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Comment

Michael Ewens

6.C1 Summary

This chapter investigates the trends in global private equity (PE) and venture capital (VC) investments in agriculture start-ups. After finding evidence for rapid increases in capital flow to these start-ups—particularly after the financial crisis of 2008—the chapter explores the sources of changes. Specifically, the capital provided to these start-ups is growing relative to the supply of capital invested by the public sector and public firms. Next, a regression analysis confirms that investment in agricultural sectors is strongly correlated with both past liquidity events in the sector and changes in prices for major commodities. The results are consistent with investors responding to investment opportunity signals in the agricultural space.

Answers to these questions are important for researchers and policy makers who aim to support the agricultural sector and its innovation. More broadly, the analysis of changing investor behaviors, such as new allocations to new industries, reveals where start-up financing constraints lie. Finally, the results contribute to perennial debates around public versus private research and development (R&D) spending.

The comments on this chapter focus on several topics, including data construction and interpretation and suggestions for additional analyses.

6.C1.1 Combining Databases: Benefits and Pitfalls

The chapter describes a major data exercise merging three databases: Crunchbase, PitchBook (Morningstar), and VentureSource (Dow Jones). The authors should be applauded for combining these related but distinct sources of data. However, such merges face challenges when data providers differ in their coverage and industry classification methodologies. Consider first the VentureSource database provided by Dow Jones. In my experience using this data, I have learned that their best coverage is for US-based start-ups backed by VC. Informal conversations with the data provider also revealed that the data quality is high only after 1990 (the firm was founded in 1987). Next, PitchBook provides significantly wider coverage by region than VentureSource. Early focus was on the US PE ecosystem but has grown and—in my opinion—improved over the last five to seven years. Given their founding in 2007, it is not clear where their historical data was sourced, which is an important uncertainty when merging with databases that have

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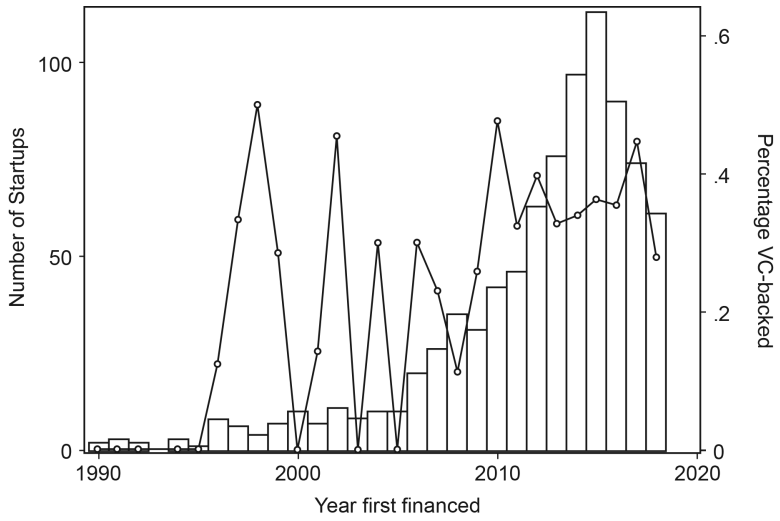

Fig. 6.C1 Agtech start-ups, PitchBook

Note: The figure reports the count of VC/PE-backed US-based agtech start-ups from 1990 to 2018. The left axis and bars report the raw counts of the number of start-ups raising such capital. The line reports the fraction that are "VC backed" according to PitchBook.

longer time series. Finally, Crunchbase fills out the financing coverage. This database is best known for its coverage of US early-stage (often pre-VC) financings. It began in 2007 by a technology blogger to keep track of start-ups covered on its site and grew as a wiki-style page. It also appears to have benefited from the switch away from PDF to XML-formatted regulatory filings for PE exemption notices in 2009. Given its short history and narrow industry focus in the early years, its quality for agriculture start-ups is unclear.

