

START-UP SPACE

UPDATE ON INVESTMENT IN COMMERCIAL SPACE VENTURES

2020



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EXECUTIVE SUMMARY

Three significant trends are shaping the start-up space environment as we enter the 2020s. First, investors continue to pour large amounts of capital into start-up space ventures, shattering previous records as increasing numbers of investors fund more recipients. Second, years into start-up space investment, many ventures still have yet to demonstrate profitability and sustainability; creating expectations for rationalization and consolidation. Finally, government stakeholders are becoming an increasingly important element of the potential success of venture-funded space start-ups as many firms turn towards the government as a potential customer.

The Start-Up Space series examines space investment in the 21st century and analyzes investment trends, focusing on companies that began as angel- and venture capital-backed startups.

The report tracks publicly-reported seed, venture, and private equity investment in start-up space ventures as they grow and mature, from 2000 through the end of 2019. The report includes debt financing for these companies where applicable to provide a complete picture of the capital available to them, and also highlights merger and acquisition (M&A) and initial public offering (IPO) activity.

Record-Setting Investment in Start-up Space

Start-up space ventures attracted \$5.7 billion in financing of all types during 2019, shattering the \$3.5 billion record set the previous year. This was largely driven by investors continuing to pour large amounts of capital into a handful of the industry's largest companies.

SpaceX and Blue Origin drew an estimated \$1.9 billion in combined investment during the year, while low-Earth orbit (LEO) broadband venture OneWeb attracted another \$1.25 billion. Sir Richard Branson's space tourism start-up Virgin Galactic raised more than \$682 million in 2019. A reverse merger with special purpose acquisition company Social Capital Hedosophia, raised \$500 million and paved the

way for public trading of Virgin Galactic shares, one of the year's more notable transactions. Together these four companies accounted for nearly 70% of the 2019 total. The continued ability of sector heavyweights like SpaceX to raise capital is one of the major storylines of Start-up Space 2020.

Other companies attracting large infusions of venture capital during 2019 included U.S. small rocket maker Relativity Space and China's Qianxun Spatial Intelligence, a Beidou-enabled (Chinese GNSS) high-precision location service provider, each raising \$140 million.

In addition to the six companies mentioned above, another 129 start-up space ventures received investment

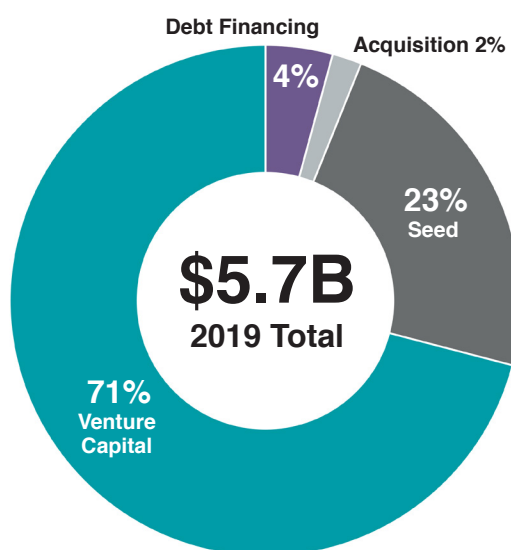


Figure E-1. Venture Capital accounted for 71% of investment in 2019.

in 2019. In total, 135 startup space ventures received investment in 2019, a 34% increase over 2018, the previous record.

Observers have speculated about a possible investment slowdown in start-up space, but 2019 brought no clear evidence of lost momentum. 2019 was a record setting year for the number of start-up ventures raising investment (+34% from 2018), investors (+46%), deals (+36%), and investment (+61%). Excluding SpaceX, OneWeb, Blue Origin, and Virgin Galactic, total investment in start-up space was \$1.8 billion in 2019, down slightly from the \$1.9 billion excluding those companies the year before. However, a sharp increase in the number of rounds with undisclosed investment (based on publicly available data)—38 in 2019 compared to 15 in 2018—suggests that the actual total for the year is above \$1.8 billion.

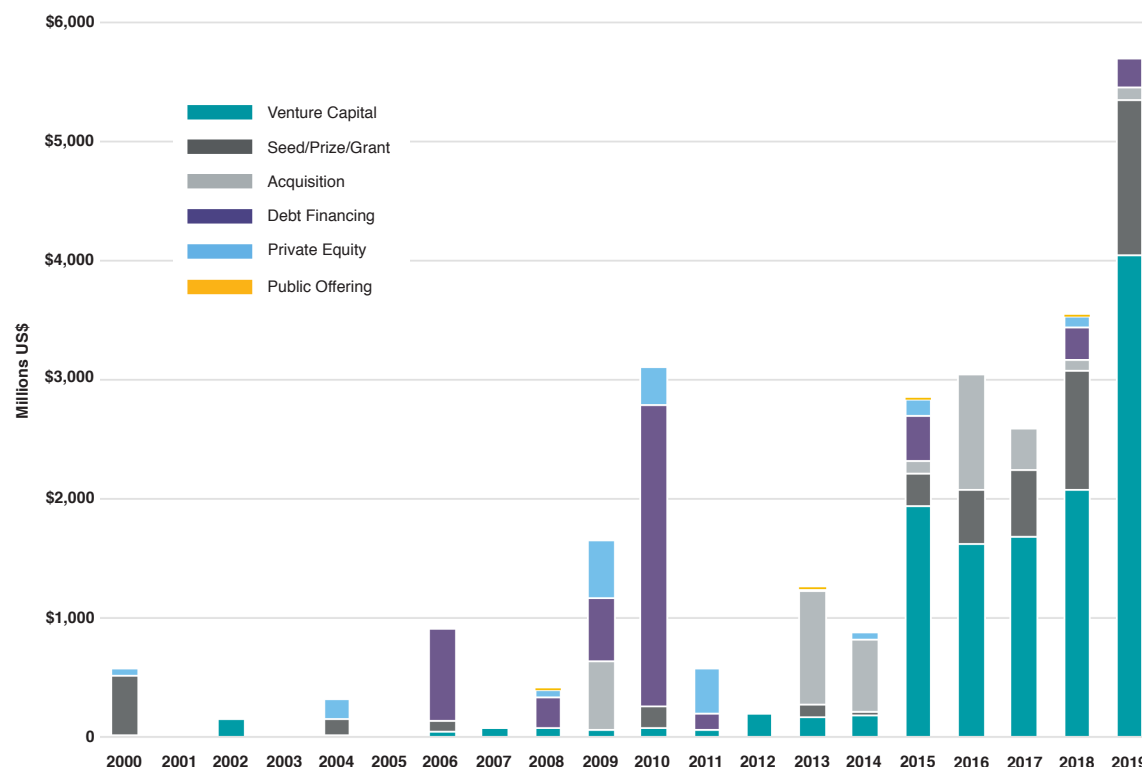


Figure E-2. The mix of types of investment in space companies varies from 2000 to 2019.

Growth in start-up space was in part due to the growing international presence. The year saw a surge in the number of non-U.S. start-ups obtaining financing: 79 in 2019, compared to 47 in 2018. The number of U.S. firms, meanwhile, appears to be leveling off, with 56 in 2019 compared to 53 the year before. This is the first year where the number of non-U.S. companies receiving investment exceed the number of U.S. companies.

The largest single start-up space investment category continues to be venture capital, with some \$4.0 billion raised during the year. About 68% of that, or about \$2.7 billion, is attributable to SpaceX, OneWeb, and Virgin Galactic. The \$1.3 billion raised by the other companies represents a 17% drop from \$1.6 billion in 2018, although, again, the number of rounds with undisclosed magnitude invested was substantially higher in 2019.

The seed investment category, meanwhile, continued to be dominated by Blue Origin, bankrolled by Amazon.com founder Jeff Bezos. Blue Origin's estimated \$1

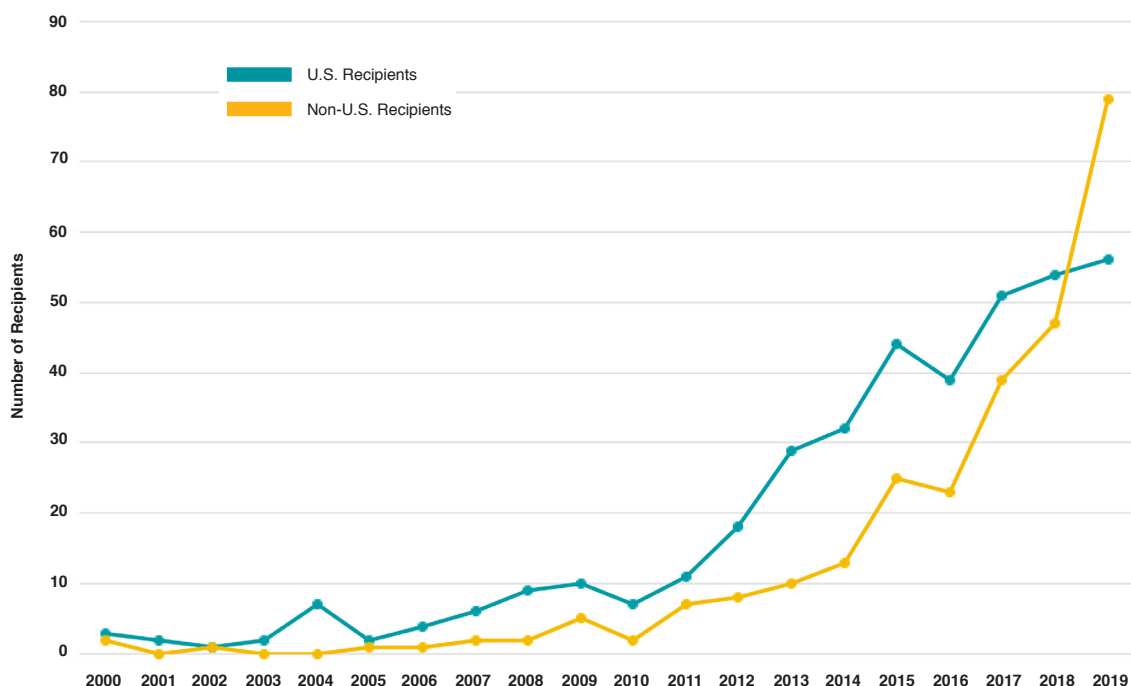


Figure E-3. Number of U.S. versus non-U.S. investment recipients.

billion in 2019 accounted for 76% of the total for the category, which also includes prize and grant money. Another 12% (\$162 million) comes from Virgin Group internal seed investment into Virgin Galactic as reported in fourth quarter earnings reports.

Yet even with all of this record-breaking investment in start-up space ventures, financial sponsors report that, from their standpoint, there's an enormous amount of available capital looking for opportunities. John Stack, managing director and head of U.S. aerospace and defense investment banking at Canaccord Genuity LLC said that with an investment capital pool of some \$1.6 trillion available, "investors continue to seek companies with strong growth potential. Furthermore, despite industry consolidation over the past few years, the publicly traded aerospace and defense companies also have meaningful capacity to acquire other businesses."

Investment Type	2017 (millions)	Change	2018 (millions)	Change	2019 (millions)
Seed/Prize/Grant	\$563.17	77%	\$998.66	31%	\$1,308.83
Venture Capital	\$1,674.17	24%	\$2,073.07	95%	\$4,043.68
Private Equity	\$0.0	--	\$85	-100%	\$0.0
Acquisition	\$360	-72%	\$100	6%	\$106
Public Offering	\$0.0	--	\$11	-100%	\$0.0
Total Investment	\$2,597.34	26%	\$3,267.73	67%	\$5,458.51
Debt Financing	\$4.97	5,273%	\$267.07	-9%	\$242.31
Total with Debt	\$2,602.31	36%	\$3,534.81	61%	\$5,700.82

Table E-1. Total 2019 start-up space investment increased about 61 percent.

Start-up Space for the Long Term?

To date, only a small percentage of the hundreds of space start-ups financed since 2015 are drawing revenue on business operations, and fewer still—if any—have reached profitability.

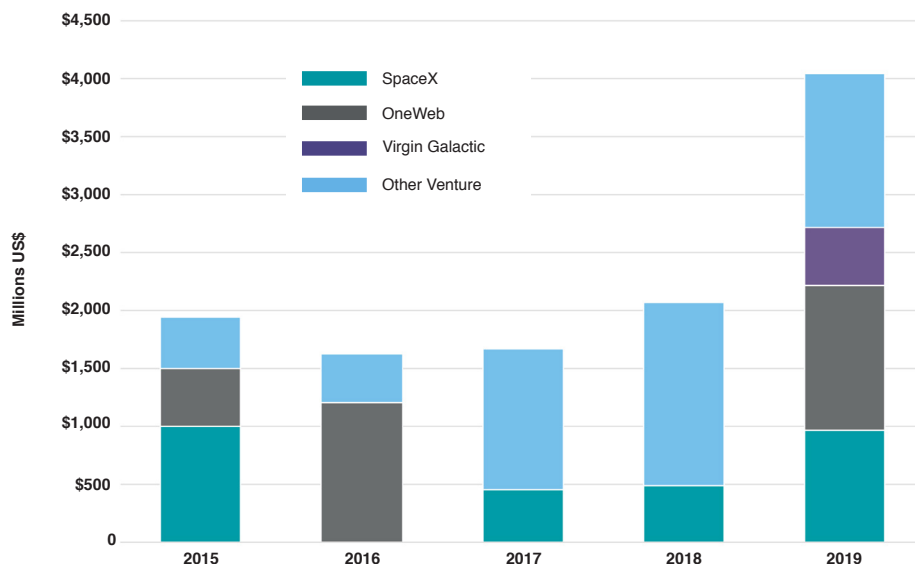


Figure E-4. About 52 percent of all venture investment in the last five years has gone to SpaceX and OneWeb.

The leveling off of the number of United States start-up space ventures receiving investment in 2019 indicates that many prospective investors are waiting to see how companies that have raised capital in the recent past perform in the months and years ahead.

“The ideas from a few years ago raised a lot of money, and the companies have turned those ideas into new technology,” said Sunil Nagaraj, founder and managing partner with the Silicon Valley-based investment firm Ubiquity Ventures. Nagaraj, whose previous firm, Bessemer Venture Partners, was an early investor in several well-known start-up space companies, including launch services provider Rocket Lab and imaging satellite operator Skybox. “The reckoning is: Does that result in business value?”

Silicon Valley capital emerged as a major catalyst five or six years ago as tech investors recognized the potential for satellite data to drive information-centric business applications. This, in turn, has fueled efforts to reduce the cost of building and launching satellites. Whether these new price points will ultimately translate into sustainable profits remains to be seen.

“In certain areas investors will take a pause to let business models evolve and see how performance shakes out,” Stack said. “Where companies are not proving themselves, there will be rationalization and consolidation, while successful companies will become prime acquisition targets.”

There are indications that the rationalization is beginning, as 2019 saw three high-profile casualties in the sector: broadband hopeful LeoSat, small rocket maker Vector, and satellite data-relay provider Audacy Space. Failure is par for the course in any venture capital-funded sector. About three-quarters of venture-backed firms in the U.S. don’t return investors’ capital. More such failures are

to be expected in the coming years as the availability of capital tightens for companies that are behind on their performance milestones or cannot realize sufficient demand for their products and services. This can be expected to lead to a rationalization and consolidation of the industry in the years ahead.

While start-up space remains unquestionably dynamic as a sector, investors have noted the dearth to date of lucrative exits.

“Every venture capitalist considering a space investment is eager to see more liquidity in the sector...” Nagaraj said. “At the moment we’re in this wait-and-see phase and as startup space companies hit more business milestones, more liquidity will emerge.”

Government’s Increasing Role in Start-up Space

An increasingly important feature of the start-up space investment landscape is the enabling role played by the government, both as a source of direct funding and a perceived stamp of approval that builds confidence among private investors.

The creation of the U.S. Space Force and an increase in study contracts awarded by government agencies are making government business more attractive to start-ups. Lucrative government contracts could offset sluggish development of commercial markets for some of these companies.

“In dealing with investors, if you have customers willing to pay and take this risk, that’s transformative,” said Pamela Melroy, a former NASA astronaut who subsequently served as deputy director of tactical technology at the Defense Advanced Research Projects Agency (DARPA).

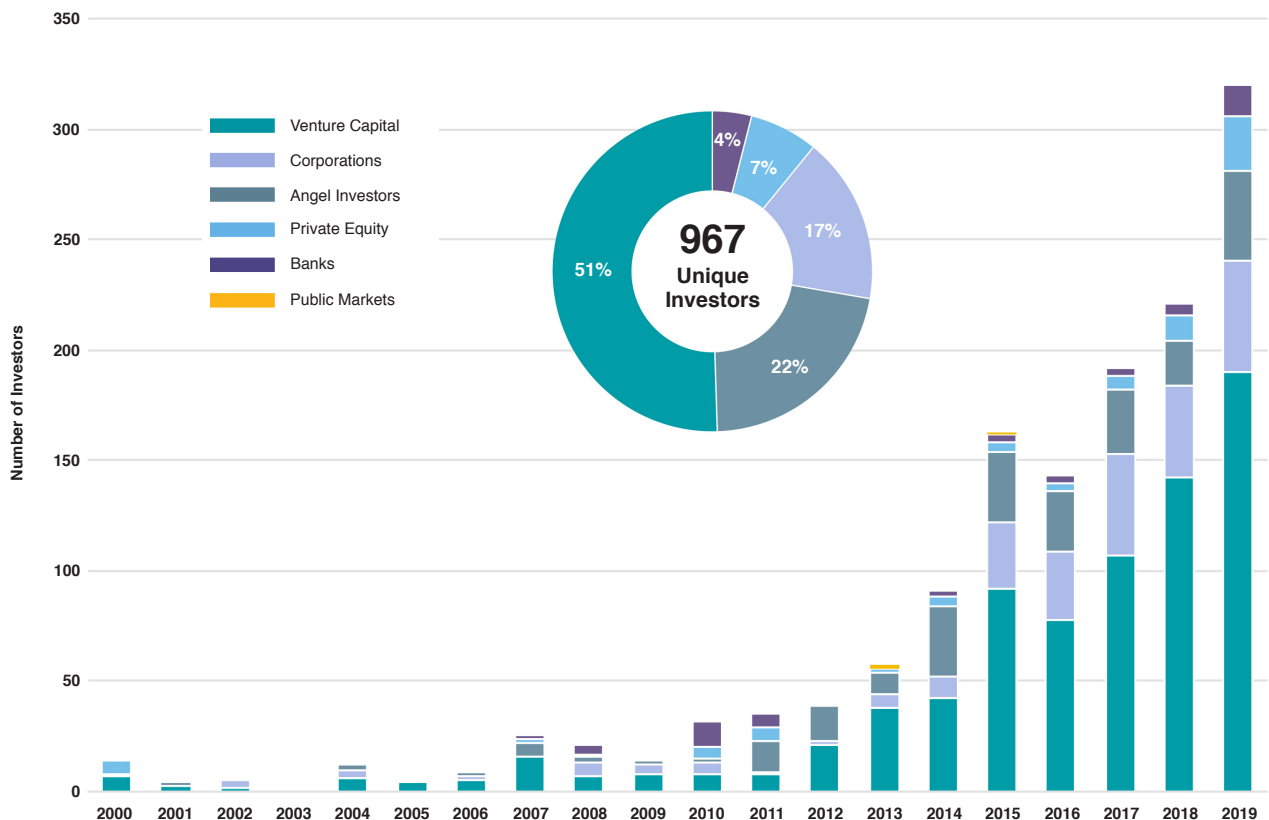


Figure E-5. The mix of investors in space companies varies year to year, with more venture capital firms in recent years.

The start-up space industry is becoming an important source of innovation for the government, Melroy said. “The pressure on defense, particularly in space acquisition, to move faster has forced a marriage with start-up space companies who are more comfortable with ‘other transactions’ and other types of rapid contracting mechanisms,” she said. The government has an opportunity to leverage emerging start-up space companies to help it to do more while spending less.

