FIRE SCOUT: ACQUISITION IN ADVERSITY
A CASE STUDY

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May 11, 2021

Why unmanned air systems

- **Military and recreation heritage**
  - Target practice, bombs, and reconnaissance
  - Flying model aircraft

- **International market today**
  - Over 100 small companies
  - Recreational and commercial use
  - ~ $47B by 2025, > 15% growth rate[1]

- **Advantages**
  - Operating costs
  - Risk to personnel

1945

1963

Source: US Navy https://www.flickr.com/photos/127906254@N06/15254535866/in/album-72157660342377952/
https://www.flickr.com/photos/127906254@N06/22174793041/in/album-72157660342377952/

1. https://www.mordorintelligence.com/industry-reports/drones-market https://www.mordorintelligence.com/industry-reports/drones-market

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Creating shipboard-capable reconnaissance and targeting UAVs

- Navy-led effort[2]
  - 1992-1998 Navy Pioneer detachments
    - Amphibious operations support
    - Crash rates – Navy program for new UAV
  - 1998 – VTUAV competition
    - Bell-Textron // Northrop Grumman-Schweitzer
    - Northrop bought Schweitzer helicopter in advance of Contract award
  - 1999 – Northrop Grumman-Schweitzer selected
    - RQ-8A ($93.7M)[3]
  - 2001 – Low Rate Initial Production Award
    - ($14.2M)[3]
  - 2001 – First prototype[4]

Pioneer recovery, USS IOWA (BB-62)

Source: PHC Jeff Hilton – Defense Imagery Still Asset Details for DNST8704514, Public Domain, https://commons.wikimedia.org/w/index.php?curid=596025

2. Jacobsen (2001) Unmanned Aerial Vehicles - The Key to Effective Situational Awareness in Littoral Operations
3. Defense Industry Daily, The Fire Scout VTUAV program: By Land and By Sea. Retrieved 2020 June 20.
4. Northrop Grumman news, Northrop Grumman takes delivery of first prototype from Schweitzer. Retrieved 2020 June 23.

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Significant technical decisions

- **Use proven platforms**
  - Schweitzer S330
  - Known system performance
  - Proven engine with lots of power margin
  - Existing 4-blade hub for future load growth

- **Adopt common interfaces & payloads**
  - Common Ground and Control systems
  - Common sensor interfaces & data links
  - No special launch/recovery systems

- **Use existing autonomy**

Source: https://www.northropgrumman.com/air/fire-scout/

Significant Fire Scout program events[5] – 2002-2007

- 2002- MQ-8A funding terminated
  - Program cancelled

- 2003 – Restart
  - New Navy need - Littoral Combat Ship
  - Flight demonstrations moved to Maryland

- 2004 award to Northrop/Schweitzer
  - Contractor upgraded power and lift capacity

- 2006: autonomous shipboard landing
- 2007: certified for Air transport

5. ibid., Defense Industry Daily, The Fire Scout VTUAV program: By Land and By Sea. Retrieved 2020 June 20.

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Significant Fire Scout program events – 2008-2014

- 2008 Navy Acquisition Strategy
  - Continue with the VTUAV EMD
  - Buy 9 developmental MQ-8Bs
  - Milestone C LRIP decision in 2007
  - Full rate production and IOC after OPEVAL

- Improved platform (MQ-8C)
  - Endurance, weapons, radar upgrades
  - New airframe, core technology retained

- 2009-2014 Operational use before IOC
  - Counter-drug and anti-piracy missions
  - Rapid deployments to AFRICOM
 - Weapons integration and testing

RCS: DD-A&T(Q&A)823-253

MQ-8 Fire Scout Unmanned Aircraft System (MQ-8 Fire Scout)

As of FY 2019 President's Budget

Defense Acquisition Management
Information Retrieval

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Significant Fire Scout program events – 2014-2019

- 2015 PB
  - Deferred procurements to align with LCS deliveries
  - More capable MQ-8C= fewer buys
  - Nunn-McCurdy unit cost Breach
  - 2014 MQ-8B IOC

- Procurement changes
  - 9 R&D systems, 30 MQ-8B, 29 MQ-8C
  - Total production limited to 63 units MQ8C
  - Congress Adds buys – Procurement cost breach

