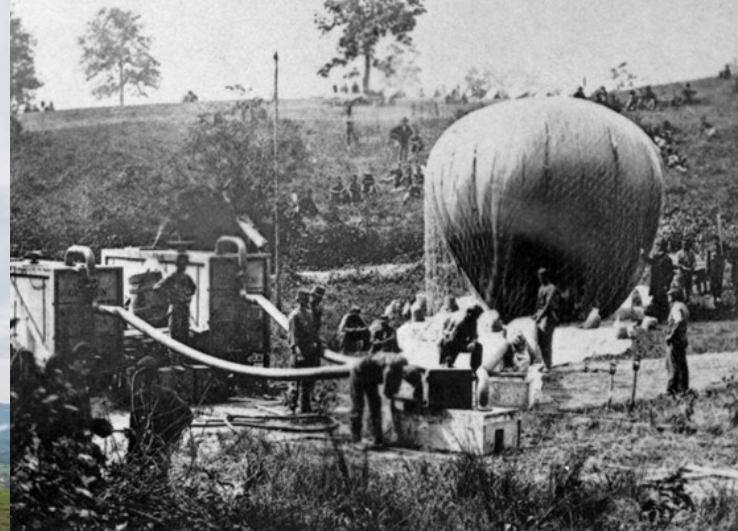


Market Dimensional Expansion, Collapse, Costs, and Viability

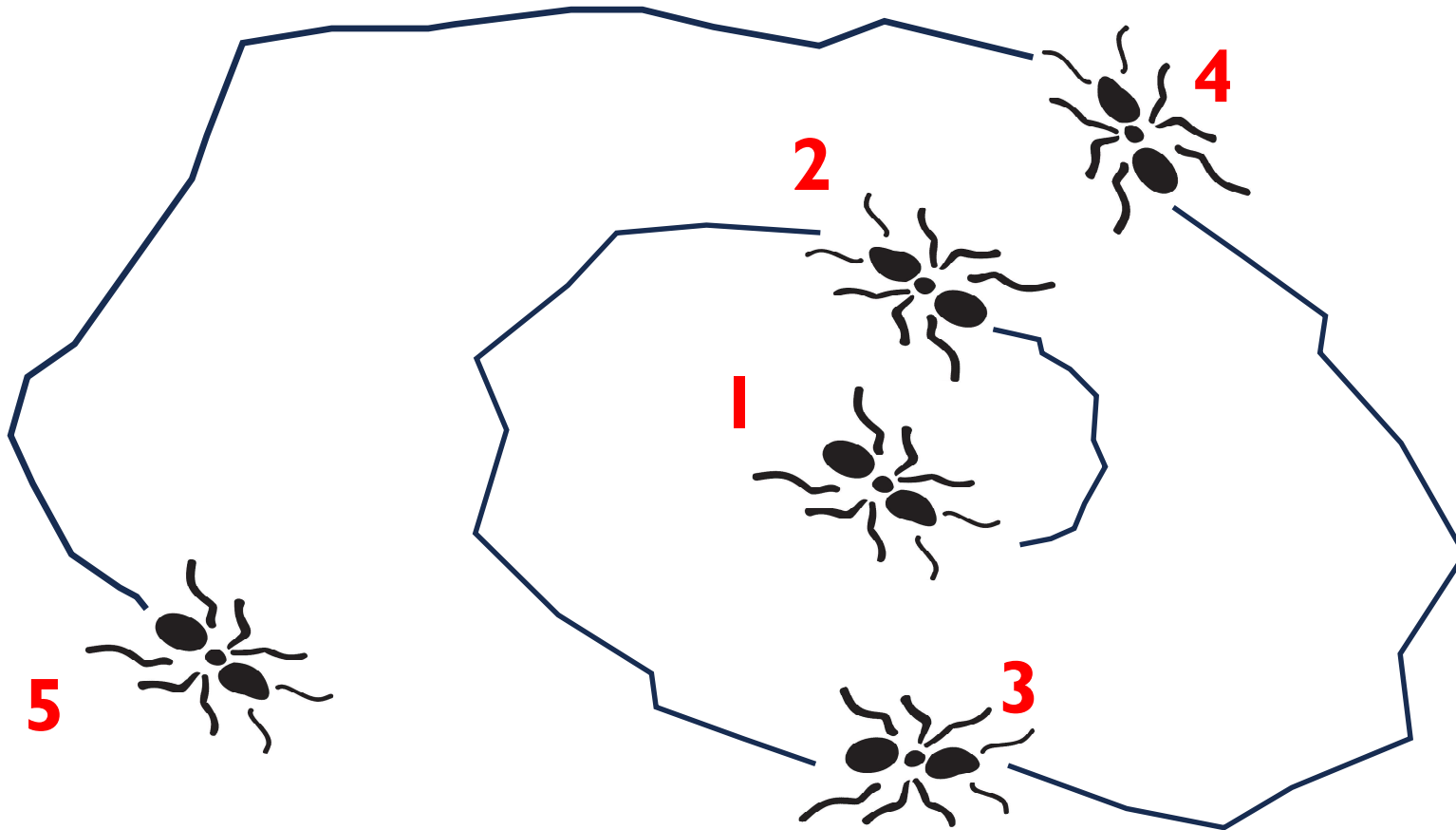


OVERVIEW



- How does a market evolve?
- What is 2D Demand?
- What is 3D Value?
- What is a 4D Market?
- How do Markets Pair to Form 7D Systems?
- What are ND Systems?
- Cost, Value, and Demand must fall within Market Constraints
- Summary

A Short Observation



What is this ant doing?

A Brief History of Reconnaissance^{*,**}



Proc Biol Sci. 2007 Jun 22; 274(1617): 1505–1509.

Published online 2007 Apr 10. doi: [10.1098/rspb.2007.0138](https://doi.org/10.1098/rspb.2007.0138)

PMCID: PMC2176157

PMID: [17426016](https://pubmed.ncbi.nlm.nih.gov/17426016/)

Reconnaissance and latent learning in ants

[Nigel R Franks](#),* [James W Hooper](#), [Anna Dornhaus](#),† [Philippa J Aukett](#), [Alexander L Hayward](#), and [Stefanie M Berghoff](#)

► Author information ► Article notes ► Copyright and License information ► [PMC Disclaimer](#)

Abstract

Go to: ►

We show that ants can reconnoitre their surroundings and in effect plan for the future. *Temnothorax albigenis* colonies use a sophisticated strategy to select a new nest when the need arises.

- Rock ants look for
- Floor area
- Headroom
- Darkness
- Hygiene state
- Proximity of hostiles

Part of their collective output (GDP) is their reconnaissance

Ants first appeared on the earth between 140 to 168 million years ago

Hypothesis: Humans have been doing reconnaissance since they emerged, forming part of their GDP

*<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2176157/>

**<https://expeditions.fieldmuseum.org/australian-ants/ant-evolution-and-environment>

Watchtowers Were A Way To Gain Early Warning



This tower, on a hill in Krupina, Slovakia (about 200 kilometers east of Vienna, Austria), built in the late 1500s, combined with others, gave the town advance warning of approaching armies (its updated stairs and porch came later)

The uneven terrain around the town called for several watchtowers, which drained resources

Watchtowers have no mobility and rely on a network of them to work well



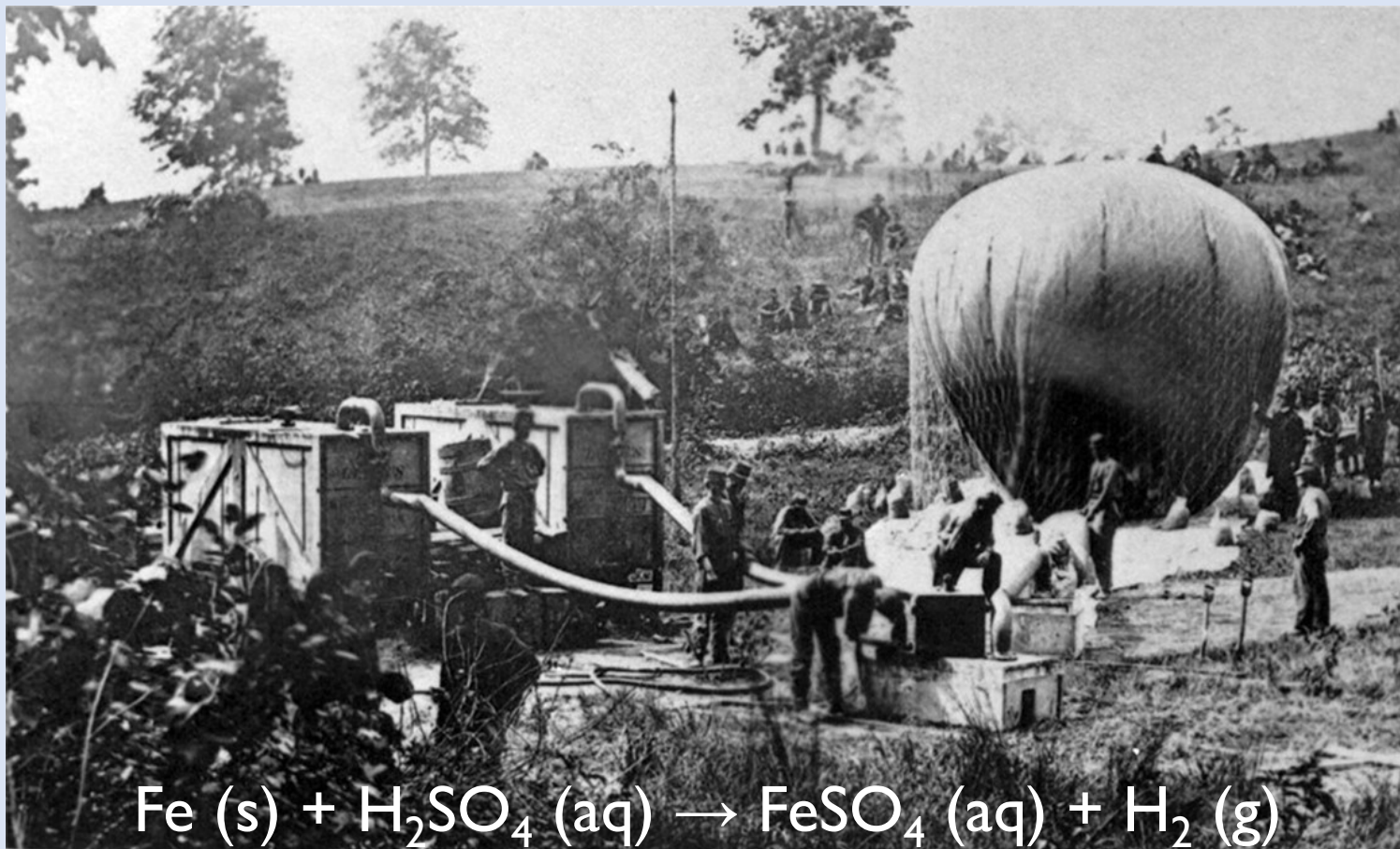
Hundreds of Years Later, There Were Advances



The French had the first use of balloons in surveillance in 1794

Both sides used balloons in the Civil War; this is the Union Balloon *Intrepid*

Balloons made great targets, and were dangerous for pilots



World War I Saw More Advances



This Caudron G.3 was an improvement



The Allied Powers flew over 2800 of these models, flying faster and higher than airships

