395. Emerging Industries: Small Launch Vehicle Sector (SLVS)

Image Source: NASA

1. Team
2. Project Overview
3. Research Goals
4. Work Stages (map with topics)
5. Data Handling
6. Lit review, State of the art
    - Catapult
    - Articles (IAC website)
    - Visualization
4. Preliminary Findings & Results
5. Visualisation Opportunities
6. Further Work
7. Q&A, Directions of Interest

The Team

Dr. Ken Davidian

Research and Program Manager | FAA Center of Excellence for Commercial Space Transportation **| AST Director**

Dr. Don Platt

Associate Professor | Extended Studies **Director** | Spaceport Education Center

Anna Wojdecka

PhD Human Centred Design for Commercial Human Spaceflight | Department of Computing

Innovation Design Engineer with expertise in Human Centred Design, Human Spaceflight and Exponential Technology Application. MA & Msc Royal College of Art, Imperial College London, Singularity University GSP 16, International Space University SSP17

Djalma Batista

MSc Engineering Management | Department of Mechanical and Civil Engineering

Engineer with expertise in Quality Engineering and Data Management. Bachelors in Industrial Engineering 18'.
Multidisciplinary approach to problem solving within multicultural teams across sectors, including aerospace and automotive.

Data

	A	B	C	D	E	F	G	H
1		Autho	Compa	Orbits	Date	articles post	Links	References
2	588	Space Fligh		[]	July 28, 2014	Space surveillance craft launched by Delta 4	https://spa	https://spaceflightnow.com/2014
3	586	Space Fligh		[]	October 8, 2014	Galileo launch failure blamed on frozen Frega	https://spa	https://spaceflightnow.com/2014
4	585	Space Fligh		[]	October 12, 2014	Winds sensor opens door for Earth science fr	https://spa	https://spaceflightnow.com/2014
5	584	Space Fligh		[]	October 13, 2014	GPS modernization continues with quick pac	https://spa	https://spaceflightnow.com/2014
6	269	Space Fligh		[]	October 14, 2014	Indian navigation satellite ready for launchO	https://spa	https://spaceflightnow.com/2014
7	268	Space Fligh		[]	October 15, 2014	Indian navigation satellite launched by PSLV(	https://spa	https://spaceflightnow.com/2014
8	267	Space Fligh		[]	October 25, 2014	Atlas 5 to fly Wednesday, continuing rapid de	https://spa	https://spaceflightnow.com/2014
9	341	Space Fligh		[]	October 27, 2014	Atlas 5/GPS 2F-8 launch timelineOctober 27,	https://spa	https://spaceflightnow.com/2014
10	583	Space Fligh		[]	October 27, 2014	China launches third space mission in a week	https://spa	https://spaceflightnow.com/2014
11	582	Space Fligh		[]	October 28, 2014	Atlas 5 rocket rolled to Cape Canaveral launc	https://spa	https://spaceflightnow.com/2014
12	266	Space Fligh		[]	October 29, 2014	50th Atlas 5 rocket puts up new GPS satellite	https://spa	https://spaceflightnow.com/2014
13	265	Space Fligh		[]	November 7, 2014	U.S. Navy communications satellite shipped	https://spa	https://spaceflightnow.com/2014
14	581	Space Fligh		[]	December 1, 2014	Soyuz rocket deploys upgraded Russian navig	https://spa	https://spaceflightnow.com/2014
15	340	Space Fligh		[]	December 16, 2014	ULA year in reviewDecember 16, 2014Justin	https://spa	https://spaceflightnow.com/2014
16	264	Space Fligh		[]	December 18, 2014	Newest GPS satellite goes activeDecember 18	https://spa	https://spaceflightnow.com/2014
17	263	Space Fligh		[]	December 19, 2014	Third quartet of satellites launched for O3b N	https://spa	https://spaceflightnow.com/2014
18	580	Space Fligh		[]	December 19, 2014	13 launches on manifest for ULA in 2015Dec	https://spa	https://spaceflightnow.com/2014
19	262	Space Fligh		[]	December 29, 2014	O3b Networks plans satellite fleet expansionI	https://spa	https://spaceflightnow.com/2014
20	261	Space Fligh		[]	January 7, 2015	Navy satellite to be hoisted atop rocket for Ja	https://spa	https://spaceflightnow.com/2015
21	339	Space Fligh		[]	January 17, 2015	Preview: Navy craft to ride milestone Atlas-C	https://spa	https://spaceflightnow.com/2015
22	260	Space Fligh		[]	January 21, 2015	Recap story: 200th Atlas-Centaur launching c	https://spa	https://spaceflightnow.com/2015
23	259	Space Fligh		[]	January 22, 2015	Did two more Iridium satellites collide with s	https://spa	https://spaceflightnow.com/2015
24	257	Space Fligh		[]	February 6, 2015	Galileo satellite deployment campaign to res	https://spa	https://spaceflightnow.com/2015
25	258	Space Fligh		[]	February 6, 2015	New Navy satellite spreads wings, unfurls ant	https://spa	https://spaceflightnow.com/2015
26	256	Space Fligh		[]	February 27, 2015	Four satellites mated to Atlas 5 rocketFebrua	https://spa	https://spaceflightnow.com/2015
27	254	Space Fligh		[]	March 4, 2015	Power system failure likely cause of military s	https://spa	https://spaceflightnow.com/2015
28	255	Space Fligh		[]	March 4, 2015	Liftoff of Indian navigation satellite postpone	https://spa	https://spaceflightnow.com/2015
29	579	Space Fligh		[]	March 8, 2015	Preview: Atlas 5 rocket to launch NASA magn	https://spa	https://spaceflightnow.com/2015
30	338	Space Fligh		[]	March 11, 2015	Atlas 5 rolled to the pad for Thursday night's	https://spa	https://spaceflightnow.com/2015
31	578	Space Fligh		[]	March 15, 2015	Delta/GPS 2F-9 launch timelineMarch 15, 20	https://spa	https://spaceflightnow.com/2015
32	253	Space Fligh		[]	March 21, 2015	Arianespace to launch satellites for Earth ima	https://spa	https://spaceflightnow.com/2015
33	337	Space Fligh		[]	March 22, 2015	Preview: 10 months, 4 launches to finish GPS	https://spa	https://spaceflightnow.com/2015
34	577	Space Fligh		[]	March 24, 2015	Photos: Soyuz rocket transferred to jungle la	https://spa	https://spaceflightnow.com/2015
35	576	Space Fligh		[]	March 25, 2015	Recap story: New bird flies for GPS navigatior	https://spa	https://spaceflightnow.com/2015
36	336	Space Fligh		[]	March 27, 2015	Managers confident ahead of critical launch t	https://spa	https://spaceflightnow.com/2015
37	252	Space Fligh		[]	March 28, 2015	Two new satellites join Europe's fledgling nav	https://spa	https://spaceflightnow.com/2015
38	335	Space Fligh		[]	March 29, 2015	Indian navigation system gets expansion with	https://spa	https://spaceflightnow.com/2015
39	273	Space Fligh		[]	March 30, 2015	Chinese navigation system enters new phase	https://spa	https://spaceflightnow.com/2015

Timeline

January 22

Introduction

- Start of the Semester
- Handover changes

February 22

Project intro

- Handover project
- Kick-off meeting
- Brainstorming
- Tasks Division
- Meeting with Dr. Davidian
- Data inspection
- Literature Review

March 22

Database & Visualization

- Data cleaning
- Querying the data
- Classification
- First testing graphs
- Visualization perspectives
- Crossing database results with industry

April 22

Visualization & Storytelling,

- Visualization ideas
- Starting Storytelling
- Scratch graphs
- Status Presentation
- Scoping Future Research Opportunities

Approach

- Gather and Inspect the Data
- Clean the Data
- Querying the Data
- Classification
- Industry Emergence Characteristics
- Visualization Opportunities
- Visual Storytelling

Q1:

How might we use science, design and visual communication to **facilitate** an **intuitive** overview changes, and an opportunity for early **detection of industry emergence** by 'listening to' the articles' content?

Q2:

How can we apply **new technology** to determine which **characteristics** could be worth tracking as the indication of change or emerging market disruption?

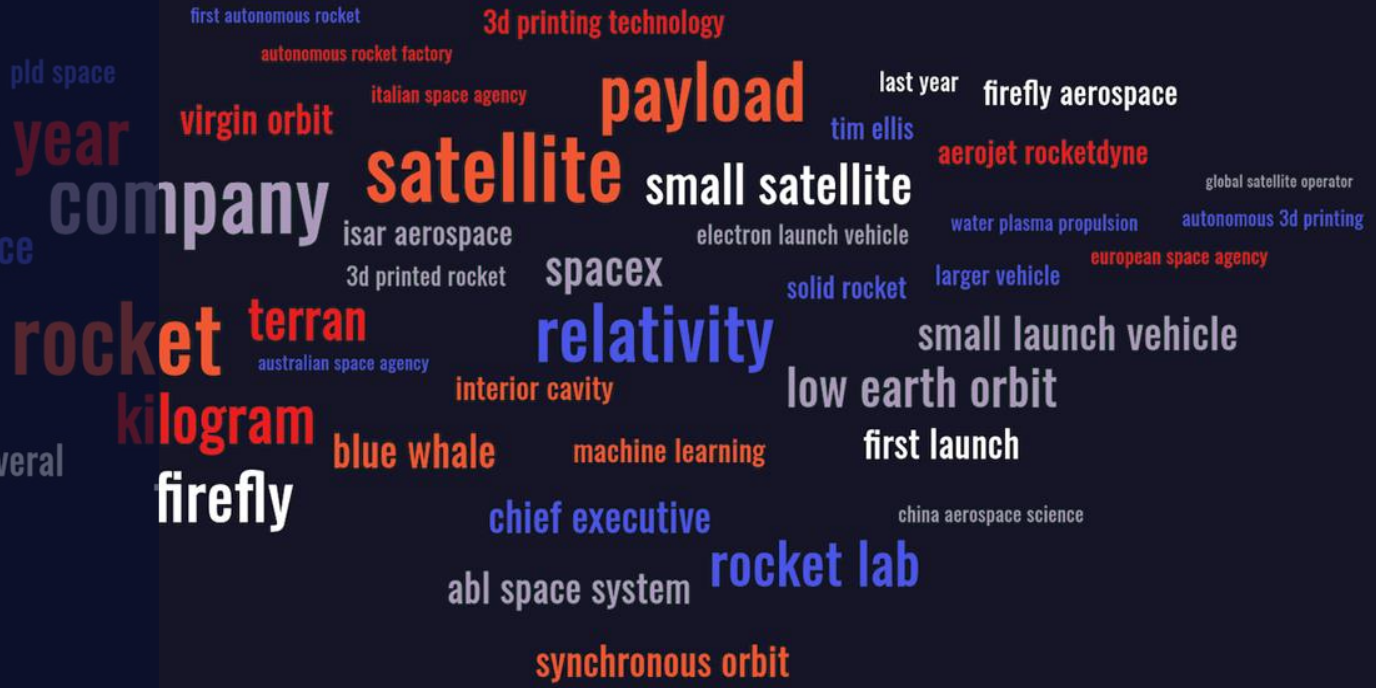


Image: Own Database

Q3:

How can we **correlate** findings from our own **Database** to current reports provided by the **industry**?

Data

Data - SLV - updates

Event ID	Company Name	Launch Vehicle	Headlines	Month	Year	Author
1	NASA		House subcommittee advances NASA authorization bill	1	2020	Jeff Foust
2	Space Force		U.S. Space Force has lifted off, now the journey begins	1	2020	Sandra Erwin
3	Firefly	Alpha	Firefly suffers anomaly during launch vehicle test	1	2020	Jeff Foust
4	SpaceX	Crew Dragon	SpaceX performs in-flight abort test of Crew Dragon spacecraft	1	2020	Jeff Foust
5	SpinLaunch	Large Mass Accelerator	SpinLaunch raises $35 million	1	2020	Jeff Foust
6	Arianespace	Ariane 5	Arianespace launches Eutelsat, ISRO satellites on first 2020 mission	1	2020	Caleb Henry
7	The Government of Luxembourg		Luxembourg establishes space industry venture fund	1	2020	Jeff Foust
8	The Commerce Department		Commerce Department seeks big funding boost for Office of Space Commerce	2	2020	Jeff Foust
9	Rocket Lab		Rocket Lab wins contract to launch NASA lunar cubesat mission	2	2020	Jeff Foust
10	Astra	One of Three	Astra emphasizes rapid iteration in its quest for low-cost, rapid launch	2	2020	Jeff Foust
11	Virgin Galactic	SpaceShipTwo	Virgin Galactic's SpaceShipTwo arrives in New Mexico	2	2020	Jeff Foust
12	Blue Origin		Blue Origin opens rocket engine factory	2	2020	Jeff Foust
13	SpaceX		SpaceX launches fifth batch of Starlink satellites, misses booster landing	2	2020	Caleb Henry
14	DARPA		DARPA makes last-minute change to launch competition rules	2	2020	Jeff Foust
15	Space Adventure	Crew Dragon	Space Adventures to fly tourists on Crew Dragon mission	2	2020	Jeff Foust
16	the National Space Council		National Space Council expands membership	2	2020	Jeff Foust
17	NASA		NASA to allow researchers to fly on commercial suborbital vehicles	1	2020	Jeff Foust
18	Expace Technology Co	Kuaizhou-1A	China launches Yinhe-1 commercial low Earth orbit 5G satellite	1	2020	Andrew Jones
19	TriSept	Orbex Prime	TriSept buys Orbex Prime rocket for rideshare flight	1	2020	Debra Werner
20	Orbex	Orbex Prime	Orbex stakes claim to European smallsat launch market	7	2018	Jeff Foust
21	Virgin Galactic	SpaceShipTwo	Virgin Galactic continues work on fleet of SpaceShipTwo vehicles	12	2020	Jeff Foust
22	EU		EU to invest 200 million euros into space industry	1	2020	Jeff Foust
23	Slingshot Aerospace		Slingshot Aerospace gets $3 million from Air Force, private investors for data analytics technolo	3	2020	Sandra Erwin
24	U.S Government		Senate approves coronavirus relief bill with $10.5 billion for Defense Department	3	2020	Sandra Erwin
25	Northern Sky Research		POWERING SATCOM THROUGH DISTRESSED FINANCIAL MARKETS	3	2020	Gagan Agrawal
26	ITU		ITU Secretary-General Houlin Zhao's statement on the launch of a global platform to help prote	3	2020	ITU
27	Telstra	TnSS	Telstra touts new satellite to select channel partners	3	2020	Lilia Guan
28	Globalstar		GLOBALSTAR ANNOUNCES 3GPP APPROVAL OF BAND 53 AS A 5G BAND	3	2020	Globalstar
29	Venezuela		Venezuela's flagship communications satellite out of service and tumbling	3	2020	Caleb Henry
30	Rocket Lab	Electron	Rocket Lab kicks off busy year with NRO launch	1	2020	Jeff Foust
31	Dawn Aerospace	Mark 1	Satellite propulsion startup Dawn Aerospace developing small launch vehicle	1	2020	Caleb Henry
32	Astra	Rocket 3.0	Astra unveils plans for frequent, low-cost launches	7	2020	Jeff Foust
33	Rocket Lab	Photon	Rocket Lab turns attention to satellite efforts	5	2020	Jeff Foust

Market Intelligence

Satellite Applications Catapult was chosen as one of the main resources related to Small Satellite Market Intelligence.

CATAPULT Satellite Applications

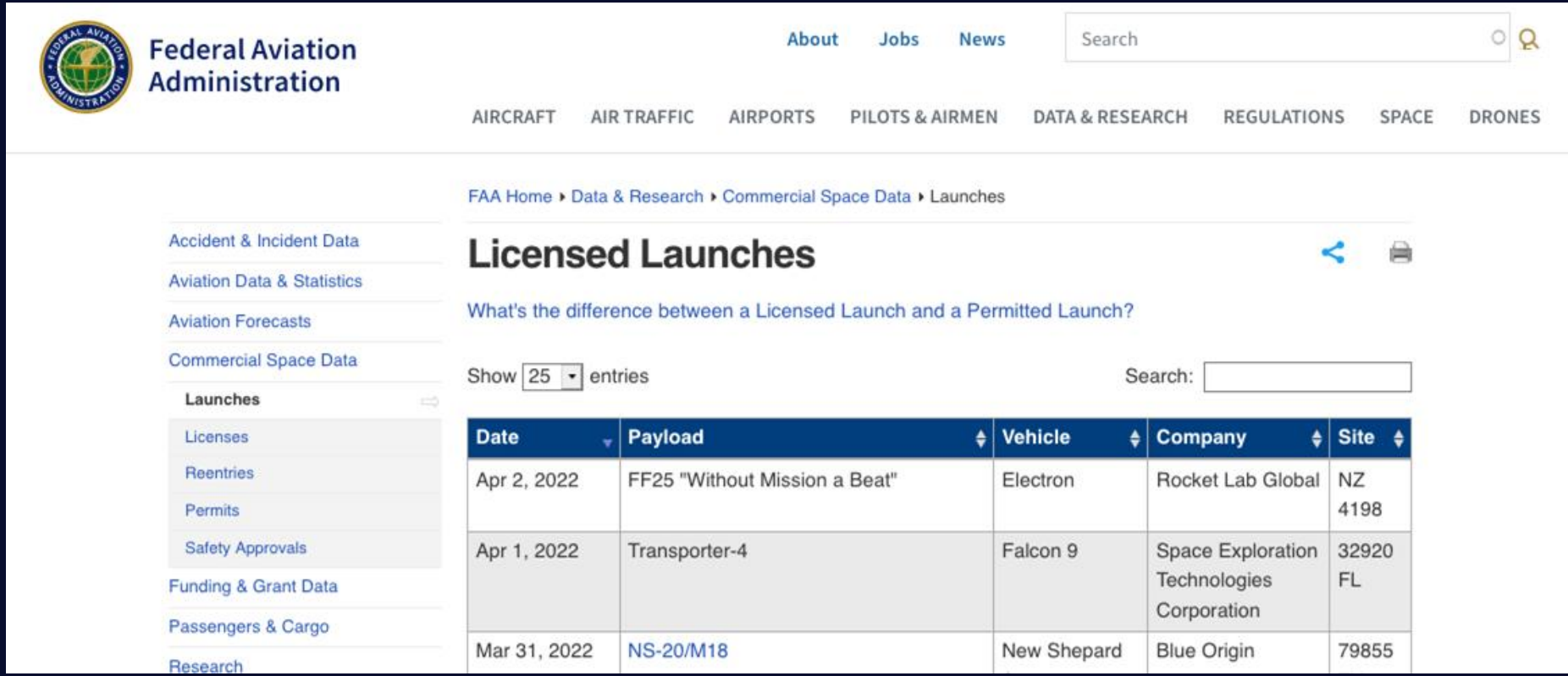
https://sa.catapult.org.uk/

Space Companies Acquired by SPACs

Company	Announced	Offering	SPAC	Ticker Symbol	Valuation*	Merger Closed?
Virgin Galactic	2019	Space tourism	Social Capital Hedosophia	SPCE	$1.4 billion	Yes
Momentus	2020	In-space transportation and infrastructure	Stable Road Capital	MNTS	$1.2 billion	No
AST SpaceMobile	2020	Space-based cellular broadband	New Providence	ASTS	$1.8 billion	Yes
Astra	2021	Launch services	Holicity	ASTR	$2.1 billion	No
Rocket Lab	2021	Launch services	Vector Acquisition Corporation	RKLB	$4.1 billion	No
BlackSky	2021	Satellite imagery as a service	Osprey Technology	BKSY	$1.5 billion	No
Spire	2021	Space-to-cloud data and analytics	NavSight	SPIR	$1.2 billion	No
Redwire	2021	Space infrastructure technology	Genesis Park Acquisition Corp	GNPK	$170 million	No

Launch resources

https://www.faa.gov/data_research/commercial_space_data/launches/?type=Licensed



Federal Aviation Administration

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- Aviation Data & Statistics
- Aviation Forecasts
- Commercial Space Data
  - Launches
  - Licenses
  - Reentries
  - Permits
  - Safety Approvals
- Funding & Grant Data
- Passengers & Cargo
- Research

Licensed Launches

What's the difference between a Licensed Launch and a Permitted Launch?

