The Effect of Market Structure on Specialization Decisions in Venture Capital

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Draft of March 27, 2009

PRELIMINARY AND INCOMPLETE DRAFT

Abstract

In making its investment decisions, a venture capital firm must consider whether to specialize exclusively in one sector or to spread its investments across several sectors. While spreading investments across sectors has benefits – such as diversifying the firm's holdings and opening up a larger pool of investment opportunities – it reduces the benefits of specialization, namely that a specialist has greater access to its sector's most promising ventures, either because it can more accurately assess a project's value or because the venture is more likely to accept an investment from a VC with specialized knowledge of its sector. In addition, competition from other VC firms will affect a firm's specialization choice in the sense that its relative standing among competitors will influence a startup's decision to accept its investment. We find empirical evidence suggesting that firms alter their specialization decisions in response to competitors and market structure using a panel dataset of VC investments from 1975 - 2003.

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1 Introduction

Over the past decade, the empirical industrial organization literature has extensively examined the tradeoffs firms face when making endogenous product choice decisions in competitive markets. As outlined in Mazzeo (2002), this literature has addressed a classic challenge facing all firms: the need to differentiate themselves from competitors to profitably capture market share, while operating in a space that holds profitable opportunities – and hence, will attract more competitors, thus eroding margins. In equilibrium, we typically observe that differentiation is a profitable strategy for firms, but that popular product-space locations are also very attractive.

In this paper, we examine the product-type decision in the context of the venture capital (VC) industry. In venture capital, the "product-type" decision of an investment firm can be characterized based on the new ventures it decides to support. In practice, we observe that many VC firms specialize in investing in ventures that intend to operate in a particular industry, while other VCs support new firms from a variety of industries, essentially choosing to be a generalist. A VC firm faces an interesting tradeoff when deciding whether to specialize in a particular sector or remain a generalist. A firm might specialize, for example, because its principals hold sector-specific expertise that affords them advantages when selecting or managing ventures. To the extent that this is true, the specialized VC may be more profitable than its local competitors who are generalists. On the other hand, specialization may instead result because a particular sector happens to have many profitable ventures in a particular market. In this case, the abundance of profitable opportunities in a particular sector will no doubt attract several competing venture funds to the area, resulting in higher bids or valuations for ventures, which will necessarily reduce each fund's ability to capture profits. A firm might find investing (and indeed, perhaps, specializing) in less-crowded sectors preferable, as less competition will make investing in ventures relatively more attractive. Or, in contrast, a firm might continue to specialize in the crowded sector,

making itself more attractive to ventures that seek funding from firms with the most extensive experience in their sectors (though at the expense of forgoing the opportunity to invest in promising ventures in other sectors).[1] As investment competition increases, this tradeoff between the potential returns to specialization and the appeal of thick market sectors for ventures may intensify for investors.

To guide intuition, consider a firm that monopolizes a VC market. This firm will want to be a generalist since it can then select the most attractive opportunities irrespective of sector. In response to competition, however, it might want to specialize if ventures are more likely to accept funds from firms that specialize in their sector. Thus, a firm will give up some flexibility in terms of sector choice to reap the gains from specialization, with the gains being that a firm will have access to the most attractive ventures in its sector of specialization. As the number of VCs and investment opportunities in a market gets larger, there may even be intense competition among specialists.

In this paper, we use econometric tools from the industrial organization literature to understand the relationship between endogenous specialization decisions and market structure in the venture capital industry. Recent work has shown that a firm's degree of specialization has a significant economic and statistical effect on its profitability. Gompers, Kovner, Lerner & Scharfstein (2005) find that, on average, more specialized venture capital firms achieve greater returns on their investments. In their analysis, they treat a firm's degree of specialization as an exogenous characteristic, while noting, however, that the choice of specialization is in fact likely endogenous. In addition, there is evidence that market structure can significantly impact endogenous decisions in venture capital. For instance, Hochberg, Ljungqvist & Lu (2008) have shown that

[1] In addition, this decision will have dynamic effects for the firm, since a firm's degree of specialization in the current period will influence its access to promising investments in future periods, both because ventures prefer funds that have expertise in their sector and because a venture capitalist's network affects her access to deals, and thus a more specialized venture capitalist will potentially have a more specialized network (Hochberg, Ljungqvist & Lu (2007)). The dynamic aspects of this decision remain to be explored in future work.

highly networked incumbents in a market lead to lower rates of entry in that market. As a consequence, it is quite important to study the connection between specialization and competition using empirical tools that account for endogenous specialization.