Governments have an opportunity to leverage emerging start-up space companies to do more while spending less—at the same appropriately managing the additional uncertainty created by this venture-backed, dynamic innovation. As start-up space activity moves into the 2020s, government stakeholders will be an increasingly important element of the potential success of venture-funded space start-ups.

Looking Forward

Looking ahead, 2020 is shaping up as an important year for many of the companies and applications that comprise the start-up space universe. Investors look to see continued progress in deploying constellations/new vehicles from high profile start-ups. SpaceX and OneWeb made significant progress in deploying their LEO broadband constellations in 2019 and investors will look for that progress to continue in 2020.

In the small launch arena, Rocket Lab appears to be hitting its stride, with six missions in 2019 and a 2020 manifest that includes its first launch from U.S. soil. Significantly, the company has said it is no longer seeking financing. Virgin Galactic spinoff Virgin Orbit, meanwhile, expects to conduct its first orbital launch in 2020. However, due in part to the large number of competitors in this arena, the outlook for small launch vehicles as a whole looks uncertain.

Finally, the U.S. government continues to be an important source of revenue for start-up space companies, both in launch services and in applications like remote sensing. Indications are that this trend, which accelerated in 2019, will continue in 2020 and beyond.

At the time of this writing, multiple companies had already announced financing during 2020; several were on the cusp of critical milestones; and others were seeking a path to profitability while adjusting to the realities of the marketplace. These and other factors have begun to shape what promises to be an eventful year ahead.



INTRODUCTION

The *Start-Up Space* series examines space investment in the 21st century and analyzes investment trends, focusing on new companies that have attracted private financing.

Start-Up Space reports on investment in start-up space ventures, defined as space companies that began as angel- and venture capital-backed start-ups. This definition differentiates start-up space ventures from aerospace and defense government contractors and large, publicly traded space enterprises. *Start-Up Space* seeks to provide insight into the dynamics of this growing space industry segment and the investment driving it.

The report tracks seed, venture, and private equity investment in start-up space ventures as they grow and mature, from 2000 through the end of 2019. The report includes debt financing for these companies where applicable to provide a complete picture of the capital available to them. The report also highlights start-up space venture merger and acquisition (M&A) and initial public offering (IPO) activity.

Purpose and Background

Bryce Space and Technology conducted the *Start-Up Space* study and produced this report, *Start-Up Space 2020*, the fifth in this series.

Capital that could be directed at any industry sector is flowing into space companies. This report seeks to inform investors, the aerospace industry, and the public about activity in this emerging space ecosystem. It reflects Bryce's ongoing commitment to providing the space community with rigorous analyses of industry dynamics to aid good decision-making in industry, government, and academia.

Methodology

Our dataset is sourced from a combination of: (a) publicly-reported investment transactions in start-up space ventures as they mature, with details on investment level and investors where reported; (b) additional companies for which little or no transaction data was reported, but which we have identified as start-up space ventures; and, (c) qualitative data about investment trends and investor motivations. Bryce conducts ongoing interviews, surveys, and conversations throughout the global investment ecosystem, including at key nodes such as Silicon Valley/San Francisco, Southern California, Washington, D.C., Seattle, New York, Florida's Space Coast, Houston, Austin, Beijing, Brussels, Hong Kong, London, Luxembourg, Paris, Singapore, Sydney, and the United Arab Emirates.

Definition of Start-Up Space Venture

Our definition of a **space company** is a business entity that provides space products or services, specifically one that:

- Manufactures satellites, launch vehicles, or other space-based systems
- Manufactures satellite ground equipment
- Provides services that rely on these systems, such as satellite TV, radio, and broadband
- Provides analytic services based on data collected extensively from space-based systems, either alone or in combination with terrestrial systems

Our criterion for a **start-up venture** is a space firm that has received and reported seed funding or venture capital. We term these firms start-up space ventures throughout this report, inclusive of all development stages.*

Data Set

We include in our data set all firms that meet these criteria at any time during the period 2000–2019. Analysis of investment magnitude (i.e., value), investors, and transactions throughout this report is based on data available as of the first quarter of 2020, covering transactions through December 31, 2019.

Our data set includes six key types of investment (seed, venture, private equity, acquisition, debt financing, and initial public offering) in the firms that fall within the definition of a start-up space venture. A firm that receives venture funding and then receives a significant investment from a private equity group would be considered a start-up space venture by our definition, and the investments of both the venture firm and the private equity group would be included. On the other hand, a long-standing aerospace firm that recapitalizes and receives an investment from the same private equity group would not be considered a start-up, and the private equity investment would not be included in this analysis. The focus of this analysis is ‘new’ start-up space ventures and the capital they are attracting.

Note that the seed category includes funding from prizes (such as business plan competitions or XPRIZE), foundations, and crowdfunding campaigns, as well as seed funding from angels and “space billionaire” super-angels.

We include debt financing for start-up space ventures to provide a complete picture of the capital available to the management team at these companies.

Sources of data on companies and investments include Bryce Space and Technology databases; company and investor press releases; annual reports, investor materials, and SEC filings; financial newsletters and databases, such as Crunchbase, PitchBook, Owler, and CB Insights; data provided by NewSpace Hub; news articles from major media outlets, investment publications, trade press, and business journals; and ongoing engagement with industry subject matter experts. Where possible, we confirmed the details of each investment using multiple sources. We further validate our data with venture capitalists, private equity investors, investment bankers, industry experts, management teams at space companies, and through targeted interviews.

The data set includes only publicly reported transactions; it does not include proprietary investment information. In some cases, transaction value, funding round, or investors are undisclosed. Depending on available information, these are either estimated or excluded.

The data set generally excludes government funding, except for certain grants, such as those provided by the Grand Duchy of Luxembourg. A few quasi-government corporations are included (e.g., Midland Development Corporation and The Valencian Institute of Finance), where they provide seed or venture investments with economic development objectives. Bryce also includes funding from publicly funded venture capital firms, such as the Central Intelligence Agency’s In-Q-Tel.

* Generally, there is not one standard, widely accepted definition for what constitutes a start-up. Typically, different stages within start-ups are described. For example, one typology defines the following stages: seed stage is an idea that is not yet operational, early stage has begun operations but is not yet fully operational, growth stage has commercial revenues but needs outside capital to scale, and expansion stage is just prior to an initial public offering (IPO). Venture capital firms may choose to build a portfolio focusing on a particular stage or diversify across companies at differing stages of maturity.

OVERVIEW OF START-UP SPACE VENTURES

Over 310 new angel- and venture-backed space companies have been founded and funded in the period from 2000 to 2019. In the early 2000s, an average of four funded space companies were started per year; today the figure is nearly eight times higher. (In the last five years, the number of funded new companies has averaged 29 per year.) That average excludes new firms that have not yet secured investment. See Figure 1.

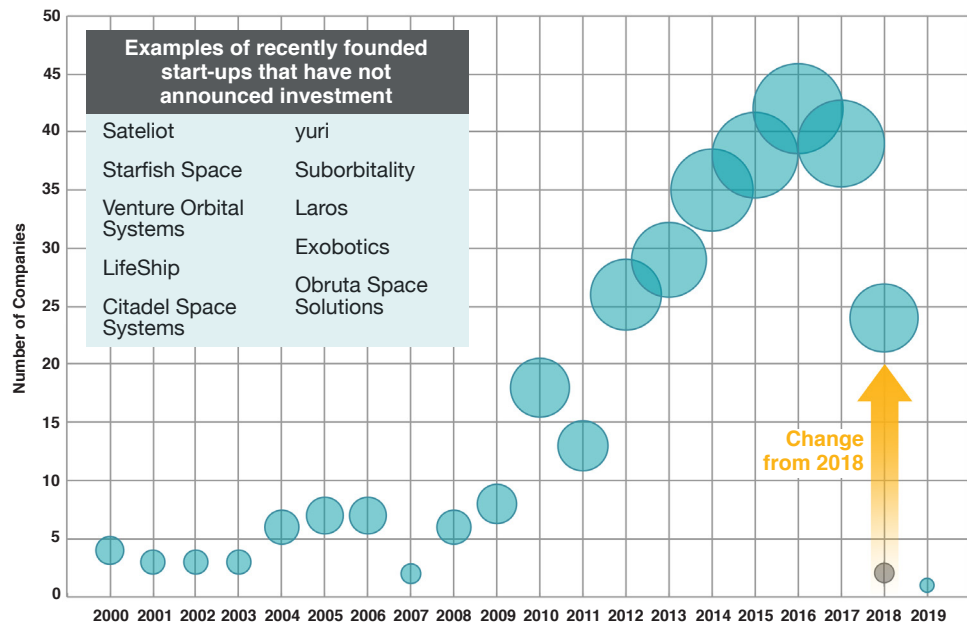


Figure 1. Over 310 angel- and venture-backed space companies have been founded and funded since 2000, and examples of space start-ups that have not announced investment. Excludes companies that have not announced investment, including many founded in the last few years. In the 2019 Start-Up Space report, only two angel- or venture-backed start-up space companies were reported as having been founded in 2018. In the 2020 Start-Up Space report, the updated 2018 number increased to 24 companies. This suggests that the number of reported start-up space companies founded in 2019 (1) will likely increase in the future. Data for inset reflects publicly reported investments through December 31, 2019.

From 2009 to 2010, the number of new space start-ups more than doubled and venture capital investment increased 55%. Three of the newly founded companies were lunar exploration start-ups, which competed in the Google Lunar XPRIZE competition (Moon Express, ispace, and Team Indus). Other companies founded in 2010 attracted \$1+ billion of venture capital in later years, including Planet, Satellogic, ispace, and Mapbox. The more than tripling of new start-up space companies from 2009 (8) to 2012 (26) coincides with a near quadrupling (to \$198 million) of venture capital invested in space start-ups during that span.

There is generally a multi-year lag from a company's founding to when it receives external investment. Therefore, recently founded companies have not had a chance to raise (and announce) external funding and are not included in Figure 1. Potential reasons for not announcing funding include actively pursuing further funding rounds, or the protection of a competitive advantage while in "stealth" mode. The total number of reported start-up ventures has increased compared to Bryce's *Start-Up Space 2019* report, reflecting new announcements by existing companies, new companies, and enhanced data sets. Based on the recent trend, Bryce anticipates that the 2019 number will increase in the next 1 to 2 years.

TYPES OF SPACE INVESTOR

This analysis considers six categories of investor to aid in understanding trends in investment and investor motivation.

The investor typology used in this study consists of: angel investors, venture capital firms, private equity (PE) firms, banks (typically not strictly investors, but an important source of capital), corporations (as strategic partners and/or internal investors, or through corporate venture funds), and public markets. This typology conceptually groups some investor types that could be treated separately but share characteristics, such as sovereign wealth funds (included in venture capital category) and hedge funds (included in the venture capital firm category). While investor categories continue to shift and evolve, the typology here provides a useful (and generally accepted) broad description of groups of investors and their typical investment behaviors.

We describe each type of investor and typical (1) role as a funding source, including the stage of involvement; (2) preferred funding instrument (e.g., debt, equity, or hybrid debt/equity instruments); and (3) general objectives in investing. For illustrative purposes, examples of select space deals are also provided.

Angel Investors

Typically, angel investors are individuals or families (including family offices) that have accumulated a high level of wealth and seek potentially high returns by investing in ventures during their early stages. In recent years, angels have also participated in syndicates, pooling investments with other angels and venture capital firms to provide more funding to start-ups. This model enables an angel to invest in more companies and spread risk. For example, instead of investing \$100,000 in a start-up, four angels will invest \$25,000 each. If the start-up fails, the angels have minimized risk through smaller, more frequent investments. We include incubators and accelerators in this investor group because they provide equity as well as mentoring and networking at the pre-seed or seed stage of a start-up. Investment by angels into start-up space ventures is usually in the form of straight equity into the company. Investments often range from \$50,000 to more than \$1 million. There is a highly visible special category of angel investor in the space ecosystem, consisting of billionaires and other ultra-high net worth individuals who have personally staked investment in new space companies. The investment level by space billionaires far exceeds typical angel levels.

By getting in at the ground floor (i.e., when a company is just starting development of its product or service), an angel investor can realize an attractive potential return, as the early investment will secure a significant foothold in the company. Time horizons for angel investors are about 5 to 7 years, meaning they seek to realize their return (i.e., exit) about 5 to 7 years from the date of investment. Angels may expect an equity stake in the company as high as 30 to 40% in return for their investment; however, frequently, angel stakes are much lower, especially after subsequent, larger investors join the capital structure.

Angel investors range from those who can comfortably make a \$50,000 investment to, as noted, particularly in commercial space ventures, 'super-angel' multi-billionaires who typically invest in space start-ups at the \$100+ million level. These investors have already made their mark in technology-driven enterprises, and include Jeff Bezos of Blue Origin (Amazon), Elon Musk of SpaceX (PayPal), and the late Paul Allen of Stratolaunch (Microsoft). Some super-angel investors

have stated an interest in space investment for purposes other than or in addition to profit seeking (e.g., exploration and the advancement of scientific knowledge). Some in the investment community have defined these investments as “self-finance.” Bryce defines these investors as super-angels, and caveats analyses of investment totals to highlight the impact of super-angel investment (\$100+ million deals) on the wider picture of investment activity.

Venture Capital Firms

Venture capital (VC) firms are groups of investors that invest in start-up, early stage, and growth companies with high growth potential, and accept a significant degree of risk. The trade of risk for potential high returns results in a high failure rate. A 2012 research study by Shikhar Ghosh, senior lecturer at Harvard Business School, finds that, “About three-quarters of venture-backed firms in the U.S. don’t return investors’ capital.”

VC funding has traditionally come in stages (or rounds), generally designated Series A, Series B, Series C, etc. The form of investment is equity; specifically, the instrument is usually preferred stock. Consequently, the VC firm has an equity ownership stake in the company, but at a higher priority (or preference) than investors at common equity (e.g., founders, employees, and angels) and a lower priority than any holders of company debt. The preferred shares are usually convertible to common stock in the instance of a stock market launch or initial public offering (IPO; see “Public Markets”) or sale of the company, which are the typical instances of a VC’s exit. There is substantial variation in the size of rounds, but Series A investment rounds typically range from \$2 million to \$10 million; Series B in the low tens of millions of dollars; and Series C in the high tens of millions of dollars. Investment syndicates comprised of multiple VC firms may significantly increase these levels. Note that the distinct ‘series’ model for VC investments is evolving, with more continuous investment by an ongoing team of investors emerging as a trend. In addition, whereas historically each successive round would be labeled consecutively, by letter, a more recent model appends numbers to rounds. For example, if a start-up raises \$7 million in a Series A financing from a group of investors, and several months later raises an additional \$3 million from new investors, under the same terms as the Series A financing, then the new investment would be considered Series A-II.

Several space-oriented VC funds have emerged from this class of investors.

In 2017 the early stage-focused angel syndicate Space Angels announced a \$50 million inaugural fund, Space Capital, which has invested in 9 start-up space ventures as of the end of 2019.

Seraphim Capital also launched a space technology fund in late 2016. Seraphim Space Fund is a \$100+ million space-focused fund, whose investors include Surrey Satellite Technology, Airbus, SES, Telespazio, Teledyne, Rolta, First Derivatives, The British Business Bank, the European Space Agency, and the United Kingdom’s Satellite Application Catapult. Based in London, the fund takes a broader interpretation in its definition of space technologies, extended to include those developed for use in space that may now be applied in other areas, such as unpiloted aerial vehicles. Seraphim Capital also backs the Seraphim Space Camp designed to enable the start-ups to become investment-ready.

In 2015, Bessemer Venture Partners announced the creation of its \$1.6 billion fund, BVP IX, to invest in innovative companies, including those in the space sector. In addition to VC funds, governments and sovereign wealth funds have emerged as

investors in start-up space companies. For example, in 2016, Luxembourg opened a \$227 million fund, SpaceResources.lu, to provide “early stage investments in innovative start-ups as well as in more mature companies, with a focus both on Luxembourg-based enterprises in the space resources industry, and companies developing substantial space resources related technologies in the Grand Duchy.”² Though Luxembourg realized capital loss of around US \$13.7 million, its fund dedicated to space resource utilization has remained active.³ In November 2017, the Luxembourg Future Fund (LFF), set up by the European Investment Fund and the Société Nationale de Crédit et d’Investissement, also provided funding to a space start-up. LFF and Promus Ventures led a \$70 million Series C in Spire Global, a weather and asset tracking space start-up. Russia (Skolkovo) and China (Cyberagent) launched Cybernaut, a \$200 million venture fund in 2015, with space technology as one focus area (reported by Fortune). In October 2015, a Russia-based satellite manufacturing start-up, Dauria Aerospace, secured a \$70 million project from Cybernaut (as reported by Tech in Asia).

In February of 2019, Starburst Aerospace and Techstars announced plans to accept applications for a new space-focused accelerator based out of Los Angeles. The accelerator, backed by the U.S. Air Force, NASA’s Jet Propulsion Laboratory, Lockheed Martin, Maxar Technologies, SAIC, and Israel Aerospace Industries, plans to award each selected participant a \$120,000 seed investment, as well as executive mentorship. Starburst Aerospace and the U.S. Air Force organized the first Air Force Space Pitch Day where 12 companies received \$750,000 Small Business Innovation Research awards. Starburst Ventures, a venture fund of Starburst Aerospace, had previously announced a \$200 million space-focused fund in 2016, but has so far reported only one investment, in 2017.

Private Equity Firms

Private equity firms manage funds of capital on behalf of limited partner investors, typically with a mandate to invest directly in companies. They traditionally invest in established companies (not start-ups) at large transaction sizes, often acquiring an entire company or a group of related companies that can merge. The funds managed by private equity firms primarily consist of capital commitments made by institutional investors, such as sovereign wealth funds, pension funds, and family offices. These investors may also invest in other types of funds, for example venture capital, as well as directly into private companies. Family office investors may be single or multi-family offices, where multi-family offices represent aggregated pools of capital from high net worth individuals.

Larger investment firms, which typically have multi-billion-dollar investment funds from which they draw funds, have shown some interest in space over the past 15 years. Historically, the appetite for such investment has been limited to investment in the telecommunications industry or government contracting, such as deals from Blackstone, Columbia Capital, Permira, Apax, and the Carlyle Group. Large private equity firms tend to invest magnitudes over \$100 million, usually in firms that are ideal candidates for debt restructuring or leveraged buyouts. This trend has been the case for several large commercial satellite operators.

However, in recent years, the traditional characteristics distinguishing private equity from venture capital investments have somewhat broken down. In an environment where asset managers of both classes are awash with investor capital looking to be deployed, many private equity and venture capital managers have expanded their investment mandates to include debt and “hybrid” capital offerings. In high growth technology sectors such as space, often characterized by companies that

are yet to demonstrate profitability, debt is typically offered secured against the revenue streams generated by customer contracts. Of late, many PE managers are making equity investments at earlier stages of companies' maturity—on a minority basis, and with longer expected exit time-horizons. It should be noted, however, that these developments are not limited to the start-up space sector, and are at least in part a reflection of the widespread proliferation of new technologies and business models throughout the global economy.

Examples of private equity investment in space include Blackstone's \$200 million investment in Sirius Satellite Radio and its nearly \$1 billion purchase of the commercial satellite capacity provider New Skies Satellite; Columbia Capital's substantial investment in XM Satellite Radio and Ligado Networks (formerly LightSquared Company); and Apax, Permira, and Carlyle Group's multi-hundred million dollar investments in the acquisitions of large satellite services companies, such as Intelsat, Inmarsat, and PanAmSat from 2003 to 2004. Permira bought Asia Broadcast Satellite for \$200 million in September 2010; however, there have been few space-related private equity deals since the financial downturn in 2007/2008.

Corporations

Corporations have often provided the funding necessary to bring space-based programs to initial operating capability, as well as to sustain ongoing programs. Corporations invest internally, in R&D, in manufacturing, in operations and processes, and in many other areas to enhance capabilities to create or strengthen an existing expertise or advantage.[†]

A corporation may also provide funding for a venture, usually in the form of straight equity or sometimes in the form of debt, often with the option to convert the instrument into equity of the investee company. Some large companies may also invest through a corporate venture fund (examples include Boeing HorizonX and Lockheed Martin Ventures), which acts as a company-owned VC equivalent.

