Complementarity in R&D Investment: Evidence from the Space Race

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Abstract

This paper examines whether venture capital (VC) can complement the public R&D investment. I leverage two shocks—the Space Race and the 1979 ERISA reform—to isolate variation in public R&D spending and the supply of VC. The Space Race created windfall R&D spending in certain regions from 1961 until 1972, while the ERISA reform significantly expanded the supply of VC in 1979. After the reform, VC flowed disproportionately to county-industries that had received NASA funding, indicating a crowd-in effect. Moreover, these county-industries exhibited higher growth. Scientists with space-related specialties were also more likely to start businesses after the reform. These findings highlight the complementarity between public and private R&D investment, suggesting that VC can play a critical role in translating scientific capabilities into entrepreneurial outcomes.

Keywords: Public R&D, Venture Capital, Entrepreneurship, Procurement, Space Race

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1 Introduction

Public R&D investment generates substantial innovation and accumulates human capital. Public funding is central to the innovation system as U.S. private corporations and startups increasingly rely on government-backed discoveries (Fleming, Greene, Li, Marx, and Yao, 2019). For each patent produced by a public grant recipient, roughly three additional patents accrue to others through spillovers (Myers and Lanahan, 2022).

The interaction between public and private R&D is, however, ambiguous. On the one hand, some findings indicate that government funding may crowd out private investment if firms reliant on federal grants expand while their industry peers reduce their R&D (Ngo and Stanfield, 2022). At an individual level, public R&D can crowd out private investment by easing scientists' financial constraints so that they no longer need to seek funding from the private sector (Babina, He, Howell, Perlman, and Staudt, 2023). On the other hand, evidence suggests that boosting public R&D can spur private investment in related technologies, especially when these projects are de-risked through government backing and procurement (Moretti, Steinwender, and Van Reenen, 2023; Pallante, Russo, and Roventini, 2023). Therefore, it creates additional demand for capital to commercialize technology (Rezaei and Yao, 2024).

This paper focuses on a special type of private R&D investment, venture capital (VC). Because the outputs of public R&D—innovation and human capital—are hard to collateralize, they are poorly served by bank lending. However, VC specializes in funding and scaling such projects. VC activity in an industry significantly increases its rate of patenting (Kortum and Lerner, 2000). Recent studies suggest a positive interaction between VC and public R&D investment. VC partnerships specialise in scaling technologies whose technical viability has already been partially demonstrated by mission-oriented public programs—examples include the BRAIN Initiative and several state "grand challenges" (Rezaei and Yao, 2024). One explanation for the R&D investment complementarity is that public R&D expands the opportunity set available to private investors.

The first part of my analysis provides causal evidence of the complementarity be-

tween VC and public R&D. I leverage two exogenous shocks: (i) the Space Race, which channeled massive federal R&D into specific technologies and locations during the 1960s, and (ii) the 1979 relaxation of the "prudent-man" rule under ERISA, which sharply increased the supply of VC by permitting pension funds to invest in the asset class (Kortum and Lerner, 2000).

The Space Race offers a clear, technology-specific windfall. It marked a decisive shift in U.S. federal investment toward the space program. Beginning in the early 1960s, the civilian space program rapidly evolved into a core national priority. NASA received an average of 2.5% of the federal budget during the Space Race, exceeding 4% in 1964 and 1965. This concentrated federal spending stimulated a sharp increase in R&D investment in space-related areas, enabling the development of technologies that would not otherwise have existed and fostering the accumulation of human capital.

The exogenous shock on the VC side came from the Employee Retirement Income Security Act (ERISA) reform of the prudent-man rule. This reform by the Department of Labor relaxed pension fund allocation restrictions and substantially increased the pool of capital available to VC firms (Kortum and Lerner, 2000; Gompers, 1994). Prior to this reform, VC firms had difficulty raising funds because the "prudent-man rule," one of the fiduciary rules of ERISA, restricted pension fund investments in higher-risk assets such as small firm equity. Existing research leveraging this policy change has yet to identify VC's causal effects.

I show that VC inflows disproportionately targeted the industries and counties that had received intense Space Race funding after 1979. This pattern is consistent with the notion that VC capital seeks opportunities that have been de-risked by prior public investment. Moreover, county-industries associated with the Space Race exhibit significantly higher post-ERISA growth, with no evidence of differential pre-trends. The fact that the VC shock occurred nearly seven years after the end of the Space Race yet generated such effects highlights the complementary role of VC in amplifying the long-term impact of public R&D investment.

To examine the microfoundation of the complementarity, I study whether scientists

whose research was boosted by the Space Race were more likely to start a business once the VC supply expanded. I construct a novel panel of U.S. scientists active in the 1960s by compiling a snapshot of their educational backgrounds and work experiences, which I then link to business registration data to observe their subsequent selection into entrepreneurship. I exploit the exogenous cross-sectional variation in scientists' work specialties by classifying the specialties according to their relevance to space technologies. Scientists with space-related work specialties are more likely to be affected by the Space Race. More importantly, these individuals did not select their specialties in anticipation of the Space Race. The results show that space scientists were more likely to start a business than non-space scientists post the ERISA reform.

Furthermore, I find that NASA builds human capital by contracting out the R&D and manufacturing to private firms. Scientists trained under such contracts, i.e., those who worked as prime contractors for NASA, responded most strongly to the ERISA reform. This indicates that government R&D shapes not only technologies but also the talent pools that convert them into entrepreneurial ventures.

Related Literature. This paper contributes to several strands of the literature on public R&D investment and entrepreneurship. First, it speaks to the literature on public and private R&D investment. While earlier studies emphasize that public R&D crowds in private investments in the mid-term (Antolin-Diaz and Surico, 2022) and generates spillovers to large-firm R&D (Azoulay, Graff Zivin, Li, and Sampat, 2019; Moretti et al., 2023), recent research suggests that government-funded R&D can catalyze private capital investment by de-risking nascent technologies (Lerner and Nanda, 2020; Nagaraj, 2022). This paper offers new evidence on how financial intermediaries complement public R&D by supporting scientists' business formation. Specifically, VC investment selectively targets government-invested industries and locations. Public R&D expenditures both mitigate technological risks and promote human capital formation through on-the-job training, thereby attracting VC participation. In turn, this VC inflow releases the entrepreneurial potential accumulated under government-funded research. This paper's findings link the literature on financial intermediation with that on government

expenditure, traditionally centered on bank lending and fiscal multipliers (Goldman, Iyer, and Nanda, 2022).

Second, I connect to the literature on the spillover of public R&D investment. The spillover effect is associated with industrial policies. Government-funded technologies influence private technology development from an aggregated level of analysis. Existing literature shows large technology spillovers from public R&D to the private sector in the fields of life sciences and energy (Azoulay et al., 2019; Myers and Lanahan, 2022). Recent work has found a first-order effect of public R&D windfall on manufacturing value added, employment (Kantor and Whalley, 2025), and technology clustering (Gross and Sampat, 2023). This study finds that the Space Race, as one of the most iconic public R&D investments, facilitated the development of specialized scientists and engineers capable of transferring space technologies to commercial applications.

Third, my results are particularly relevant to the long-term effect of industrial policy. The existing research is divided as to whether R&D-related industrial policy (Gross and Sampat, 2023) has a long-lasting, direct impact. The persistent effect of place-based policy can be explained by capital formation by local public investment (Ehrlich and Seidel, 2018; Garin and Rothbaum, 2025), the learning-by-doing of firms (Choi and Levchenko, 2021), and agglomeration forces (Schweiger, Stepanov, and Zacchia, 2022). Recent research shows how industrial policy can be intermediated via VC, with the government investing passively across active funds, relying on their private expertise in selecting and supporting firms (Aragoneses and Saxena, 2025). This paper shows that the human capital accumulation resulting from industrial policy can be unlocked by VC to transform commercial potential into long-term effects.

The rest of this paper is organized as follows. Section 2 provides an overview of the historical context of the Space Race and the ERISA reform in relation to the VC industry. Section 3 introduces the identification strategy. Section 4 examines the reduced-form relationship between public R&D investment and VC. Section 5 explores the microfoundation of the complementarity. Section 6 concludes.

2 Historical Context

2.1 Space Race and Public R&D Investment

2.1.1 The Start and End of the Space Race

The Space Race, often seen as an outcome of realpolitik, was in essence a public R&D investment. This federal R&D spending was a deliberate strategic shift in government resources toward space programs. The Space Race drove an unexpected surge in R&D activities across the various industry contractors that were involved in it.[1]

The Space Race was spurred by Yuri Gagarin's historic flight in April 1961 and Soviet propaganda, combined with the political concerns of the time. Gagarin's flight triggered a strong reaction in the U.S. which was on a par with, if not surpassing, that of Sputnik 1 and catalyzed a reassessment of the U.S. space program.

During the six months between December 1960 and May 1961, the American civilian space program was transformed from a scientific endeavor into a critical component of the national strategy. This was coupled with many factors, including the change in administration from Eisenhower to Kennedy, James Webb's[2] effective advocation of NASA, Lyndon Johnson's conviction, and Robert McNamara's[3] concern about the military's growing power (Logsdon, 2010). In May 1961, President Kennedy claimed that the U.S. would put a man on the moon before the end of the decade, and the Apollo project was born. The budget for FY1962 was approved in the same year.

I define the start of the R&D windfall and the Space Race as fiscal year 1962 when there was a surge in the budget for NASA following the deliberation between Congress and the federal government. As shown in Figure A2, NASA received an average of 2.5% of the federal budget during the Space Race, exceeding 4% in 1964 and 1965. The Apollo Program itself cost almost 30 billion US dollars.

[1] Despite the ambition of the Space Race, the public was never enthusiastic about human lunar exploration. See page 193 of Launius (2019), according to a set of Gallup, Harris, NBC/Associated Press, CBS/New York Times, and ABC/USA Today polls conducted throughout the 1960s.

[2] James Webb was the second Administrator of NASA, who led NASA from 1961 to 1968, taking it from the beginning of the Kennedy administration through to the end of the Johnson administration.

[3] The eighth U.S. Secretary of Defense, serving from 1961 to 1968 under presidents John F. Kennedy and Lyndon B. Johnson.

The Space Race effectively concluded in 1972 with the launch of the last Apollo mission, Apollo 17. After Apollo 17, both the Soviet Union and the U.S. gradually shifted their focus from the race to more collaborative and long-term space endeavors.[4] Since the Space Race, NASA has hovered between 1% and 0.4% of all U.S. government spending.

2.1.2 Technology Impact

The Space Race produced innovations in various fields, many of which were a direct result of NASA's investment. Through interviews with 161 technical leaders in the space program, Robbins, Kelley, and Elliott (1972) showed that NASA helps to demonstrate the application of new technologies[5] that would not have occurred without the agency's involvement. NASA also facilitates the development of early-stage technologies and brings them to industrial use.

This technological impact is reflected in patenting activities. Figure A1 illustrates the patents assigned to NASA or those explicitly acknowledging NASA's support in their government interest statements. The start of the Space Race and the huge investment in space programs saw an increase in NASA-related patents. While the number of patents owned by NASA declined significantly after the Space Race, the number of patents acknowledging NASA's support continued to grow. Table A1 presents the technology categories of NASA patents. NASA's most patented technologies lay in Measuring and Testing, Power Systems, and Electrical Devices. This is consistent with the technology requirements of the Space Race.

It is worth pointing out that there are two views on the technologies generated by NASA. One view is that much of the technology developed by the space program is irrelevant to the needs of non-aerospace firms. The requirements set by the space program differ significantly from the commercial market, making the technology irrelevant to broader industry needs. On the other hand, while NASA's initial focus was

[4]This was particularly the case after the Apollo-Soyuz Test Project in 1975, a joint space mission between the United States and the Soviet Union.

[5]E.g., in the field of integrated circuits, microwave systems, simulation, and telemetry.

predominantly on the Moon mission, space technologies facilitated numerous subsequent innovations. These contributed to real economic activity through advancements, especially in manufacturing. Although there is some anecdotal evidence of commercial products which originated in NASA research,[6] as yet there has been no systematic evidence of any spillover effect of the Space Race. This paper investigates and substantiates the spillover effect of the Space Race.

2.1.3 Industrial Involvement

The development of the Apollo spacecraft involved extensive nationwide collaboration. Constructing the Saturn V rocket was a monumental manufacturing and logistical effort, with over 3,000,000 components produced across 29 states.The manufacturing locations of Saturn V components span from the East Coast to the West Coast. These parts were then transported, either via canal or barge, to the Deep South for final assembly. The Space Race significantly impacted certain areas, as NASA established new facilities and expanded existing ones to support the Apollo program, stretching from Texas to Florida.[7]

NASA chose not to develop in-house production capabilities but relied on outsourcing to industry partners for the development and manufacturing of its technologies. The agency collaborated with a network of contractors, leveraging their expertise to achieve its mission objectives. Key large prime contractors included companies such as Boeing, Northrop, and Lockheed. NASA's procurement model benefited industrial firms by funding facilities, workforce recruitment, and technical training. For example, the Martin Company began publishing annual aerospace bibliographies and patent summaries in 1961, at the start of the Space Race, as shown in Figure A6.

[6]For example, memory foam, developed by NASA in 1966 to absorb shocks in airplane seats, ultimately found uses in football helmets, shoes, and hospital beds. https://science.howstuffworks.com/innovation/nasa-inventions/nasa-change-diapers.htm

[7]Source: National Air and Space Museum, Washington D.C.

2.1.4 Human Capital Development

The R&D investments made during the 1962–1972 period resulted in significant human capital accumulation. More importantly, the principles of NASA's contracting led to human capital accumulation in private industry. NASA separated evaluation and production by delegating the technical direction and monitoring to the centers.[8] NASA did not itself set up production capacity that already existed in the private sector. As shown in Figure A7, there was a significant expansion in NASA's workforce, with the number of civil servants increasing from 10,200 at the beginning of Kennedy's presidency to 34,500 by the end of 1965. Additionally, the contractor workforce associated with NASA experienced even more rapid growth, reaching a total of 376,700 by the end of 1965.

Another policy that significantly affected the supply of technical personnel during the Space Race was the National Defense Education Act (NDEA), signed into law by President Eisenhower in 1958. The NDEA sought to enhance technical and scientific education, transforming how physics was taught in high school by introducing more mathematics into the curriculum earlier, which increased the supply of technical personnel near the end of the Space Race and afterward. There was a particular focus on science, mathematics, and foreign languages. Universities and corporate R&D facilities were also enlisted in the space effort, creating a strongly interconnected system for harnessing innovative talent (Nicholas, 2019).

2.2 ERISA Reform and Private R&D Investment

The Employee Retirement Income Security Act (ERISA) reform was a unique shock in its significant impact on VC fundraising. Prior to the ERISA reform, the "prudent man" rule specified that a fiduciary must discharge its duty "with the care, skill, prudence, and diligence under the circumstances then prevailing that a prudent man acting in a like capacity and familiar with such matters would use in the conduct of an enterprise

[8] Levine, Arnold S. Managing NASA in the Apollo era. No. 4102. Scientific and Technical Information Branch, National Aeronautics and Space Administration, 1982.

of a like character and with like aims." This rule deterred many pension managers from putting money into VC funds, as investing in small business securities can be high risk.

In 1979, the Department of Labor (DOL) explicitly clarified the fiduciary requirement in a federal register, specifically allowing fund managers to invest their capital in venture funds on the grounds that investment in small firm stocks would be proper provided it was part of an overall portfolio plan.