Show 25 entries Search:

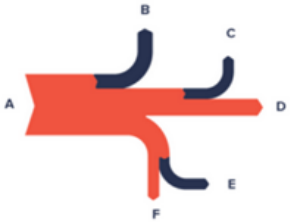
Date	Payload	Vehicle	Company	Site
Apr 2, 2022	FF25 "Without Mission a Beat"	Electron	Rocket Lab Global	NZ 4198
Apr 1, 2022	Transporter-4	Falcon 9	Space Exploration Technologies Corporation	32920 FL
Mar 31, 2022	NS-20/M18	New Shepard	Blue Origin	79855

Visualization Library

https://datavizproject.com/

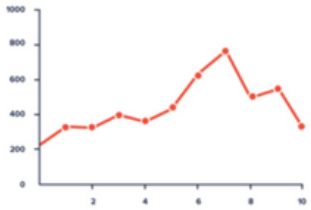
Alluvial Diagram

Sankey Diagram

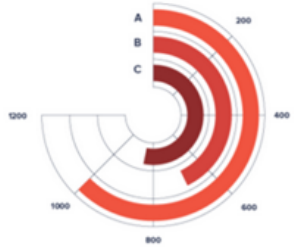


Donut Chart

Line Graph



Radial Bar Chart

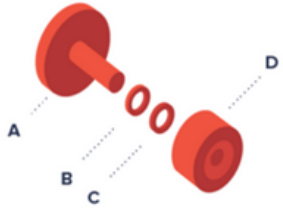


Polar Area Chart

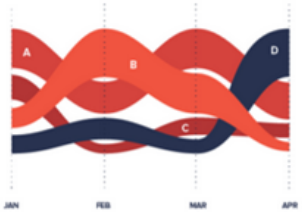
Pictorial Fraction Chart

Radial Histogram

Exploded View Drawing



Sorted Stream Graph



Bar Chart (Vertical)

Sunburst Diagram

Flow Map

Treemap

Stacked Bar Chart

Literature & Studies

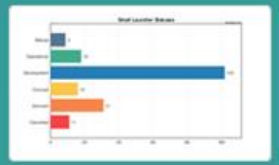
https://www.newspace.im/launchers

CONSTELLATIONS | SMALL LAUNCHERS | SPACE FUNDING

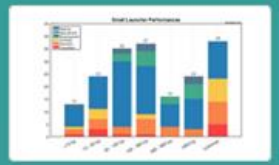
Small Satellite Launchers

Aiming to gather all small launchers (microlaunchers) with up to 1500 kg performance to SSO. Active, planned and cancelled initiatives included.

Erik Kulu. **"Small Launchers: 2021 Industry Survey and Market Analysis."** 72nd International Astronautical Congress (IAC 2021). Oct 29, 2021.
Erik Kulu. **"Satellite Constellations - 2021 Industry Survey and Trends."** 35th Annual Small Satellite Conference. Aug 10, 2021.

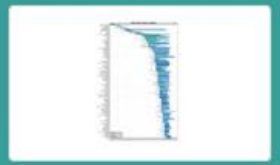


Statuses
large | pdf | svg

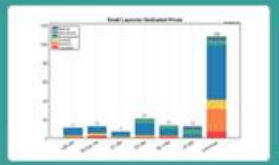


Performances
large | pdf | svg

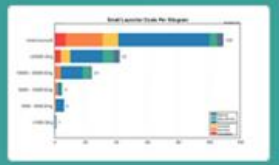
Founded
large | pdf | svg



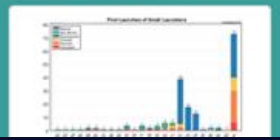
Timelines
large | pdf | svg

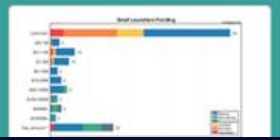


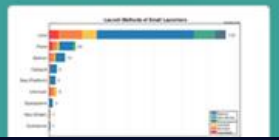
Prices
large | pdf | svg



Prices per Kg
large | pdf | svg







SLVs

187 launchers in this table.

Organization	Launcher	Founded	Status	First Launch	Launches	Cost	Performance	Price per kg	Funding	Logo	Photo
Northrop Grumman	Pegasus (XL)	1994	Operational	1990	45	$56M	443 kg	126410 $/kg	Yes		
MITT	Start-1	1991	Operational	1993	7	-	167 kg	-	Yes		
Northrop Grumman	Minotaur C (Taurus-XL)	1989	Operational	1994	12	$50M	1054 kg	47440 $/kg	Yes		
Lockheed Martin	Athena-1	1993	Retired	1995	4	$17M	794 kg	21410 $/kg	Yes		
Makeyev OKB	Shtil	1947	Retired	1998	2	-	160 kg	-	Yes		
Lockheed Martin	Athena-2	1993	Retired	1998	3	$65M	1165 kg	55790 $/kg	Yes		
Northrop Grumman	Minotaur I	1997	Operational	2000	12	-	331 kg	-	Yes		
CASC	Kaituozhe-1 (KT-1)	1998	Retired	2002	2	-	100 kg	-	Yes		
SpaceX	Falcon 1 / Falcon 1e	2002	Retired	2006	5	$11M	1000 kg	11000 $/kg	$1B+		
KARI	Naro (KSLV-1)	2002	Retired	2009	3	-	100 kg	-	$490M		
AJRD	SPARK / Super Strypi	1942	Retired	2015	1	$15M	300 kg	50000 $/kg	Yes		
CALT	Long March 11 (CZ-11, SD-2)	2008	Operational	2015	11	-	350 kg	-	Yes		
CASC	Long March 6	2009	Operational	2015	7	-	1080 kg	-	Yes		
JAXA	SS-520-4	2003	Retired?	2017	2	$3.5M	4 kg	875000 $/kg	Yes		
ExPace / CASIC	Kuaizhou-1A (Fei Tian 1)	2016	Operational	2017	14	$6M	300 kg	20000 $/kg	Yes		

Types of Innovation

PROFIT MODEL
The way in which you make money

*For example, how **Netflix** turned the video rental industry on its head by implementing a subscription model*

STRUCTURE
Alignment of your talent and assets

*For example, how **Whole Foods** has built a robust feedback system for internal teams*

PRODUCT PERFORMANCE
Distinguishing features and functionality

*For example, how **OXO Good Grips** cost a premium but its "universal design" has a loyal following*

SERVICE
Support and enhancements that surround your offerings

*For example, how "Deliver WOW through service" is **Zappos'** #1 internal core value*

BRAND
Representation of your offerings and business

*For example, how **Virgin** extends its brand into sectors ranging from soft drinks to space travel*

NETWORK
Connections with others to create value

*For example, how **Target** works with renowned external designers to differentiate itself*

PROCESS
Signature or superior methods for doing your work

*For example, how **Zara's** "fast fashion" strategy moves its clothing from sketch to shelf in record time*

PRODUCT SYSTEM
Complementary products and services

*For example, how **Nike+** parlayed shoes, sensors, apps and devices into a sport lifestyle suite*

CHANNEL
How your offerings are delivered to customers and users

*For example, how **Nespresso** locks in customers with its useful members only club*

CUSTOMER ENGAGEMENT
Distinctive interactions you foster

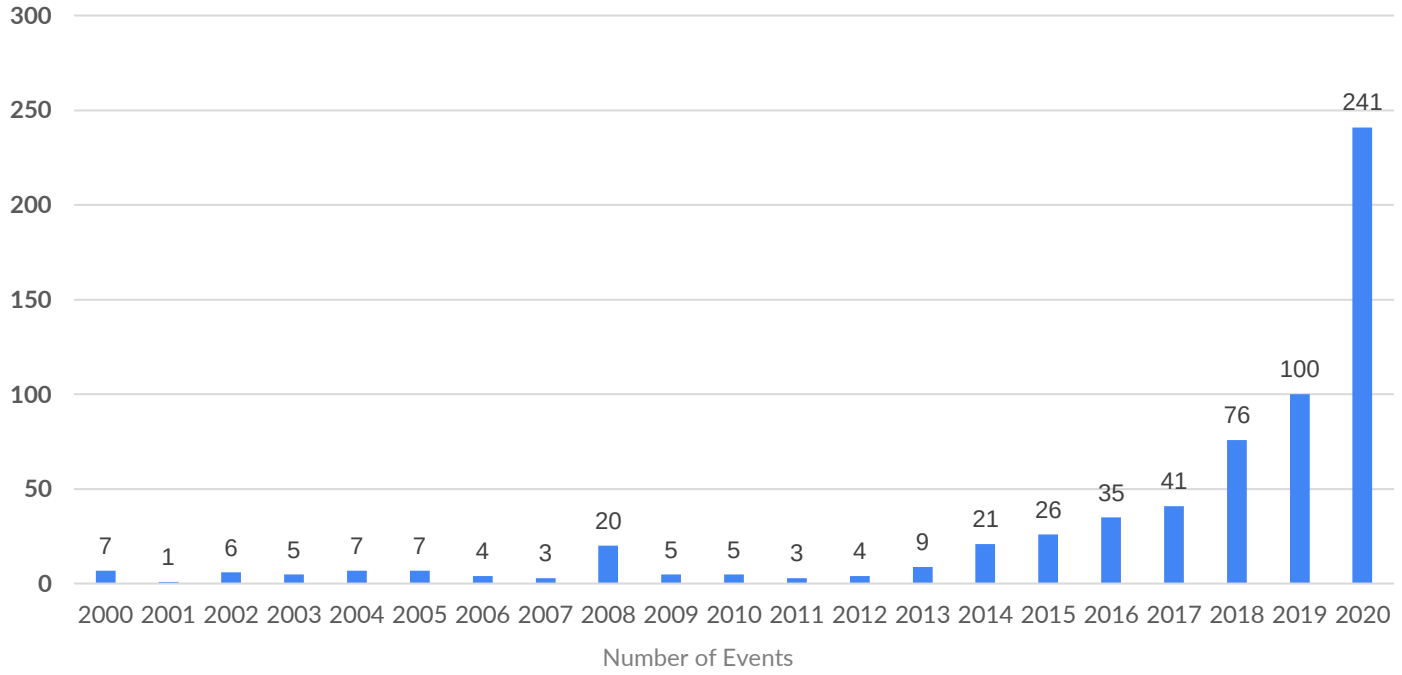
*For example, how **Wii's** experience draws more from the interactions in the room than on-screen*

Source: https://doblin.com/ten-types

Preliminary Findings

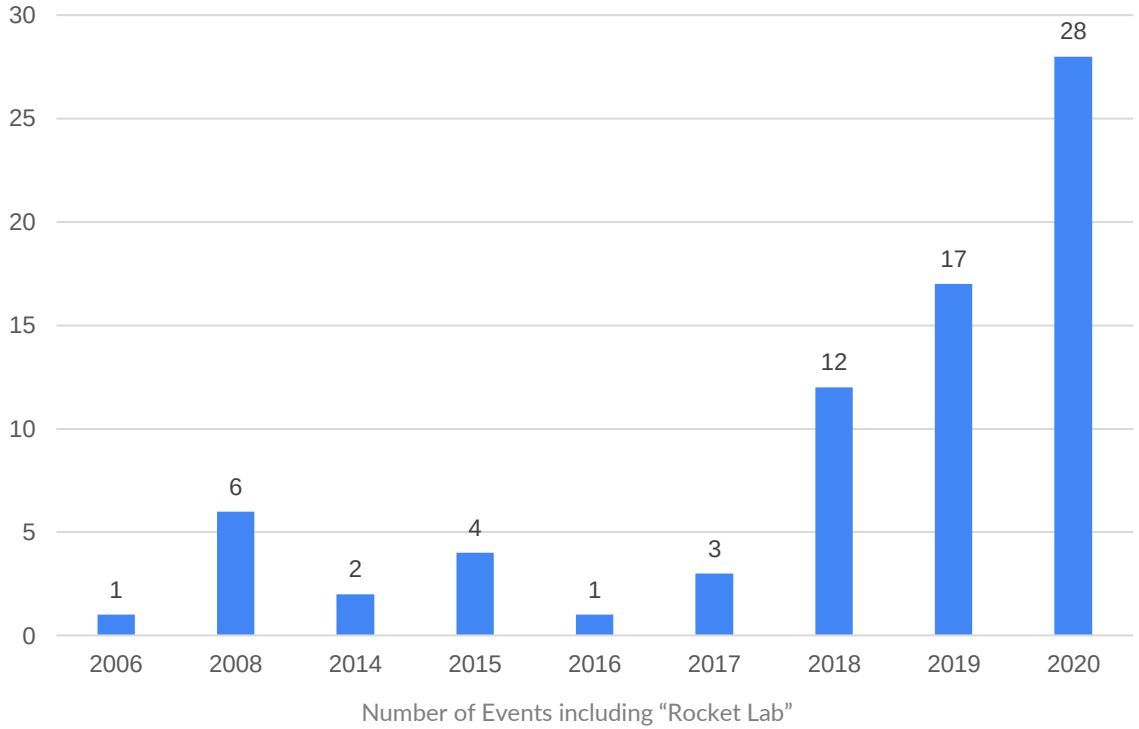
Image Source: NASA

Database – Events vs Time



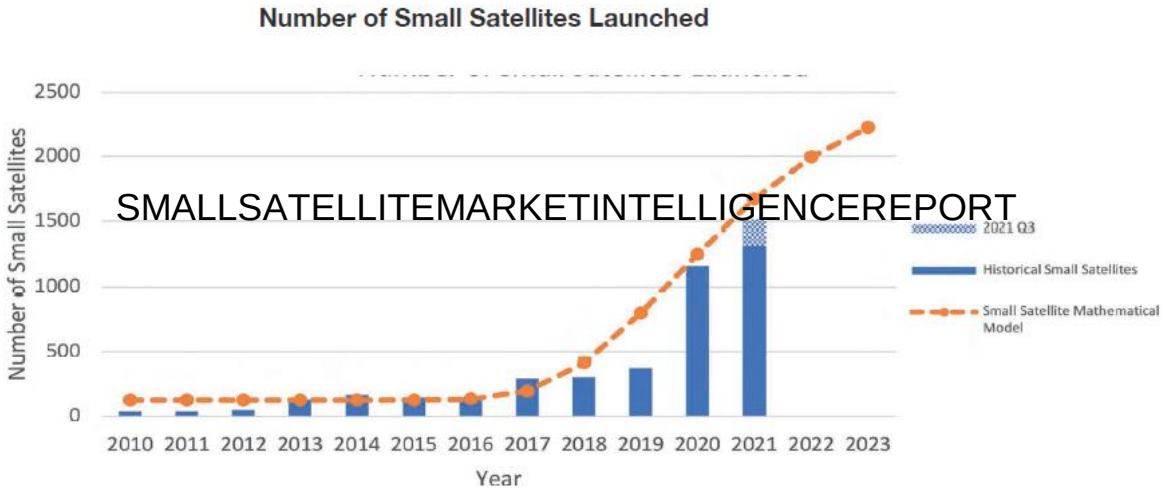
Source: Own Database

Rocket Lab – Events vs Time



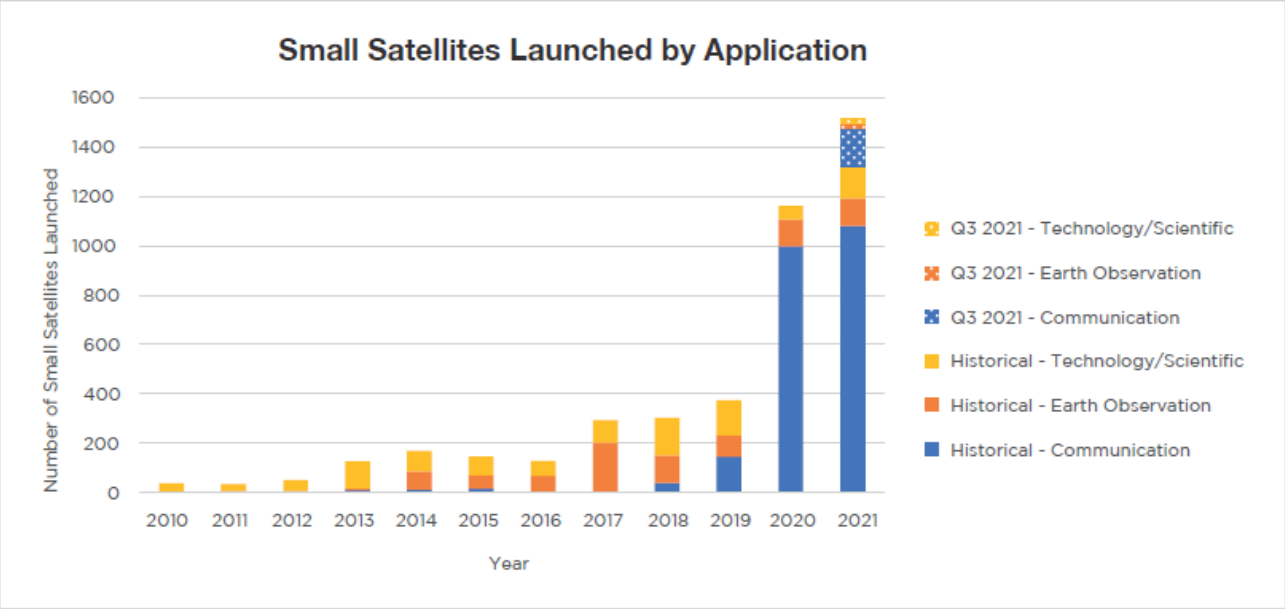
Source: Own Database

Number os Small Satellites Launched



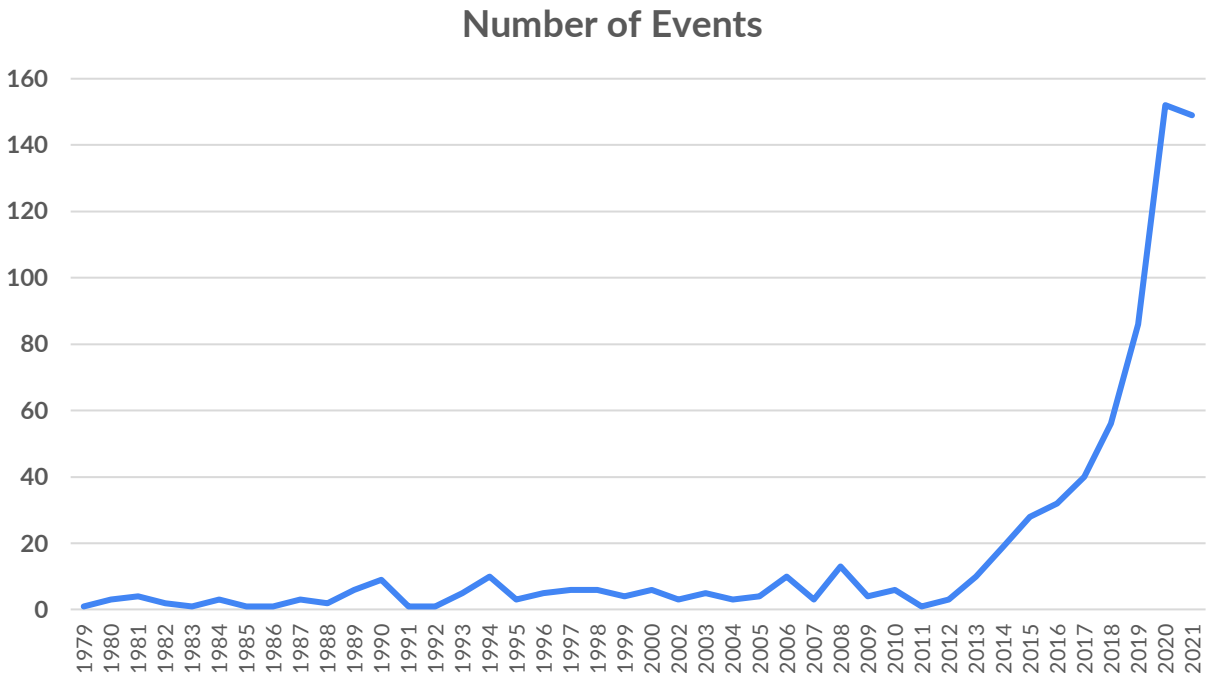
Source: Small Satellite Market Intelligence Report – Q3 2021 / Catapult Satellite Application