Liberty Global, a longtime cable operator, is one example of a corporation serving as a strategic partner. Liberty Global participated in private equity and venture capital deals from 2008 to 2013 in O3b, a satellite-based internet delivery constellation, and Kymeta, an omnidirectional satellite antenna developer. In 2009, SES, a commercial geosynchronous orbit (GEO) satellite fleet operator, invested \$75 million (a 30% stake, early in the investment cycle) in O3b.

More recently, the industry has seen a variety of corporations investing in space, with Lockheed Martin's undisclosed investment in small launcher ABL Space Systems; ESRI and Airbus and others investing \$70 million of Series B in Hawkeye 360; and Chevron, Sky Perfect JSAT Corp, Google, and others investing \$50 million of Series D in Orbital Insight. SoftBank, Virgin, Coca-Cola, Intelsat, Airbus, Qualcomm, and Hughes Network Systems, Totalplay, and Bharti Enterprises invested a total of \$3 billion in OneWeb from 2015 to 2019.[‡] In February 2015, Google invested \$900 million in SpaceX, "to support continued innovation in areas of space transport, reusability and satellite manufacturing."

Corporations may also acquire firms. A record-setting example is the AT&T purchase of DirecTV in 2015 for \$48.5 billion, which set a new bar for acquisition of a space company. More recently, Northrop Grumman acquired Orbital ATK for \$7.8 billion in mid-2018. Note that DirecTV and Orbital ATK are not start-up space ventures under our definition. These transactions are more typical of the merger and acquisition activity for established companies. With that said, corporations have recently also acquired firms that fit the model of start-up space

ventures. In 2019, corporations acquired six space start-ups for an estimated total of \$106 million (see Table 5 later in this report).

Banks

Banks have been heavily involved in providing and facilitating funding for space-based programs of large, established firms, such as GEO satellite operators, during the past 20 years. The basic model is that equity investors provide a substantial “cushion” (e.g., 30% of the total capital expense or CapEx required for a certain program, such as deployment of a satellite or satellites). The remainder of CapEx (or other types of programmatic expenditure) is financed by debt, sometimes in the form of “convertible debt,” meaning that the initial instrument is in the form of debt. At certain trigger points, the debt can be converted, in whole or in part, into an equity stake in the financed company.

Commercial banks based in the United States, such as Wachovia, Wells Fargo, and Citibank, and non-U.S.-based banks, such as Deutsche Bank, BNP Paribas, and ABN AMRO, in Europe, have provided debt financing at a magnitude of \$100 million to \$1 billion (sometimes exceeding \$1 billion) per funding event. Most of the companies financed are companies with large satellite CapEx requirements, such as Intelsat, SES, and Inmarsat, for which multiple GEO satellites are required at a cost of \$250 million to \$300 million each to build, launch, and insure. Other companies financed (e.g., Iridium and GlobalStar) have \$2 billion to \$3 billion CapEx requirements for low Earth orbit (LEO) satellite constellations.

In addition, government-backed banks (i.e., export credit agencies), such as U.S. Export-Import (Ex-Im) Bank and COFACE of France, have provided debt funding (or guaranteed third-party debt funding) for several satellite systems. The purpose of these banks is to support deals that benefit domestic enterprises. For example, the Ex-Im bank may provide financing to benefit an export deal involving a U.S. satellite manufacturer. Ex-Im Bank has provided multi-hundred million-dollar debt financing at various points in the past to satellite operators, including ViaSat of the United States, AsiaSat and Asia Broadcast Satellite in Asia, and Spacecom in Israel. The Export-Import (Ex-Im) Bank lost its quorum in 2015, which meant that its board of directors could not make any commitments over \$10 million. Ex-Im regained its quorum in 2019 when three new board members were confirmed by the Senate and received a seven-year re-authorization. COFACE has backed the debt obligations of several satellite constellations, including O3b, GlobalStar, and Iridium. Both Ex-Im Bank and COFACE have provided loans and debt guarantees to an Australian company, NewSat, for \$400 million. Moreover, Ex-Im Bank provided \$525 million in debt financing for ViaSat in November 2014. Proceeds were earmarked for the build and launch of the company’s two Ka-Band (broadband) satellites. In 2019, Kacific Broadband Satellites secured \$160 million in debt from the Asian Development Bank and other institutions.

Banks are less likely to have a major role in providing financing for start-up ventures.

[†] A special category of internal investment typical of space firms for whom the U.S. government is a major customer is “independent research and development (IR&D),” which is a type of government-sanctioned R&D expenditure that affects how the government pays a contractor firm for the work that it does.

[‡] In Q1 2019, OneWeb announced that it had raised a total of \$3.4 billion since its founding, including a \$1.25 billion round in 2019. This implies additional, undisclosed funding beyond the \$2.95 billion in disclosed transactions (roughly \$1.7 billion through 2018 and the \$1.25 billion transaction in 2019). Given the uncertainty around the timing of this previously undisclosed funding, Bryce will treat it as a 2019 investment, consistent with the date OneWeb included the amount in its public statements.

Investment Banking

Note that investment banks and investment bankers—often-visible actors in complex investment transactions typically involving private equity, corporations, and/or public markets—often act as brokers arranging and facilitating these transactions, rather than as the principal lenders or investors. Investment banks play a variety of roles, including advising on capital raising approaches and more strategic transactions such as mergers and acquisitions (M&A), as well as underwriting a capital raising event (e.g., an IPO). Investment banks often focus on large transactions (typically in the multi-hundred million-dollar to over \$1 billion range), and large space/satellite communications companies work with investment banks as financial advisors. These institutions will usually take the role of “lead managers” of a financing transaction, often with several fulfilling that position. For example, J.P. Morgan, Lehman Brothers, and UBS acted as joint lead managers for a \$500 million capital raise in 2007 for fledgling mobile satellite services operator TerreStar (now owned by DISH Network).

Public Markets

Toward the later stages of a space-based company’s funding trajectory, there can be a public sale of the company’s equity (common stock), or initial public offering (IPO). The IPO enables additional capital to be raised to supplement prior funding rounds and provide previous investors an exit mechanism for their investments (i.e., sell their equity shares in the public market place). Many established space companies and government contractors have long since had their IPOs and continue to trade publicly. Examples include Boeing, Lockheed Martin, Northrop Grumman Corporation, and Harris Corporation.

IPOs in the space industry, while somewhat rare, have ranged from around \$100 million (e.g., GlobalStar and Orbcomm) to about \$800 million (e.g., Intelsat). Secondary offerings (post-IPO) also serve to provide funds for capital expenditures and other corporate purposes (e.g., operations, working capital, and retirement of debt). DigitalGlobe raised \$279 million in 2009, and in 2014, Iridium raised \$170 million through public sales of \$50 million in common stock and \$120 million in convertible preferred stock. (Iridium is not a start-up space company, by our definition.) IPOs of space start-ups have been very limited, with the only notable examples being UrtheCast, which went public on the Toronto Stock Exchange through a reverse IPO in 2013, and exactEarth, a geospatial analytics and maritime AIS data services company that went public in 2016 for an undisclosed amount. More recently, Kleos Space went public in 2018 with an \$11 million IPO raise. Virgin Galactic became a publicly traded company in 2019 after merging with Social Capital Hedosophia (see “Public Offering”). Virgin Galactic became a publicly traded company in 2019 after merging with special purpose acquisition company Social Capital Hedosophia. Virgin Galactic raised \$500 million in venture capital through the merger with the fund. We anticipate funds to be raised through public offering of new shares in 2020 and beyond (see Table 1).

Type of Investor	Characterization of Investor	Typical Space Investment	Investment Type	Examples of Transactions	Expected Returns/Exit Horizon
Angel Investors	High net worth individuals, families, or groups of angels	\$50K – \$1M	Equity	York Space Systems with \$250K of angel investment from Dylan Taylor in 2015	5-10X investment/5-7 years
Venture Capital Firms	Groups of investors focusing on early stage, high growth ventures and accepting a significant degree of risk	\$2M – \$75M	Equity preferred stock in several tranches (e.g., Series A, B, C)	Kymeta with \$218M of venture capital from multiple (2012–present)	5X investment/5 years
Private Equity Firms	Large investment houses that have multi-billion dollar investment funds—focus on established companies	\$100M – \$1B	Equity	Virgin Galactic with \$490M of investment from Aabar Investments (2009 and 2011)	3-5X investment/3-5 years
Corporations	<p>Large companies providing strategic investments to support large CapEx space projects</p> <p>Internal R&D for special projects</p> <p>Independent R&D as government contractor</p> <p>Merger and acquisition</p> <p>Venture investing</p>	\$100M – \$1B	Equity and sometimes debt	OneWeb with \$3.0B of investment from SoftBank, Airbus, Intelsat, and other corporations (2015-2019)	Significantly less returns than for PE firms/horizon is over a long term
Banks	Private and government-backed banks providing substantial debt financing layered over equity	\$100M – \$1B	Debt, sometimes convertible into equity	O3b with \$184M of debt financing from COFACE in 2015	Straightline interest rates (e.g., 5–10%)
Public Markets	Independent R&D as government contractor	\$100M – \$1B	Equity	Iridium raising \$170M in an IPO	Serves as a vehicle to allow the earlier investors to exit

Table 1. Different types of investors pursue different types of investment objectives.

SPACE INVESTMENT BY THE NUMBERS

Cumulative investment (including debt financing) in start-up space ventures since 2000 totals \$27.8 billion, including \$12.5 billion in early and late stage venture capital, \$4.6 billion in seed financing, \$1.8 billion in private equity, and \$5.1 billion in debt financing. This cumulative investment also includes \$3.8 billion in merger, acquisition, and public offering events. More than 60% of investment in start-up space ventures since 2000 has occurred in the last five years. Including debt financing, investors have provided more than \$2 billion to space start-ups in each of the last five years: \$2.8 billion in 2015, \$3 billion in 2016, \$2.6 billion in 2017, \$3.5 billion in 2018, and \$5.7 billion in 2019. Nearly \$18 billion (more than 80%) of investment since 2015 has been seed and venture capital. Looking at investment only (excluding debt financing), more than 70% of investment in start-up space ventures since 2000 has been in the last five years.

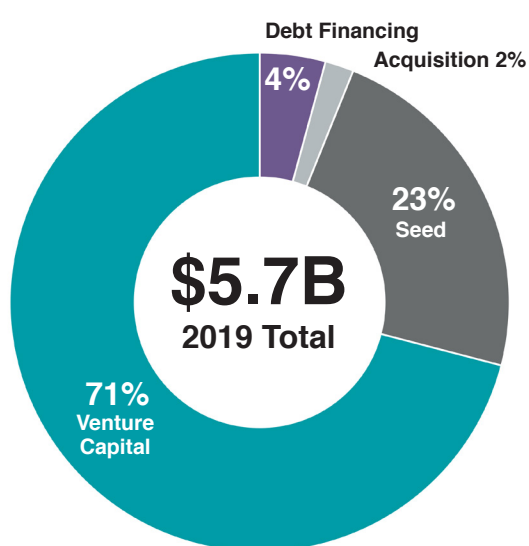


Figure 2. Venture Capital accounted for 71% of investment in 2019.

Investors provided a record \$5.7 billion to start-up space companies in 2019, about \$2.2 billion more than in 2018, the previous record year (see Figure 2). This difference is primarily driven by three large late-stage investments in SpaceX (at over \$200 million each), \$682 million raised by Virgin Galactic through seed and venture funding, \$1.25 billion investment into OneWeb, and one large investment in Blue Origin from Jeff Bezos (estimated at \$1 billion).

Investment in 2019 stemmed from 328 investors, across 150 deals. The number of start-up space companies reporting investment in 2019 was 135, increasing from 101 in 2018. The number of investors increased by 46% in 2019 (from 225 in 2018) while the number of deals grew 36% (from 110 in 2018).

The year 2019 featured 11 deals exceeding \$100 million. The largest were OneWeb's \$1.25 billion venture capital investment and Blue Origin's estimated \$1 billion angel investment from Jeff Bezos, followed by three raises for SpaceX totaling \$962 million. Together, transactions from these three companies made up 56% of all investment raised in 2019. When including Virgin Galactic's raises in 2019, these four companies account for 68% of all investment raised that year.

The mix of investment types (including debt financing) has evolved over the last 20 years. Seed funding is evident in most years; however, seed funding has typically been at a lower magnitude as compared to other investment types, with the notable exception of Jeff Bezos's super angel investment in Blue Origin. Debt financing is prominent in the middle years of this timeframe, whereas venture capital has significantly increased in more recent years. Private equity is also most evident in the middle period, when debt financing peaked. See Figure 3 for annual investments by type. Figure 4 shows annual investment of private equity, venture capital, and seed/prize/grant investment. In addition, Table 2 on Page 13 shows investment by type and percent change between the past three years.

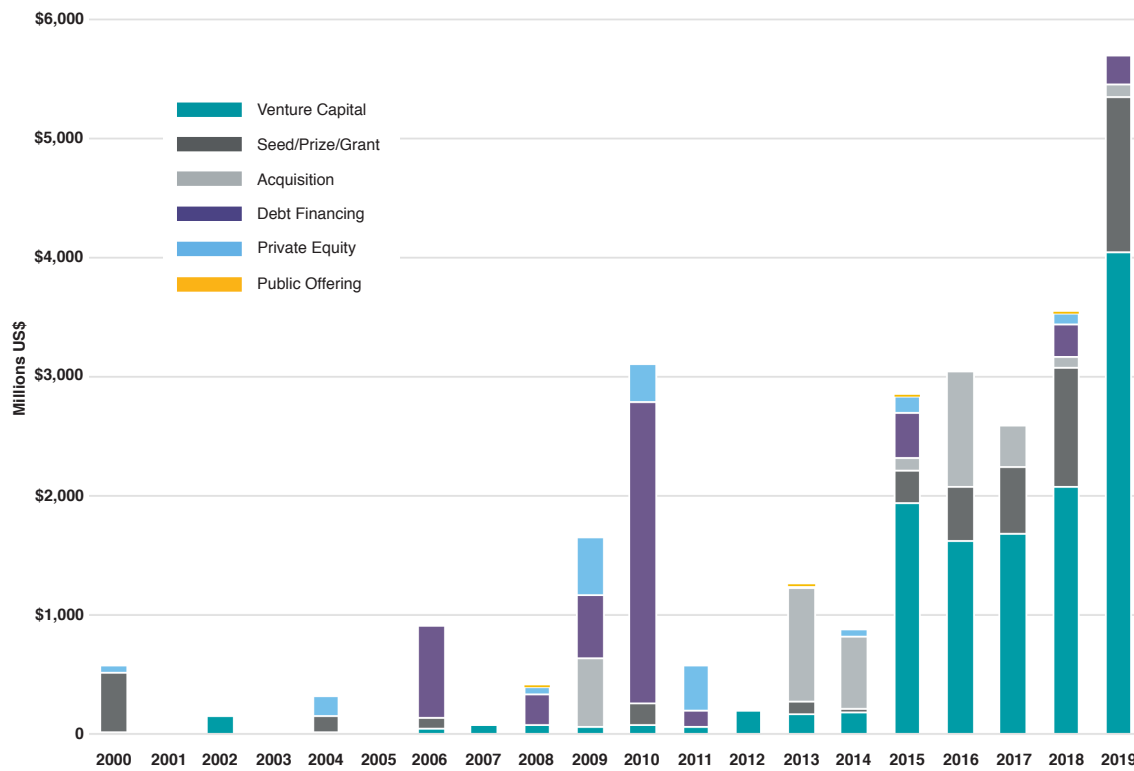


Figure 3. The mix of types of investment in space companies varies from 2000 to 2019.

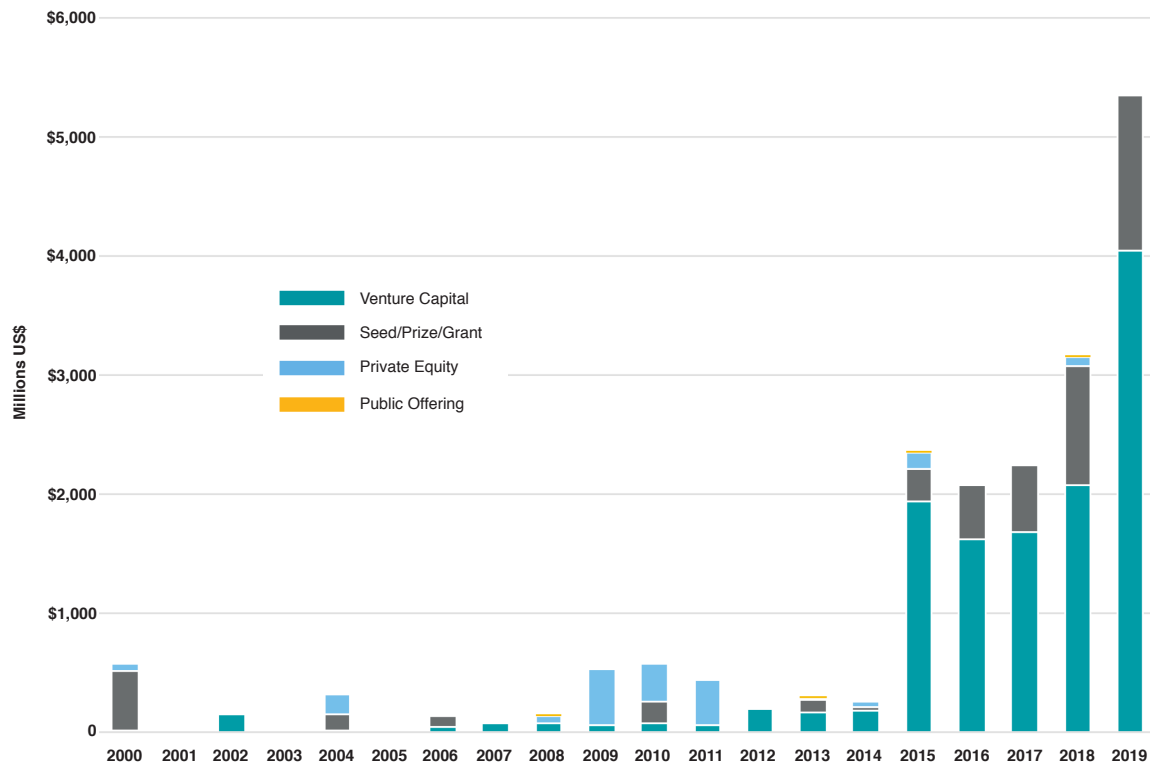


Figure 4. The mix of public offering, private equity, venture capital, and seed/prize/grant investment in space companies varies from 2000 to 2019.

Investment Type	2017 (millions)	Change	2018 (millions)	Change	2019 (millions)
Seed/Prize/Grant	\$563.17	77%	\$998.66	31%	\$1,308.83
Venture Capital	\$1,674.17	24%	\$2,073.07	95%	\$4,043.68
Private Equity	\$0.0	--	\$85	-100%	\$0.0
Acquisition	\$360	-72%	\$100	6%	\$106
Public Offering	\$0.0	--	\$11	-100%	\$0.0
Total Investment	\$2,597.34	26%	\$3,267.73	67%	\$5,458.51
Debt Financing	\$4.97	5,273%	\$267.07	-9%	\$242.31
Total with Debt	\$2,602.31	36%	\$3,534.81	61%	\$5,700.82

Table 2. Total 2019 start-up space investment increased about 61 percent.

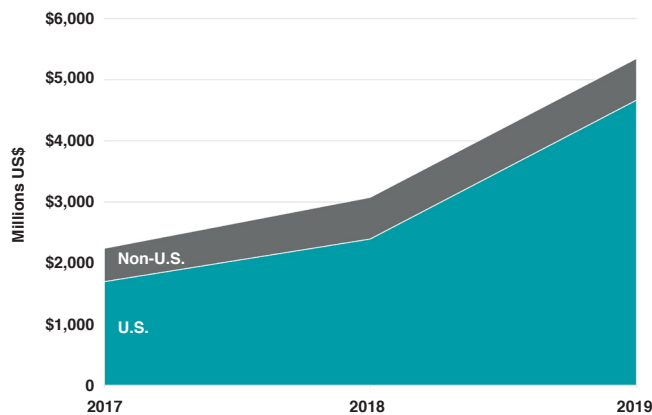


Figure 5. Seed and venture capital investment in space start-ups increased from 2017 to 2019.

