Government as Venture Capitalists in AI

Martin Beraja
Wenwei Peng
David Y. Yang
Noam Yuchtman *

July 10, 2024

In preparation for *Entrepreneurship and Innovation Policy and the Economy (vol.4)*

Abstract

Venture capital plays an important role in funding and shaping innovation outcomes, characterized by investors' deep knowledge of the technology, industry, and institutions, as well as their long-running relationships with the entrepreneurship and innovation community. China, in its pursuit of global leadership in AI innovation and technology, has set up government venture capital funds so that both national and local governments act as venture capitalists. These government-led venture capital funds combine features of private venture capital with traditional government innovation policies. In this paper, we collect comprehensive data on China's government and private venture capital funds. We draw three important contrasts between government and private VC funds: *(i)* government funds are spatially more dispersed than private funds; *(ii)* government funds invest in firms with weaker ex-ante performance signals but these firms exhibit growth rates exceeding those of firms in which private funds invest; and *(iii)* private VC funds follow government VC investments, especially when hometown government funds directly invest on firms with weaker ex-ante performance signals. We interpret these patterns in light of VC funds' traditional role overcoming information frictions and China's unique institutional environment, which includes important frictions on mobility and information.

*. Beraja: Massachusetts Institute of Technology and NBER; maberaja@mit.edu. Peng: Harvard University; wenwei_peng@fas.harvard.edu. Yang: Harvard University, NBER, BREAD and J-PAL; davidyang@fas.harvard.edu. Yuchtman: University of Oxford and CEPR; noam.yuchtman@economics.ox.ac.uk.

1 Introduction

Venture capital plays an important role in funding and shaping technological progress and innovation outcomes around the world (see, among others, Kortum and Lerner (2000), Samila and Sorenson (2011), Puri and Zarutskie (2012), Bernstein, Giroud, and Townsend (2016), Nicholas (2019), and Akcigit et al. (2022)). Venture capitalists are characterized by their deep knowledge of the technology, industry, and institutions, as well as their long-running relationships with the entrepreneurship and innovation community. China, in its pursuit of global leadership in innovation and frontier technology (e.g., in the sector of Artificial Intelligence, AI henceforth), has set up government venture capital funds at both the national and local government levels.

These government venture capital funds combine features of private venture capital and government innovation policies. Compared to (more conventional) government innovation policies and industrial policies more generally, government VCs may leverage virtues of traditional venture capital. For example, the government VC funds may possess expertise to improve the investment targeting of specific sectors and firms, aided by the funds' long-term relationship with the firms. Such expertise may be reinforced by the aligned interests between firms' interests and fund owners/managers, as the government acts as residual claimant of firms' growth and revenue (though this alignment may become a vehicle for corruption as well). Moreover, the government VC funds may create a virtuous cycle as funds' positive performance could feed into government's fiscal revenue and thus enhancing the business environment in which firms operate (further stimulating firm performance, etc.).

Compared to private venture capital, government VC funds may have different objectives as they may weigh funds' financial return against their ability to generate local economic spillovers, may prioritize strategic objectives of the government, or may undercut innovation output due to corruption opportunities. The government VC funds may also have different time horizons from their private counterparts, different information sets when choosing investment portfolios (e.g., explicit signals that could resolve policy uncertainty), as well as geographic dispersion (e.g., away from cities and major innovation and financial hubs where private VCs tend to be concentrated in).

In this paper, we provide descriptive facts about Chinese government venture capital funds and their role in financing the AI sector. We enumerate the distinctions between government and private venture capital, and we examine their interactions and differences empirically.

To do so, we collect comprehensive data on the government VC funds and their investment portfolios. In particular, because the government VC funds make a significant portion of their investments in other government and private VCs (rather than investing directly in firms), we delve four layers deep into the equity investment tree until more than 90% of the investments can be traced to specific firms. We cover 1,863 government VC funds, 6,514 intermediate funds, 45,419 firms as investees. Together, these government VC funds invested in 912 billion USD in the decade leading up to the second quarter of 2023, with yearly investments comparable in magnitude with the annual spending on all industrial policies initiated by the United States during the same period (and nearly double the spending on EU industrial policies) (see Hufbauer and Jung (2021) and Landesmann and Stöllinger (2020), respectively). [1]

We focus on investments in 1.4 million firms identified as AI firms in China's official firm registration records. These account for 24% of the total investment transactions and 23% of the total investment amount of the government VCs funds. The AI sector makes up a similar share of the private VCs' investment portfolio as well: 22% of their total investment transactions, and 21% of the total investment amount.[2]

We begin with examining VC funds' geographic dispersion. The government VCs may help address a key market friction in China due to spatial mobility constraints that potentially undermine private VC's activities. China's mobility restriction entails that not all entrepreneurs can move to high-tech centers where private VCs are clustered, making it less likely that private VCs can identify high potential firms in China's periphery. In this regard, more spatially dispersed government VCs substitute private VCs in those regions. Indeed, we find that while the private VCs are headquartered primarily in China's coastal regions that are disproportionally more developed, the government VCs represent a more even geographic spread where inland, less developed regions also have sizable government VC funds and investment activities. Importantly, as we compare the geographic distribution of funds with the distribution of AI firms across the country, we find that private VCs are overrepresented, relative to the presence of AI firms, in regions with high GDP per capita, and underrepresented, relative to the share of AI firms, in regions with low GDP per capita. The reverse is true for government VCs: they are overrepresented,

1. Beraja, Yang, and Yuchtman (2023) and Beraja et al. (2023) highlight an important role for Chinese government procurement of facial recognition AI in stimulating innovation. Government procurement of AI across applications amounts to $5.6 billion per year.

2. Although precise figures are difficult to obtain, it's estimated that the Chinese government has invested up to US$10 billion in AI R&D in 2018 alone (Acharya and Arnold 2019), and this spending has grown rapidly in recent years. Similarly, the United States also made significant public investments in AI. For example, under President Joe Biden's administration, around $6 billion has been invested in AI-related research projects in the first two years of his office; in both 2020 and 2023, the National Science Foundation (NSF) announced $100-140 million in funding for National AI Research Institutes.

relative to the share of AI firms, in low GDP per capita regions. Consistent with government VCs acting in place of “missing" private VCs in less developed regions (where matching frictions may be greatest), we observe that “hometown" government VCs play a greater role in AI investment in less developed regions.

Next, we investigate the portfolio composition of the government and private VC funds.[3] At the sector level, we find that government and private VC funds’ investment portfolio composition exhibit a high degree of similarity: among the top five sectors (at HS-2 digit level) that receive investment, four are identical across the government and private VC funds. Moving to investees within the AI sector, we find that government VC funds are more likely to invest in firms with weaker ex-ante productivity signals (measured as the number of major AI software products prior to investment) than their private counterparts. However, AI firms invested in by the government VC funds significantly outperform AI firms not receiving such investments (even accounting for ex-ante differences) and even exhibit higher software production growth rates than AI firms receiving funds from private VCs.

We next examine whether VC funds possess an advantage in choosing high performing AI firms located in the region of the funds’ headquarters, separately examining government and private VCs. We find little difference in the ex-ante software production of firms receiving funds from a “hometown" VC compared to an “out of town" VC, and this is true for both government and private VCs. Yet, we find that firms receiving investments from hometown VCs (whether government or private) produce significantly more software by 2023 than firms receiving investments from “out of town" funds. This suggests an ability for hometown funds to select high potential investment opportunities among local firms."

Finally, we study how government and private VC funds interact in making investment choices. We focus on the substantial share (4,115 out of 9,623) of AI firms in which we observe that receive investment from both the government and private VC funds. The presence of frictions due to policy uncertainty in China may undermine private VCs’ activities: these frictions make the growth of sectors and firms highly dependent on the government policy environment and its evolution, which may be uncertain and opaque to private VCs. In this regard, government VCs’ investments could carry information to private VCs, crowding in their investments.

To examine the relationship between government and private VC investments, we

3. The portfolio composition reflects both the choices of VC funds and the actions of firms. The latter may have multiple funding options and potentially preferences over their funding sources as well (see, for example, Colonnelli, Li, and Liu (2024) for firms’ funding preferences in the Chinese context).

first consider the order in which funds invest in the same firm. An indication that government VC funds' choices are valued by the private market is that, in the vast majority of cases in which both government and private VCs invest in the same firm, private VC investments follow the government VC funds' investments (rather than *vice versa*). We then investigate which government VC funds' investment decisions prompt more private VC follow-up investments. Government VC funds' *direct* investment in specific firms are much more likely to induce subsequent private VC investments in those firms, as compared to government funds' *indirect* investments through other funds. This suggests that it is not the government money *per se* that the private VC funds interpret as a valuable signal, but rather the explicit government choices of specific firms. Among direct investment choices, those made by hometown government are associated with slightly larger likelihood of prompting subsequent private VC investments, as compared to those made by non-hometown government funds. Finally, the direct government investments — either by hometown or non-hometown funds — are differentially more likely to be followed by private investments among firms with exhibit weaker ex-ante signals of productivity (i.e., less pre-investment software production). Our findings suggest that government investment induce private VC sector by identifying promising local firms that are better matched with the policy environment, especially when alternative signals are lacking.

Taken together, this project finds that on one hand, China's government VC funds act like private VC funds, investing in high potential firms and resolving information uncertainty in early stages of sectoral and firm development. On the other hand, the government VC funds are also distinct from their private counterparts: as such, their acts to invest convey distinct information from that which is otherwise available, and these important signals affect other market actors. Government as VCs may turn out to be a new and effective vehicle to carry innovation policies. In an environment such as China where there exists frictions and a role for government to extract informational rents, government acting as VCs can shape (or indeed, "guide") private market investment activities and even address some of the informational asymmetries between the public and private actors.

2 Institutional background

2.1 The development of government venture capital

Venture capital in China has grown rapidly over the past few decades, transforming from a nascent industry into one of the world's largest and most dynamic VC markets, second only to the US.[4] The Chinese VC industry began to take shape in the late 1980s and early 1990s, initially influenced by foreign VC firms and government initiatives aimed at fostering innovation. The VC activity saw a surge in 2000s, and the success of early tech giants like Alibaba and Tencent. Since 2010, China has grown into a global VC powerhouse, with significant investments in AI, biotechnology, clean energy, and other cutting-edge sectors.