This reform significantly increased the supply of capital to VC funds. Pre-ERISA reform, the limited partners of VC funds were evenly distributed among industrial corporations, insurance companies, foundations, and individuals. But by 1984, pension funds had become the single most important source of VC funds (Florida and Kenney, 1988). The fundraising patterns were mirrored in the investments by venture capitalists into private R&D in small firms (Kortum and Lerner, 2000).[9]

3 Identification Strategy

The ERISA reform in 1979 serves as an exogenous shock to the supply of VC and is reflected in private R&D investment. After the reform, both the number of deals and the total investment amount surged, as illustrated in Figure A4.

The Space Race provides a cross-sectional variation of locations, industries, and technologies that are funded by the R&D windfall. To isolate the variation of U.S. government R&D investment during the Space Race, this study locates counties where U.S. pre-Space Race technology overlapped with post-Sputnik Soviet technologies based on patent records. This approach involves assessing the text similarity between full-text USPTO patent documents and the CIA National Intelligence Estimates (NIEs) of Soviet space capabilities, while the pre-processing involves removing stop words and applying Porter stemming to technology terms,[10] patent texts, and NIE texts. This is

[9] In addition to the ERISA reform, the high cost of capital in the 1980s, when U.S. interest rates reached 21.5% as the Federal Reserve sought to fight inflation, may also have had a nuanced impact on equity financing. The high interest rates during this period made debt financing more expensive. Small firms unable to secure affordable loans may have increasingly turned toward equity financing, thereby potentially increasing the opportunities for venture capital investments in startups.

[10] The Science Direct technology term corpus is used to index the technologies.

followed by a dimensionality reduction process, which removes infrequent and overly frequent terms and topics with more than four words. The final refined dictionary consists of 25,767 technology concepts, providing a manageable framework for further analysis. Using this corpus, Kantor and Whalley (2025) calculated the text similarity using cosine similarity measures, comparing patent documents issued before 1958 with NIE documents issued after 1958. This approach yields a numerical similarity score for each comparison, allowing for the identification of common technology concepts between pre-Sputnik patents and post-1958 NIE Soviet space technology intelligence reports. The patent-space similarity is then aggregated at the county-industry level. The county-industry-level median of the cosine similarity measure, termed the *space score*, indicates the extent to which technology concepts in U.S. patents are similar to those in NIEs.[11]

County-industries with above-median space scores are defined as a *SpaceCountyIndustry*. Space counties are regions with significant technological overlap with Soviet space capabilities and thus were more likely to receive R&D investment from the U.S. federal government during the Space Race. Figure 1 maps the geographical distribution of space scores, identifying key space counties in California, Texas, and Florida, which aligns with the common perception of these states' central roles. Interestingly, the measure also identifies Wyoming as a space county, despite its limited participation in the Space Race. This suggests that this metric indicates the *potential* for receiving space program funding rather than actual federal R&D investment. This distinction underscores the focus on technological alignment with space program objectives, rather than historical investment records.

The county-industry measure of space capability is exogenous to subsequent R&D allocation. It does not reflect superior technological advancement or the productivity of certain counties, nor does it result from endogenous selection by NASA. Instead, the measure captures the extent to which pre-Sputnik U.S. technologies coincidentally aligned with the technological domains pursued by the Soviet Union during the early

[11] I thank Alex Whalley for sharing the space score data.

stages of the Space Race. These overlaps reflect geopolitical priorities rather than domestic technological frontiers. Moreover, the nature of the Space Race was driven by Cold War dynamics rather than an assessment of the commercial promise of space technologies.

4 Complementarity between VC and Space Race Investment

With the ERISA shock in 1979 on the supply of VC and the cross-sectional variation of the likelihood of being funded by NASA during the Space Race, I conduct a DiD analysis based on the following specification:

$$Y_{ict} = \beta SpaceCountyIndustry_{ic} \times Post1979_t + \theta_{it} + \delta_{ic} + \gamma_{ct} + \epsilon_{ict} \quad (1)$$

Y_{ict} includes outcome variables such as the number of VC deals, the total amount of VC investment, the number of businesses, or the employment count in a certain county-industry. $SpaceCountyIndustry_{ic}$ is assigned to one if the space score of a focal county-industry is above the median, and is exogenous because it simply reflects the technology and places that are suitable for the space program as defined by the Soviet Union. Consequently, it does not capture any potential selection bias associated with NASA's actual investment decisions. θ_{it}, δ_{ic}, and γ_{ct} denote industry-year, county-industry, and county-year fixed effects, respectively. The industry-year fixed effects, θ_{it}, control for time-varying shocks or trends common to all counties within a given industry, such as industry-wide technological advancements and regulatory changes. The county-industry fixed effects, δ_{ic}, account for time-invariant characteristics specific to a particular industry within a county, such as historical industrial specialization, infrastructure, or long-term local policy environments favoring certain sectors. The county-year fixed effects, γ_{ct}, absorb any county-level shocks or time-varying characteristics that could affect all industries within a county, such as changes in local labor market conditions or

local government policy changes.

The parameter of interest is β, which captures the differential effect of increased venture capital activity in county-industry pairs associated with the Space Race following 1979. This specification ensures that the estimated effect is not driven by common shocks to specific industries, persistent differences across county-industry pairs, or time-varying county-level conditions. I cluster standard errors at the county level.

4.1 Flow of Venture Capital

I first investigate whether VC flows into county-industries that received significant government investment during the Space Race. Regions funded by the Space Race may either attract or deter private capital. These regions were not initially developed for commercial purposes, as the Space Race was driven by strategic and geopolitical goals rather than commercial objectives. However, the intangible capital created through public R&D investment may continue to benefit local businesses, potentially making these regions more attractive to private capital (Haskel and Westlake, 2017). Government R&D funding can spur innovation by providing a higher tolerance to failure (Custódio, Ferreira, and Matosc, 2017) and thus generates more investment opportunities.[12]

The private capital investment data comes from Venture Economics, a comprehensive repository of information widely recognized in the field of economics, which particularly focuses on the venture capital and private equity sectors. The database includes fields such as investors, invested startups, and fund profiles. This is the only database that covers the VC and PE deals in 1970s, making it a valuable resource for the analysis in this study, and it is used by many foundational papers in the entrepreneurial finance literature (Kortum and Lerner, 2000; Ewens, Nanda, and Rhodes-Kropf, 2018).

The results in Table 2 and the dynamic specification in Figure 5 show that following the ERISA deregulation, private capital investment increasingly flowed into county-industries that were more likely to have received Space Race investments. Columns (1) and (2) report the total log deal size of early-stage VC investments in a given county-

[12]Appendix A further illustrates how government investment influenced the inception of Silicon Valley and the VC industry.

industry, while Columns (3) and (4) present the number of deals. Columns (1) and (3) include year, industry, and county fixed effects, whereas Columns (2) and (4) incorporate industry-year, county-industry, and county-year fixed effects. All interaction terms β are statistically significant, suggesting that VC investment is concentrated in regions rich in scientific and technical talent. However, it is worth noting that, in the absence of the *Post1979* term, space-related industries and counties received relatively little VC investment. This is likely due to the fact that venture capital activity was limited prior to ERISA, and many technologies that were developed during the Space Race were subject to non-disclosure agreements (NDAs) and other confidentiality restrictions. These limitations may have hindered the commercialization of such technologies, thereby reducing the investment opportunities for VC.

Appendix B further illustrates the linkage between VC-invested industries and the Space Race using patent data. The technology classes of NASA-funded patents are mapped to industry codes based on how likely it is that the technology classes will be used or manufactured in each industry. This mapping gives rise to a NASA index for each industry which shows the extent to which the industry was affected by NASA-funded patents. The results show that technologies invented during the Space Race attracted greater investment from VCs, thus validating the hypothesis that a significant number of VCs invested in places that were more likely to receive public R&D investments during the Space Race.

4.2 Complementarity and Industry Growth

The previous section shows that VC flowed into county-industries that received investment during the Space Race. Literature has shown that human capital and knowledge accumulated have a local effect (Gennaioli, La Porta, Lopez-de Silanes, and Shleifer, 2013; Jaffe, Trajtenberg, and Henderson, 1993). Therefore, this section investigates the industry growth of high-space-capability county-industries after the VC inflows.

The identification equation is the same as Equation 1, and the outcome variables are from the County Business Patterns (CBP) data files from 1974 to 1984. The CBP data

collection process heavily relied on administrative records, particularly from the Internal Revenue Service (IRS), and existing Census Bureau surveys, with employer-reported information forming the foundation. The IRS's quarterly payroll file[13] served as the cornerstone for collecting payroll data, especially for single-establishment employers.

Table 3 presents the effects of VC on industry-level outcomes. Columns (1) and (2) indicate that, following the ERISA reform, a 0.1 point increase in the space score leads to four more establishments in the county-industry. Relative to the pre-ERISA mean of 19.9 establishments per county-industry, this corresponds to a 20% increase. Columns (3) and (4) demonstrate that this effect is concentrated in counties with VC activity. These patterns are consistent across measures based on employment. Columns (5) and (6) indicate that, following the ERISA reform, a 0.1 point increase in the space score leads to 345 more employees in the county-industry. Relative to the pre-ERISA mean of 979 employees per industry, this corresponds to a 35% increase. Columns (7) and (8) demonstrate that this effect is concentrated in counties with VC activity. In these counties, the effect is nine times larger than in counties with less VC activity for the number of establishments, and 16 times larger for the number of employees. These findings suggest that VC played a significant role in expanding the size of intangible industries in the post-ERISA period.

Figure 6 plots the event-study coefficients, illustrating the parallel trends in the pre-ERISA period and the subsequent divergence in county-industry growth following the reform.

To test the robustness of my results, I change the space score to SpaceCountyIndustry as used in the previous section. Table A6 shows that the results still hold. Columns (2) and (6) indicate that, following the ERISA reform, county-industries with a higher than median space score had one more establishment and 58.94 more employees than those below the median.

The results on VC flows and the growth of space-related county-industries highlight the importance of VC in complementing public R&D. Even today, few private space

[13] Treasury Form 941.

companies are profitable enough to self-fund or hold sufficient collateral to secure debt financing. The key players are still large defense contractors and a few established satellite firms. Most small firms rely on government contracts for fixed-cost funding and private equity or venture capital for external equity financing (Megginson, 2024).

5 Microfoundation of the Complementarity

5.1 Individual-Level Data

This section dives further into the complementarity between VC and the Space Race at an individual level. Similar to the county-industry level analysis, in theory scientists who are funded by public R&D often face fewer financial constraints, potentially reducing their need for additional capital; hence public R&D funding crowds out private investment. However, public R&D funding also allows scientists to accumulate human capital and increases their demand for capital to commercialize innovations. Studies (Evans and Jovanovic, 1989; Fehder, Hausman, and Hochberg, 2025) have shown that those with higher entrepreneurial ability require more capital to start a business.

To examine whether scientists funded by NASA or who were positively influenced by the Space Race were more likely to start a business due to the greater accumulation of human capital, I match business registration records with comprehensive historical data on U.S. scientists in the 1960s.

Business Registration Data Business registration data in the U.S. is stored separately by each state's secretary. OpenCorporates[14] gathers the data and distributes it as a one-off download package. This study uses data from all jurisdictions (i.e., states) within the U.S. to measure business formation at the county level.

The business registry data from OpenCorporates covers 76 million businesses across all U.S. states except Illinois. The data includes incorporation dates and dissolution dates, and indicates the state and registration address for the business. Most businesses

[14]I obtained the data under the reference OCESD-14963, data version as of January 2025.

are registered in the same state listed as their physical address, but businesses can also be registered in more than one state. For example, a Texas business that also does business in Florida may be registered as a domestic company in Texas and as a foreign company in Florida (Griffin, Kruger, and Mahajan, 2023). In addition, many firms are registered in the state they operate in and in Delaware. OpenCorporates covers both and often connects the two with the branch and foreign company variables.

Although some census data such as County Business Patterns (CBP) has business registration information at county-industry level, the CBP data before 1975 has not been systematically digitized and made available for public use, but Eckert, Lin, Mian, Müller, Schwalb, and Sufi (2022) digitized and cleaned the CBP files from 1946-1974. However, the census omitted small county-industry combinations before 1974. Moreover, the industry classification changed significantly in 1957 (i.e., SIC 1957), making the pre- and post- Space Race data hard to compare. OpenCorporates provides business registry data dating back to the 1940s or earlier, depending on the state's records. It includes officers' names linked to companies, which is essential for matching with the data on scientists. Therefore, OpenCorporates provides the most consistent publicly available dataset on U.S. business registrations, including records that date back to the period before the Space Race.

Data on Scientists and Engineers To gain a comprehensive understanding of the Space Race's technical personnel, I collected individual-level data from two sources: the National Register of Scientific and Technical Personnel from the National Archives and the American Men of Science.

I retrieved the National Register of Scientific and Technical Personnel (NRSTP) dataset from the National Archives Access to Archival Databases. Originally developed by the National Science Foundation (NSF) to identify specialized professionals for national emergencies, the NRSTP later evolved into a key statistical resource for analyzing the U.S. scientific and engineering workforce, supporting national science policy and informing Congress and government agencies. The dataset includes detailed records of professionals across a range of scientific disciplines—including biology,

chemistry, economics, geology, mathematics, psychology, and more—collected in collaboration with major academic societies. The NRSTP surveys were conducted across eight waves from 1954 to 1970, primarily targeting academic and research professionals, and recorded a wide array of demographic, educational, and employment information, such as institution, age, job function, income, language ability, citizenship, and professional affiliations. Later waves added fields such as place of birth and government sponsorship. I processed the dataset by extracting information from digitized numerical codes, which required extensive manual cleaning due to the lack of optical character recognition in the scanned codebooks. Each line of raw data represents an individual scientist, with variable positions parsed and matched to their textual descriptions. For faint or incomplete scans, I used GPT-4o to reconstruct likely words based on standard disciplinary terminology, as transformer models are well suited to inferring structured content from partial inputs. The overall response rate to the survey was approximately 60%, with variation by discipline, and the NSF reported that the 1964 wave alone captured over 90% of U.S. science doctorates, making this dataset a comprehensive source for studying the scientific labor force during the Space Race era.

I digitized the eleventh edition of American Men and Women of Science (AMS), compiled between 1960 and 1965. Originally published in 1906 by James McKeen Cattell, the AMS directory serves as a uniquely comprehensive source of biographical information on scientists across the United States and Canada. The data was collected through questionnaires with the support of scientific societies, research institutions, universities, and an Advisory Committee appointed by the National Academy of Sciences, the National Research Council, and the American Association for the Advancement of Science. According to the Preface, inclusion required one of the following: (1) attainment of scientific stature through training and experience equivalent to a doctoral degree with continued activity in research; (2) demonstrated high-quality research, as evidenced by peer-reviewed publications or, in cases where work could not be disclosed (e.g., due to classified projects), verified by peer evaluations; or (3) a position of significant responsibility requiring equivalent scientific expertise. The directory is divided into two

sections—Physical and Biological Sciences, and Social and Behavioral Sciences—but only the former was digitized, given the project's focus on scientific and technical personnel. This section consists of six volumes, with roughly 25,000 entries per volume, yielding over 150,000 individual scientist records. Each entry contains detailed information on scientists' education, employment, and research areas, along with personal data such as date of birth, year of marriage, number of children, and mailing address. While 59% of the addresses initially included zip codes, many others contained only partial location data (e.g., street or city). To improve geographic precision and facilitate record linkage across datasets, I employed the OpenStreetMap API to impute missing zip codes, raising the coverage to 64%. This enhancement is critical for geographic analysis and for matching individuals across sources based on name and location.

The data on scientists is drawn from the 1962–1968 waves of the NRSTP and the eleventh edition of AMS, providing comprehensive coverage of U.S. scientific personnel during the Space Race. The 1962–1968 NRSTP waves are used because they uniquely report the city of residence, enabling linkage with other datasets. Business formation is observed from 1970 to 1986, spanning eight years before and after the ERISA shock. The final sample includes 443,975 scientists in the U.S.