The added features did not ensure safety



Flying battlefield assessment, this G.3 pilot (my grandfather) had his tail shot off (friendly fire)

USG Response: Go Higher and Faster

After WWII, The Cold War Drove New Platforms



The Lockheed U-2 went higher than ever



While it flew successfully for years, the Russians eventually shot one down

Solution: Higher and Much, Much Faster



The SR-71 went to 85K' and Mach 3.2 and was never shot down – but it was costly

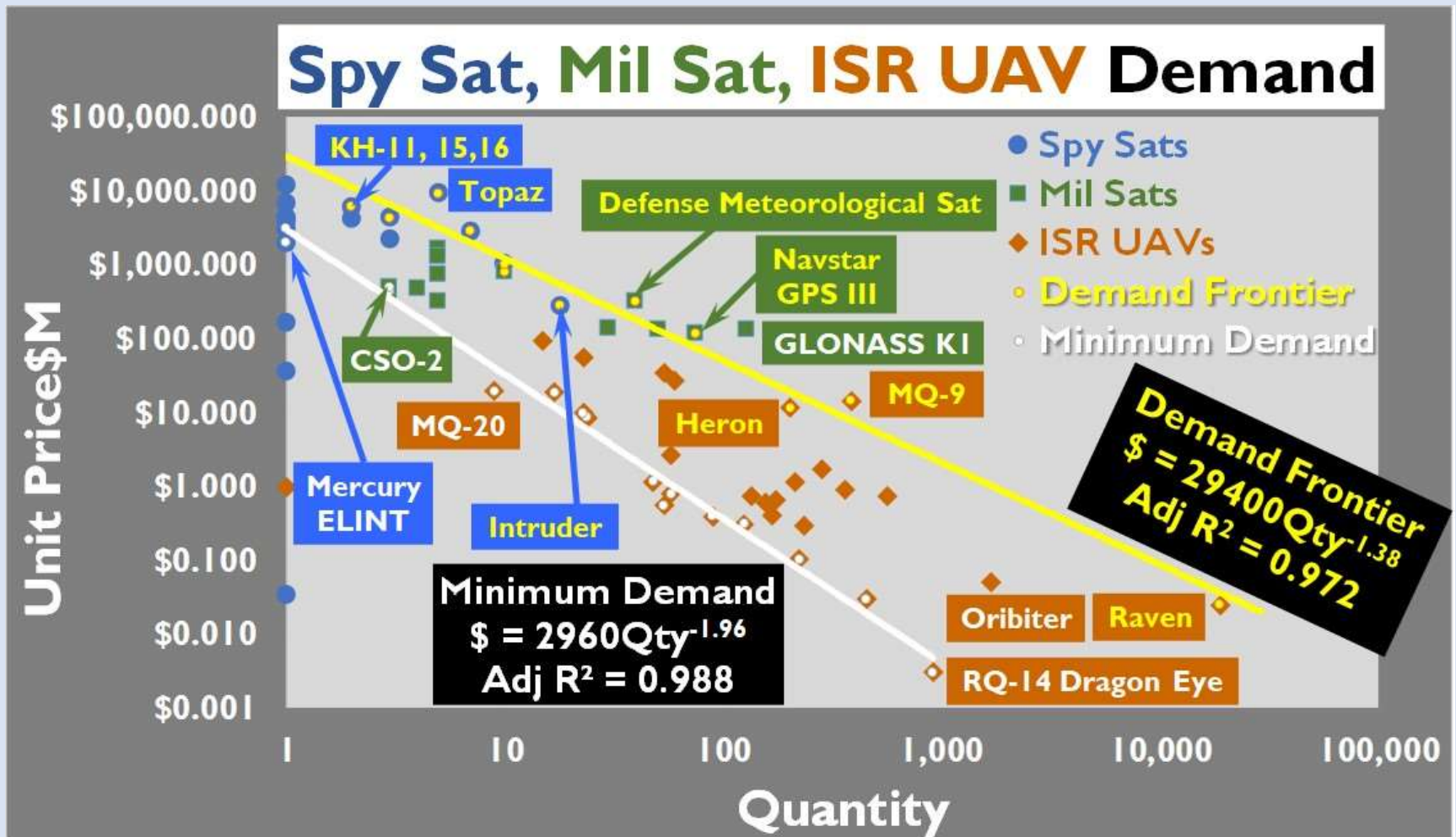
An Evolved Response: Go Unpiloted

Partial Move to Satellites And UAVs



Satellites and UAVs share Steep Demand slopes, revealing more money at the top of the market

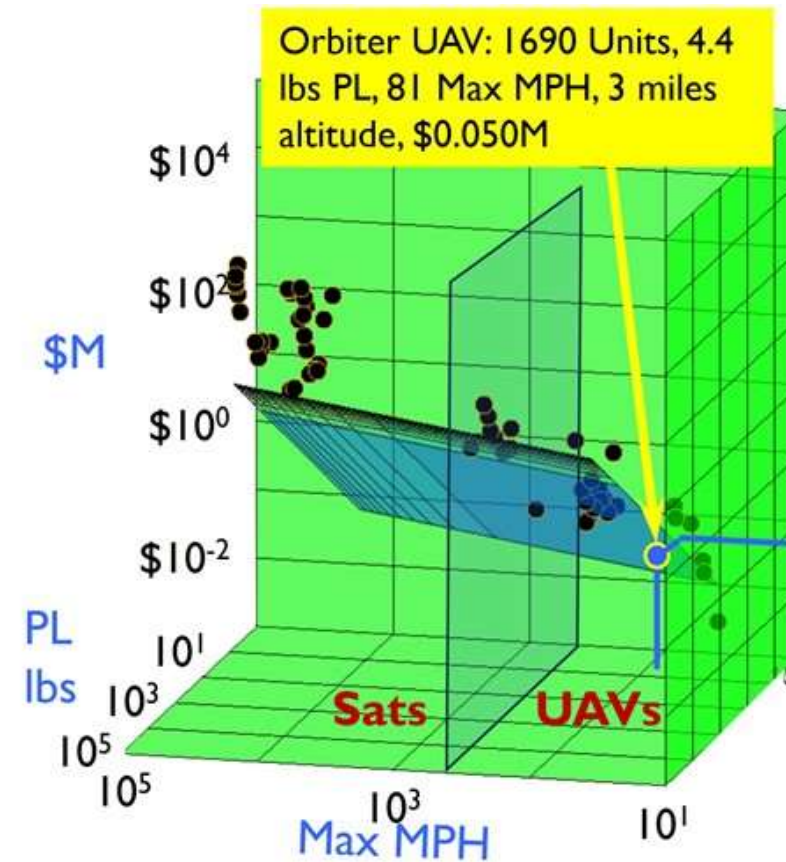
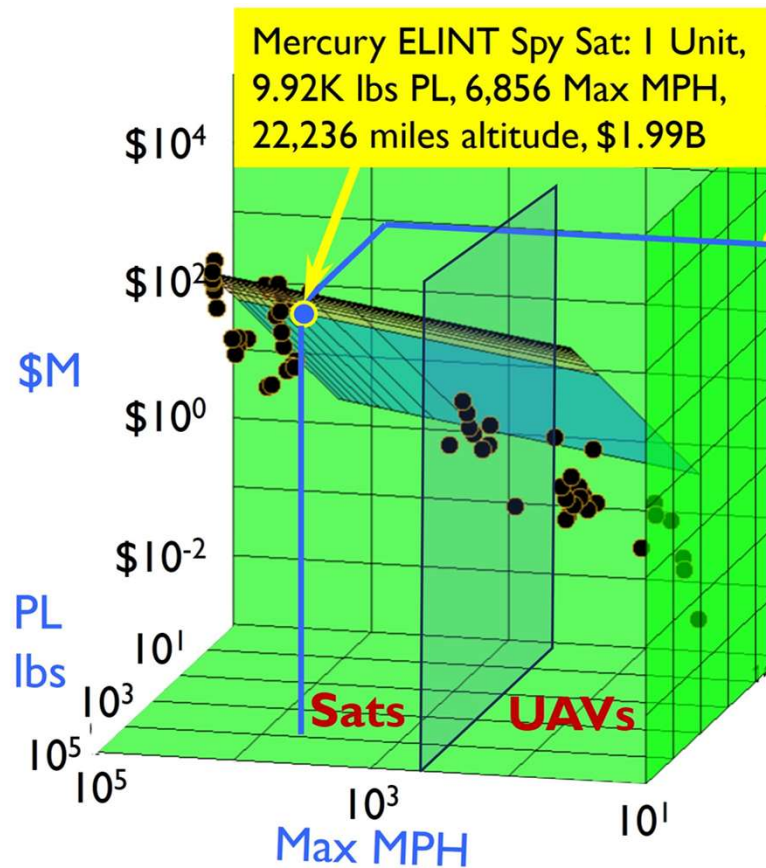
The market minimum suggests that if you can build one good unit, you'll have a baseline expectation set by the Minimum Demand



UAVs and Sats Have The Same Value Proposition



Buyers pay more for Payload, Miles per Hour, and Altitude, and pay less for each succeeding unit (that is they have a Product Demand Curve)