Our empirical analysis is based on a sample of all U.S. VC investment data from 1975-2003. We investigate sector specialization at the geographic market level, focusing on how specialization choices of individual firms are related to various measures of market competition. Increased competition tends to correlate with more specialization in markets overall; however, as the number of operating VCs in a market increases, the markets become less specialized in one sector. In the spirit of Bresnahan & Reiss (1991), we also computed a market size value for each geographic area based on the total VC funding in that market, and compared market size with the number of operating firms. A relatively larger market size per firm is observed in markets with more operating firms, suggesting that more competition in a market for ventures results in less favorable terms for VCs, on average. We also investigate how specialization mediates the relationship between market size and the number of competing VCs in a market.

Our findings provide a number of contributions to the academic literature. First, our study contributes to the literature exploring VC investment decisions. While there is a large literature exploring the relationship between VCs and their portfolio companies (see e.g. Gorman & Sahlman (1989), Sahlman (1990), Gompers & Lerner (1999), Hellmann & Puri (2002), Kaplan & Stromberg (2004) and Hochberg (2006)), much less is known about VCs' decisions to invest in particular companies, or even in particular industries. A notable exception is recent work by Sorensen (2008), who explores the role learning on the part of VCs acts to resolve uncertainties about investment opportunities. Our work adds nuance to the findings in Sorensen (2008), and expands the body of knowledge regarding VCs' selection of investment opportunities. Second, our work contributes to the emerging literature studying the industrial organization of the VC market (see e.g. Sorenson & Stuart (2001), Hochberg et al. (2007) and Hochberg

et al. (2008)). Our study complements the evidence in Gompers et al. (2005), who show evidence of a strong positive relationship between specialization and success. In contrast to Gompers et al. (2005), who take the VC firm's level of specialization as an exogenous characteristic, our work explores how the competitive structure of the market influences VC specialization decisions. Finally, our study contributes to the large literature on product differentiation in the industrial organization literature.

Four additional sections follow this introduction. In Section 2, we describe the source and the manipulation of the data used in our analysis. Section 3 contains the empirical framework commonly used in the IO literature to study the endogenous characteristics related to market structure and how we have adapted it for the purposes of examining the VC industry. We present our results in Section 4 and conclude in Section 5.

2 Data and Industry Description

The data for our empirical analysis come from Thomson Financials Venture Economic database. Venture Economics began compiling data on venture capital investments in 1977, and has since backfilled the data to the early 1960s. Gompers & Lerner (1999) investigate the completeness of the Venture Economics database and conclude that it covers more than 90 percent of all venture investments. In this paper, we use the data from Venture Economics from 1975 through 2003 to construct our variables and conduct the empirical analysis.

Most VC funds are structured as closed-end, often ten-year, limited partnerships. They are not usually traded, nor do they disclose fund valuations. The typical fund spends its first three or so years selecting companies to invest in, and then nurtures them over the next few years (Ljungqvist & Richardson 2003). In the second half of a fund's life, successful portfolio companies are exited via IPOs or sales to other companies, which generates capital inflows that are distributed to the fund's investors.

At the end of the fund's life, any remaining portfolio holdings are sold or liquidated and the proceeds distributed to investors.

We concentrate solely on the investment activity of U.S.-based VC funds, and exclude investments by angels and buyout firms. While VC funds have a limited (usually ten-year) life, the VC management firms that control the funds have no predetermined lifespan. Success in a first-time fund often enables the VC firm to raise a follow-on fund (Kaplan & Stromberg 2004), resulting in a sequence of funds raised a few years apart. In particular, the experience, contacts and human capital acquired while running one fund typically carries over to the next fund. This suggests that an analysis that focuses on the causes and consequences of specialization should be done at the firm level. In addition, startups seeking capital generally seek this capital from a VC firm, rather than a specific fund within that firm.

Our dataset includes 1,974 VC firms. These firms operate a total of 3,469 funds. So, while many firms operate multiple funds, for a large number there is no distinction between a fund and a firm. The activity of these firms includes 47,705 investment rounds involving 16,315 portfolio companies.

In order to analyze any aspect of the competition among VCs (such as specialization), it is critical to note the role of geography in determining the match between venture capitalists and startup firms seeking capital. The nature of these relationships – including research, establishing personal contacts, and monitoring – makes venture capital a decidedly local industry. Therefore, we define the relevant geographic market at the level of the Metropolitan Statistical Area (MSA). VCs operating in a particular MSA are assumed to be competitors and the specialization of VCs in terms of sectors are defined based on their portfolio of startups in that MSA.[2] The relevant units of observation are the MSA-year (for markets) and the VC-market-year (for individual

[2]The reasonableness of this assumption warrants scrutiny, as past work has examined the extent to which VC firms cooperate as part of a network when managing and investing in portfolio companies (e.g., Hochberg et al. (2007). While the collusive nature of the VC industry is an interesting area for future research, we leave aside those issues in this paper.

investing firms).