Small Sattellites by Application



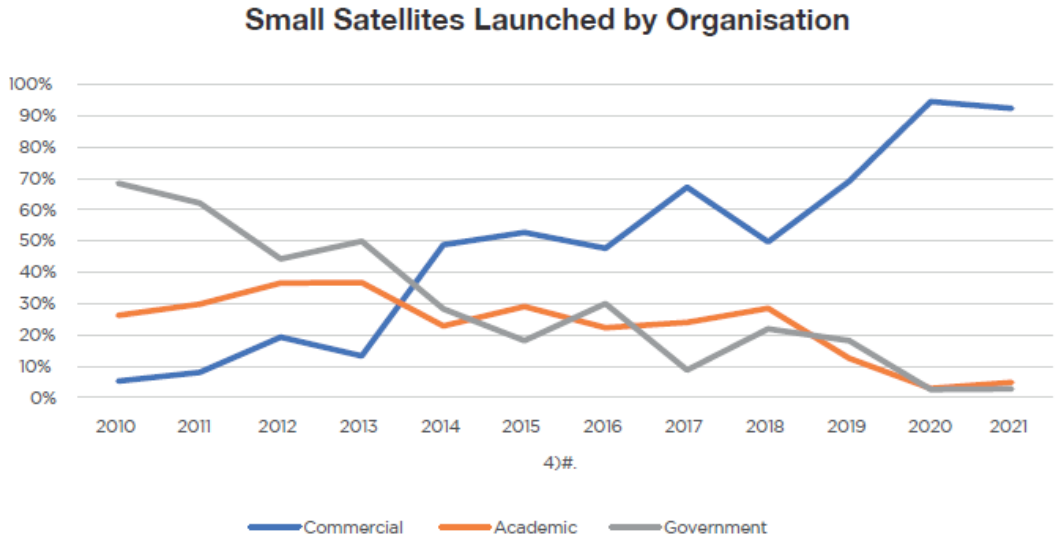
Source: Small Satellite Market Intelligence Report – Q3 2021 / Catapult Satellite Application

Events - counting



Source: Own Database

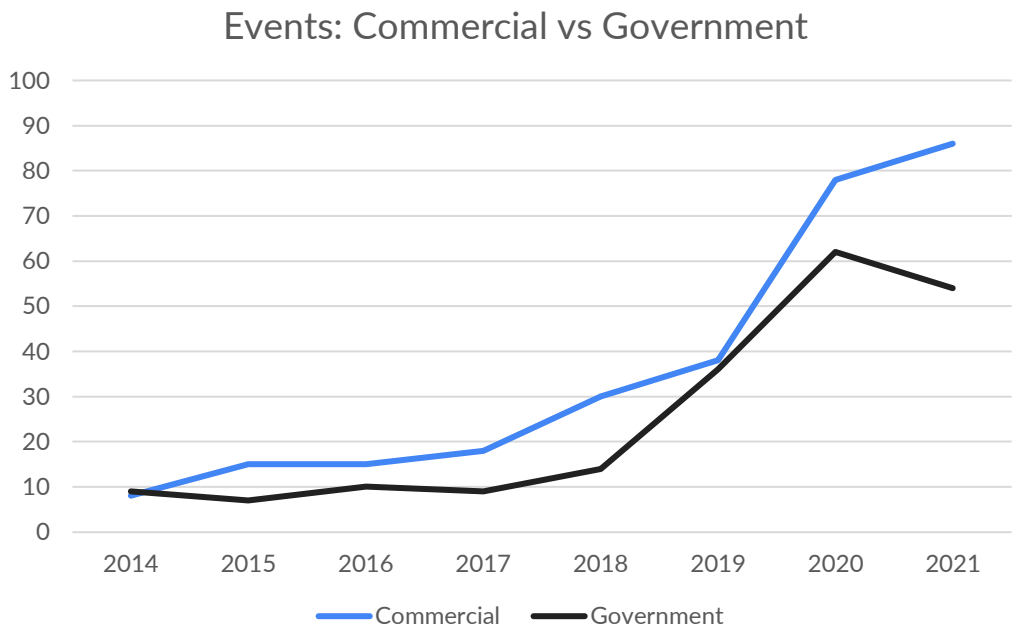
Percentage Share



Source: Small Satellite Market Intelligence Report – Q3 2021 / Catapult Satellite Application

Preliminary Results

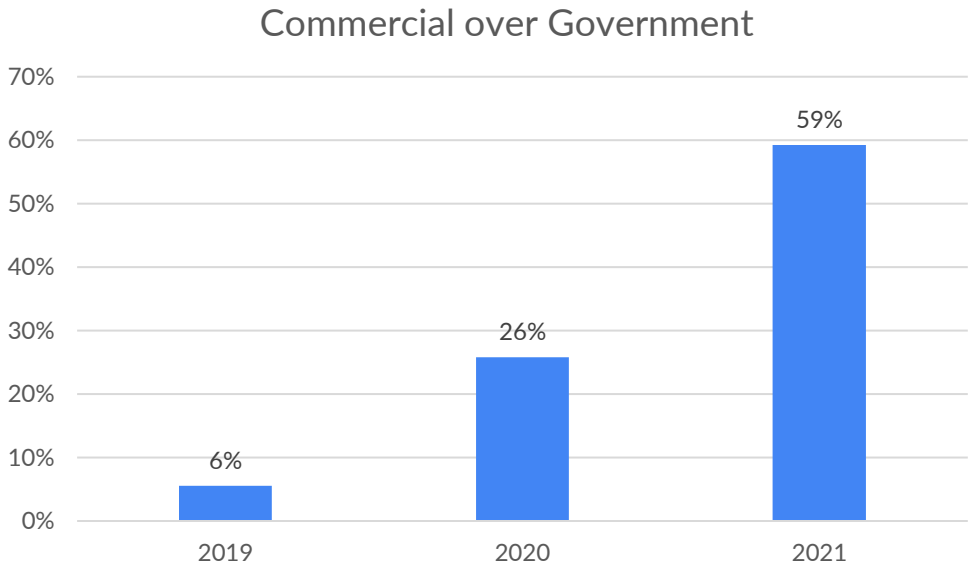
In our data base, we used the search of “Commercial” and “Government” words, the following chart shows the quantitative results for this search.



Source: Own Database

Preliminary Results

In our data base, we used the search of “Commercial” and “Government” words, the following chart shows how much more “Commercial” appears over the presence of “Government”.



Source: Own Database

Constellations Data

July 28, 2014	Space surveillance craft launched by Delta 4	https://spa htt
October 8, 2014	Galileo launch failure blamed on frozen Frega	https://spa htt
October 12, 2014	Winds sensor opens door for Earth science fr	https://spa htt
October 13, 2014	GPS modernization continues with quick pac	https://spa htt
October 14, 2014	Indian navigation satellite ready for launchO	https://spa htt
October 15, 2014	Indian navigation satellite launched by PSLV	https://spa htt
October 25, 2014	Atlas 5 to fly Wednesday, continuing rapid d	https://spa htt
October 27, 2014	Atlas 5/GPS 2F-8 launch timelineOctober 27,	https://spa htt
October 27, 2014	China launches third space mission in a week	https://spa htt
October 28, 2014	Atlas 5 rocket rolled to Cape Canaveral launc	https://spa htt
October 29, 2014	50th Atlas 5 rocket puts up new GPS satellite	https://spa htt
November 7, 2014	U.S. Navy communications satellite shipped	https://spa htt
December 1, 2014	Soyuz rocket deploys upgraded Russian navig	https://spa htt
December 16, 2014	ULA year in reviewDecember 16, 2014Justin	https://spa htt
December 18, 2014	Newest GPS satellite goes activeDecember 18	https://spa htt
December 19, 2014	Third quartet of satellites launched for O3b N	https://spa htt
December 19, 2014	13 launches on manifest for ULA in 2015Dec	https://spa htt
December 29, 2014	O3b Networks plans satellite fleet expansionI	https://spa htt
January 7, 2015	Navy satellite to be hoisted atop rocket for Ja	https://spa htt
January 17, 2015	Preview: Navy craft to ride milestone Atlas-C	https://spa htt
January 21, 2015	Recap story: 200th Atlas-Centaur launching	https://spa htt
January 22, 2015	Did two more Iridium satellites collide with	https://spa htt
February 6, 2015	Galileo satellite deployment campaign to res	https://spa htt
February 6, 2015	New Navy satellite spreads wings, unfurls ant	https://spa htt
February 27, 2015	Four satellites mated to Atlas 5 rocketFebrua	https://spa htt
March 4, 2015	Power system failure likely cause of military s	https://spa htt
March 4, 2015	Liftoff of Indian navigation satellite postpone	https://spa htt
March 8, 2015	Preview: Atlas 5 rocket to launch NASA magn	https://spa htt
March 11, 2015	Atlas 5 rolled to the pad for Thursday night's	https://spa htt
March 15, 2015	Delta/GPS 2F-9 launch timelineMarch 15, 20	https://spa htt
March 21, 2015	Arianespace to launch satellites for Earth ima	https://spa htt
March 22, 2015	Preview: 10 months, 4 launches to finish GPS	https://spa htt
March 24, 2015	Photos: Soyuz rocket transferred to jungle la	https://spa htt
March 25, 2015	Recap story: New bird flies for GPS navigatior	https://spa htt
March 27, 2015	Managers confident ahead of critical launch f	https://spa htt
March 28, 2015	Two new satellites join Europe's fledgling nav	https://spa htt
March 29, 2015	Indian navigation system gets expansion with	https://spa htt
March 30, 2015	Chinese navigation system enters new phase	https://spa htt

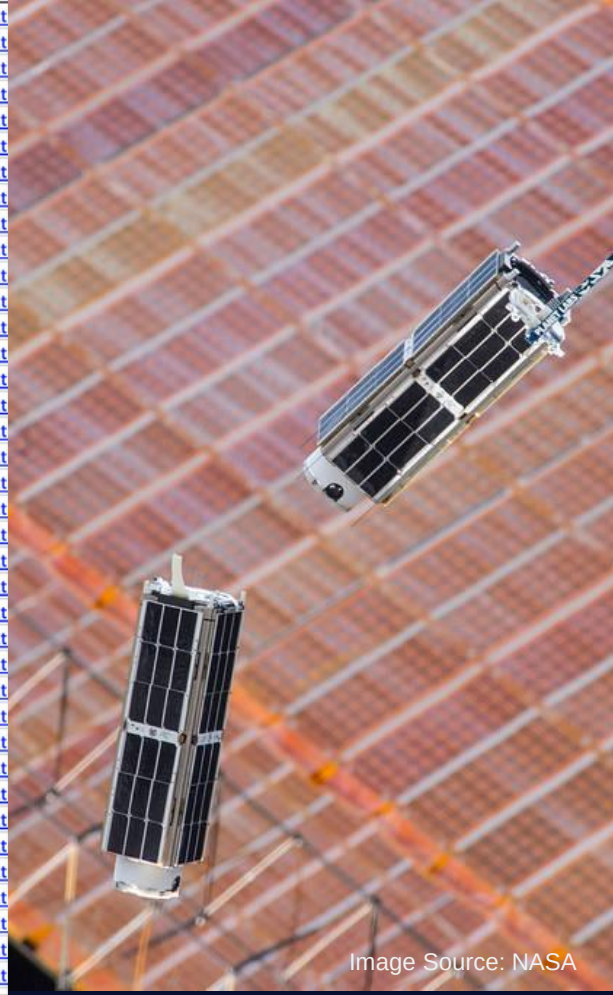


Image Source: NASA

Keyword Search - Constellations

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		Autho	Compa	Orbit	Date	articles post	Links	References	Year	failure	success	launch	invest	acqui	demand	profit	revenue	innovat
2	588	Space Fligh		[]	July 28, 2014	Space surveillance craft launched by Delta 4	https://spa	https://spaceflightnow.com/2014/07/	2014	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
3	586	Space Fligh		[]	October 8, 2014	Galileo launch failure blamed on frozen Frega	https://spa	https://spaceflightnow.com/2014/10/	2014	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
4	585	Space Fligh		[]	October 12, 2014	Winds sensor opens door for Earth science fr	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
5	584	Space Fligh		[]	October 13, 2014	GPS modernization continues with quick pac	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
6	269	Space Fligh		[]	October 14, 2014	Indian navigation satellite ready for launchO	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
7	268	Space Fligh		[]	October 15, 2014	Indian navigation satellite launched by PSLV	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
8	267	Space Fligh		[]	October 25, 2014	Atlas 5 to fly Wednesday, continuing rapid de	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
9	341	Space Fligh		[]	October 27, 2014	Atlas 5/GPS 2F-8 launch timelineOctober 27,	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
10	583	Space Fligh		[]	October 27, 2014	China launches third space mission in a week	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
11	582	Space Fligh		[]	October 28, 2014	Atlas 5 rocket rolled to Cape Canaveral launc	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
12	266	Space Fligh		[]	October 29, 2014	50th Atlas 5 rocket puts up new GPS satellite	https://spa	https://spaceflightnow.com/2014/10/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
13	265	Space Fligh		[]	November 7, 2014	U.S. Navy communications satellite shipped	https://spa	https://spaceflightnow.com/2014/11/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
14	581	Space Fligh		[]	December 1, 2014	Soyuz rocket deploys upgraded Russian navig	https://spa	https://spaceflightnow.com/2014/12/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
15	340	Space Fligh		[]	December 16, 2014	ULA year in reviewDecember 16, 2014Justin	https://spa	https://spaceflightnow.com/2014/12/	2014	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
16	264	Space Fligh		[]	December 18, 2014	Newest GPS satellite goes activeDecember 18	https://spa	https://spaceflightnow.com/2014/12/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
17	263	Space Fligh		[]	December 19, 2014	Third quartet of satellites launched for O3b N	https://spa	https://spaceflightnow.com/2014/12/	2014	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE
18	580	Space Fligh		[]	December 19, 2014	13 launches on manifest for ULA in 2015Dec	https://spa	https://spaceflightnow.com/2014/12/	2014	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
19	262	Space Fligh		[]	December 29, 2014	O3b Networks plans satellite fleet expansionI	https://spa	https://spaceflightnow.com/2014/12/	2014	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
20	261	Space Fligh		[]	January 7, 2015	Navy satellite to be hoisted atop rocket for Ja	https://spa	https://spaceflightnow.com/2015/01/	2015	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
21	339	Space Fligh		[]	January 17, 2015	Preview: Navy craft to ride milestone Atlas-C	https://spa	https://spaceflightnow.com/2015/01/	2015	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
22	260	Space Fligh		[]	January 21, 2015	Recap story: 200th Atlas-Centaur launching	https://spa	https://spaceflightnow.com/2015/01/	2015	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
23	259	Space Fligh		[]	January 22, 2015	Did two more Iridium satellites collide with s	https://spa	https://spaceflightnow.com/2015/01/	2015	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
24	257	Space Fligh		[]	February 6, 2015	Galileo satellite deployment campaign to res	https://spa	https://spaceflightnow.com/2015/02/	2015	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
25	258	Space Fligh		[]	February 6, 2015	New Navy satellite spreads wings, unfurls ant	https://spa	https://spaceflightnow.com/2015/02/	2015	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
26	256	Space Fligh		[]	February 27, 2015	Four satellites mated to Atlas 5 rocketFebrua	https://spa	https://spaceflightnow.com/2015/02/	2015	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
27	254	Space Fligh		[]	March 4, 2015	Power system failure likely cause of military s	https://spa	https://spaceflightnow.com/2015/03/	2015	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
28	255	Space Fligh		[]	March 4, 2015	Liftoff of Indian navigation satellite postpone	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
29	579	Space Fligh		[]	March 8, 2015	Preview: Atlas 5 rocket to launch NASA magn	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
30	338	Space Fligh		[]	March 11, 2015	Atlas 5 rolled to the pad for Thursday night's	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
31	578	Space Fligh		[]	March 15, 2015	Delta/GPS 2F-9 launch timelineMarch 15, 20	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
32	253	Space Fligh		[]	March 21, 2015	Arianespace to launch satellites for Earth ima	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
33	337	Space Fligh		[]	March 22, 2015	Preview: 10 months, 4 launches to finish GPS	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
34	577	Space Fligh		[]	March 24, 2015	Photos: Soyuz rocket transferred to jungle la	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
35	576	Space Fligh		[]	March 25, 2015	Recap story: New bird flies for GPS navigatior	https://spa	https://spaceflightnow.com/2015/03/	2015	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
36	336	Space Fligh		[]	March 27, 2015	Managers confident ahead of critical launch f	https://spa	https://spaceflightnow.com/2015/03/	2015	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE

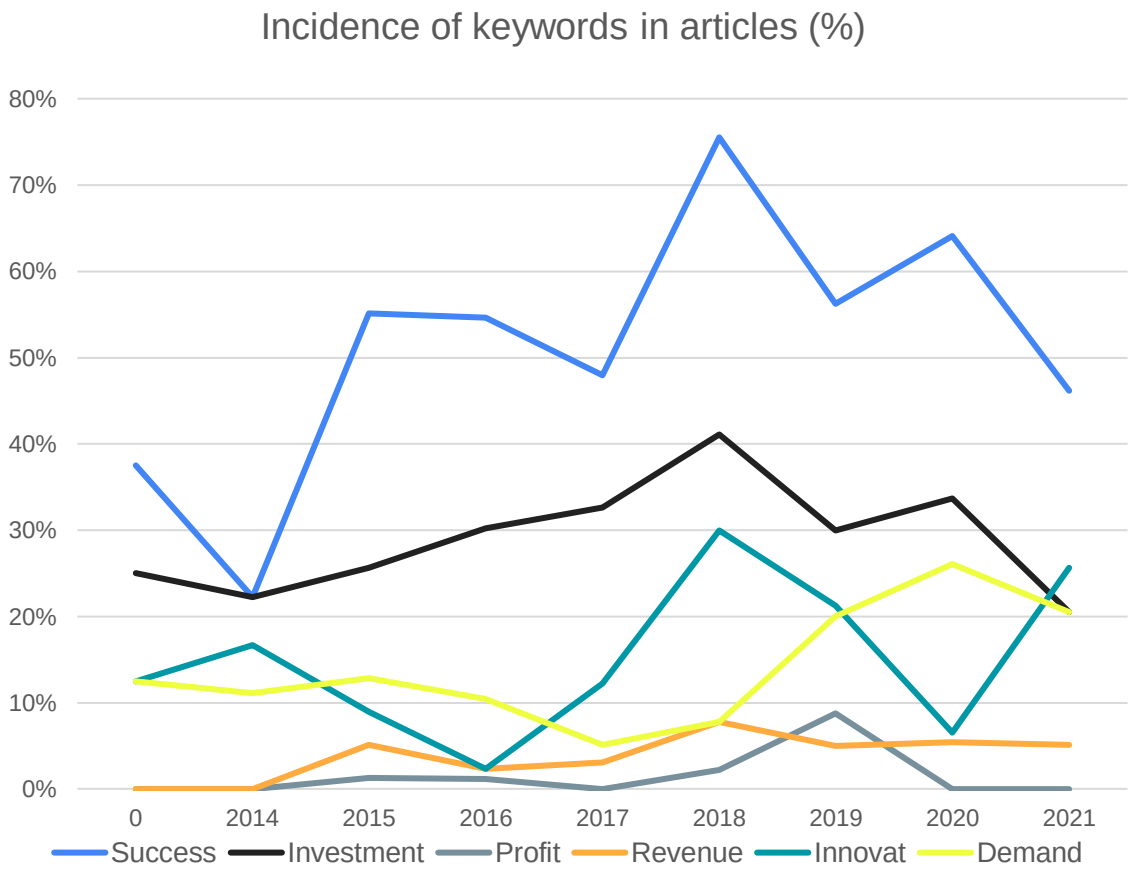
Keyword Search - Constellations

Success
Launch
Failure /fail/

Invest
Demand
Acquire /aqui/

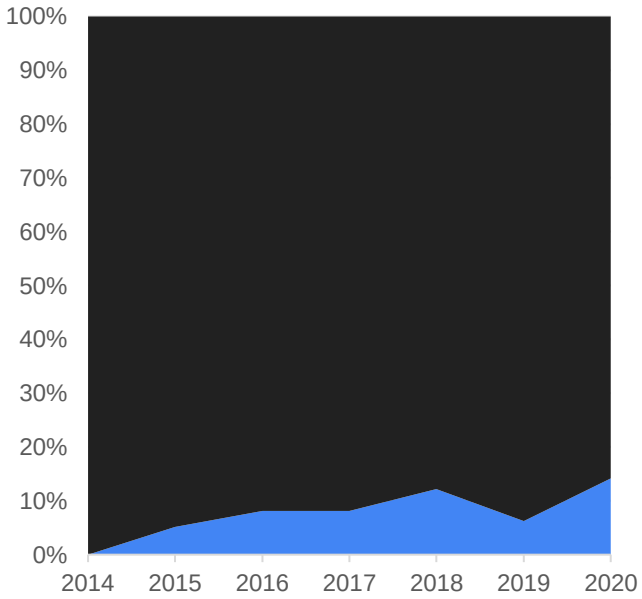
Profit
Revenue
Innovation /innovat/

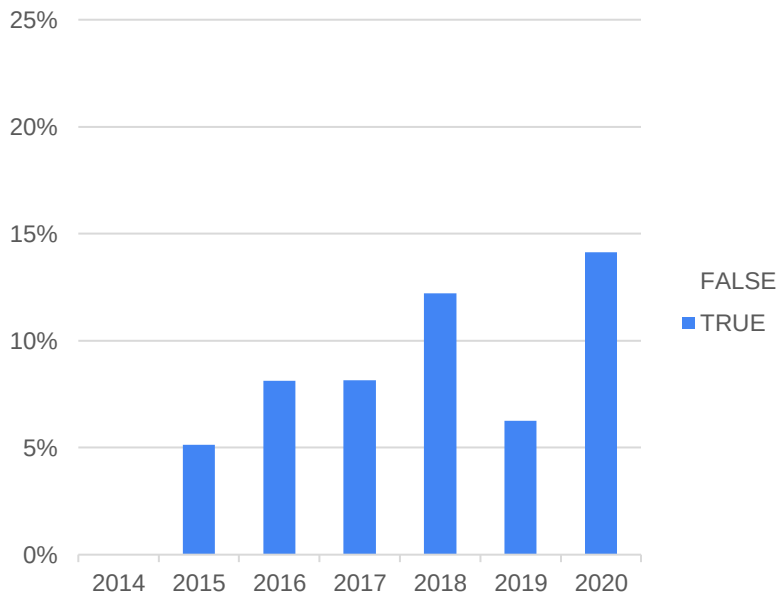
Incidence of Keywords



Source: Own Database

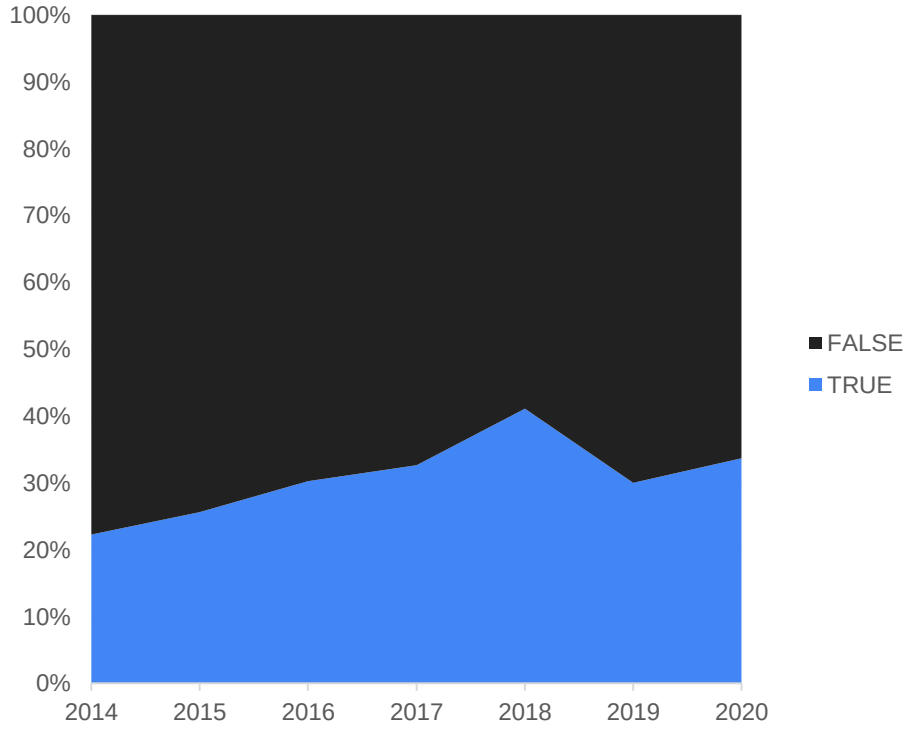
Acquisition





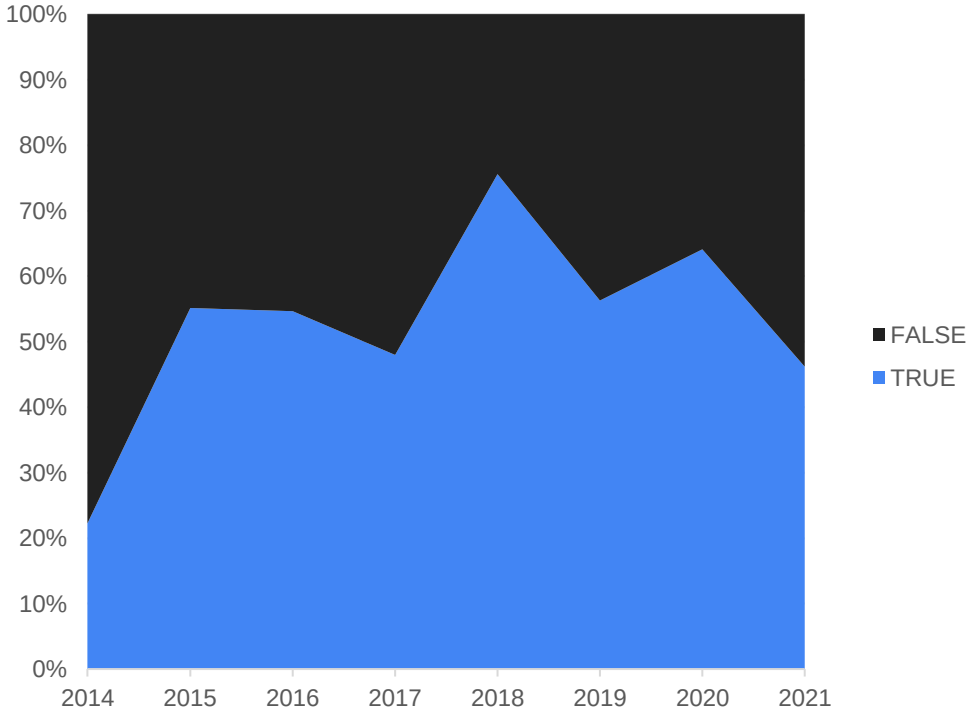
Source: Own Database

Invest



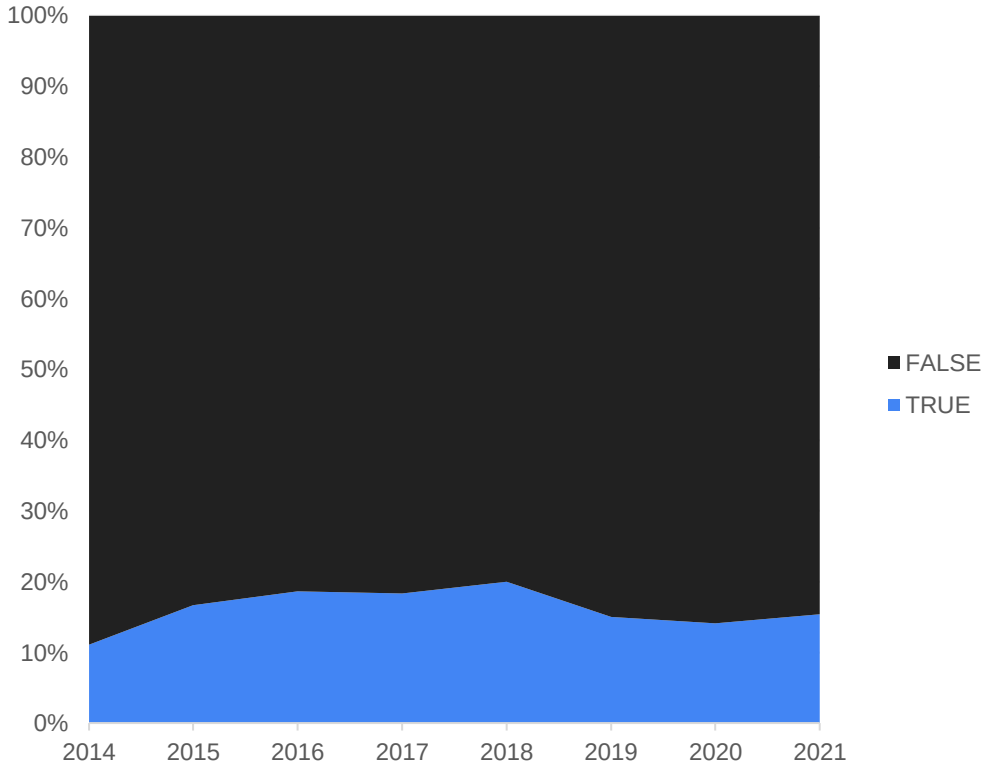
Source: Own Database

Success



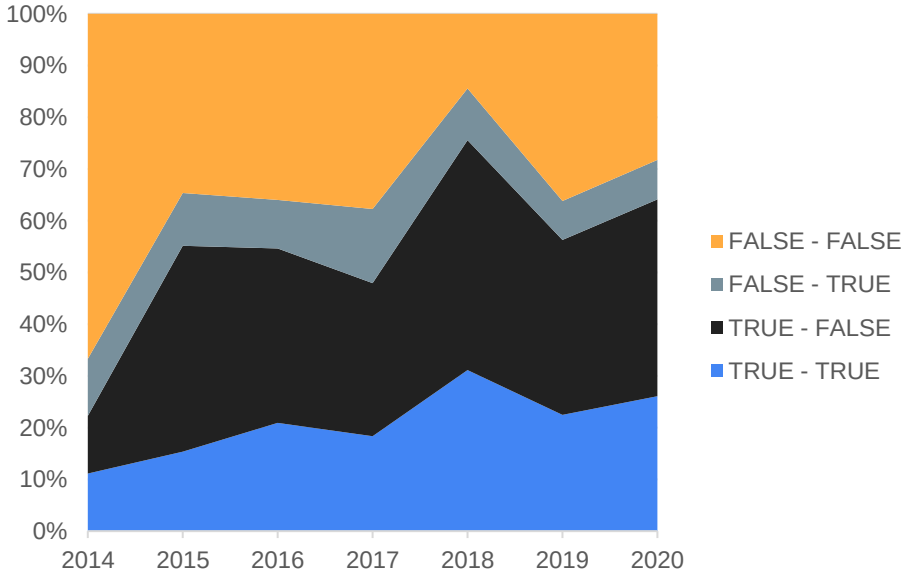
Source: Own Database

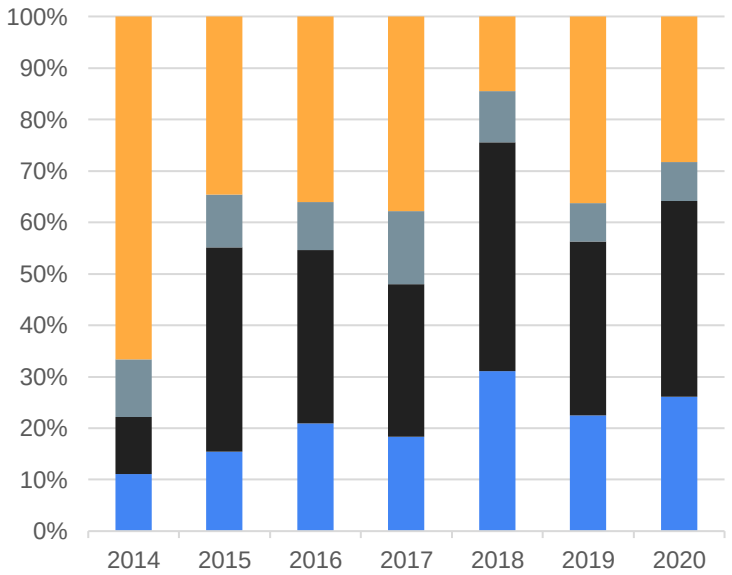
Failure



Source: Own Database

Invest & Success - simultaneous word occurrence





Source: Own Database

Launchers

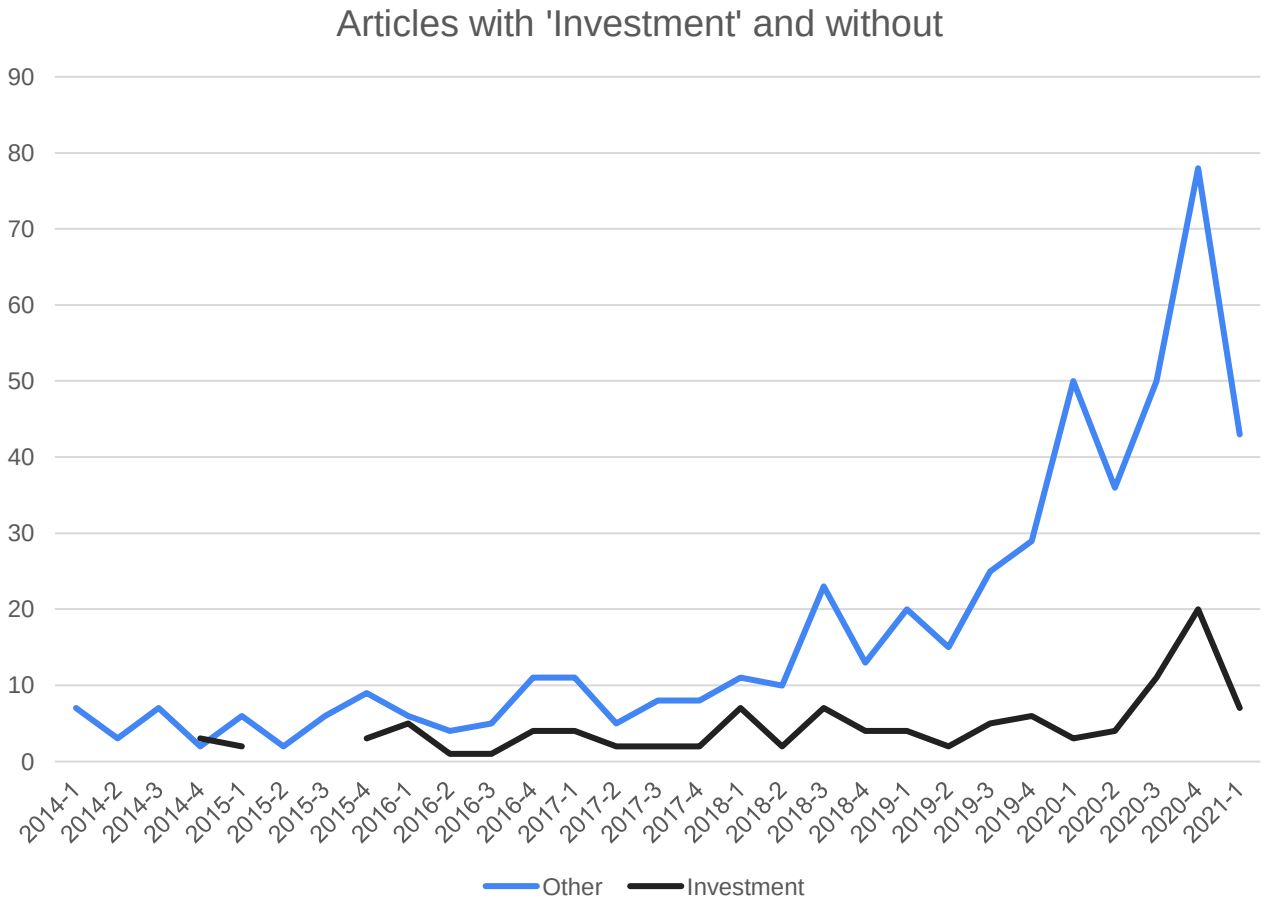
IIE	Headline	Outcomes	Category	Country	IOR	y	mo	quar	year-quar
2.2.8.Venture Ca	Astranis raises $90	Funding	Satellite	United States	FALSE	1900	1	1	1900-1
2.2.8.Venture Ca	One of the world's	Funding	Satellite	United States	FALSE	1900	1	1	1900-1
3.3.6.Non-Gover	Malaysian satellite to	Announcment of	Launch	Russia	FALSE	1900	1	1	1900-1
1.1.5.Industry Re	Australia updates	Creation Event	Launch	Australia	TRUE	2019	8	3	2019-3
1.1.5.Industry Re	Australia to establish	Creation Event	Government	Australia	FALSE	2017	9	3	2017-3
3.1.3.Testing	Vega's Zefiro 9 Engine	Reveal of Name,	Launch	Italy	FALSE	2020	10	4	2020-4
3.3.2.Cultural Nc	Q&A | Avio CEO Ranzo	Reveal of Name,	Launch	EU	FALSE	2016	11	4	2016-4
2.1.1.Gov't Cont	ESA pours $107 million	Funding	Launch	EU	TRUE	2017	11	4	2017-4
2.2.4.Equity Inv	Small-rocket-builder	Funding			TRUE	2017	5	2	2017-2
3.3.3.Governem	Axiom to fly Crew	Reveal of Name,	Launch	United States	FALSE	1900	1	1	1900-1
3.3.5.Firm creat	Beijing Interstellar Glory	Creation Event	Launch	China	FALSE	2016	10	4	2016-4
2.2.4.Equity Inv	Beijing Interstellar Glory	Funding	Launch	China	TRUE	2020	8	3	2020-3
3.3.5.Firm creat	For Entrepreneur, 'Fly	Creation Event	Launch	United States	FALSE	1900	1	1	1900-1
3.3.5.Firm creat	Bigelow Aerospace lays	Expression of	Launch	United States	FALSE	1900	1	1	1900-1
3.1.1.Manufacti	Blue Origin opens	Reveal of Name,	Launch	United States	FALSE	1900	1	1	1900-1
3.1.3.Testing	Blue Origin's New	Successful	Launch	United States	FALSE	2020	10	4	2020-4
2.3.2.Recruitme	Blue Origin creates	Reveal of Name,	Launch	United States	FALSE	2020	12	4	2020-4
2.2.7.Common S	Bezos Cashing in $3.1	Funding	Launch	United States	FALSE	2020	11	4	2020-4
3.1.3.Testing	Startup tests hybrid	Successful	Launch	United States	FALSE	2021	1	1	2021-1
3.3.5.Firm creat	One Small Step for	Creation Event	Launch	United States	FALSE	2014	1	1	2014-1
2.2.2.Gov't Cont	One Small Step for	Funding	Launch	United States	FALSE	2014	1	1	2014-1
3.1.1.Manufacti	Boeing Studying Air-	Reveal of Name,	Launch	United States	FALSE	1900	1	1	1900-1
3.1.1.Manufacti	Business Digest	Reveal of Name,	Launch	United States	FALSE	1900	1	1	1900-1
3.1.3.Testing	Boeing to fly second	Announcment of	Launch	United States	FALSE	1900	1	1	1900-1
3.3.1.Marketing	Boeing; Lockheed	Creation Event	Launch	United States	FALSE	1900	1	1	1900-1
1.1.5.Industry Re	BRAZIL TO SIGN	Creation Event	Government	United States	FALSE	1900	1	1	1900-1
1.1.3.Launch Lic	Brazilian Space Agency	Receipt of	Launch	Brazil	TRUE	2020	12	4	2020-4
3.3.5.Firm creat	Brazil Plans Launch of	Creation Event	Launch	Brazil	TRUE	2020	10	4	2020-4
2.2.5.Industry-V	Brazilian Space Sector	Creation Event	Government	Brazil	TRUE	2020	9	3	2020-3
Gov't Programs	Quitting the space race	Creation Event	Government	EU	FALSE	1900	1	1	1900-1
2.2.6.Gov't Prog	UNITED KINGDOM:	Funding	Launch	EU	FALSE	1900	1	1	1900-1
2.2.4.Equity Inv	British government and	Creation Event	Satellite	EU	FALSE	1900	1	1	1900-1
2.2.5.Industry-V	Startup financing	Funding	Launch	United States	FALSE	1900	1	1	1900-1
3.2.4.Partnershi	Spaceport America and	Reveal of Name,	Spaceport	United States	TRUE	2020	10	4	2020-4
