Venture capital: A model of search and bargaining ☆

Rafael Silveira [a], Randall Wright [b,c,d,*]

[a] *J.P. Morgan, United States*
[b] *Federal Reserve Bank of Chicago, United States*
[c] *Federal Reserve Bank of Minneapolis, United States*
[d] *University of Wisconsin, Madison, United States*

A B S T R A C T

This paper develops a model of the venture capital market, focusing on the search process that matches capitalists with entrepreneurs, and the bargaining problem that splits the surplus between them. Venture capitalists repeatedly go through the following cycle: (1) fund raising; (2) search for a project/partner; (3) implementation; (4) exit from the project. The analysis focuses on project selection when there are match-specific costs and returns, decisions to enter the market in the first place, investments during implementation, and fund size. The model is consistent with the stylized facts and provides a tractable framework for formalizing descriptive and institutional studies of this market.

© 2015 Elsevier Inc. All rights reserved.

An important problem in a market economy, and the one the VC attempts to solve, occurs when an entrepreneur has a good idea, but no money, while investors have money, but no good ideas.

[Kaplan and Lerner (2009)]

How are different entrepreneurs matched with different VCs? In terms of theory, this is a search and matching problem.

[DaRin et al. (2011)]

1. Introduction

This paper develops a search-and-bargaining model of the venture capital (VC) market, as a new application of tools successfully deployed in other areas. There are textbook search models of labor, goods, and marriage markets, where firms and workers, buyers and sellers, or men and women get together over time through frictional matching processes. For labor applications, see Mortensen and Pissarides (1994), Burdett and Mortensen (1998) or Mortensen (2003); for goods markets with an emphasis on money and liquidity see Shi (1995, 1997), Trejos and Wright (1995) or Lagos and Wright (2005); for marriage models see Mortensen (1988), Burdett and Coles (1997, 1999) or Shimer and Smith (2000). The VC market is somewhat different because it is a three-sided market, with third parties called VC's intermediating between entrepreneurs

and investors. There are, of course, already applications of search to markets with intermediation, including Rubinstein and Wolinsky (1987) (for an updated version, see Nosal et al., 2015). There are also search-based models of over-the-counter financial markets with intermediation, including Duffie et al. (2005) (for an updated version, see Lagos and Rocheteau, 2009 or Lagos and Zhang, 2014). While there are also a few applications of search theory to VC markets, as discussed below, we think it is time to start applying these methods in a bigger way.

To begin, we provide some institutional detail concerning venture capital, a form of private equity. Some entrepreneurs have ideas for projects, or ventures, but have trouble getting financing from banks or other conventional sources, because their ideas are technically difficult for non-experts to evaluate. Venture capitalists, or VC's, are intermediaries that raise funds from institutional investors and wealthy individuals, and have expertise in locating, evaluating and selecting high-risk but potentially high-return projects. VC's also have expertise in implementation – more than just lending money, they enter into active partnerships with entrepreneurs. Assuming a project does not fail, once it matures, and can be more easily evaluated or operated by others, the venture typically goes public or is sold to another company. The exiting VC transfers some of his gains back to the original investors, keeps the rest, and starts over by raising a new fund. This dynamic process, which can last as long as 10 years, is called *the venture capital cycle* (Gompers and Lerner, 1999).

Why study this market? As calculated by NVCA (2011, 2012), venture capital under management in the US in 2011 was about $200 billion, down from $307 billion in 2006, but over the longer horizon there has been extraordinary growth. DaRin et al. (2011) report VC investments in the US totalled $610 million in 1980, increased to $2.3 billion by 1990, peaked at over $100 billion during the dotcom bubble before falling back to around $30 billion. They also report over 200 new VC funds were created per year since 2000. And as Metrick and Yasuda (2011) say, private equity's role in the economy and managers' compensation have drawn increasing attention from policymakers since the financial crisis, with ongoing debate about taxing profits. Moreover, although it is only part of the larger financial sector, the VC market is an engine of growth, with many blue-chip firms receiving such funding in their early stages, and much VC funding concentrating on the important health care and information technology sectors. Hence, venture capital provides a vibrant market worthy of study.[1]