My suggestion to the authors is to first motivate the merge of these three databases. For example, is there evidence that one has poor coverage of exits or nonsoftware companies? The main concern is that the quality, coverage, and definitions differ widely across (and possibly within) data providers. Note that each of these companies likely makes most of their revenue from nonacademic customers, which means they are less concerned with historical data and have resources devoted to the current period. The best motivation for this merge would be to fill in gaps in each databases' coverage. Alternatively, the authors could pick one as a "master" data set and use the remaining two to fill in coverage gaps or missing values.

As an example of possible time-varying coverage, consider a query of PitchBook for US-based agricultural start-ups financed in 1990–2018 for "all" investor types in figure 6.C1.

Several questions emerge from this figure that warrant some discussion

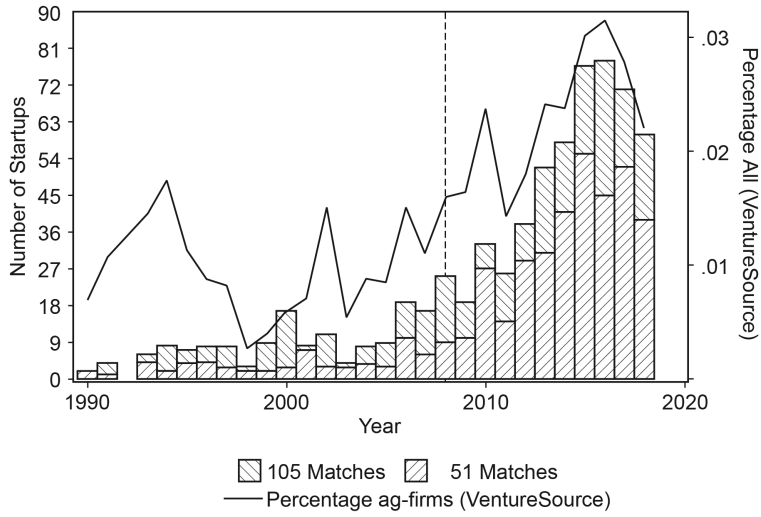

Fig. 6.C2 Merge of VentureSource and PitchBook

Note: The figure reports the counts of successful merges of start-ups in VentureSource and PitchBook using two different search queries for VentureSource.

in the chapter. First, note the increase in counts that coincides with the founding of PitchBook in 2007. Can the authors confirm that this is a real phenomenon rather than a coverage change? Second, for the chapter's analysis of VC-backing changes over the sample period, how does one explain the line of percent VC backed? It exhibits significant variation but no major break in the 2008–9 period.

Next, I was able to conduct a quick merge of VentureSource and PitchBook for US-based VC-backed agricultural start-ups. The first challenge is selecting industries. Unlike publicly traded firms that have at least one Standard Industrial Classification (SIC) code, private firms have self-assigned industries or classifications given by data providers. Private firm data providers do not always use SIC or North American Industry Classification System (NAICS) codes, which limits merging across databases. My attempt to get agricultural start-ups in VentureSource and PitchBook was thus challenging. For VentureSource, I choose the broad category "Agriculture and Forestry" with added flags in business descriptions for "farm," "harvest," and "agriculture." The latter is important because tractor guidance software is categorized as "Software," but the start-ups have "farm" in their description. I followed the chapter's approach to querying PitchBook.

The merge of VentureSource and PitchBook was done using the start-up's name (after some basic cleaning). Figure 6.C2 presents the number of observations from the successful merge of the search results using the "Agriculture and Forestry" category (51 matches) and the 105 keywords. The

General Information

Description
Developer of agricultural data platform design to offer insights and analytics for the agricultural commodities supply chain. The company's agricultural data platform is an application that converts big-data from satellites and weather stations into actionable, macro-level insights on agricultural production, enabling agricultural businesses to avail information of flooding, drought, and other adverse conditions that might affect their commodities.

Most Recent Financing Status (as of 13-Aug-2018)
The company raised $100,000 of convertible debt financing from Mindset Ventures on February 20, 2017.