3.3.6.Non-Gover	Cancom Announces	Reveal of Name,	Satellite	United States	FALSE	1900	1	1	1900-1
2.2.7.Common S	Cancom announces sale	Funding	Satellite	United States	FALSE	1900	1	1	1900-1
2.2.7.Common S	Cancom Sells Shares in	Other	Satellite	Canada	FALSE	1900	1	1	1900-1
3.3.2.Cultural Nc	How many small launch	Expression of	Launch	United States	FALSE	1900	1	1	1900-1
3.1.1.Manufacti	Chinese rocket		Launch	China	FALSE	2020	9	3	2020-3
3.1.3.Testing	Launch of China's new	Expression of	Launch	China	FALSE	1900	1	1	1900-1
3.3.3.Governem	Long March launches	Successful	Launch	China	FALSE	1900	1	1	1900-1
3.3.6.Non-Gover	China launches third	Creation Event	Launch	China	FALSE	1900	1	1	1900-1
3.3.6.Non-Gover	China resumes space	Successful	Launch	United States	FALSE	1900	1	1	1900-1
	China Launches New	Successful	Launch	China	FALSE	2013	9	3	2013-3
3.1.1.Manufacti	Kuai Zhou (Fast Vessel)	Creation Event	Launch	China	FALSE	2009	1	1	2009-1
3.1.3.Testing	Kuaizhou first test	Successful	Launch	China	FALSE	2012	3	1	2012-1
3.2.2.Merger	Kuai Zhou (Fast Vessel)	Reorganization	Launch	China	TRUE	2011	1	1	2011-1
3.3.3.Governem	China Launches Two	Reveal of Name,	Launch	China	FALSE	2014	11	4	2014-4
3.3.6.Non-Gover	Chinese Kuaizhou 1A	Expression of	Launch	China	FALSE	2020	9	3	2020-3
3.3.6.Non-Gover	Chinese commercial	Creation Event	Launch	China	FALSE	2020	4	2	2020-2
2.2.2.Gov't Cont	China successfully	Funding	Launch	United States	FALSE	2012	11	4	2012-4
3.1.3.Testing	Chinese new-	Creation Event	Launch	United States	FALSE	1900	1	1	1900-1
3.3.6.Non-Gover	Celcom develops	Creation Event	Satellite	United States	FALSE	1900	1	1	1900-1
2.2.9.Gov't Gran	Celestia UK to develop	Reveal of Name,	Satellite	EU	FALSE	1900	1	1	1900-1
3.3.4.Consumer	New launch complex for	Reveal of Name,	Spaceport	China	FALSE	2021	2	1	2021-1
3.3.6.Non-Gover	Long March 11	Successful	Launch	China	FALSE	2020	12	4	2020-4
3.3.6.Non-Gover	First launch of Chinese	Expression of	Launch	China	FALSE	2020	7	3	2020-3
3.3.3.Governem	China to construct	Reveal of Name,	Launch	China	FALSE	2021	3	1	2021-1
3.3.3.Governem	Successful launch takes	Successful	Satellite	United States	FALSE	1900	1	1	1900-1
3.3.3.Governem	China launches Shiyan-	Creation Event	Launch	China	FALSE	1900	1	1	1900-1
3.3.6.Non-Gover	China to continue world-	Other	Launch	China	FALSE	1900	1	1	1900-1
3.1.3.Testing	Long March 3B carrying	Launch Failed	Launch	China	FALSE	1900	1	1	1900-1
3.3.6.Non-Gover	Chinese Long March 6	Successful	Launch	China	FALSE	2020	11	4	2020-4
3.3.6.Non-Gover	Chinese Long March 11	Successful	Launch	China	FALSE	2020	9	3	2020-3
3.2.4.Partnershi	E-Town Capital invests	Creation Event	Launch	China	TRUE	2016	11	4	2016-4
3.3.5.Firm creat	E-Town Capital invests	Creation Event	Launch	China	FALSE	2016	11	4	2016-4
3.3.6.Non-Gover	China's commercial	Creation Event	Launch	China	FALSE	2019	8	3	2019-3
3.1.1.Manufacti	China moving to	Creation Event	Launch	China	FALSE	1900	1	1	1900-1
1.2.2.Regulation	Guiding Opinions of the	Passage of Law	Government	China	TRUE	2014	11	4	2014-4
3.3.3.Cultural Nc	Space industry group	Expression of	Government	United States	FALSE	1900	1	1	1900-1

Launchers

Inclusion for SVLS

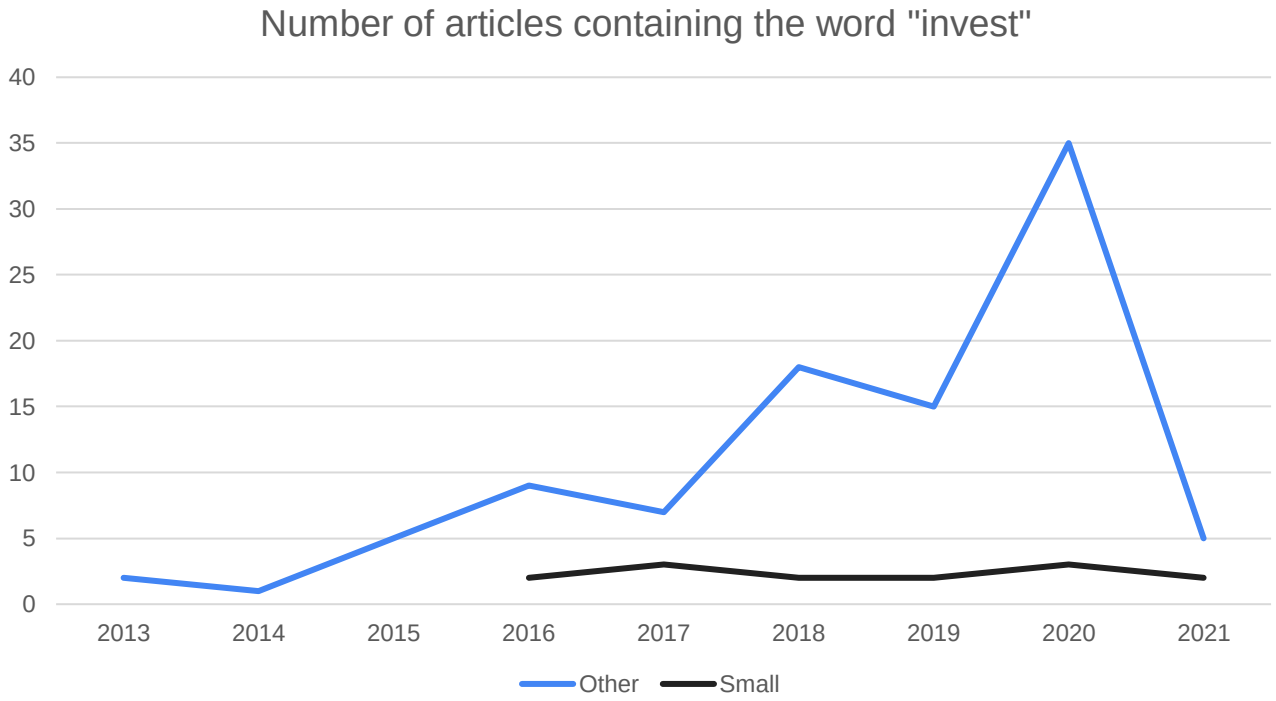
vehicle		TOT	
Electron		190	
LauncherOne			
vega			
vega C			
Vega			
Vega C			
Alpha			
Alpha 1			

Rocket Lab's Electron - (list of all launches)
Virgin Orbit's LauncherOne - (list of launches)
Astra's Rocket - (list of launches)
(not in the xcl data currenty)
Firefly's Alpha - (list of launches)
Vega - (list of launches)

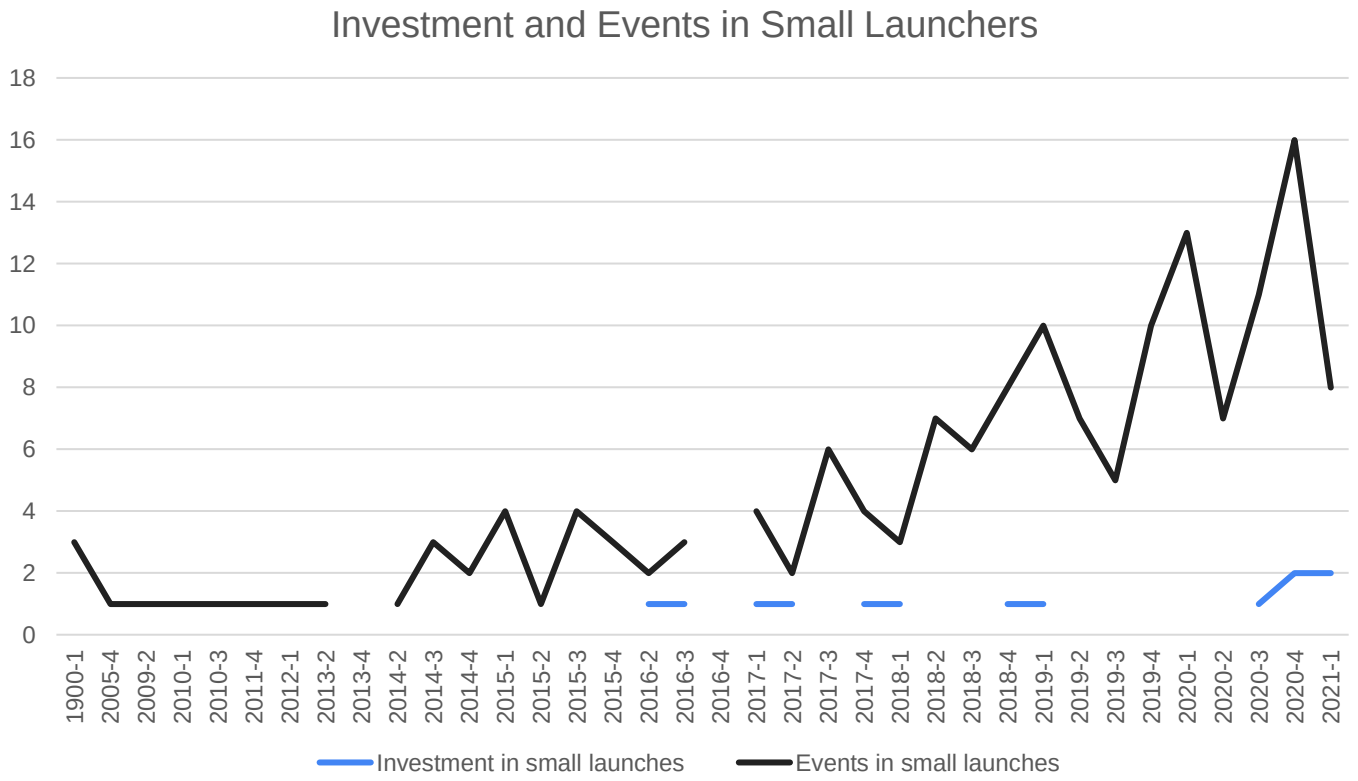


Source: Own Database

Investment in SVLa and other

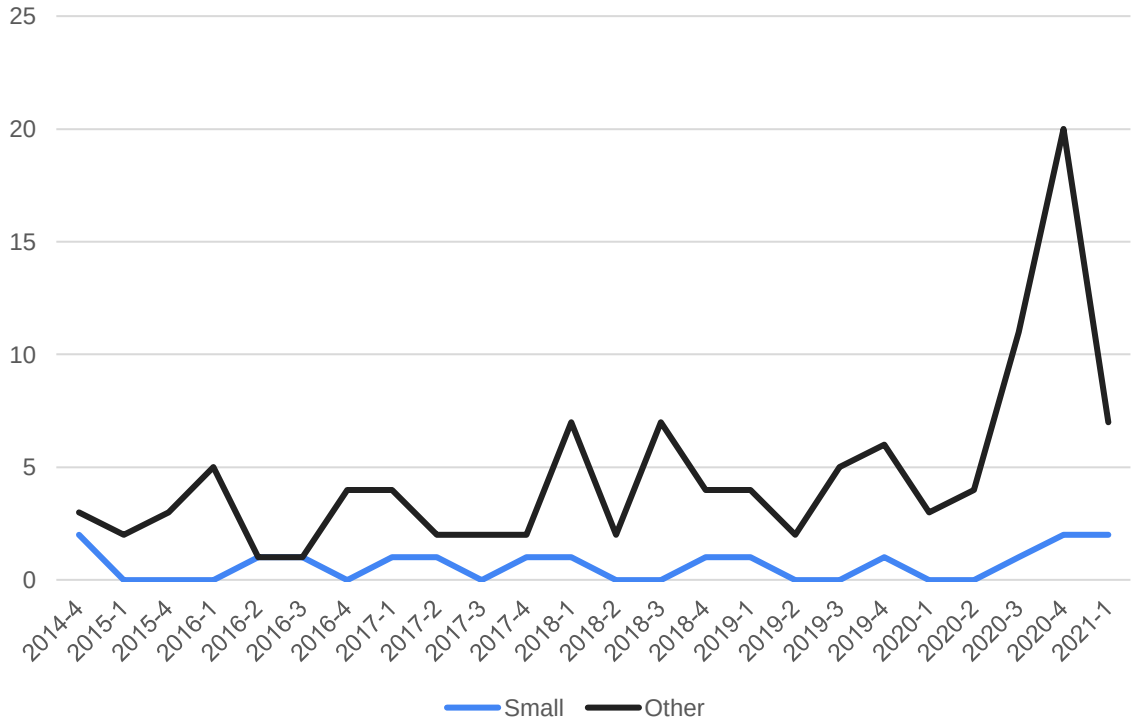


Source: Own Database



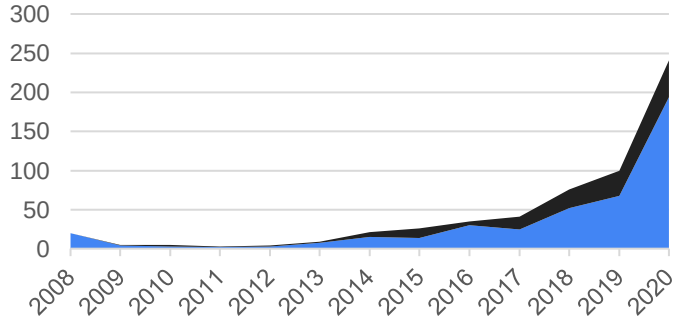
Source: Own Database

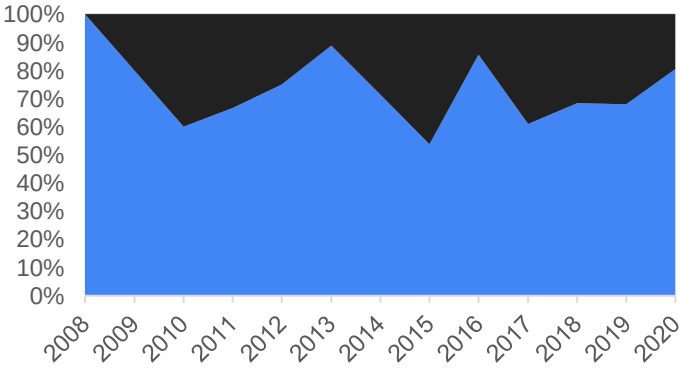
Investment in small launchers and non-small