5.2 Descriptive Analysis

I begin by presenting descriptive evidence comparing scientists with space-related specialties to those without. Table 4 illustrates the top specialties that are funded by government defense or space programs. Scientists specializing in Engineering Psychology and Aeronautical Engineering are likely to work for the defense programs, while those specializing in Electronics Engineering and Solar/Planetary specialties are likely to work for the space program.

Table 5 shows summary statistics comparing scientists with and without space-related specialties across educational attainment, gender, and birth year. Panel A shows the distribution of the highest degree obtained. The composition is broadly similar across groups. Panel B reports gender distributions, indicating lower female representation

among space scientists (3.9%) compared to non-space scientists (10.0%). Panel C presents birth year statistics: space scientists are, on average, approximately two years younger than their non-space counterparts, with a similar dispersion across cohorts.

Table 6 documents the individual-level relationship between specialization and individual-level innovation and entrepreneurship outcomes. It presents the results from binary and count outcome models assessing whether space scientists are more likely to start a business, file patents, or publish academic papers. Panel A reports the marginal effects from logit regressions, while Panel B reports the incidence rate ratios from Poisson models. All models are estimated on a pooled cross-section of scientists for their activity during 1900-1990, controlling for the level of their highest degree, gender, and birth cohort.

Column (1) in Panel A shows that space scientists are significantly more likely to start a business, with a coefficient of 0.3374, corresponding to a 40% increase in the likelihood of entrepreneurship relative to non-space scientists. Column (2) suggests a modest but statistically significant increase in patenting activity for space scientists, while Column (3) reveals a negative association between space specialization and publishing likelihood. Panel B confirms these patterns in count outcomes: space scientists start more businesses and file more patents on average, but produce fewer academic publications. These differences remain robust after controlling for detailed individual characteristics, including educational attainment, gender, and birth cohort. These findings highlight a reallocation of innovative output toward commercialization among scientists engaged in space-related research.

5.3 Identification

In the spirit of the cross-sectional variation variables constructed in Section 3, I use scientists' work specialties as a proxy for their exposure to the Space Race funding shock. Their work specialty reflects the extent to which their research fields overlapped with areas prioritized in space investment. The rationale is that scientists did not select their research specialties in anticipation of the Space Race, which began in the 1960s. Most

scientists in the sample were already in their 30s or 40s at that time and would have chosen their fields of specialization during their graduate studies in their 20s.

As a result, scientists' work specialties offer plausibly exogenous cross-sectional variation in their exposure to the Space Race. This variation can be leveraged in a DiD framework. Specifically, scientists whose specialties were more aligned with the technological domains prioritized during the Space Race were more likely to receive federal funding.

The Space Race concluded just seven years prior to the ERISA reform, making it a relevant historical event for analyzing long-term government investment effects. Figure 4 illustrates the potential connection between ERISA and the Space Race, showing that business formation increased most post-ERISA among scientists who were previously funded by defense and space programs.

I investigate whether scientists living in the space counties exhibited a higher propensity to start a business because of the Space Race investment and the influx of VC. I conduct a triple DiD analysis based on the following specification:

$$StartBusiness_{it} = \alpha_{it} + \beta \times SpaceSpecialty_i \times Post1979_t + \theta_i + \gamma_t + \epsilon_{it} \qquad (2)$$

$StartBusiness_{it}$ represents whether scientist i starts a business in year t. $SpaceSpecialty_i$ is a binary variable that equals one if the scientist's work specialty is related to space technology. $Post1979_t$ is an indicator variable for the post-ERISA reform period. η_i and η_t denote individual and year fixed effects respectively. Individual fixed effects capture time-invariant determinants of business formation by individual scientists, such as gender and age. Year fixed effects control for aggregate shocks and common trends in business formation activity produced by legal and institutional changes at the federal level, such as the Economic Recovery Tax Act of 1981. The parameter of interest is β, which captures the differential effect of ERISA on business formation by scientists with space or non-space related specialties. Each scientist is retained in the data only until the year when they start a business, such that β can be interpreted as the differential change in the hazard of business formation after

ERISA by scientists with intangible and tangible specialties (Basker and Simcoe, 2021).

Table 7 shows that following the 1979 ERISA deregulation, scientists with space-related work specialties were significantly more likely to establish new ventures. The results are robust by adding controls in Column (1), year fixed effects in Column (2), and individual scientist fixed effects in Column (4). The dynamic specification in Figure 7 shows that the parallel trends assumption is satisfied, indicating that, in the absence of treatment, the treatment and control groups would have followed similar trends over time.

6 Concluding Remarks

In this paper, I provide evidence that public R&D investment and VC complement each other. Using county–industry-level data, I show that VC systematically flowed into county–industries that experienced R&D windfalls during the Space Race. These county–industries subsequently exhibited higher growth in the number of establishments and employment. Individual-level analysis further indicates that business formation by scientists, especially spinouts from NASA's prime contractors, may be a channel.

There are two broader policy implications of R&D-related industrial policies. First, the development of human capital and the training of high-skilled workers during the implementation of such policies are critical for generating persistent economic benefits. When designing R&D-related policy, labor training and industry involvement via government procurement should be considered. Second, private capital investment plays a complementary role in amplifying the impact of these policies. This paper shows the critical role of VC in translating publicly supported scientific advances into commercial applications. By providing the necessary financial resources, private capital can unlock business potential and enhance entrepreneurial activity, leading to spillover effects that benefit the broader economy.

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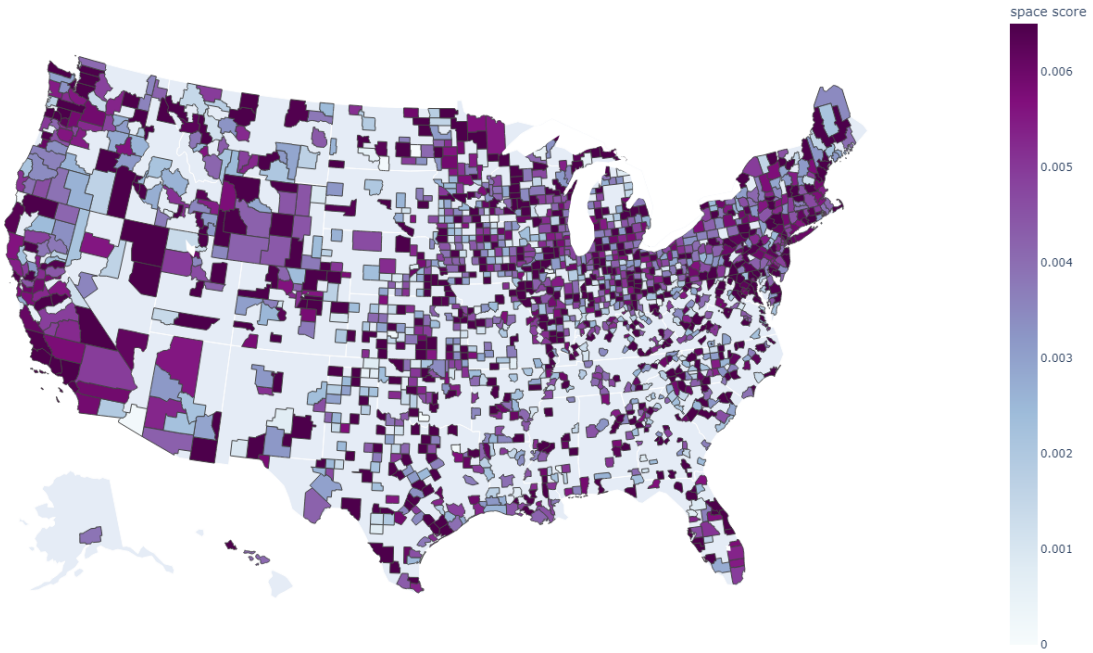
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Figures

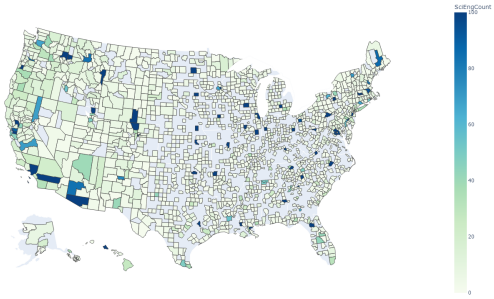
Figure 1: Geographical Distribution of the Space Score



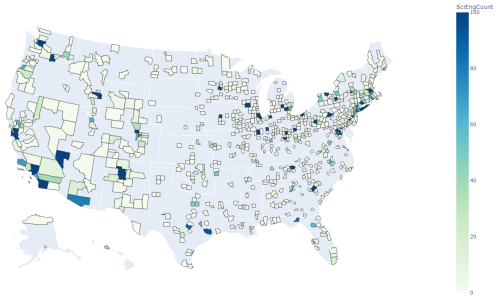
Notes: The graph presents the geographical distribution of the space score as measured by Kantor and Whalley (2025). The space score is computed as the median of the cosine similarity between technology concepts in U.S. patents and those in NIEs at the county level.

Figure 2: Geographical Location of Government-Funded Scientists and Engineers

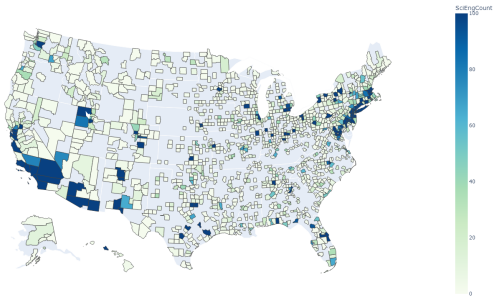
(**a**) Agriculture



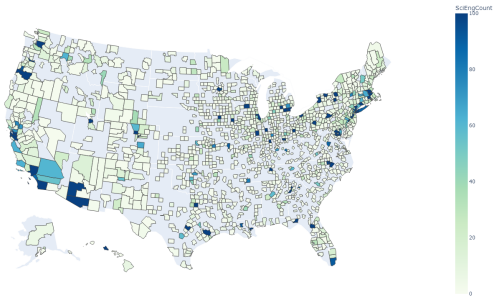
(**b**) Atomic



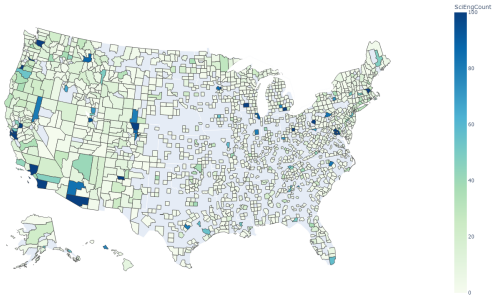
(**c**) Defense



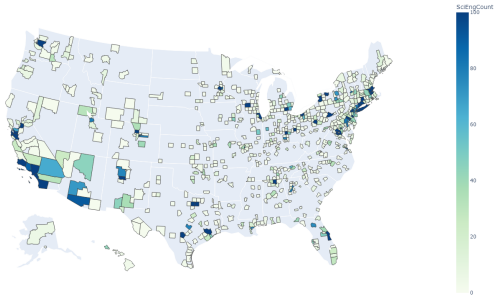
(**d**) Education



(**e**) Natural Resources

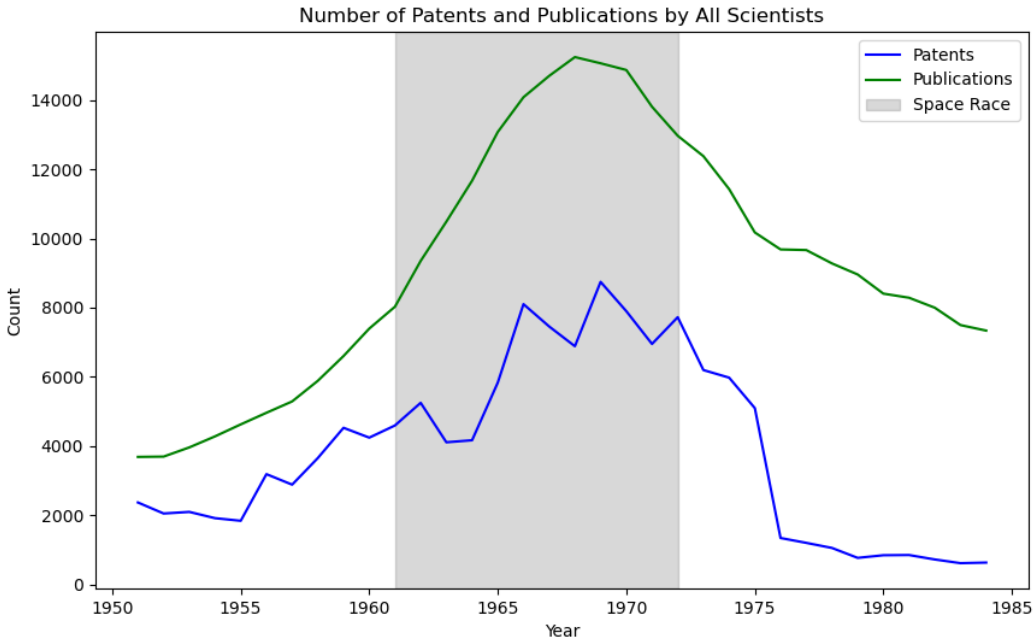


(**f**) Space



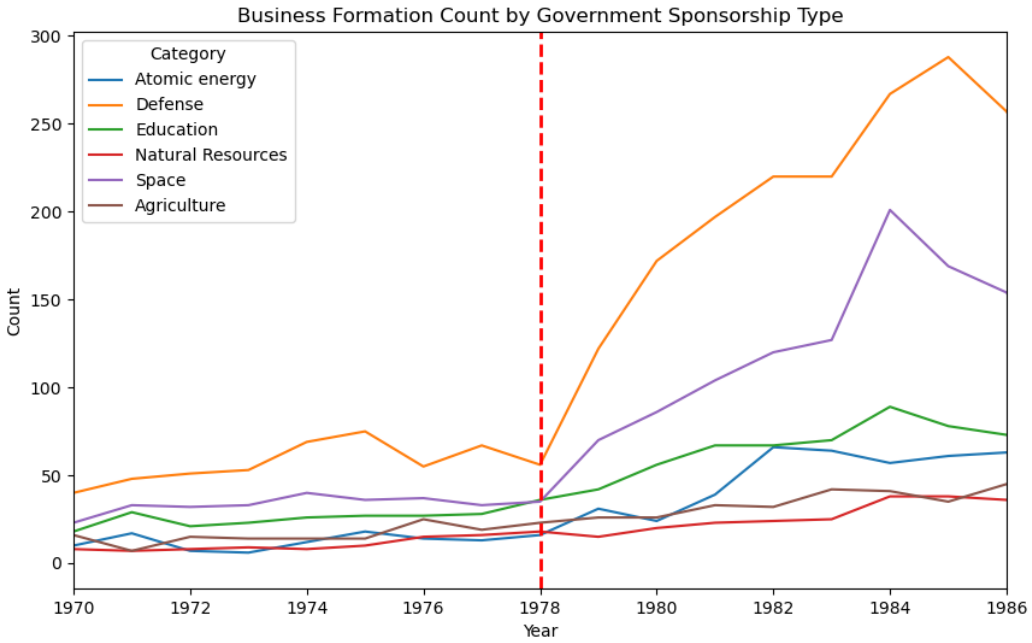
Notes: The graph presents the geographical distribution of scientists and engineers as recorded in the 1962, 1964, 1966, and 1968 NRSTP. The surveys from the specified years include data on whether a respondent is involved in government-funded projects in specific areas. The visualization uses color to represent the count of scientists in each county, with the color intensity indicating the number of scientists present. To standardize the comparison, the color scale is capped at a maximum count of 100. For counties which had no respondents to the survey, their boundaries are not outlined, distinguishing them from those which did record scientists and engineers.

