DOES THE APPLE ALWAYS FALL CLOSE TO THE TREE? THE GEOGRAPHICAL PROXIMITY CHOICE OF SPINOUTS

Luca Berchicci
Rotterdam School of Management
Erasmus University
Burg. Oudlaan 50
3062 PA Rotterdam – the Netherlands
(lberchicci@rsm.nl)
Tel. +31 10 408 9608
Fax. +31 10 408 9015

Andrew King
Tuck School of Business
Dartmouth College
202 Chase Hall
Hanover, NH 03755 – USA
(andrew.a.king@dartmouth.edu)
Tel. +1 603 646 8985
Fax. +1 603 646 8711

Christopher L. Tucci*
College of Management of Technology
École Polytechnique Fédérale de Lausanne (EPFL)
Odyssea 1.04
Station 5
CH-1015 Lausanne – Switzerland
(christopher.tucci@epfl.ch)
Tel. +41 21 693 0021
Fax. +41 21 693 0020

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* Corresponding author

ABSTRACT

Previous studies suggest that spinouts will locate in close proximity to the firm from which they spawn. As a result of this process, clusters of entrepreneurial activity tend to develop around a few strong parent firms. But do all spinouts really stay close to home? We demonstrate that spinout firms choose heterogeneous technological and market strategies, and hypothesize that firms with more aggressive strategies have a greater need to maintain local relationships. We find supporting evidence of our theory by analyzing the location, technology, and market decisions of intra-industry spinouts in their first year in the disk drive industry.

INTRODUCTION

Theories of agglomeration from evolutionary economics suggest that industry clusters emerge from the seeding of an area by an original strong firm (Klepper, 2005). These theories argue that capable parents endow their spinout[1] children with certain advantages. The implicit assumption is that, like apples falling from a tree, spinout firms tend to take root near their parent. Because these children tend to thrive and themselves spawn further spinouts, an industrial cluster emerges. Scholars propose that this process gave rise to well known clusters such as the semiconductor agglomeration in Silicon Valley (Saxenian, 1994) and the assemblage of automobile producers in Detroit, Michigan (Klepper, 2002; Klepper, 2005).

In support of this theory, considerable evidence has been marshaled to show that strong parents do produce spinouts that have a greater chance of success (Agarwal, Echambadi, Franco, & Sarkar, 2004; Franco & Filson, 2006; Klepper, 2002, 2007). And while previous research has been addressing technology and market as 'spatial dimensions' (Agarwal, Audretsch, & Sarkar, 2007; Agarwal *et al.*, 2004; Buenstorf & Klepper, 2008; Klepper, 2007; Klepper & Sleeper, 2005; Klepper & Thompson, 2010) in which spinouts can be close to their parents, much less evidence has been gathered to investigate the theory's expectation that spinouts tend to operate geographically close to their parents. Such lack of analysis may be caused by a common perception that entrepreneurs consistently establish spinouts near to where they have already been working. Yet anecdotal evidence suggests that a surprising number of spinouts choose to move away. For example, when Sirjang Lai Tandon left IBM to found a successful rival hard disk drive producer, Tandon Corporation, he chose to move 500 miles from his original

[1] The terms 'spin-out' (or 'spinout') and 'spin-off' (or 'spinoff') are all used for cases in which an employee or owner leaves a previous position and starts a company producing a competing product. Since there is no consensus in the literature, we choose the most common term, 'spinout.'

employer. Such examples suggest the need for additional analysis of whether and when spinouts choose to locate near their parents.

In this article, we consider what might influence entrepreneurs to locate spinout ventures near their parent or to move to a new location—what we term the *stay/leave decision*. Prior work has tended to overlook this decision because it is outside the scope of most studies of spinout formation or cluster development. As a result, current theoretical models do not fully explore or predict when a spinout will choose to stay near its parent. By attempting to model the spinout's stay/leave decision as a strategic choice, we aim to bridge strategic entrepreneurship with evolutionary theories of agglomeration.

To formulate a theory of the stay/leave decision, we first review how the stay/leave decision has been conceptualized in the evolutionary economics literature[2] (Agarwal *et al.*, 2004; Buenstorf *et al*., 2008; Klepper & Simons, 2000; Klepper *et al*., 2005), showing how the stay/leave decision may have been discounted. We then consider three explanations for why a firm might choose to locate near its parent. First, we consider whether or not the decision to stay near the parent is based more on the underlying attributes of the parent's location rather than the mere fact that the parent is there *per se*. Second, we consider whether the cost of breaking and losing valuable local connections could cause certain types of spinouts to stay home. Finally, we consider theories that address the location choices of diversifying or expanding firms to explore whether these theories can provide insight on the stay/leave decision that spinouts face (e.g. Shaver & Flyer, 2000).[3]

[2] Evolutionary economics is concerned with the dynamics of change in the economy, and the central role that path dependencies, routines, and knowledge accumulation / transfer at the firm level (and other levels) play in such dynamics (Nelson & Winter, 1982).
3 The multi-location choice decision that diversifying firms face is very different than the choice spinouts face in deciding whether to locate away from their parent. Nevertheless, the literature on firm location has developed and tested several factors that could influence the stay/leave decision.

Our research advances the existing literature in three main ways. First, we draw attention to the importance of the stay/leave decision among spinout firms. We show that in one industry (hard disk drives) a surprising number of spinouts chose to move away from their parent. Second, we emphasize the unique aspects of the decision to stay or leave home and thus propose a different perspective than prior research, which conceptualized the decision as a choice among many locations. We develop a theory that emphasizes the role of entrepreneurs' strategy in the stay/leave choice and is appropriate to the discrete nature of this decision. We hypothesize that spinouts are more likely to stay close to home when they plan to pursue technological or market leadership and therefore have a greater need to maintain existing links to technological and market resources. We show that in the hard disk drive industry, the decision to stay or leave a parent's locale was indeed associated with the spinout's technological and market strategy. Spinouts pursuing more advanced technology and market positions were more likely to locate near their parent. Third, we show that both location and strategy influenced the tendency of spinouts to themselves engender new spinout firms, and both explain cluster formation. In total, we find support for an evolutionary view of cluster formation—but one that is reinforced by the strategic choices of spinout firms.