We develop a dynamic equilibrium model, focusing on the process that matches VC's with entrepreneurs, the bargaining problem of dividing the rents, decisions about whether to enter the market in the first place, investments in implementation, and fund size. The previous VC literature is surveyed in Gompers and Lerner (1999, 2001), Metrick and Yasuda (2010, 2011) and DaRin et al. (2011). To put our contribution in perspective, although we study many issues, here are two that are especially relevant: What determines the duration of different phases in the VC cycle? What determines equilibrium fund size? On the former, timing is clearly a concern, with Cochrane (2004) saying "The risk facing a venture capital investor is as much when his or her return will occur as it is how much that return will be." On the latter, fund size is affected by many factors discussed in the empirical literature, but there is no benchmark theory. These are both issues naturally addressed using search theory. While there is much work using search to study other markets, there is no general, standard, model using it to analyze the VC market.[2]

Having said that, the idea that the VC market is not frictionless is by no means new. As Metrick and Yasuda (2010) say, "For every investment made, a VC may screen hundreds of possibilities." Gompers and Lerner (2000) argue there is a positive relation between the valuation of VC investment and liquidity inflows to the market not driven by improvements in potential prospects, and interpret this as evidence against frictionless markets. Gompers and Lerner (1999) and Lerner (2003) describe recurrent imbalances in the supply and demand for funds, which we find reminiscent of the coexistence of unemployed workers and unfilled vacancies in labor markets. Others recognize that the VC market has frictions, although at the risk of generalizing, the focus is on imperfect information and contracting between VC's and entrepreneurs.[3] While information and contracting issues are important, they have been the focus in much previous work, and we want to propose something novel. Hence, we concentrate on the stochastic length of the cycle, on the decision to enter a venture or to enter the market, on simultaneously getting entrepreneurs with ideas looking for cash and VC's with cash looking for ideas, and on determining fund size, which have been relatively neglected.[4]

---

[1] Examples of VC funded firms include Apple, FedEx, Intel, Microsoft, Cisco Systems, Facebook, Amazon, Twitter, Starbucks, Google, Whole Foods, Home Depot, Staples and Jet Blue. Many studies find VC-backed firms perform well by a variety of criteria. Kortum and Lerner (2000), e.g., estimate that although VC-backed firms account for only 3% of all R&D spending, they generate about 14% of the innovation. NVCA (2002) reports that from 1970–2000, per dollar of assets, VC-backed companies had twice the sales, paid almost three times the federal taxes, generated about twice the exports, and invested nearly three times as much in research and development as other companies. NVCA (2011, 2012) reports that despite VC investment being less than 0.2% of GDP, VC-backed firms' revenue is 21% of GDP, and they account for 11% of private sector employment. In areas like software and biotechnology, VC-backed jobs constitute 90% and 74% of industry employment.

[2] In addition to the papers mentioned above, for surveys on search and labor see Pissarides (2000) or Rogerson et al. (2005), and for surveys on monetary economics see Williamson and Wright (2010) or Nosal and Rocheteau (2011). Our framework shares some features with these models, but also modifies them to better match aspects of the VC market. For instance, the typical labor model has no consideration of an ex ante fund size, and the typical monetary model has no long-term relationships. So, while those with a background in search will recognize components of the specification, the model is novel in the ways they are combined and put to work.

[3] See Aghion and Tirole (1994), Bergemann and Hege (1998), Hellmann (1998), Kaplan and Strömberg (2001), Bascha and Walz (2001), Casamatta (2003), Hellmann and Puri (2000, 2002) and Schmidt (2002). The above-mentioned surveys contain additional references.

[4] As we say below, potentially valuable research may eventually integrate models using search and those using other information frictions. Given there is already much work on asymmetric information, we focus in this project on search, and leave the eventual integration for future work.