Figure 3: Number of Patents Filed by Scientists



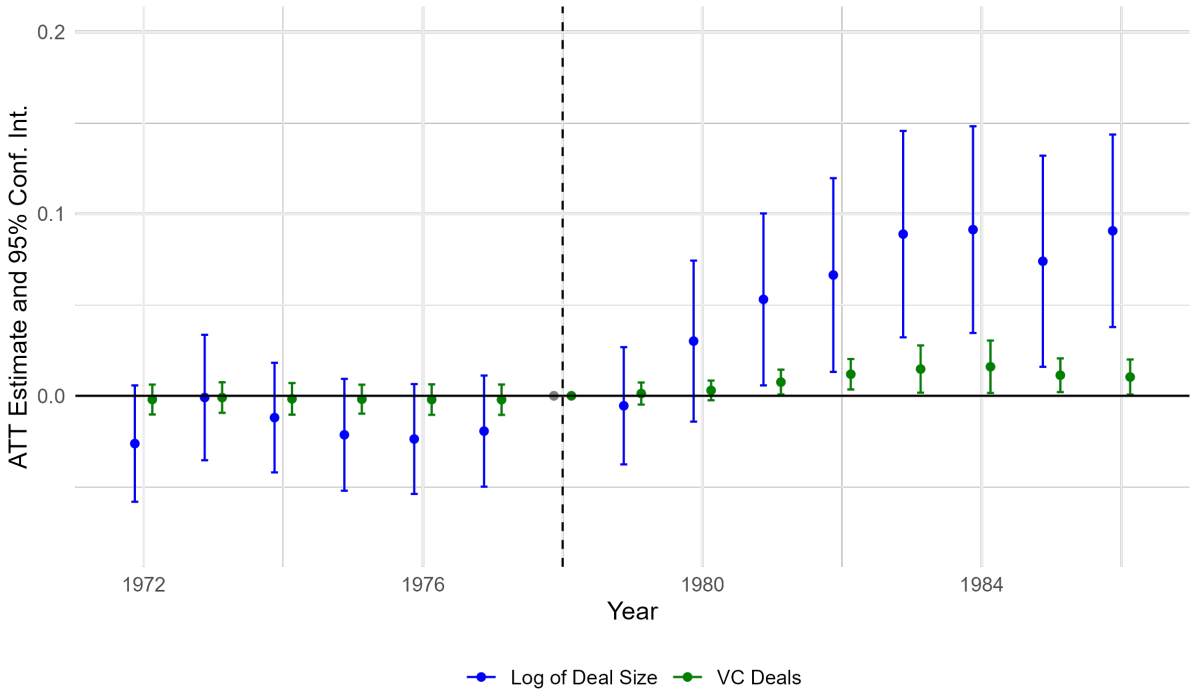
Notes: This figure plots the number of granted patents filed and published papers by scientists in my data sample from 1950 to 1985. The dataset includes only patents that were granted; applications that were not granted are not observed. Only papers published in journals are included.

Figure 4: Business Formation Count by Government Sponsorship Type



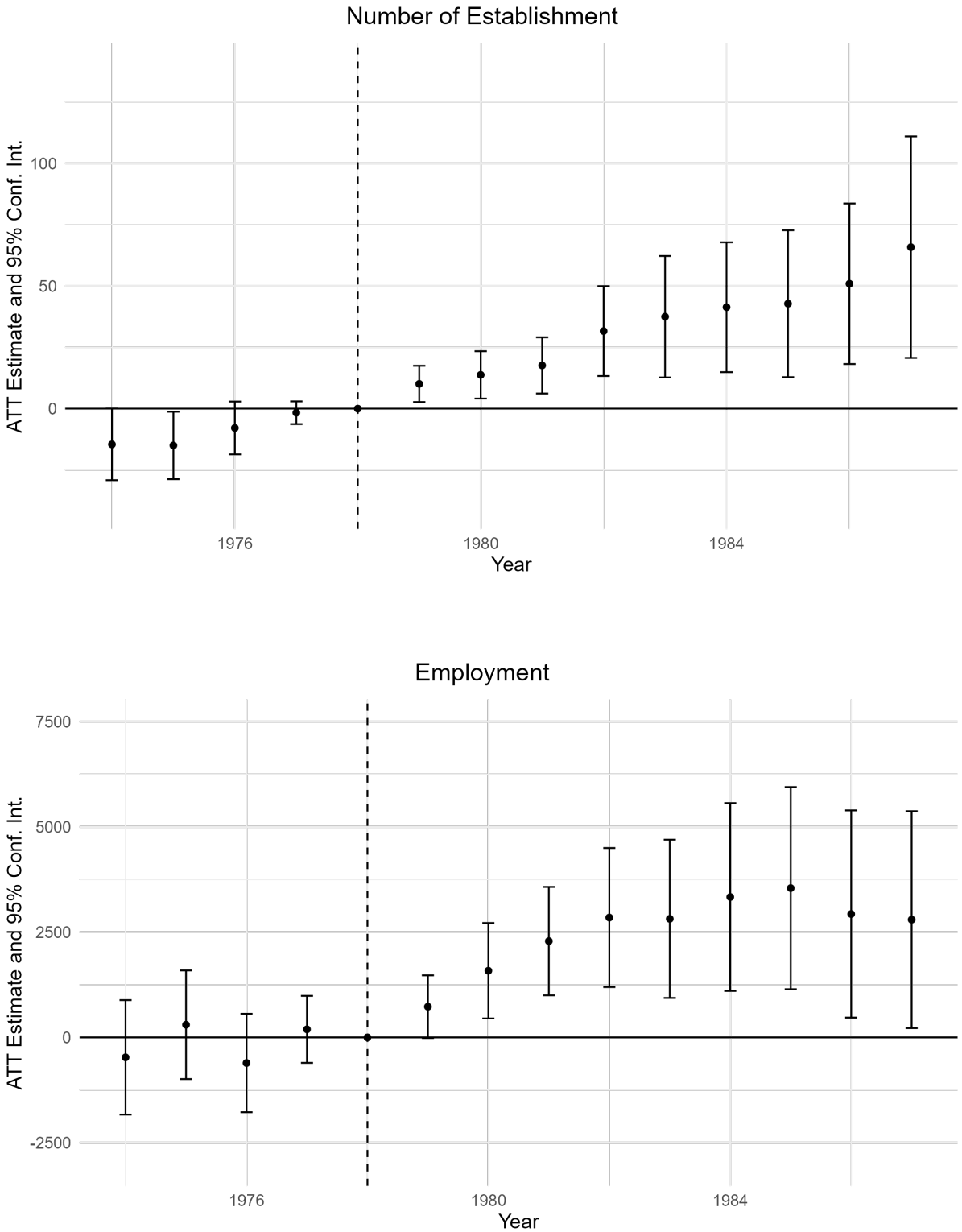
Notes: This figure plots the business formations by scientists and engineers from 1970 to 1986. The scientists are classified based on their government-sponsored program, as self-reported in the NRSTP.

Figure 5: Complementarity: Flow of Venture Capital



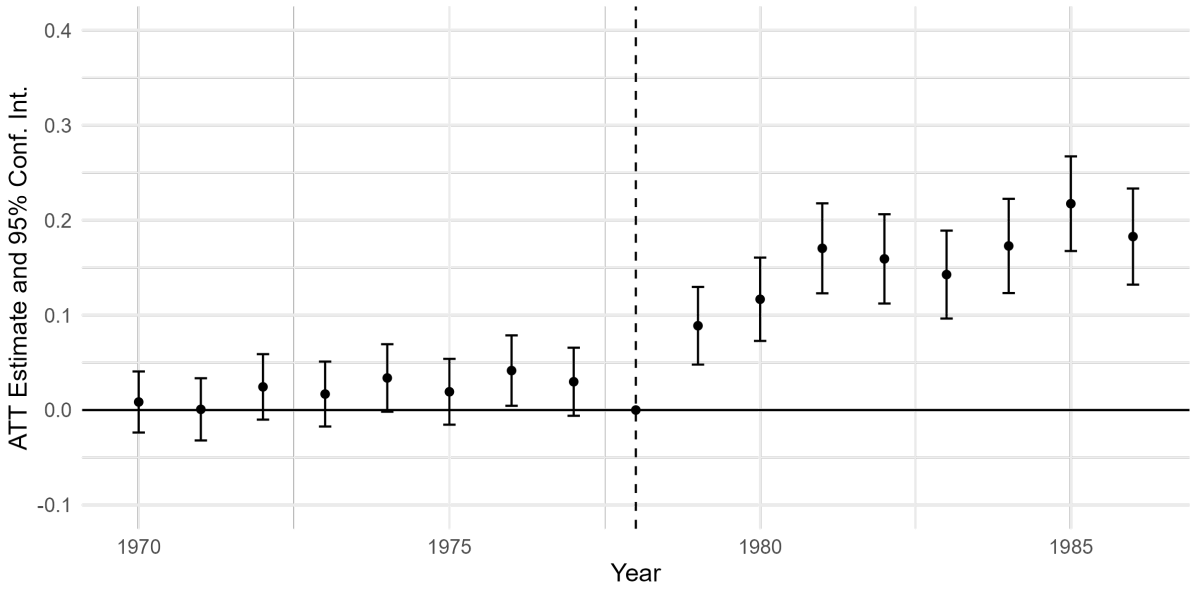
Notes: This figure displays the coefficients from the difference-in-differences estimation from Columns (2) and (4) in Table 2. The vertical lines represent the 95% confidence intervals for the coefficient estimates.

Figure 6: Complementarity: Business Count and Employment



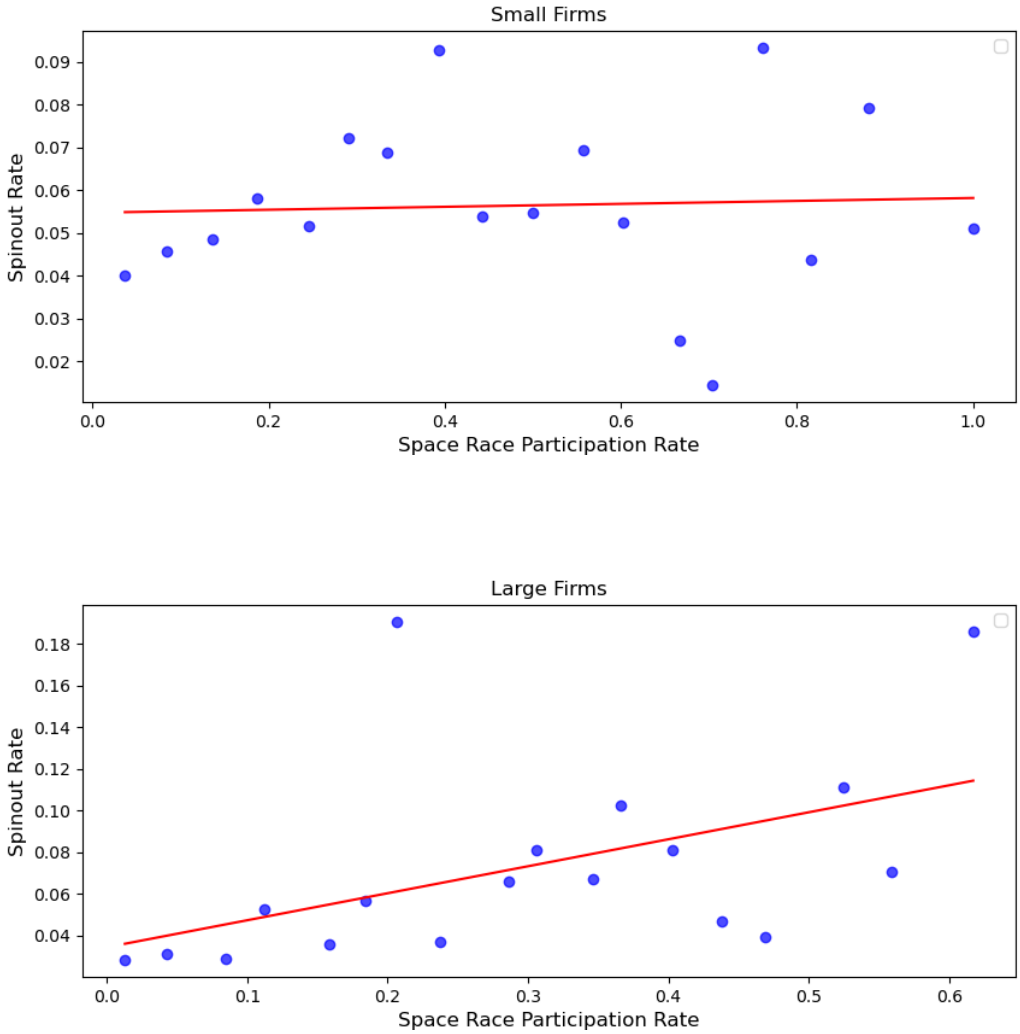
Notes: This figure displays the coefficients from the difference-in-differences estimation of Columns (2) and (6) in Table 3. It illustrates the heterogeneous treatment effects based on the type of employer for scientists and engineers. The vertical lines represent the 95% confidence intervals for the coefficient estimates.

Figure 7: VC and Space Scientists' Entrepreneurial Entry



Notes: This figure displays the coefficients from the difference-in-differences estimation from Column (4) in Table 7. The vertical lines represent the 95% confidence intervals for the coefficient estimates.

Figure 8: Space Participation and Spinout Rate



Notes: This figure presents the bin scatter plots of the regression analyses on the spinout rate. The independent variable, the space participation rate, is defined as the proportion of scientists within a firm who report having been involved in the Space Race. The dependent variable measures the share of scientists who subsequently founded a business. Firms are categorized by size: small firms are those with fewer than 100 scientists, while large firms have more than 100 scientists. This classification allows for an examination of potential differences in spinout behavior between large firms and small firms.

Tables

Table 1: Summary Statistics on Business Formation, Patenting, and Publication

Statistic	Count	Min	50%	Mean	95%	99%	Max	Std. Dev.
Space Score	15,903	0	0.0043	0.0056	0.0137	0.0265	0.245	0.0067
VC Deals	238,545	0	0	0.0089	0	0.0320	38.8	0.247
Private Money	238,545	0	0	0.184	0	9.390	18.6	1.400
Establishment Count	173,371	0	5	19.9	71	243	4,896	85.4
Employment	173,371	0	23	979	4,203	13,866	179,069	4,207

Notes: This table presents the summary statistics of the variables related to the patenting and publication activities of scientists. All variables are at the individual level. BizCount represents the number of businesses formed by a scientist. StartBusiness equals one if a scientist has started at least one firm. PatCount is the number of patents where the scientist is listed as an inventor. FilePatent equals one if a scientist has filed at least one patent. PaperCount is the number of journal publications authored by the scientist. PubPaper equals one if a scientist has published at least one journal article.