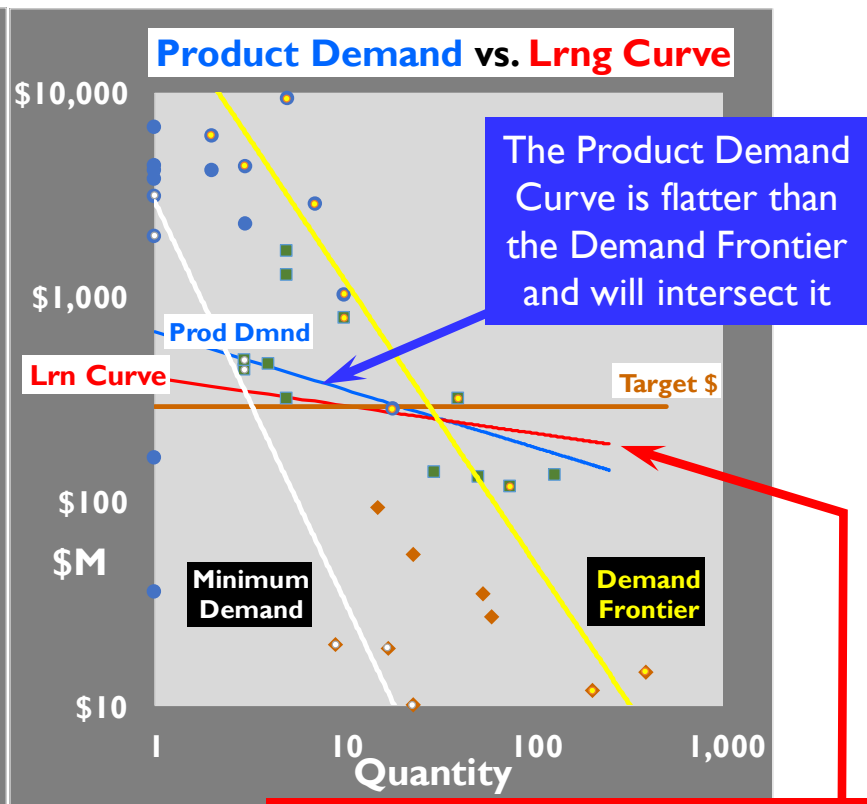
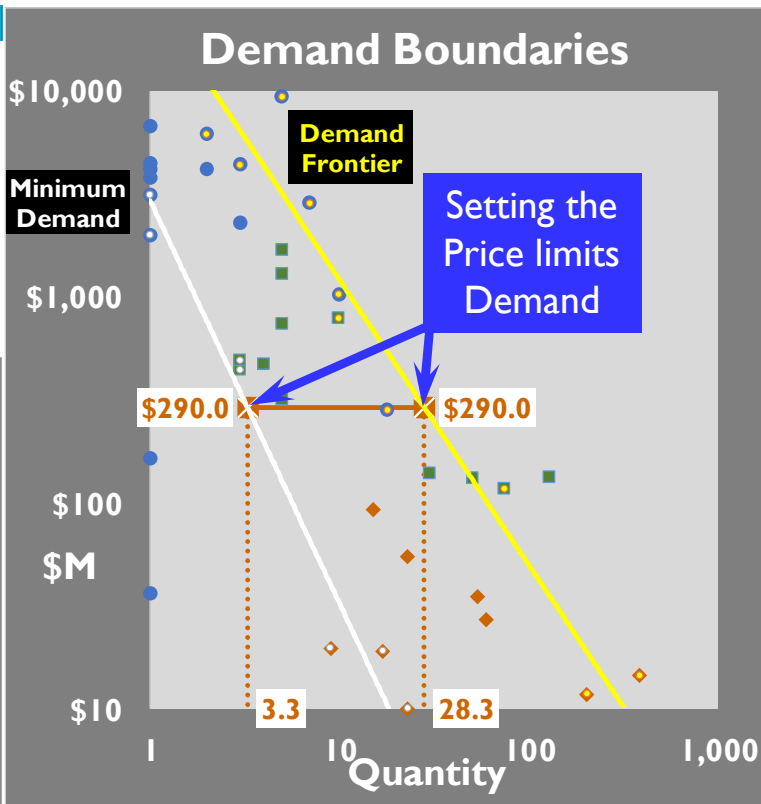
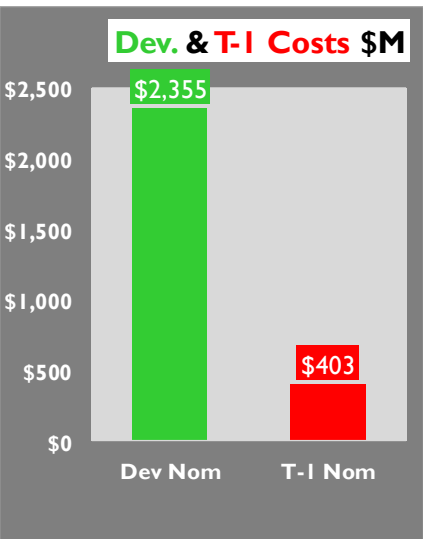


Successful programs balance Cost, Value, and Demand

An Interactive Estimator Helps Bound The Problem



Feature	Qty	Units
Altitude	500	Miles
Payload	4,000	lbs
Max Speed	17,000	MPH
Quantity	20	Units
Empty Wt	32,000	lbs
Lrn Curve	91.0	%



New Product Estimator

$$\text{\$M} = 0.0291 * \text{PL lb}^{0.766} * \text{Max MPH}^{0.301} * \text{Alt Miles}^{0.169} * \text{Qty}^{-0.283}$$

2022\$
\$290.0

If your Learning Curve is > 82.4%, it will intersect Product Demand

Every addition to the market changes it; analysts should follow its movement

Suppose You Needed To Estimate Business Jets



Hypernomica

File About

Database Scatterplot Model Analyze Demand 4D Plot

	Manufacturer	Model	\$2019M	MxMPH	Pass	Cab Vol	CabH	CabW	Cabl	VolPss	Range M	Engs	BalFL	T1J2	Qty0413	Qty0918
1	Airbus	ACJ318 Elite	61.8830	540.5000	8	5.3897e+03	7.4167	12.1667	70.9167	283.67...	4830	2	5870	2	17	8
2	Airbus	ACJ319	74.4269	540.5000	8	5843	7.4167	12.1667	78.7500	315.97...	7.7625e+03	2	6070	2	54	26
3	Airbus	ACJ320 Prestige	81.1170	540.5000	25	6.9682e+03	7.4167	12.1667	91	366.74...	6.9000e+03	2	6900	2	15	10
4	Airbus	ACJ321	95.3333	540.5000	8	8547	7.4167	12.1667	113	449.84...	4830	2	7970	2	1	1
5	Airbus	ACJ330	191.5029	566.9500	25	1.7235e+04	7.9167	17.2500	137.64...	907.10...	1.1558e+04	2	9090	2	6	5
6	Airbus	ACJ340	277.8200	566.9500	25	2.0503e+04	7.9167	17.2500	177.17...	820.13...	11385	4	10430	2	4	1
7	Boeing	Boeing Business Jet	65.2281	540.5000	8	5396	7.0833	11.5833	79.1667	656.25...	8.0500e+03	2	5775	2	49	29
8	Boeing	Boeing Business Jet 2	77.7719	541	8	6525	7.0833	11.5833	98.3300	836.75...	7.6360e+03	2	6985	2	9	8
9	Boeing	Boeing Business Jet 3	82.7895	541	8	7290	7.0833	11.5833	107.16...	911.25...	7.4922e+03	2	8042	2	7	7
10	Boeing	737-800	98.9334	541	8	6525	7.0833	11.5833	98.3300	836.75...	7.6360e+03	2	6985	2	0	2
11	Boeing	Boeing Business Jet 747	307.7427	594.9000	19	2.4955e+04	7.8333	20.0833	207.50...	1.3134...	1.0206e+04	4	10600	2	8	9
12	Boeing	Boeing Business Jet 777	275.9649	608.1200	19	2.0456e+04	7.8333	19.2500	194.25...	1.0766...	1.3402e+04	2	10800	2	3	8
13	Boeing	Boeing Business Jet 787	214.9181	627.9500	19	1.6501e+04	7.5000	18.8333	158.75...	868.47...	1.1437e+04	2	6020	2	1	12
14	Bombardier	Global 7500	72	611.4250	19	2637	6.2000	8	54.5000	138.78...	8855	2	5800	2	0	1
15	Bombardier	Global 6000	62.3100	581.6800	13	1.9975e+03	6.5000	7.9167	40.7500	153.65...	6.9000e+03	2	6476	2	322	355
16	Bombardier	Global 5000	50.4400	581.6800	13	1882	6.5000	7.9167	42.4583	144.76...	5984	2	5540	2	139	153
17	Bombardier	CL 890	47.5000	541.6500	14	2821	6.2000	8.3000	59.2000	201.50...	2.7186e+03	2	6465	2	8	8
18	Bombardier	CL 870	40.5300	541.6500	14	2860	6.2000	8.3000	59.2000	204.28...	2.8785e+03	2	5562	2	10	1
19	Bombardier	CL 850	30.9900	527.8500	14	1990	6.2000	8.3000	48.4167	142.14...	2.8244e+03	2	6305	2	60	12
20	Bombardier	Challenger 650	33.3500	540.5000	10	1146	6	7.9167	25.5833	114.60...	4.3194e+03	2	5665	2	0	78
21	Bombardier	Challenger 605	32.8200	561.2000	9	1150	6.0833	8.1667	28.4167	127.77...	4.4091e+03	2	5840	2	225	202
22	Bombardier	Challenger 300	27.0819	547.4000	9	860	6.0833	7.1667	28.5833	95.5556	3.5247e+03	2	4810	2	446	210
23	Bombardier	Challenger 350	28.1369	540.5000	10	860	6.0800	7.1667	25.2000	86	3.6800e+03	2	4835	2	0	259
24	Cessna	CE-680A Citation Latitude	17	512.9000	9	1059	6	6.4167	21.7500	117.66...	3.1050e+03	2	3580	2	0	169
25	Cessna	750 Citation X	23	618.0350	12	538	6	6	24	44.8333	3.3235e+03	2	5250	2	93	12
26	Cessna	750 Citation X+	24.7300	618.0350	12	593	6	6	25	49.4167	3.9790e+03	2	5242	2	0	27
27	Cessna	680 Sovereign+	18	527.8500	9	585	6	6	25	65	3.1890e+03	2	3260	2	0	169
28	Cessna	680 Citation Sovereign	18	528.8000	9	571	6	6	25	63.4444	3.0130e+03	2	3750	2	8	80
29	Cessna	560 Citation XLS+	13	507.1500	9	422	5.6667	5.5000	18.5000	46.8889	2415	2	3560	2	349	62
30	Cessna	525C Citation CJ4	9.2000	518.6500	10	293	4.7500	4.8333	17.3300	29.3000	2.4898e+03	2	3410	2	144	286

File: Business Jet 2019 Rev 4.m4d Variables: 16

Version: 1 Records: 95

Data Filtering

Filtering Enabled	Plot Highlight	Variable	Filter	Value	Delete?
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Qty0918	>	0	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Qty0413	>	0	<input type="checkbox"/>

File: Business Jet 2019 Rev 4.m4d Using 95 data points out of a possible 115

If you built a database of business aircraft, what could you do with it beside estimating their costs?

Here, we have Quantity highlighted

If we add Price, we have a lot to consider

2D Demand is the Quantity-Price Relationship



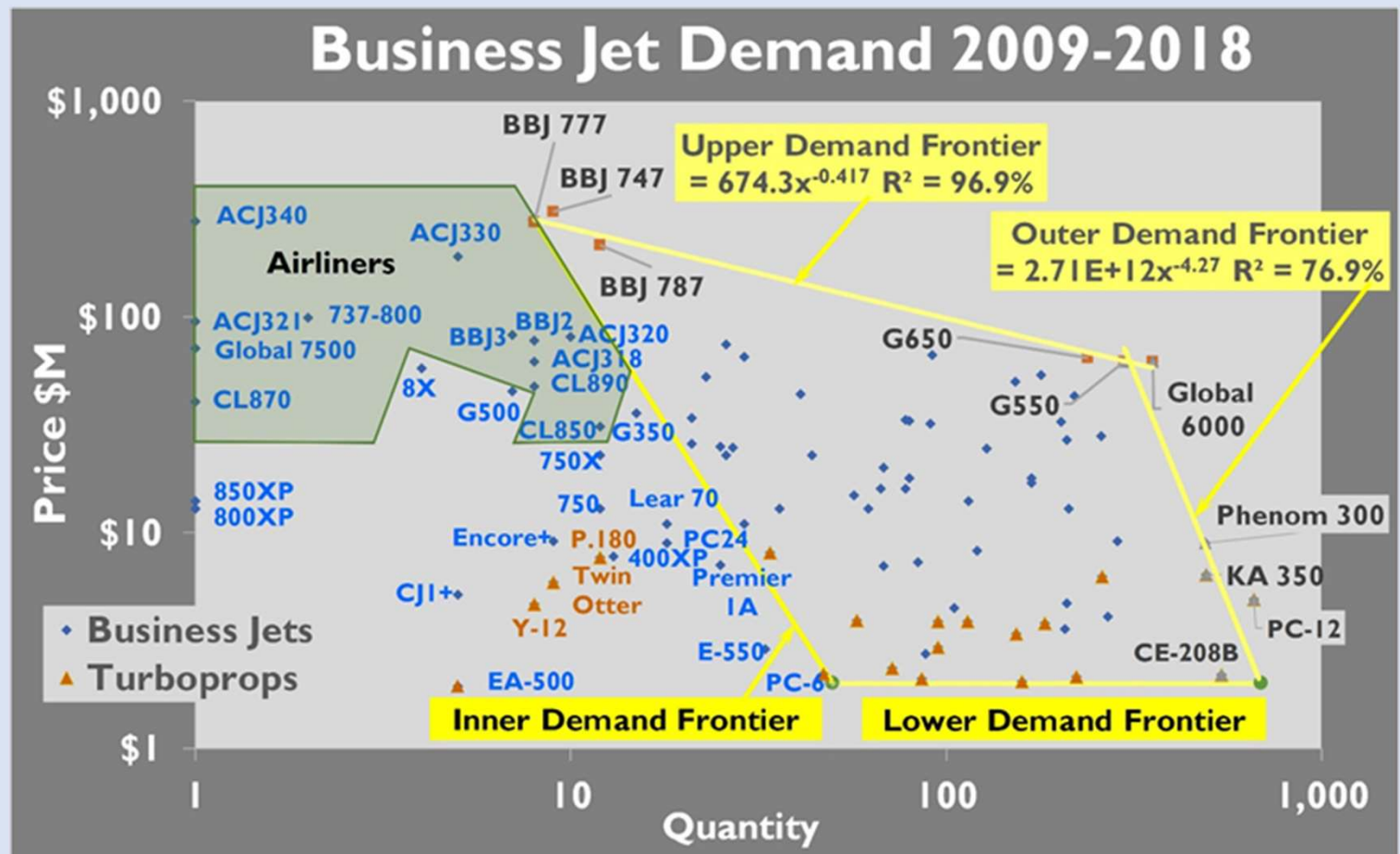
Markets have limits:

Upper Demand Frontier:
Price Limited

Outer Demand Frontier:
Saturation Limited

Lower Demand Frontier:
Margin Limited

Inner Demand Frontier:
Efficiency Limited



Not knowing these limits can sink a program or an entire company

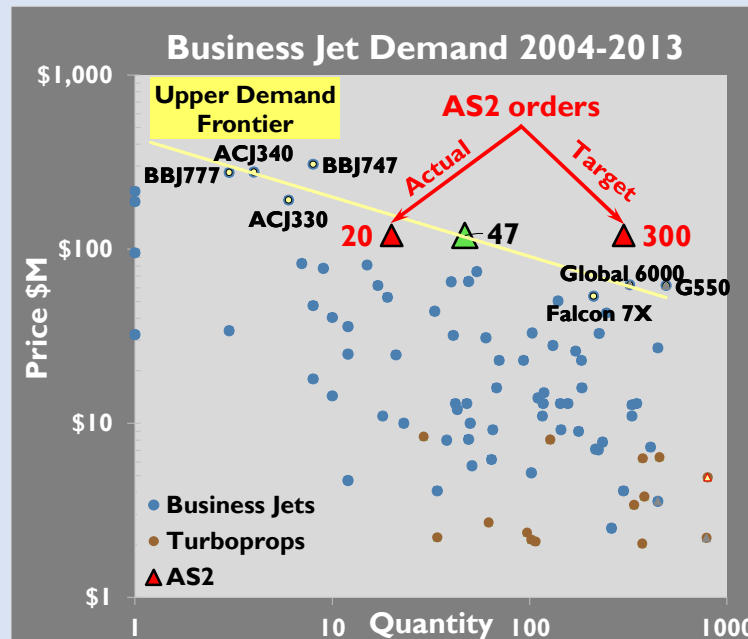
Ignoring These Limits Can Lead To Financial Disaster



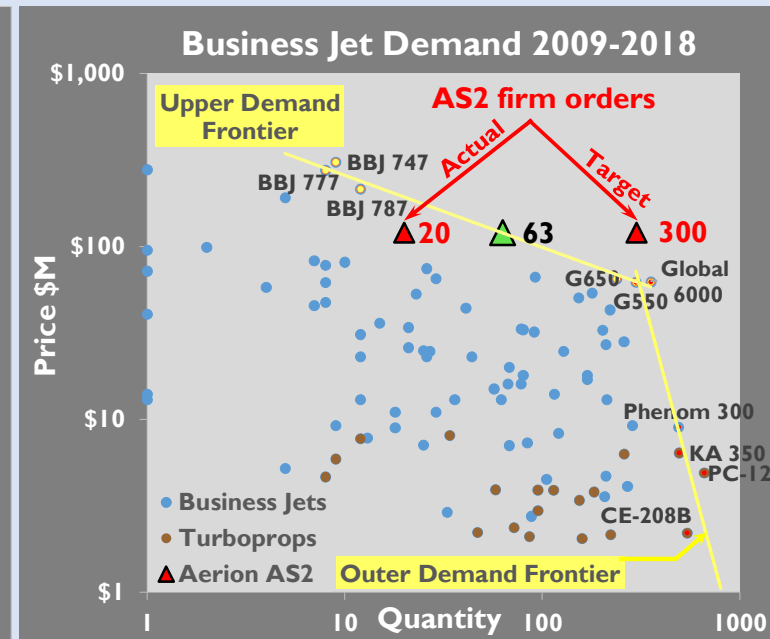
Consider the Aerion AS2



They launched with 20 orders



5 Years later, they still had 20 orders



The company wanted to build 300 supersonic business jets in 10 years at \$120M each

In Dec 2020, I wrote a LinkedIn post stating that they wouldn't get 300 orders since that would put them past the Demand Frontier



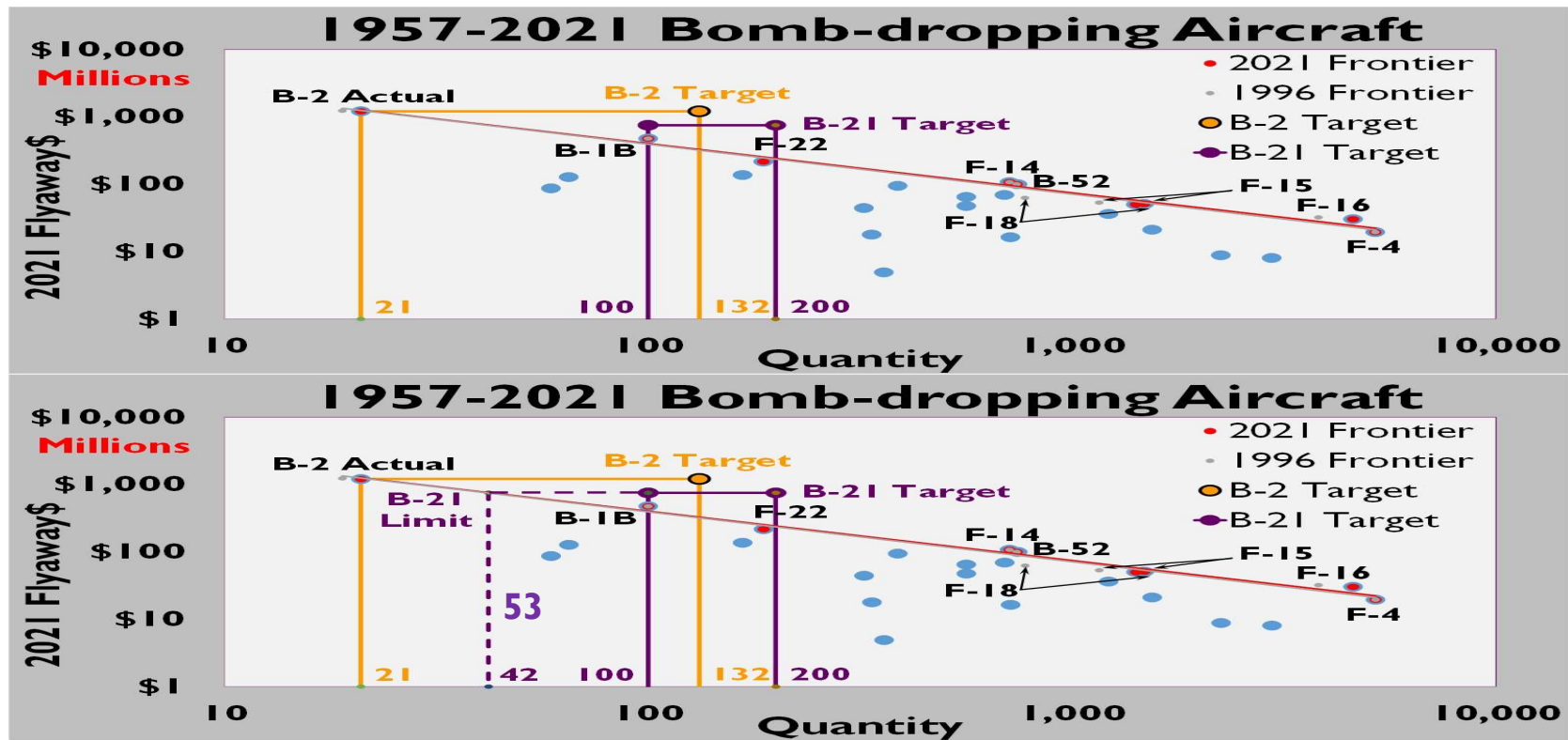
A New Bomber Must Abide By Its Demand Frontier



That Frontier has moved only 2% over 25 years

The B-2 ran afoul of it

The B-2I faces the same issue



These limits mean we can only afford a few squadrons at very high prices –
This means we should get more less-expensive solutions forward-based

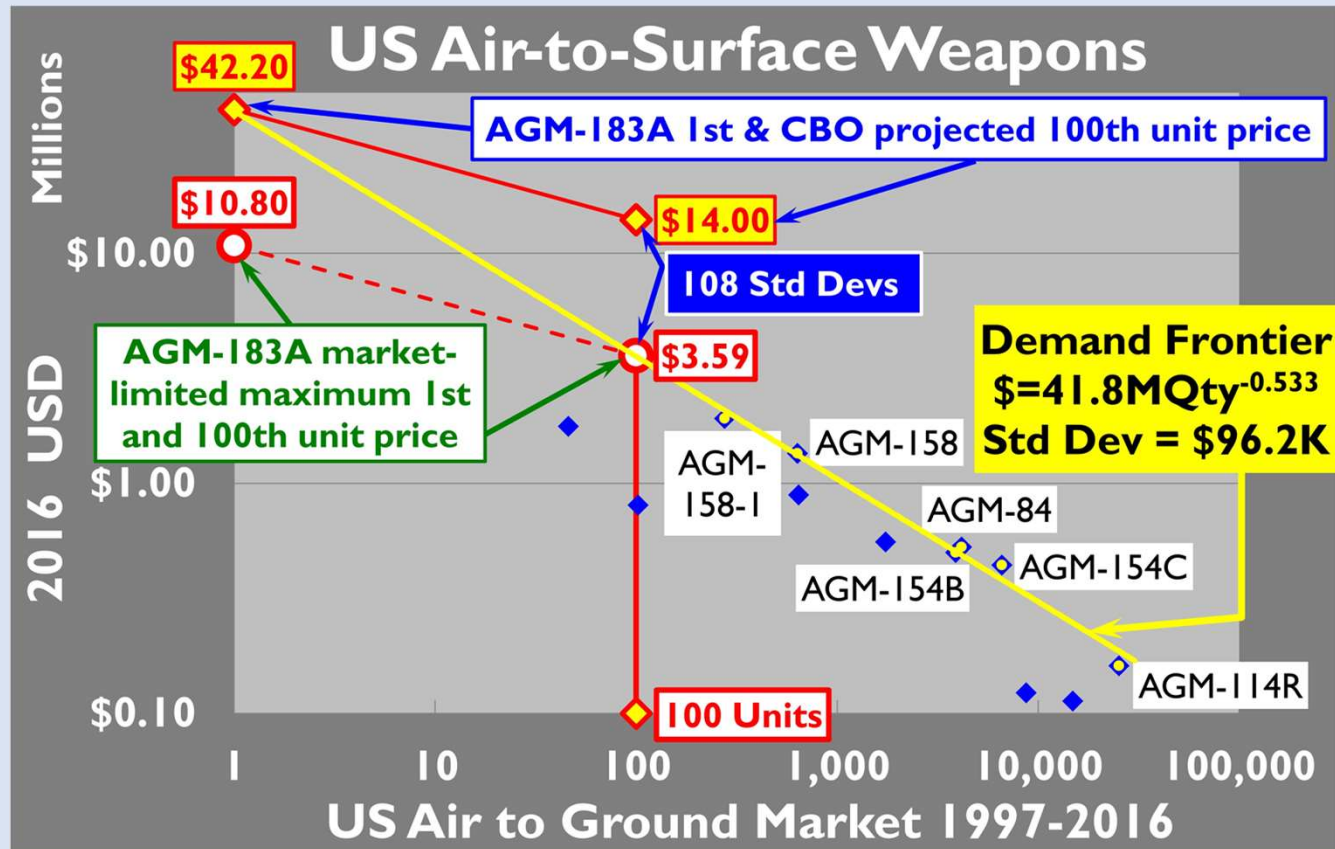
Air To Surface Missiles Have Limits Too



The USAF wanted 100 AGM-183s



The United States Congressional Budget Office said they would recommend buying 100 of these missiles, with an average price of \$14M each, but...