- Program office adaptations [8]
  - Rapid Capability Procurement
  - Eliminated need for LRIP approvals
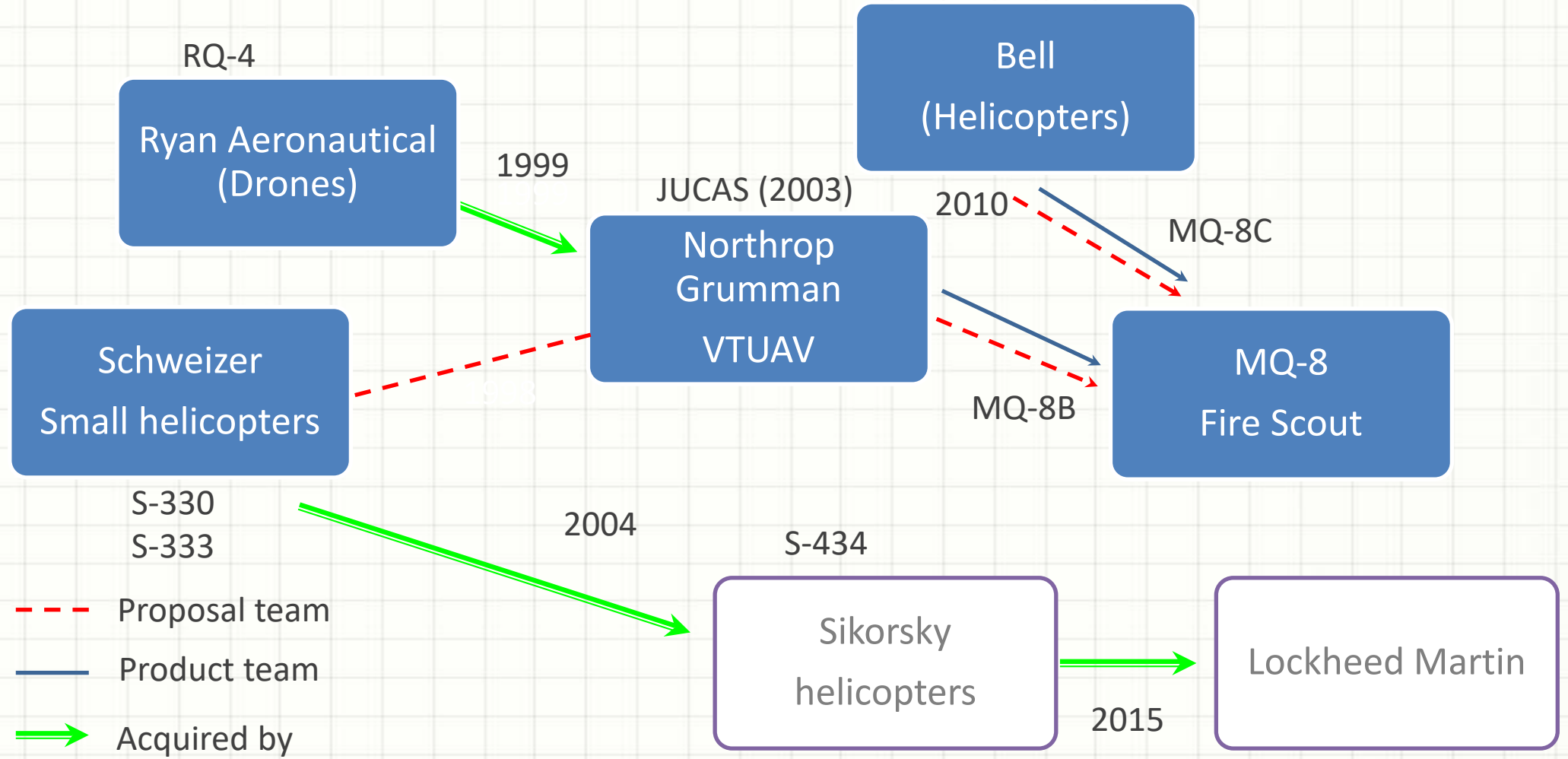 - 2019 MQ-8C IOC
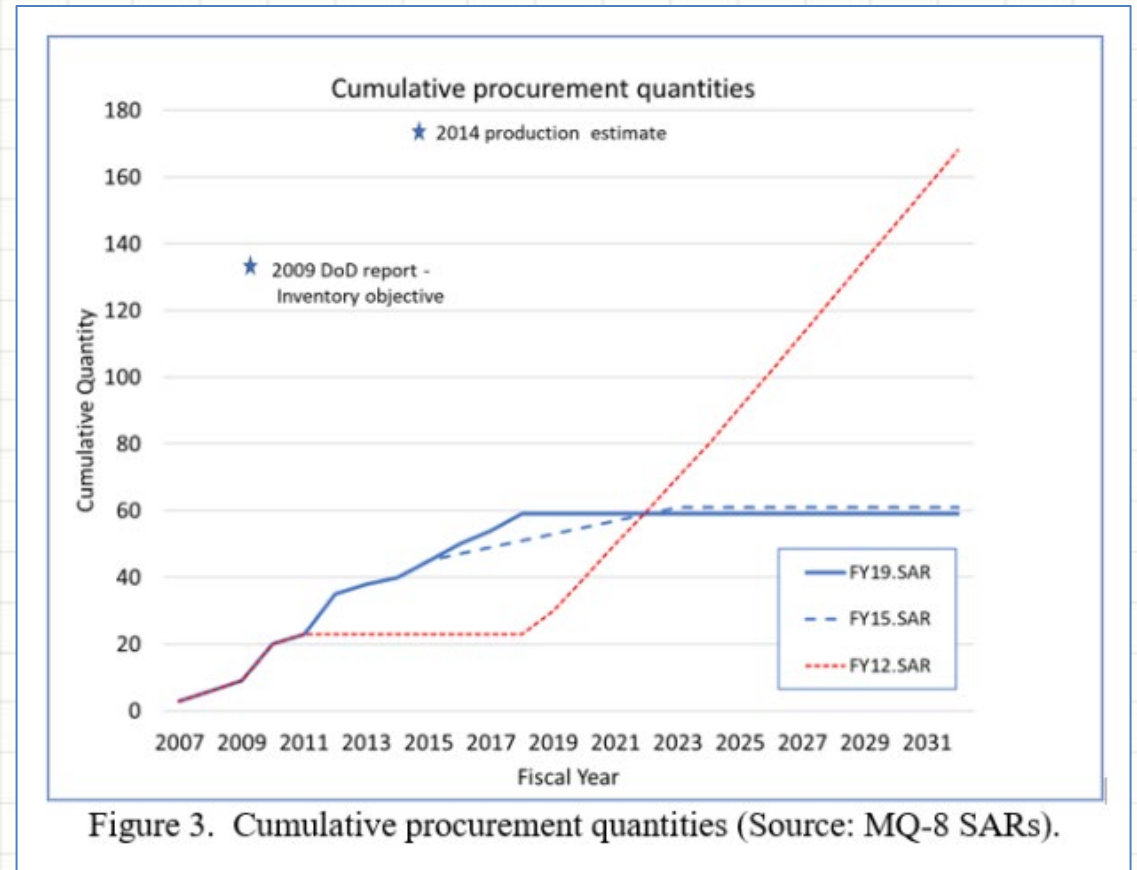
Figure 3. Cumulative procurement quantities (Source: MQ-8 SARs).

9. Dodaro G. (2015) GAO-15-342SP, DEFENSE ACQUISITIONS_ Assessments of Selected Weapon Programs. Retrieved from: https://www.gao.gov/assets/670/668986.pdf#page=125

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Northrop Grumman acquisitions – strategic market positioning

Table I. Northrop UAV-related acquisition actions (Source: Northrop.com).