The Chinese government plays a pivotal role in shaping the development and direction of the VC sector. Beyond establishing regulatory bodies and frameworks to oversee it, one of the most important initiatives taken by the Chinese government is the establishment of government-guided funds, also known as government venture capital (VC) funds. These funds aim to channel capital into strategic industries to bolster China's position as a global leader in technology. Supported by all levels of government using fiscal revenues, these funds operate similarly to venture capitalists. They are public investment vehicles that not only seek financial returns but also support the state's industrial policy goals, including advancing China's leadership in AI and other strategic and emerging technologies.

In the early 2000s, the initiative to create such government VC funds was spearheaded by the Chinese central government and a selection of local governments. Between 2007 and 2012, several legal frameworks were instituted to regulate and encourage the development of subnational VC funds, which led to their rapid proliferation.[5]

From 2013 to 2018, there was a notable surge in the establishment of subnational VC funds, with an average of 238 funds created annually. This growth was driven by central government policies that favored such investments, relatively lenient restrictions on VC fund expenditure compared to other types of government spending, and a competitive environment among local officials eager to set up these funds.

However, the expansion of government VC funds has decelerated since 2019, with an average of only 115 funds being established each year. This slowdown is largely due to the broader economic slowdown in China and more stringent regulations governing the activities of government VC funds.

4. As revealed by CB Insights' database, China hosts the second largest number of startups with valuations over $1 billion (unicorn companies) as of 2023. Source: https://www.cbinsights.com/research-unicorn-companies.

5. For example, in 2007, the Ministry of Finance (MOF), in collaboration with the Ministry of Science and Technology, outlined the framework for administering Technology-SME-oriented VC investment guidance funds see: http://www.gov.cn/ztzl/kjfzgh/content_883848.htm.

2.2 Organizational structure, funding sources, and investment strategies

Government venture capital (VC) funds in China are typically organized as limited partnerships. In this structure, a government agency acts as the general partner, taking on the responsibility for making investment decisions. This arrangement allows the government to retain veto power, thus ensuring that investments align with strategic national and regional objectives. The primary sources of funding for these VC funds include government budgets — comprised of tax revenues and proceeds from land sales — as well as contributions from limited partners. These limited partners are frequently state-owned enterprises (SOEs) or state-run banks, often described as "social capital" investors. It is expected that these social capital investors contribute a significant amount of a fund's capital, with the remaining (majority) portion supplied by the government entity acting as general partner.

Government VC funds may choose to invest directly in companies or projects, or they might adopt a fund-of-funds approach. In the latter, they invest in other investment funds that then channel capital into various projects and businesses. Moreover, most government VC funds operate under specific regulatory rules and requirements that shape their investment activities. These regulations typically focus on three key dimensions: *(i)* geographic considerations, where many funds are encouraged or mandated to invest locally (this may be aligned with local government officials' preferences to boost the local economy or, in some cases, to extract personal rents); *(ii)* targeted industry sectors; *(iii)* investment stages, directing capital to different phases of business development.

3 Data

In this section, we first outline the primary data sources that allow us to construct comprehensive data on China's government venture capital investment funds; we then describe the measurement of private venture capital funds as an alternative source of investment in comparison, and AI firms as investees of interest.

3.1 Main data sources

We integrate information from three principal data sources: *(i)* Zero2IPO, which was established in 2000 and is recognized as a leading venture capital and private equity service provider in China. It offers one of the most comprehensive commercial VC/PE datasets in the country; *(ii)* China Venture Source (CVSource), a prominent investment market information consulting firm that specializes in China's private equity, strategic investment, and mergers and acquisitions (M&A) markets; and *(iii) Tianyancha*, a database that provides access to comprehensive registration records for businesses in China. These records are licensed by the National Enterprise Credit Information Publicity System, and maintained by the State Administration for Industry and Commerce (SAIC). The *Tianyancha* database covers all firms registered in China over the past four decades, totaling over 80 million firm entries (including branches) by 2023.

These sources together provide extensive and comprehensive information on the venture capital investment landscape and dynamics in China.

3.2 Government venture capital investment funds

We compile a comprehensive dataset on government investment funds in China from 2000 to 2023, primarily sourced from Zero2IPO and CVSource, with supplementary data from *Tianyancha*. Both Zero2IPO and CVSource provide extensive coverage of government-guided funds (also known as government venture capital funds), providing detailed information about fund contributors, the government agencies that established the funds, inception dates, target and raised capital, registered locations, and direct investment records made by the funds.

However, there are two potential limitations to this dataset: first, the data are largely publicly disclosed, self-reported, or collected by Zero2IPO and CVSource, which may biased toward high-profile, late-stage, and successful deals; second, in both sources, each investment record typically includes only the name of the investee, with further details being limited.

To cross-validate and enrich our dataset, we utilize the firm registration data maintained by *Tianyancha* in two key ways. First, as *Tianyancha* covers the shareholder and holdings information for the universe of firms, including their historical changes, it should also encompass the universe of investment activities conducted by government venture capital funds (government VC). We match the government VC name list with the shareholder information in *Tianyancha* to construct the government VC investment profile, considering that government VC, other regular funds, limited partners, and portfolio companies can be linked to each other through shareholder information in two shareholding structures: a) a typical fund-of-fund structure, where government VC funds and limited partners are shareholders of regular funds (intermediate funds), and regular funds can be current or historical shareholders of portfolio companies; b) a simple equity structure, where government VC funds can be current or historical direct shareholders of portfolio companies.

Second, with the names of fund investees obtained from Zero2IPO and CVSource, we match these investees with detailed firm-level information from the *Tianyancha* dataset. This allows us to link government venture investment funds to comprehensive data on their investees' sectors, registered locations, years of establishment, detailed business scope descriptions, their investments, each investee's software production, patents, and all historical changes or updates to these items. This cross-validation and integration of datasets enables a more comprehensive and nuanced analysis of the investment activities and impacts of government venture capital funds in China.

Our final dataset covers 1,863 government venture capital investment funds with a total capital of 912 billion USD by the second quarter of 2023, involving 6,514 intermediate funds and 45,419 firm investees.[6]

3.3 Constructing government funds' investment portfolios

We next outline our procedures for constructing government funds' investment portfolios based on the data described above. A significant challenge in this process is that government VC often make indirect investments in companies through intermediate funds. These intermediate funds themselves do not provide direct insights into the government's investment portfolio at the firm level, yet they represent an essential aspect of government investment activity. Our data show that a substantial portion of government investment — 82% of the total investment transactions and 73% of the total investment amount — is channeled through these intermediate funds rather than directly into firms that produce goods and services. Many of the intermediate funds themselves invest in other funds, rather than directly in firms, further complicating the construction of investment funds' portfolios at the firm level.

To address this challenge and capture the comprehensive distribution of government investment funds' portfolios, we delve four layers deep into the equity investment tree for each government investment fund utilizing the *Tianyancha* database. This involves tracing the investment path from government investment funds to intermediate funds (considered the 1st-layer investments) and then further down to their investees, which could be either firms or other funds (constituting the 2nd layer, and so on). We continue

6. Our data share similarities with those constructed by Fei (2018) and Li (2022). We differ from the existing work by providing detailed and comprehensive information on government investment funds' firm investees. Specifically, we not only examine direct investees receiving investments directly from government funds but also trace through the equity investment tree to identify indirect investees, as discussed in Section 3.3. Furthermore, our dataset includes firm-level outputs and extends the coverage period to 2023.

this process through four layers, ceasing our exploration at any point where the end investee is a firm actively engaged in producing services or products, rather than another investment fund. Appendix Figure A.1 visualizes this procedure.

Our approach to navigating through the four layers of the equity investment tree allows us to link more than 90% of the total investment amount from government investment funds to companies involved in the production of goods or services.

3.4 Private venture capital funds

We also collect a comprehensive dataset on private PE/VC fund investment records, focusing on transactions directed towards Chinese firms from both domestic and international investors, from 2000 to 2023. The primary sources for this data are *Zero2IPO*, *CV-Source*, and *Tianyancha*. The dataset comprises a total of 331,302 investment entries. For each investment record, the dataset captures essential variables including the investor, the investee, the date of investment, and the amount invested.

3.5 AI firms and characteristics

Our AI firm-level data is sourced from *Tianyancha*. Among 80 million firm registration records in *Tianyancha*, we identify around 1.4 million AI firms using keywords related to AI, based on the firm's business scope description in the registration data.[7] For each AI firm, we have detailed information on its location, ownership type, legal representatives, shareholders and their holdings, software and patent production, executives, registered capital value, industry code, year of establishment, and all historical changes/updates to these items.

4 The AI sector in government VC investment portfolios

Between 2000 to 2023, the government VC funds invested in 9,623 unique AI firms through more than 20,000 transactions, in total 184 billion USD. Figure 1, Panel A, presents the sectoral composition of investment portfolios across the national government VC funds, local government VC funds, and private VC funds. The AI sector accounts for a remarkably similar share of the investment portfolios across these funds. Among government

7. These keywords include: Artificial Intelligence (AI), Big Data, Image Processing, Facial Recognition, Natural Language Processing (NLP), Machine Learning (ML), Deep Learning, Neural Networks, Robotics, Automation, Computer Vision, Data Science, Cognitive Computing.

VC funds, AI firms make up of 21% of the total firm investees, 24% of the total investment transactions, and 23% of the total investment amount.[8] Among private VC funds, AI firms make up of 20% of the total firm investees, 22% of the total investment transactions, and 21% of the total investment amount.

We find substantial variation in the AI sector's contribution to the investment portfolio across the government investment funds. Figure 1, Panel B, presents the distribution of the share of AI investment across government funds, and one can observe a small share of funds fully dedicated to the AI sector (likely with an explicit mandate to invest in AI) and almost all funds carrying a positive portfolio in AI. Finally, in Figure 1, Panel C, we trace the AI investment by government VC funds over time, both in terms of dollar amount and the number of firms receiving investments. One observes a steady growth in the government funds' AI investment since 2015.

Finally, in Figure 1, Panel C, we trace the AI investment by government VC funds over time, both in terms of dollar amount and firms invested. One observes a steady growth in the government funds' AI investment since 2015.

5 Funds' geographic dispersion

We next examine VC funds' geographic dispersion. Appendix Figure A.2 maps, at the province level, the number of government VC funds and private VC funds across China.[9] We find that while the private VCs are headquartered primarily in China's coastal regions that are disproportionally more developed, the government VCs represent a more even geographic spread where inland, less developed regions also have sizable government VC funds and investment activities. This pattern likely holds in many parts of the world, where private VC funds are concentrated in a handful of technology and innovation hubs.