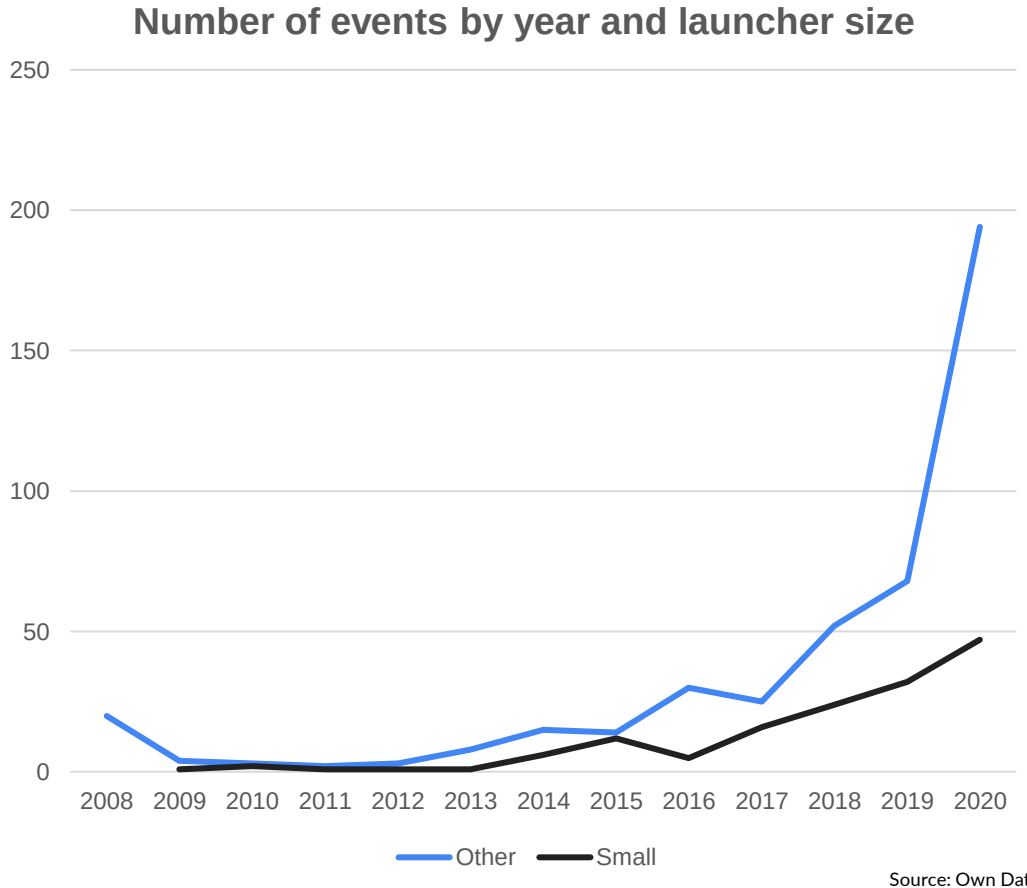


Source: Own Database

Events - Launchers





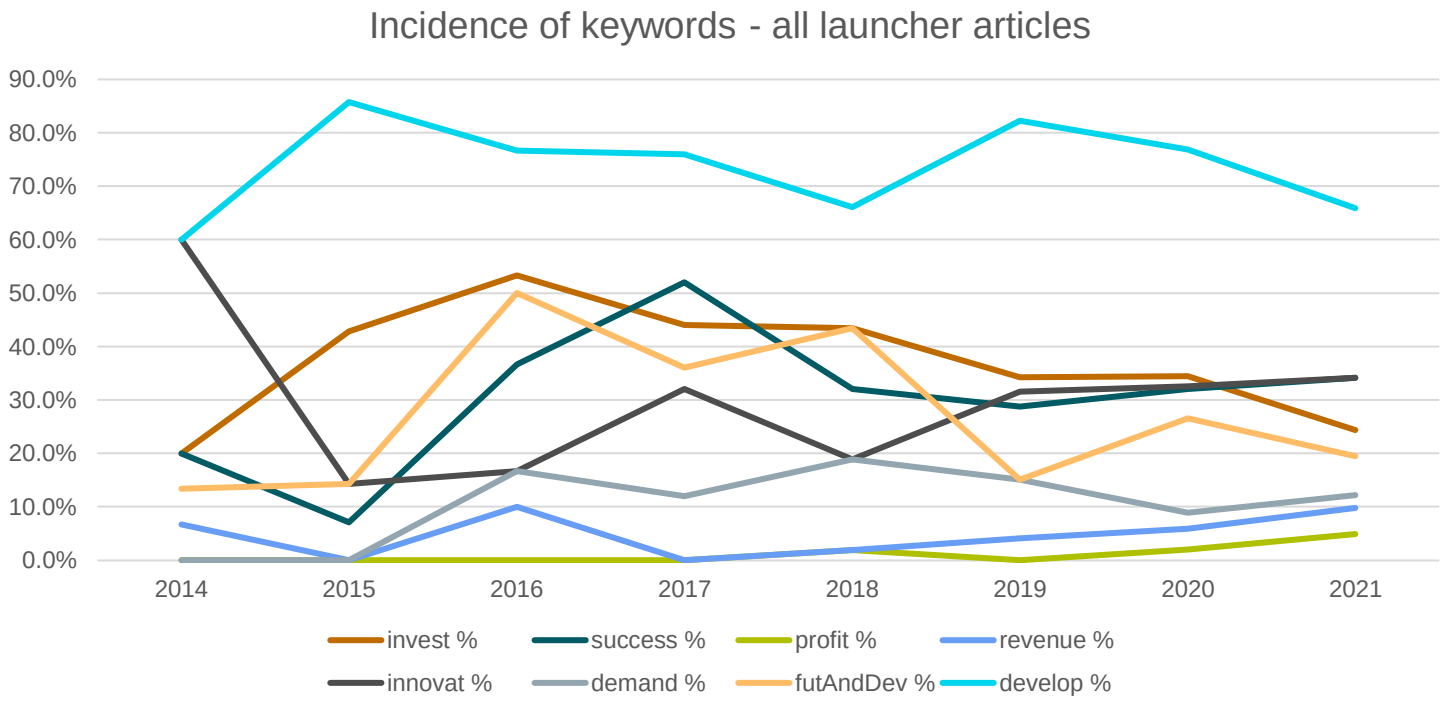


Source: Own Database

Launchers - Keyword Search

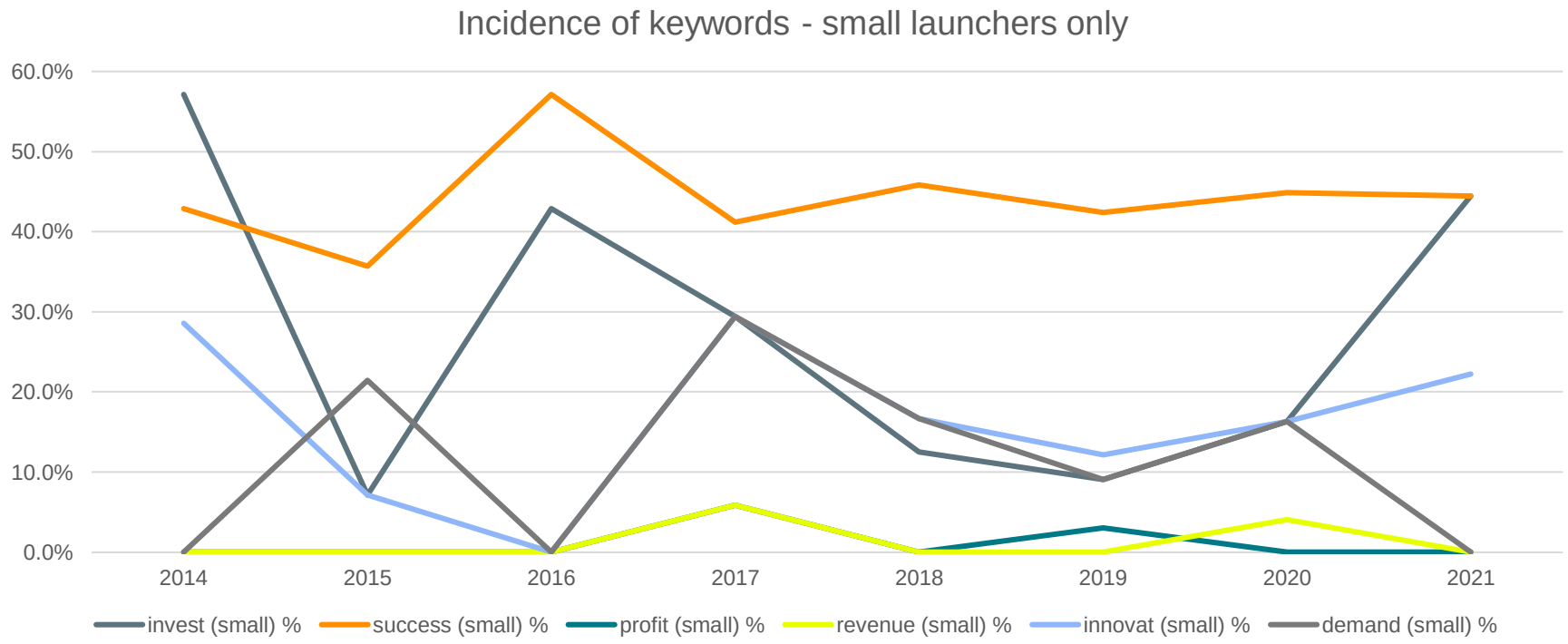
KD's	IIE	Headline	Outcomes	Category	Country	IOR	ye	mon	quart	year-quart	small-launch	invest	success	profit	revenue	innovat	demand	future	develop	futAndDev	commercial	government
	2.2.8.Venture Ca	Astranis raises $90	nding Received	Satellite	United States	FALSE	1900	1	1	1900-1	FALSE	1	0	0	0	0	0	0	0	0	0	0
	2.2.8.Venture Ca	One of the world's	nding Received	Satellite	United States	FALSE	1900	1	1	1900-1	FALSE	1	0	0	0	1	0	0	1	0	0	0
	3.3.6.Non-Govern	Malaysian satellite to be	nouncment of	Launch	Russia	FALSE	1900	1	1	1900-1	FALSE	0	0	0	0	0	0	0	1	0	0	0
	1.1.5.Industry Re	Australia updates	ation Event	Launch	Australia	TRUE	2019	8	3	2019-3	FALSE	0	0	0	0	1	0	0	1	0	1	1
	1.1.5.Industry Re	Australia to establish	ation Event	Government	Australia	FALSE	2017	9	3	2017-3	FALSE	0	0	0	0	1	0	0	1	0	0	1
	3.1.3.Testing	Vega's Zefiro 9 Engine	veal of Name,	Launch	Italy	FALSE	2020	10	4	2020-4	TRUE	1	1	0	0	1	0	1	1	1	0	1
	3.3.2.Cultural No	Q&A | Avio CEO Ranzo	veal of Name,	Launch	EU	FALSE	2016	11	4	2016-4	TRUE	0	1	0	0	0	0	1	0	0	0	0
	2.1.1.Gov't Contr	ESA pours $107 million	nding Received	Launch	EU	TRUE	2017	11	4	2017-4	TRUE	0	1	0	0	0	0	1	1	1	0	0
	3.3.3.Governme	Axiom to fly Crew	veal of Name,	Launch	United States	FALSE	1900	1	1	1900-1	FALSE	1	0	0	0	0	0	0	1	0	1	[illegible]
	3.3.5.Firm creatic	Beijing Interstellar Glory	ation Event	Launch	China	FALSE	2016	10	4	2016-4	FALSE	0	0	0	0	0	0	0	1	0	1	[illegible]
	2.2.4.Equity Inve	Beijing Interstellar Glory	nding Received	Launch	China	TRUE	2020	8	3	2020-3	FALSE	1	1	0	0	0	0	1	1	1	1	[illegible]
	3.3.5.Firm creatic	For Entrepreneur, 'Fly	ation Event	Launch	United States	FALSE	1900	1	1	1900-1	FALSE	0	1	0	0	0	0	0	1	0	1	[illegible]
	3.3.5.Firm creatic	Bigelow Aerospace lays	ression of	Launch	United States	FALSE	1900	1	1	1900-1	FALSE	0	0	0	0	0	0	0	1	0	1	[illegible]
	3.1.1.Manufactur	Blue Origin opens rocket	veal of Name,	Launch	United States	FALSE	1900	1	1	1900-1	FALSE	1	0	0	0	0	0	0	1	0	0	[illegible]
	3.1.3.Testing	Blue Origin's New	ccessful Launch	Launch	United States	FALSE	2020	10	4	2020-4	FALSE	0	1	0	0	0	0	1	1	1	1	[illegible]
	2.3.2.Recruitmen	Blue Origin creates	veal of Name,	Launch	United States	FALSE	2020	12	4	2020-4	FALSE	0	0	0	0	0	0	0	1	0	0	[illegible]

Launchers - Keyword Search - sentiment



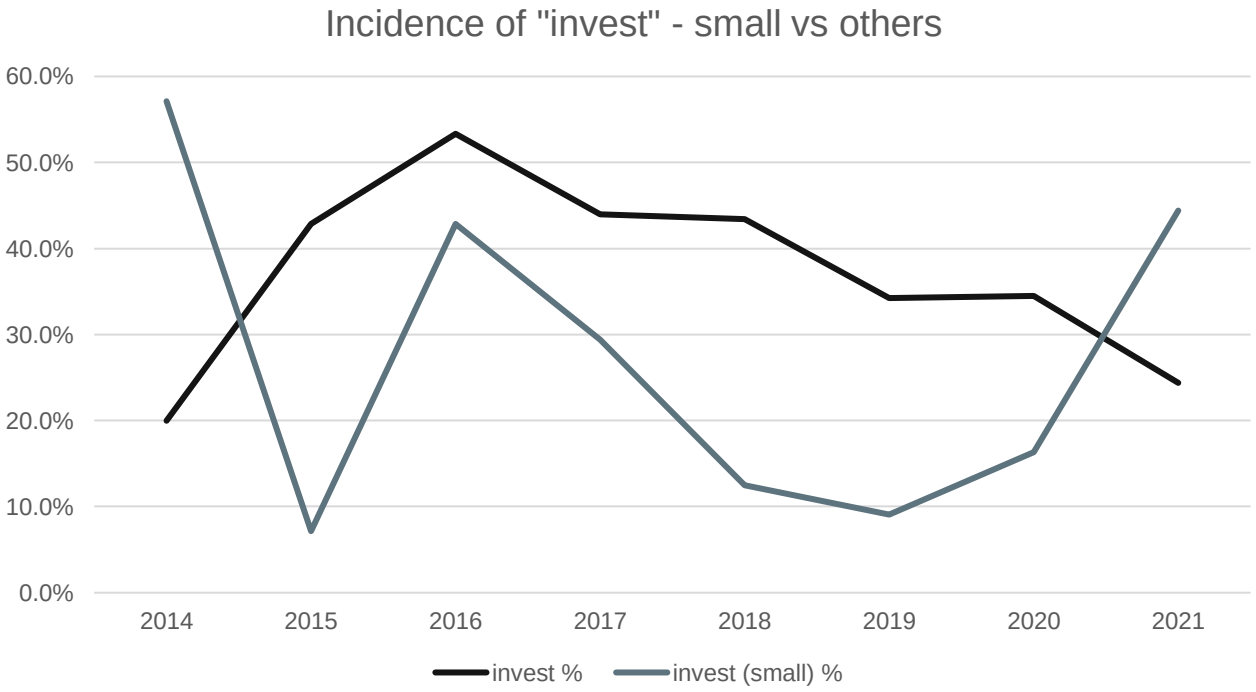
Source: Own Database

Keyword Search - SLVs

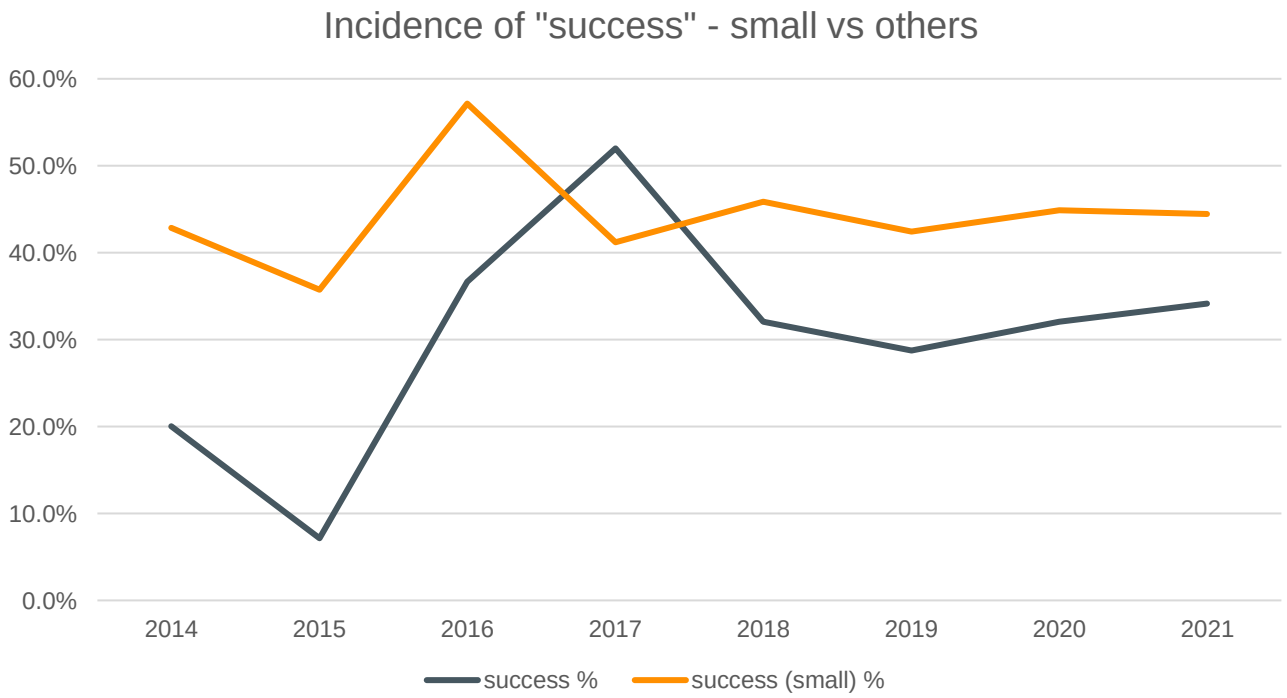


Source: Own Database

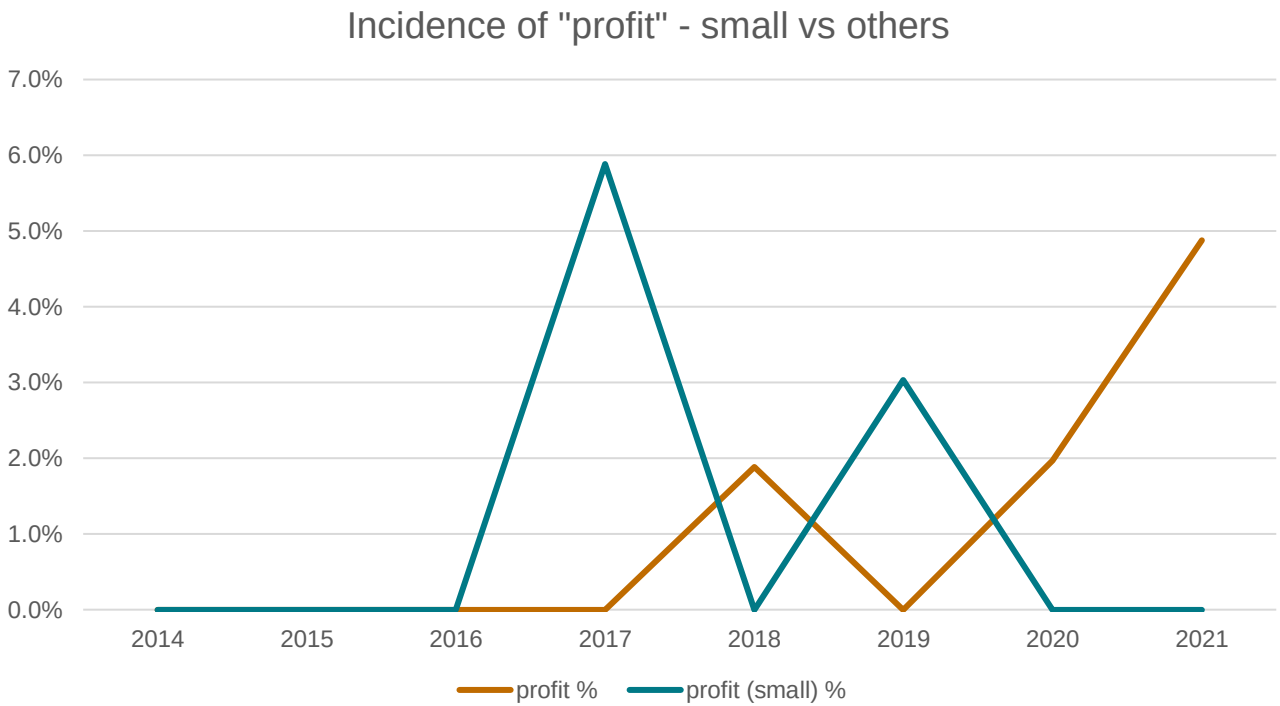

Incidence of "invest" - small vs others
Incidence of "success" - small vs others
Incidence of "profit" - small vs others
Incidence of "revenue" - small vs others
Incidence of "innovat" - small vs others
Incidence of "demand" - small vs others
and "government" - SMALL
Incidence of "future" and "develop" - small vs others
Incidence of "commercial" and "government" - non-small
Incidence of "commercial"