Website	www.aerialintel.com		
Entity Types	Private Company	**University**	Venture Capital
Legal Name	Aerial Intelligence, Inc.	**Primary Industry**	Media and Information Services (B2B)
Business Status	Generating Revenue	**Other Industries**	Database Software
Ownership Status	Privately Held (backing)		Business/Productivity Software
Financing Status	Venture Capital-Backed	**Verticals**	Artificial Intelligence & Machine Learning
			Big Data
			Saas
			TMT

Fig. 6.C3 Example description of start-up in PitchBook not listed as "agtech"

results indicate not only that casting a wide net in any search is important for increasing the sample size but also that individual matches demand random checks for false positives.

A closer analysis of the failed merges suggests that some hand collection is necessary. Aerial Intelligence (figure 6.C3) is found in PitchBook, but not as an agriculture firm. The start-up's description strongly suggests it is agtech. Next, the start-up VinSense is not found in VentureSource. It has the following business description: "Developer of a crop management software designed to enhance crop uniformity and increase crop volume. The company's software helps to improve crop management using soil sensors and offers optimal soil nutrient management, enabling producers, field managers and winemakers to manage soil moisture, pruning, irrigation, canopy management and water conservation."[1]

An analysis of VinSense's financings shows that over half of its capital raised was in the form of government grants, while its equity investors made abnormally small investments. This example makes clear that data providers also have different methodologies to determine what constitutes "VC backed." It also shows how valuable merging different databases can be for improving coverage. I would like to see more discussion of the rules each data provider uses when classifying and collecting data for the industries of interest.

1. See the company website at https://www.vinsense.net/product-services/.

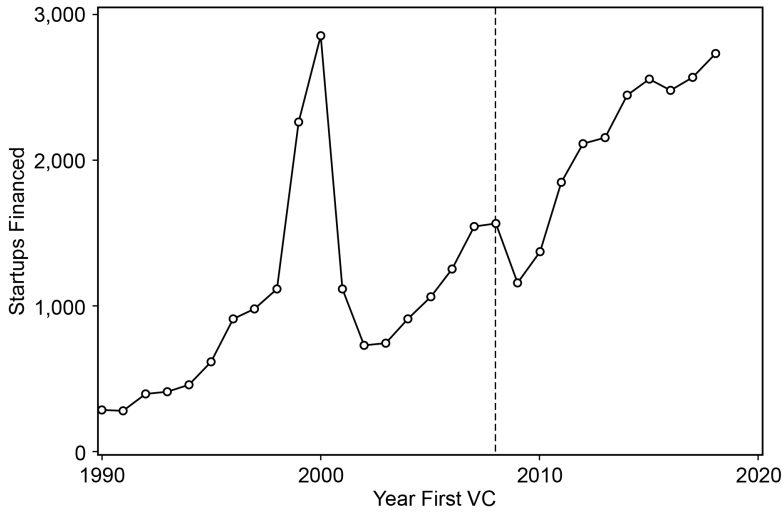

Fig. 6.C4 Number of start-ups financed by VC

Because data providers change methodology and quality over time, merging them can create spurious trends. This leads to two concrete suggestions:

1. Run the analysis on each database separately and demonstrate that results all go in the same direction.
2. Manually merge all three using a wide net on each database and document why they disagree.

6.C1.2 What's the Counterfactual?

The chapter argues that there has been a meaningful increase in capital provided to agriculture start-ups. The authors could do more to tease out the overall or macro trends from these changes. For example, figure 6.C4 shows the number of start-ups backed by VC since 1990 (according to VentureSource). The vertical dashed line shows the break in financing proposed by the authors. Clearly, the overall VC market experienced a change around 2008. Thus I suggest that the authors isolate an area *within* agriculture that grew differently. For example, one could conduct a structural break test with an unknown break in mean (constant), repeating the exercise for the changes in agricultural prices.

6.C1.3 What Are the Next Steps?