Table 1 summarizes our data regarding market participation at the MSA-year level. The table is a histogram, with the frequency column indicating the number of market-year observations that contain the corresponding number of operating VC firms. Note that there is considerable variety in the level of competition in VC markets. While the familiar notion of a populated VC market such as Silicon Valley or Route 128 is represented at one end of the spectrum, the majority of VC markets have relatively few operating firms. Indeed, about half of the market-year observations have six or fewer operating VCs. This allows for an implementation of models of oligopoly market structure, as it seems reasonable economically to assume competitive interactions between the firms in these markets.

We define a VC firm as specialized in a particular sector if it has made greater than 75% of its market-level investments in that sector over the previous five years. Any firm making fewer than 75% of its investments in one particular sector in the market is considered a generalist. In what follows, all of our analyses are robust to changes in this threshold from 60% to 90%. The sectors we consider in this paper are the six broad sectors defined by Venture Economics: biotechnology, communications & media, computer-related (e.g., software), medical, non-high technology, and semiconductors. We provide a frequency table for the sectors of firm-level specialization in Table 2. We note that VC firms in the market-years we analyze – those with six or fewer operating VC firms – are predominately specialized in non-high technology investments (48.1%), while comparatively few are generalists (3.4%).

At the market level, we capture the degree of specialization by defining markets which have a "monopoly sector" – that is, all the operating VCs in the market are specialized in the same sector. A histogram of the market-years that have firms exclusively specialized in a given sector is provided in Table 3. Notably, market-years are more likely to have a monopoly specialization than not (71% vs. 29%), and the most common monopoly sector is non-high technology (42%). The market-years monopo-

lized by non-high technology specialists are predominately one-firm markets (599 out of 1,005), which in some cases may represent one-off ventures rather than systematic VC activity.

The next set of tables (Tables 4 - 9) investigates a more nuanced definition of market structure, including both the number of operating firms and the specialization status of each. Each panel breaks down the specialization patterns of firms for a given number of total operating firms. Again, these are frequency tables indicating the number of market-year observations with particular specialization patterns. The relevant specialization pattern is indicated by the numbers in parentheses in the first column of the table. The last number in parenthesis is always the number of generalist firms in the market. The previous entries cover specialists, starting with the number of specialists in the market's most popular overall sector. Subsequent entries (which, by definition, can only be populated in markets with more operating firms) represent the number of specialists in less-popular sectors.

For example, there are six market structure categories represented among the 347 market-years in which there are three VCs operating. Reading from the bottom of the panel, the most common market structure, with 185 market-years, is the (3,0,0,0) configuration – the three operating firms are all specialists in the most common specialty in that market (e.g., all three specialize in biotechnology investments). There are 120 market-years in which the configuration is (2,1,0,0), indicating that two of the operating VCs are specialists in the most common specialty and one is a specialist in a second specialty (e.g., two firms specialize in biotechnology, while the other specializes in semiconductor investments). The remaining configuration with all specialists is (1,1,1,0). In our data, there are 23 market-year observations where there are three specialists operating, each in a different specialty.

The other three configurations contain at least one generalist (recall that the last number in parentheses is always the number of market generalists). Starting from the top of the panel, we see that there are two market-year observations in our data

that contain one specialist and two generalists listed under configuration (1,0,0,2). In addition, there are eleven observations with configuration (1,1,0,1), containing one VC in each of two specialties along with one generalist. Finally, there are six market structures of (2,0,0,1) configurations with two specialists in the most common category, plus one generalist.

Across the panels in Tables 4 – 9, there is a limited frequency of configurations that contain a generalist; this is not surprising, given the lack of generalists reported in the data overall. On the other extreme, for all the panels – except the last – the most common configuration found in the data is the one in which all the operating firms are specialists in the most common specialty category. The share of configurations in this category, however, diminishes as the number of operating VCs in the market increases. As it does, the share of configurations that have specialists in more than one specialty category tends to increase. These are the key margins that we will investigate in the empirical analysis. In particular, we will examine the extent to which the tendency of VCs to leave the most common specialty in a market and become a specialist in something else, or a generalist, is influenced by the number of competitors and the overall market size.