THEORY AND HYPOTHESES

Evolutionary economics and spinout location

Theories of cluster formation from evolutionary economics suggest that clusters emerge because capabilities pass from parent firms to their spinout children. These theories argue that even though the founders of spinouts retain no formal link with their 'parent' firm, spinouts keep parental traits through inheritance (Agarwal *et al.*, 2007; Franco *et al*., 2006; Klepper *et al*., 2000; Klepper *et al*., 2005; Phillips, 2005). Better firms generate a greater number of spinouts, these theories suggest, and entrepreneurs take from their firms valuable technological and market know-how (Agarwal *et al.*, 2007; Agarwal *et al.*, 2004). If these spinouts locate near their parents, a cluster of firms will appear. In the same way a strong tree might seed a grove of its progeny, a few firms can thereby create an observed cluster.

An implicit supposition of these theories is that the apple falls close to the tree—that is, spinouts are founded physically proximate to the parent firm. Why might a spinout choose to locate near its parent? The most common explanation is that the entrepreneur is so embedded in the local context that moving is infeasible or too costly (Figueiredo, Guimaraes, & Woodward, 2002). Entrepreneurs require support from boards of directors, financial services, and legal firms. Developing such contacts often requires face-to-face interaction, and once these relationships have been developed, it may be difficult to break them. Managers in supporting services (like venture capital) may prefer to work with entrepreneurs with local ties because they can better assess their quality (Stuart & Sorenson, 2003; Zook, 2002).

Drawing on the above, the literature on cluster formation from evolutionary economics has tended to assume that spinouts stay close to home. For example, in a study of the U.S. automobile tire industry, Buenstorf and Klepper (2008) propose a model that assumes that 'spinoffs mostly locate where they originate, causing the spinoff dynamics to reinforce the existing geographical differences in the birth potential for new entrants, both in their number and quality' (p. 11). In a separate paper, the same authors model the cost of losing these connections as a fixed cost that is borne by any entrepreneur who chooses to found his firm away from his existing location.

In summary, researchers have tended to assume that entrepreneurs prefer to stay near their existing location (i.e., near their parent) and have operationalized this idea as a constant tendency affecting all spinout firms. Few would doubt that on average an entrepreneur would choose to stay near his or her home. Yet we also know of entrepreneurs such as Sirjang Tandon who chose to move to a new location to found a spinout. What might explain differing stay/leave decisions? In the next section, we draw on existing research to develop hypotheses of what might influence the decision.

Characteristics of the parent's location

One explanation for why a firm might tend to locate near its parent is that both parents and spinouts tend to choose areas with attractive properties. If so, the observed tendency for spinouts to locate in close proximity to the parent would result from the location's characteristics, and the attribution to the parent would be spurious. Research on firm location has created a well-established literature on the factors that attract firms to locate in particular areas (e.g., Aharonson, Baum, & Feldman, 2007; Kalnins & Chung, 2004). We turn now to these studies to inform our development of a theory of a spinout's stay/leave decision.[4]

A central issue in the location literature is the value of locating in an agglomeration of other firms. Scholars suggest that proximity to a firm or an agglomeration of firms can provide several benefits. Close proximity can allow firms to share infrastructure costs and obtain spillover demand from their rivals (Krugman & Obstfeld, 1997). Based on a study of hotel

4 We recognize that this literature provides an imperfect analog to the options faced by a spinout entrepreneur. Much of the research on location decisions that we will review has investigated firms that, unlike spinouts, could not locate near their existing home. Examples include geographically diversifying entrants, new franchises, and foreign firms expanding into new countries. Despite its imperfect fidelity to our setting, however, this literature provides the most complete analysis of location decisions and thus may provide guidance for the development of our theory.

locations, Kalnins and Chung (2004) argue that smaller hotels may be attracted to locate near large name-brand stores in order to benefit from the brand's advertisements. They also note that larger hotels invest in public services (e.g., a restaurant) that attract additional customers. Hotels also experience variable demand, and close proximity may allow hotels to gain spillover demand (Kalnins & Chung, 2004). Supply chain costs can also encourage agglomeration (Krugman *et al.*, 1997). To avoid transportation costs, firms may choose to locate near major customers or large markets. Linkages to suppliers of services can also be important. As discussed earlier, Stuart & Sorenson (2003) find that proximity to legal and venture capital services can influence location choices. Kleebe & Nuchum (2003) find the local concentration of specialized service suppliers was one of the main reasons for media firms to locate in the area of Soho, London, UK.

Firms may also choose to locate near other firms to gain spillover knowledge (Lucas, 1988). Numerous studies demonstrate that knowledge transfer often requires proximity (Florida, 1995; Maskell & Malmberg, 1999). Jaffe, Trajtenberg, and Henderson (1993) find that new patents disproportionally referenced research in the surrounding geographic area. Audretsch and Feldman (1996a) find that proximity is an important determinant of knowledge spillovers, while Ciccone and Hall (1996) show that proximate firms often have higher productivity. Henderson (1986) shows that the creation of a new production facility raises the performance of similar surrounding facilities. Others find that firms tend to choose to locate near innovative or resourceful incumbents (Aharonson, Baum, & Feldman, 2007) to benefit from agglomeration economies.

The factors discussed in the literature cited above suggest that it could be the agglomeration benefits presented by a parent's location—such as close proximity to suppliers and buyers—and not proximity to the parent itself which encourage the spinout to 'stay home' rather than move to a new location.

H1: Spinouts are more likely to locate close to their parent if their parent's locale includes a greater number of related businesses.

Characteristics of the spinout's initial technical and market position

An alternative perspective on the spinout's stay/leave decision emphasizes the qualitative difference of a home location from any other. Staying home allows one to maintain the value of existing physical assets, contextual knowledge, and social connections and avoid the cost of finding or developing these elsewhere. Theories of cluster formation from evolutionary economics have noted the importance of such costs (Buenstorf *et al.,* 2008; Figueiredo *et al.,* 2002).[5] Buenstorf and Klepper (2005; 2008) note that moving might be valuable if it would allow the startup to tap better resources, but they argue that superior connections in the home locale greatly reduce any benefit of moving: 'even if a county was … short on specialized input suppliers, labor, and sources of technological knowledge, potential entrants that originated in the county might still know where to secure these factors based on their pre-entry experience' (Buenstorf *et al.*, 2005: 18).

The loss of connections to top-quality labor and material inputs will influence firms differently. The literature on technology or knowledge transfer suggests that those firms trying to compete at technological or market frontiers are likely to find the disruption of these connections most burdensome. Abernathy and Clark (1985) note that a firm's links to technologies and markets are particularly vital to its success. Allen (1984) argues that

5 'Moving costs' include the cost of finding, evaluating, and acclimating to a new location.

technological links are most important for those trying to stay on the technological frontier. As knowledge ages, it becomes more accessible until it floats 'in the air' (Marshall, (1920: 271), but when it is fresh and rare it moves through geographically proximate social networks (Allen, 1984; Figueiredo *et al.*, 2002). Thus, firms pursuing advanced technological positions and more novel markets should derive greater benefit from maintaining access to local networks.