Year	Company	Action	Notes
1992	Vought Aircraft	Acquisition	Aerostructures manufacture
1994	Grumman Aerospace	Acquisition	Aircraft and Apollo Lander expertise, F-14 support
1996	Westinghouse Electric Corporation	Acquisition	Defense Electronic Systems Group, aircraft radar systems
1997	Logicon	Acquisition	Information technology and battle management systems
1998	Inter-National Research Institute	Acquisition	Command and Control, data fusion expertise
1998	California Microwave	Acquisition	Airborne ISR, mission planning
1999	Teledyne Ryan Aeronautical	Acquisition	UAV expertise
2000	Vought Division	Sale	Divest - metal structures production
2001	Aerojet General	Acquisition	Smart Weapons expertise
2007	Scaled Composites	Acquisition	Specialty composites and flight test expertise

VTUAV critical associations

RQ-4

Ryan Aeronautical (Drones)

1999

JUCAS (2003)

Bell (Helicopters)

2010

MQ-8C

Northrop Grumman VTUAV

Schweizer Small helicopters

MQ-8B

MQ-8 Fire Scout

S-330
S-333

2004

S-434

- - - - Proposal team

——— Product team

——→ Acquired by

Sikorsky helicopters

2015

Lockheed Martin

Return on Investment

- ## Northrop Grumman
  - ### Bought Ryan Aerospace in 1999, $140M
  - ### Obligations > buy cost in 5 years

NGC funding profile
VTUAV/Fire Scout, source: FPDS.gov

VTUAV-Fire Scout 2000-2019
Cumulative Navy Obligations source: FPDS.gov

$y = 4E+07x - 6E+06$
$R^2 = 0.9809$
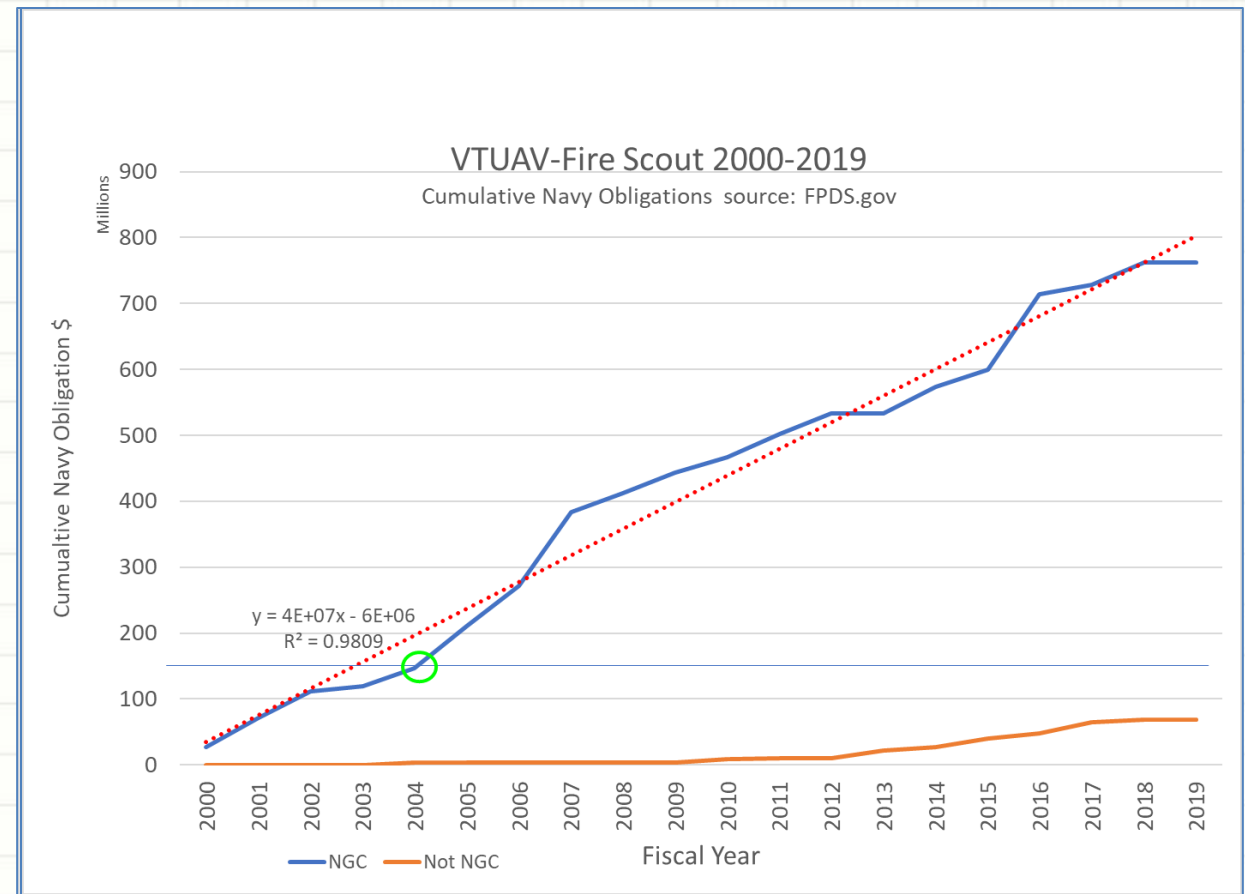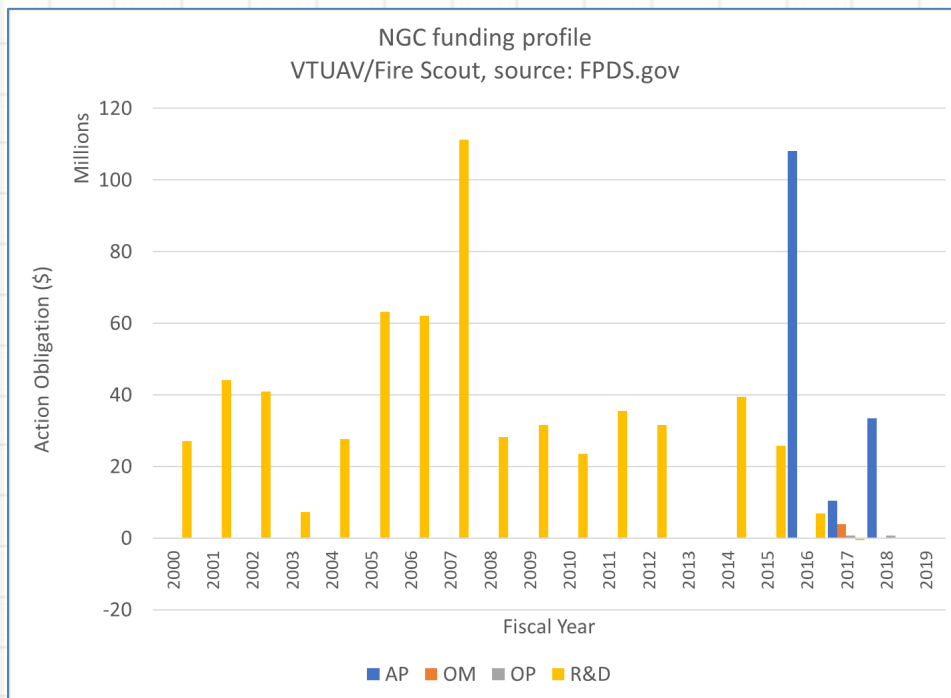
Contractor strategy and result