3 Empirical Framework

The empirical analyses in this paper are designed to examine the causes and competitive consequences of specialization decision by participants in the venture captial industry. The frameworks used are among a series of "multiple-agent qualitative-response" models introduced into the industrial organization literature to evaluate entry strategies and market competition.[3] In these models, firms' strategies can be represented by discrete outcomes; in our case, specialization in one particular category of investment opportu-

[3]In addition to the papers cited here, see Berry (1992), Toivanen & Waterson (2005), and Seim (2005). Reiss (1996) provides a discussion of the empirical framework.

nities. The main underlying assumption is that VCs make the decision that generates the observed outcomes by evaluating the attractiveness of potential alternatives. The observed outcome is then assumed to be optimal, given the VCs' characteristics and the competitive environment.

As is typical with qualitative response models, the goal of the econometrician is to parameterize the decision rule of the optimizing agents and estimate the parameters using data on the agents' observed decisions. Estimation in this case may be complicated by the fact that the agents are competing firms. As such, the decisions of competitors may affect the attractiveness of the potential alternative action for individual firms; for example, entry into a market may be less attractive if several other VCs have also entered the market. The multiple-agent qualitative response models enable the analysts to estimate the key parameters from an observed market-structure outcome by applying a game-theoretic behavioral model to the choices made by interacting agents.

We begin by analyzing the relationship between VC market structure and market size using the methodology introduced by Bresnahan & Reiss (1991). This method does not address the potential for firm heterogeneity, so we make some extensions to this framework to incorporate specialization by VCs into the analysis. In the Bresnahan & Reiss framework, firms are assumed to be symmetric and decide whether to operate in a market based on whether it is attractive to do so. The attractiveness of operating in a market, m, is captured by a stylized profit function, flexibly specified as:

$$\Pi_m = (\text{Variable Profit Rate})_m * (\text{Market Size})_m - (\text{Entry Costs})_m. \quad (1)$$

Entry opportunities into a market for individual firms are defined by tradeoffs among these three elements – the variable profit rate, market size, and entry costs. Intuitively, entry costs need to be covered; otherwise operating in the market is not an attractive choice. If the variable profit rate is higher, these entry costs can be covered by a relatively smaller market size, and vice versa.

The effects of competition are incorporated by allowing variable profits to be a function of the number of firms.[4] In the context of the venture capital industry, it may well be that VCs will be required to accept less-attractive terms if there are more investors vying for a given set of entrepreneurial ventures. In the raw data, we can investigate this by simply examining how the per-firm market size varies with the number of operating VCs. If the variable profit rate decreases with competition, this relationship should be positively correlated.

To estimate this relationship more precisely, we can specify the returns of each of n symmetric firms operating in market m to be:

$$\Pi_{n,m} = X_m\beta - \mu_n + \epsilon_m, \tag{2}$$

where X_m are exogenous market factors (including market size), μ_n measures the effect of n competitors on per-firm profits, and ϵ_m is a market-level error term assumed to follow a normal distribution. We assume that firms enter the market if they expect to earn non-negative profits. Therefore, the probability of observing n firms in equilibrium equals:

$$P(\Pi_n \geq 0 \ \& \ \Pi_{n+1} < 0) = \Phi(\overline{\Pi}_n) - \Phi(\overline{\Pi}_{n+1}), \tag{3}$$

where $\Phi(\cdot)$ is the cumulative normal density function and $\overline{\Pi}_n = X_m\beta - \mu_n$. In practice, we can use an ordered probit model to estimate the parameters specified above.

Conceptually, specialization can potentially affect the relationship posited above in two ways. First, it is possible that a specialist VC firm would have greater efficiency due to its experience, contacts, and other factors. In that case, specialist VCs may have a higher variable profit rate, all else equal. In addition, competition among VCs

[4]This formulation implicitly assumes that the market size does not enter into the tastes of consumers. As such, an increase in observed per-firm quantities can be correlated with a reduction in margins. It is also possible that incumbent firms could erect more explicit barriers-to-entry, causing entry costs to rise as the number of market participants increases. We will not be able to distinguish between these two explanations in this analysis.

may be softened to the extent that the various VCs in the market are specialized in different sectors (or are generalists). If specialist VCs do not attempt to finance startups outside of their area of expertise, the remaining VCs ought to secure better terms – again, potentially increasing the variable profit rate.

To investigate these hypotheses empirically, we return to the tradeoff among entry costs, variable profits, and market size. We can make inferences about the effects of specialization on variable profits – which we cannot measure – by comparing the per-firm market size in markets with more specialists. Similarly, we can evaluate how markets with different specialist types look vis-a-vis markets in which all the specialists are of the same type. Based on this kind of analysis, we can draw conclusions about the returns to specialization for VC firms, as well as the competition-softening effect of VC differentiation.