U.S. start-ups have traditionally dominated start-up space, comprising more than 80% of investment in the last three years (see Figure 5). For the first time, the number of non-U.S. companies receiving investment exceeded the number of U.S. companies, making up nearly 60% of start-up companies receiving investment in 2019 (see Figure 6). Non-US investors also participated more in 2019, comprising 63% of investors (see Figure 7) Total investment in non-U.S. space start-ups increased by 27% in 2019 compared to 2018.[§] The largest investments were Kacific's \$160 million debt financing round and Qianxun Spatial Intelligence's \$141 million Series A. Non-U.S. seed and venture investment, the number of non-U.S. firms reporting investment, and the number of non-U.S. investors are greater than in 2018. The

number of non-U.S. investors increased from 119 to 205. From 2018 to 2019 the number of non-U.S. investors rose from 53% to 63% of all investors. Most non-U.S. investors in 2019 were from China and Japan (see Table 3).

Category	Location	2017	Change	2018	Change	2019
		(millions)		(millions)		(millions)
Total Investment	U.S.	\$2,024.5M	39%	\$2,822.8M	70%	\$4,799.8M
	Non-U.S.	\$577.8M	23%	\$711.9M	27%	\$900.9M
Seed and Venture Investment	U.S.	\$1,695.0M	42%	\$2,398.8M	94%	\$4,661.7M
	Non-U.S.	\$542.3M	24%	\$672.8M	3%	\$690.7M
		Number		Number		Number
Number of Investors	U.S.	97	9%	106	16%	123
	Non-U.S.	95	25%	119	72%	205
Number of Recipients	U.S.	51	6%	54	4%	56
	Non-U.S.	39	21%	47	68%	79

Table 3. Investment magnitude in U.S. and non-U.S. space start-ups, number of investors, and number of recipients from 2017 to 2019.

[§] This total considers investment in OneWeb to be investment in the United States, given the location of the majority of OneWeb activities.

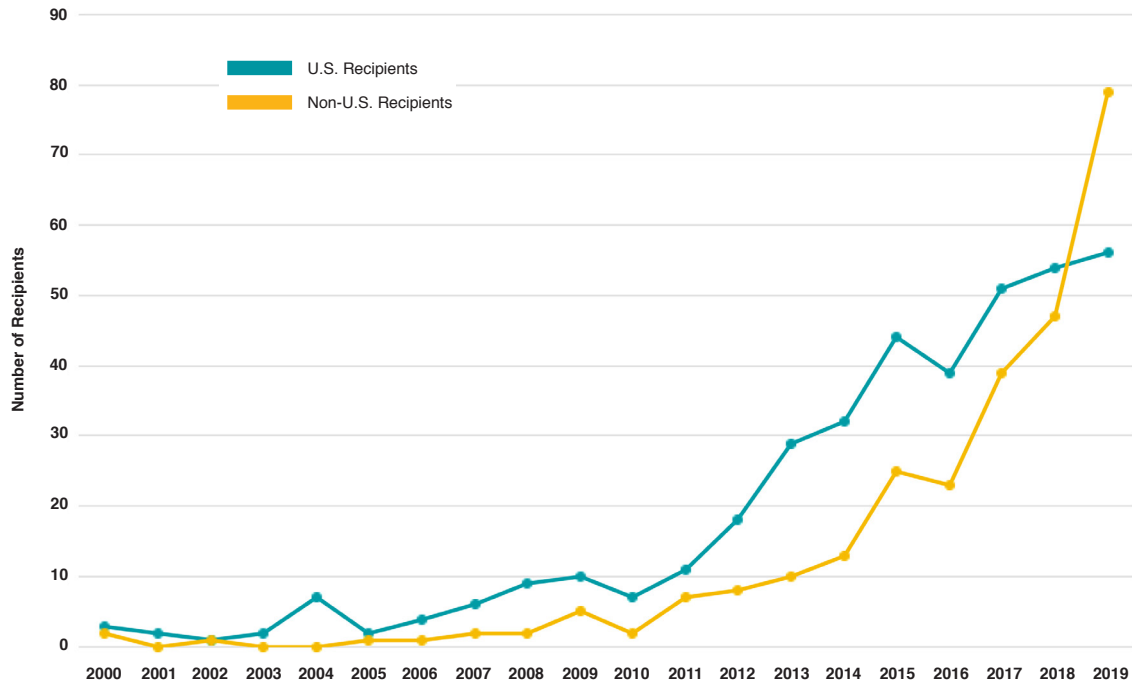


Figure 6. Number of U.S. versus non-U.S. investment recipients.

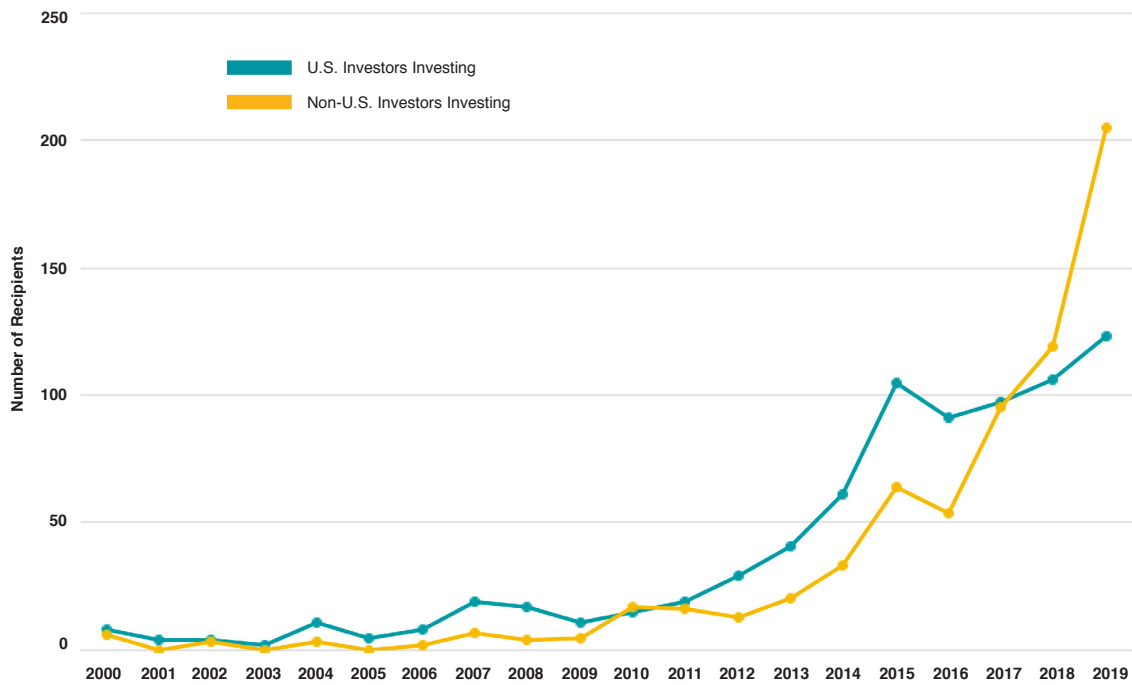


Figure 7. Number of U.S. versus non-U.S. investors.

Total investment in non-U.S. space start-ups in 2019 was \$901 million, a 27% increase from last year (\$712 million). Companies in China and the Singapore received 56% of the non-U.S. total. Seed and venture investment in non-U.S. space start-ups rose from \$673 million in 2018 to \$691 million in 2019.

Excluding investment associated with acquisitions, since 2000 four start-up space companies have attracted investment in excess of \$1 billion: Jeff Bezos is estimated to have invested more than \$3.4 billion in Blue Origin since 2000 (with some sources placing this total much higher); Google, Fidelity, and other investors have invested over \$3.4 billion in SpaceX since 2006; and SoftBank and other investors have invested \$3 billion in OneWeb since 2015.[∞] Virgin Galactic raised nearly \$1.5 billion through seed investment, private equity, and venture capital rounds (\$500 in venture capital from Social Capital Hedosophia and Chamath Palihapitiya in 2019). SpaceX closed a billion dollar deal in 2015 while OneWeb closed billion dollar deals in 2016 and 2019.

Seed Funding

For the total period covered in this report, seed funding is \$4.6 billion. Note that the large seed funding amounts in 2000 and from 2015 to 2019 primarily represent an estimated \$3.4 billion commitment by Jeff Bezos to Blue Origin; \$500 million of this estimated funding is counted here in the year of the company's founding. However, the timing of the commitment is not public. It may be spread over the study period. We have estimated investment in Blue Origin in 2019 at \$1 billion.

Virgin Galactic also received \$157 million in 2018 and \$162 million in 2019, which we have identified as seed funding from Virgin Group and Richard Branson.

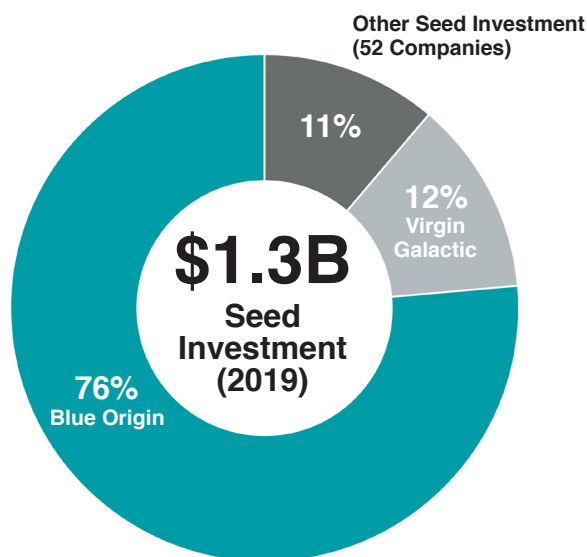


Figure 8. Blue Origin and Virgin Galactic comprise 88% of seed investment in 2019.*

Overall, seed investment rose by 31% in 2019, from \$999 million to \$1.3 billion. Seed funding totals are dominated by a few super-angel seed investments, including investment by Jeff Bezos in Blue Origin, Elon Musk's early investment in SpaceX (\$100 million in 2006), Richard Branson's investment in Virgin Galactic, and Robert Bigelow's investment in Bigelow Aerospace (\$250 million largely invested around the period 2010 to 2013). Figure 8 separates estimated super-angel investment in Blue Origin and Virgin Galactic from other seed investments in 2019.

Excluding super-angel investments, average seed funding dropped by nearly a third from the 2000-2004 (\$8 million) to 2005-2009 (\$2.3 million) periods, then increased by a factor of nearly 11 from the 2005-2009 to 2010-2014 (\$25.5 million) periods, and then more than tripled to \$79 million 2015-2019. Despite the drop in magnitude between the 2000-2004 and 2005-2009 periods, the average number

[∞] In Q1 2019, OneWeb announced that it had raised a total of \$3.4 billion since its founding, including a \$1.25 billion round in 2019. This implies additional, undisclosed funding beyond the \$3.0 billion in disclosed transactions. Also, in October 2016, SoftBank announced the SoftBank Vision Fund, and in May 2017, funding closed at \$93 billion. Some reports suggest the investment in OneWeb will be offered to the Vision Fund.

* Figures may not add to 100 due to rounding.

of angels quadrupled at the same time and then increased by a factor of more than 5 in 2010-2014. This upward trend continued from the 2010-2014 to 2015-2019 intervals, with the number more than tripling (see Figure 9).

Excluding investment from super-angels, total seed investment in 2019 was \$146.4 million, an increase from 2018 (\$92.1 million); seed investment has increased 615% since 2015 (\$20.4 million). In addition, average investment per seed deal decreased modestly from \$3.4 million in 2018 to \$2.7 million in 2019 while number of seed deals doubled from 27 in 2018 to 54 in 2019. Average investment per seed deal has risen by 324% since 2015 (\$0.6 million).

Including investment from super angels, seed investments in start-up space ventures increased 31% from 2018 (\$999 million) to 2019 (\$1.3 billion). The number of seed deals nearly doubled from 2018 (29) to 2019 (55). The average deal size decreased by 32%, from \$34 million in 2018 to \$23 million in 2019.

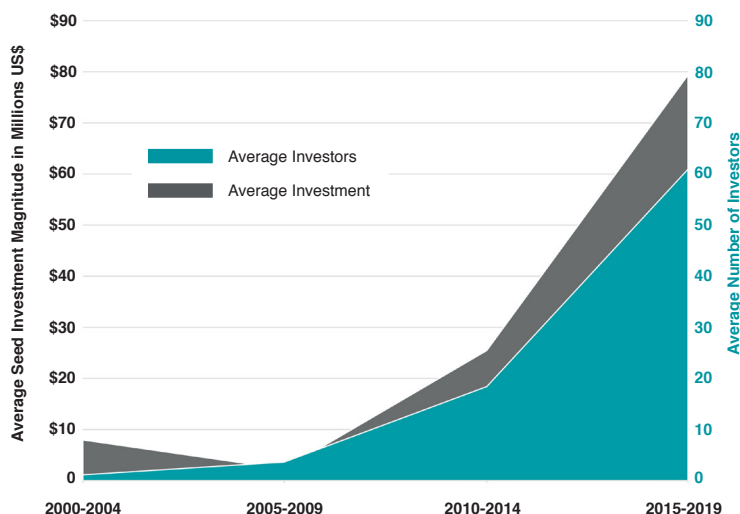


Figure 9. The yearly average magnitude of seed investment and average number of seed investors are trending up. Note that this figure excludes super-angel investments.

Venture Capital

Venture capital investment in start-up space ventures since 2000 totals \$12.5 billion, with 91% invested in the last five years.

Total venture capital investment rose 95% from 2018 to 2019, to roughly \$4 billion, reflecting an increase of nearly \$2 billion from 2018. Venture deals continued to increase in frequency, with 78 deals in 2019 (the most of any year), including 66 early-stage venture deals. Of the 190 venture capital firms (+34% versus 2018) that invested in start-up space companies in 2019, 63 had previously reported investment in start-up space companies; 127 had not, and appear to be new additions to the start-up space ecosystem.

Eight 2019 venture deals exceeded \$100 million, as compared to six deals in 2018. The largest venture capital deal belonged to OneWeb's \$1.25 billion Series D round announced March 2019, led by Softbank and others. Following this deal, Chamath Palihapitiya and Social Capital Hedosophia invested \$500 million into Virgin Galactic during the company's merger. There were an additional three SpaceX Venture rounds: a \$213 million Series J round, a \$536 million Series K round, and a \$214 million Series L round. Qianxun Spatial Intelligence and Relativity Space each raised \$140 million in venture capital rounds in 2019. In past years, the largest venture deals have been those in SpaceX and OneWeb. Figure 10 on the following page shows the impact of venture investments in SpaceX and OneWeb on total annual venture investment. The category "Other" represents the total sum of all venture deals each year, excluding the SpaceX and OneWeb deals. About 52% of all venture investment in the last five years has gone to SpaceX and OneWeb.

Excluding \$100+ million deals, venture investment decreased from 2018 (\$1 billion) to 2019 (\$950 million).

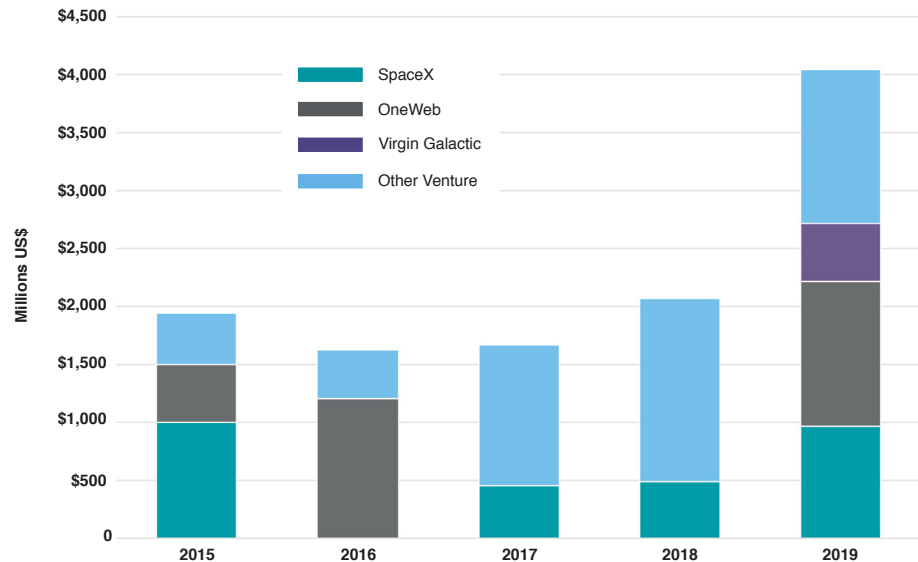


Figure 10. About 52 percent of all venture investment in the last four years has gone to SpaceX and OneWeb.

Across all segments (not only space), 2019 saw a historic number (213) of venture capital mega-deals (deals valued at \$100+ million), surpassing a record-breaking 2018 (194). Eight venture mega-deals were in start-up space companies, and the overall number of venture deals in space start-ups increased by 15% from 2018 to 2019. Global funding across all venture capital investments (not specifically space) fell from 2018 by 9% to \$108 billion in 2019. By contrast, venture capital investment in start-up space companies grew by almost \$2 billion from 2018 to 2019.

In 2019, 75 space start-ups reported venture investment, surpassing the prior record set in 2018 (66). During the 20-year period of this study, venture investment totaled nearly \$12.5 billion in 184 firms. The largest venture investments in that period were OneWeb's \$1.25 billion Series D round in 2019 and \$1.2 billion undisclosed round in 2016 and SpaceX's \$900 million Series E in 2015.

Venture deals overall increased by 15% to 78, a more modest increase than the 36% increase of the previous year and 72% increase from 2016 to 2017. The number of early stage venture deals rose from 61 in 2018 to 66 in 2019. The year 2019 saw 12 late-stage venture deals, nearly doubling from the 7 in 2018. Venture deal size increased from 2018 to 2019. Including "mega-deals" over \$100 million, the average venture deal in 2019 was \$51.8 million, compared to \$30.5 million in 2018. Excluding transactions over \$100 million, the average space venture deal in 2019 was about \$14 million, slightly less than \$17 million in 2018.

The number of venture capital firms investing in start-up space increased by 34% in 2019, from 142 to 190 firms.[°]

Private Equity

Private equity investment in space start-ups has totaled \$1.8 billion since 2000. The year 2018 marked the first time since 2015 that publicly disclosed private equity funding was invested in a start-up space venture. There were no publicly reported private equity investments in start-up space in 2019. Previous notable private equity transactions since 2000 include Aabar Investments' \$380 million

[°] The reported number of venture capital firms investing in 2017 has increased since our previous report, as more companies have announced transactions and as new data sets have become available.

to Virgin Galactic in 2009 and another \$110 million in 2011. Additionally, O3b received investment of \$230 million in 2010 from a group of investors including Google, North Bridge Venture Partners, Allen & Company, SES, Liberty Global, HSBC Holdings, Development Bank of Southern Africa, Sofina, and Satya Capital. In 2011, Ligado Networks raised \$265 million from Harbinger Capital Partners, Spectrum Equity Management, and other undisclosed investors.

Acquisition

Acquisitions of start-up space ventures total \$3.8 billion from 2000 to 2019. Forty percent of the value from acquisitions in space start-ups since 2000 has come from transactions in the last four years (\$1.5 billion). Since 2000, 330 angel- and venture-backed space companies have received investment; 30 of these companies have been acquired. The substantial values for acquisitions in 2013, 2014, and 2016 largely represent Monsanto's acquisition of the Climate Corporation, Google's acquisition of Terra Bella, and SES's acquisition of O3b, respectively.