- **Strategy**
  - Key acquisitions
  - Recognized competition[7]
  - Unstable demand for MQ-8B[7]
  - Improvement before government demand[8]

- **Long-term result**
  - Major unmanned air system contractor

Major Air system programs 1998 to 2018

System	Name	1998 ($M)	2018 ($M)	NOC
AH-64	Longbow Apache (C/D/E/reman)	609.2	1,441.9	Sub
E-2	Hawkeye (C//D)	374.8	1,116.4	Prime
F-18	Hornet (E/F) //Super Hornet	3274.6	1,253.1	Sub
B-2	Spirit	307.6	0	Prime
E-8	JSTARS	850.3	0	Prime
F-35	Joint Strike Fighter//Lightning II	909.1	10,837.9	Sub
V-22	Osprey	985.1	961.8	Sub
F-15	Eagle	274.8	963.1	Sub
F-22	Raptor	2,406.5	915.5	Sub
C-130	Hercules	0	886.1	Sub
P-8	Poseidon	0	1,609.4	Sub
MQ-1	Predator UAS	0	174.4	*
RQ-4	Global Hawk UAS	0	1,282.3	Prime
MQ-9	Reaper UAS	0	1,009.8	*
UAV	Smaller UAVs	0	129.7	*

7. Heintz, K. (2012) ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934 For the fiscal year ended December 31, 2011 – The Northrop Grumman Corporation. Retrieved from https://www.northropgrumman.com/AboutUs/AnnualReports/Pages/default.aspx
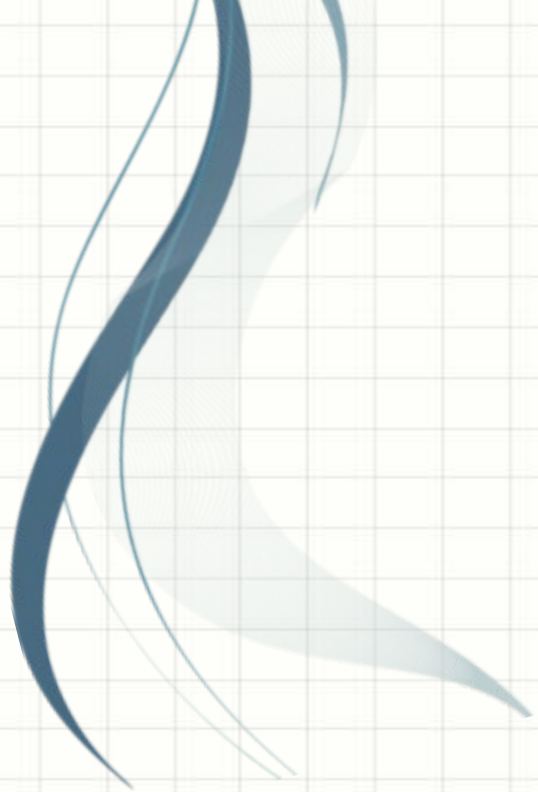8. Defense Industry Daily Dec 11 2019. Retrieved from. https://www.defenseindustrydaily.com/the-fire-scout-vtuav-program-by-land-and-by-sea-updated-01316/

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Program office and Contractor keys

- **Early, continuous customer exposure**
  - Understand what is really important to users
  - LRIP deployed to sea before IOC
  - Afghanistan, AFRICOM/CENTCOM

- **Kept technical risk within capabilities**
  - Early strategic technical decisions
  - Kept ahead of customer explicit demands

- **Tenacity**
  - Change happens
  - Sufficient funding / support
  - Delivered product adaptively

- **Responsive**

9. Dodaro G. (2015) GAO-15-342SP, DEFENSE ACQUISITIONS_ Assessments of Selected Weapon Programs. Retrieved from: https://www.gao.gov/assets/670/668986.pdf#page=125

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Backup

Summary

- Almost 20 years- program start to IOC
  - Two IOCs, funding changes, restructures

- Program office commitment
  - Restart after each termination
  - Found sufficient funding to keep moving

- Contractor commitment
  - Worked ahead of explicit requirements

- Tenacity
  - Engage with Fleet users

- Program overview

- Contractor view

- Summary

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Adaptations – new roles, customers

- **New roles**
  - 2005:Army selects for Future Combat System
  - 2005 DoD approves multi-mission capability
    - RQ-8 to MQ-8 (Recon to Multi-mission
  - July 2005: Northrop Gruman test fires rockets from MQ-8A at Yuma Proving Grounds

- **Prospected new customers and uses**
  - US Coast Guard[6]
  - Foreign Military Sales interest