We can adapt the two-stage model employed in the literature, in which VC firms in the first stage decide simultaneously whether or not to enter a particular local market. Because the local markets we restrict our sample to are fairly concentrated, the markets appear more oligopolistic than competitive so that VC firms base their entry decisions on market demand, fixed costs and expectations about competitors' entry and operating decisions (such as whether to specialize in a given sector).

In the second stage, conditional on entry, firms compete with one another to invest in ventures within the market, offering terms to ventures in a manner similar to firms competing on price in the traditional models. We can then infer the extent of "price" competition from the estimated relationship between the observed number of competitors and the minimum market size necessary to support the observed number of firms. Using the same revealed-preference argument described above, it is assumed that each incumbent VC is profitable and that any further entrants would be unprofitable, which guarantees a unique Nash equilibrium.

More formally, suppose that VC firms in a market face a demand for capital of

$$Q = d(p, x)S, \tag{4}$$

with $d(p, x)$ representing the demand of the typical venture in the market, p is the "price" of an investment, x are exogenous demand shifters, and S is the size of the market.

Profits are then determined by

$$\pi(n) = (r(n) - p(n))d(p(n), x(n))\frac{S}{n} - F, \tag{5}$$

with r representing the return from an investment, p the price of the investment, and $\frac{S}{n}$ the per-firm market size in a market with n VC firms. F is the fixed cost of entry.

As stated earlier, n firms enter a market if and only if

$$\pi(n) \geq 0, \tag{6}$$

holds, and we will observe a market with n firms if the $n + 1$ firm would find entry unprofitable; that is, if

$$\pi(n + 1) < 0. \tag{7}$$

This implies that the minimum market size per firm for which n firms break even is

$$\frac{S}{n} = \frac{F}{[r(n) - p(n)]d(p(n), x(n))} \tag{8}$$

Adapting the intuition from Bresnahan & Reiss (1991), entry will cause the equilibrium price level to increase, and hence the expected profits from an investment to fall – that is, the investment terms will be more favorable for a venture and less favorable for a venture capitalist. VC firms then require a larger market size as compensation for the lower expected return per investment. Although we do not observe

$\frac{F}{[r(n)-p(n)]d(p(n),x(n))}$, we can still infer the effect of entry on expected profit margins by estimating the entry thresholds. As in Bresnahan & Reiss (1991), if $\frac{S_{N+1}}{N+1}\frac{N}{S_N} > 1$, entry has a pro-competitive impact on the market. As is well documented in the literature, this model is equivalent to estimating an ordered probit with the observed number of firms as the dependent variable.

4 Estimation Results

In this section, we present three sets of empirical analyses that correspond to the frameworks described in the previous section. First, we look at the local VC markets using the methodology developed in Bresnahan & Reiss (1991). We then examine specialization decisions by investigating markets in which all VC firms are specialized in the same sector.

4.1 Market-Size Thresholds

To begin our investigation of the relationship between market structure and competition in the VC industry, we estimate an ordered probit model described in Section 3. From the results in Table 10, we find that, in line with the market-size threshold literature in the spirit of Bresnahan & Reiss (1991), markets with more operating firms require a relatively larger market-size per firm in order to sustain each firm. This effect lessens gradually – that is, the move from a monopoly to a duopoly requires relatively more, per firm, than a move from five to six firms. For instance, a market moving from one firms to two requires a doubling of the market's size to sustain the second firm, while a market moving from five firms to six requires an increase of only half as much. These thresholds are consistent with a scenario in which a monopolist VC firm can extract very generous terms from its portfolio companies when there is no competition in a market, but must accept less favorable terms in order for ventures to

accept their funds in markets with relatively more competition. More colloquially, the thresholds estimated in Table 10 indicate that VCs obtain "more for their money" in less-competitive markets than they do in more contested markets. As a result, VCs require more deals to justify the sunk costs of entry in these markets.

4.2 Monopoly-Sector Markets

In general, as competition in a market increases – as measured by the number of VCs operating in the market, the ratio of market sizes – as measured by the aggregate value of investments made in the market over the previous five years – for markets with a monopoly sector and those without a monopoly sector declines, as indicated by the summary statistics presented in Table 11. For instance, the average monopoly-sector market with one operating VC is approximately 3.5 times as large as the average non-monopoly market. For markets with six operating VC firms, however, the ratio is nearly reversed, and the average non-monopoly market is nearly 2.5 times as large as the average monopoly-sector market. In other words, larger markets tend not to have all VC firms specialized in the same sector, which is again consistent with the notion that a market-size threshold for profitable differentiation into alternative sectors exists for these markets. This result holds – but is less severe – when the sample is restricted to those markets with more than one VC firm, as market-years with only one operating VC firm tend to be both smaller and more likely to be concentrated solely in one sector.