Advanced technological knowledge, because it is 'sticky' or tacit in nature, often requires parties to interact face to face (Feldman, 2000) and have shared understandings and mutual trust (Daft & Lengel, 1986). Transfer is also facilitated by frequent exchange, because this allows the development of a shared understanding of how knowledge can be best codified (Gertler, 2003). Local contacts with key individuals can also be critical (Fleming & Marx, 2006), and the maintenance of one's network position can be vital to the acquisition of new knowledge. Within a region, such networks can be essential to the success of new enterprises, particularly when those enterprises are attempting to pursue technology or market leadership positions (Fleming & Juda, 2004). Allen (1984) shows that connections to technological gatekeepers are most valuable when a technical group is pursuing a novel design. Taken together, the above literature suggests that the value of staying close to home is higher for firms pursuing advanced technology.

Similarly, market resources are especially important when a market is embryonic. When a market is in its early stages, connections between startups and pioneering users can help reduce risk. Novel products for new markets often require closer interaction between suppliers and potential buyers (Henderson & Clark, 1990; Ulrich & Eppinger, 2000). This is particularly true when new products will become embedded as a component in a product produced by the buyer (Kaufman, Theyel, Tucci, & Wood, 2005). In this case, buyers need to understand the operating characteristics of the components they will be using. They also need to be able to trust the information that they receive from their suppliers. The local connections and the repeated exchanges between suppliers and buyers foster better coordination and trust (Porter, 1998).

Novel products are also less likely to use standardized or modular components, and the development of customized products elevates the importance of communication between buyers and potential suppliers (Utterback, 1996). Once a product market is known and the criteria of performance standardized, private information is less common, market knowledge is pervasive in the industry and thus rich communication connections to market actors become less valuable. Thus the value of staying close to home would tend to be less important for firms pursuing more mature markets.

In summary, drawing on research on the use of local networks to access technological and market information, we hypothesize that local connections should be particularly valuable to spinouts pursuing more advanced technologies and/or novel markets.

> *H2: Spinouts are more likely to be founded geographically close to their parent firm when they are targeting (a) a more advanced technology position or (b) a more novel market.*

Characteristics of the interaction between the parent's location and the spinout's initial position

In the above sections, we consider how the stay/leave decision may be influenced by the agglomeration attributes of the home location or the technological and market position of the spinout. In this section, we consider the effect of the interaction of the two. The most developed literature on the subject comes from research on the location decisions of expanding international firms. Shaver and Flyer (2000) argue that firms with different capabilities may have different incentives to locate in close proximity. They postulate that knowledge flows more easily among clusters of firms, and thus clusters essentially pool knowledge from local firms. They also assume that firms have differing levels of knowledge or differing abilities to generate valuable knowledge. Some firms are better at producing new knowledge, while other firms are better at consuming it (Knott, 2008; Massini, Lewin, & Greve, 2005).

Shaver and Flyer (2000) theorize that firms with better technology will contribute more to a cluster's knowledge pool, gain less back, and thus regress toward the average. In contrast, firms with weaker technology will contribute little, learn more, and advance toward the average. Thus, better firms should tend to shun these clusters, and locate instead in regions where they can protect their existing advantages. Empirical evidence consistent with this theory has been found for diversifying entrants and geographically expanding multinationals (Kalnins *et al.*, 2004; Knott & Posen, 2005; Shaver *et al*., 2000).

Extending this line of reasoning to a spinout's stay/leave decision, a logical conclusion would be that spinouts with better technology should tend to leave agglomerated areas.

H3: Spinouts are less likely to be founded close to their parent when they are targeting a more advanced technological position and their parent's geographical region is highly agglomerated.

The theories behind Hypotheses 1 and 2 on one hand, and Hypothesis 3 on the other hand are conflicting, but they are not perfectly nested. Hypothesis 3 predicts that the stay/leave decision will be influenced by the interaction of the forces predicted in Hypothesis 1 (agglomeration spillovers) and Hypothesis 2 (strategy-specific benefit of local networks).

METHOD

To test our hypotheses, we started with the census of 208 organizations listed in the *Disk/Trend Report* (*D/TR*) as having ever produced a rigid hard disk drive between 1976 and 1995. The *Disk/Trend Report* is a highly reliable, thorough, and credible industry analysis report that covers the global disk drive industry in several categories, including rigid hard drives (Christensen, 1997; Christensen & Bower, 1996; Christensen & Rosenbloom, 1995). To identify spinouts, we used data from the *Disk/Trend Report*, *Lexis/Nexis*, and Franco & Filson (2006: 844). We were able to identify a set of 45 spinout companies that entered the industry in the US via a founder leaving an incumbent from 1976 to 1995. To identify agglomerations and obtain county characteristics, we merged data from the US Business County Pattern Data on the yearly number of establishments by industry (the one 4-digit Standard Industry Classification [SIC] code for storage technology) and by county.

Variables specifications

Dependent variable

Measuring proximity of a start-up to a parent is not a trivial task. The unit of proximity used by previous researchers takes different forms—such as co-location within an administrative border (state, county, metropolitan area) or closeness in physical distance. Spatial scales also vary among previous studies. For example, the link between knowledge spillovers and innovation activities has been studied at the state level (Audretsch & Feldman, 1996b; Shaver *et al.*, 2000) and at spatial distances of as little as hundreds of meters (Aharonson *et al*., 2007). While many scholars agree on the benefits of agglomeration, they do not agree on a standard scale for measuring agglomeration benefits (Aharonson *et al.*, 2007; Anselin, Varga, & Acs, 1997; Rosenthal & Strange, 2003).

We chose to use United States Counties as our scale for two reasons. First, the choice of the county as unit of analysis has precedence in the existing literature (Buenstorf *et al.*, 2005). Second, analysis at this level facilitates measurement of both local conditions and co-location. At the county level we are able to measure both the agglomeration effects (the number of potential suppliers and clients) and the characteristics of the region. State and metropolitan area measures do not allow us to get a detailed picture, due to a concentration of spinouts in a single state (California) or outside a metropolitan area (such as Boulder, Colorado).