The different geographic distribution of government and private VC funds suggests that they may be differentially representative of the spatial distribution of the AI firms — that would be the case, for example, if the location decisions of private and government VCs were differentially responsive to agglomeration forces. In Figure 2, we compare the geographic distribution of funds with the distribution of AI firms across the country. Specifically, we plot, in the left panel, the ratio of a province's share of government VC funds (in terms of total dollar amount) and the share of a province's AI firms (by head-

8. About 20.3% of the government VC funds' investment transactions to AI firms are direct investments, and the remaining are carried out indirectly through investment in other funds which ultimately invest in AI firms.

9. Appendix Figure A.3 presents analogous maps in terms of total fund size, rather than counts of funds, at the province level.

quarter). A ratio above one means that a province has a larger share of China's government VC funds than its share of China's AI firm headquarters. We plot this ratio against the corresponding province's economic conditions (as measured by average local GDP per capita during the period). The right panel repeats the exercise but focusing on private VC funds. We observe strikingly different patterns comparing government and private VCs. Government VCs are distributed broadly, and quite proportionally (relative to AI firms), across provinces. To the extent that there is over-representation of government VCs, it is observed in the low GDP per capita provinces. We see the opposite for private VCs: these are over-represented in the high GDP per capita provinces, and one can see many poorer provinces with almost no private VC representation at all.

These patterns suggest that government VCs may help address a key market friction in China due to spatial mobility constraints that potentially undermine private VC's activities. China's mobility restriction imply that not all entrepreneurs can move to high-tech centers where private VCs are clustered, making it less likely that private VCs will identify high potential firms in China's periphery. In this regard, more spatially dispersed government VCs act as a substitute for absent private VCs in peripheral regions.

In such a context of mobility restrictions and information frictions, hometown government VC funds could play a disproportionate role in supporting AI firms in poorer, peripheral regions. To evaluate this possibility, in Figure 3, we decompose the share of government VC funding — from national government VCs, hometown government VCs, or non-hometown government VCs — received by AI firms headquartered in specific regions. We separate Beijing and Shanghai, the richest and largest centers for AI and VC activities, at the top of figure, and we group the rest of the China's provinces by terciles of GDP per capita. We observe that, indeed, compared to other government VCs, hometown government VCs contribute a greater share to AI firms' funding in less developed regions.

6 Portfolio composition: government vs. private funds

In this section, we investigate the portfolio composition of the government and private VC funds. We use "portfolio composition" and "portfolio choices" interchangeably, though it is important to note that the portfolio composition that we observe captures an equilibrium outcomes of funds' active choices and firms' decisions, as firms would have options and potentially preferences over their funding sources as well.

We begin with the comparison at the sector level. Appendix Figure A.4 plots the sectoral composition at the HS-2 digit level, both in terms of total amount of investment allocated to the sector and the share of investment portfolio dedicated to the sector. We find that government and private VC funds' investment portfolio composition exhibit a high degree of similarity. Among the top five sectors (at HS-2 digit level) that receive investment, four are identical across the government and private VC funds. They are: *(i)* Computer, chips, and electronic equipment manufacturing; *(ii)* Software and information technology services; *(iii)* Technology promotion and application services; *(iv)* Research and experimental development.

Next, we zoom in on the AI sector and compare investees within the AI sector. Among all the AI firms that the funds could choose to invest in, we examine which AI firms are more likely to be invested in by (any) government VC funds compared to their private VC counterparts. We focus on the AI software production prior to any VC investment as a key observable indicator of firms' current and future innovative output. To include in our analysis firms that do not receive any VC investments during the sample period, we consider their software production during the third year since their founding, as this is when the typical VC investment arrives. Figure 4, panel A, present the comparison. One observes that government and private VCs both invest in firms with greater ex-ante software production than firms not receiving investments (the omitted comparison category in our analysis). Furthermore, government VC funds invest in firms with weaker ex-ante productivity signals — namely, less major AI software produced prior to investment — than their private counterparts. In fact, the average firms invested in by private VC funds produced three times more software at the time of investment than those firms invested in by government VC funds.

We next find that AI firms receiving funding from both private and government VCs exhibit substantial increases in software production after they receive investment. Measured as the level of total software produced by the end of the sample period (shown in panel B), AI firms invested in by government VC funds produce substantially more than AI firms receiving no funding. AI firms invested in by private VC funds exhibit even greater cumulative software output. The performance of firms receiving government VC investments is at odds with theories of investment emphasising corruption, bureaucrat bias, or wasted resources. Indeed, in terms of the percentage growth of software production since investment (panel C), one observes that the AI firms invested in by government VC funds grew by around 500% by the end of 2023, even greater than firms invested in by private VC funds

Finally, we examine whether VC funds possess advantage in choosing high performing AI firms located in the region of the funds' headquarters. We zoom in on AI firms that have received at least some VC investment, either from government or private funds, and compare those that are invested in by hometown funds (defined as funds that share headquarters location with the AI firms) with those invested in by non-hometown funds. We again focus on AI software production prior to investment to capture the ex-ante signal of firm quality, and cumulative software production until 2023 to capture overall performance since investment. Figure 5 presents the results, first on government VC funds (panel A) and then on private VC funds (panel B). We find that hometown government VC funds, relative to non-hometown government funds, invest in AI firms that exhibit very similar observable ex-ante performance signals. However, the firms in which hometown funds invested significantly outperform the firms in which non-hometown funds invested in terms of their software output by the end of 2023. A similar, if not stronger, pattern is observed among private VC funds. In other words, both the government and private VC funds appear able to use unobservables (at least to us) to select high potential investment opportunities from firms co-located with the funds' headquarters.

Such hometown advantage in investment may reflect funds' expertise, information asymmetry, and managerial relationships with firms co-located in the region. Combined with the pattern that the government and private VC funds exhibit distinct geographic distribution relative to the presence of AI firms (shown in Section 5), the hometown advantage could translate into important aggregate differences in the ability for VC funds to select, invest, and nurture high potential AI firms across the country.

7 Interaction between government and private funds

In this final section, we study how government and private VC funds interact when they make investment choices. In particular, we examine the substantial number of AI firms (4,115 to be exact) that have received investment from both the government and private VC funds. These firms account for 52% of the government VC funds' investment portfolio, and 27% of that of the private VC funds. Do government investment decisions influence private VCs' investment, or vice versa?

We begin by documenting that government VC funds' choices appear to be valued by the private market. In Figure 6, Panel A, we plot, for each of the AI firms that eventually receive both government and private investment, the year in which the government and private investment arrives.[10] One observes that during the early years, firms either receive no VC investment or sparsely receive investment from the government VC funds.

10. We focus on the subset of AI firms that are established after 2010 (3,600 out of 4,115) for easy visualization, though the general pattern remains if we focus instead on all AI firms regardless of founding years.

Private VC investments follow, rather than precede, the government VC funds' investments. Panel B plots the distribution of the timing difference between the firms' first government investment and private investment. Around 71% of the firms fall to the left of the 0 line, indicating that the government investment arrives earlier than private one.

Next, we investigate which government VC funds' investment decisions prompt more private VC follow-up investments. Specifically, we focus on AI firms that have received at least one government VC investment prior to any private VC investment, and we regress the private VC investment decisions for the corresponding firm on a set of indicators of the types of government VC investment. The results are presented in Figure 7, Panel A. Government VC funds' direct investments in specific firms are much more likely to induce subsequent private VC investments in those firms, as compared to government funds' indirect investments through investment in other funds. This suggests that it is not the government money *per se* that the private VC funds interpret as a valuable signal, but rather the explicit government choices in specific firms. Among direct investment choices, those made by hometown government are associated with slightly larger likelihood of prompting subsequent private VC investments, as compared to those made by non-hometown government funds. [11]

In Panels B and C, we divide the AI firm sample into two groups based on their *ex-ante* software production levels: firms with lower (below mean) and higher (above mean) production. This classification is based on observable performance signals at the time of government investment, prior to any potential private VC investment. We then examine subsequent private VC follow-up investments in response to different types of government investment decisions using these two subsamples respectively. Two notable patterns emerge. First, direct government investments — either by hometown or non-hometown funds — are differentially more likely to be followed by private investments if the invested firms exhibit weaker *ex-ante* signals of their productivity (i.e., in Panel B). Second, the bar graph for AI firms with lower ex-ante software production (Panel B) shows a steeper gradient compared to the gradient for firms with higher ex-ante software production (Panel C), indicating that (direct) government investment plays a stronger role among firms with weaker observable performance signals. These suggest that the government investment crowds in private VC investment especially when alternative signals

11. These signals are valuable relative to no signal from the government VC at all. In Appendix Figure A.5, we include the rest of the firms that didn't receive any government VC investment and examine the effect of AI firms receiving different types of government VC investments on follow-up private VC investments, compared to those without government VC investments. We find consistent patterns that receiving receiving direct investment from hometown government VC funds substantially increases the likelihood of subsequent private VC investment.

that can be observed by the private investment market are lacking. While we are unable to pin down the exact mechanism underlying government's ability to identify promising firms, our results suggest that the government VCs may have particular expertise in picking firms in contexts with few private VCs, or the government may be better at finding firms that are compatible with the (anticipated) policy environment. We also find that private VC investors are similarly responsive to hometown and non-hometown government investments in AI firms with weaker ex-ante signals. This suggests that local favoritism is unlikely to be the primary driving force, though the value of government connections and opportunities to benefit from more complex forms of corruption may play a role in inducing private VCs to invest.

8 Conclusion

China has established itself as one of the world's leaders in AI innovation and entrepreneurship. In this paper, we study the role of China's government venture capital funds and their investments in fostering early-stage firms within the country's AI sector. We uncover three characteristics of these funds. First, the government VCs are headquartered in locations much more geographically dispersed than the private VCs, in fact more representative of the spread of AI firms around the country. Second, like private VC funds, they invest in promising firms and mitigate information uncertainty during the early stages of sectoral and firm development. Third, the government VC investment actions tend to precede their private counterparts, potentially because they carry important signaling value.

In China's unique environment, characterized by frictions and the government's role in extracting informational rents, government-led VC activities can shape private market investments and alleviate information asymmetry between public and private actors. Indeed, consistent with this hypothesis, we find that the government VCs are able to identify high potential firms in particularly low information environments, and these actions are valued by the private VCs as they often follow the government investments. This confluence creates an innovation investment ecosystem that represents a novel form of government innovation policy, incorporating features from the private investment sector while addressing critical market frictions.