Table 2: Complementarity: Flow of VC Investment

Dependent Variables	**Log(DealSize)**		**DealCount**	
	(1)	(2)	(3)	(4)
Post1979 × SpaceCountyIndustry	0.0985***	0.0483***	0.0134**	0.0078***
	(0.0221)	(0.0083)	(0.0066)	(0.0016)
Year FE	Yes		Yes	
County-Industry FE	Yes	Yes	Yes	Yes
County-Year FE		Yes		Yes
Observations	238,545	238,545	238,545	238,545
R^2	0.22496	0.63557	0.08797	0.55657

Notes: This table reports the difference-in-differences estimates of the effect of ERISA on venture capital flow. The analysis is restricted to early-stage deals with an investment stage categorized as Seed, Early Stage, or VC Partnership. The variable for deal size represents the natural logarithm of the disclosed equity contribution (in USD). *SpaceCountyIndustry* is an indicator variable reflecting a county-industry being above median in terms of the similarity between the technologies present in pre-1958 patents and the National Intelligence Estimates of Soviet Space Capabilities between 1958 and 1992 (the Space Capability Score), as described in Kantor and Whalley (2025). The results remain consistent when a logarithmic transformation is applied. Deal count refers to the total number of deals within each county. Standard errors are clustered by county. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 3: Complementarity: Business Count and Employment

Dependent Variable:	**Firm Count**			
	(1)	(2)	(3)	(4)
	Full Sample		More VC	Less VC
Post1979 × SpaceScore	36.62***	41.43***	119.0***	13.48**
	(14.16)	(11.90)	(43.69)	(5.238)
Year FE	Yes			
County-Industry FE	Yes	Yes	Yes	Yes
County-Year FE		Yes	Yes	Yes
Observations	173,371	173,371	54,476	118,895
R^2	0.98727	0.99039	0.99012	0.97385
Dependent Variable:	**Employment**			
	(5)	(6)	(7)	(8)
	Full Sample		More VC	Less VC
Post1979 × SpaceScore	3,453.9***	2,616.5***	8,453.0***	515.2
	(900.0)	(959.7)	(2,760.4)	(764.6)
Year FE	Yes			
County-Industry FE	Yes	Yes	Yes	Yes
County-Year FE		Yes	Yes	Yes
Observations	173,371	173,371	54,476	118,895
R^2	0.95718	0.96385	0.96610	0.87353

Notes: This table reports the difference-in-differences estimates of the effect of ERISA on industry growth from 1974 to 1987. The dependent variables are the number of establishments and employment size reported in CBP. *SpaceScore* is a continuous variable reflecting a county-industry's technologies present in pre-1958 patents and the National Intelligence Estimates of Soviet Space Capabilities between 1958 and 1992 (the Space Capability Score), as described in Kantor and Whalley (2025). *Post1979* equals one for years after 1978. Standard errors are clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 4: Government Sponsored Work Specialties

Panel A: Defense Programs	
Work Specialty	Share of Scientists
Engineering Psychology	0.68
Aeronautical Engineering	0.60
Human Engineering	0.60
Meteorological Instrumentation	0.56
Acoustics	0.55
Network Engineering	0.53
Electricity and Magnetism	0.52
Aeronautical and Astronautical Engineering	0.52
Synoptic Meteorology	0.51
Geodesy	0.51
Panel B: Space Programs	
Work Specialty	Share of Scientists
Electronics Engineering	0.75
Environmental Engineering	0.71
Solar/Planetary Specialties	0.69
Engineering of General	0.53
Material Engineering	0.52
Aeronautical and Astronautical Engineering	0.51
Aeronautical Engineering	0.51
Energy Conservation Programs	0.51
Engineering Science	0.48
Astronomy	0.43

Notes: This table presents the top scientific specialties associated with government-sponsored programs. The data is sourced from the NRSTP, where scientists self-report their participation in government funding programs. The reported share represents the proportion of scientists within each specialty who receive support from a specific program. Panel A lists the leading specialties within government defense programs, while Panel B highlights those most associated with government space programs.

Table 5: Level and Year of Highest Degree

Panel A: Level of Highest Degree		
	Non-Space	Space
Bachelor	104,008	38,234
Master	94,048	36,440
MD	10,487	509
PhD	127,520	32,562
Panel B: Gender		
	Non-Space	Space
Female	34,613	4,282
Male	312,188	105,715
Panel C: Birth Year		
	Non-Space	Space
Min	1859	1860
Mean	1927.70	1929.69
Median	1930	1932
Max	1973	1974
Std. Dev.	11.32	10.30

Notes: Compared to AMS, the NRSTP offers a broader view of the workforce. The NRSTP covers a wider range of fields and is more oriented toward workforce analysis, while AMS emphasizes individual recognition and contributions within the scientific community. AMS primarily includes renowned scientists, most of whom are affiliated with universities and hold PhDs. In contrast, the NRSTP encompasses a broader group of individuals engaged in R&D activities, many of whom may not possess advanced degrees. PhD+ means that the person has more than one PhD degree, or has both PhD and MD degrees.

Table 6: Baseline Regressions

Panel A: Binary Outcome Variables with Logit			
Dependent Variables:	StartBusiness	FilePatent	PublishPaper
	(1)	(2)	(3)
Space	0.3374***	0.1424***	-0.1888***
	(0.0188)	(0.0125)	(0.0138)
Controls	Yes	Yes	Yes
Observations	443,975	443,975	443,975
Pseudo R^2	0.00827	0.05135	0.12831
Panel B: Count Outcome Variables with Poisson			
Dependent Variables:	BizCount	PatCount	PaperCount
	(4)	(5)	(6)
Space	0.4114***	0.0291	-0.2909***
	(0.0311)	(0.0278)	(0.0287)
Controls	Yes	Yes	Yes
Observations	443,975	443,975	443,975
Pseudo R^2	0.01263	0.09537	0.20829

Notes: This table reports OLS estimates of the effect of being a space scientist on business formation, patenting, and publication outcomes. Panel A presents the results where the dependent variable is a binary indicator for whether an individual has ever started a business, filed a patent, or published a paper. Panel B reports the estimates where the dependent variables are counts of businesses formed, patents filed, and papers published. *Space* is a binary indicator equal to one if a scientist's primary specialty is related to the Space Race. Control variables include indicators for the highest degree attained, gender, and birth cohort. Standard errors are clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 7: Mechanism: Space Specialty and Business Formation

Dependent Variable:	$100 \cdot 1\left[\textbf{StartBusiness}_t \mid \textbf{NoBusiness}_{t-1}\right]$			
	(1)	(2)	(3)	(4)
Post1979 × Space	0.1369***	0.1292***	0.1292***	0.0701***
	(0.0097)	(0.0097)	(0.0097)	(0.0095)
Space	0.0305***	0.0018	0.0018	
	(0.0049)	(0.0050)	(0.0050)	
Post1979	0.1354***	0.1306***		
	(0.0038)	(0.0038)		
	0.1070***	-0.0466***		
	(0.0022)	(0.0038)		
Controls		Yes	Yes	Yes
Year FE			Yes	Yes
Individual FE				Yes
Observations	7,797,951	7,738,954	7,738,954	7,738,954
R^2	0.00049	0.00400	0.00406	0.13445

Notes: This table reports the difference-in-differences estimates of the effect of ERISA on business formation by scientists from 1970 to 1986. The dependent variable is a binary indicator of whether a scientist started a business in a given year. *Space* is a binary variable indicating whether the scientist's work specialty is related to the Space Race. *Post1979* equals one for years after 1978. All specifications include individual fixed effects and year fixed effects. Standard errors are clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 8: Top Contractors of NASA

Contractor	**Place**	**Total Large Contracts Value ($000)**
North American Aviation, Inc.	Canoga Park, CA; Downey, CA	5,493,974
Grumman Aircraft Engineering Corp.	Bethpage, NY	1,728,243
Boeing Co.	Seattle, WA; New Orleans, LA	1,487,965
McDonnell Aircraft Corp.	St. Louis, MO; Santa Monica, CA	1,132,575
General Electric Co.	Philadelphia, PA; Daytona Beach, FL; Huntsville, AL	983,627
Douglas Aircraft Co., Inc.	Santa Monica, CA	894,677
International Business Machines Corp.	Rockville, MD; Huntsville, AL	692,263
Aerojet-General Corp.	Azusa, CA; Sacramento, CA	682,703
General Dynamics Corp.	San Diego, CA	569,976
Chrysler Corp.	Detroit, MI; New Orleans, LA	483,526
Bendix Corp.	Teterboro, NJ; Owings Mills, MD	462,393
Radio Corporation of America	Princeton, NJ; Huntsville, AL	370,603
General Motors Corp.	Indianapolis, IN; Milwaukee, WI	359,925
TRW Inc.	Redondo Beach, CA; Cleveland, OH; Houston, TX	279,426
United Aircraft Corp.	Windsor Locks, CT; West Palm Beach, FL	227,714
Lockheed Aircraft Corp.	Sunnyvale, CA; Houston, TX	225,508
LTV Aerospace Corp.	Dallas, TX	181,179
Philco Corp.	Palo Alto, CA; Houston, TX	170,056
Brown Engineering Co., Inc.	Huntsville, AL; San Diego, CA; Northridge, CA	159,352
Sperry Rand Corp.	Great Neck, NY; St. Paul, MN; Huntsville, AL	154,437

Notes: This table presents the top NASA prime contractors based on data aggregated from the 1963–1968 Top 100 Contractors reports in the NASA Historical Data Book, Annual Procurement Report. Awards include contracts with different principal places of performance; the listed location corresponds to the county with the largest award value. A single firm may appear with different places over the years. The data includes R&D contracts of $10,000 or more and all other contracts of $25,000 or more. Total Value is expressed in thousands of U.S. dollars. The data for Douglas Aircraft Co., Inc., and McDonnell Aircraft Corp. are underestimated due to their 1967 merger into McDonnell Douglas Corp. The entry for TRW Inc. reflects awards to its division, TRW Space Technology Laboratories.

Table 9: Mechanism: Spinout of Prime Contractors

Dependent Variable:	$100 \cdot 1\left[\textbf{StartBusiness}_t \mid \textbf{NoBusiness}_{t-1}\right]$			
	(1) Private Industry	(2) Space Prime Contractor	(3) University	(4) Military
Post1979 × Space	0.0732***	0.1274**	0.0145	0.0022
	(0.0126)	(0.0617)	(0.0114)	(0.0334)
Controls	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,729,692	159,845	2,229,322	190,506
R^2	0.14822	0.15339	0.14795	0.15919

Notes: This table reports the difference-in-differences estimates of the effect of ERISA on business formation by scientists from 1970 to 1986. The sample is split based on the type of employer. The dependent variable is a binary indicator of whether a scientist started a business in a given year. *Space* is a binary variable indicating whether the scientist's work specialty is related to the Space Race. *Post1979* equals one for years after 1978. All specifications include individual fixed effects and year fixed effects. Standard errors are clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Online Appendix for
"Complementarity in R&D Investment: Evidence from the Space Race"
Xuelai Li
August 2025

A Early History of Silicon Valley and VC

Silicon Valley's early history is closely tied to government defense spending. During World War II and the subsequent Cold War period, the U.S. DoD channeled significant funds into R&D for advanced electronics and computing startups in Silicon Valley. Government contracts helped reduce production costs by purchasing at scale, which drives prices down to more feasible levels. For example, NASA acted as a major customer for cryogenic insulation materials long before commercialization was feasible and bought in large quantities to lower the price (Robbins et al., 1972). Universities also played an important role in the early days. Beginning in the 1930s, Stanford faculty—most notably Frederick Terman—encouraged students and colleagues to commercialize their research, which laid a foundation for technology-focused spinouts. Over the following decades, this close collaboration between academia and industry spurred a culture of innovation that attracted talent, funding, and further opportunities for new ventures to flourish.

One result of combining government spending and university talent is NASA's Ames Research Center. That laboratory was an expansion of the NACA (National Advisory Committee for Aeronautics), and it transitioned to a research center with the advent of NASA in 1958. Over time, it has cultivated close collaborations with Stanford University, local startups, and large firms.

The inception of the VC industry is also closely related to government defense spending. The first institution similar to VC was American Research and Development, founded in 1946 by George Doroit, who was a general in the U.S. Army in World War II. The mission of American Research and Development was to commercialize the technologies that were developed during the war. The first VC structured as a limited partnership, Draper, Gaither & Anderson, was launched in Silicon Valley by two military generals and the former chair of RAND and the Ford Foundation in 1959.

Given such circumstances, when the ERISA reform took place in 1979, it was natural to link VC investment to the publicly-funded technologies. The next section further illustrates this.

B VC Investment and Space Technologies

To examine the industry focus of VC investments more closely, I construct a NASA Index using the methodology established in the literature (Hausman, 2022). I map the USPC classes of NASA patents to the SIC-3 code with a patent-industry concordance by Kerr (2008). The methodology by Kerr (2008) employs a probabilistic concordance, initially developed by the Canada Patent Office, that assigns each 3-digit SIC industry a probability that it is associated with the manufacture of a given technology class. The formula for the NASA Index incorporates two key variables: p_n is the number of patents in technology class n granted to or acknowledging NASA pre-1976, and w_{in} signifies

the industry i most likely to manufacture the technology class n.

$$NASAIndex_i = \sum_n w_{in} p_n \tag{3}$$

Table A5 shows that VC invested heavily in the electronics and computing industries. These sectors saw considerable innovation as a result of NASA funding, indicating a correlation between NASA's funding and the areas attracting VC investment. However, it is noteworthy that industries such as aircraft and aircraft parts, despite being relevant to NASA's domain, did not appear to attract a similar level of VC investment. This discrepancy suggests that VC interests and investments were not uniformly distributed across all NASA-influenced sectors but were rather concentrated in specific areas. One example of the results above is that the semiconductor industry benefited immensely from the Space Race, which provided a crucial early customer. Government procurement played a critical role in reducing costs and making these technologies viable for commercial markets. The first integrated circuit produced for commercial markets, used in a Zenith hearing aid, had initially been designed for a NASA satellite (Miller, 2022).

The results show that venture capital systematically flows into regions and industries with prior public R&D investment. This is consistent with the fact that the establishment of Draper, Gaither & Anderson was driven by the goal of commercializing technology developed during World War II. This historical connection underscores the broader relationship between government-funded technological advancements and the evolution of the VC industry.

C Space Race Procurement and Spinouts

This section provides evidence that scientists might gain on-the-job training with NASA contractors, increasing the likelihood of spin-out activity. To isolate the role of procurement in shaping entrepreneurial entry, I compiled historical records of NASA's top 100 contractors, which together account for over 90% of NASA's procurement expenditures between 1962 and 1968. These major contractors are listed in Table A7. Within the study sample, 37,307 scientists were employed by these prime contractors, offering a unique context to evaluate the impact of government-sponsored R&D on entrepreneurial outcomes.

The results in Table A8 indicate that scientists working for NASA contractors exhibit a higher propensity to start a business. This finding is consistent with the hypothesis that human capital accumulation during the Space Race was concentrated within a select group of firms that played a central role in NASA's procurement activities.

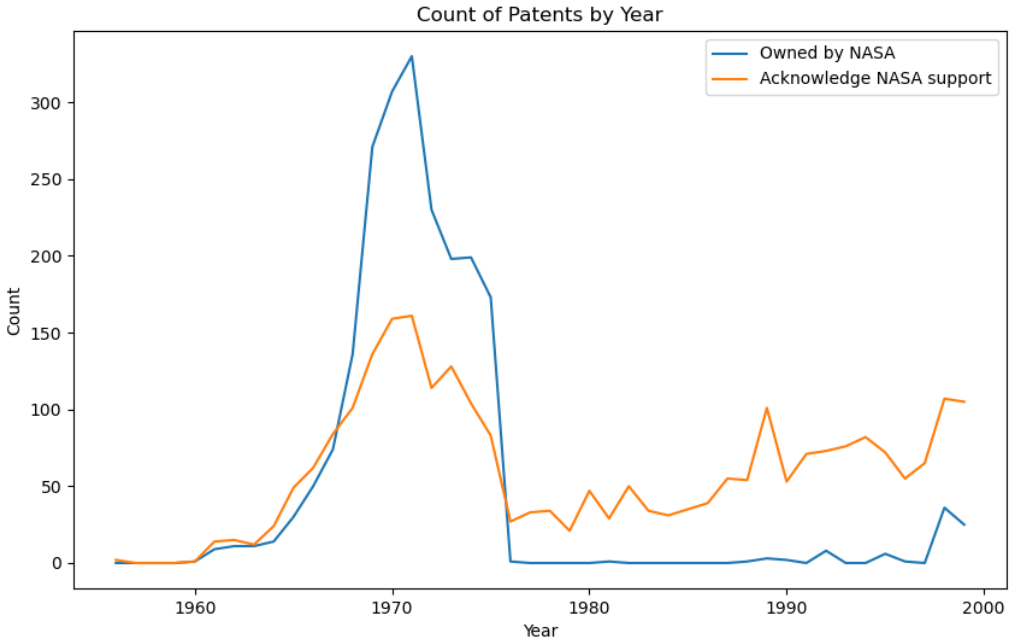
Figure 8 compares the relationship between the space participation rate and the spinout rate at the firm level. The results indicate little correlation between these two variables in small firms. However, in large firms, the relationship is significantly positive, suggesting that a higher proportion of scientists who participated in the Space Race is associated with an increased spinout rate.