For our investigation, we used a limited dependent variable to model the entry decision of a spinout into a county. The dependent variable (*stay home*) takes the value of 1 when the spinout location is in the same county as the parent and zero otherwise. Some spinouts are founded by more than one ex-employee. When a spinout had founders from different companies, we considered the 'main' founder's company only. We defined the main founder as the person mentioned first or emphasized in reports on the spinout in the *D/TR*, Lexis-Nexis, and other sources.

Independent variables

We constructed independent variables that capture characteristics of the parent firm's county, the characteristics of the parent firm, and those of the spinout. The model is parsimonious given the small number of observations.

Parent county agglomeration. Hypothesis 1 proposes that spinouts locate close to their parents when they can benefit from agglomerations present in their parent's county. *Parent county agglomeration* captures the agglomeration measure of the parent county, in the year of a spinout's founding, relative to other counties in which there were disk drive manufacturers, suppliers, or industrial customers.

First, we created an agglomeration measure by summing the number of competitors, suppliers, and industrial customers in all the counties with at least one establishment (of suppliers, competitors and potential customers). This variable is constructed with data from the Bureau of Economic Analysis (BEA), where the number of establishments is given by year, county and industry (using the 4-digit SIC code). We identified suppliers and customers via the Input-Output data (from BEA), where 95 percent of the clients and 57 percent of the suppliers are in the same 'industry' as disk drive companies. Second, we built the *parent county agglomeration* variable by taking the normalized standard deviation of the agglomeration measure of the parent county in the year of spinout's founding.[6]

Spinouts' technological and market position. For the spinout firms, we constructed two variables related to their technological and market position. The *spinout's technological position* captures the technological performance of the spinout firm relative to all disk drive producers in the industry (in the year of the spinout's market entry). In the disk drive industry, technological position is commonly measured as the maximum amount of information that can be stored in bits

[6] In some counties in a certain year, one parent's county may have been more than one standard deviation below the mean agglomeration level. When we take the average across all spinouts in the year they were founded, the value can be slightly less than zero. For example, when Rodime was founded in 1980, the parent, Burroughs Corporation, was located in Wayne County, Michigan, and that county (which includes Detroit) did not have a large number of suppliers, competitors, and customers in it; in fact, it was 1.5 standard deviations below the mean in that year. Across all counties in which a disk drive was produced across all years, the mean value is indeed zero, but just averaging across the 45 spinouts in the years they were founded gives us a mean value slightly below zero.

per inch (density) (Agarwal *et al.*, 2004; King & Tucci, 2002). We adopt the method used in Agarwal et al (2004) where the firm's technological position is calculated in terms of areal density using the following two-step procedure.

The areal density (A) of the best drive produced by firm *i* of diameter *j* in the year of entry *t* divided by the highest areal density in that diameter available in the market that year to obtain the firm's diameter-specific relative technological position (TK_{ijt}):

$$TK_{ijt} = A_{ijt}/\max(A_{ijt}) \quad (1)$$

The result of this measure is averaged across all diameters (*j*=1 to *n*) produced by the firm in the year of entry to obtain the firm's average relative technological position (TK*it*) in that year:

$$TK_{it} = \sum TK_{ijt}/n \quad (2)$$

Every spinout introduced only one disk diameter in the year of founding (i.e., entered one market only) except one; therefore, for almost all the spinouts in the sample, TK_{it} is equal to TK_{ijt} and captures the spinout's initial technological position.[7] Spinouts that entered in the year of founding with the highest density drives were the ones with the higher technological position or with the most advanced technology. This variable is consistent with the imitation of business practices in evolutionary economics (Klepper, 1996; Nelson & Winter, 1982).

Spinout's market position captures the market position relative to other producers in the year of the spinout's founding. From the late 1970s to the early 1990s, new markets opened up with smaller and smaller disk drive formats. More than six new format sizes (defined by the diameter of the spinning disk) were introduced—each considerably smaller than the previous

[7] There is only one spinout that entered two different markets in its first year in the industry – Orca Technology. This firm entered both the 8-in and 5.25-in markets in 1989.

one, and each serving a different type of customer. For example, the 14-inch disk drive could initially be found in mainframe computers, the 8-inch in mini-computers, the 5.25-inch in workstations, the 3.5-inch in personal computers, the 2.5-inch drives in laptops and the 1.8-inch drives in video cameras and audio players.[8] Our *spinout's market position* takes the value of 1 if the firm operates in the most advanced market (producing the smallest disk size in the industry) in the year of entry, zero otherwise.

As discussed below, we also take into account the technological and market position of the parent firms of these spinouts. Their variables are built in a similar fashion where TK_{it} captures the parent firm's average relative technological position in its spinout's year of entry.

To control for specific market characteristics, we take into account whether the market in which the spinouts entered (*Market transition in 14-in drive*, *Market transition in 08-in drive* and *Market transition in 03-in drive*) had a direct influence on the spinout's stay/leave decision. Likewise we introduce in all the models two time period dummies – *Pre-1983* and *Post-1988.* They are equal to 1 when spinoffs entered between 1977 and 1982 and between 1989 and 1995 respectively. Dividing in this fashion allows us to have three relatively equal sized groups representing the time periods in our sample; the results are not sensitive to the exact cutoff date (e.g., 1990 instead of 1989).

The model specification

We chose to employ a probit model to directly evaluate the determinants of a spinout's decision to stay or leave its home location:

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[8] Between 1981 and 1994 a 9-inch and 10-inch drive were also produced. Their commercialization, however, was very limited and sales volume negligible.

$$P_i\ (\lambda=1|z) = \Phi\ (\mathbf{Z}_i\ \delta) \tag{3}$$

where P_i is the probability of spinout *i* to locate in the same county as the parent (λ=1), in which δ is the coefficient estimate for the probit model, and the vector **Z** contains characteristics of the parent's location, characteristics of the spinout, and characteristics of the parent firm. The estimation concerns the first year of spinout's existence with 45 observations (spinouts).

Some prior studies have employed a conditional model (such as a conditional logistic regression) to understand the choice of location among a set of alternatives. These models assume that managers choose among a set of rival options when making their choice, and seek to understand which regional characteristics attract inward movement of entrepreneurs. In some cases, these models recognize that the home location may have a unique pull for entrepreneurs and capture this effect through the use of a dummy variable (cf. Buenstorf & Klepper, 2005). In our analysis, we wished to unpack this attractive power of the home location. We wished to understand which parent and spinout attributes might influence the choice to **stay** or **leave**. Since these attributes would be constant across all other locations, we decided a conditional model was less appropriate.[9]

RESULTS

Table 1 presents the descriptive statistics and correlations for our variables, and Table 2 presents the first set of results. To economize on the predictive power from our observations, we specify a limited number of variables in each test. To separate spinouts of different market generations,

[9] It may also be unlikely that an entrepreneur considers all locations that are theoretically feasible. Baum and Haveman (1997) argue that in such a case the use of a conditional model (such as a conditional logit) may lead to biased estimates.

we included in all models dummy variables capturing the drive format of the spinout firm (8 inch, 5.25 inch, etc.).