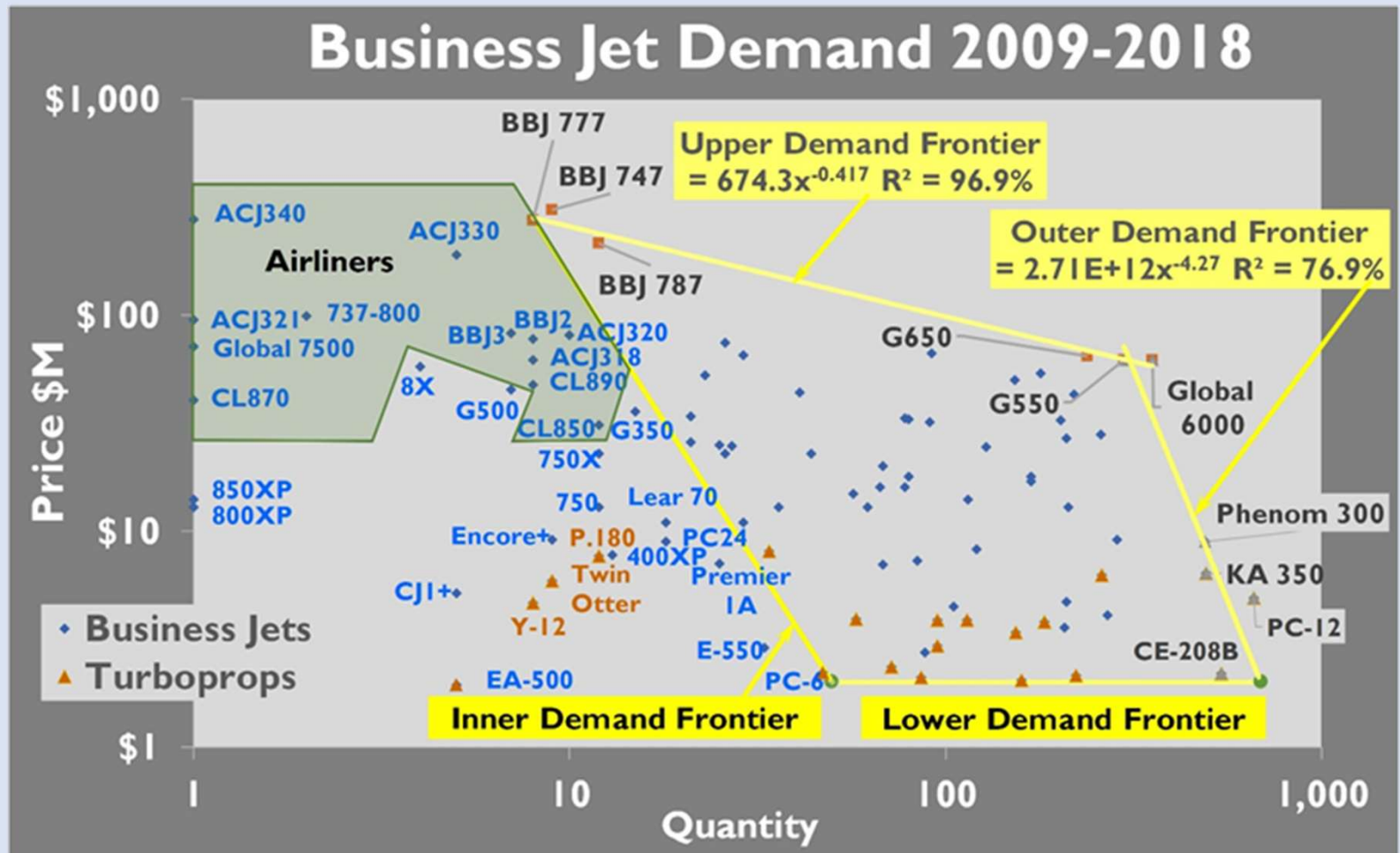


At 108 Standard Deviations past the Demand Frontier, there was no chance that the USG can afford 100 AGM-183s, and it was canceled

If 2D Demand is the Quantity-Price Relationship



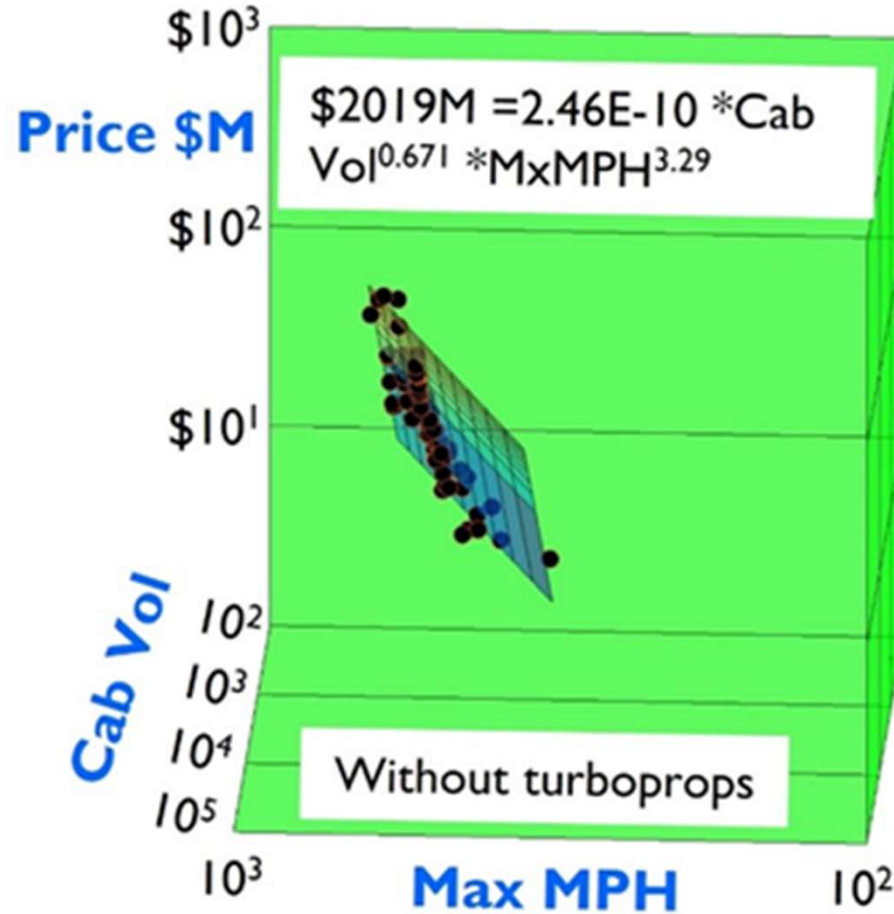
What holds the Prices up?



3D Value Reveals What Customers Willingly Pay For



Business Jet buyers
who can afford it
willingly pay for bigger
cabins and faster planes

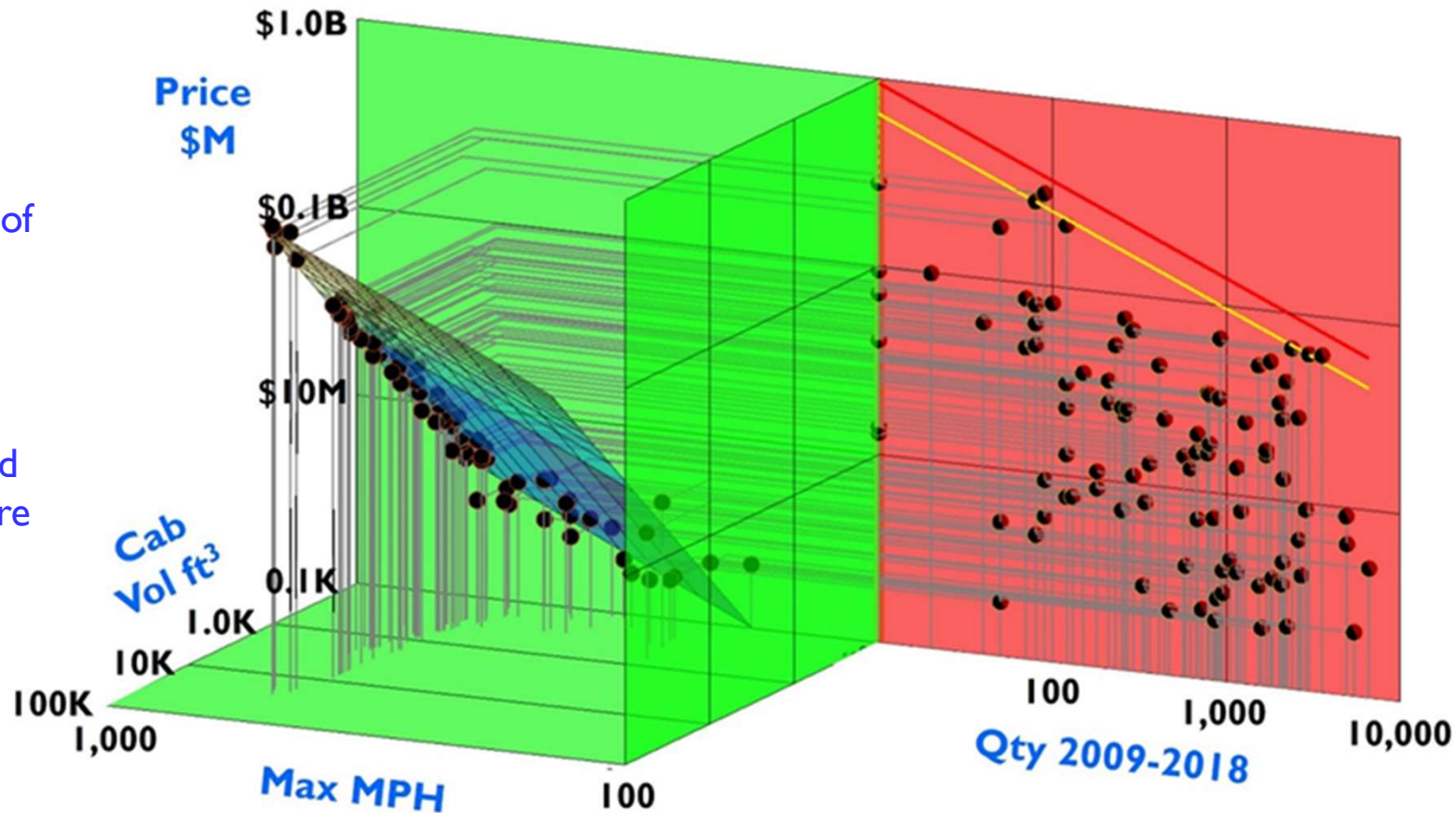


4D Markets Merge 2D Demand and 3D Value Space



Every market forms these relationships as ordered quads governed by the Law of Value and Demand:

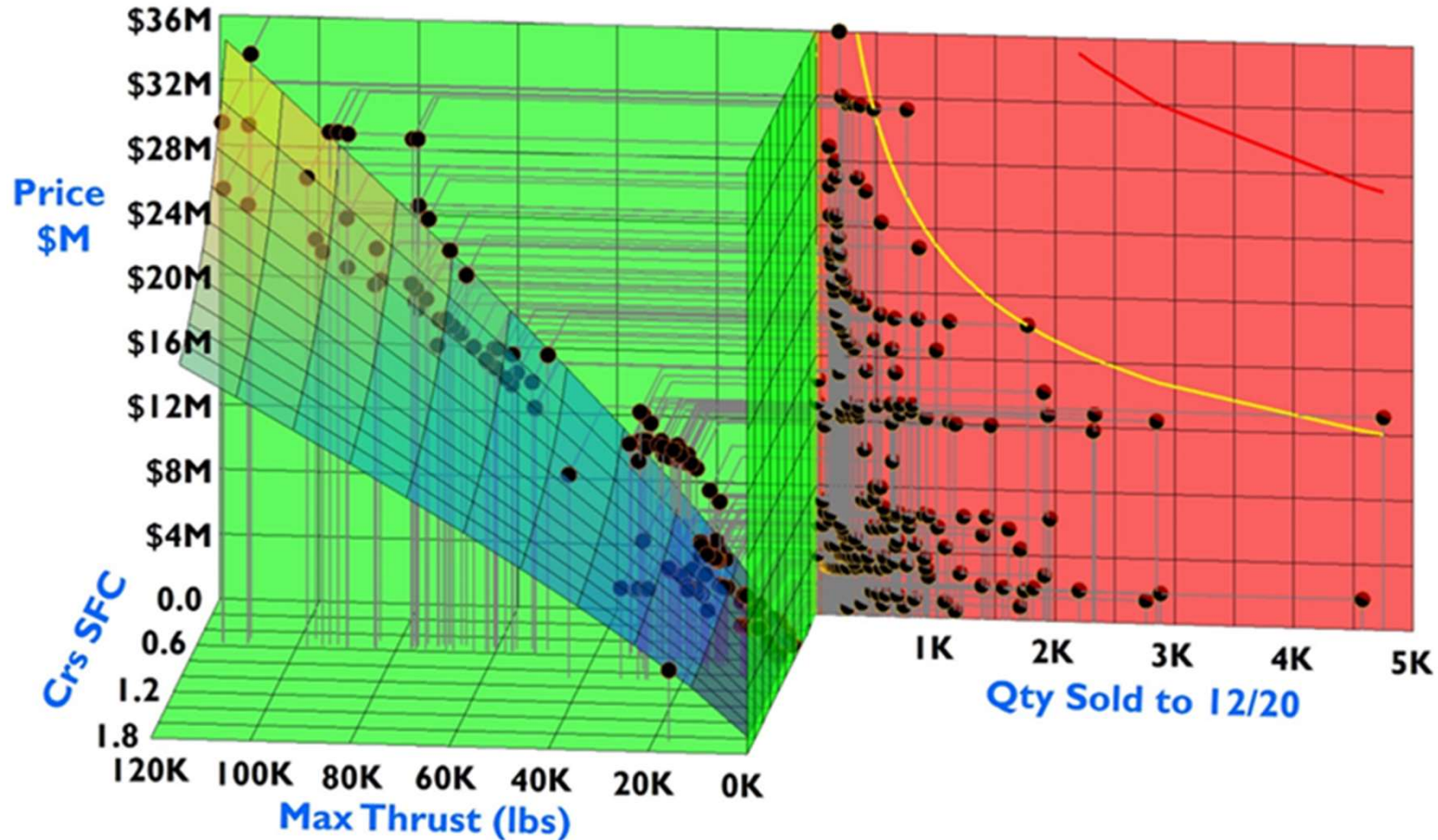
- 1) Features drive Value
- 2) Value sets Price
- 3) Price limits quantity sold
- 4) Quantity sold is a feature



Consider the 4D Market for Turbofan Engines



It behaves much the same way as the market for business jets, with ordered quads explaining market positions



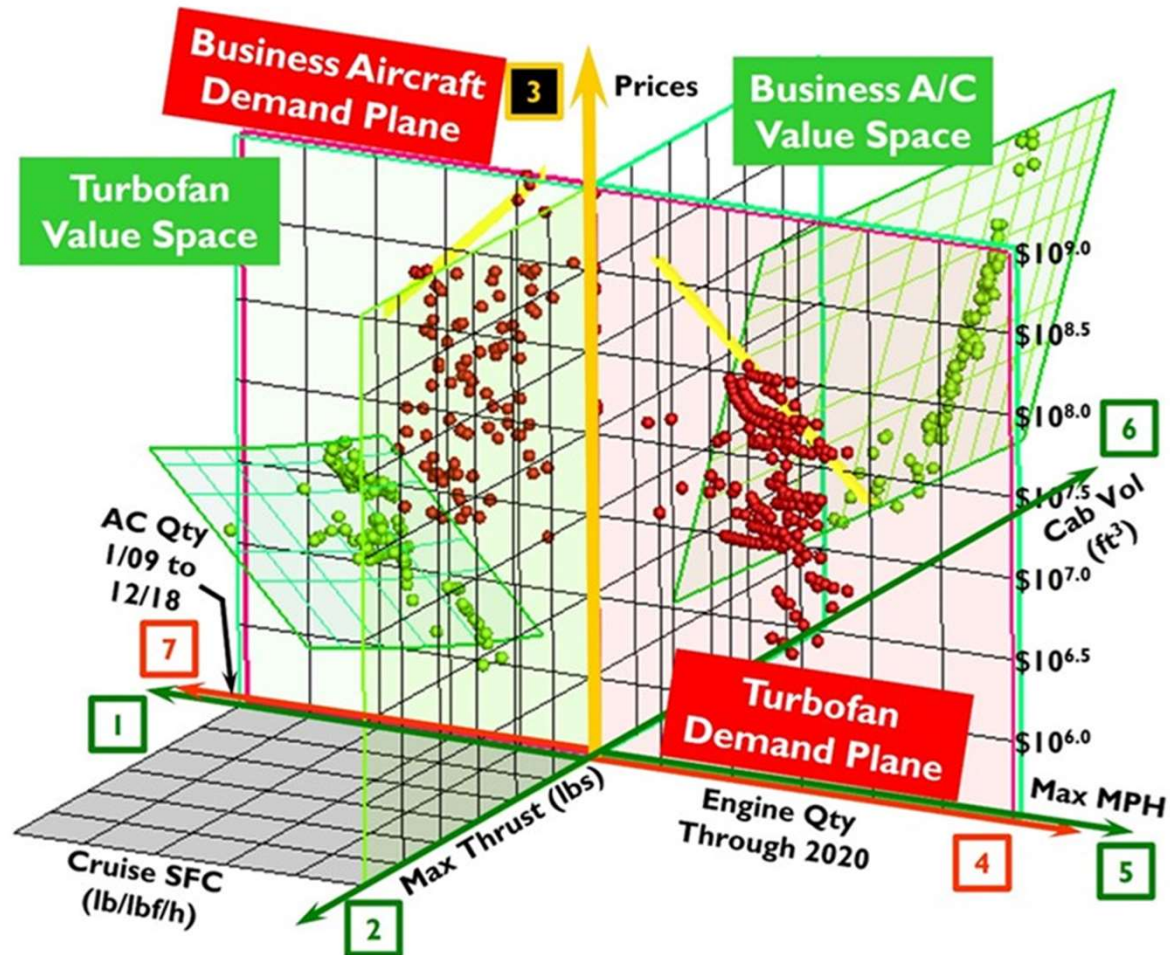
Note that Turbofans and Business Jets Share the Price Axis, meaning ²⁰

7D Systems Form Between Related 4D Markets



Since both markets share
the Price axis,

$$4D+4D=7D$$

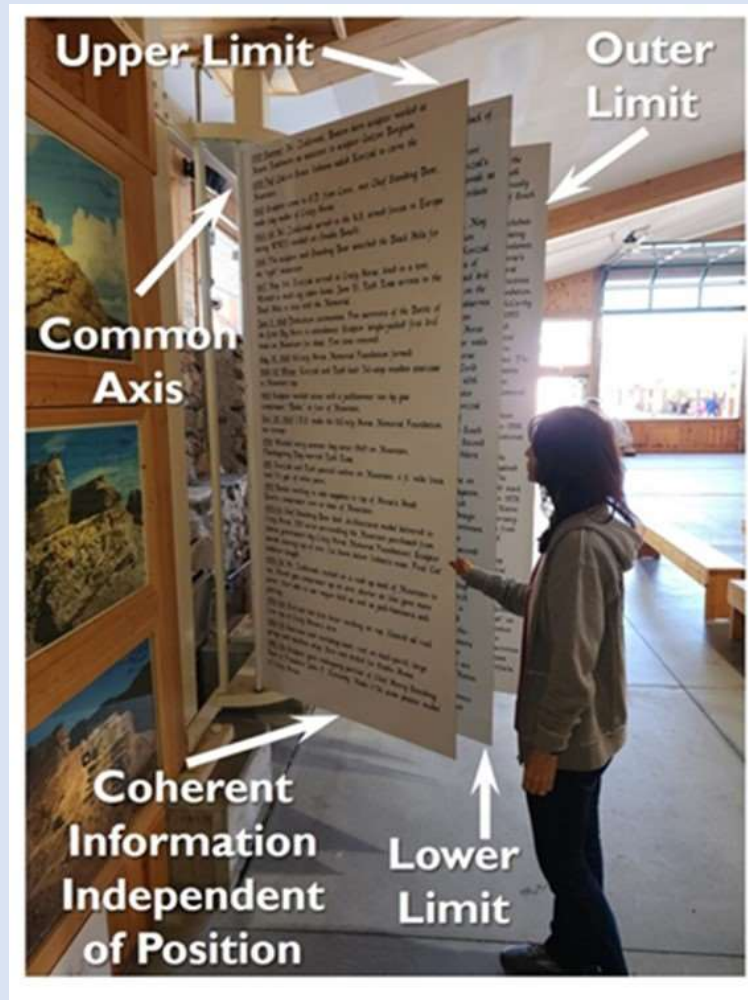


What If We Wanted More Dimensions In One View?



Have you ever noticed how poster racks and Rolodexes keep their information intact?