We show that this result is statistically and economically significant in Table 12 in which we present the results of an OLS regression in which the dependent variable is the log of the market's size (as determined by the value of the investments made in the market over the previous five years) and the independent variable is an indicator equal to one if the market-year has a monopoly sector, with year fixed effects included as controls. As shown in the raw data, monopoly-sector markets are significantly smaller than non-monopoly-sector markets.

In Tables 13 – 15, we present the results of our estimates regarding the effect of market size on the likelihood that the market has a monopoly sector. In this panel structure, the dependent variable is an indicator variable that takes a value of 1 if all firms in a market are specialized at the 75% threshold in the market's dominant sector. The model is estimated using a panel probit estimator with year fixed effects (output omitted). The tables present the marginal effects following this estimation. For the estimation, it is clear, once again, that larger markets are less likely to have firms specialized exclusively in one sector. For instance, from Table 13, we can see that a market that is marginally larger than the average market is approximately 4.2% less likely to be specialized exclusively in one sector. Moreover, a market that has marginally more operating VC firms than the average market – i.e., a move from 2 to 3 firms – is approximately 56.3% less likely to be specialized exclusively in one sector.

An interesting result from Table 15 is that, once an interaction between a market's concentration of investments (by firm) and the number of firms in a market is added, the effect of the number of firms and the concentration of investments in a market on the likelihood of that market having a monopoly specialization both become positive. This suggests that markets in which a relatively large number of firms have concentrated investments (i.e., one or two dominant firms out of, say, six) are less likely to have all firms specialized in the same sector. This is consistent with a scenario in which a few dominant firms prefer to be generalists in a market (perhaps because they can secure the most promising ventures for themselves regardless of sector), or with a scenario in which the dominant firms invest in one sector and the fringe firms (perhaps because they cannot compete with the dominant firms for deals) specialize in the minority sectors.

In the raw data, presented in Table 16, it is evident that as markets become more competitive – as measured by the number of operating VC firms – these markets become less likely to be specialized in one sector. This is consistent with a scenario in which, as more firms enter a market, the relative gains from specializing in a sector other than

the dominant one begin to outweigh the returns to specializing in the same sector as the other firms in the market. That is, there is scope for profitable differentiation in regards to investment concentration between sectors. This outcome would be expected if the firms specializing in the majority sector bid up the valuations of ventures in that sector to the point at which the minority sectors would then have more attractive opportunities on a price-adjusted basis.

5 Concluding Remarks

The analyses in the preceding section provide suggestive evidence that the industrial organization of venture capital markets can be construed similarly to markets for other goods and services that have been analyzed empirically. In particular, we have found that VC markets require more per-firm investments to attract additional local entry. This indicates a reduction in profitability in more concentrated markets, likely due to additional competition. Firm differentiation – through sector specialization – appears to soften this competition significantly. In future work, we will examine more deeply the project-sector decision of VCs, including dynamic aspects of firm and market-level specialization.

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A Tables

Firms	Freq.	Percent	Cumulative
1	1,040	21.4	21.4
2	478	9.8	31.2
3	347	7.1	38.3
4	231	4.7	43.0
5	159	3.3	46.3
6	147	3.0	49.3
7	128	2.6	51.9
8	153	3.1	55.1
9	103	2.1	57.2
10	99	2.0	59.2
11	80	1.6	60.9
12	94	1.9	62.8
13	75	1.5	64.3
14	73	1.5	65.8
15	51	1.1	66.9
16	52	1.1	68.0
17	41	0.8	68.8
18	35	0.7	69.5
19	34	0.7	70.2
20	32	0.7	70.9
21+	1,419	29.1	100.0
Total	4,871	100.0	100.0
0	2,404	33.0	100.0

Table 1: Number of VC firms operating in a market-year.

Monopoly Sector	Freq.	Percent	Cumulative
0	169	3.4	3.4
1	153	3.0	6.4
2	715	14.2	20.6
3	839	16.6	37.2
4	454	9.0	46.2
5	2,425	48.1	94.3
6	288	5.7	100.0
Total	5,043	100.0	100.0

Table 2: Number of VC firms in market-years with six or fewer operating VC firms for which the sector of specialization is 0 (Generalist), 1 (Biotech), 2 (Comm./Media), 3 (Comp. Related), 4 (Medical), 5 (Non High Tech.), and 6 (Semicond.).