Six acquisitions in 2019 totaled \$106 million, although the magnitude of several acquisitions was undisclosed. The largest acquisition in 2019 appears to be Cubic Corporation's acquisition of Nuvotronics, a space hardware provider, for \$64 million. Other acquisitions in 2019 include: Echostar's acquisition of Helios Wire, a company which aimed to provide satellite enabled IOT connectivity, and Cerberus Capital Management's acquisition of Stratolaunch Systems. Planet also acquired Boundless Spatial, a geospatial data management software company, for \$16 million, reportedly reduced from \$40 million following Boundless Spatial's failure to disclose information concerning material customer contracts (reported by Quartz). The year 2019 also saw the acquisition of several smaller start-up space companies, including Altius Space Machines and Deep Space Industries.

Virgin Galactic merged with Social Capital Hedosophia in 2019. Bryce treats the latter as the acquired company while funding from the merger (\$500 million) is attributed as venture capital from Social Capital Hedosophia and Chamath Palihapitiya.

Other acquisitions in recent years include SES's acquisition of O3b for \$730 million (2016) and Apple's acquisition of Mapsense for \$25 million (2015). In addition, Uber acquired deCarta in 2015 and Spaceflight Industries acquired OpenWhere in 2016, both for undisclosed amounts.

Table 4 shows five companies that started and exited during the study period. Note that in the 2014 Terra Bella transaction, the acquisition value was approximately 5.3 times the reported previous investment. In The Climate

Company	Acquirer	Acquisition Year	Acquisition Value (millions)	Pre-Acquisition Total Investment (millions)
Nuvotronics	Cubic Corp.	2019	\$64.0	\$15.2
Terra Bella	Planet	2017	\$325.0	\$91.0
deCarta	Uber	2015	--	\$56.2
Terra Bella	Google	2014	\$478.0	\$91.0
The Climate Corporation	Monsanto	2013	\$930.0	\$108.9
WildBlue	ViaSat Inc.	2009	\$568.0	\$756.0

Table 4. Examples of start-up space ventures acquired for substantial values.
Note that the acquisition value for Terra Bella in 2017 is an estimate.

Corporation example, it was 8.5 times. Other acquisitions during the study period include BlackBridge by Planet (undisclosed), Deimos by UrtheCast (\$84.2 million), SkyWave by Orbcomm (\$130 million), Horsebridge Defence and Security by Viasat (\$15 million), and Millenium Space Systems by Boeing (\$30 million).

Public Offering

UrtheCast, exactEarth, Satrec Initiative, Kleos Space, and Virgin Galactic are the only start-up space companies to be traded on public markets. Not all of these came to the market through a traditional initial public offering (IPO). UrtheCast became public after a reverse IPO and Virgin Galactic became a publicly traded company in 2019 after merging with special purpose acquisition company Social Capital Hedosophia. The last major public offering for a space company was in 2013 when Intelsat raised \$349 million through an IPO. (Intelsat does not meet our criteria for a start-up company.)

In one of the year's more notable start-up space developments, Sir Richard Branson's suborbital space tourism start-up Virgin Galactic's merger with SCH paved way for public trading of Virgin Galactic shares. We anticipate funds to be raised through public offering of new shares in 2020 and beyond.

At the time of writing, Virgin Galactic's stock has risen from a low of \$7 per share at the close of 2019 to as high as \$37.35 per share on February 19, 2020. In addition to the volatility of the price, the stock has seen a high volume of trading. In its annual report to the SEC, Virgin Galactic reported revenue of \$3.8 million and a net loss of about \$211 million for 2019.

Debt Financing

Debt financing for start-up space ventures totals \$5.1 billion since 2000. A majority of debt financing transactions was concentrated in or near the 2007–2012 period for Protostar (2006, 2008), WildBlue (2006), O3b (2009, 2010), and Ligado Networks (2010). In 2015, O3b, Planet, and UrtheCast obtained significant debt financing. In 2016, Ecometrica, Kepler Communications, Space Tango, and Ursa Space Systems also reported debt financing, and in 2017, Ecometrica, and Vector reported debt financing. The year 2018 saw debt financing transactions reported by SpaceX and Audacy.

Ten companies reported debt financing transactions in 2019. Kacific Broadband Satellites' \$160 million debt round from the Asian Development Bank, Guarant Co, and other institutions was the largest. Other debt transactions in 2019 include \$50 million for Blacksky's Earth observation satellite constellation from Intelsat and \$5.1 million for Axelspace from the Japan Finance Corporation.

Investment Across All Types

Since 2000, start-up space ventures have attracted around \$27.8 billion of investment, including \$12.5 billion in early and late stage venture capital, \$4.6 billion in seed financing, \$1.8 billion in private equity, and \$5.1 billion in debt financing. Since 2000, over 310 angel- and venture-backed space companies have been founded and funded. Thirty of these companies have been acquired, at a total value of about \$3.8 billion. Most investment activity has occurred recently, and since 2015, annual investment has consistently reached at least \$2 billion.

In 2019, investment reached \$5.7 billion, a record amount and a 61% increase from 2018 historic \$3.5 billion.

Over 60% of all investment since 2000 occurred in the period 2015–2019.

Over 90% of venture capital investment occurred in the period 2015–2019, and contributed over 60% of all investment in that period. All investment types have grown noticeably with the exception of private equity and debt financing.

The average start-up space investment per year over the period since 2000 is over \$1.4 billion. Looking at the individual investment types, average annual venture capital activity totals \$624 million per year since 2000, with an average of \$2.7 billion in the most recent five-year period. The average acquisition activity equals about \$190 million per year, and is \$1.6 billion per year in the most recent five-year period. The average seed funding level is about \$718 million per year in the last five years, up nearly 12x from a \$61 million average per year in the prior five-year period. In addition, the average private equity funding level is \$45 million in the last five years, a decrease from the \$155 million per year in the 2010-2014 period. Looking at the data in these multi-year groupings, average annual values for seed, venture, acquisition, and public offerings have increased, while those of private equity have decreased. Debt financing has decreased and risen again somewhat in recent years (see Table 6).

Investment Type	2000-2004 (millions)	2005-2009 (millions)	2010-2014 (millions)	2015-2019 (millions)	Total 2000-2019 (millions)
Seed/Prize/Grant	\$640.1	\$111.6	\$307.4	\$3,590.0	\$4,649.4
Venture Capital	\$189.2	\$253.5	\$689.1	\$11,356.1	\$12,487.9
Private Equity	\$232.8	\$542.7	\$777.3	\$228.0	\$1,780.9
Acquisition	\$0.0	\$584.0	\$1,566.5	\$1,637.7	\$3,788.2
Public Offering	\$0.0	\$10.0	\$9.3	\$25.0	\$44.3
Total Investment	\$1,062.2	\$1,501.9	\$3,349.9	\$16,836.8	\$22,750.9
Debt Financing	\$0.0	\$1,530.1	\$2,680.5	\$887.9	\$5,098.5
Total with Debt	\$1,062.2	\$3,032.0	\$6,030.4	\$17,724.8	\$27,849.5

Table 5. The magnitude of investments varies based on investment type and time period.

Investment Type	Average 2000-2004 (millions)	Average 2005-2009 (millions)	Average 2010-2014 (millions)	Average 2015-2019 (millions)	Average 2000-2019 (millions)
Seed/Prize/Grant	\$128.0	\$36.5	\$61.5	\$718.0	\$232.5
Venture Capital	\$37.8	\$50.7	\$137.8	\$2,271.2	\$624.4
Private Equity	\$4.6.6	\$108.5	\$155.5	\$45.6	\$89.0
Acquisition	--	\$116.8	\$313.3	\$327.5	\$189.4
Public Offering	--	\$2.0	\$1.9	\$5.0	\$2.2
Average Investment	\$212.4	\$300.4	\$670.0	\$3,367.4	\$1,137.5
Average Debt Financing	--	\$306.0	\$536.1	\$177.6	\$254.9
Average with Debt	\$212.4	\$606.4	\$1,206.1	\$3,545.0	\$1,392.5

Table 6. The annual average of space investments varies based on investment type and time period.

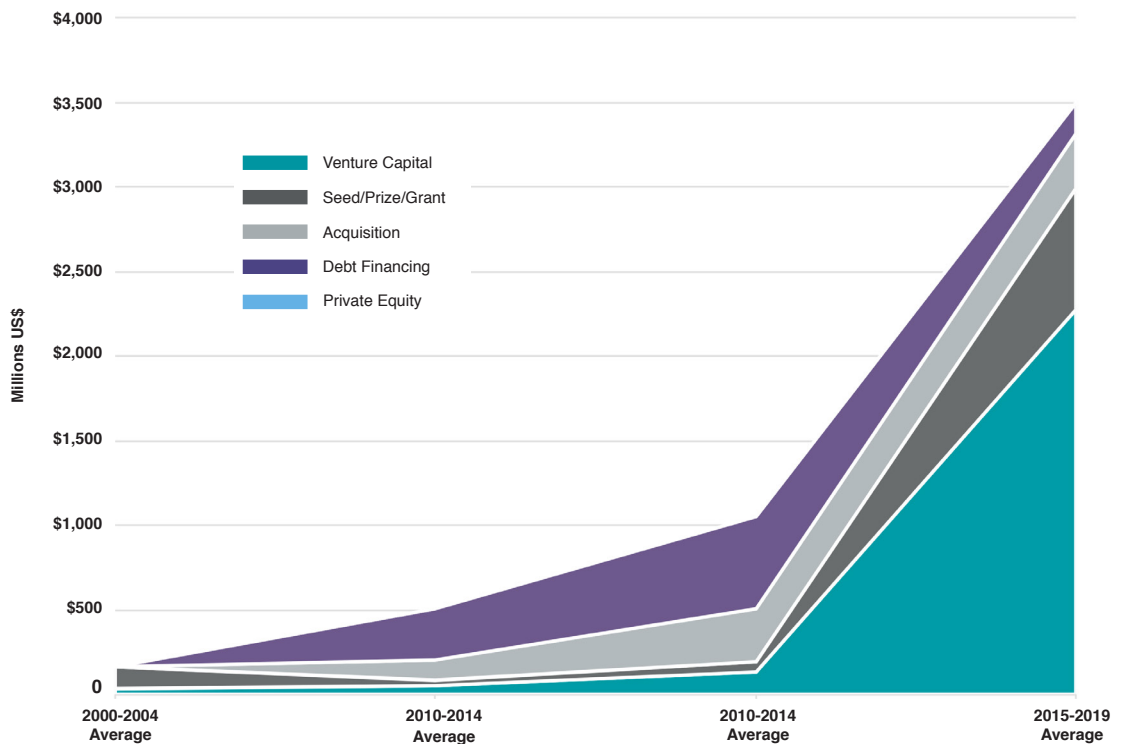


Figure 11. Considering multi-year periods, average annual start-up space seed funding, venture capital, and acquisitions have increased

Valuation

Investors focus on valuations and exits. SpaceX is an undisputed space unicorn (a private company with a valuation of \$1 billion or more); in early 2020, SpaceX's valuation was reported at more than \$36 billion.

Several other start-up space companies, including OneWeb, Planet, and Rocket Lab, have been reported by some sources to be unicorns. Investment publications and analytics firms have published valuations for each of the companies that exceed \$1 billion. After Planet closed a Series C round of venture capital in 2015, PitchBook valued the company at \$1.13 billion. Forbes published a valuation in excess of \$1 billion for Rocket Lab after the space start-up closed a Series D round of venture capital in March 2017, and PitchBook highlighted the company in its Unicorn List of 2018, publishing a \$1.1 billion valuation as of March 2017. OneWeb has reported nearly \$3.0 billion of investment since 2015 and was valued at \$2.5 billion in 2017, but did experience a roughly \$480 million write down in 2019. Mapbox and Kymeta are likely on the unicorn path; both companies have raised nearly \$225 million in venture capital and seed investment. Spire Global and Relativity Space have each raised nearly \$200 million, potentially placing them on the path to unicorn status as well.

While unicorn valuations are increasing in number, some financial analysts caution that many unicorns (across sectors, not specifically in space) have exaggerated valuations.

Casualties

Venture capitalists pursue a business model where the majority of the start-ups on which they place bets will fail. Investors are willing to accept these odds because those start-ups that do succeed provide payoffs that more than offset the losses. Start-up space is no different. A substantial portion of the start-up space companies that have drawn investment in the last four or five years have yet to report any revenue, much less profit.

While money continued to pour into the sector during 2019, the year also brought high-profile start-up space casualties: Vector, which was developing a small satellite launcher; LeoSat, one of several companies planning to deploy large low Earth orbiting satellites for global broadband services; and Audacy, which was developing a constellation of data-relay satellites. Vector, which raised over \$100 million for its small satellite launcher, ceased operations after a key investor balked at further investing in the project. LeoSat was one of a number of companies that obtained Federal Communications Commission licenses to deploy broadband constellations in 2018, but failed to raise significant investment in its proposed \$3 billion, 84-satellite system. Audacy, which had raised about \$13 million of the estimated \$300 million needed to deploy its medium-Earth orbit constellation, foundered after defaulting on its debt.

More such failures are to be expected in the coming years as the availability of capital tightens for companies that are behind on their performance milestones. Investors generally agree that late-stage capital tends to be driven more by performance than promise, and thus is becoming harder to attract in the start-up space sector. This trend can be expected to lead to a rationalization and consolidation of the industry in the years ahead.

After start-up space companies shuttered their doors in 2019, some of their assets were acquired by other space companies. For example, following Vector's bankruptcy filing, Lockheed Martin will obtain Vector's GalacticSky satellite technology assets with a bid of \$4.25 million. Australia-based Electro Optical Systems will acquire Audacy and its FCC license for \$6.7 million to establish its own communications relay system in Medium Earth Orbit. As a shakeout of start-up space companies approaches, additional failures will likely lead to the acquisition of intellectual property, technology, and regulatory rights from defunct companies.

SPACE INVESTORS BY THE NUMBERS

Overall

This research has identified 967 investors in start-up space companies, a 38% increase from last year's report (701). Since not all investors are disclosed, the total number of investors is higher.

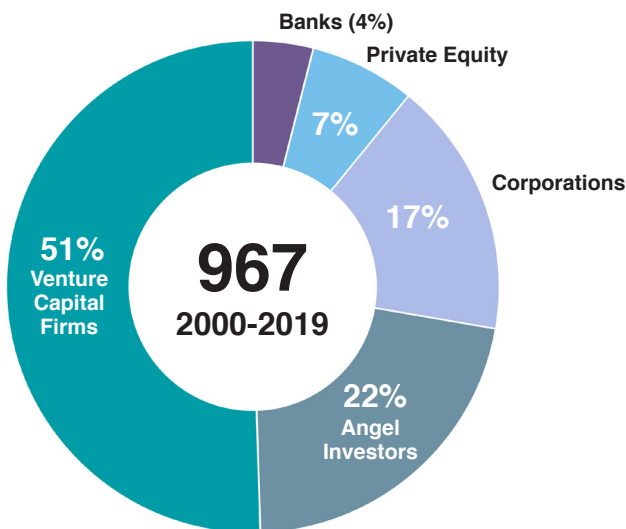


Figure 12. By number of investors, VCs are the largest investor group for space start-ups. Note that angel investors and altruists are combined into the angel investors category in this chart.

Over the 20-year period, we looked at the distribution of investors across five categories. Venture capital firms represent the largest number of investors in start-up space companies, followed by angel investors. Together, these two investor groups comprise about 73% of the investors in start-up space ventures. Corporations, private equity firms, and banks make up the remaining 28%. There is small participation by a few altruists, who have provided grants or prizes, such as Thiel Foundation, Knight Foundation, XPRIZE Foundation, and Space Frontier Foundation, primarily through business plan pitch contests or other competitions. These altruists are included in our totals for angel investors (see Figure 12).

Investment in start-up space is seeing sustained growth. In 2019, 328 investors (up from 225 in 2018) invested into 135 start-up space companies across 150 deals (up from 111 in 2018). New investors continue to enter the ecosystem: 127 venture capital firms, 38 angel

investors, and 29 corporations invested in start-up space ventures for the first time in 2019. Notable entities like Boeing, C5 Capital, Echostar, Lockheed Martin, Goldman Sachs, Planet, and Softbank invested in or acquired start-up space companies in 2019.

The profile of investment in start-up space companies has diversified substantially over the last 20 years. From 2000 to 2004, the number of investors per year averaged only 8, but by the end of 2009, the average number had increased to 16. The average number of investors then more than tripled to 53 in 2010–2014. Since 2014, this figure has quadrupled, reaching an average of 212 investors in 2015–2019. This represents a nearly twenty-six-fold increase from the first period to the fourth. Figure 13 shows the number of investors and investment magnitude (excluding debt financing) since 2000.

The mix of investors changes from year to year, as shown in Figure 14. The trend for each investor group is discussed in the sections below. From 2000 to 2004, an average of four venture capital firms, two corporations, one angel investor, and two private equity firms invested in start-up space companies each year. During 2005–2009, the average number of venture capital firms investing more than doubled (from 4 to 8). The average annual number of angels investing grew from one to three during this period. Banks also entered into the ecosystem during this period, at an average of one participating in investment activity in some form annually, while the number of corporations increased slightly.

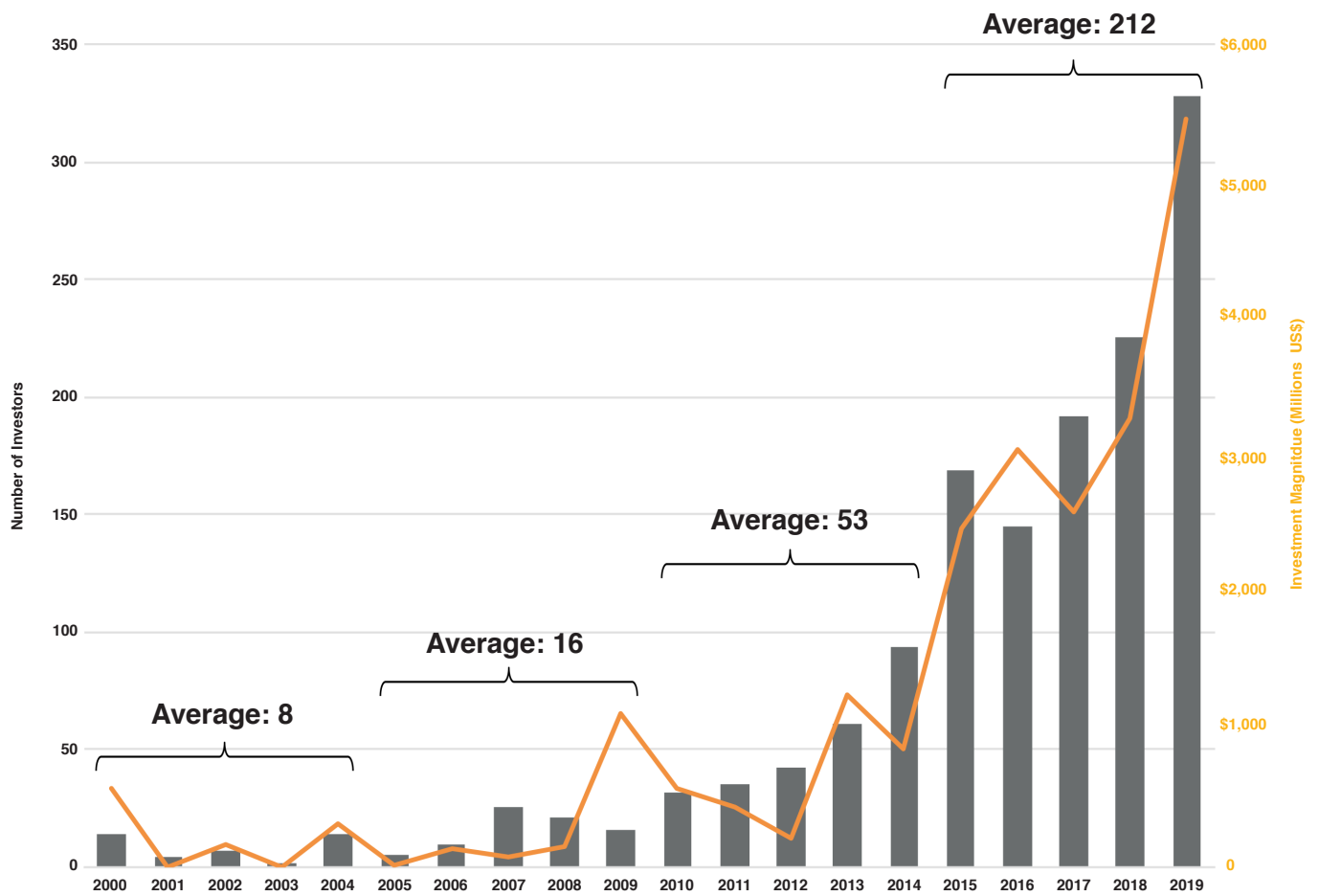


Figure 13. The average number of space investors per year has grown from 8 to 212, looking at five year periods.