Source: Own Database



Source: Own Database



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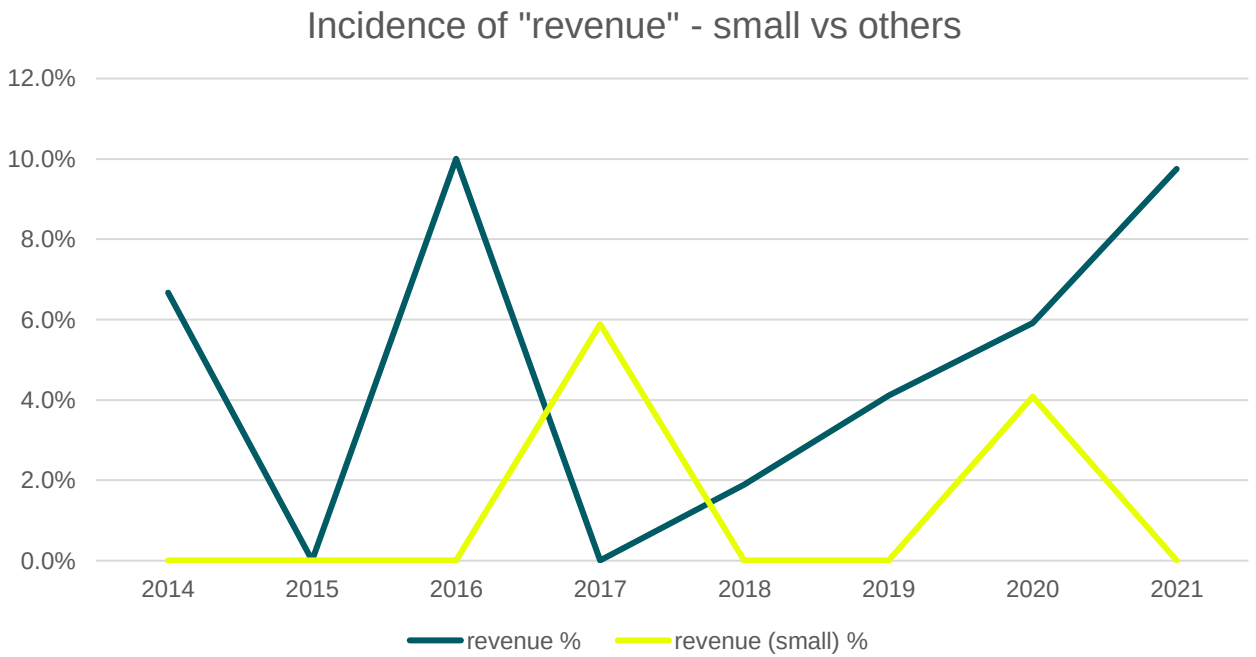

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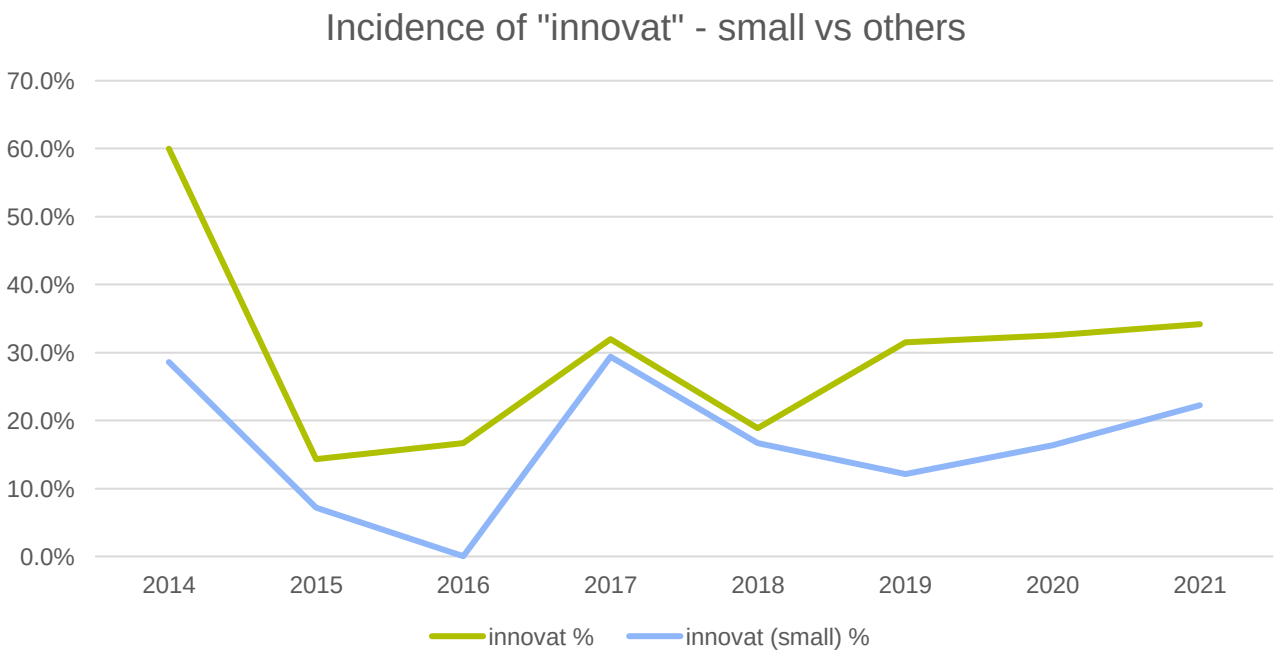
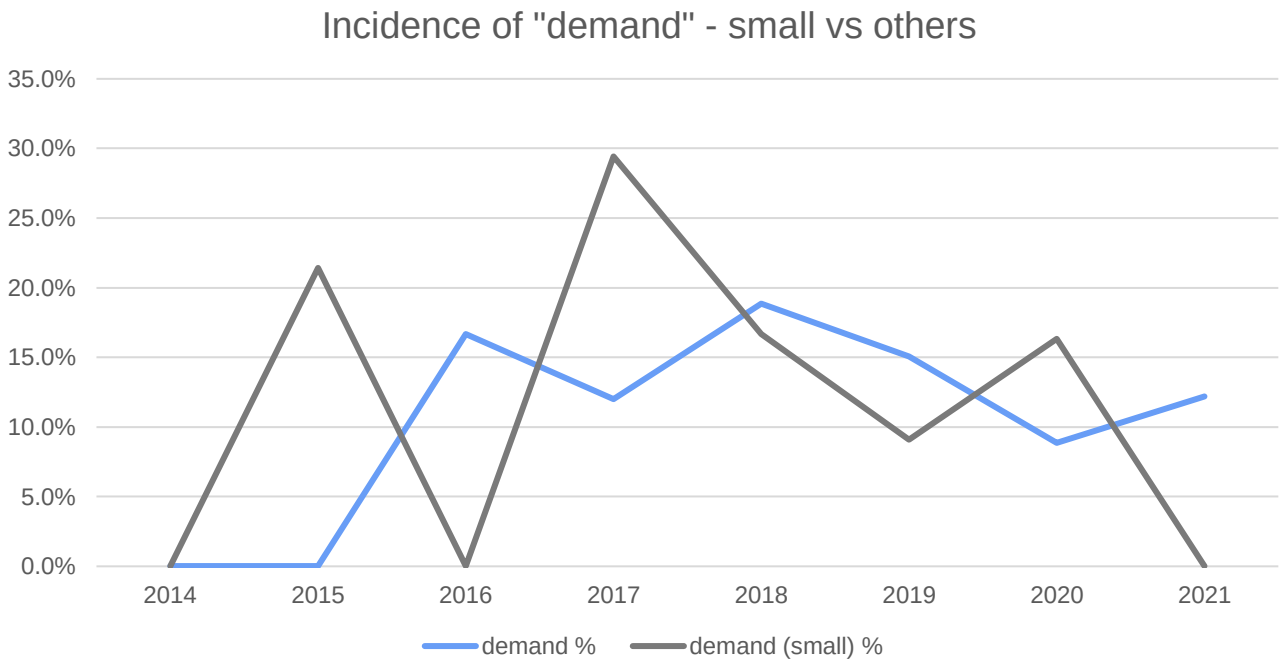


Source: Own Database



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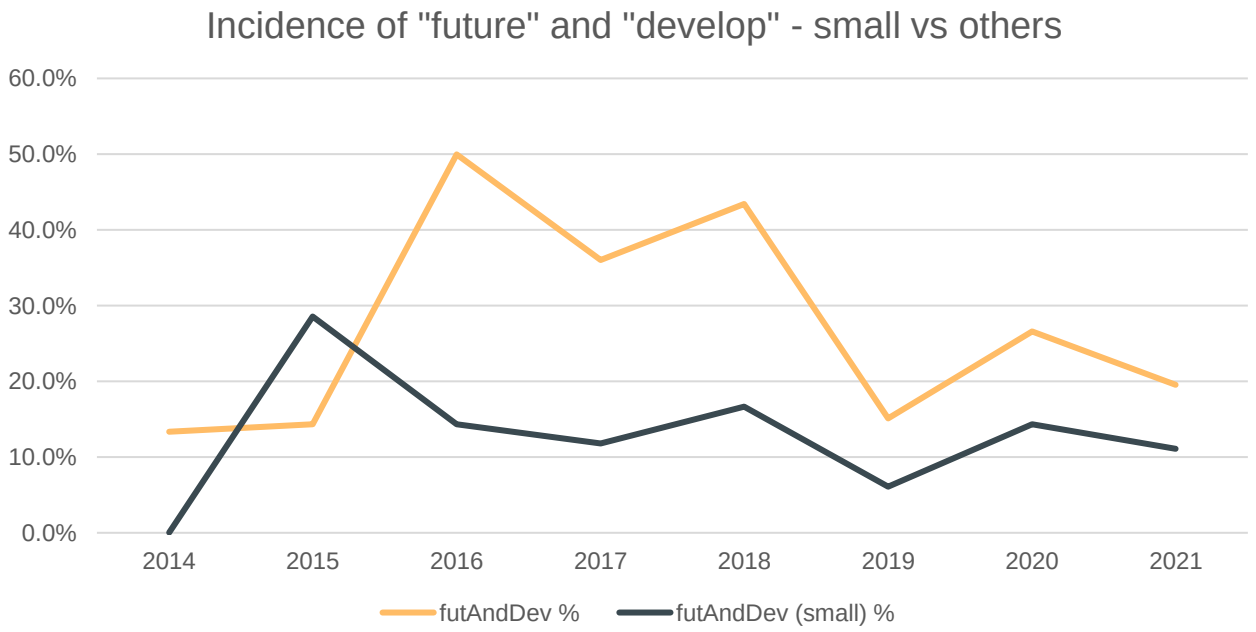

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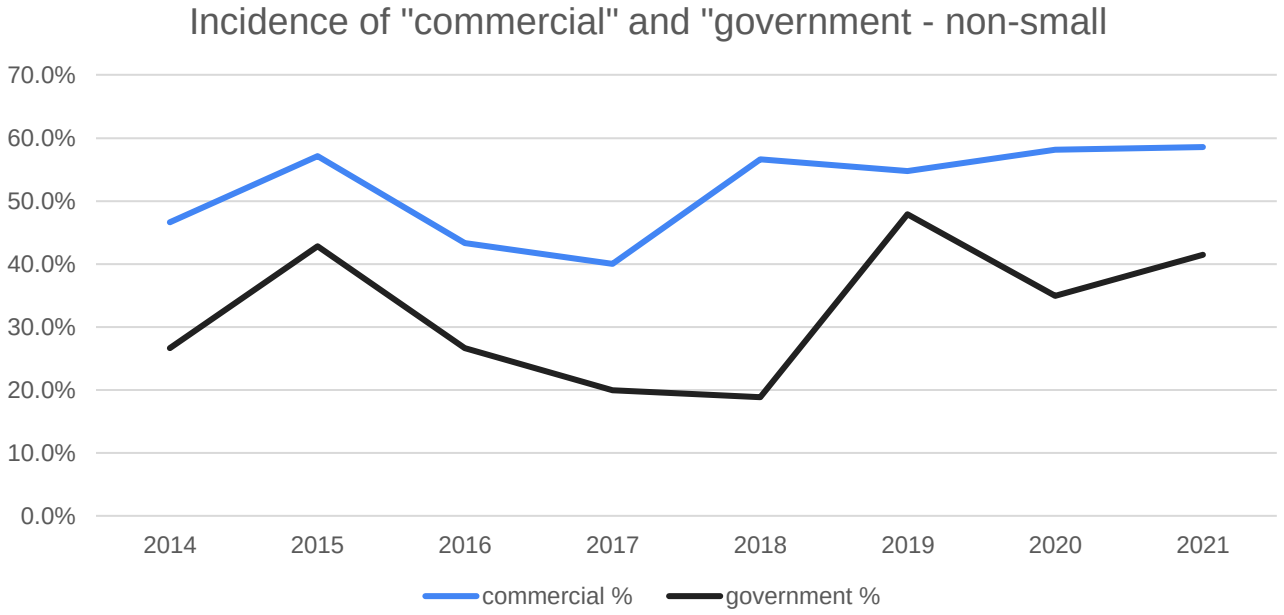
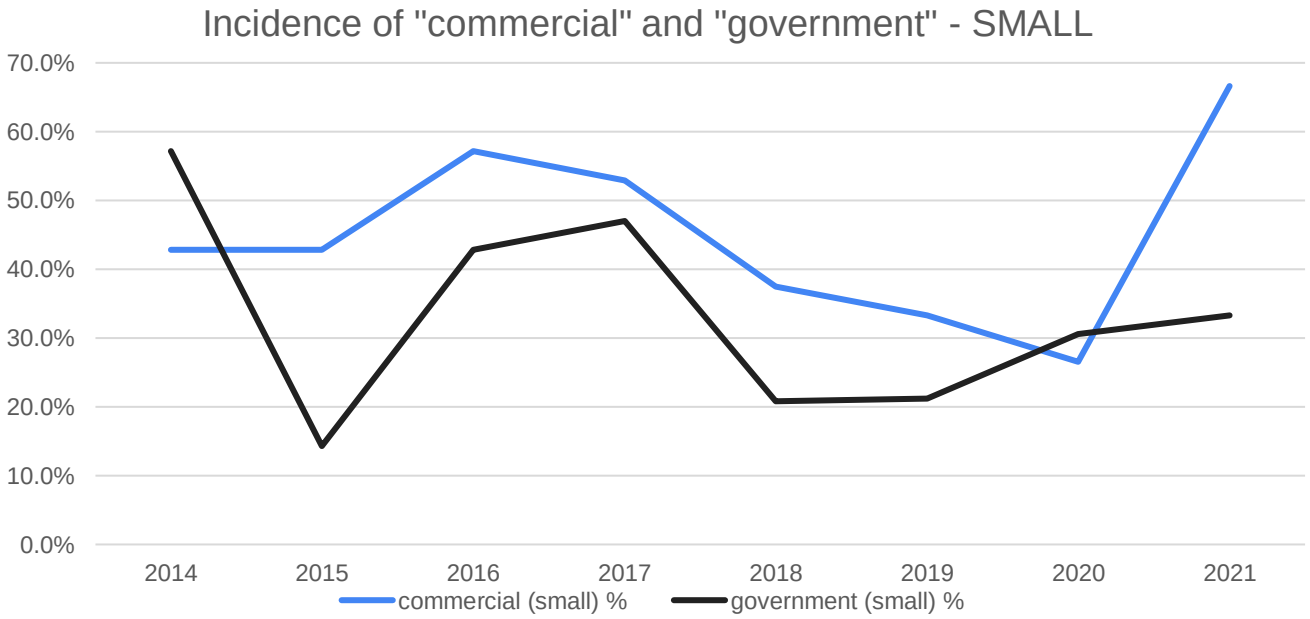


