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REASSESSING THE ENTREPRENEURIAL SPINOFF PERFORMANCE ADVANTAGE: A NATURAL EXPERIMENT INVOLVING A COMPLETE POPULATION

Richard A. Hunt
University of Colorado, richard.hunt@colorado.edu

Daniel A. Lerner
University of Colorado

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Richard A. Hunt, University of Colorado at Boulder, USA
Daniel A. Lerner, University of Colorado at Boulder, USA

Abstract

Through the discovery and exploitation of a natural experiment comprised of a complete industry population, this paper presents empirical evidence challenging widely held beliefs related to intra-industry entrepreneurial spinoffs. Extant spinoff theory holds that knowledge and capabilities are transferred from parent-firms to spinoffs in hereditary fashion, endowing spinoffs with a performance advantage over *de novo* entrants. Our analysis of all 612 industry entrants, including 448 spinoffs, paints a dramatically different picture. In the context of a complete population, we find that: (a) *de novo* entrants actually outperform spinoffs; (b) parent-firm quality exerts no discernible influence on spinoff quality; and, (c) founder-specific experience, not parental lineage, is the primary driver of spinoff performance heterogeneity.

Introduction

Intra-industry entrepreneurial spinoffs (sometimes called "spinouts") occur when employees leave a corporate parent to start a new, completely independent company as an entry vehicle into the same industry as their former employer (Klepper, 2001), without support or sponsorship from the parent-firm. Entrepreneurial spinoffs are richly in evidence during periods of new industry formation, appearing as both a driver of new industry opportunities and a primary beneficiary of emerging industry opportunities (Garvin, 1983). It has become popular in recent years for scholars studying intra-industry business spinoffs to invoke the language of procreation and genetics as an explanatory model for spinoff creation and performance. An expanding set of studies supporting a progeny model (Phillips, 2002) variously refer to the parent-child ties (Klepper, 2001) as "spawning" (Gompers et al., 2005; Chatterji, 2009), "inheritance" (Nelson, 1991; Agarwal et al., 2004), "organizational births" "children" and "offspring" (Dyck, 1997), "parenting" (Klepper & Sleeper, 2005), and "heredity" (Dick et al., 2011). The use of proto-biological speak is evidence that spinoff scholars believe they have secured sufficient empirical support to advance a widening set of "stylized facts" (Klepper 2009) that provide a theoretical foundation for the subject, namely: that spinoff founders learn lessons from their parents that are advantageously deployed towards an improved likelihood of survival and the achievement of superior performance. As Klepper and Sleeper asserted, "Firms can be thought of as giving birth to spinoffs, so that spinoffs have parents from whom they inherit specific traits, in this case knowledge" (2005: 1303).

Central among these "stylized facts" is the widely held belief that entrepreneurial spinoffs live longer and perform better than *de novo* entrants (Brittain & Freeman, 1986; Christensen, 1993; Stuart & Sorenson, 2003; Agarwal, Echambadi, Franco & Sarkar, 2004; Klepper & Sleeper, 2005; Chatterji, 2009). "Spin-outs have a survival edge in the market over other entrants as the result of a combination of entrepreneurial flexibility and inherited knowledge," noted Agarwal and colleagues (2004: 519). It is also widely propounded that high-performing parent-firms serve as a wellspring for high-performing spinoffs (Gompers, Lerner & Sharfstein, 2005; Eriksson & Kuhn, 2006; Klepper, 2009; Elfenbein, Hamilton & Zenger, 2010). As Klepper and Sleeper asserted, "Spinoffs inherit technical and market-based knowledge from their parents that shapes their nature at birth" (2005:1303). Simply put, the common wisdom has become: "Better-performing firms have better-performing intra-industry spinoffs" (Klepper & Thompson, 2010: 5).

On the face of it, these increasingly formalized assertions present a formidable case in support of a hereditary theory of entrepreneurial spinoffs. And yet, this general acclamation of spinoff superiority is vexed by a very simple, very perplexing fact: most spinoffs fail to become substantively operational. In fact, spinoff failure rates often exceed those exhibited by the general population of firms (Garvin, 1983; Klepper, 2002; 2007). The sheer number of entrepreneurial spinoff failures raises several important research questions. First, if spinoff performance can be most aptly portrayed as involving a hereditary linkage between parent-firms and their spawn, then why do so many spinoffs fail? Second, if high-performing parent-firms are generally thought to produce high-performing spinoffs, then why do many *low*-performing spinoffs come from *high*-performing parents and many *high*-performing spinoffs come from *low*-performing parents?

The extreme heterogeneity in spinoff performance constitutes a theoretical fissure that can only be resolved through the use of fine-grained, comprehensive data that allows close examination of spinoff successes and failures. Using data from a natural experiment that arose through legislative action related to the regulation of asbestos removal and disposal in Colorado, we directly address the performance heterogeneity complications by employing a complete industry population. In this fashion, our study breaks new ground in several important respects. First, we contribute to entrepreneurial spinoff theory by providing the first substantive head-to-head comparison between a complete population of spinoff entrants and *de novo* entrants. Our study provides the circumstances and data necessary to test the foundational assumption that market entrants who possess high-quality parental lineages outperform those that do not. Through this empirical breakthrough, we offer a corrective course for the development of a more robust and encompassing spinoff theory. In the absence of a clear spinoff performance advantage, existing theories are unable to explain the high failure rates, especially failed spinoffs spawned from better-performing parent-firms (Eriksson & Kuhn, 2006; Klepper, 2009). Our analysis materially enriches spinoff theory by providing explanatory bases for failures as well as successes.