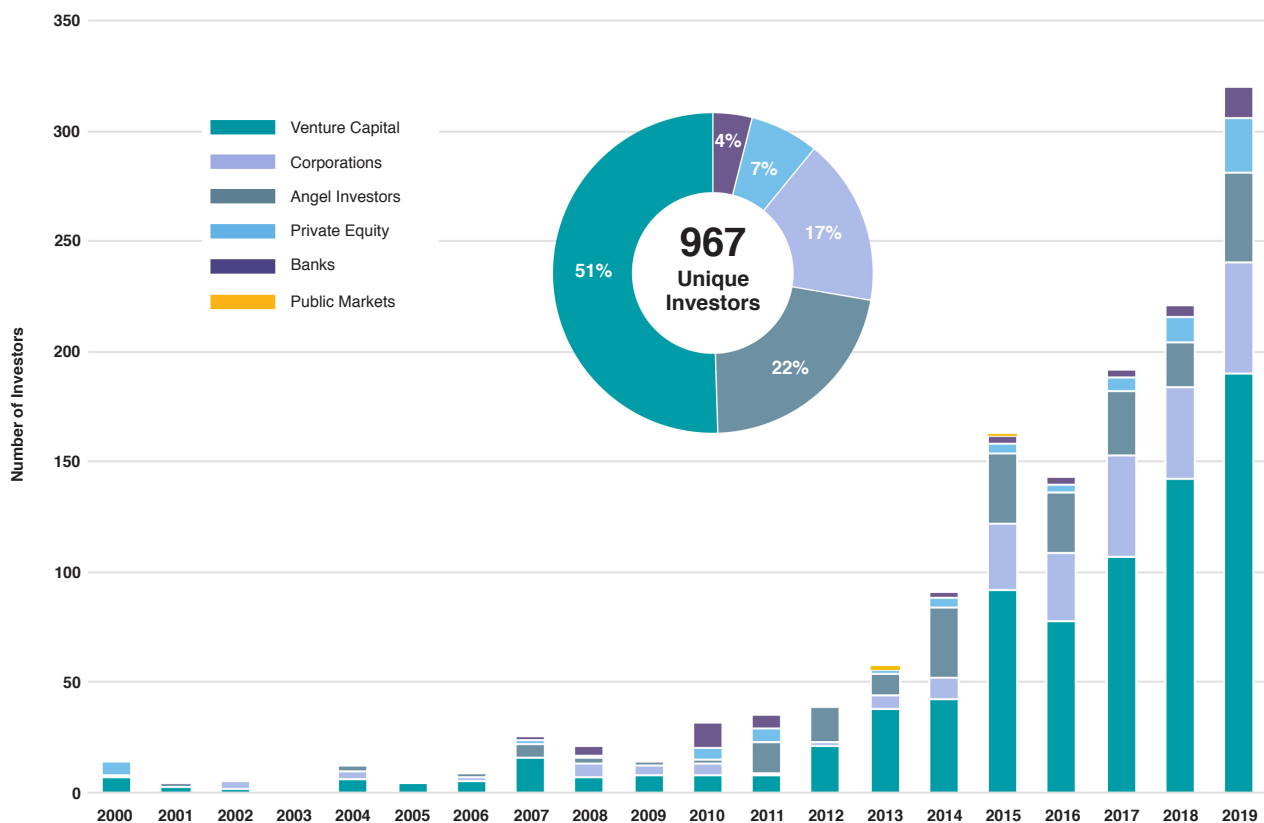


Figure 14. The mix of investors in space companies varies year to year, with more venture capital firms in recent years.

Banks (typically acting as the initial provider of debt financing) appear prominently in 2010 and 2011. Deals for O3b and Ligado Networks brought many banks to the table in 2010 and 2011. Banks were increasingly active in 2019, with 14 banks investing throughout the year, a record for start-up space. There has been comparatively little activity in public markets from 2000 to 2019, as only a few start-up venture companies have gone public.

Within the United States (461 investors), California is home to over 40% of these investors, representing 20% of the global total. Of the other 265 investors in the United States, New York hosts the next largest number (61). See Figure 15.



A total of 506 non-U.S. investors are based in 41 countries. China is home to 21% of these investors (104), followed by Japan (85), the United Kingdom (80), India (25), Canada (24), Israel (20), Spain (19), and Australia (19). See Figure 16.

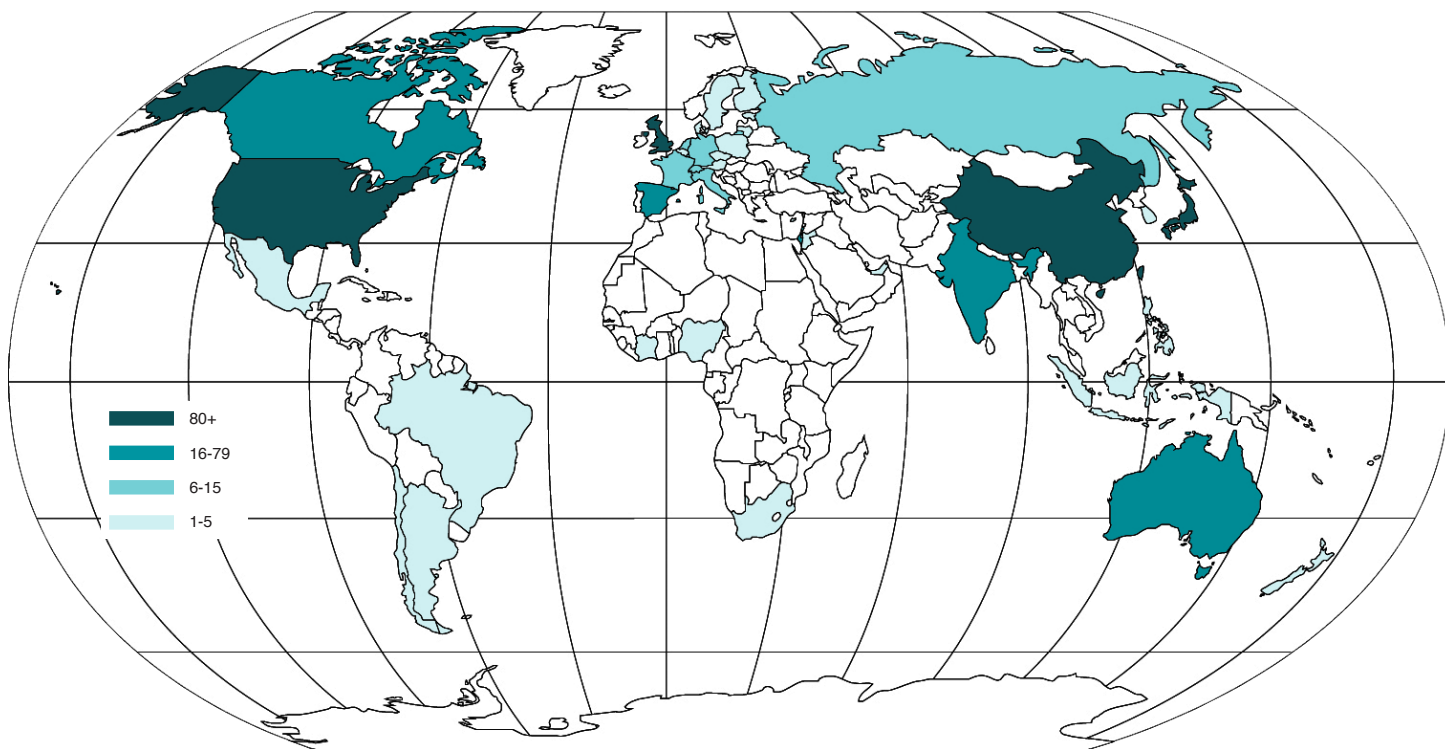


Figure 16. Investors in start-up space ventures headquartered outside the U.S.

In 2019, 205 investors were based outside the United States, compared to 123 in the United States. This is the first time that there is a major differential between the number of non-U.S. and U.S. investors. Most new non-U.S. investors were venture capital firms. More non-U.S. venture capital firms provided funding to space start-ups in 2019 than U.S. venture capital firms (113 non-U.S. and 77 U.S.). Forty of these venture capital firms are headquartered in China, with 16 based in the United Kingdom and 14 in Japan.

Start-up space companies themselves are primarily based in the United States. These 180 companies make up 55% of the global total (330). California is home to 71 of these companies, which represents 39% of the U.S. total and 22% of the overall global total. Start-up space companies headquartered outside of the United States (150) make up 45% of the global total. Overall, 31 space start-ups are headquartered in China, comprising roughly 21% of all non-U.S. space start-ups. The United Kingdom has the second most start-up space companies (24), followed by Canada (10), Japan (8), India (8), Singapore (7), and Israel (7). Seventy-nine start-up space companies based outside the United States received funding in 2019.

The largest investment in a non-U.S. space start-up was a \$160 million debt financing round for Kacific Broadband Satellites, a Singapore-based satellite operator servicing South East Asia and Pacific Islands with broadband. Other notable 2019 investments in non-U.S. space start-ups included a \$141 million Series A round in Qianxun Spatial Intelligence, a Beidou-enabled high-precision location service provider; a \$100 million Series A round in Synspec (Japan); and a \$71 million Series C round in LandSpace (China).

In 2019, 205 investors were based outside the United States, compared to 123 in the United States.

Angels

Since 2000, 208 angel investors have invested in start-up space companies. Angel investors include individual angels and groups of angels. In the United States, angels must be accredited investors, as defined by the Securities and Exchange Commission (SEC), with either earned income that exceeds \$200,000 (or \$300,000 if married) per year or net worth over \$1 million, either alone or together with a spouse (excluding the value of the person's primary residence). This is not the case for direct investments in other prominent start-up-space-investing countries. (As noted in the *Jobs Act of 2012*, crowdfunding platforms are also exempt from these requirements.) For example, Space Angels, a global syndicate of 250 accredited angel investors, provides funding to primary early and seed-stage space start-ups. For an angel syndicate to be included in our data set, at least one angel has to have announced an investment as a part of the syndicate. Most angel investments are not made public, so the actual number of angel investors is higher.

The most prominent angel investors are “space billionaires.” These billionaires have accrued their wealth through other successful businesses or investments and have either founded a space company or invested their own money in a space company. Several high-profile billionaires such as Jeff Bezos, Richard Branson, and Elon Musk are space investors. Other well-known billionaires, such as Bill Gates, Mark Zuckerberg, and the late Paul Allen, have been affiliated with space ventures.

Other notable individual angel investors are Dylan Taylor and Esther Dyson. Taylor has invested in 10 different space start-ups, and Dyson has invested in NanoRacks, Space Adventures, and XCOR. Other start-ups receiving standout support from individual angel investors are Moon Express (14 angels), Planetary Resources (9), Team Indus (9), Astroscale (9), Interstellar Technologies (9), Relativity Space (8), Sen (8), Vector (7), and Dauria Aerospace (6).

Individual angel investors often pool their resources. These angel investment groups (sometimes called syndicates) include Desert Angels, which invested in Vector in 2017; Green Angel Syndicate, which invested in Global Surface Intelligence in 2014; and Boston Harbor Angels, which invested in XCOR Aerospace in 2007. Of angel groups, Space Angels based in New York City has been the most active, establishing an online investment platform for angels to provide largely early stage capital to well over two dozen different start-up space companies. Notable investments by Space Angels in 2019 include Isotropic Systems and SpeQtral.

Angels are still predominately based in the United States (111), comprising 60% of the global total (208). Of U.S.-based angels, nearly half are based in California, marking nearly 30% of the overall global total. The other 54% of U.S.-based angels investing in start-up space companies in the United States are spread across New York, Washington, Arizona, Florida, and several other states.

China, India, Japan, Russia, and the United Kingdom are host to five or more angels investing in space companies. About 20% of non-U.S. angels are based in Japan, another 20% are based in India, and an additional 19% are based in the United Kingdom. The remaining 40% of angels are from 16 other non-U.S. countries.

Angel activity has continued to increase in recent years. From 2000 to 2004, the average number of angel investors per year was one. From 2005 to 2009, the average was three. Starting in 2010, the average number of angel investors per

year jumped to 17—a six-fold increase over the 2005–2009 period. The average number of angels investing nearly doubled again, to 33, in the 2015–2019 period.

A record 47 angel investors reported investing in start-up space ventures in 2019 (see Figure 17).

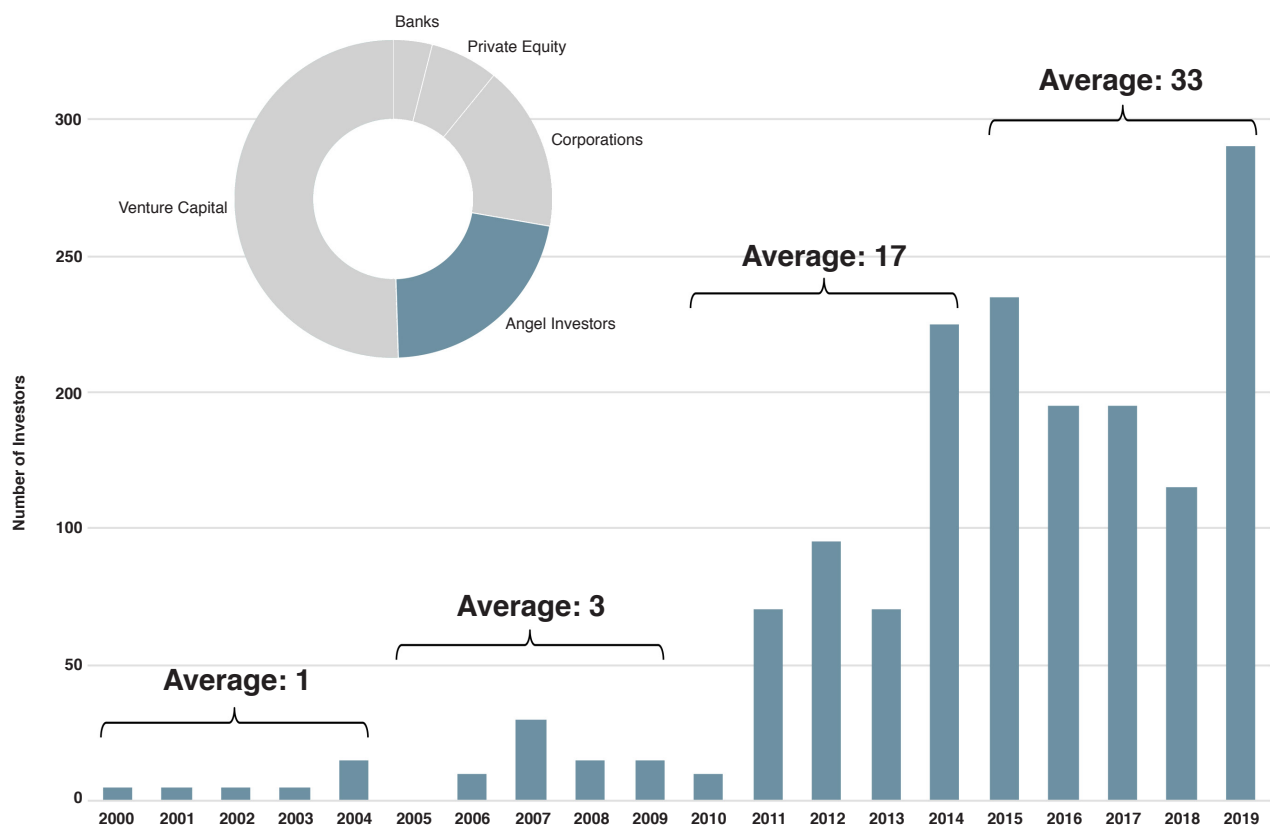


Figure 17. Considering multi-year periods, angel investor activity has increased.

Venture Capital Firms

Since 2000, nearly 500 VC firms have invested in start-ups. VCs generally invest in start-ups and early stage companies with high growth potential, and accept a significant degree of risk. These investors frequently invest in syndicates, pooling investment with other VCs, but they can also include angel investors, corporations, private equity firms, and banks in their transactions. The number of venture capital firms investing in start-up space increased to 190 in 2019 from 142 firms in 2018. (This reported number of venture capital firms investing in 2018 has increased since our previous report, as more companies have publicly announced transactions and as new data sets have become available.) Of the 190 VCs that invested in start-up space companies in 2019, 63 had previously reported investment in start-up space companies, while 127 appear to be new additions to the start-up space ecosystem.

As shown, the average number of VC firms investing in space companies has taken a sharp upturn in the last five years. From 2000 to 2004, the average number of VCs per year is four. Over the next five years (2005–2009), the average doubled. From 2010 to 2014, the average nearly tripled before increasing by a factor of more than five to 122 in 2015–2019. See Figure 18 on the following page.

The number of U.S. VCs investing in space companies (247) nearly matches the number of non-U.S. VCs (242). Over half of U.S. VCs (53%) are based in California, representing 27% of the global total. New York, Massachusetts, Maryland, Virginia, Colorado, and Illinois lead the remaining states hosting U.S. VCs investing in space.

Non-U.S. VCs investing in start-up space ventures have headquarters in 34 countries. Australia, Canada, China, Germany, India, Israel, Italy, Japan, Singapore, Spain, and the United Kingdom are all home to six or more VCs investing in space companies, with China hosting 70, the United Kingdom hosting 40, and Japan hosting 23.

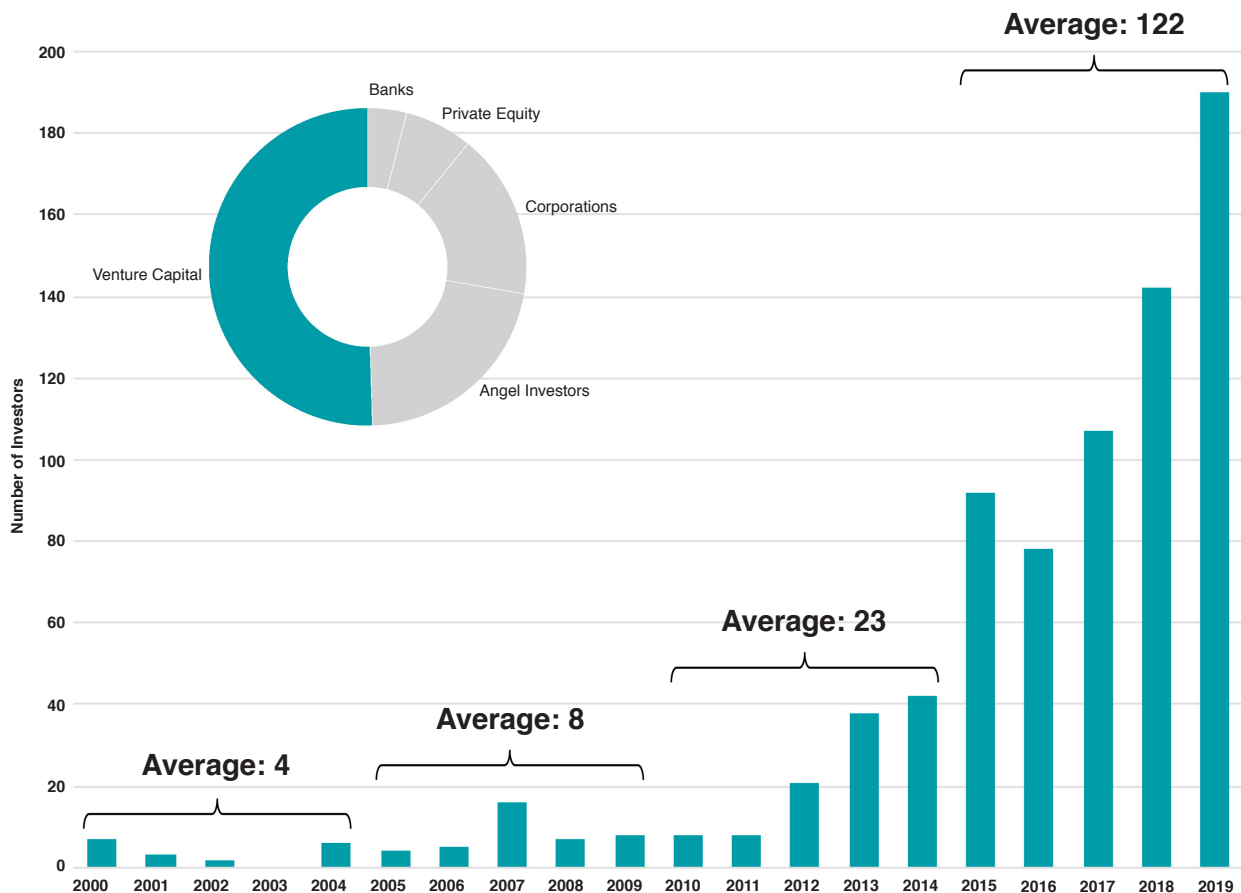


Figure 18. More VCs have invested in start-up space in recent years.