Insert Tables 1 and 2 about here

In Model 1 (and for all subsequent specifications), we examined whether characteristics of the parent county influence the spinout's stay/leave choice. In each specification that includes only a main effect, we estimated a coefficient for *parent county agglomeration,* and these coefficients are positive and statistically significant. In totality, our results provide supporting evidence for Hypothesis 1: higher concentrations of related businesses in the parent county are associated with a tendency of spinouts to stay close to their origins.

To test our Hypothesis 2 that the spinout's technological and market position influence its propensity to stay home, we first included measures of each construct in two separate models (Models 2 and 3) and next we included measures of both constructs in Model 4. Consistent with our theory that the need to maintain connections to advanced technology might encourage spinouts to stay home if they are pursuing technological or market leadership, we found evidence that spinouts with a more advanced technological position were more likely to stay near their parents (see Model 2 and Model 4). In further support of the network relationship theory, we find evidence that spinouts are more likely to stay close to their origins when they decide to compete at the market frontier (see Model 3 and Model 4).

The economic impact of these two variables is significant as well. A change of one standard deviation in the technological position increases the probability that a spinout will stay home by 70 percent. Likewise, a change in market leadership position from 0 to 1 increases the probability that the spinout will stay home by 73 percent (see Figure 1). Thus, from the perspective of both statistical significance and economic impact, we find that spinout firms pursuing more advanced technological or market positions are more likely to locate near their parent.

Insert Figure 1 about here

Turning our attention to Hypothesis 3—that firms with better technological capabilities will tend to shun agglomerated home locations—we conducted tests measuring the interaction between the spinout's initial technological position and the parent's agglomeration area. In Model 5, we find that the combination of spinouts' advanced initial technology and their origin from an agglomerated area is weakly associated with their decision to stay in the parent's locale ($p < 10\%$).[10] The sign of the relationship is opposite to what Hypothesis 3 predicted and thus is counter to the outcomes predicted by theories of FDI location. Hypothesis 3 is thus rejected.

In total, we find that spinout firms are more likely to stay close to their current home locations if that location is agglomerated and the spinout is pursuing a position at the technological or market frontier. Our findings are consistent with our prediction that spinouts stay in agglomerated regions to gain spill-in benefits and sales advantages, and that firms pursuing frontier positions stay near their parent to benefit from their existing connections, and finally that this effect is greatest when the home location is agglomerated.

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[10] This interpretation does not change when the full range of covariate values is examined computationally or graphically (Hoetker, 2007).

Robustness checks and other explanations

To verify the robustness of our findings, we conducted extensive additional analyses. First, we employed alternative specifications, examples of which are shown in Models 6–8. These robustness tests reconfirmed our inference that spinouts' market and technology position influence the spinout's stay/leave decision. For example, we tested whether technological and market positions of the *parent firm* influence the stay/leave decision of the spinout. We find no significant evidence of either (Models 6 and 7).

We also evaluated whether our measures were confounded with some county differences. Model 8, for example, evaluates whether specific technological and market resources in the parent's county, in comparison with other counties, may influence the spinout's stay/leave decision.[11] We find no significant evidence that any county characteristics that we were able to collect are associated with the decision to stay or leave the parent's location.

We also investigated whether spinouts emerging in the dominant location—*Silicon Valley*[12]—behaved differently from other spinouts. We find no evidence that a home location in Silicon Valley increases the chance that a spinout will stay home (results available from authors). Out of 28 spinouts originating from parents located in Silicon Valley, 14 decided to stay close to their parents, while 14 chose to leave. Likewise, Silicon Valley itself does not seem to be an abnormally attractive destination for disk drive spinouts leaving their home counties. We also ran models where Silicon Valley was considered as one single county with qualitatively identical results (available from authors).

[11] *Parent county's technological position* and *parent county's market position* capture, respectively, the technological and market position of the parent county relative to other counties in which at least one disk drive producer was active (they are in normalized standard deviation form).

[12] The variable Silicon Valley represents three counties – San Mateo, Alameda and Santa Clara.

To check whether the importance of suppliers vs. customers might be driving the refutation of H3, we also disaggregated the agglomeration measure and examined the results with agglomeration only determined by the number of suppliers, and then again using only the number of customers. There were no qualitative or quantitative differences between using these two measures. It may be interesting to consider a deeper examination of this issue in future research.

Finally, to rule out the potential that binary differences between the home county and potential target counties might explain our findings (rather than the parent county's relative position to all counties), we investigated whether spinouts that did in fact leave home tended to move to relatively more agglomerated areas. To perform this analysis, we compared the level of agglomeration of the parent's county with the county to which the spinouts moved. We found no significant evidence that the spinouts in fact moved to more agglomerated areas.

Unobserved Spinout Strength and Endogenous Choice

In a final robustness test, we explored the potential for an unobserved variable to influence our reported findings. The evolutionary economics literature suggests that spinouts vary in their underlying strength (or health), and we cannot directly measure such strength in our analysis. It could be that unobserved differences in such strength influence the decision to locate near a parent. If health is associated with technical and market leadership, our findings might reflect the influence of this unobserved variable.

To explore this possibility, we investigated whether firms choosing to locate near their parents tended to be more successful than those that moved away. If stronger firms remained home, firms that made this decision should perform better. On the contrary, if founders of spinouts chose both strategy and location to maximize their expected return, we should find no evidence that one choice is strictly better for most firms.

Thus our goal in this robustness test was to investigate whether the spinout's location decision to stay home influenced the spinout's performance in terms of disk sales. Since recent literature suggests that any strategic decision is by definition not random, the strategic decision is intrinsically linked to the expected outcome (see Hamilton & Nickerson, 2003). We address this potential endogeneity problem between the strategic choice of location (whether to stay or to leave the parent's county) and spinout's sales performance (the expected outcome) by using a two-stage treatment approach (Greene, 2003; Maddala, 1983). This method is particularly suitable when one wants to examine how a discrete strategy (stay or leave) influences a continuous performance measure (sales).