Our findings indicate the possibility that the government VCs enhance the efficiency of capital allocation and contribute positively to the combination of government innovation policies and market incentives. Yet caution is needed in extracting general policy lessons from this research.[12] First, many economies may not exhibit the market and political economy frictions that China embodies, thus limiting the extent to which the government VC could contribute to the innovation investment landscape. Second, even in China, more evidence is needed to determine whether the innovation return of the government VC funds justifies the investments, and exceeds that from other government industrial and innovation policies. Finally, the details of institutional design matter: as the government VC funds grant a high degree of discretion to officials and bureaucrats, there exists a risk of corruption and political capture that must be mitigated with complementary institutions to ensure the effectiveness of the government VC as an investment and policy vehicle.

12. Recent papers have highlighted issues such as inefficient fund allocation (Howell 2017), inefficient crowd-out of private spending (Lerner 2020), and potential political interference in firms' decision-making (Colonnelli, Li, and Liu 2024).

References

Acharya, Ashwin, and Zachary Arnold. 2019. "Chinese public AI R&D spending: provisional findings." *Center for Security and Emerging Technology* 12.

Akcigit, Ufuk, Emin Dinlersoz, Jeremy Greenwood, and Veronika Penciakova. 2022. "Synergizing ventures." *Journal of Economic Dynamics and Control* 143:104427.

Beraja, Martin, Andrew Kao, David Y Yang, and Noam Yuchtman. 2023. "AI-tocracy." *The Quarterly Journal of Economics* 138 (3): 1349–1402.

Beraja, Martin, David Y Yang, and Noam Yuchtman. 2023. "Data-intensive innovation and the state: Evidence from AI firms in China." *The Review of Economic Studies* 90 (4): 1701–1723.

Bernstein, Shai, Xavier Giroud, and Richard R Townsend. 2016. "The impact of venture capital monitoring." *The Journal of Finance* 71 (4): 1591–1622.

Colonnelli, Emanuele, Bo Li, and Ernest Liu. 2024. "Investing with the government: A field experiment in China." *Journal of Political Economy* 132 (1): 248–294.

Fei, Celine Yue. 2018. "Linking different data sources of venture capital and private equity in China." *Available at SSRN 3524066.*

Howell, Sabrina T. 2017. "Financing innovation: Evidence from R&D grants." *American economic review* 107 (4): 1136–1164.

Hufbauer, Gary Clyde, and Euijin Jung. 2021. *Scoring 50 years of US industrial policy, 1970–2020.* Peterson Institute for International Economics.

Kortum, S, and J Lerner. 2000. "Assessing the Impact of Venture Capital to Innovation." *Rand Journal of Economics* 31:674–692.

Landesmann, Michael, and Roman Stöllinger. 2020. *The European Union's industrial policy: What are the main challenges?* Technical report. Policy Notes and Reports.

Lerner, Josh. 2020. *Government incentives for entrepreneurship.* Technical report. National Bureau of Economic Research.

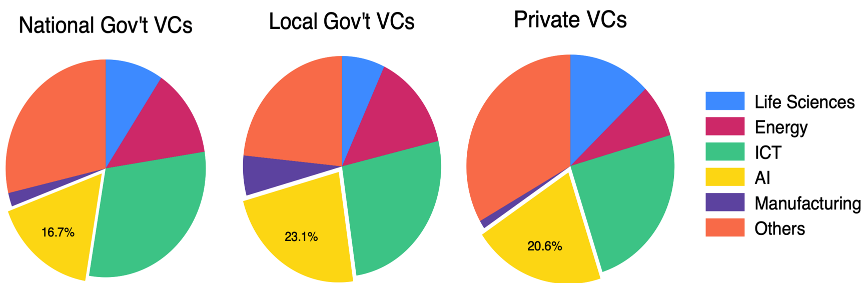
Li, Jinlin. 2022. "Government as an equity investor: Evidence from Chinese government venture capital through cycles." *Available at SSRN 4221937.*

Nicholas, Tom. 2019. *VC: an American history.* Harvard University Press.

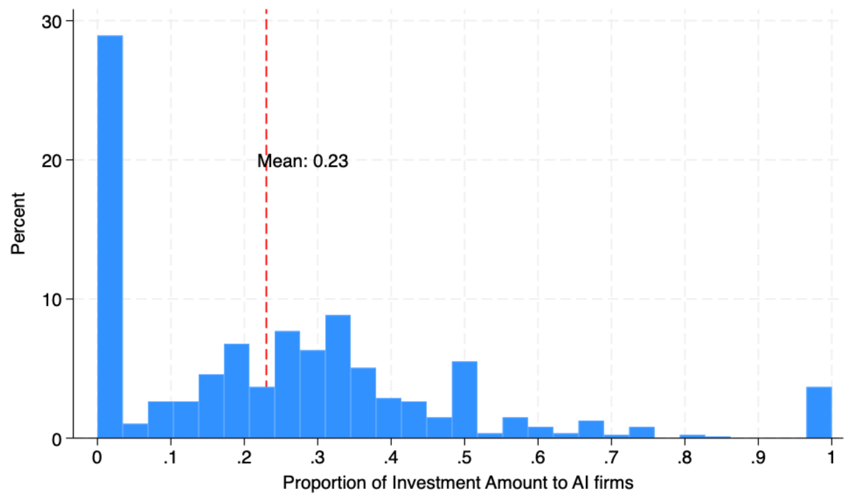
Puri, Manju, and Rebecca Zarutskie. 2012. "On the life cycle dynamics of venture-capital- and non-venture-capital-financed firms." *The Journal of Finance* 67 (6): 2247–2293.

Samila, Sampsa, and Olav Sorenson. 2011. "Venture capital, entrepreneurship, and economic growth." *The Review of Economics and Statistics* 93 (1): 338–349.