Most Active Space VCs

Thirty-seven venture capital firms have invested in three or more start-up space companies. Space Capital has invested in nine; Data Collective has invested in eight, Khosla Ventures has invested in seven, Founders Fund, Promus Ventures, Seraphim Capital, and Y Combinator have invested in six; Draper Fisher Jurvetson, Horizons Ventures, In-Q-Tel, Kleiner Perkins Caufield, Lux Capital, RRE Ventures, and Shasta Ventures have invested in five; 500 Startups, New Enterprise Associates, Social Capital, and Techstars have invested in four; and 19 other companies have invested in three start-up space companies. In addition, 55 venture capital firms have invested in two start-up space companies (see Figure 19).



Figure 19. VCs investing in three or more space companies.

Thirty-three start-up space companies have attracted investment from two or more of the most space-focused VCs (that is, of the 37 VCs shown in Figure 19 that have invested in three or more start-up space companies, thirty-four VCs have repeatedly invested in common with others). This relationship is diagrammed in Figure 20.

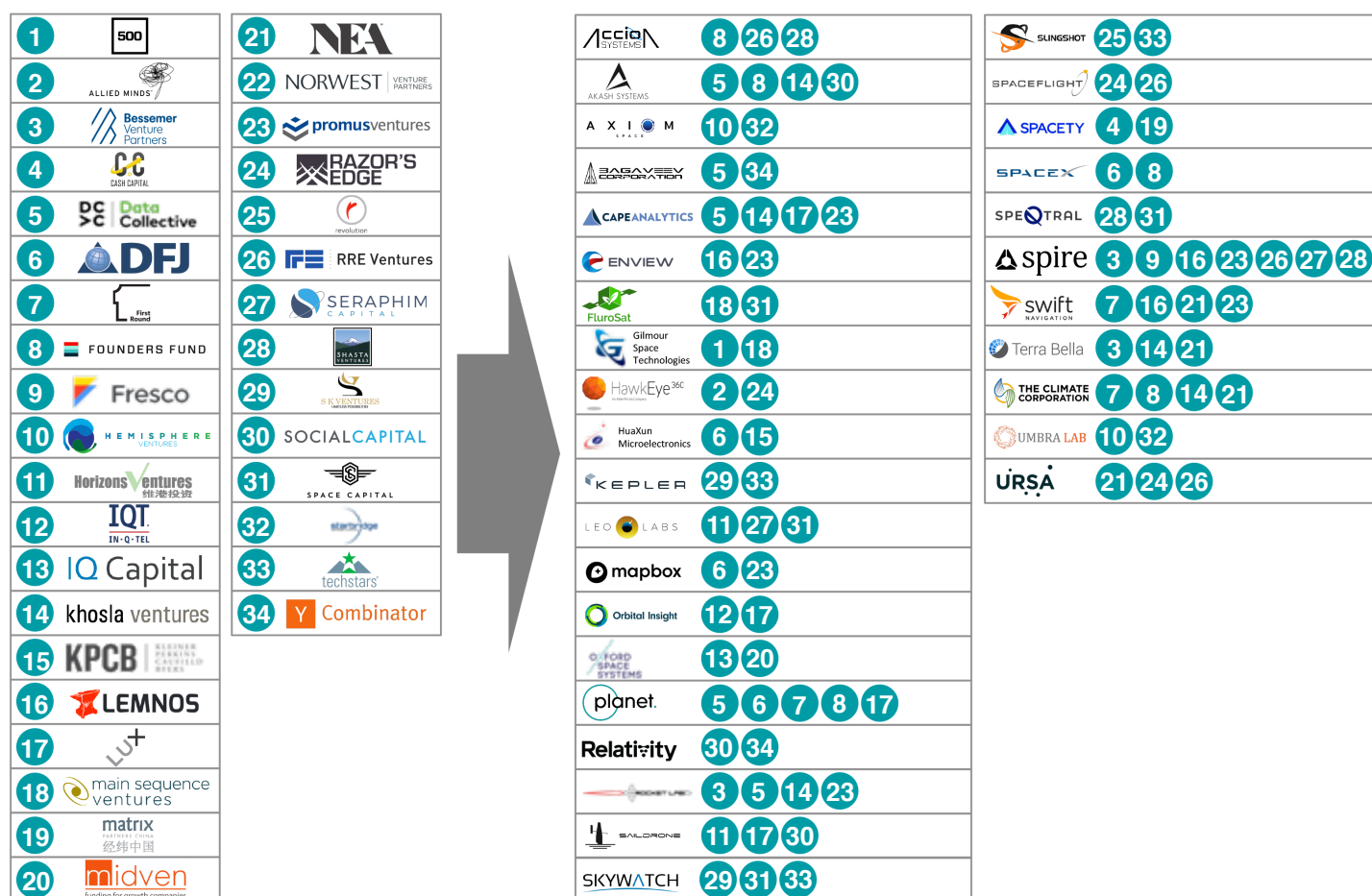


Figure 20. Common investments among highly space-focused VCs.

Thirty-two VCs have participated in at least five start-up space deals since 2000. (That is, these VCs have participated in multiple rounds or other specific transactions, which may include more than one investment in a single company.) Khosla Ventures lead this group, having participated in 17 start-up space deals during the study period. It is followed by Lux Capital (15), Data Collective (13), Draper Fisher Jurveston (13), Founders Fund (12), RRE Ventures (12), Promos Ventures (10), Space Capital (10), Bessemer Venture Partners (9), Kleiner Perkins Caufield & Buyers (9), New Enterprise Associates (8), Sequoia Capital (8), Y Combinator (8), First Round Capital (7), In-Q-Tel (7), Seraphim Capital (7), TechStars (7), 500 Startups (6), Allied Minds (6), IQ Capital (6), Lemnos Labs (6), Matrix Partners China (6), Norwest Venture Partners (6), Razor's Edge Ventures (6), Shasta Ventures (6), Social Capital (6), Capricorn Investment Group (5), Crosslink Capital (5), Horizons Ventures (5), Innovation Endeavors (5), Midven (5), and SK Ventures (5). See Figure 21.

Private Equity Groups

Since 2000, 67 private equity (PE) firms have invested in start-up space companies. The number of PE firms investing in space start-ups has varied over the study period, averaging four per year. In recent years, several PE firms have been observed participating in atypical private equity investments such as early- and mid-stage venture capital rounds, as noted on page 14. (For the purposes of our dataset, those transactions have been categorized as venture capital activity.) 2019 saw only no private equity rounds, however PE firms continued investing in atypical rounds. The year 2019 saw an great increase in the number of private equity firms participating in non-PE-led financing activity, more than doubling to 25 from the previous year (12). Private equity transactions over \$100 million, involving Ligado Networks, O3b, and Virgin Galactic, took place in 2004, 2009, 2010, 2011, and 2015 (see Figure 22).

Less than 30% of PE firms investing in space companies are headquartered within the United States. About a third of these U.S.-based private equity firms are based in New York, with 21% located based in California. The remainder is largely split between Florida, Illinois, and Massachusetts.

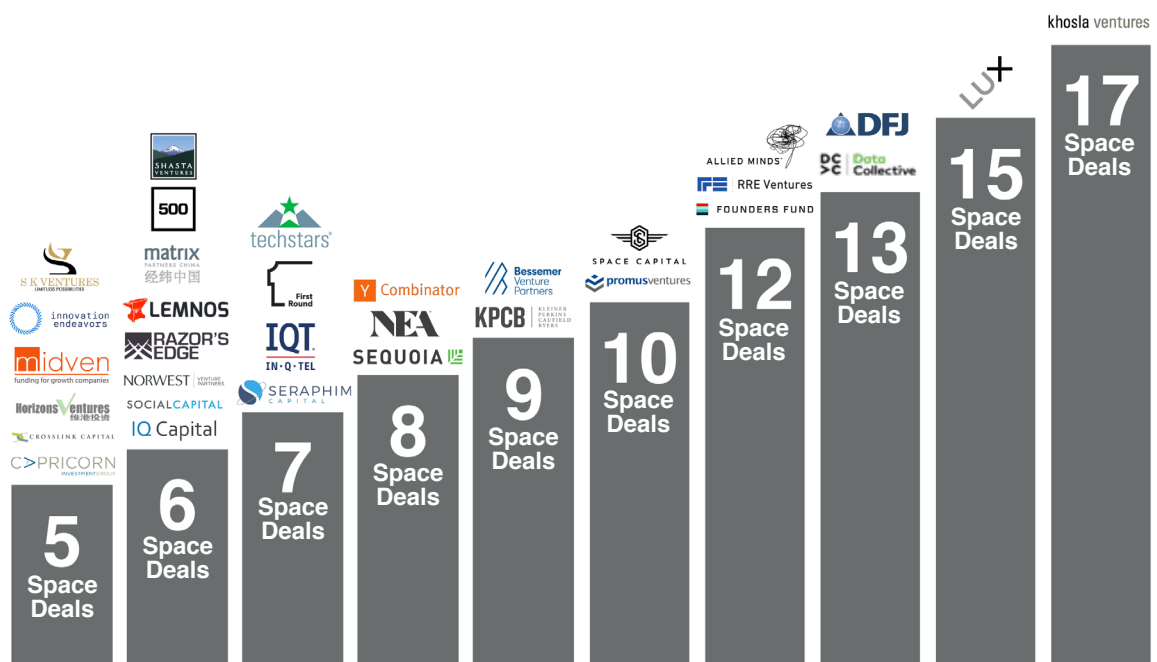


Figure 21. VCs that have participated in multiple start-up space deals since 2000.

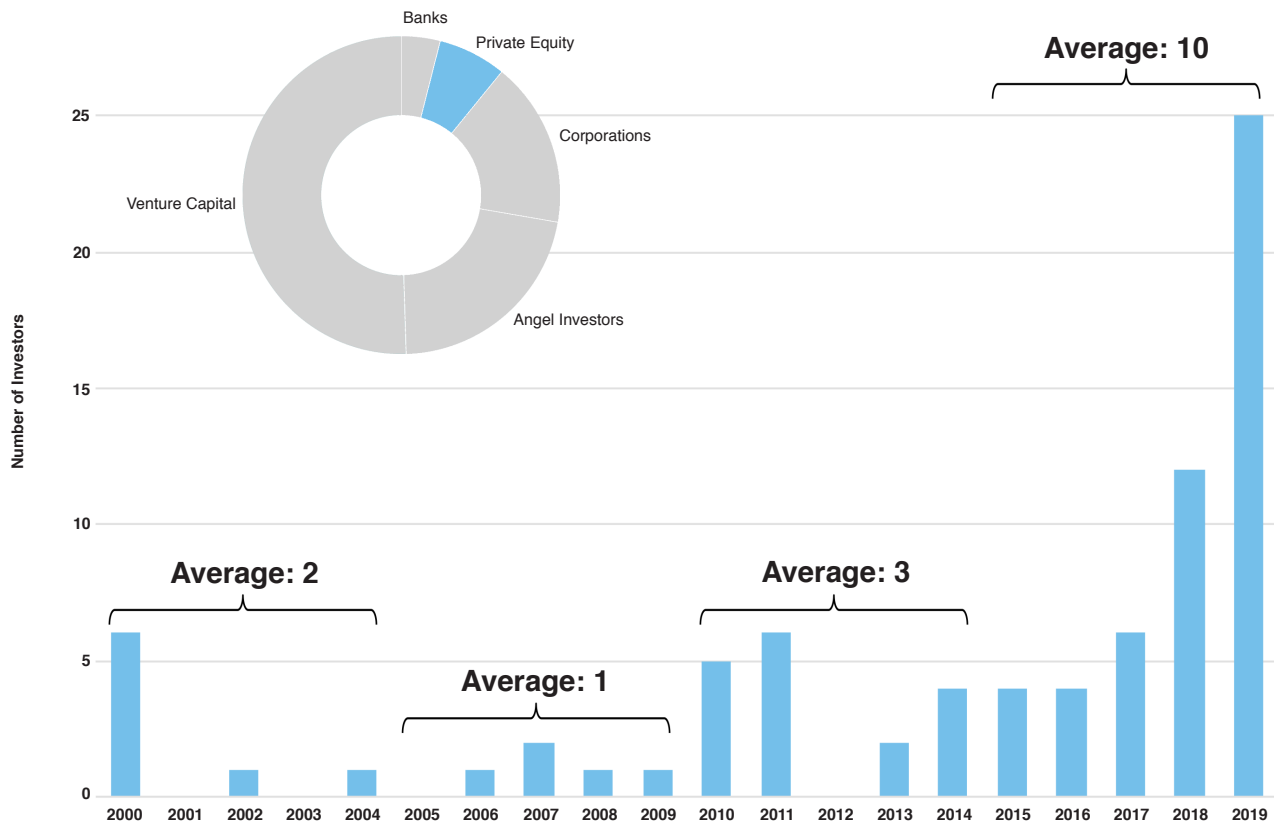


Figure 22. Private equity investment activity is variable over the study period, looking at multi-year periods.

Non-U.S. PE firms have headquarters in 15 countries. Nearly 30% (14) of non-U.S. PE firms are based in China with an additional 21% (10) based in the United Kingdom. Canada and Israel are home to four such firms.

Corporations

Since 2000, 164 corporations have reported investing in start-up space companies. The number of corporations investing in start-up space ventures increased by 19% from 2018 (42) to 2019 (50). Participation from corporations was low in the first fifteen years of the study with the average number of corporations investing rising from two in 2000–2004 to three in 2005–2009, before increasing slightly to five in 2010–2014. From 2015 to 2019, the average is 40. This represents more than an eight-fold increase in the average number of corporations investing in start-up space ventures (see Figure 23 on the following page).

Of the corporations investing in start-up space ventures, 38% are headquartered in the United States, about a third of which are based in California (12% of the global total). The remaining U.S. portion of the global total is distributed across the United States, with New York, Illinois, Maryland, Texas, and Virginia leading. Non-U.S. corporate investors comprise 62% of the global total, 33% of which are based in Japan, 14% in China, and 10% in the United Kingdom.

Both space companies and non-space companies are investing in start-up space ventures. Space companies represent 30% of this investor group at 50 companies, while non-space corporations represent a 70% majority (114 companies). Of space companies investing in space-start-ups, 42% (21) are U.S.-based. Of the non-space corporations, 36% (41) are headquartered in the U.S. See Figure 24 on Page 34.

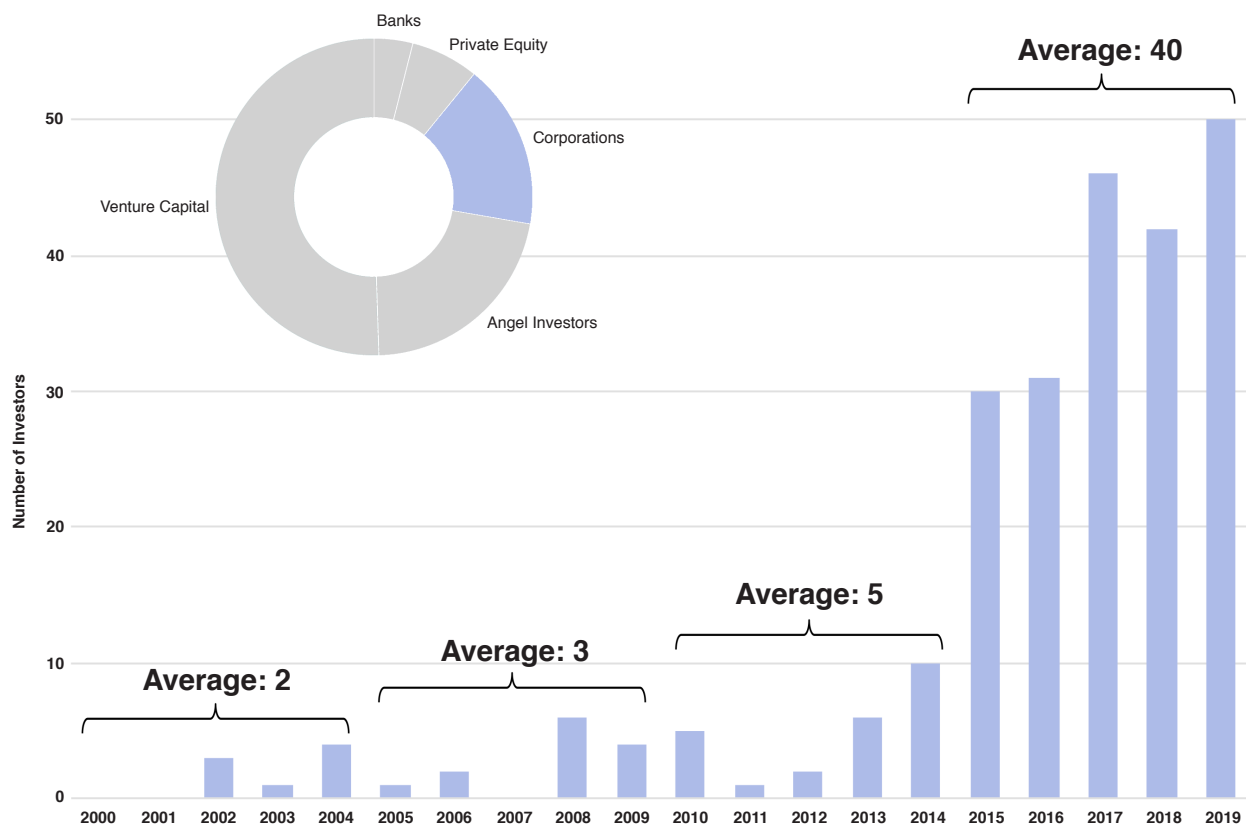


Figure 23. The number of corporations investing in start-up space ventures has surged since 2014.

Corporations outside the United States investing in start-up space companies stem from 22 countries. Japan is home to 33% of these companies (34), followed by China (14), and the United Kingdom (10). Others include Canada and Spain, each of which is home to nine corporations investing in start-up space companies.

Corporations have invested in 113 start-up space companies and participated in 184 deals since 2000. About 16% of deals corporations have invested in have been acquisitions. 2019 acquisitions include Deep Space Industries by Bradford Space, Nuvotronics by Cubic Corporation, Boundless Spatial by Planet, and Helios Wire by Echostar. Previous acquisitions include FeatureX by Orbital Insight, Horsebridge Defence and Security by ViaSat, Mavrx by Taranis, Millennium Space Systems by Boeing, Planetary Resources by Consensus, Poncho by Dirty Lemon, TellusLabs by Indigo Ag, Clyde Space by AAC Microtec, OmniEarth by EagleView Technologies, Terra Bella by Planet, BlackBridge by Planet, deCarta by Uber, Deimos by UrtheCast, Terra Bella by Google, SkyWave by Orbcomm, The Climate Corporation by Monsanto, WildBlue by ViaSat, O3b by SES, GATR Technologies by Cubic Corporation, and Mapsense by Apple.