These findings align with the hypothesis that human capital accumulation led to higher spinout rates post-ERISA. First, while small firms may have received funding from the Space Race, they may have lacked the systematic training provided to scientists employed by NASA's prime contractors. Second, in small firms, scientists may have found it easier to appropriate their innovations within the existing organizational struc-

ture, reducing the incentive to spin out. In contrast, in large firms, where bureaucratic constraints and intellectual property restrictions may limit individual appropriation, scientists may have been more likely to leave and establish new ventures following the ERISA reform.

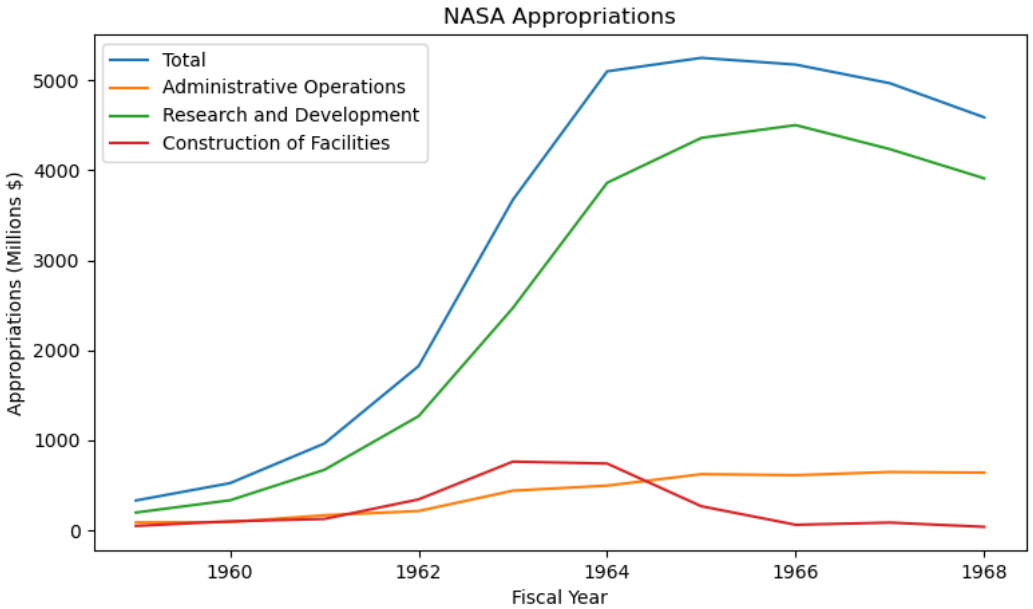
Appendix Figures

Figure A1: Patents Related to NASA



Notes: This figure plots the number of granted patents that are owned by NASA or acknowledge support from NASA by application year. The data is constructed by parsing the government-support clause when present (Fleming et al., 2019). The disclosure of government support was standardized in 1980. Before that, disclosure requirements were agency-specific. Nevertheless, using internal NASA records, Kantor and Whalley (2025) confirm that most NASA-supported patents disclosed this relationship before 1980.

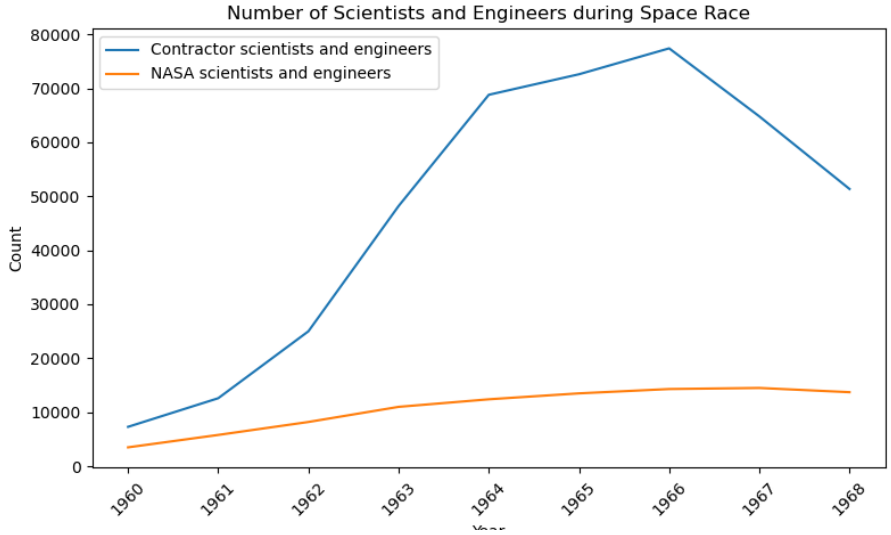
Figure A2: NASA Appropriations



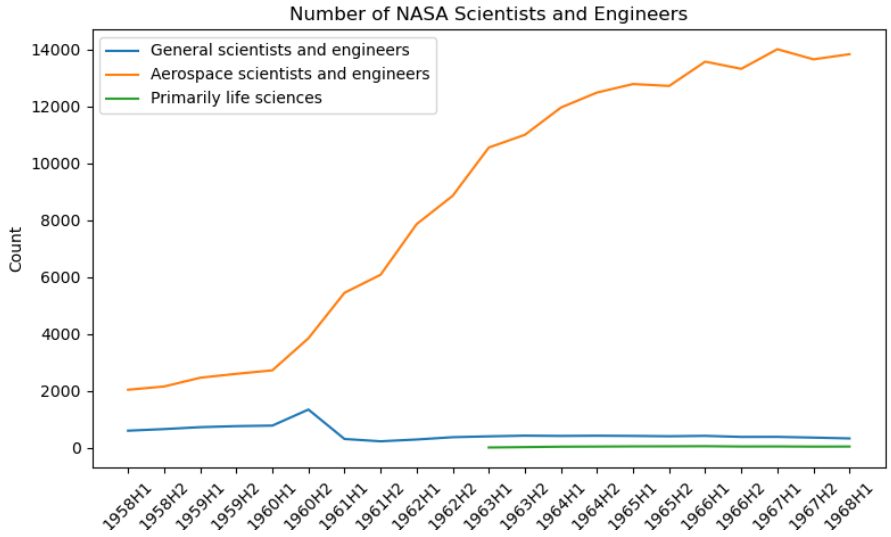
Notes: This figure plots the appropriations of NASA during 1959-1968. The data is drawn from the NASA Historical Data Books page 116. The data for FY 1968 is as of June 30. During this period, NASA spent (obligated) just over $32 billion. This sum represented over three percent of the money spent by the federal government.

Figure A3: NASA Technical Workforce during the Space Race

(**a**) NASA in house and contractors

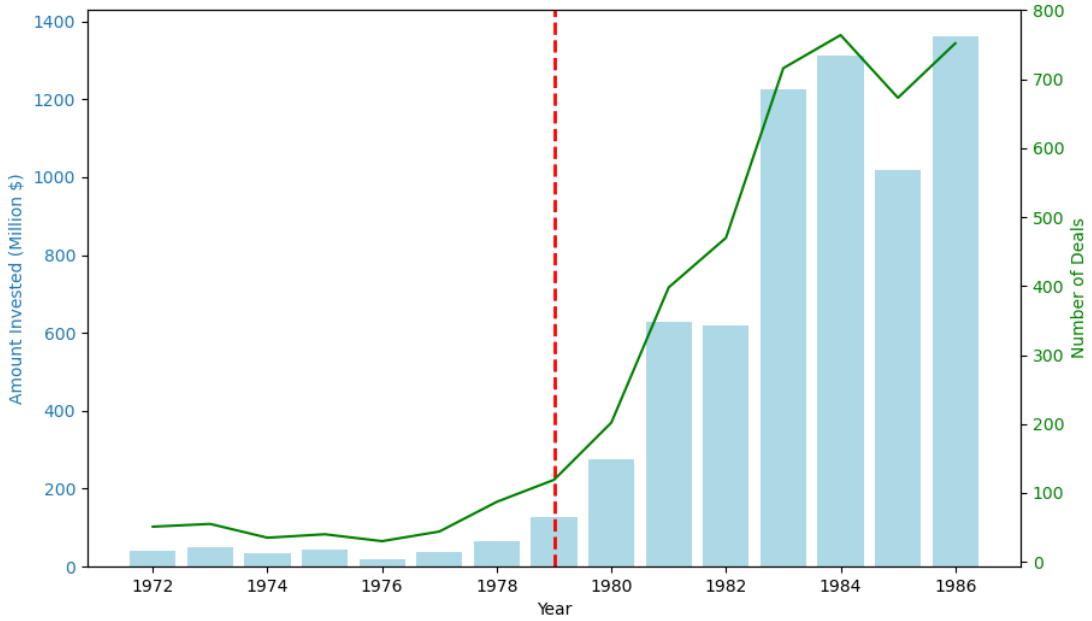


(**b**) NASA in house



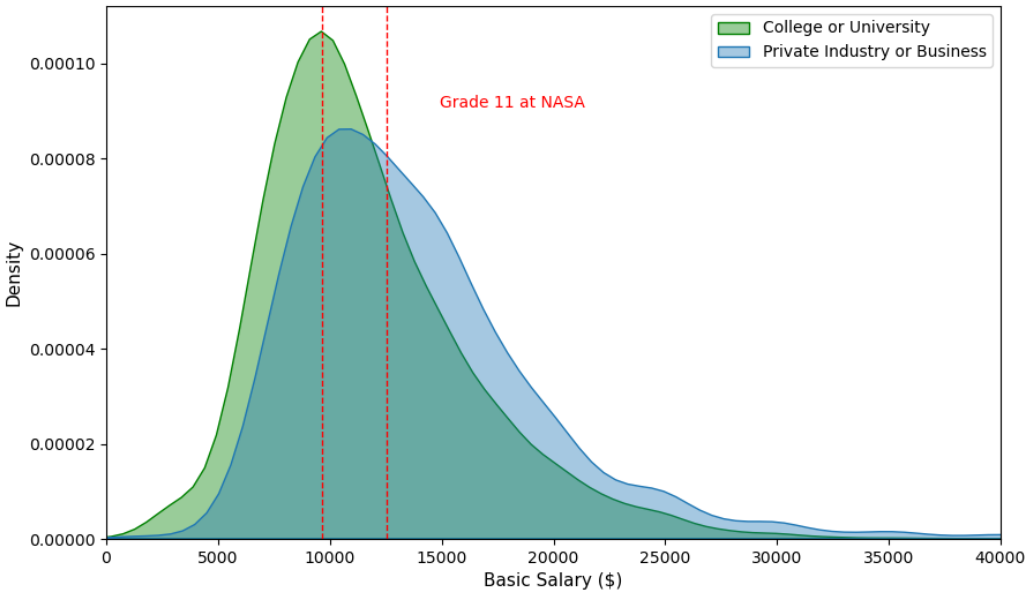
Notes: The data is drawn from NASA Historical Data Books. General Scientist and Engineers include professional positions in the physical sciences, engineering, and mathematics that are not specifically associated with aerospace technology. Aerospace Scientific and Engineering are professional scientific and engineering positions requiring Aero-Space Technology (AST) qualifications. This category encompasses professional roles engaged in aerospace research, development, operations, and related work, including the development and operation of specialized facilities and supporting equipment. Life Science includes professional life science positions that do not require AST qualifications. This category includes medical officers and other roles performing professional work in psychology, the biological sciences, and professions that support the science of medicine, such as nursing and medical technology.

Figure A4: VC Investment and the ERISA Reform



Notes: This figure plots the total amount of VC investment and the number of deals in the U.S. Note that these values are underestimated due to incomplete data coverage in the dataset, particularly for the 1980s. In addition, many of the deals did not disclose the deal size. The data is from Venture Economics, a repository of information widely recognized in the field of economics, which particularly focuses on the venture capital and private equity sectors. The database includes fields such as investors, invested startups, and fund profiles. This is the only database that covers the VC and PE deals in the 1970s, making it a valuable resource for the analysis in this study. The database is used by many foundational papers in the entrepreneurial finance literature (Kortum and Lerner, 2000; Ewens et al., 2018).

Figure A5: Basic Salaries and NASA General Schedule Grades for Employees



Notes: This graph presents the distribution of scientists' annual base salaries. It includes a reference line derived from NASA's General Schedule Salary Rates in 1968, drawn from the NASA Historical Data Book. There are a total of 18 grades, with Grade 18 representing the highest salary rate. According to the Historical Data Book, GS-14 salaries span from $815,841 to $820,593, GS-13 from $813,507 to $817,557, GS-12 from $811,461 to $814,899, GS-11 from $809,657 to $812,555, and GS-10 from $808,821 to $811,467. For illustration purposes, salaries above $40,000 are dropped from the graph but are included in the density analysis.

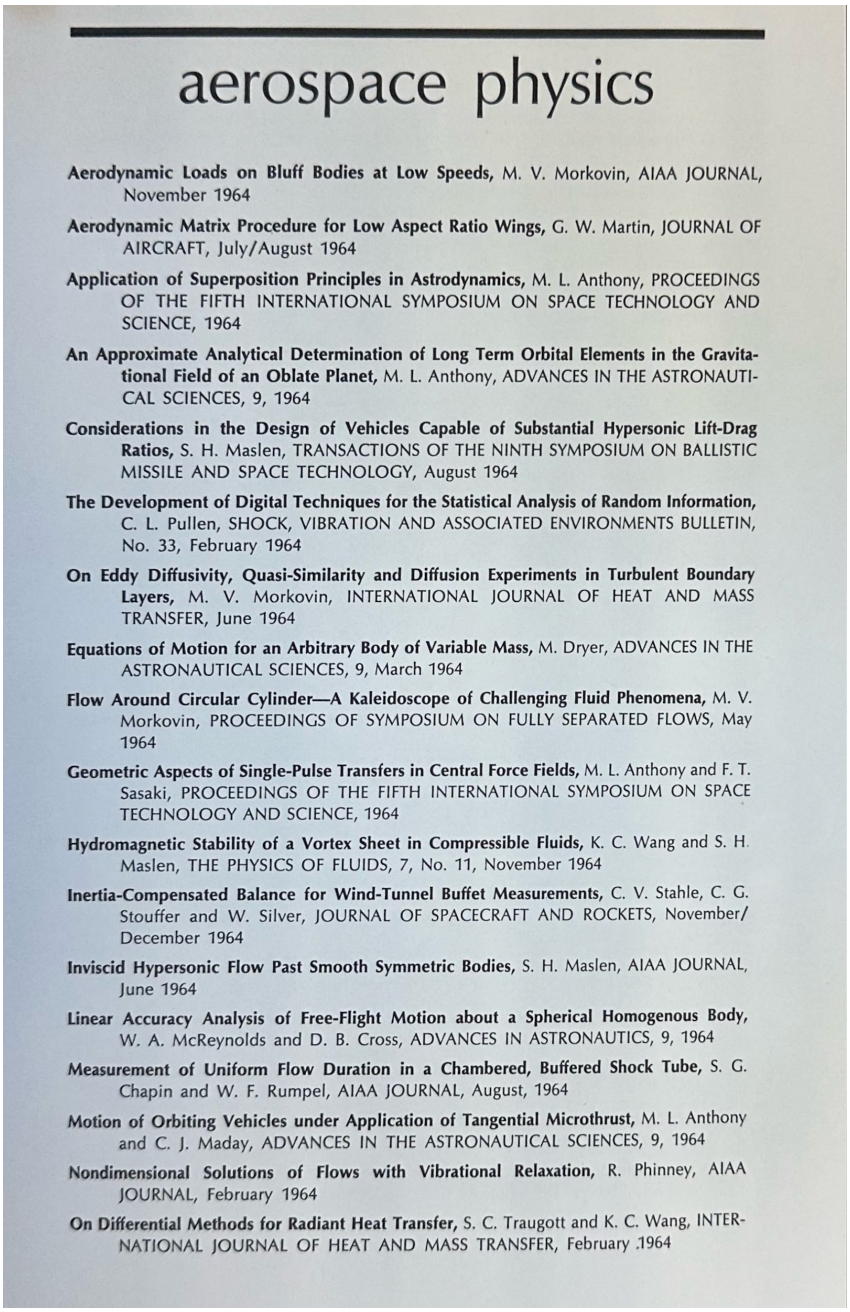
Appendix Tables

Table A1: Top 10 and Bottom 10 Categories of NASA Patents

SubCatName	Total Patents	SubCatName	Total Patents
Measuring & Testing	446	Receptacles	18
Power Systems	338	Agriculture, Food, Textiles	15
Electrical Devices	302	Furniture, House Fixtures	14
Miscellaneous-Others	240	Biotechnology	10
Communications	239	Miscellaneous-Drgs&Med	8
Nuclear & X-rays	187	Computer Peripherals	5
Miscellaneous-chemical	175	Drugs	5
Metal Working	168	Amusement Devices	5
Transportation	167	Organic Compounds	4
Miscellaneous-Elec	154	Earth Working & Wells	4