- **New capabilities**
  - UAV Common Automatic Recovery System
  - New sensor capability – COBRA mine detection
  - Example: Cargo Unmanned Air System[5]

- **Contractor investing to improve product[6]**
  - 2002 – More lift (4-blade hub)
  - 2003 – New solicitation for MQ-8B
  - 2010 – Northrop Gruman/ Bell FIRE-X
  - 2011 – MQ-8C competition

S Northrop offers Fire-X for unmanned resupply. May 4, 2010. Retrieved from
https://www.flightglobal.com/pictures-northrop-offers-fire-x-concept-for-unmanned-resupply/93312.article
6. Defense Industry Daily, The Fire Scout VTUAV program: By Land and By Sea. Retrieved 2020 June 20

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Additional contract data results

- Data filtering in FPDS
  - Example MQ-8 (Fire Scout)
  - Very specific by Contract number

- Creates data cleaning issues
  - "UCAV" finds both
    - Unmanned combat air vehicle
    - Undefinitized contract action

- Analyses
  - Funding profiles over time
  - Market share analysis
  - Statistics
    - Outliers
    - Significant factors
  - Logistic regressions

Market share

- Northrop Grumman
  - Captured most Navy obligations related to VTUAV/Fire Scout
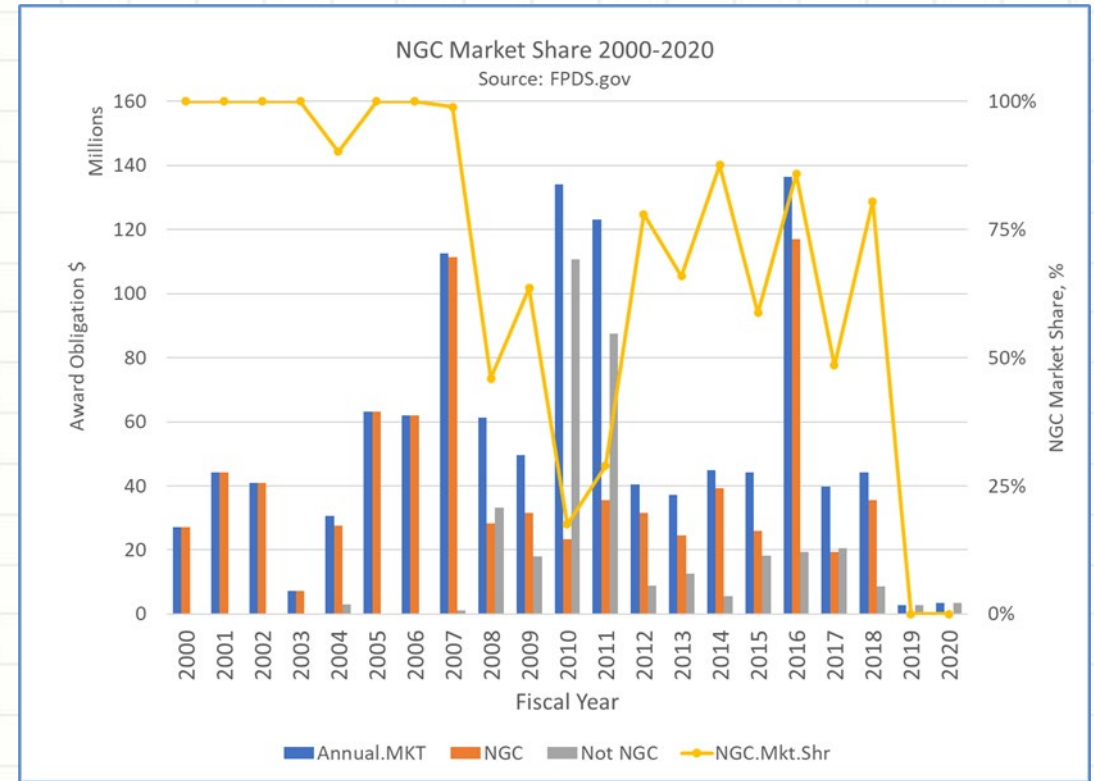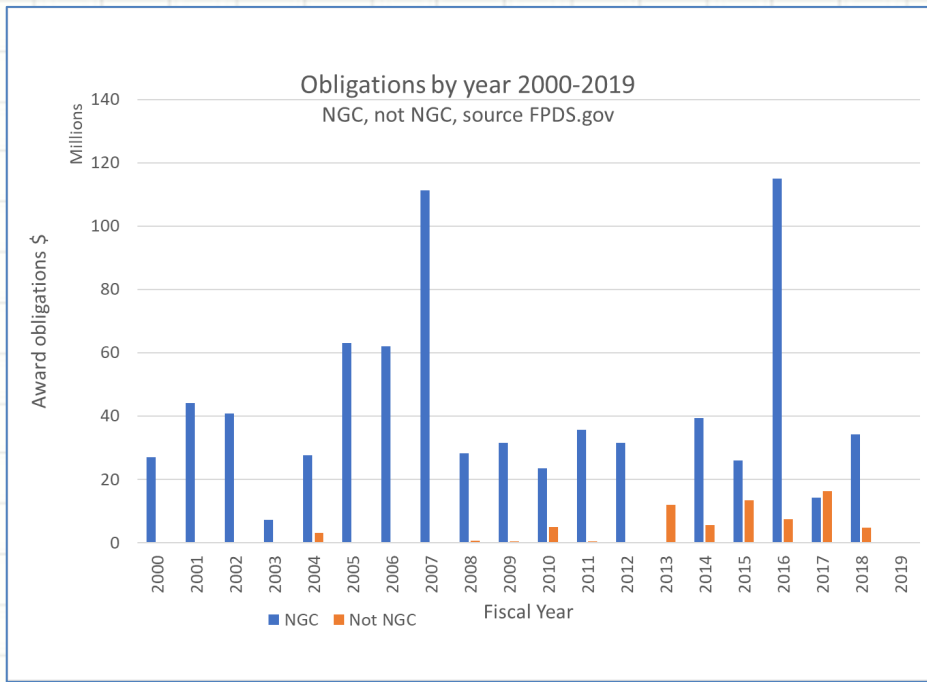
Contract N00019-00-C-0277 outlier test (R&D contract)