Banks and Other Financial Institutions

Relatively few—only about 1 in 20—of the transactions covered in this analysis have reported debt financing as a significant component. The number of banks (typically acting as the initial provider of debt financing) investing in start-up space ventures had peaked in 2010 and 2011, but 2019 witnessed a historic number of banks investing in start-up space companies (14). See Figure 25.

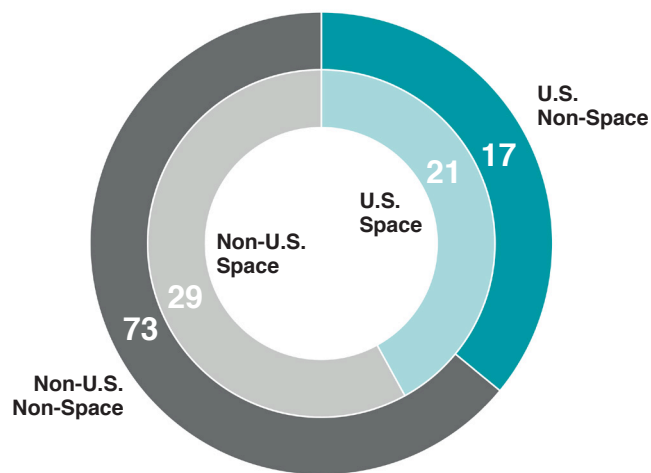


Figure 24. Space and non-space corporations investing in start-up space ventures have traditionally been more likely to be headquartered outside of the United States, though this gap is closing.

Notable examples of start-up space ventures receiving debt financing include:

- Kacific Broadband Satellites received \$160 from the Asian Development Bank, Guarant Co, and other institutions in 2019.
- Blacksky received \$50 million from satellite operator Intelsat in 2019.
- SpaceX received \$250 million facilitated by Bank of America in 2018.
- Vector received \$4.5 million from Desert Angels, Arizona Technology Investors, Kurrent Investment, Space Angels, Kanematsu Corporation, Sequoia Capital, and Shaun Coleman in 2017.
- Ecometrica received about \$900,000 from Clydesdale Bank in 2016.
- O3b received \$525 million from COFACE, France's export credit agency, and others in 2009.
- Planet received \$25 million from Western Technology Investment in 2015.
- Kepler Communications received \$100,000 from Right Side Capital Management in 2016.

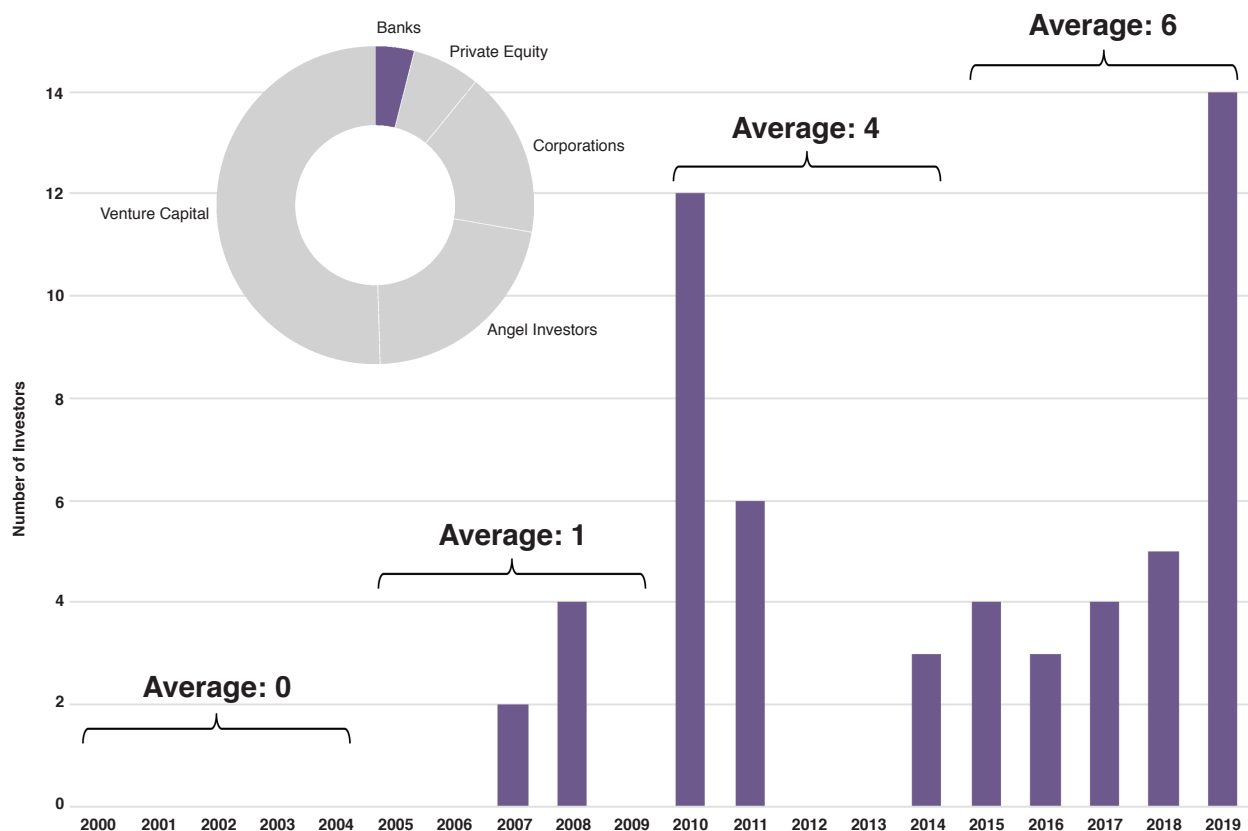


Figure 25. Banks financing start-up space ventures peaked in 2010 and 2011, coinciding with the peak in debt financing during the study period.

SPECIAL TOPIC: CHINESE ACTIVITY IN START-UP SPACE VENTURES

Traditionally dominated by the United States, start-up space is becoming increasingly international with more non-U.S. companies than U.S. companies receiving investment for the first time. China has taken the lead among non-U.S. countries: In 2019, China surpassed all other countries outside the United States in the number of companies receiving financing, the amount of money invested, the number of deals made, and participating investors.

China's Evolving Commercial Space Sector

China's government has historically engaged in comparatively high oversight of the country's industrial capacity, including its space technology industrial base. However, in recent years, China has prioritized its ability to adapt to the changing global economy. In 1999, China began major managerial reforms to state-operated enterprises (SOE) impacting space. More recently, China's space industry has included more diversified investment—much of it allegedly private—targeted at the development of dedicated small satellite launch vehicles and constellations of small satellites, which support the provision of communication and Earth observation services. Investment in non-governmental Chinese space ventures has particularly expanded following the 2014 government decision to incentivize private capital's participation in China's space sector.

In the context of this report, the term “non-governmental” refers to what are commonly regarded as “commercial” space ventures in capitalist economies, as opposed to Chinese government space activities and SOEs. A small network of “frontrunner” Chinese venture capital firms investing in non-governmental space has emerged. Key players will likely continue to shift as more firms add space ventures to their portfolios.

In keeping with global start-up space trends, many of the Chinese ventures that have emerged since 2014 are focused on launch services. Although a majority of

the start-ups are likely receiving undisclosed financial support from the Chinese government directly, investment activity from Chinese venture capital firms continues to grow, and new ventures are emerging each year. Note that many Chinese venture capital firms have access to government funding and therefore do not operate on an entirely private basis.

Some sources have indicated upwards of 100 independent space start-ups have surfaced in China, but that number is much lower for start-ups that have publicly announced funding.

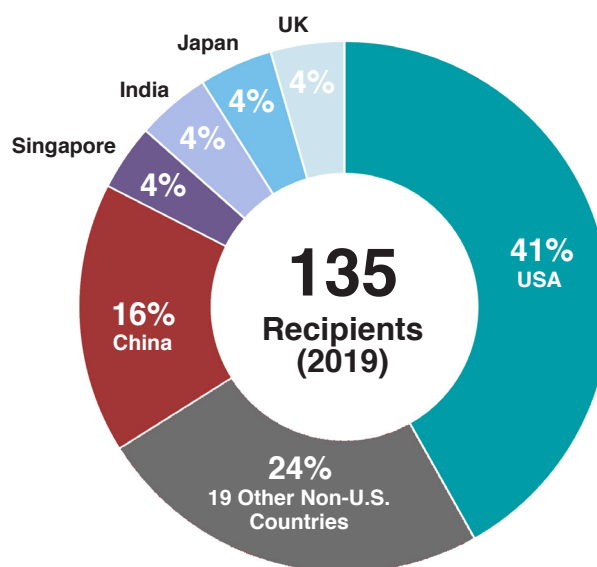


Figure 26. Total 135 investment recipients in 2019—China largest share of non-U.S.

China Most Active in Start-Up Space After U.S.

Counting only those companies that have announced funding, China is now the leader of non-U.S. space ventures. Of the 79 non-U.S. space ventures receiving investment in 2019, 22—more than a quarter—were located in China, up from 10 the year before. Three countries—the United Kingdom, Japan and India—were tied for second, with six each (see Figure 26).

Investors, most if not all based in China, invested \$314.2 million into Chinese ventures during 2019, up from \$288 million in 2018. These investment totals far exceeded those for other non-U.S. countries, with Japan placing second at \$130.6 million. There were 24 financing deals in Chinese start-up space during 2019, double the 2018 number. The number of Chinese investors investing in space also nearly doubled from 2018 to 62, the most of any non-U.S. country. Venture capital firms made up 65% of these investors.

The biggest Chinese investment during the year was a \$141 million infusion into Qianxun Spatial Intelligence, a positioning services venture that will use data from the government's Beidou satellite positioning system. Another significant round in 2019 was Chinese launch service start-up LandSpace, which received \$85 million in two tranches.

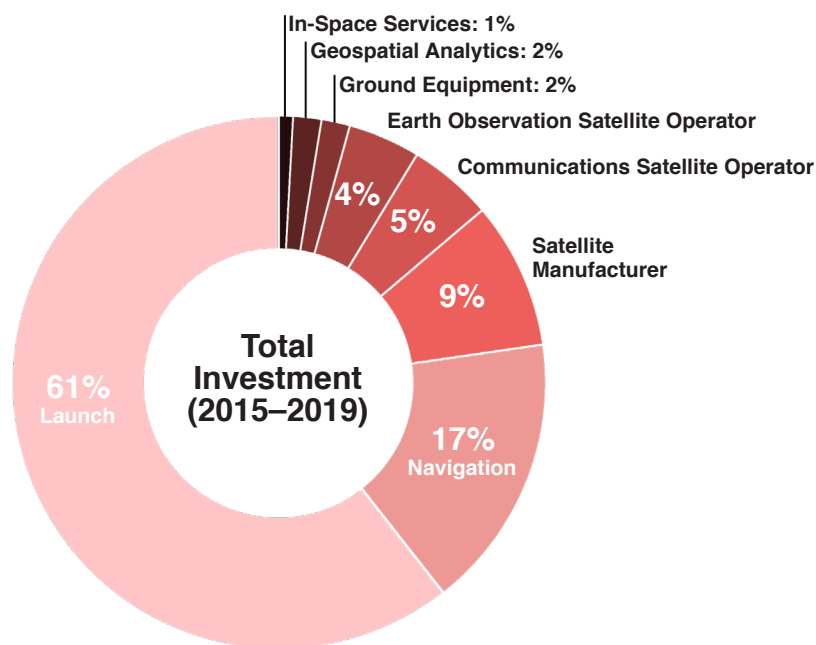


Figure 27. Investment in Chinese Start-up Space Ventures by Activity.

Conclusion

China's space industry has evolved rapidly to meet a dynamic globalized market. Chinese policy and investment in space activities are encouraging greater commercial activity and technological innovation in the country. Consequently, new actors are emerging within China to address a growing demand in space-based services. The future of these ventures and their business case success remains uncertain.



Limiting Foreign Investments in Start-Up Space

Start-up space companies in the United States faced a new financing hurdle following the late 2018 passage of a law that subjects even modest foreign investments in the sector to government scrutiny. Some companies have raised concerns that this has resulted in increased investment in non-U.S. space start-ups.

The Foreign Investment Risk Review Modernization Act, or FIRRMA, expanded the scope of deals subject to government review to include those that might give a foreign investor access to certain critical technologies and infrastructure, including space. Previously such reviews, conducted by the interagency Committee on Foreign Investment in the United States (CFIUS), were limited to transactions that would give a foreign entity a controlling stake in a U.S. company, typically one performing national security work.

Foreign investments in the specified technologies and infrastructure now require a mandatory short-form “declaration” to the government 30 days prior to the transaction closing date. At the close of that 30-day period the government has three options: clear the transaction; request that the parties file a more detailed “voluntary” notice; or say it has insufficient information to clear the deal.

Once the long-form voluntary notice has been filed—which can be done either in lieu of the mandatory declaration or at the government’s request—a 45-day review commences. That review that often results in a more detailed investigation lasting another 45 days.

CFIUS reviews are led by the U.S. Department of the Treasury. Legal fees can be in the tens of thousands of dollars, often a considerable sum for companies just trying to get off the ground. Because of that, and because of the uncertainty these reviews introduce, space start-ups may avoid them, even if it means turning away a willing overseas investor.

Although the rules implementing FIRRMA were not finalized until February 13, 2020, interim regulations were published in October 2018 and reportedly affected the start-up space industry during 2019. For example, Cloud Constellation, a start-up planning a constellation of low Earth orbiting data-storage satellites, cited CFIUS as one of the reasons for turning down a \$100 million investment from Hong Kong-based HCH Group. Cloud Constellation also said its desire to do business with the Department of Defense made ties with a Chinese entity problematic.

Cloud Constellation is one of a number of U.S. space start-ups that have turned down potential investments for fear of triggering CFIUS reviews.

The final rules carve out exceptions for Canada, the United Kingdom, and Australia. However, investors from these countries still have to meet certain requirements that were not in place before FIRRMA.

The United States is not alone in tightening scrutiny of outside investments in critical national security sectors. Japan’s Diet, or parliament, passed legislation November 2019 that requires prescreening for foreign investors taking a 1 percent stake in a Japanese company in one of 12 specified sectors, including space. Previously, that threshold was 10 percent. Although rules implementing the law have yet to be worked out, non-Japanese investors can expect to face increased paperwork to take stakes in the specified sectors in Japan. Also affected are industries including defense, aircraft, utilities, railways and water supply.

START-UP SPACE: WHAT'S NEXT?

The year 2019 was a record-setting one for start-up space, with more than \$5.7 billion in investment reported. Several companies are planning important technical demonstrations for 2020, and others are promising an expansion of operations. Services and products that have long attracted investment are scheduled to deploy in 2020, particularly those related to commercial human spaceflight (SpaceX, Virgin Galactic, and Blue Origin). The revenue dynamics and operational performance of maturing start-up space firms are important trends to watch in start-up space.

Large LEO Constellations

Deployment of SpaceX and OneWeb's large LEO telecommunications constellations began in 2019 and will expand in 2020. At the time of writing SpaceX had deployed 300 operational Starlink satellites—180 in 2020 alone—and OneWeb had deployed 40 satellites. A historic number of satellites will be launching in the coming months, with tens of thousands of additional smallsats planned for the next several years. The year 2019 was also an important one for Earth observation satellite start-ups. Multiple Earth observation satellite operators received study contracts from the National Reconnaissance Office (NRO) during the year and NASA signaled increasing interest in commercial imagery by awarding new contracts. These contracts, coupled with increasing investment, are indicators of continuing growth in Earth observation small satellites.

Both Earth observation and telecommunications smallsat business ventures face significant hurdles in proving their business models. Earth observation satellite operators seek to expand markets for data analytics to new types of users. Telecom constellations will face strong competition from terrestrial competitors, price pressure on bandwidth, and have still not solved the core problem of convenient and price-appropriate ground infrastructure.

This market nonetheless drives interest in smallsat launch ventures and attracts the attention of the non-space business and financial communities. Financial outcomes of today's smallsat companies will therefore have a broader impact on the start-up space environment at large.

Smallsat Launch Ventures

Dozens of new small launch vehicles are in varying phases of development and operation, many receiving significant investment in the past few years. Relativity Space, for instance received \$140 million in Series C in 2019. Of these new companies, Rocket Lab is the sole American start-up provider in operation, launching 6 missions in 2019, and directing efforts to increase reusability of its Electron rocket. Notably, Rocket Lab officials disclosed that they are no longer seeking investment, signaling maturation of the company's business.

Small launch ventures are receiving increasing interest from national security customers. The NRO is deepening its ties with Rocket Lab through smallsat launches and the U.S. Air Force has awarded multiple small launch contracts through expedited mechanisms.

Yet, the small launch sector is dynamic, and will likely experience significant changes as companies mature business plans or bow out of the market.

While governments are increasingly interested in small launch vehicles, competition with larger vehicles and business case uncertainty will shape the commercial market.

As an example of the volatility of this market, within the same week Vector was awarded its first contract to launch a mission for the U.S. Air Force and then suspended operations, citing financial issues. With over 130 prospective small launch vehicles in some stage of development, many not progressing beyond paper and lacking significant investment, a shakeout of the market is inevitable as it matures. The next year will be critical as both launch providers and their prospective customers prove their technologies and business plans.

Space Tourism

Long awaited commercial suborbital human spaceflights are expected to begin soon. Virgin Galactic achieved historic milestones in 2019, becoming publicly traded, moving key personnel and equipment to Spaceport America, and conducting additional test flights. The company is also planning to reopen ticket sales and aims to fly Richard Branson in 2020, but additional commercial flights may be pushed into the 2021. Blue Origin completed three test flights of its New Shepard vehicle in 2019. The company did not meet plans to launch a crewed mission onboard the New Shepard launch vehicle by the end of 2019, but reports it is progressing toward crewed launches.

Commercial Crew

In March 2019, SpaceX successfully launched the Demo-1 mission of an autonomous, uncrewed flight of the Crew Dragon spacecraft to the International Space Station (ISS), where the vehicle docked and later splashed down to Earth. This was followed by SpaceX's successful in-flight abort test in January 2020. These tests paved the way for Dragon's first crewed flight to ISS, marking NASA's first human spaceflight from U.S. soil since 2011 and a significant start-up space milestone. Though not a start-up, Boeing also a contractor for commercial crew program, conducted an uncrewed test flight of its CST-100 Starliner vehicle December 2019, though it was unable to rendezvous with the ISS.

Exploration

NASA's Artemis program, which seeks to return humans to the moon by 2024, creates significant opportunities for start-up companies. Fourteen companies, including start-ups like Astrobotic, are engaging in NASA's Commercial Lunar Payload Services (CLPS) program, competing for task orders to fly specific research payloads or instruments to the moon. In 2019, NASA awarded \$253 million in task orders on that contract to Astrobotic, Intuitive Machines, and Orbit Beyond to fly NASA's first science and technology payloads to the lunar surface. Start-up companies can also increase readiness of their technologies through lunar-focused Small Business Innovation Research awards and other initiatives. NASA's Artemis program will continue to provide on-ramps and opportunities throughout the decade as NASA aims to create a sustainable lunar presence. Governments, particularly NASA, are likely to remain the primary source of demand for these activities.

National Security

In many ways, 2019 was the year of government activity in the start-up space ecosystem, as many firms turned towards the government as a potential customer. The creation of the U.S. Space Force and other new space organizations and an increase in study contracts awarded by intelligence agencies are making U.S. government business more accessible to start-ups. Government contracts could offset sluggish development of commercial markets for some of these companies. Concurrently, governments have an opportunity to leverage emerging start-up space companies to do more while spending less—at the same time dealing with the additional uncertainty created by this venture-backed, dynamic innovation. As start-up space activity moves into the 2020s, government stakeholders will be an increasingly important element of the potential success of venture-funded space start-ups.



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