Monopoly Sector	Freq.	Percent	Cumulative
0	702	29.2	29.2
1	32	1.3	30.6
2	244	10.2	40.7
3	185	7.7	48.4
4	139	5.8	54.2
5	1,005	41.8	96.0
6	95	4.0	100.0
Total	2,402	100.0	100.0

Table 3: Number of market-years for markets with six or fewer operating VC firms for which the monopoly sector is 0 (all VC firms not specialized in the same sector), and the remaining sectors are: 1 (Biotech), 2 (Comm./Media), 3 (Comp. Related), 4 (Medical), 5 (Non High Tech.), and 6 (Semicond.).

Market Structure	Freq.	Percent	Cumulative
(0,1)	23	2.2	2.2
(1,0)	1,017	97.8	100.0
Total	1,040	100.0	100.0

Table 4: Market structure for market-years with one operating VC firm. Last number indicates number of generalists in the market. Numbers prior to last number indicate the number of specialist firms in a given sector.

Market Structure	Freq.	Percent	Cumulative
(1,0,1)	10	2.1	2.1
(1,1,0)	141	29.5	31.6
(2,0,0)	327	68.4	100.0
Total	478	100.0	100.0

Table 5: Market structure for market-years with two operating VC firms. Last number indicates number of generalists in the market. Numbers prior to last number indicate the number of specialist firms in a given sector.

Market Structure	Freq.	Percent	Cumulative
(1,0,0,2)	2	0.6	0.6
(1,1,0,1)	11	3.2	3.8
(1,1,1,0)	23	6.6	10.4
(2,0,0,1)	6	1.7	12.1
(2,1,0,0)	120	34.6	46.7
(3,0,0,0)	185	53.3	100.0
Total	347	100.0	100.0

Table 6: Market structure for market-years with three operating VC firms. Last number indicates number of generalists in the market. Numbers prior to last number indicate the number of specialist firms in a given sector.

Market Structure	Freq.	Percent	Cumulative
(1,1,1,0,1)	1	0.4	0.4
(1,1,1,1,0)	1	0.4	0.9
(2,0,0,0,2)	1	0.4	1.3
(2,1,0,0,1)	10	4.3	5.6
(2,1,1,0,0)	22	9.5	15.2
(2,2,0,0,0)	20	8.7	23.8
(3,0,0,0,1)	13	5.6	29.4
(3,1,0,0,0)	61	26.4	55.8
(4,0,0,0,0)	102	44.1	100.0
Total	231	100.0	100.0

Table 7: Market structure for market-years with four operating VC firms. Last number indicates number of generalists in the market. Numbers prior to last number indicate the number of specialist firms in a given sector.

Market Structure	Freq.	Percent	Cumulative
(1,1,0,0,0,3)	1	0.6	0.6
(2,1,0,0,0,2)	1	0.6	1.2
(2,1,1,0,0,1)	1	0.6	1.9
(2,1,1,1,0,0)	1	0.6	2.5
(2,2,0,0,0,1)	5	3.1	5.7
(2,2,1,0,0,0)	16	10.1	15.7
(3,1,0,0,0,1)	12	7.6	23.3
(3,1,1,0,0,0)	11	6.9	30.2
(3,2,0,0,0,0)	24	15.1	45.3
(4,0,0,0,0,1)	7	4.4	49.7
(4,1,0,0,0,0)	30	18.9	68.6
(5,0,0,0,0,0)	50	31.5	100.0
Total	159	100.0	100.0

Table 8: Market structure for market-years with five operating VC firms. Last number indicates number of generalists in the market. Numbers prior to last number indicate the number of specialist firms in a given sector.

Market Structure	Freq.	Percent	Cumulative
(2,1,1,0,0,0,2)	1	0.7	0.7
(2,1,1,1,0,0,1)	3	2.0	2.7
(2,2,0,0,0,0,2)	1	0.7	3.4
(2,2,1,0,0,0,1)	2	1.4	4.8
(2,2,1,1,0,0,0)	2	1.4	6.1
(3,1,1,0,0,0,1)	8	5.4	11.6
(3,1,1,1,0,0,0)	3	2.0	13.6
(3,2,0,0,0,0,1)	11	7.5	21.1
(3,2,1,0,0,0,0)	14	9.5	30.6
(3,3,0,0,0,0,0)	18	12.2	42.9
(4,1,0,0,0,0,1)	4	2.7	45.6
(4,1,1,0,0,0,0)	7	4.8	50.3
(4,2,0,0,0,0,0)	16	10.9	61.2
(5,0,0,0,0,0,1)	6	4.1	65.3
(5,1,0,0,0,0,0)	31	21.1	86.4
(6,0,0,0,0,0,0)	20	13.6	100.0
Total	147	100.0	100.0

Table 9: Market structure for market-years with six operating VC firms. Last number indicates number of generalists in the market. Numbers prior to last number indicate the number of specialist firms in a given sector.