The treatment-effect model estimates the effect of an endogenous binary treatment λ_j on a continuous variable (sales) y_j, conditional on independent variables x_j (and z_j, see below).

$$y_j = \mathrm{x}_j \beta + \delta \lambda_j + e_j \tag{4}$$

where λ_j is the endogenous dummy variable that indicates whether the treatment is assigned or not (stay/leave). The binary choice decision is assumed to stem from an unobservable latent variable:

$$\lambda_j^* = \mathrm{z}_j \delta + u_j \tag{5}$$

where

$$\lambda_j = \begin{cases} 1, & \text{if } \lambda_j^* > 0 \\ 0, & \text{otherwise} \end{cases} \tag{6}$$

For the first stage of this analysis, we used the same specification as Model 4 in Table 2, where the dependent variable is the location choice strategy and the independent variables are market and technology positions, agglomeration, and the control variables. In other words, we use the variables in the first stage that were proposed to influence location choice. These variables include the 'strategy' of the spinouts as well as 'attractiveness' of the location (the agglomeration). This generates an estimation of the propensity of the spinout to stay or move.

The specification of the second stage and the resulting coefficient estimates are shown in Table 3. The dependent variable in Model 1 is the normalized standard deviation of the log sales of the spinout in the year after founding. In Model 2, the dependent variable is the normalized standard deviation of the log sales of all future sales of the firm as long as it stayed in the disk drive industry. We added three new variables as controls. One captures the market entry order of every firm in the sample in the year of first entry. *Relative market entry timing* is calculated as the normalized standard deviation of the year of entry into the first form factor (market) in which the spinout produces a drive relative to the average year of entry into that form factor.[13] This calculation enables us to aggregate all the spinouts into one regression, regardless of which particular market they entered first. The second control variable is Silicon Valley. The inherent logic for including this variable is that some theories predict that the performance of firms located in the main industry cluster may be systematically different (Stuart *et al.*, 2003). Finally, the third variable, named *Industry intensity*, captures the number of firms in the industry by year.

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[13] For example, Conner Peripherals entered the 3.5-inch market in 1985, four years after the first entry into the 3.5-inch market, and 2.5 years after the average spinout entry into the form factor, 1982.5. Thus their relative market entry timing is 0.72, which is 0.72 standard deviations above the mean for that particular form factor. A higher number indicates a later relative entry for the particular market of the spinout's first market.

Insert Table 3 about here

We expected that tougher competition would erode unit sales of individual firms and it did. In all models, we find that firms that enter early in their market reap most of the benefits; however, we do not find any difference in terms of performance between those spinouts that stayed close to their origins and those that moved away. In results not reported here (available from authors), we also incorporated some parent characteristics, including the parent's experience in the prior generation, and found that parents with more experience bred spinouts that performed better.

Moreover, to decrease the risk of spurious results from our choice of instrument in the first stage, we use an alternative model for the first stage by including the parent's market and technological positions rather than those of the spinout (Model 6 in Table 2). We also apply alternative estimation models, such as the use of the nonlinear fitted values as instruments in a conventional 2SLS procedure (Angrist & Pischke, 2009, p. 143).[14] Again, we do not find any statistically significant difference in performance between those spinouts that stayed close and those spinouts that moved away. In total, our results provide little evidence that spinouts choosing to stay or leave home had systematically higher performance. Indeed, our results suggest that the merits of either option were conditional on the spinouts' initial technological and market position.

[14] There is a debate in the literature concerning the use of non-linear regressions in the first stage of two-stage analyses (cf. Greene, 2003, Chapters 9 and 21 vs. Angrist & Pischke, 2009, Chapter 4). In this case, we get qualitatively identical results regardless of whether we use a linear or non-linear parametric form in the first stage.

Implications of the findings for cluster formation

Our results present challenges to agglomeration theories from evolutionary economics. Those theories implicitly assume that spinouts stay near their origin, and they imply that the ones staying home are the stronger[15] firms and so maintain the health of clusters. In contrast, we find that almost 50 percent leave and cannot find evidence that those that stay home have greater success. High rates of healthy firms that moved away would tend to cause the creation of new clusters and the geographic expansion of existing ones. Depending on the tendency of the two types of spinouts (those that stay and those that leave) to themselves create further spinout progeny, the process we document could lead to the diffusion of clusters.

To explore this potential, we examined those spinouts that generated other spinouts. This process can create grandchildren, if you will, and even great-grand children of the original parent. Table 4a and 4b present respectively the technology position and market position (*laggard* versus *leader*) of each spinout and its stay/leave decision (*move away* versus *stay home*). The raw numbers in these two tables reconfirm the findings in Table 2. To analyze whether these differing choices influenced their propensity to engender a next generation of spinouts, we tabulate the number of second-generation spinouts and the number of possible first generation parents. In Table 4c and 4d, the denominator shows the number of possible first generation spinout parents and the numerator the number of future generation offspring given their stay/leave decision and technology and market position. These tables show that the highest ratio of offspring per possible parent is achieved by those first generation spinouts that stayed close to home. Therefore, those spinouts that remain near the parent are the most fecund. They also show that the more technologically advanced and stay-home parents generated more spinout

[15] The strength of a firm usually refers to the firm's ability to perform and/or survive. Stronger firms perform better and/or survive longer.

descendants.

Insert Table 4 about here

To our surprise, we found that market laggards—not leaders—were the more fecund (1.4 descendents compared to 0.6 descendents). Why might this be? This may be partially explained by the 'disagreement' theory developed by Agarwal *et al.* (2004), Klepper (2007; 2010), Klepper and Thompson (2010) and Chen and Thompson (2010). They argue that spinouts often occur when subordinates do not agree with the direction that senior managers take. Potential founders may quit the company if the parent does not exploit a new market. If, as we have shown, those firms that stay close to home are usually technological leaders, then such disagreements may occur when these firms become market laggards.

Taken together, our results not only restore the fundamental logic underlying current theories of cluster formation, they amplify them. While we do show that at least in the hard disk drive industry existing theories overstate the tendency of spinouts to stay home, we also show that these theories underestimate the multiplicative effect of entrepreneurial stay/leave decisions. More ambitious spinouts tend to stay near their parents, and those with advanced technology generate more next-generation spinouts. Through this process the 'genetic material' for ambition is kept local, while the genetic material with less potential to generate ambitious new spinouts tends to move away.