Outlier Test: Action Obligation ($)

Method

Null hypothesis	All data values come from the same normal population
Alternative hypothesis	Smallest or largest data value is an outlier
Significance level	α = 0.05

Dixon's r22 Ratio Test

Variable	NGC-NotNGC	N	Min	x[2]	x[3]	x[N-2]	x[N-1]	Max
Action Obligation ($)	NGC	118	-1362752	0	0	30000000	43412000	70000000
	NOT NGC	34	-16236	-6969	0	3000000	3000000	8300000

Variable	NGC-NotNGC	r22	P
Action Obligation ($)	NGC	0.57	0.000
	NOT NGC	0.64	0.000

x[i] denotes the ith smallest observation.

Outlier

Variable	NGC-NotNGC	Row	Outlier
Action Obligation ($)	NGC	44	70000000
	NOT NGC	124	8300000

Outlier Plot of Action Obligation ($) vs NGC-NotNGC

Outlier Plot of Action Obligation ($) vs NGC-NotNGC

Dixon's r22 Ratio Test				
NGC-NotNGC	Min	Max	r22	P
NGC	-1362752.00	70000000.00	0.57	0.000
NOT NGC	-16235.76	8300000.00	0.64	0.000
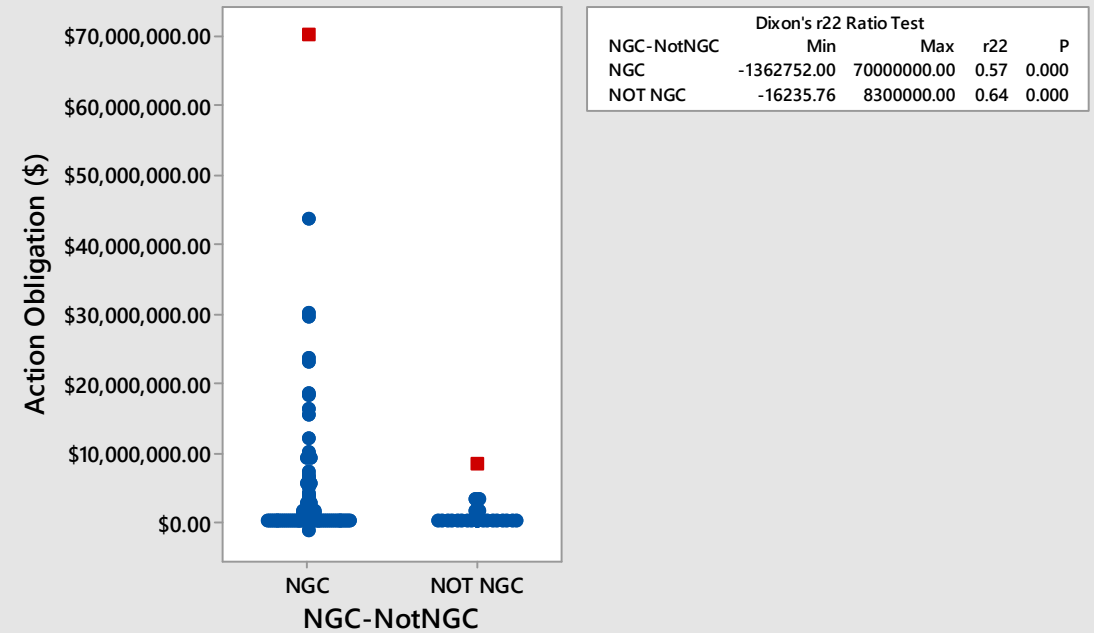
Northrop Grumman dataset

Outlier Test: Action Obligation ($)

Method

Null hypothesis	All data values come from the same normal population
Alternative hypothesis	Smallest or largest data value is an outlier
Significance level	$\alpha = 0.05$

Dixon's r22 Ratio Test

Variable	FUNDING	N	Min	x[2]	x[3]	x[N-2]	x[N-1]
Action Obligation ($)	AP	8	0	0	0	10362211	33479478
	OM	3	0	932618	2944221	0	932618
	OP	6	0	0	0	74328	723154
	R&D	166	-1362752	-631264	-476653	39377370	43412000

Variable	FUNDING	Max	r22	P
Action Obligation ($)	AP	108118000	0.90	0.013
	OM	2944221	*	*
	OP	759023	0.90	0.449
	R&D	70000000	0.43	0.015

x[i] denotes the ith smallest observation.

Outlier

Variable	FUNDING	Row	Outlier
Action Obligation ($)	AP	169	108118000
	R&D	42	70000000

Outlier Plot of Action Obligation ($) vs FUNDING

Outlier Plot of Action Obligation ($) vs FUNDING

Dixon's r22 Ratio Test				
FUNDING	Min	Max	r22	P
AP	0.00	1.08118E+08	0.90	0.013
OM	0.00	2944221.00	*	*
OP	0.00	759023.00	0.90	0.449
R&D	-1362752.00	70000000.0	0.43	0.015