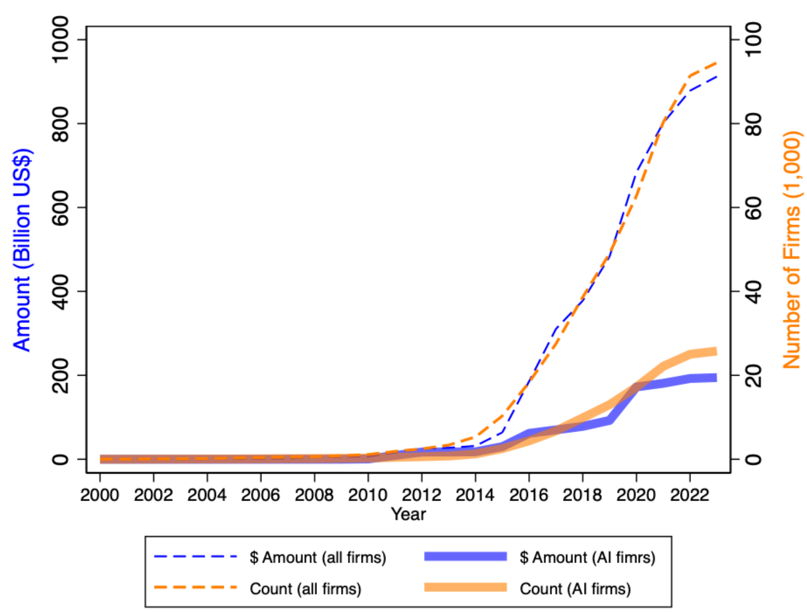
Figures and tables



(a) Share across different types of funds

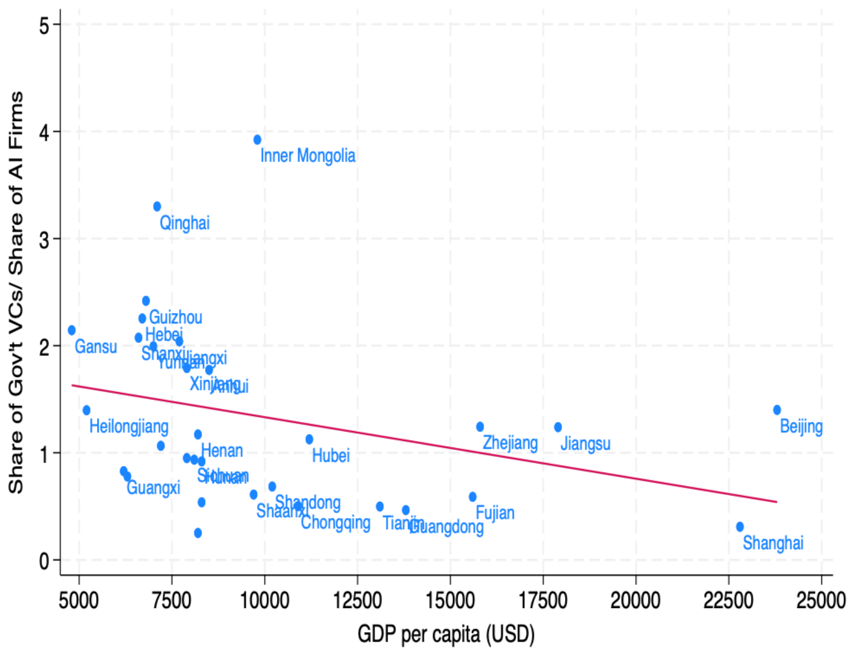


(b) Share distribution across government funds

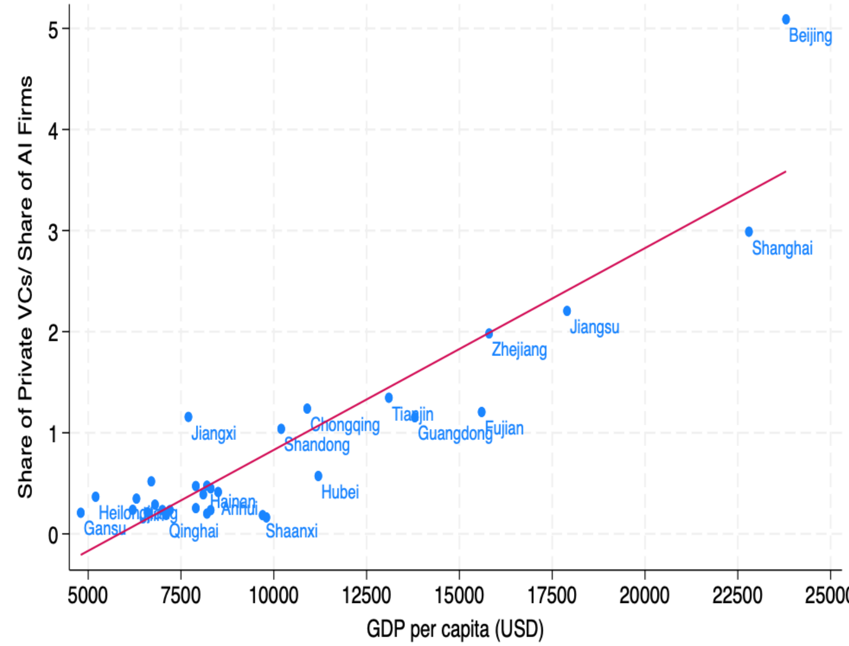


(c) Trend for government investment funds

Figure 1: The AI sector in the VC fund's portfolios



(a) Government VC



(b) Private VC

Figure 2: VC funds' geographic distribution relative to AI firms

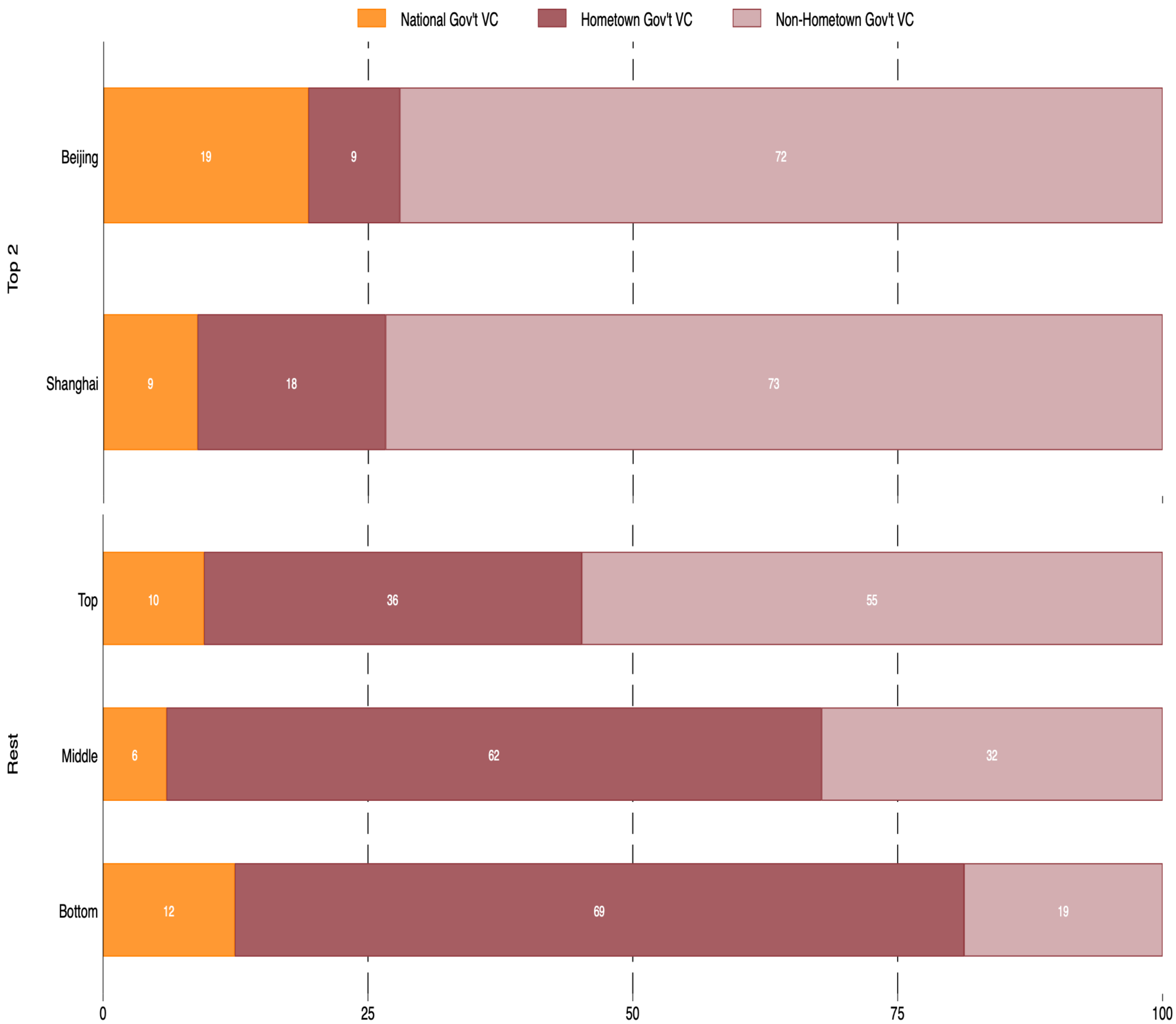


Figure 3: Decomposition of government VC fund shares across provinces

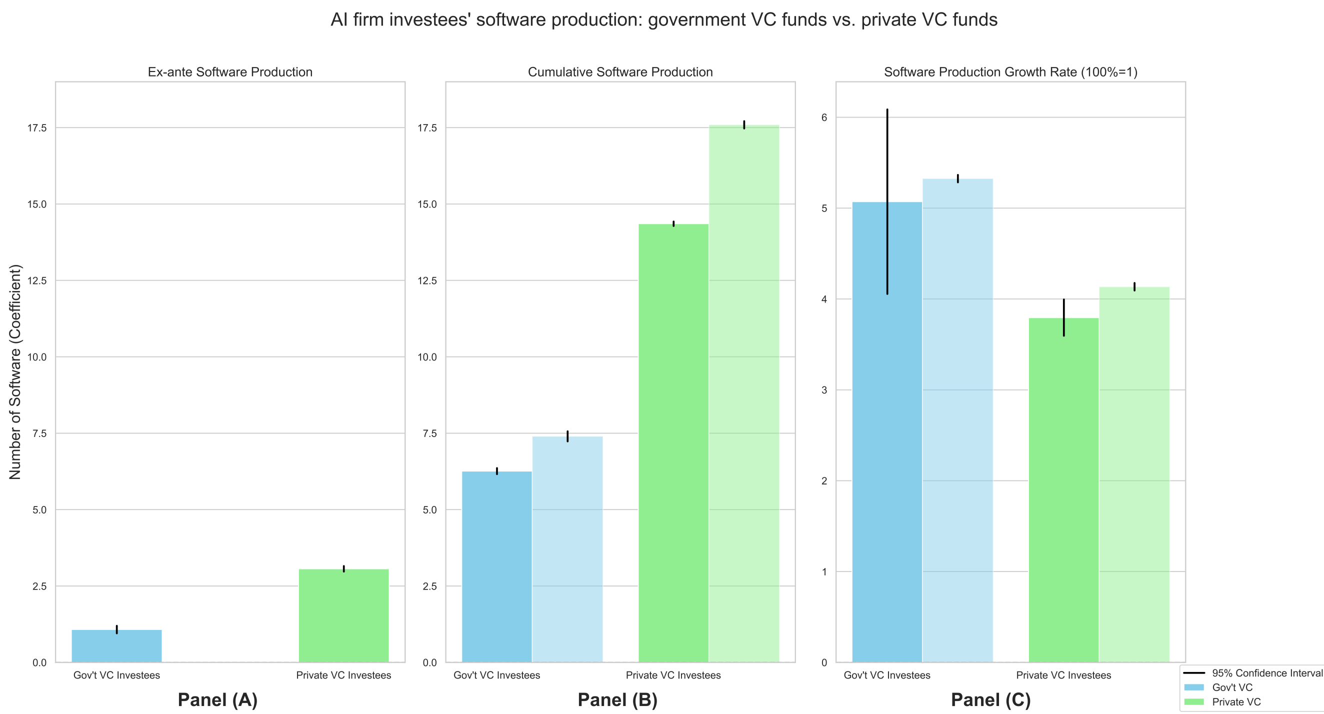


Figure 4: Investment in AI firms: government VC funds vs. private VC funds

Notes: This figure plots the coefficients comparing software production between AI firms that received different types of VC investments (e.g., government VC or private VC) and those that did not receive any VC investment. In Panel (A), we compare the ex-ante software production of AI firms receiving different types of VC investment with firms that didn't receive any VC investment. For firms with investments, the ex-ante software production is measured before receiving their first investment. For firms without any investment (the omitted baseline group), the ex-ante software production is measured from the third year after the firm's establishment, as firms with investments typically receive their first investment in the third year. In Panels (B) and (C), we focus on cumulative software production and growth rate, these are cross-sectional comparisons by aggregating the software production up to the end of our study period in 2023. For bars in darker blue and green colors, we plot the coefficients where we control for firm age and ex-ante software production. For all regressions, we control for firms' entry year fixed effects and firm's location fixed effects. Standard errors are clustered at the province level. The corresponding regression table is presented in Appendix Table A.1