Notes: NASA patents are characterized as those awarded before 1976 which are either assigned directly to NASA or which recognize NASA's support. These patents are categorized according to the NBER technology classification, utilizing the crosswalk methodology developed by https://historicip.com/nber. The NBER US Patent Citations Data includes all the U.S. patents granted between 1963 and 1999. The NBER has mapped the USPC categories into simpler groups that have been used in economic work. I use this classification because it is based on the technology categories in the last century. Due to the ever-changing nature of technology, this classification more accurately reflects the technology in my research timeframe.

Figure A6: Bibliography and Patent Summary by The Martin Company



aerospace physics

Aerodynamic Loads on Bluff Bodies at Low Speeds, M. V. Morkovin, AIAA JOURNAL, November 1964

Aerodynamic Matrix Procedure for Low Aspect Ratio Wings, G. W. Martin, JOURNAL OF AIRCRAFT, July/August 1964

Application of Superposition Principles in Astrodynamics, M. L. Anthony, PROCEEDINGS OF THE FIFTH INTERNATIONAL SYMPOSIUM ON SPACE TECHNOLOGY AND SCIENCE, 1964

An Approximate Analytical Determination of Long Term Orbital Elements in the Gravitational Field of an Oblate Planet, M. L. Anthony, ADVANCES IN THE ASTRONAUTICAL SCIENCES, 9, 1964

Considerations in the Design of Vehicles Capable of Substantial Hypersonic Lift-Drag Ratios, S. H. Maslen, TRANSACTIONS OF THE NINTH SYMPOSIUM ON BALLISTIC MISSILE AND SPACE TECHNOLOGY, August 1964

The Development of Digital Techniques for the Statistical Analysis of Random Information, C. L. Pullen, SHOCK, VIBRATION AND ASSOCIATED ENVIRONMENTS BULLETIN, No. 33, February 1964

On Eddy Diffusivity, Quasi-Similarity and Diffusion Experiments in Turbulent Boundary Layers, M. V. Morkovin, INTERNATIONAL JOURNAL OF HEAT AND MASS TRANSFER, June 1964

Equations of Motion for an Arbitrary Body of Variable Mass, M. Dryer, ADVANCES IN THE ASTRONAUTICAL SCIENCES, 9, March 1964

Flow Around Circular Cylinder—A Kaleidoscope of Challenging Fluid Phenomena, M. V. Morkovin, PROCEEDINGS OF SYMPOSIUM ON FULLY SEPARATED FLOWS, May 1964

Geometric Aspects of Single-Pulse Transfers in Central Force Fields, M. L. Anthony and F. T. Sasaki, PROCEEDINGS OF THE FIFTH INTERNATIONAL SYMPOSIUM ON SPACE TECHNOLOGY AND SCIENCE, 1964

Hydromagnetic Stability of a Vortex Sheet in Compressible Fluids, K. C. Wang and S. H. Maslen, THE PHYSICS OF FLUIDS, 7, No. 11, November 1964

Inertia-Compensated Balance for Wind-Tunnel Buffet Measurements, C. V. Stahle, C. G. Stouffer and W. Silver, JOURNAL OF SPACECRAFT AND ROCKETS, November/December 1964

Inviscid Hypersonic Flow Past Smooth Symmetric Bodies, S. H. Maslen, AIAA JOURNAL, June 1964

Linear Accuracy Analysis of Free-Flight Motion about a Spherical Homogenous Body, W. A. McReynolds and D. B. Cross, ADVANCES IN ASTRONAUTICS, 9, 1964

Measurement of Uniform Flow Duration in a Chambered, Buffered Shock Tube, S. G. Chapin and W. F. Rumpel, AIAA JOURNAL, August, 1964

Motion of Orbiting Vehicles under Application of Tangential Microthrust, M. L. Anthony and C. J. Maday, ADVANCES IN THE ASTRONAUTICAL SCIENCES, 9, 1964

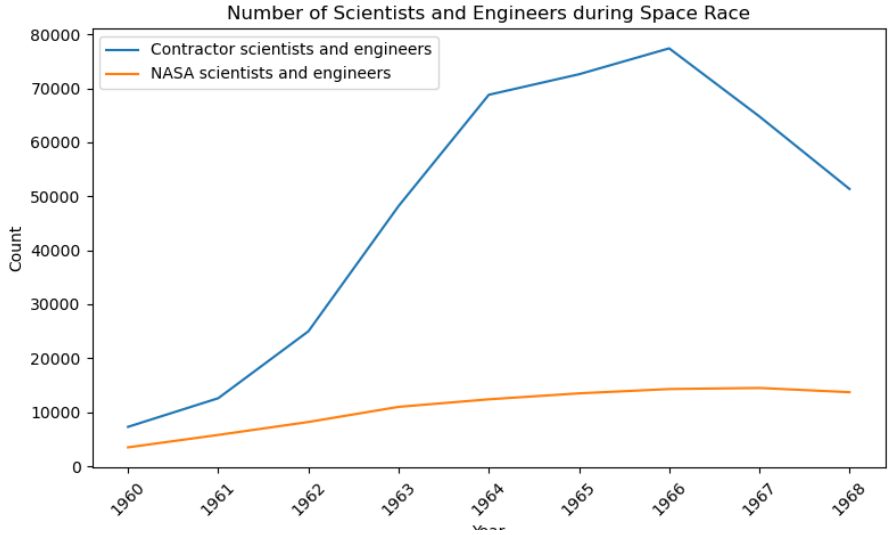
Nondimensional Solutions of Flows with Vibrational Relaxation, R. Phinney, AIAA JOURNAL, February 1964

On Differential Methods for Radiant Heat Transfer, S. C. Traugott and K. C. Wang, INTERNATIONAL JOURNAL OF HEAT AND MASS TRANSFER, February 1964

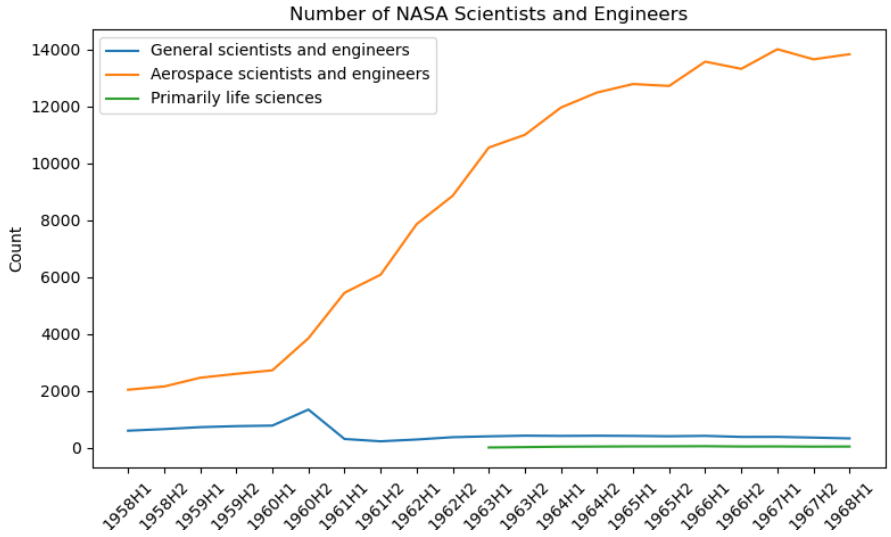
Notes: This is a page from a publication by The Martin Company (later part of Martin Marietta and now Lockheed Martin), that acknowledges the contributions of its engineers and scientists to the aerospace industry. It was edited by George F. Metcalf, the Vice President of Research and Engineering at The Martin Company. The document was retrieved from National Archives College Park, Maryland in June 2024.

Figure A7: NASA Technical Workforce during the Space Race

(**a**) NASA in house and contractors



(**b**) NASA in house



Notes: The data is drawn from the NASA Historical Data Books. General Scientist and Engineers include professional positions in the physical sciences, engineering, and mathematics that are not specifically associated with aerospace technology. Aerospace Scientific and Engineering includes professional scientific and engineering positions requiring Aero-Space Technology (AST) qualifications. This category encompasses professional roles engaged in aerospace research, development, operations, and related work, including the development and operation of specialized facilities and supporting equipment. Life Science includes professional life science positions that do not require AST qualifications. This category includes medical officers and other positions performing professional work in psychology, the biological sciences, and professions that support the science of medicine, such as nursing and medical technology.

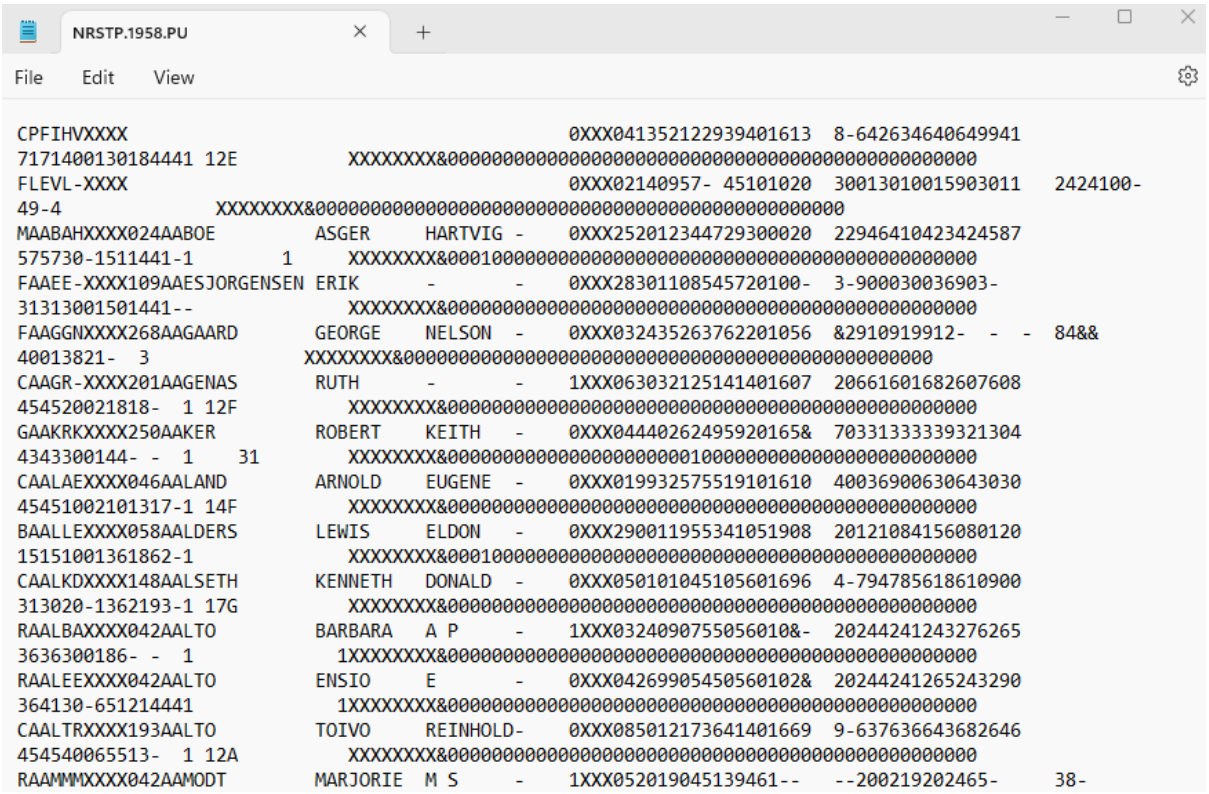
Figure A8: Example of raw data from the AMS

CHOYKE, DR. WOLFGANG J(USTUS), Westinghouse Research Labs, Churchill Boro, Pittsburgh, Pa. SOLID STATE PHYSICS. Berlin, Germany, July 24, 26; nat; m. 49; c. 2. B.Sc, Ohio State, 48, Ph.D.(physics), 52. Res. physicist, WESTINGHOUSE RES. LABS, 52-60, fel. physicist, 60-62, ADV. PHYSICIST, 63- Sig.C, U.S.A, 44-46. Phys. Soc. Experimental nuclear physics, applying Wilson cloud chambers and diffusion cloud chambers; solid state physics, photoelectric processes; radiative recombination processes; optical absorption; silicon carbide.

HADDOCK, DR. ROY P, b. Nogales, Ariz, Mar. 30, 28; m. 52; c. 5. NUCLEAR PHYSICS. A.B, California, Berkeley, 52, Ph.D.(physics), 57. Asst. res. physicist, CALIFORNIA, Berkeley, 57-59, asst. prof. NUCLEAR PHYSICS, LOS ANGELES, 59-63, ASSOC. PROF, 63- Consult, Lawrence Radiation Lab, Berkeley, 59- U.S.N, 46-48. Phys. Soc. High energy nuclear physics research and instrumentation. Address: Dept. of Physics, University of California, 415 Hilgard, Los Angeles, Calif. 90024.

Notes: This figure includes two example entry extracts from AMS. Each entry reports the scientist's name, birth details, marital and citizenship status, educational background, and field of specialization. Their professional history is listed chronologically, including research positions, academic appointments, consulting roles, and society memberships. Their research interests and areas of expertise are described briefly at the end of each entry.