Outliers are platform orders –
R&D – development
AP - production
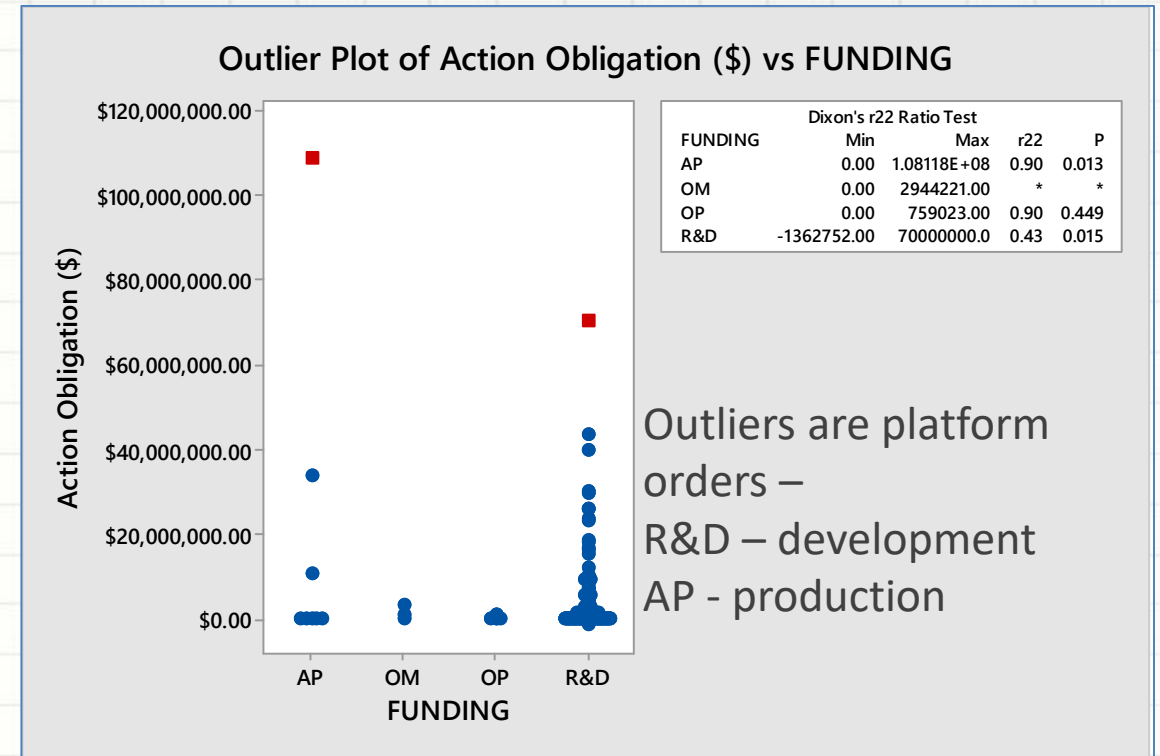
Not Northrop Grumman data subset

Outlier Test: Action Obligation ($)

Method

Null hypothesis	All data values come from the same normal population
Alternative hypothesis	Smallest or largest data value is an outlier
Significance level	$\alpha = 0.05$

Dixon's r22 Ratio Test

Variable	FUNDING	N	Min	x[2]	x[3]	x[N-2]	x[N-1]
Action Obligation ($)	AP	19	-13856	0	0	12091480	33479478
	OM	9	0	8643	13318	102510	932618
	OP	51	0	0	0	4410760	5073976
	R&D	192	-1362752	-631264	-476653	39377370	43412000

Variable	FUNDING	Max	r22	P
Action Obligation ($)	AP	108118000	0.89	0.000
	OM	2944221	0.97	0.000
	OP	6349870	0.31	0.109
	R&D	70000000	0.43	0.016

x[i] denotes the ith smallest observation.

Outlier

Variable	FUNDING	Row	Outlier
Action Obligation ($)	AP	232	108118000
	OM	243	2944221
	R&D	44	70000000

Outlier Plot of Action Obligation ($) vs FUNDING

Outlier Plot of Action Obligation ($) vs FUNDING

Dixon's r22 Ratio Test

FUNDING	Min	Max	r22	P
AP	-13856.00	1.08118E+08	0.89	0.000
OM	0.00	2944221.00	0.97	0.000
OP	0.00	6349870.00	0.31	0.109
R&D	-1362752.00	70000000.0	0.43	0.016
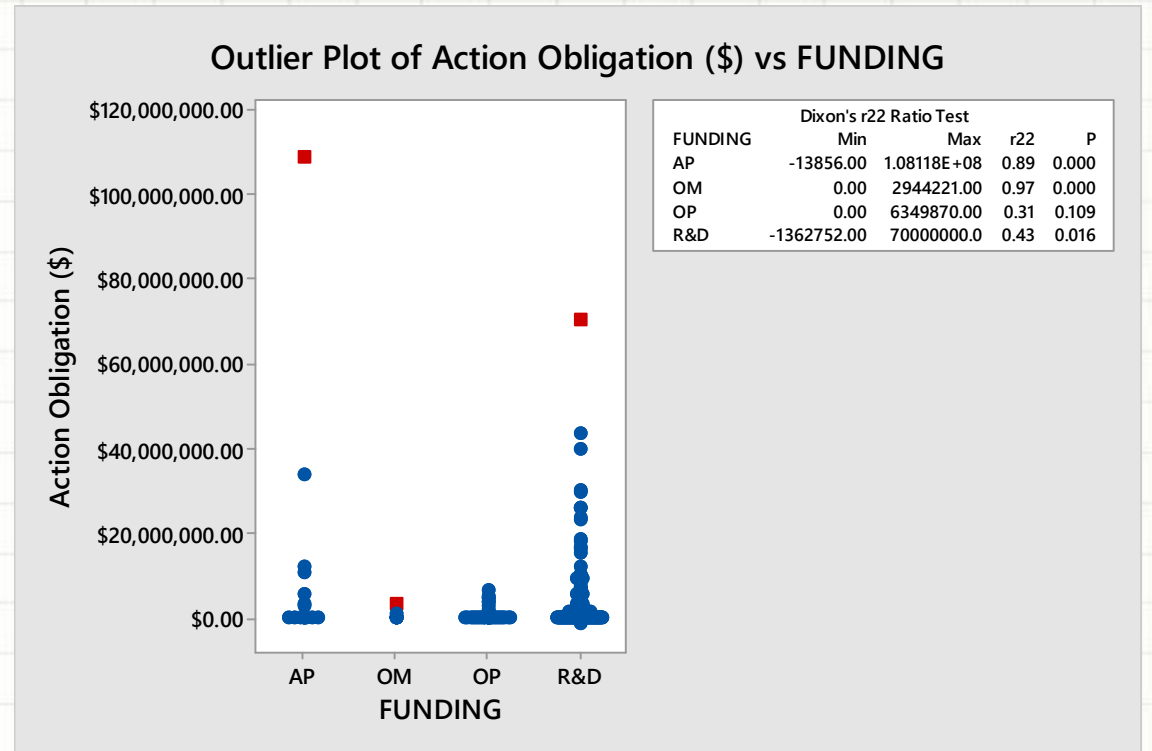
Median and mean testing