The chapter has the opportunity to explore deeper issues in both agriculture and venture capital. The chapter hints at one direction: "Several factors may have affected the hurdle rate, such as an increase in the ratio of agricultural prices to nonagricultural commodity prices, the occurrence of

large exit events in highly visible start-ups, the emergence of new technological opportunities based on advances in enabling technologies (such as cheaper genome sequencing, genome editing, or data capacity of sensors and networks), and changes in (agricultural) labor markets in both high-income and middle-income countries."

One suggestion is to follow a similar strategy found in Ewens, Nanda, and Rhodes-Kropf (2018). They study the impact of changing start-up costs after the introduction of the cloud. Their focus was on the information technology (IT) sector; however, it is likely that impacts are *within* agriculture. The same technological shock could be used to study the role of investor value-add to this industry or how capital flows between different sectors in the agricultural space.

Another avenue for additional analysis begins with the premise that the increase in capital to agriculture is real. One can ask, Who are the investors? This is an interesting question because agriculture is a nontraditional space for both VC and PE. One prediction is that existing investors are pivoting toward agriculture to exploit new technology in the space. Here, changes in investing represent not a demand shock but rather a spillover from a lack of investment opportunities elsewhere. Alternatively, the new investments have new investor entrants that are VCs. Such a pattern is consistent with a supply-side shock or exits from established agtech firms. One way to investigate this issue would require tracking the work histories of the partners in the start-up financings. Finally, it is possible that the growth in agtech is facilitated by new *types* of investors (e.g., incubators, corporate VC, PE hybrids)? If so, then the facts would be consistent with existing VCs having

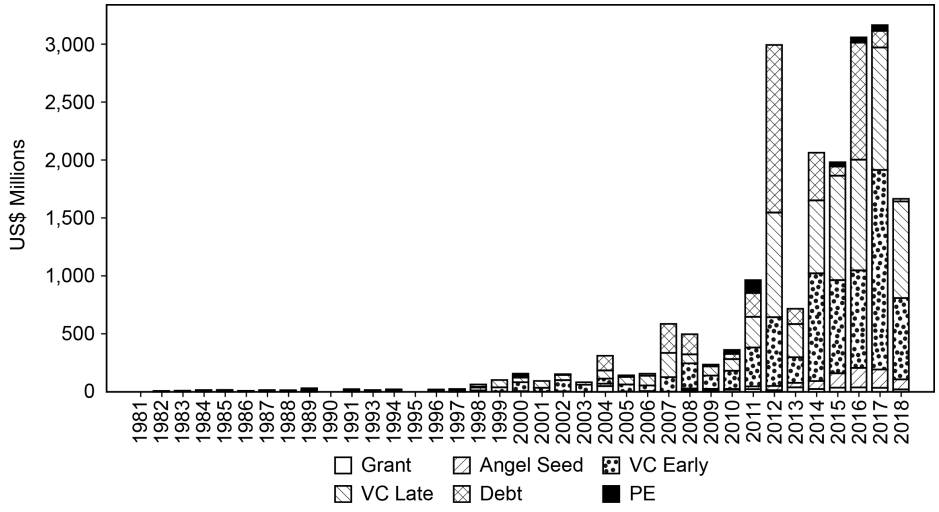

Fig. 6.C5 Figure 6.4 from chapter 6

real constraints on either skill or capital for agricultural investment opportunities. In fact, figure 6.4 in the chapter (re-created below) shows that VC is not the only source of capital in these start-ups and there is some evidence of changing composition of investors.

6.C2 Conclusion

The chapter documents changes to the entrepreneurial finance ecosystem in agriculture. Moreover, it documents strong correlations between the flows to start-ups and signals of investment opportunities. My suggestions for the authors are threefold. First, they should conduct a careful review of the database creation with particular attention paid to the variation in industry and coverage differences by data provider. Next, more evidence is needed to convincingly demonstrate that the financing environment changed in agriculture in ways different from that experienced in all of the start-up ecosystem. Finally, the authors have many opportunities to explore how VC investment dynamics are connected to changes in the agriculture industry or changes to the supply side of the market.