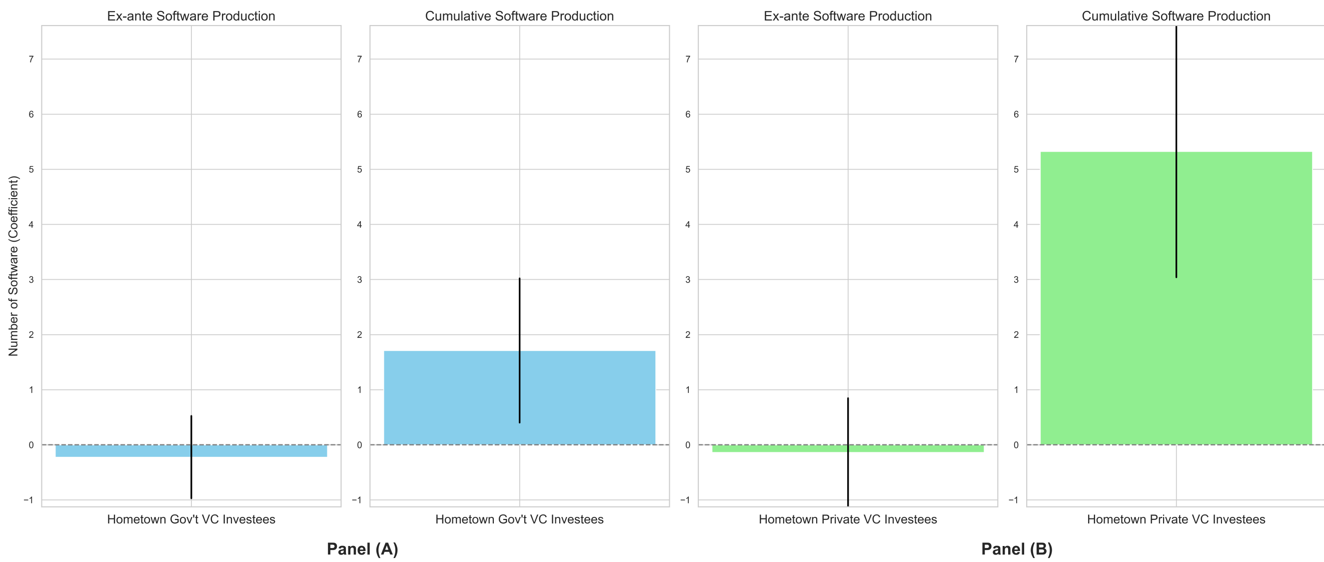
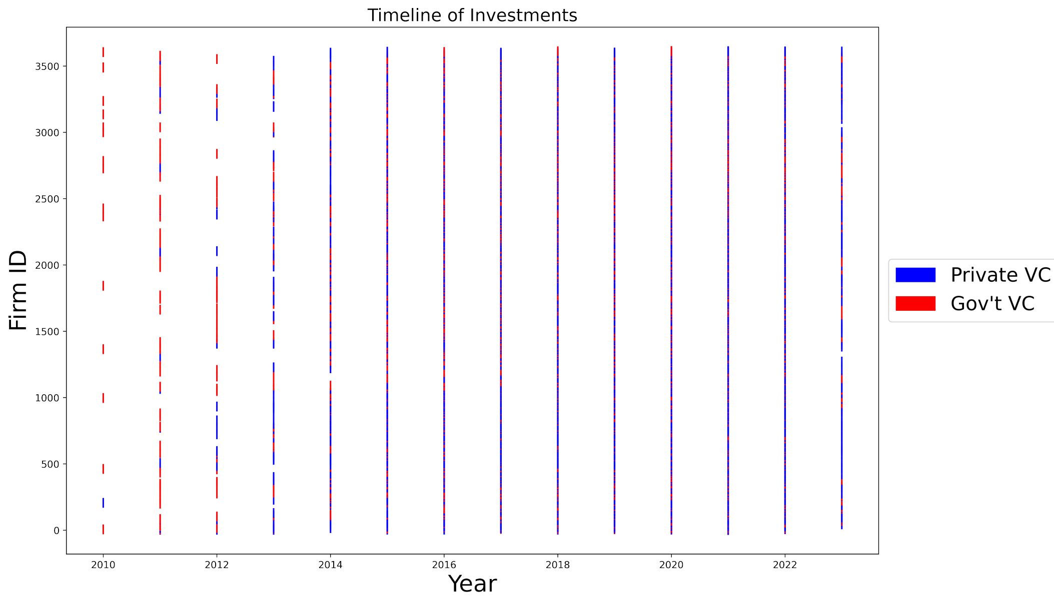
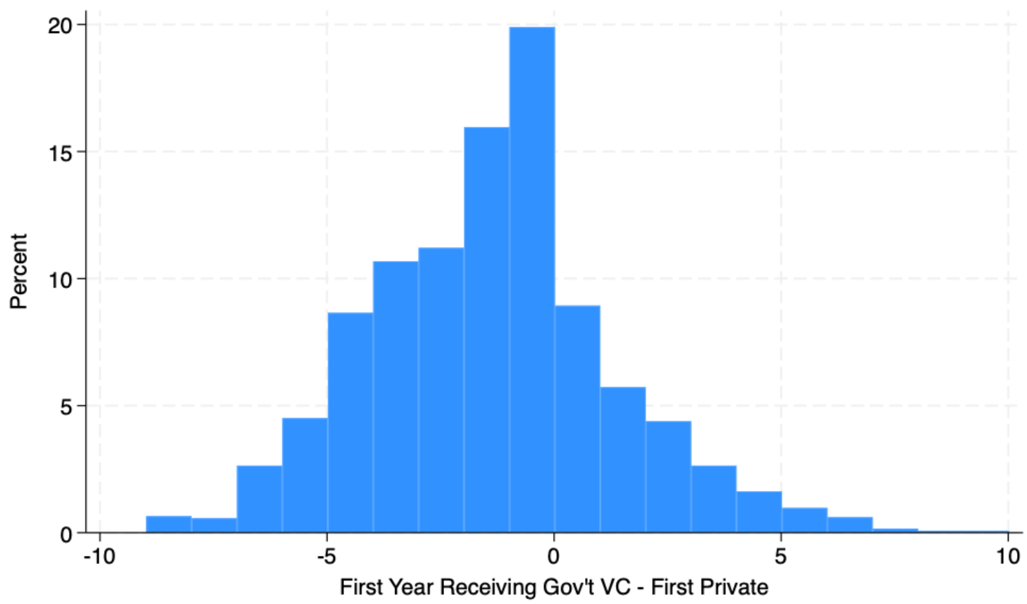


Figure 5: Hometown advantage in choosing high performing AI firms based on unobservables

Notes: This figure plots the coefficients comparing ex-ante and ex-post software production between AI firms that received hometown government VC investment (or hometown private VC investment) and those that received non-hometown government VC investment (or non-hometown private VC investment). In Panel (A), we compare the software production of AI firms that received hometown government VC investment to those that received non-hometown government VC investment. In Panel (B), we compare the software production of AI firms that received hometown private VC investment to those that received non-hometown private VC investment. For cumulative software production comparisons, we control for firm age and ex-ante software production. All regressions control for firms' entry year fixed effects and firm location fixed effects. Standard errors are clustered at the provincial level. The corresponding regression table is presented in Appendix Table A.2.



(a) Investment timeline by VC types



(b) Timing difference between firms' 1^{st} government and private investments

Figure 6: Government vs. private VC: who is leading whom in AI investment?

Notes: Panel (a) demonstrates the investment timeline by VC types (e.g., government vs. private) for 3,600 AI firms established after 2010 and receiving investments from both government and private VC. Each horizontal line represents a AI firm investee, red dots indicate receiving investments from government VC, while blue dots for private VC. Panel (b) plots the distribution of the timing difference between the firms' first government investment and private investment.

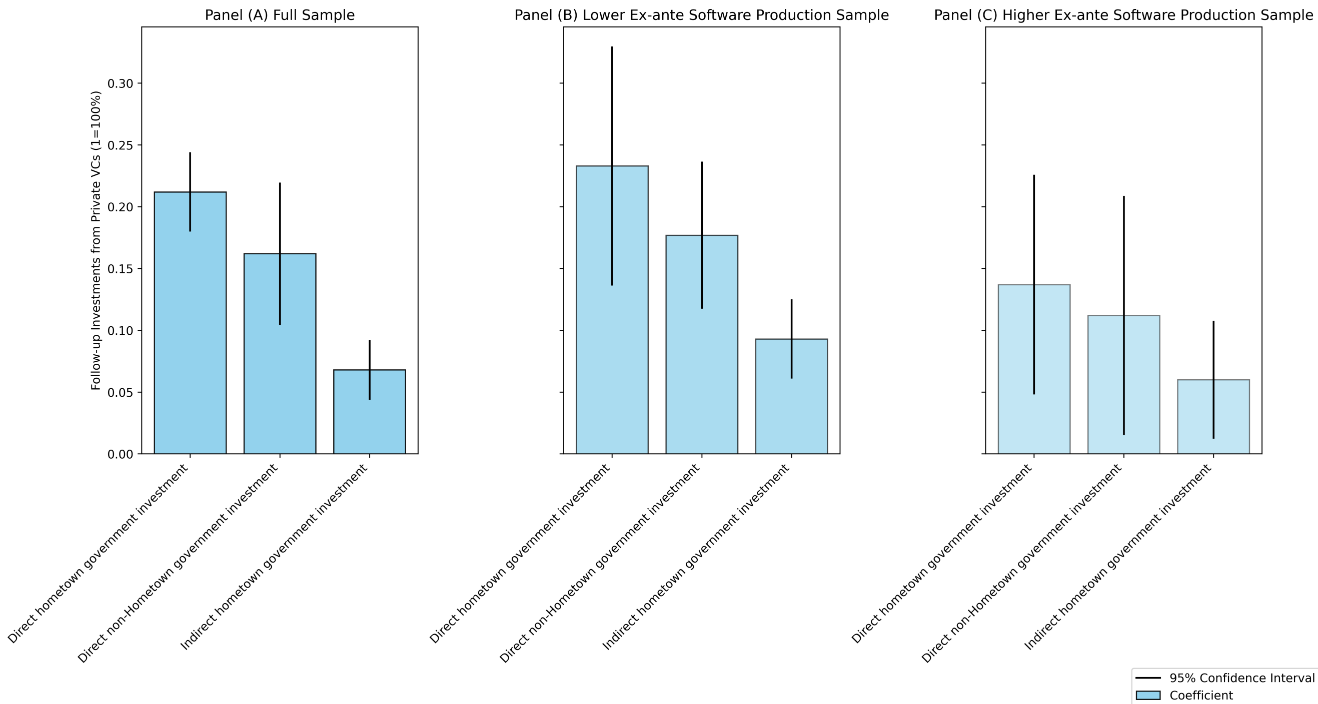


Figure 7: Which government VC funds' investment decisions prompt more private VC follow-up investments?

Notes: This figure examines which types of government VC funds' investment decisions prompt more follow-up investments from private VC firms, focusing on AI firms that have received at least one government VC investment. In Panel (A), we analyze all AI firms with at least one government VC investment, comparing the effect on follow-up investments from private VC across four types of government VC funds' investment decisions: (a) direct investment from hometown government VCs; (b) direct investment from non-hometown government VCs; (c) indirect investment from hometown government VCs; and (d) indirect investment from non-hometown government VCs (omitted group). In Panels (B) and (C), we focus on subsamples of AI firms with lower (below mean) ex-ante software production and higher (above mean) ex-ante software production, respectively. The Firms' ex-ante software production is measured before receiving their first investment. All regressions control for firms' entry year fixed effects and location fixed effects. Standard errors are clustered at the province level. The corresponding regression table is presented in Appendix Table A.3. Appendix Figure A.5 replicates the exercises by including the rest of AI firms that didn't receive government VC investment in the sample and making this group the omitted group in regression.