Mood's Median Test: Action Obligation ($) versus NGC-Not

Descriptive Statistics

NGC-Not	Median	N <= Overall Median	N > Overall Median	Q3 – Q1	95% Median CI
NGC	180000	86	97	2500000	(0, 724518)
NOTNGC	59186	50	38	393407	(15561.4, 101625)
Overall	78000				

95.0% CI for median(NGC) - median(NOTNGC): (-52925.7,580244)

Test

Null hypothesis H_0: The population medians are all equal
Alternative hypothesis H_1: The population medians are not all equal

DF	Chi-Square	P-Value
1	2.29	0.130

Two-Sample T-Test and CI: Action Obligation ($), NGC-Not

Method

μ_1: mean of Action Obligation ($) when NGC-Not = NGC
μ_2: mean of Action Obligation ($) when NGC-Not = NOTNGC
Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: Action Obligation ($)

NGC-Not	N	Mean	StDev	SE Mean
NGC	183	4166607	11698650	864789
NOTNGC	88	785637	1851079	197326

Estimation for Difference

Difference	95% CI for Difference
3380970	(1631866, 5130074)

Test

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$
Alternative hypothesis H_1: $\mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
3.81	200	0.000

Classifying as NGC award

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC
37.46%	36.58%	221.69

Deviance Table

Source	DF	Seq Dev	Contribution	Adj Dev	Adj Mean	Chi-Square	P-Value
Regression	3	127.97	37.46%	127.97	42.6570	127.97	0.000
Action Obligation ($)	1	16.20	4.74%	14.48	14.4775	14.48	0.000
FY	1	73.95	21.64%	10.34	10.3394	10.34	0.001
PSC Type	1	37.82	11.07%	37.82	37.8223	37.82	0.000
Error	267	213.69	62.54%	213.69	0.8004		
Total	270	341.67	100.00%				

Coefficients

Term	Coef	SE Coef	95% CI	Z-Value	P-Value	VIF
Constant	-324	103	(-526, -121)	-3.13	0.002	
Action Obligation ($)	-0.000000	0.000000	(-0.000000, -0.000000)	-2.26	0.024	1.04
FY	0.1615	0.0512	(0.0610, 0.2619)	3.15	0.002	1.26
PSC Type						
S	-2.506	0.438	(-3.364, -1.647)	-5.72	0.000	1.30

Odds Ratios for Categorical Predictors

Level A	Level B	Odds Ratio	95% CI
PSC Type			
S	P	0.0816	(0.0346, 0.1926)

Odds ratio for level A relative to level B

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Action Obligation ($)	1.0000	(1.0000, 1.0000)
FY	1.1752	(1.0629, 1.2994)

Deviance Residual Plots for NGC-Not

Normal Probability Plot — N 271, AD 11.076, P-Value <0.005

Histogram

Versus Order
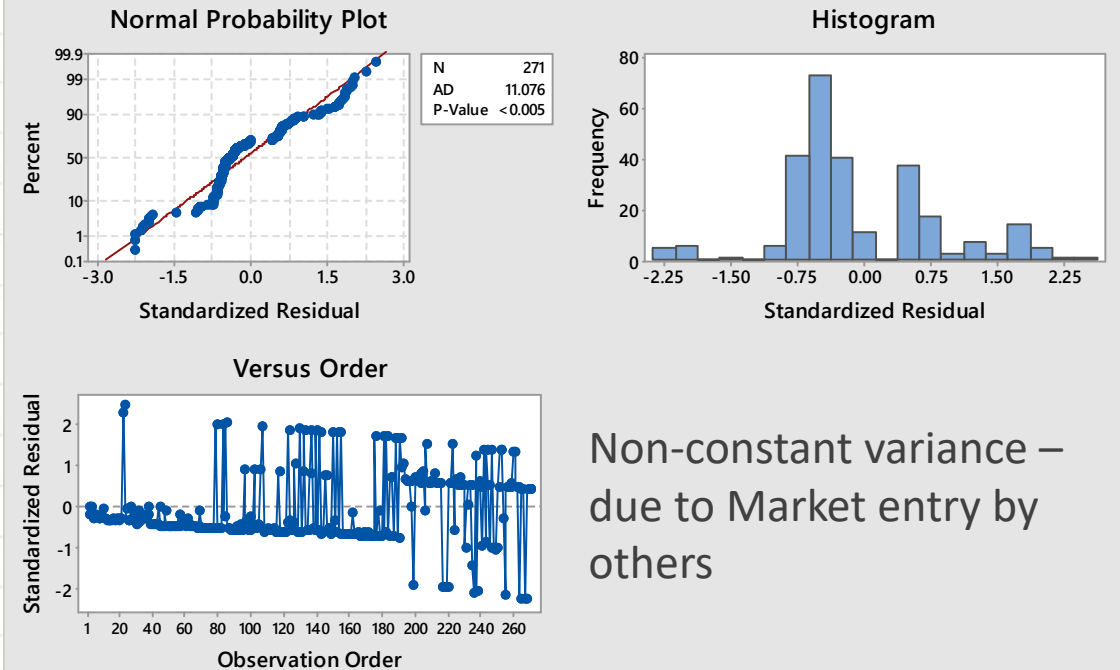
Non-constant variance – due to Market entry by others

Goodness-of-Fit Tests

Test	DF	Chi-Square	P-Value
Deviance	267	213.69	0.993
Pearson	267	259.22	0.622
Hosmer-Lemeshow	8	25.30	0.001

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