CONCLUSION

In this article, we take seriously the proposition that spinout entrepreneurs exercise choice in deciding whether to stay near a parent firm. We reveal that in one industry a surprising number of spinout entrepreneurs chose to found their firms at some distance from their parent. We extend existing theories to consider this understudied phenomenon. We draw on theories of agglomeration and strategic location to develop hypotheses of what might influence these varying decisions to stay or leave a parent's location.

Empirically, we extend previous research by showing that spinouts were more likely to stay near their parent if the existing location provided some agglomeration benefits. We also find that spinouts that seek to be on the 'bleeding edge' of technology or pioneer new markets are less likely to move away from their parent's location. We infer that these firms have a disproportionate need to maintain existing network relationships. Furthermore, we infer that the value of maintaining knowledge networks is sufficient to motivate spinout firms to locate in agglomerated areas, even if they are pursuing advanced technical or market positions.

Although a rigorous test would be required, this network relationship theory may also be extended to inter-industry spinouts. Spinouts from unrelated industries and novice entrepreneurs who are unfamiliar with the specific industry domain would need to seek knowledge about a particular technology or market where it exists (i.e., near an incumbent disk drive producer). According to the results above for spinout companies, those who target market or technology at the frontier would be more likely to choose a location where they have pre-existing connections to technology or markets. This could be an additional explanation for phenomena observed by Dahl and Sorenson (2009).

Our findings suggest extensions to two literatures. For the literature on location choice, our analysis emphasizes the importance of the stay/leave decision as a precursor to any location choice. Because the literature on location choice has emphasized the analysis of firms attempting to expand geographically, the stay/leave decision has gone understudied. We show that novel forces may be at work when a firm can choose to stay home, and therefore the resulting location decision may not match the predictions made by existing theories of location choice. Our analysis reveals the importance of considering an entrepreneur's existing relationship network.

For the literature on cluster formation, our analysis refines and amplifies the internal workings of the cluster formation process. We show that the apple does not always fall close to the tree. Instead, entrepreneurs choose locations where they believe their firm can best take root. We find, however, that certain apples that are planted nearest the parent tree tend to be the most bountiful. And thus, as suggested by theory, this seeding process causes a cluster of fertile trees to emerge.

This analysis also enriches the strategic entrepreneurship literature in two ways. First, by examining strategic determinants of spinouts' decision choices, this paper suggests that spinouts' location is indeed a strategic choice. Second, by realizing the strategic nature of spinouts' stay/leave decision and its implication for cluster formation, this paper attempts to bridge the strategic entrepreneurship literature with evolutionary theories of agglomeration.

Our research also suggests a potential direction for future research in entrepreneurship by revealing a surprising diversity in the strategies of spinouts. Only about half of the new firms in our sample initially pursued technology and market leadership. Some chose to follow or even lag trends. We show that this latter choice is not a sign of weakness, but that it does influence the other decisions entrepreneurs make. In further research, we hope to analyze how other differing attributes of spinouts are connected to their observed choices and to their ability to succeed.

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Table 1: Descriptive statistics

	Variables	Description	Mean	Std. Dev.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Agglomeration	The normalized standard deviation of total number of establishments of suppliers, competitors and clients in the year of founding related to all the counties with at least 1 establishment.	-0.03	1.00	-1.55	1.20	1														
2	Technological position	The areal density of the best drive produced by firm i of diameter j in year t divided by the highest areal density in that diameter available in the market that year and averaged across all diameters produced by the firm in a year to obtain the firm's average relative technological position	0.61	0.41	0.02	1	-0.18	1													
3	Market position	=1 if the spinout is at market frontier by producing the smallest drive in the industry when it entered the market	0.38	0.49	0	1	-0.20	0.45	1												
4	Parent's technological position	Similar to spinoff's technological position	0.57	0.36	0	1	0.07	0.00	-0.14	1											
5	Parent's market position	=1 if the parent is at market frontier by producing the smallest drive in the industry when its spinout entered the market	0.13	0.34	0	1	-0.13	0.07	0.10	0.14	1										
6	Parent county's technological position	normalized standard deviation of parent county technology position	0.38	1.11	-2.10	4	-0.01	0.11	-0.10	0.28	-0.28	1									
7	Parent county's market position	normalized standard deviation of parent county market position	0.49	1.44	-0.83	4.30	-0.35	0.28	0.36	-0.17	0.50	-0.26	1								
8	Market transition in 14-in drive	=1 if spinoff market entry is in the 14-in drive	0.13	0.34	0	1	0.13	-0.10	-0.17	0.25	0.04	-0.07	-0.15	1							
9	Market transition in 08-in drive	=1 if spinoff market entry is in the 05-in drive	0.09	0.29	0	1	-0.30	0.02	-0.08	0.07	0.11	-0.07	0.16	-0.12	1						
10	Market transition in 03-in drive	=1 if spinoff market entry is in the 03-in drive	0.27	0.45	0	1	0.19	-0.17	0.05	-0.15	-0.24	-0.07	-0.20	-0.24	-0.19	1					
11	*Pre-1983*	=1 if spinout market entry is 1982 or before	0.51	0.51	0	1	-0.23	0.26	0.03	0.13	0.12	-0.22	-0.01	0.38	0.15	-0.52	1				
12	*Post-1988*	=1 if spinout market entry is 1989 or later	0.20	0.40	0	1	0.20	-0.04	-0.05	0.12	-0.03	0.32	-0.06	-0.20	0.04	0.20	-0.51	1			
13	Market entry order	The normalized standard deviation of the spinoff market entry	0.41	1.11	-2.45	3.39	0.12	-0.23	-0.40	-0.07	-0.15	0.25	-0.15	-0.43	-0.02	0.43	-0.72	0.60	1		
14	Market density	the number of firms present in the industry	64.89	12.30	29	82	-0.36	-0.06	-0.08	-0.26	-0.22	0.07	0.00	-0.41	-0.06	0.15	-0.07	-0.38	0.02	1	
15	Silicon Valley	=1 whether the parent is located in the Silicon Valley cluster	0.53	0.50	0	1	0.01	0.17	-0.10	0.12	0.37	-0.05	-0.07	-0.03	-0.02	0.06	0.07	0.02	-0.12	0.00	1