Online Appendix

Appendix A Additional figures and tables

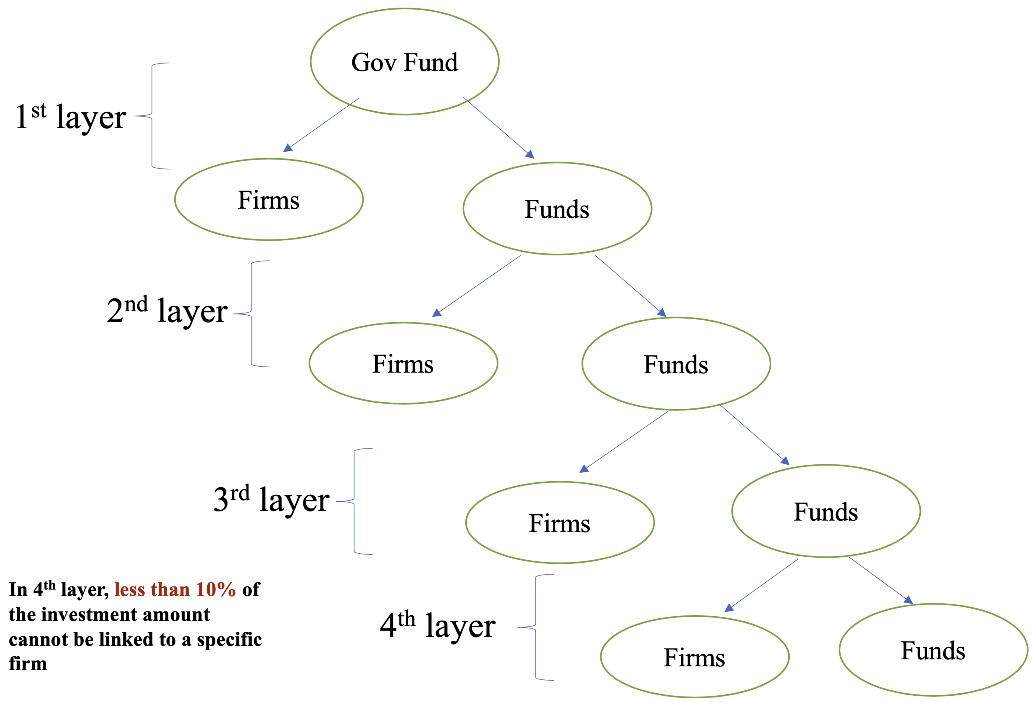
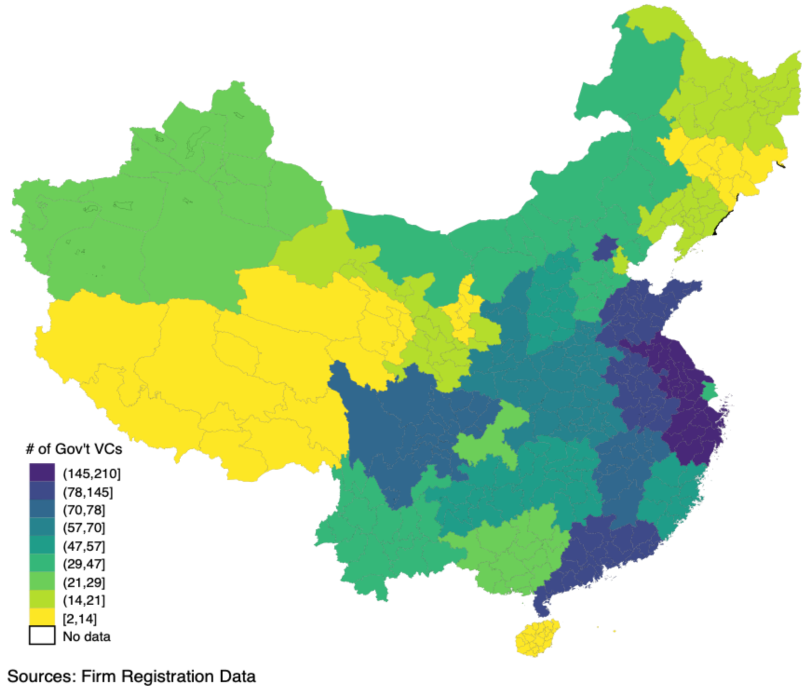
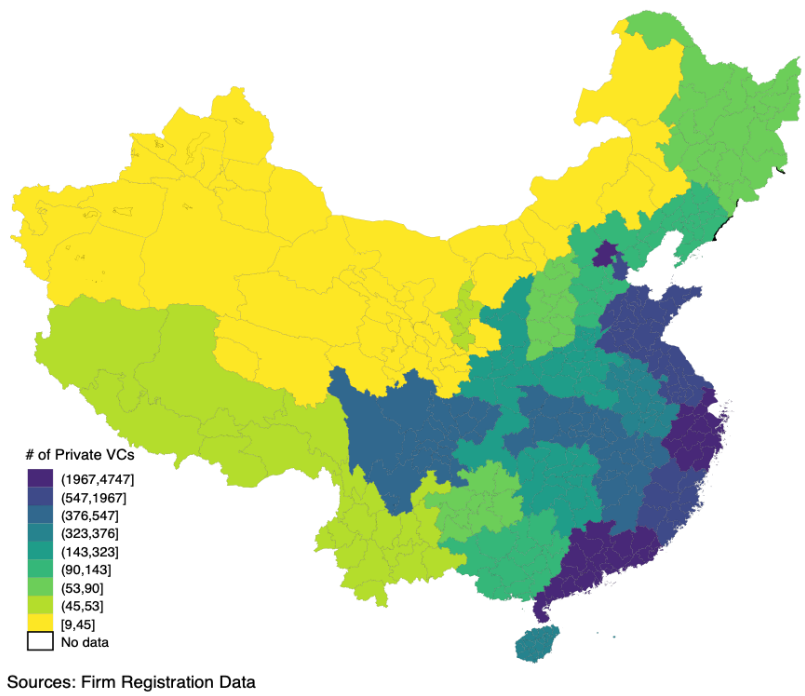