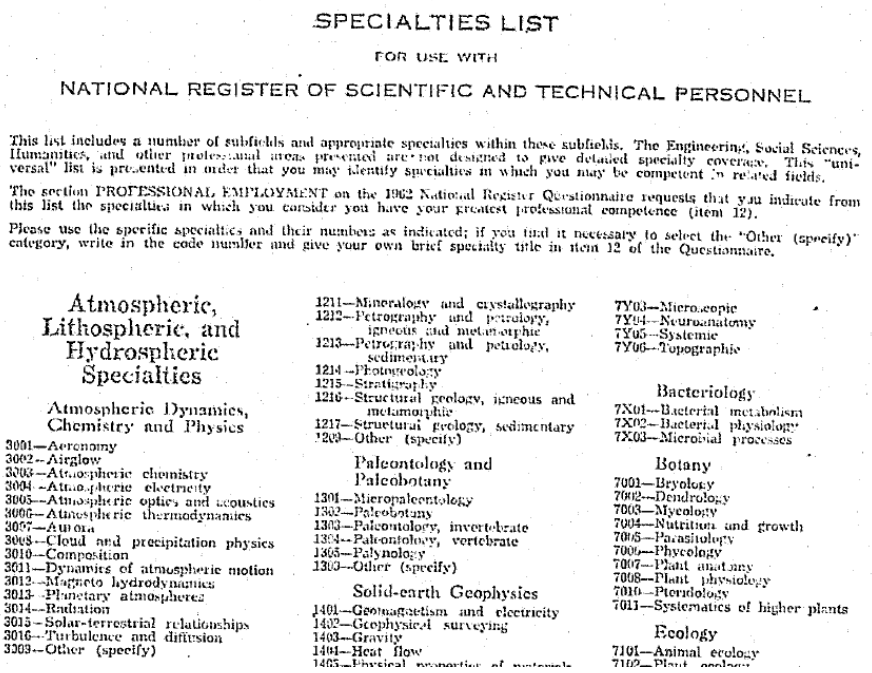
Figure A9: Example of raw data from the NRSTP



Notes: The raw dataset from the NRSTP consists of thousands of entries, with each line representing an individual record. The values in different positions in the line correspond to different variables (i.e., survey questions). To analyze the data, I first separate these values into their respective variables. I then match the numbers with their descriptions based on codebooks, which are scanned documents without optical character recognition (OCR). I manually clean the codebooks to ensure accurate mapping between numerical values and descriptions.

Figure A10: Examples of the codebook for the NRSTP

(**a**) Work Specialty



SPECIALTIES LIST

FOR USE WITH

NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

This list includes a number of subfields and appropriate specialties within these subfields. The Engineering, Social Sciences, Humanities, and other professional areas presented are not designed to give detailed specialty coverage. This "universal" list is presented in order that you may identify specialties in which you may be competent in related fields.

The section PROFESSIONAL EMPLOYMENT on the 1962 National Register Questionnaire requests that you indicate from this list the specialties in which you consider you have your greatest professional competence (item 12).

Please use the specific specialties and their numbers as indicated; if you find it necessary to select the "Other (specify)" category, write in the code number and give your own brief specialty title in item 12 of the Questionnaire.

Atmospheric, Lithospheric, and Hydrospheric Specialties

Atmospheric Dynamics, Chemistry and Physics

3001—Aeronomy
3002—Airglow
3003—Atmospheric chemistry
3004—Atmospheric electricity
3005—Atmospheric optics and acoustics
3006—Atmospheric thermodynamics
3007—Aurora
3008—Cloud and precipitation physics
3010—Composition
3011—Dynamics of atmospheric motion
3012—Magneto hydrodynamics
3013—Planetary atmospheres
3014—Radiation
3015—Solar-terrestrial relationships
3016—Turbulence and diffusion
3099—Other (specify)

1211—Mineralogy and crystallography
1212—Petrography and petrology, igneous and metamorphic
1213—Petrography and petrology, sedimentary
1214—Photogeology
1215—Stratigraphy
1216—Structural geology, igneous and metamorphic
1217—Structural geology, sedimentary
1299—Other (specify)

Paleontology and Paleobotany

1301—Micropaleontology
1302—Paleobotany
1303—Paleontology, invertebrate
1304—Paleontology, vertebrate
1305—Palynology
1399—Other (specify)

Solid-earth Geophysics

1401—Geomagnetism and electricity
1402—Geophysical surveying
1403—Gravity
1404—Heat flow
1405—Physical properties of materials

7Y03—Microscopic
7Y04—Neuroanatomy
7Y05—Systemic
7Y06—Topographic

Bacteriology

7X01—Bacterial metabolism
7X02—Bacterial physiology
7X03—Microbial processes

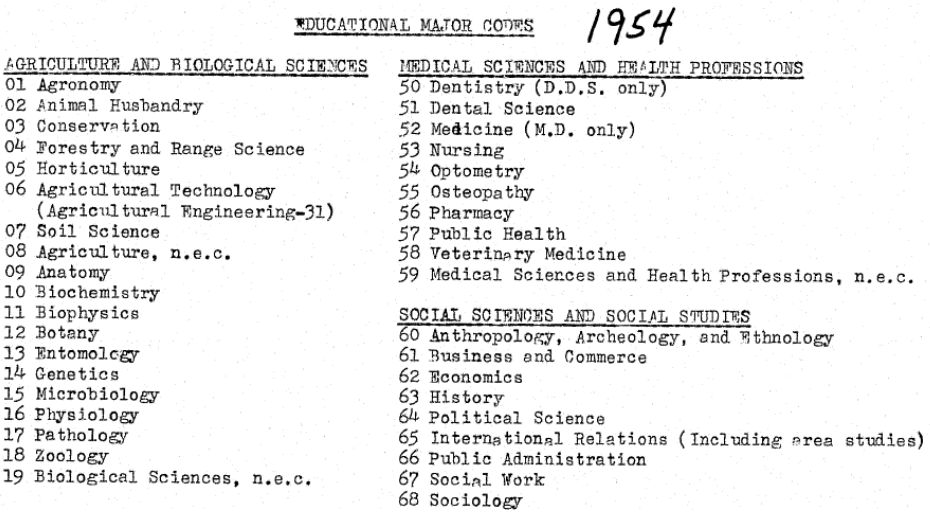
Botany

7001—Bryology
7002—Dendrology
7003—Mycology
7004—Nutrition and growth
7005—Parasitology
7006—Phycology
7007—Plant anatomy
7008—Plant physiology
7010—Pteridology
7011—Systematics of higher plants

Ecology

7101—Animal ecology
7102—Plant ecology

(**b**) Major



EDUCATIONAL MAJOR CODES 1954

AGRICULTURE AND BIOLOGICAL SCIENCES
01 Agronomy
02 Animal Husbandry
03 Conservation
04 Forestry and Range Science
05 Horticulture
06 Agricultural Technology (Agricultural Engineering-31)
07 Soil Science
08 Agriculture, n.e.c.
09 Anatomy
10 Biochemistry
11 Biophysics
12 Botany
13 Entomology
14 Genetics
15 Microbiology
16 Physiology
17 Pathology
18 Zoology
19 Biological Sciences, n.e.c.

MEDICAL SCIENCES AND HEALTH PROFESSIONS
50 Dentistry (D.D.S. only)
51 Dental Science
52 Medicine (M.D. only)
53 Nursing
54 Optometry
55 Osteopathy
56 Pharmacy
57 Public Health
58 Veterinary Medicine
59 Medical Sciences and Health Professions, n.e.c.

SOCIAL SCIENCES AND SOCIAL STUDIES
60 Anthropology, Archeology, and Ethnology
61 Business and Commerce
62 Economics
63 History
64 Political Science
65 International Relations (Including area studies)
66 Public Administration
67 Social Work
68 Sociology

Notes: A major challenge was to compile the scientists' work specialties and majors into an individual-year panel. The NRSTP generated a sequence of identifiers for each specialty in each wave of the survey. However, these identifiers varied across waves, and the classification of specialties changed year by year. For instance, *Probability and Statistics* was later divided into two separate specialties: *Probability* and *Statistics*. To link specialties across years, I standardize names and manually merge or split the specialties as needed. Figure (a) is an example of a work specialty codebook from 1962. Figure (b) is an example of an educational major codebook from 1954.

Table A2: Educational Background based on Work Specialty

Panel A: Space Scientists	
University	Count
Massachusetts Institute of Technology	2,964
University of California, Berkeley	2,698
University of Michigan – Ann Arbor	2,430
Columbia University	2,076
Harvard University	2,071
University of California, Los Angeles	2,068
Stanford University	1,950
University of Oklahoma – Norman	1,877
New York University	1,631
Ohio State University – Main Campus	1,604
Panel B: Non-Space Scientists	
University	Count
University of Michigan – Ann Arbor	8,363
Columbia University	8,160
University of California, Berkeley	6,844
Purdue University – Main Campus	6,308
New York University	6,304
Harvard University	6,242
University of Wisconsin Colleges	6,104
Ohio State University – Main Campus	5,952
University of Chicago	5,822
Iowa State University	4,993

Notes: This table reports the institutions where scientists and engineers obtained their highest degrees, as recorded in the NRSTP and AMS. Scientists are classified based on whether their work specialty is related to the Space Race.

Table A3: Top Employers of Scientists and Engineers

Panel A: Space Scientists	
Firm Name	Count
International Business Machines Corp	2,107
General Electric Company	1,312
Humble Oil & Refining Co	816
North American Rockwell Corporation	664
Radio Corporation of America, Inc	656
Lockheed	644
Shell Oil Co.	643
Union Carbide Corp	628
Bell Telephone Company	624
Westinghouse Electric Corp	602
Panel B: Non-Space Scientists	
Firm Name	Count
DuPont de Nemours, Inc.	3,988
Union Carbide Corp	2,180
Dow Chemical Company (The)	1,643
Shell Oil Co.	1,443
Monsanto Co	1,350
General Electric Company	1,163
International Business Machines Corp	987
Allied Chemical Corp	950
American Cyanamid Co	847
Esso Chem Co Inc	835

Notes: This table shows the top employers of scientists and engineers. I standardize and consolidate information on mergers and acquisitions (M&As) by aligning historical corporate entities with their post-merger counterparts. Firms that merged before 1972, such as the North American Rockwell Corporation (1967) and the McDonnell Douglas Aircraft Corporation (1967), were identified and recorded to maintain historical accuracy. Similarly, post-1972 M&As, including the Lockheed Martin Corporation (1995) and the Northrop Grumman Corporation (1994), were documented by tracing their predecessor firms.

Table A4: Top 10 and Bottom 10 Categories of VC-Backed Patent Categories

Panel A: Top 10 VC-backed patent categories			
SubCatName	VC-backed Patents	Total Patents	Share
Electrical Devices	2,446	33,720	7.25%
Semiconductor Devices	821	16,699	4.92%
Miscellaneous-Elec	1,208	28,057	4.31%
Electrical Lighting	666	17,414	3.82%
Information Storage	588	18,220	3.23%
Communications	1,010	43,583	2.32%
Metal Working	798	36,010	2.22%
Computer Hardware & Software	660	30,296	2.18%
Resins	669	40,825	1.64%
Coating Chemical	267	16,840	1.59%
Panel B: Bottom 10 VC-backed patent categories			
SubCatName	VC-backed Patents	Total Patents	Share
Earth Working & Wells	88	17,787	0.49%
Transportation	159	33,139	0.48%
Receptacles	108	22,971	0.47%
Furniture, House Fixtures	91	22,626	0.40%
Agriculture, Husbandry, Food	93	24,605	0.38%
Heating	67	17,945	0.37%
Apparel & Textile	72	19,713	0.37%
Surgery & Med Inst.	82	26,720	0.31%
Amusement Devices	28	10,669	0.26%
Miscellaneous-Drgs &Med	10	7,108	0.14%

The sample consists of patents applied for through the USPTO between 1976 and 1990. A patent within this sample is classified as VC-backed if its assignee received venture capital investment and was not publicly listed before the ERISA reform. *Total patents* refers to the aggregate number of patents filed in a specific category throughout the specified period.

Table A5: NASA Innovation and VC Investment

Panel A: NASA innovation related industries	
Industry Name	NASA Index
Communications Equipment	490.37
Electronic Components and Accessories	265.75
Ophthalmic Goods	136.38
Miscellaneous Electrical Equipment and Supplies	136.04
Computer and Office Equipment	132.43
Aircraft and Parts	125.15
Panel B: VC invested industries	
Primary VE Industry Sub-Group	Count
Computer Hardware	642
Computer Software	628
Medical/Health	596
Communications	517
Industrial/Energy	468
Semiconductor/Electr	457

Notes: This table reports the SIC 2-digit industries with the highest NASA index and the Venture Economics industry sub-groups that received the most deals from venture capital.

Table A6: Robustness: Business Count and Employment

Dependent Variable:	**Firm Count**			
	Full Sample		More VC	Less VC
	(1)	(2)	(3)	(4)
Post1979 × SpaceCountyIndustry	1.121***	0.8961**	1.623	0.4896***
	(0.2413)	(0.3752)	(1.036)	(0.0800)
Year FE	Yes			
County-Industry FE	Yes	Yes	Yes	Yes
County-Year FE		Yes	Yes	Yes
Observations	173,371	173,371	54,476	118,895
R^2	0.98728	0.99040	0.99013	0.97391
Dependent Variable:	**Employment**			
	(5)	(6)	(7)	(8)
	Full Sample		More VC	Less VC
Post1979 × SpaceCountyIndustry	76.78***	58.94**	111.2*	29.74**
	(22.94)	(23.60)	(61.67)	(12.80)
Year FE	Yes			
County-Industry FE	Yes	Yes	Yes	Yes
County-Year FE		Yes	Yes	Yes
Observations	173,371	173,371	54,476	118,895
R^2	0.95719	0.96386	0.96610	0.87356

Notes: This table reports the difference-in-differences estimates of the effect of ERISA on industry growth from 1974 to 1987. The dependent variables are the number of establishments and employment size reported in CBP. *SpaceCountyIndustry* is an indicator variable reflecting a county-industry being above median in terms of the similarity between the technologies present in pre-1958 patents and the National Intelligence Estimates of Soviet Space Capabilities between 1958 and 1992 (the Space Capability Score), as described in Kantor and Whalley (2025). *Post1979* equals one for years after 1978. Standard errors are clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table A7: Ranking of NASA's Top Ten Contractors

Contractor	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966	FY 1967	FY 1968
North American Rockwell Corp.[a]	1	1	1	1	1	1	1
McDonnell Aircraft Co., Inc.[b]	2	2	2	6	4	4	4
Douglas Aircraft Co., Inc.[b]	3	4	4	3	3	3	3
Aerojet-General Corp.	4	3	3	8	8	8	8
United Aircraft Co.	5	5	5	-	-	-	-
Chrysler Corp.	6	7	7	9	-	-	-
General Dynamics Corp.	7	6	6	6	9	-	-
Ling-Temco-Vought, Inc.	8	-	-	-	-	-	-
Grumman Aircraft Engineering Corp.	9	10	10	10	10	9	10
General Electric Co.	10	8	8	4	-	5	5
Boeing Co.	-	-	-	7	7	5	9
International Business Machines Corp.	-	-	-	-	6	10	-
Radio Corp. of America	-	-	-	-	-	-	6
Bendix Corp.	-	-	-	-	-	-	7
General Motors Corp.	-	-	-	-	-	-	-

[a] North American Aviation, Inc. until FY 1967.
[b] Merged to form the McDonnell Douglas Corporation.
Source: NASA, Annual Procurement Report, FY 1962-1968.

Table A8: Prime Contractors and Scientists' Spinouts

Dependent Variable:	**StartBusiness**		
	(1)	(2)	(3)
PrimeContractor	0.6460***		
	(0.1400)		
TotalVal		0.0010***	
		(0.0001)	
TotalVal_lg			0.1723***
			(0.0283)
Controls	Yes	Yes	Yes
Observations	141,811	141,811	141,811
R^2	0.00514	0.00579	0.00531

Notes: This table reports the business formation by scientists employed in the private industry or sector. *StartBusiness* is a binary variable scaled to 100. *PrimeContractor* is a binary variable indicating whether the firm received more than $2 million in NASA contracts between 1963 and 1968. *TotalVal* denotes the total procurement contract amount awarded to the scientist's employer by NASA during the same period. Control variables include the scientists' basic salary, gender, highest degree level, and birth year. The sample is restricted to industry scientists. * $p < .10$, ** $p < .05$, *** $p < .01$.