Market Expands From:	Cut Point	Mkt. Size Threshold	Mkt. Size per Firm	Ratio
1 to 2	4.411	982.5	491.3	-
2 to 3	5.066	2,736.3	912.1	1.9
3 to 4	5.705	7,428.2	1,857.0	2.0
4 to 5	6.114	14,062.8	2,812.6	1.5
5 to 6+	6.514	26,278.5	4,379.8	1.6

Table 10: The sample pools 2,402 market-year observations for those markets with six or fewer operating VC firms. A firm enters the sample in the fifth year after its first investment in a market. All included variables are constructed on a five-year moving basis. In this panel structure, the dependent variable is a categorical variable representing the number of VC firms operating in a market. The model is estimated using an ordered probit estimator with year fixed effects (output omitted). The table presents the market-size thresholds to support one additional firm at each cut point in the spirit of Bresnahan & Reiss (1991), with the market size here defined as the volume of venture capital investments in a market over the previous five years.

Variable	**Coefficient**	**(Std. Err.)**
1[Monopoly Sector Market]	-1.121**	(0.072)
Intercept	7.511**	(0.184)
N	2402	
R^2	0.201	
$F_{(25,2376)}$	23.92	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 12: OLS on log market size with year fixed effects (output omitted) for market-years with six or fewer firms.

	All Market-Years			Monopoly Mkts.			Non-Monopoly Mkts.		
Firms	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
One	3628.479	19190.933	1040	3688.36	19402.166	1017	980.696	1027.432	23
Two	5405.763	8695.521	478	5639.809	9576.605	327	4898.921	6383.5	151
Three	6213.5	7490.008	347	5683.299	6958.881	185	6818.977	8032.887	162
Four	9184.226	12643.85	231	10058.535	14824.374	102	8492.912	10619.046	129
Five	13346.668	21437.785	159	17695.558	33950.033	50	11351.764	11689.014	109
Six	12725.646	12615.169	147	5608.645	5398.633	20	13846.434	13065.306	127

Table 11: Average market size for markets with and without a monopoly specialization and six or fewer operating VC firms (in thousands $USD).

Variable	Coefficient	(Std. Err.)
Log Market Size	-0.0419**	(0.0121)
Log Num. VC Firms	-0.5626**	(0.0364)
Avg. VC Mkt. Share in Market	0.000**	(0.000)
N	2402	
Log-likelihood	-957.337	
$\chi^2_{(27)}$	985.939	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 13:

Variable	Coefficient	(Std. Err.)
Log Market Size	-0.0375**	(0.0122)
Log Num. VC Firms	-0.7684**	(0.0589)
Avg. VC Mkt. Share in Market	0.0000**	(0.000)
Log HHI of VC Firms' Invest. in Market	-0.1862**	(0.0391)
N	2402	
Log-likelihood	-945.39	
$\chi^2_{(28)}$	1009.832	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 14:

Variable	Coefficient	(Std. Err.)
Log Market Size	-0.0291*	(0.0120)
Log Num. VC Firms	1.2806**	(0.4401)
Avg. VC Mkt. Share in Market	0.000**	(0.000)
Log HHI of VC Firms' Invest. in Market	0.1539†	(0.0813)
Log HHI * Log Num. VC Firms	-0.2313**	(0.0397)
N	2402	
Log-likelihood	-935.297	
$\chi^2_{(29)}$	1030.018	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 15: sample pools 2,402 market-year observations for those markets with six or fewer operating VC firms. A firm enters the sample in the fifth year after its first investment in a market. All included variables are constructed on a five-year moving basis. In this panel structure, the dependent variable is an indicator variable that takes a value of 1 if all firms in a market are specialized at the 75% threshold in the market's dominant sector. The model is estimated using a panel probit estimator with year fixed effects (output omitted). The table presents the marginal effects following this estimation.

VC Firms	Total Market Years	Monopoly Specialized	Not Monopoly Specialized
0	2,404	N/A	N/A
1	1,040	1,017	23
2	478	327	151
3	347	185	162
4	231	102	129
5	159	50	109
6	147	20	127
Total	4,806	1,701	701

Table 16: Breakdown of market-years by monopoly specialized and not monopoly specialized.