Table 2: Probit models of the determinants of spinouts' stay/leave decision

				Location choice				
Independent variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Agglomeration	0.613***	0.902***	1.013***	1.189***	0.0534	0.606**	1.333***	1.194***
	(0.23)	(0.30)	(0.36)	(0.40)	(0.55)	(0.24)	(0.44)	(0.40)
Spinout’s technological position		1.982***		1.649**	1.933***		1.857**	1.639*
		(0.74)		(0.81)	(0.72)		(0.84)	(0.84)
Spinout’s market position			1.639**	1.245*			1.539**	1.269*
			(0.69)	(0.71)			(0.75)	(0.73)
Interaction term: agglomeration X technological position					1.169*			
					(0.70)			
Parent’s technological position						-0.127	-0.0717	
						(0.62)	(0.75)	
Parent’s market position						-0.545	-1.323	
						(0.67)	(0.93)	
Parent county's technological position								0.0701
								(0.31)
Parent county's market position								-0.00968
								(0.22)
Market transition in 14-in drive	0.406	1.225	0.966	1.498*	1.542*	0.451	1.619*	1.518*
	(0.68)	(0.80)	(0.80)	(0.89)	(0.87)	(0.69)	(0.93)	(0.89)
Market transition in 08-in drive	0.712	1.437	1.722	2.221**	1.025	0.780	2.812**	2.252**
	(0.76)	(0.90)	(1.05)	(1.13)	(0.87)	(0.79)	(1.34)	(1.13)
Market transition in 03-in drive	-0.329	-0.275	-0.492	-0.504	-0.0909	-0.398	-0.655	-0.464
	(0.54)	(0.60)	(0.58)	(0.64)	(0.63)	(0.55)	(0.65)	(0.75)
Pre-1983	-0.339	-1.162	-0.593	-1.218	-1.199	-0.314	-1.138	-1.183
	(0.56)	(0.72)	(0.61)	(0.75)	(0.73)	(0.57)	(0.78)	(0.80)
Post-1988	-0.185	-0.450	-0.186	-0.280	-0.464	-0.143	-0.155	-0.344
	(0.57)	(0.64)	(0.62)	(0.68)	(0.66)	(0.58)	(0.72)	(0.75)
Constant	0.203	-0.729	-0.356	-1.030	-0.564	0.320	-1.162	-1.076
	(0.44)	(0.60)	(0.52)	(0.67)	(0.57)	(0.51)	(0.77)	(0.73)
Observations	45	45	45	45	45	45	45	45
Prob > chi2	9.001	18.26	17.49	22.19	21.02	9.754	24.46	22.27
Pseudo R-squared	0.144	0.293	0.280	0.356	0.337	0.156	0.392	0.357

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3: Performance models

Independent variables	Performance: Sales the year after founding	Performance: Total future sales
	Model 1	**Model 2**
Stay/leave choice	-0.158	-0.421
	(0.29)	(0.48)
Technological position	0.182	0.197
	(0.23)	(0.37)
Market position	-0.193	-0.0883
	(0.20)	(0.32)
Relative market entry timing	-0.178**	-0.667***
	(0.077)	(0.13)
Silicon Valley	-0.0114	0.0951
	(0.15)	(0.26)
Industry intensity	-0.0135**	-0.0258**
	(0.0068)	(0.011)
Constant	0.400	1.675*
	(0.53)	(0.89)
Observations	45	45
Chi2	18.36	46.58
Prob > chi2	0.019	0.000

Standard errors in parentheses ***** p<0.01, ** p<0.05, * p<0.1**

Table 4: Number of descendants from possible first-generation spinout parents

Table 4a: Number of all spinouts relative to their *technological* position and stay/leave choice

	Technological position		
	Laggard	Leader	Total
Move away	12	10	22
Stay home	7	16	23
Total	19	26	45

Table 4b: Number of all spinouts relative to their *market* position and stay/leave choice.

	Market position		
	Laggard	Leader[16]	Total
Move away	16	6	22
Stay home	12	11	23
Total	28	17	45

Table 4c: number of second-generation spinouts (numerator) given their *technological* position and stay/leave choice and number of possible first generation spinout parents (denominator)

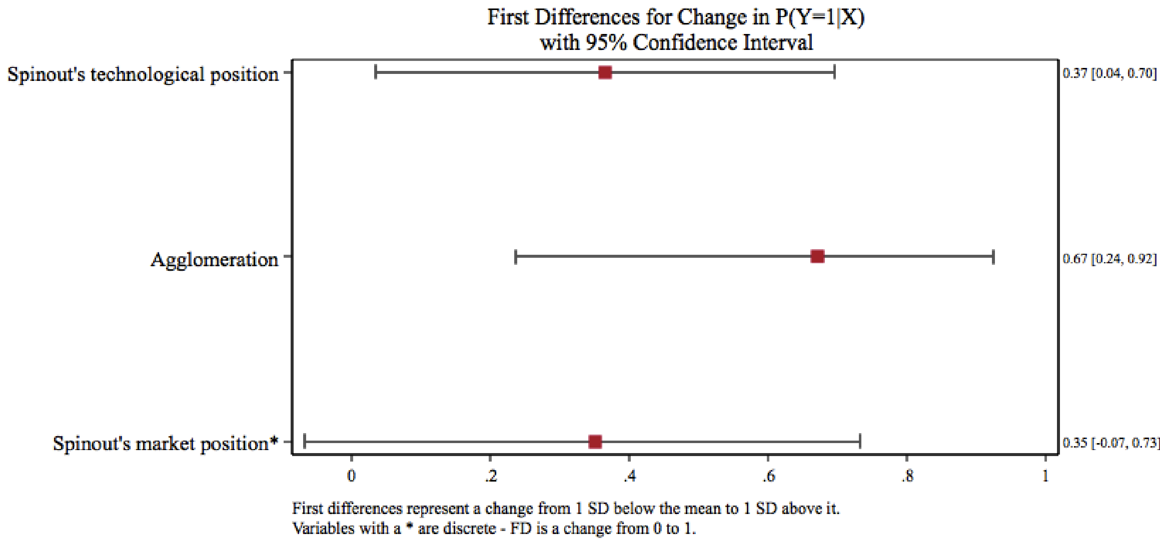
	Technological position		
	Laggard	Leader	Total
Move away	5/7	4/6	9/13
Stay home	2/5	9/7	11/12
Total	7/13	13/13	

Table 4d: number of second-generation spinouts (numerator) given their *market* position and stay/leave choice and number of possible first generation spinout parents (denominator)

	Market position		
	Laggard	Leader	Total
Move away	6/10	3/3	9/13
Stay home	7/5	4/7	11/12
Total	13/15	7/10	

[16] Those firms that produced a drive smaller than the industry average drive are defined as market leaders.

Figure 1. Illustration of the marginal effects of the main variables of interest.[17]



[17] We use the STATA command PLOTFDS to create this graph (Boehmke, 2008)