Source: Own Database

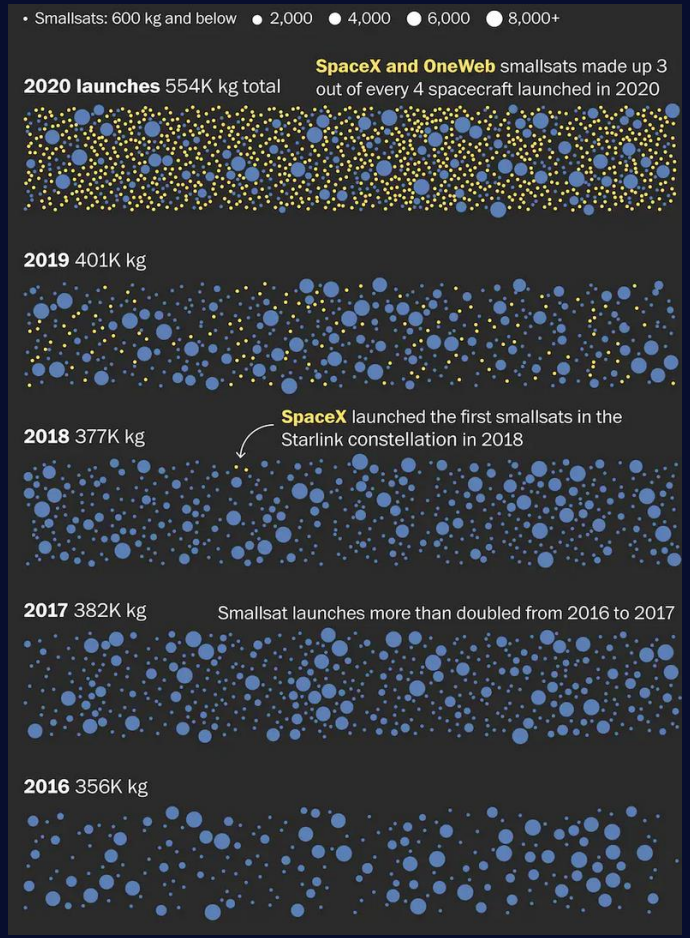


Source: Own Database

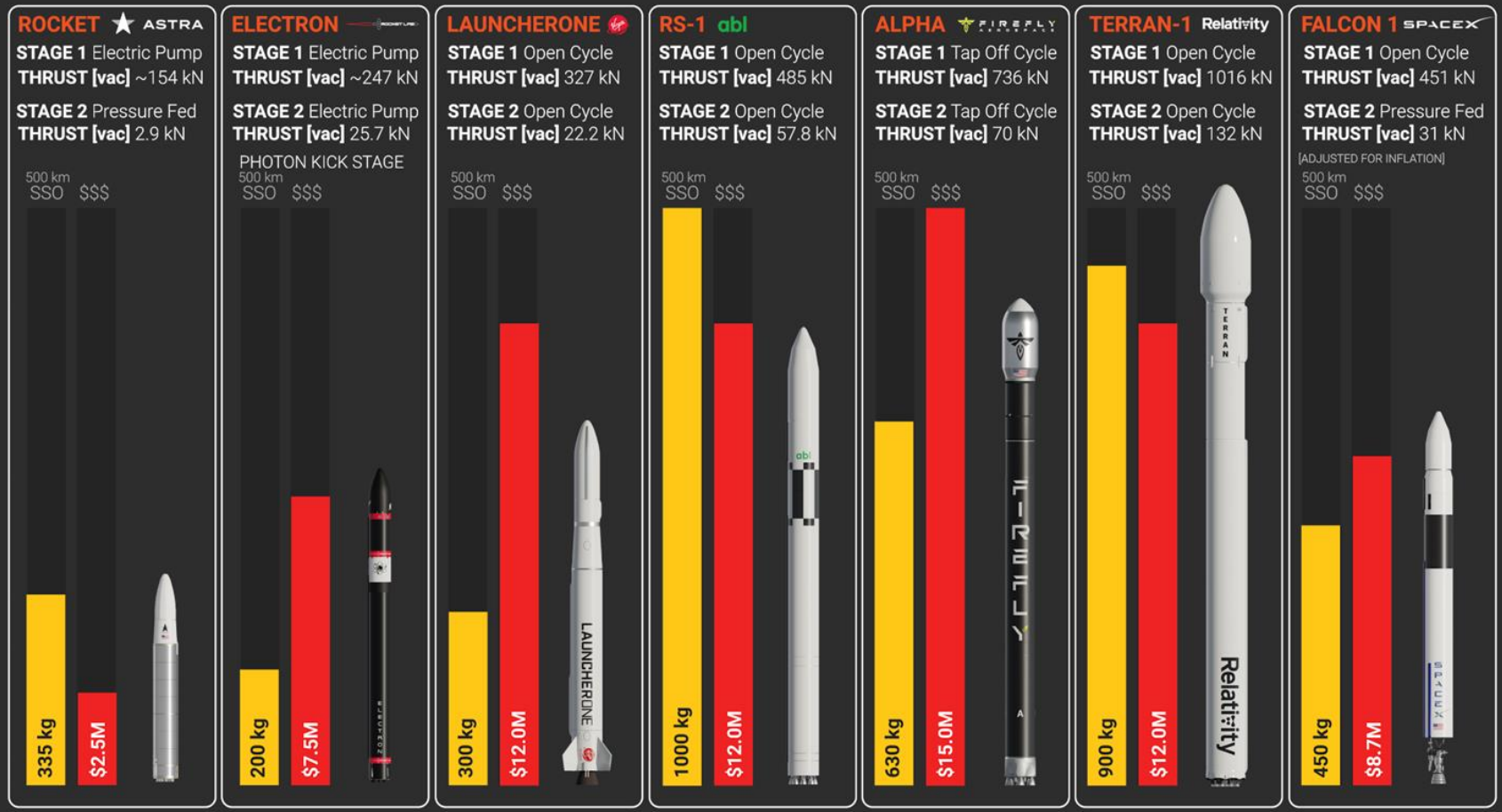
Wordcloud – Launchers Data

Source: Own Database

Emergence Visualization



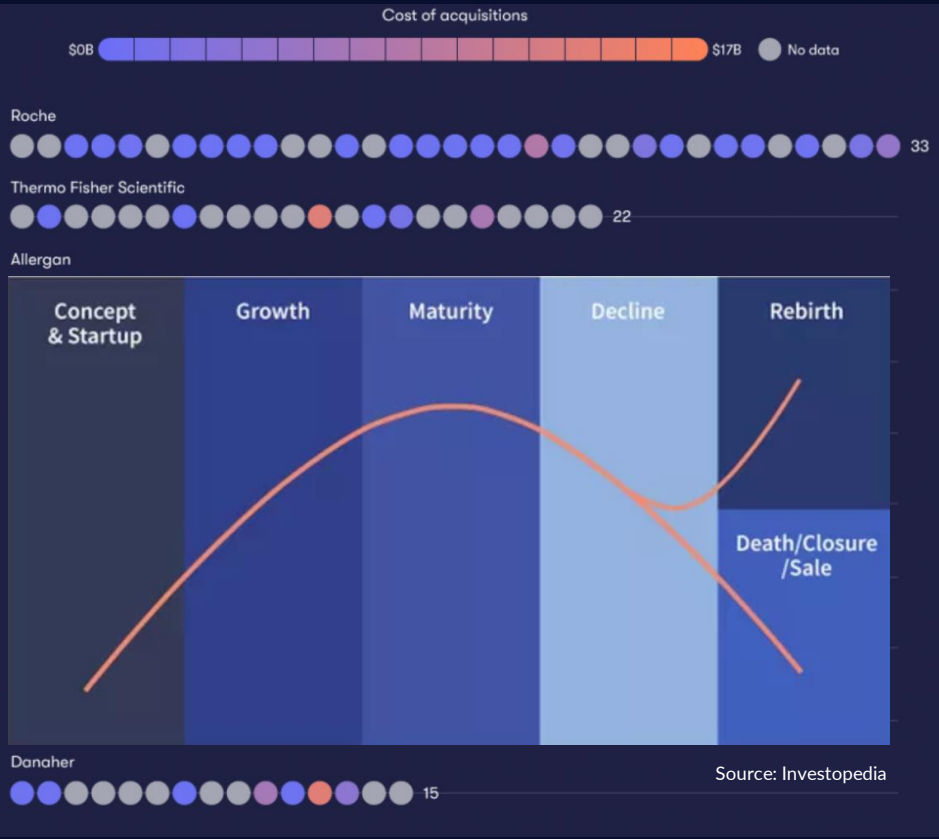
Source: Bryce Tech

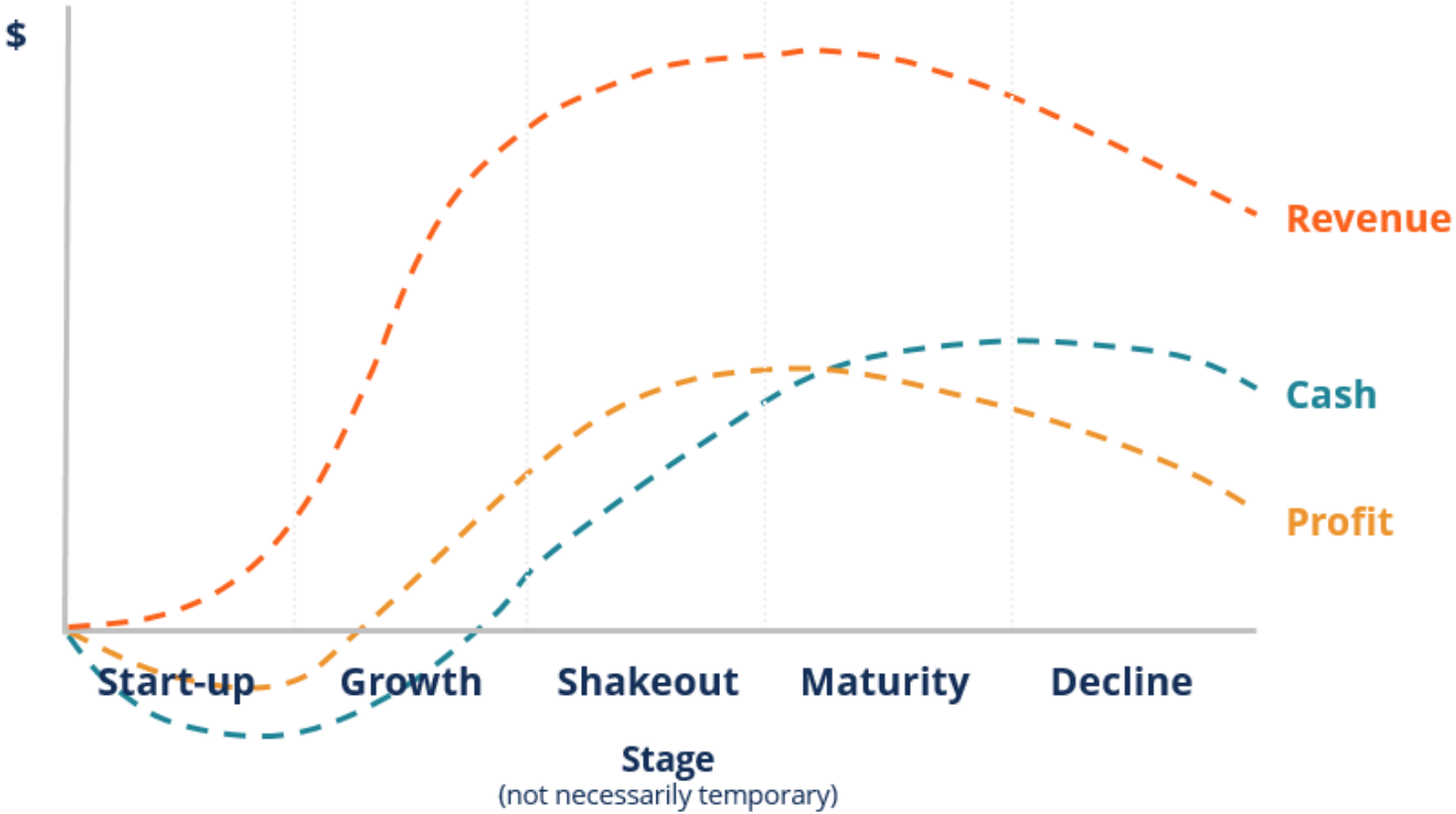


EVERYDAY ASTRONAUT

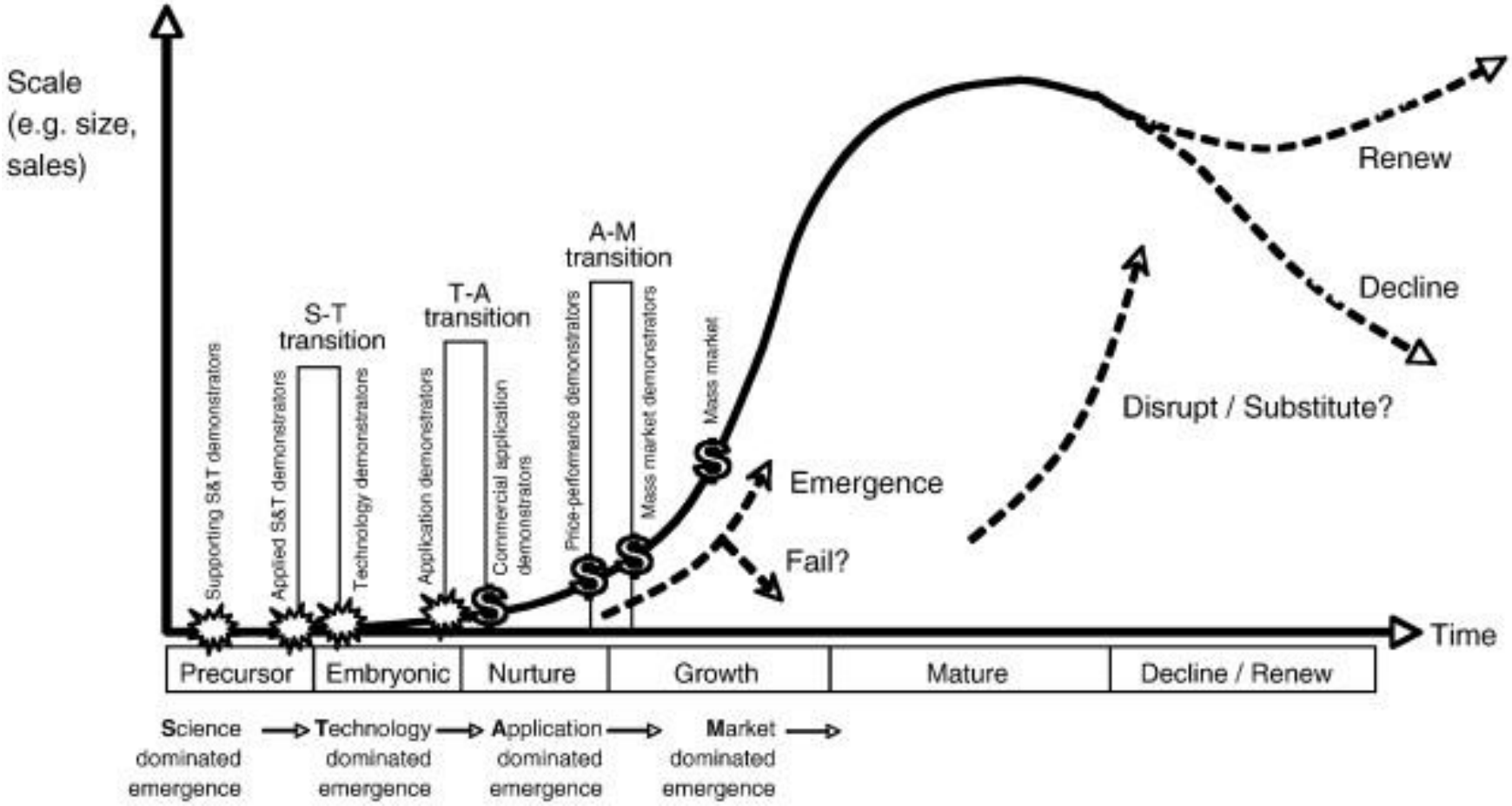
Source: Everyday Astronaut

Visualization



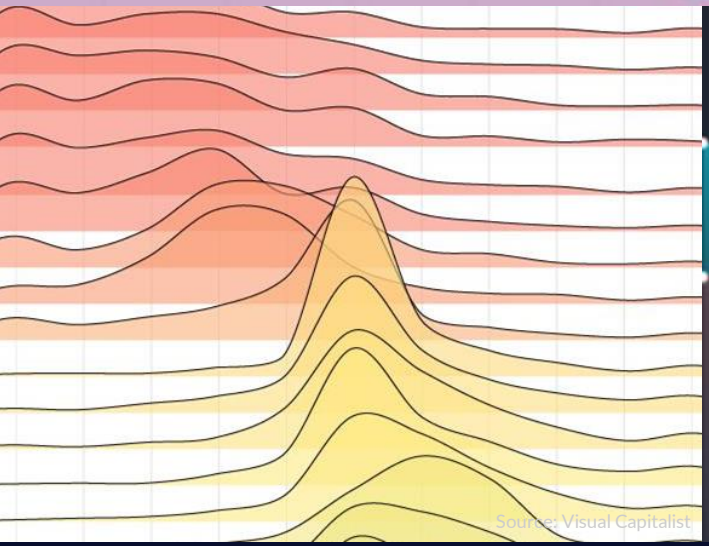


Source: https://doblin.com

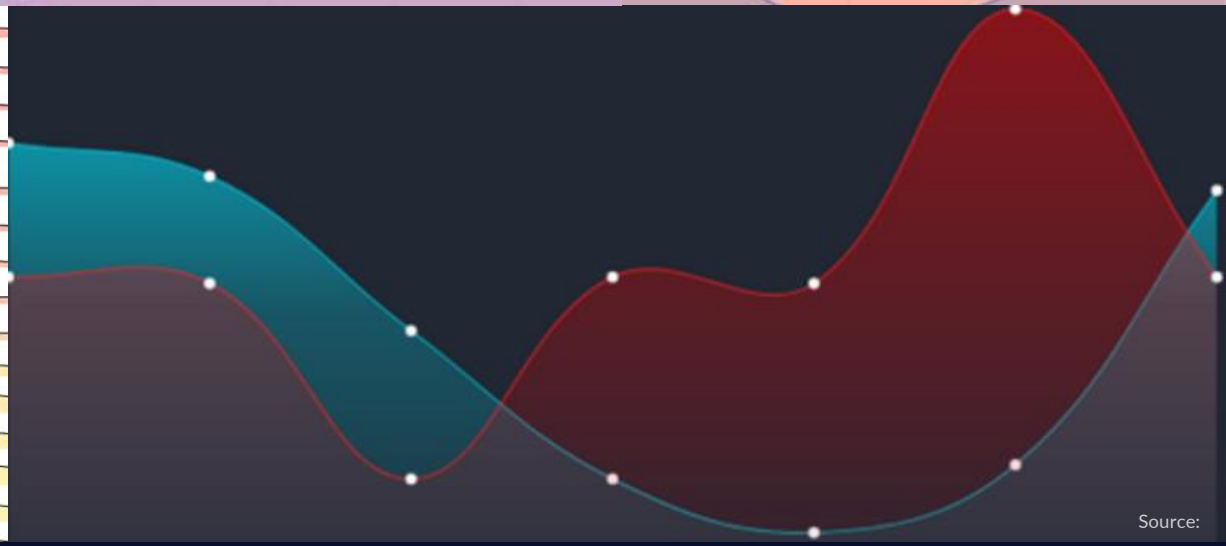


Source: (Phaal, 2011)

Visualization of Sentiment & Emergence



Source: Visual Capitalist



Source:

February 22

Project intro

- Handover project
- Kick-off meeting
- Brainstorming
- Tasks Division
- Meeting with Dr. Davidian
- Data inspection
- Literature Review

March 22

Database & Visualization

- Data cleaning
- Querying the data
- Classification
- First testing graphs
- Visualization perspectives
- Crossing database results with industry

April 22

Visualization & Storytelling

- Visualization ideas
- Starting Storytelling
- Scratch graphs
- Status Presentation
- Scoping Future Research Opportunities

Summer 22 +

Visualization & Prototyping

- Visualization prototyping
- Storytelling & Visual Narrative
- Research Application of New Technologies & Visualization to support ML

Questions
& Brainstorming

1. Which aspects of visual storytelling suit best the expected outcomes from the research?

2. Which types of visualizations would be the most appropriate to demonstrate the Small Launch Vehicle Emerging Industry?

3. What else can be exploit from our own Database?

4. How can we predict the future trends from this industry using our current Database?

Image Source: NASA

References

Davidian, K. (2021). *What makes space activities commercial?* Acta Astronautica, 182, 547-558.

Davidian, K. J. (2020). *Small Satellite Market Research Methods.* In J. N. Pelton (Ed.), Handbook of Small Satellites: Technology, Design, Manufacture, Applications, Economics and Regulation (pp. 1–12). Springer International Publishing. https://doi.org/10.1007/978-3-030-20707-6_106-2

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