This gives us some ideas for displaying markets

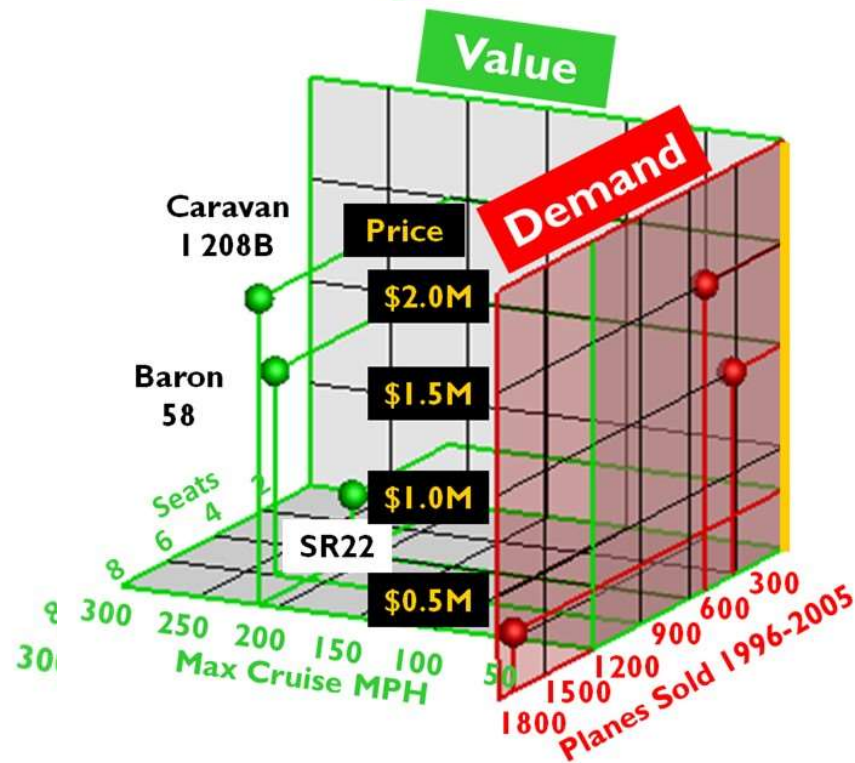


Consider These 3 General Aviation Planes



Model	Seats	Max MPH	\$M (2005)	Quantity
SR22	4	212	\$0.29	1705
Baron 58	6	232	\$1.00	330
Caravan I	8	213	\$1.50	504

Their 4D plot is



ce
 .0M
 M
 .5M
 M
 .0M
 M
 .5M
 M

The Demand Plane is like a poster; we can rotate it

Once rotated, what once took 180° of arc now needs 90°

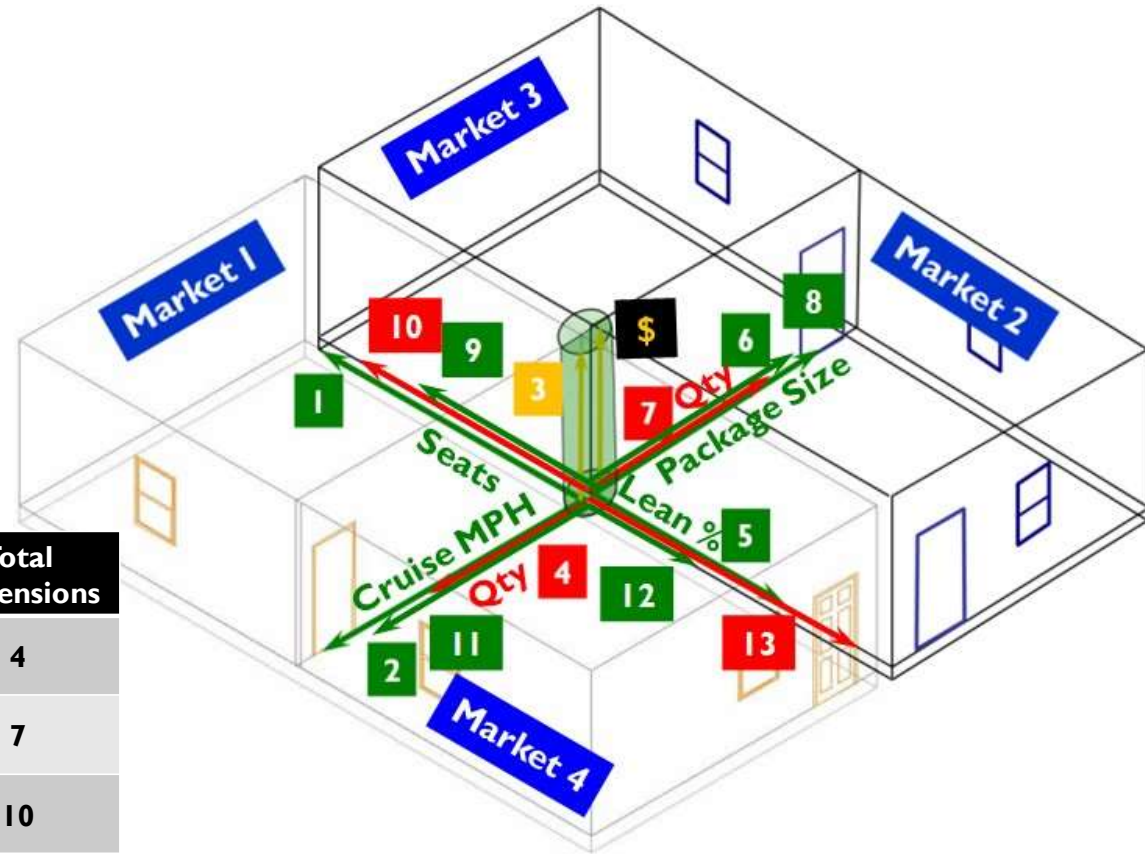
With Each Market Taking 90°, We can Plot 4 at Once



Here, Market 1 is the one for General Aviation Aircraft, while Market 2 is for Ground Beef

We could also plot Markets 3 and 4 (which could be anything)

A pattern develops...



Note the center cylinder—how can use that?

Markets	Value Dimensions	Quantity Dimensions	Currency Dimension	Total Dimensions
1	2	1	1	4
2	4	2	1	7
3	6	3	1	10
4	8	4	1	13
n	2n	n	1	3n + 1

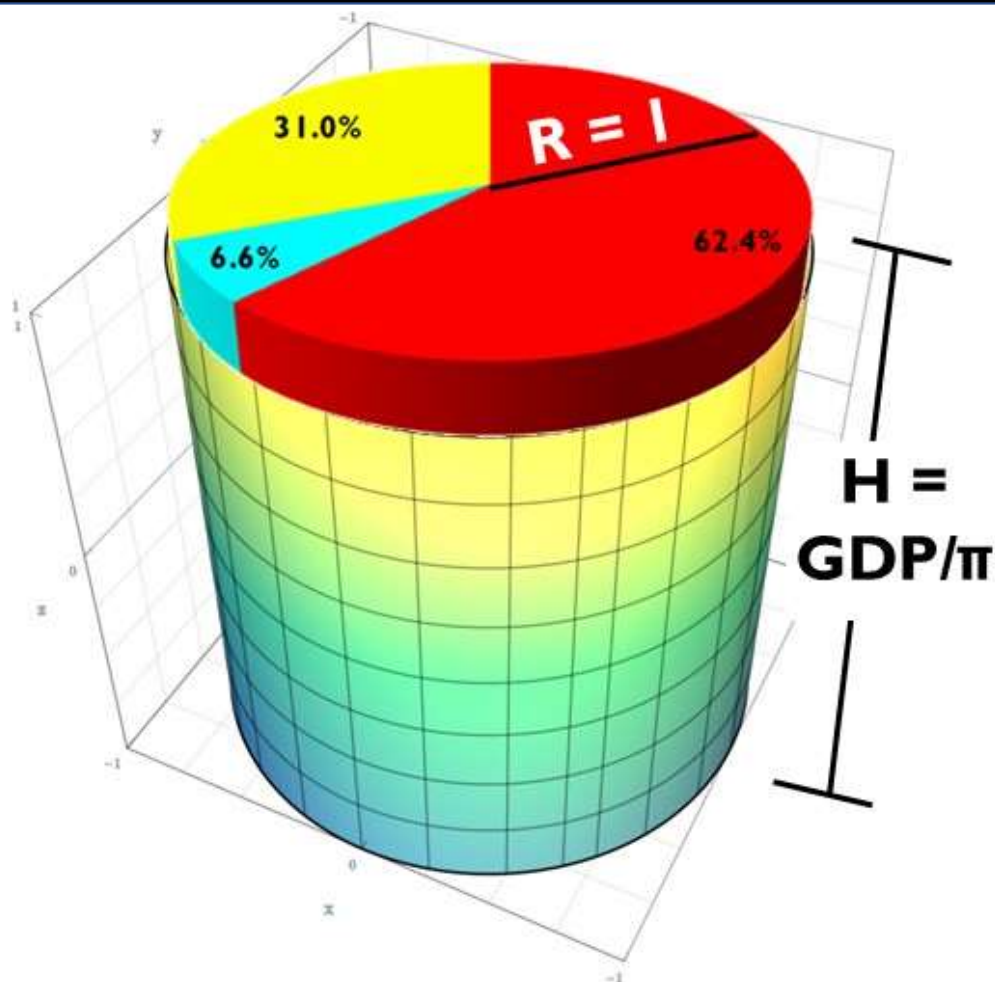
The CIA on GDP



In 2014, the CIA characterized about \$78.3T of GDP in this way:

Blue = Agriculture
Yellow = Industry
Red = Services

We could show every subset of the economy at the same time – but for that, we'll need *dimensional collapse*



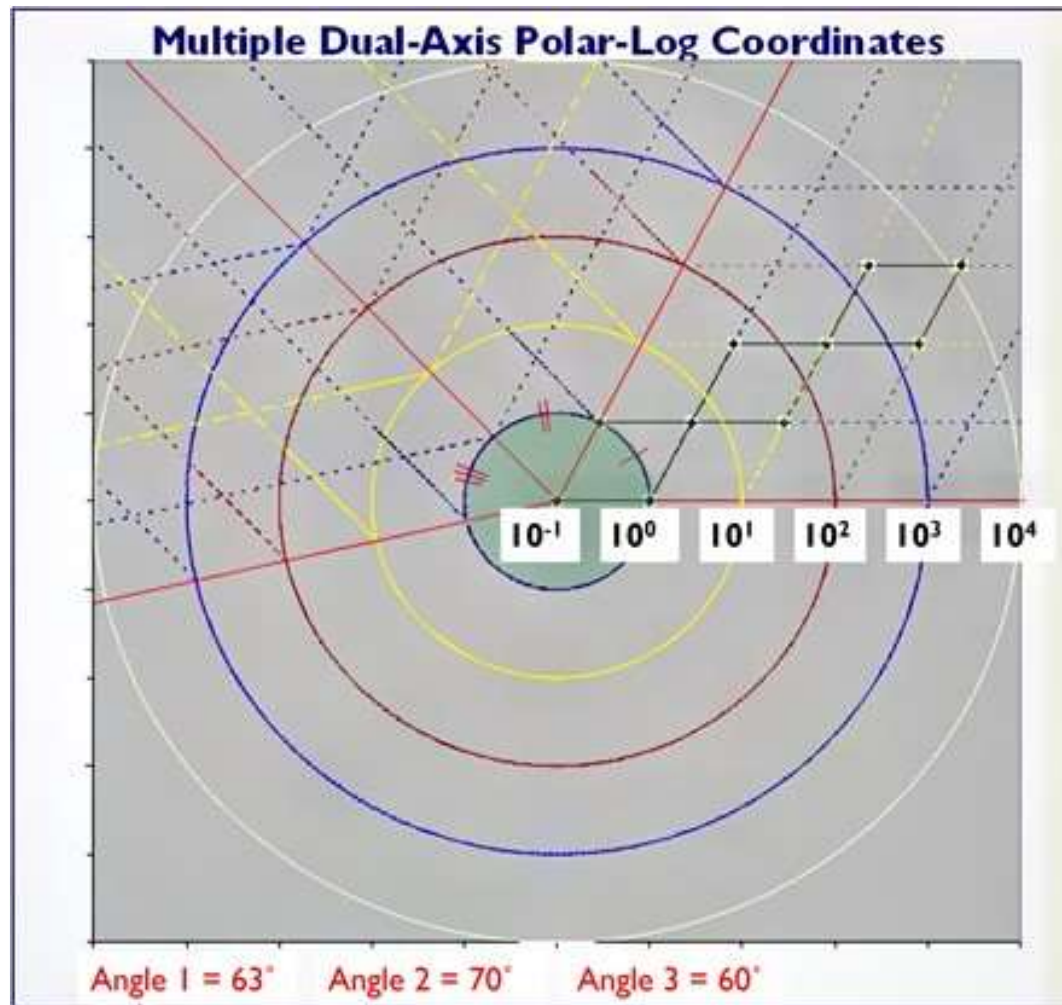
Compressing All Markets Simply Extends The Process