Figure A.1: Procedure for constructing government funds' investment portfolio

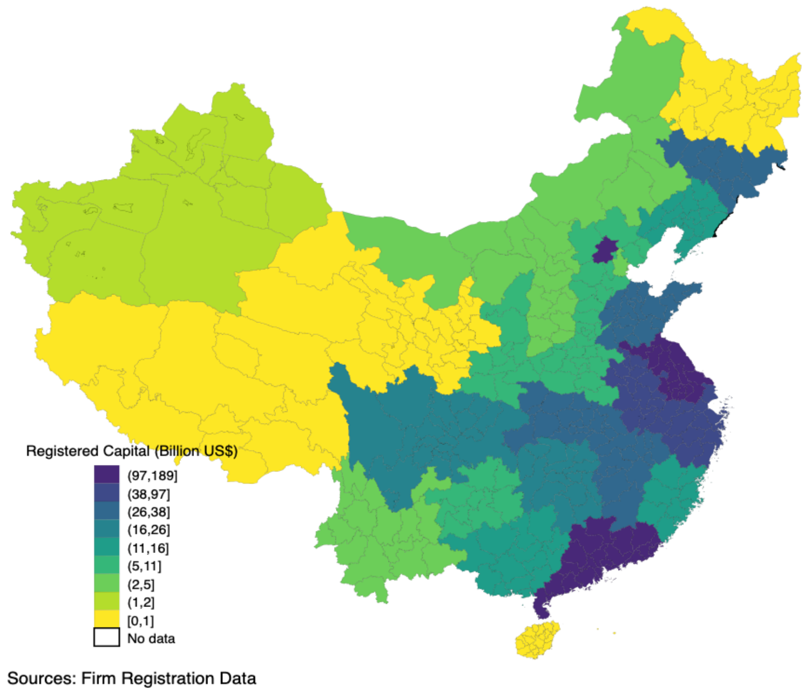


(a) Government VC

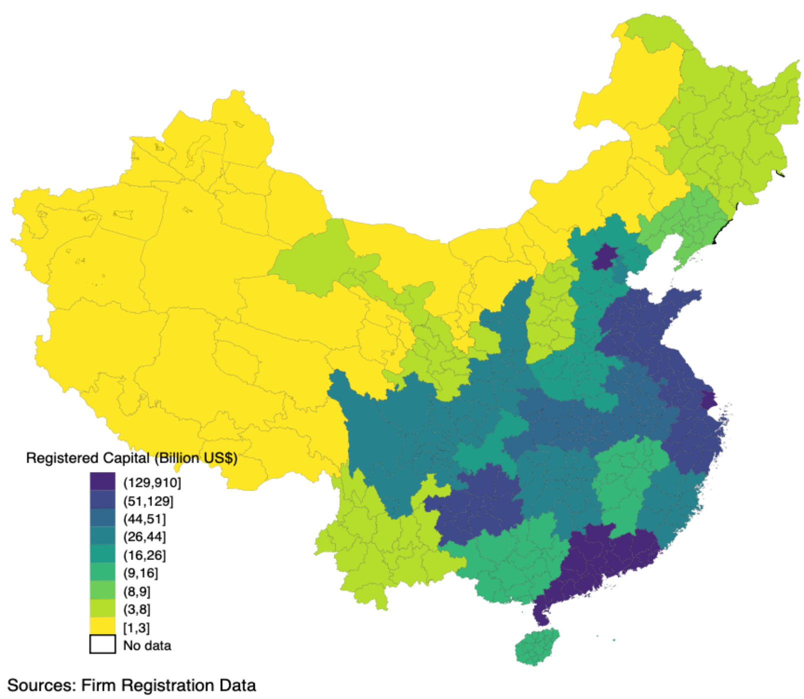


(b) Private VC

Figure A.2: Spatial distribution of VC funds in China

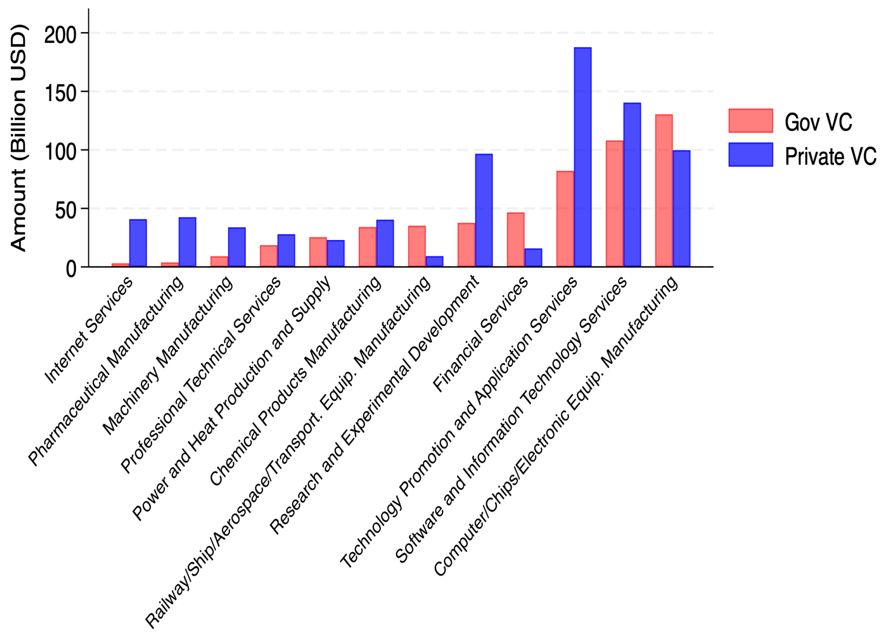


(a) Government VC

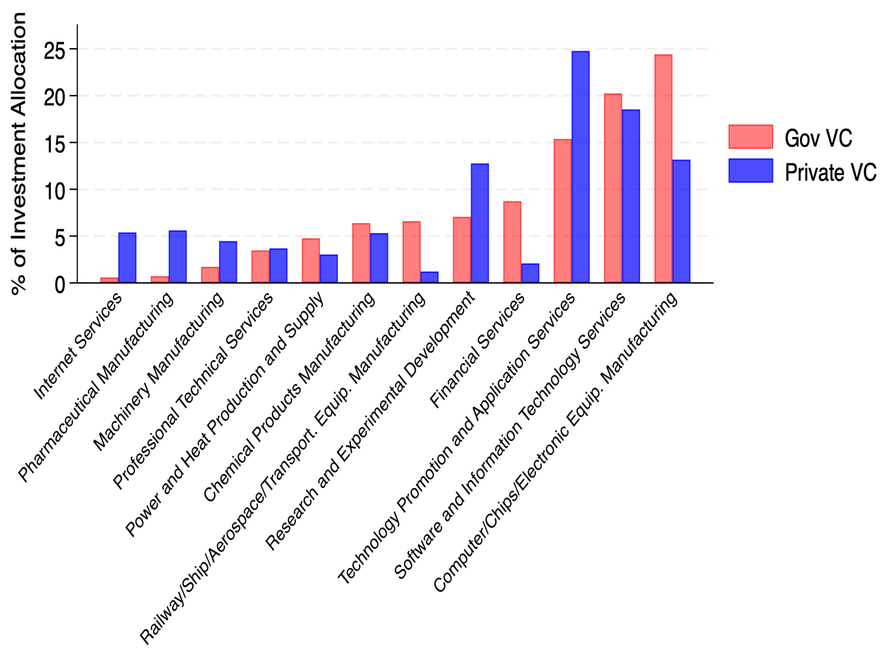


(b) Private VC

Figure A.3: Spatial distribution of VC funds in China by capital



(a) Gov't VC vs. private VC (level)



(b) Gov't VC vs. private VC (%)

Figure A.4: Sectoral composition of VC funds at the HS-2 digit level

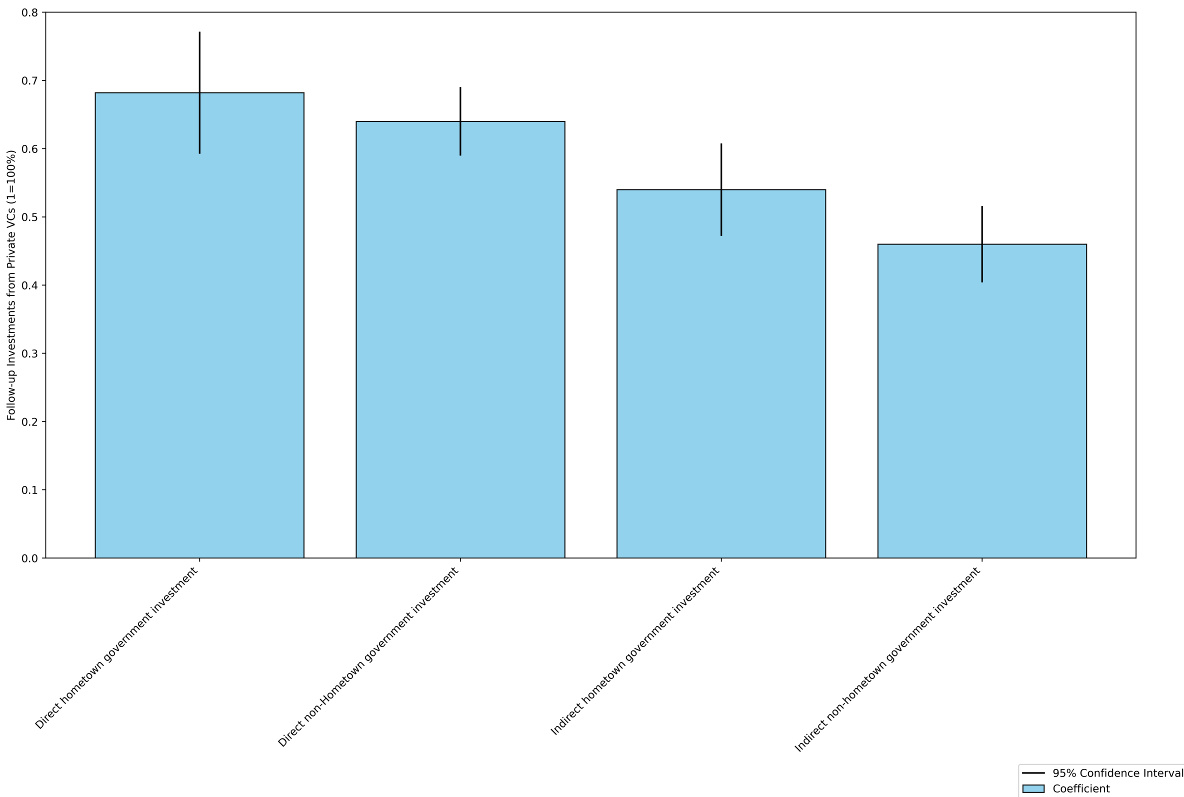


Figure A.5: Which government VC funds' investment decisions prompt more private VC follow-up investments?

Notes: In this figure, we investigate whether AI firms receiving investments from government VC funds induce follow-up investments from private VCs, relative to AI firms that did not receive any investments from government VC funds. Specifically, we compare the effects across four categories of government VC investments: (a) direct investment from hometown government VCs, (b) direct investment from non-hometown government VCs, (c) indirect investment from hometown government VCs, (d) indirect investment from non-hometown government VCs, compared to firms with no investment from government VC funds (omitted group). All regression models include controls for firms' entry year fixed effects and location fixed effects. Standard errors are clustered at the province level.

Table A.1: Investment in AI firms: government VC funds vs. private VC funds

	Software Production				
	Ex-ante Number	Cumulative Number		Growth Rate (100%=1)	
	(1)	(2)	(3)	(4)	(5)
Gov't VC	1.077***	7.399***	6.261***	5.325***	5.071***
	(0.063)	(0.084)	(0.051)	(0.021)	(0.518)
Private VC	3.064***	17.593***	14.356***	4.135***	3.795***
	(0.046)	(0.061)	(0.037)	(0.017)	(0.102)
Mean of Outcome	0.71	0.90	0.90	0.05	0.05
Firm Start Year FE	Y	Y	Y	Y	Y
Firm Province FE	Y	Y	Y	Y	Y
Ex-ante controls	N	N	Y	N	Y
Observations	1,452,478	1,452,478	1,452,478	1,450,150	1,450,150
R-Squared	0.083	0.164	0.693	0.109	0.110

Notes: This table focuses on all AI firms. Standard errors clustered at the provincial level are reported below the coefficients. Ex-ante controls include firm age and ex-ante software production. In column (1), we run a cross-sectional regression comparing the ex-ante software production of AI firms receiving different types of VC investment. For firms with investments, the ex-ante software production is measured before their first investment. For firms without any investment (the omitted group), the ex-ante software production is measured from the third year after the firm's establishment, as firms with investments typically receive their first investment in the third year. For the cumulative measure and growth rate in columns (2) to (6), these are cross-sectional regressions aggregating the software production up to the end of our study period in 2023. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table A.2: Hometown advantage in choosing high performing AI firms based on unobservables

	Software Production					
	Ex-ante	Cumulative	Cumulative	Ex-ante	Cumulative	Cumulative
	(1)	(2)	(3)	(4)	(5)	(6)
Hometown Gov't VC	-0.224	2.037**	1.711**			
	(0.381)	(0.822)	(0.668)			
Hometown Private VC				-0.139	5.324***	4.820***
				(0.503)	(1.166)	(0.948)
Mean of Outcome	5.57	19.53	19.53	7.16	24.10	24.10
Firm Start Year FE	Y	Y	Y	Y	Y	Y
Firm Province FE	Y	Y	Y	Y	Y	Y
Ex-ante controls	N	N	Y	N	N	Y
Observations	7,207	7,207	7,207	10,641	10,641	10,641
R-Squared	0.097	0.206	0.475	0.049	0.475	0.131

Notes: Columns (1)-(3) focus on AI firms that received at least one government VC fund's investment. Columns (4)-(6) focus on AI firms that received at least one private VC fund's investment. Standard errors clustered at the province level are reported below the coefficients. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table A.3: Which government VC funds' investment decisions prompt more private VC follow-up investments?

	Receiving Follow-up Investments from Private VCs (=1)		
	(1)	(2)	(3)
	Full Sample	Less Ex-ante Software	More Ex-ante Software
Direct Hometown Gov't VC	0.213***	0.234***	0.137***
	(0.042)	(0.050)	(0.045)
Direct Non-Hometown Gov't VC	0.165***	0.176***	0.113**
	(0.030)	(0.030)	(0.050)
Indirect Hometown Gov't VC	0.069***	0.076***	0.047*
	(0.015)	(0.017)	(0.025)
Mean of Outcome	0.53	0.51	0.63
Firm Start Year FE	Y	Y	Y
Firm Province FE	Y	Y	Y
Observations	6,679	5,413	1,266
R-Squared	0.151	0.182	0.061

Notes: This table examines which types of government VC funds' investment decisions prompt more follow-up investments from private VC firms, focusing on AI firms that have received at least one government VC investment prior to private VC investment (if any). In column (1), we analyze all AI firms with at least one government VC investment, comparing the effect on follow-up investments from private VC across four types of government VC funds' investment decisions: (a) direct investment from hometown government VCs; (b) direct investment from non-hometown government VCs; (c) indirect investment from hometown government VCs; and (d) indirect investment from non-hometown government VCs (omitted group). In columns (2) and (3), we focus on subsamples of AI firms with lower (below mean) ex-ante software production and higher (above mean) ex-ante software production, respectively. The Firms' ex-ante software production is measured before receiving their first investment. All regressions control for firms' entry year fixed effects and location fixed effects. Standard errors clustered at the province level are reported below the coefficients. * significant at 10% ** significant at 5% *** significant at 1%.