We start with one market off an anchor line, with its **proportion of the center circle representing its contribution to GDP**

If a market's contribution to GDP is larger, indicative of **dimensional expansion**, we represent it appropriately

We can add another market according to its part in the World GDP



And another...

Obviously, there is no upper limit to the number of markets we could depict

Each market's portion of GDP varies over time

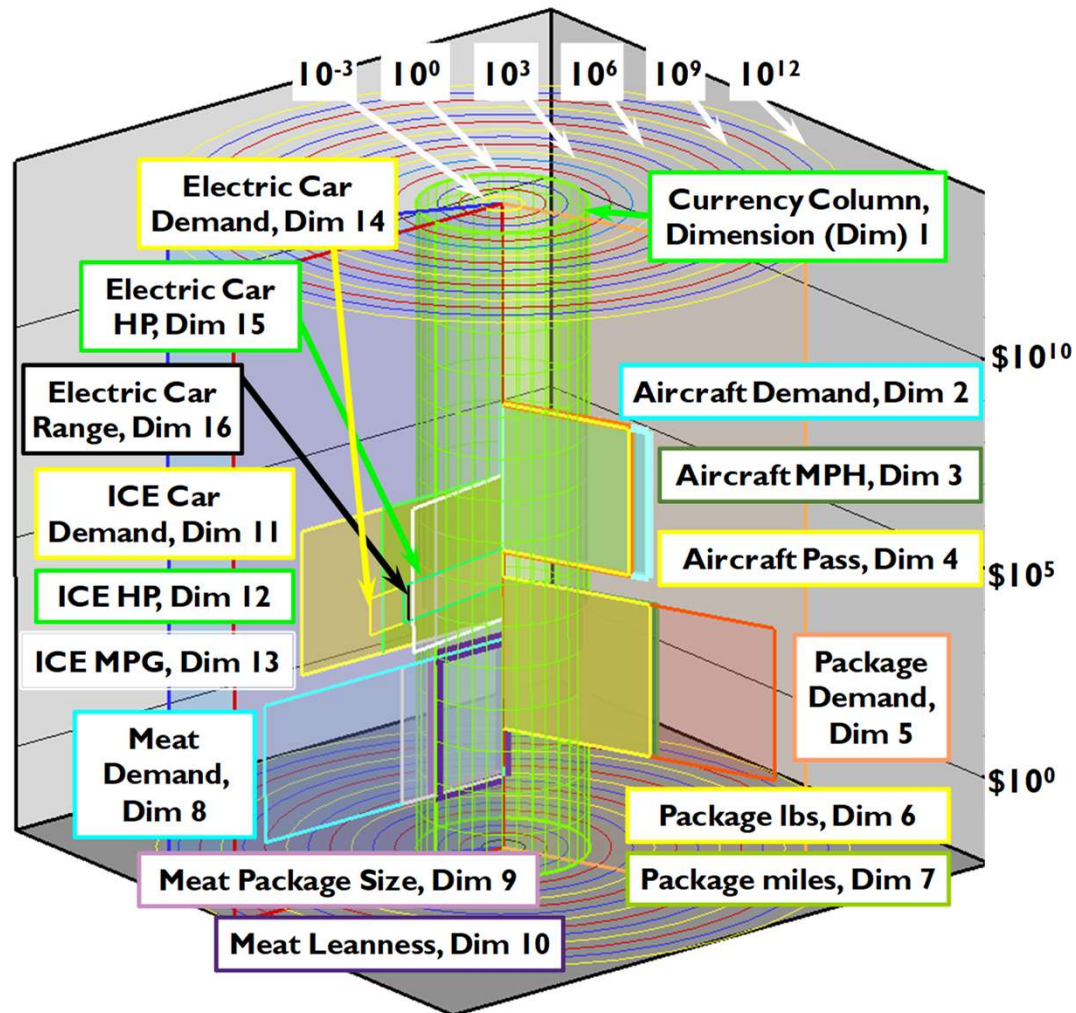
What Does a 5-Market, 16D System Look Like?



Electric cars use
Dimensions 14, 15, & 16

Internal Combustion
Engine (ICE) cars use
Dimensions 11, 12, & 13

Ground Beef uses
Dimensions 8, 9, & 10



The Currency Axis,
Dimension 1, is
common to all markets

Aircraft market uses
Dimensions 2, 3, & 4

Package Delivery uses
Dimensions 5, 6, & 7

Here's How We Built Up The Previous View



After we employ one common currency axis for Price, each market takes two Value dimensions and one Quantity dimension

Market	Dimension Name	Units	Dimension Type			Number of	
			Common	Value	Demand	Markets	Dimensions
All	Currency	Dollars	X				1
Civil Aircraft	Demand	Units per Year			X	1	2
	Max MPH	Miles per Hour		X			3
	Passengers	Seats		X			4
Package Delivery	Demand	Parcels per Year			X	2	5
	Package lbs	Pounds		X			6
	Package Miles	Miles to Delivery		X			7
United States Meat	Demand	Pounds per Year			X	3	8
	Package Size	Pounds per Package		X			9
	Leanness	Percentage		X			10
Internal Combustion Engine Car	Demand	Units per Year			X	4	11
	HP	Horsepower		X			12
	MPG	Miles per Gallon		X			13
Electric Car	Demand	Units per Year			X	5	14
	HP	Horsepower		X			15
	Range	Miles		X			16
All		Dimension Count	1	10	5		

How Did We Depict The Markets We Used?



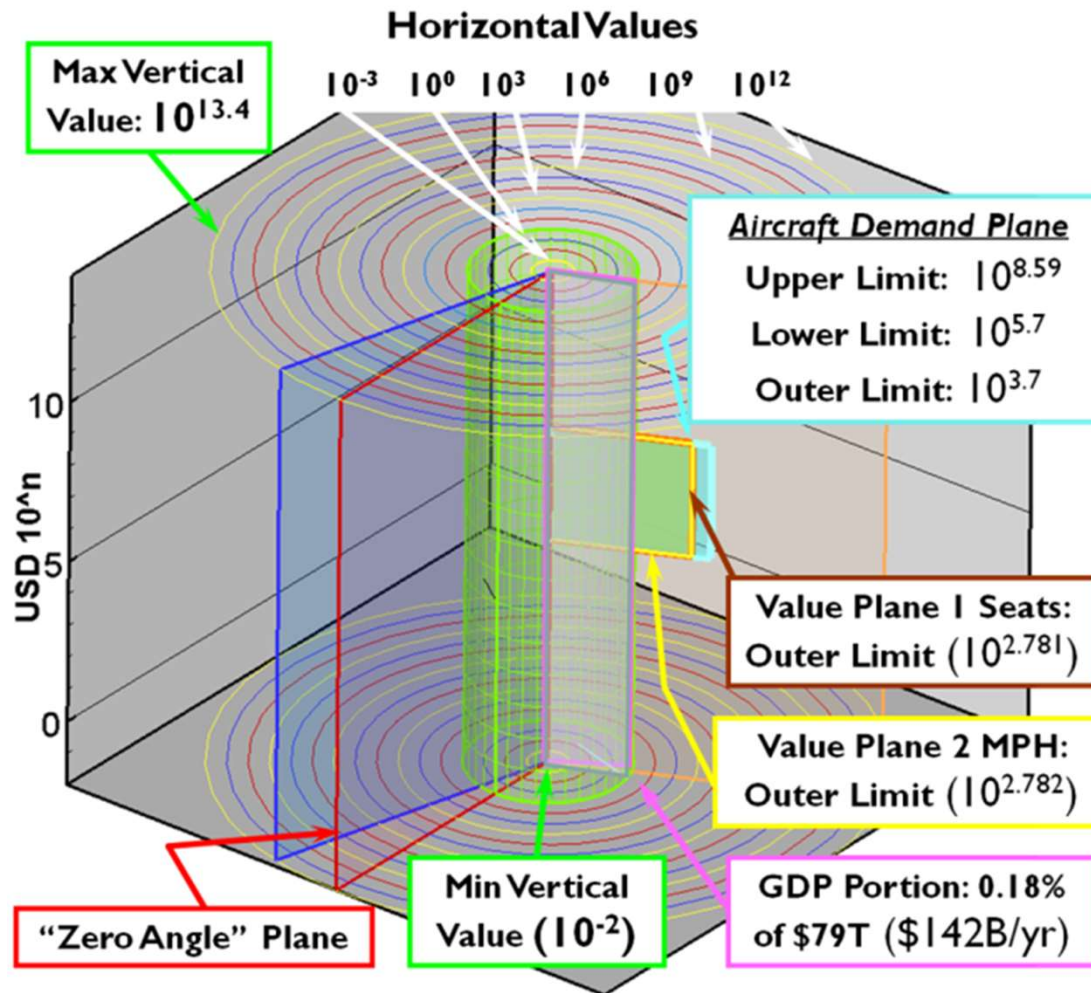
Draw a “Floor to Ceiling”
Angle 0 Plane (in Red, for
the start of Industry)

Add Services (Orange)
and Agriculture (Blue)

Create a center cylinder
with $R=1$, for GDP

Horizontally, each ring
goes out by a factor of 10

Vertically, each level goes
up by a factor of 10



The upper boundary
for all planes in a
market is that market's
highest-priced item

The lower boundary
for all planes in a
market is that market's
lowest-priced item

The lateral extent for
all planes is the highest
value for that variable

The angle between the
Value Planes shows that
market's part of GDP

Summary



- Reconnaissance has been part of our GDP since the beginning of humanity
- All Markets work in 4D according to the Law of Value and Demand
 - Features drive Value
 - Value sets Price
 - Price limits quantity sold
 - Quantity sold is a feature
- We can combine any number of markets into a single view
 - Each market slice is its portion of GDP
 - Markets evolve over time
- Viable products balance Cost, Value, and Demand