Secondly, we contribute to the knowledge-transfer literature (e.g. Kogut & Zander, 1992) by addressing the effect-conflation issues that have bedeviled prior studies of nascent industries (Aldrich & Fiol, 1994), including those examining spinoffs. By dissecting the drivers of spinoff performance heterogeneity, we offer a more detailed evaluation of parent knowledge transfers to spinoffs. Prior studies have used aggregated spinoff data, thereby failing to capture performance heterogeneity. This has led to strong, but untested assumptions linking parent performance to spinoff performance. By comparing firm-level heterogeneity to overall heterogeneity, we offer the first meaningful test of whether or not transferrable knowledge is instrumental to spinoff outcomes. Finally, we provide important insights for entrepreneurship research methods through our sensible explication of unobservable non-linear relationships (Daniels and Hogan, 2008) by using a natural experiment, rather than simulated data. Much of the prior literature in this realm has come to rely upon a patchwork of explanations that are conceptually sound but functionally disengaged from the actual challenge of assessing truncation effects. Through the innovative use of a natural experiment, we address the persistent dilemma of data truncation, which inherently understates spinoff occurrence and overstates spinoff survival and performance.

In the following section, we provide additional context regarding spinoff theory and develop a set of four hypotheses that are tested using OLS regression models. After detailing the database and methods used in the study, we present the results of the data analysis associated with this natural experiment. We conclude by reflecting on the implications for future study.

Theoretical Development and Hypotheses

Spinoff Theory and Data Truncation

Spinoff scholars have drawn strong connections to a wide range of seminal management theories for the purpose of advancing spinoff studies, including: evolutionary theory (Nelson & Winter, 1982; 1987), organizational learning (Cyert & March, 1963; Fiol & Lyles, 1985; Leavitt & March 1988), tacit and explicit knowledge transfer (Kogut & Zander, 1992; Teece & Pisano, 1994; Franco & Filson, 2006), and a variety of economic-based (Geroski 1995) and sociology-based (Hannan & Freeman, 1977; 1989; Aldrich & Fiol, 1994) explanations for market entry. Credible linkage to these theoretical frameworks requires scholars to demonstrate the soundness of a hereditary-based theory of spinoff performance. Unfortunately, comprehensive spinoff data has been notoriously elusive. For the data that has been gathered to-date, analysis has been confounded by left-side data truncation, meaning that observations on both the dependent variable and regressors are missing (Cameron & Trivedi, 2005). Figure 1 displays a stylized representation of the truncation problem. The individual data points represent the complete population of firms entering a hypothetical market. The truncation threshold represents the beginning of the observation window. This means studies that define the observation window through the use of trade catalogues (Klepper, 2001), venture capital financing (Chatterji, 2008) or industry journals (Agarwal et al., 2004) may exclude early spinoff failures from the analysis.

In Figure 1, the mean performance (Y_O), comprised of only the observed values of y (y_o), overstates the operational performance and understates the entry rate of the complete population. This is because there exists an unobservable non-linear relationship in the complete population of observations. Since the unobserved values of y (y_u) do not share a linear relationship with the population of values comprising Y_O, conventional efforts to relate Y_O and Y_U will be impaired by the inability to apply the distributional assumptions underlying parametric correction tools, such as the Tobit Model. Corrections that relax distributional assumptions such as maximum-likelihood estimation and the Heckman two-step estimator are marginally more robust, but suffer from the notable liability of being “fragile to even very minor misspecification of error distributions” (Paarsch, 1982; Cameron & Trivedi, 2005). When the boundaries of possible solutions are so broad as to include the parametric estimators that are assuredly wrong and the non-parametric estimators that are assuredly uninformative, then these features render the estimators difficult to interpret (Tsiatis, 2006) and unsatisfying to apply to management research.

Given the formidable methodological challenges associated with any examination of spinoffs, a natural experiment involving a complete population is perhaps the only tool through which this complex array of issues can be comprehensively addressed. Due to of the manner in which Colorado chose to implement the federal requirements governing asbestos abatement, there exists a well-defined database, extending back 25 years to the industry's inception. Equipped with the data from this uncensored population, we advance two arguments (see Figure 2):

H1a: De novo entrants live as long as or longer than spinoff entrants.

H1b: De novo entrants perform as well as or better than spinoff entrants.

Spinoff Performance Heterogeneity

Prior studies have largely attributed the heterogeneity of performance among entrepreneurial spinoffs to hereditary linkages between parent-firms and their respective spawn, saying in essence that good parents produce good kids and bad parents produce bad kids. "Spinoffs will initially have the same expected profits and survival prospects as their parents, thus more innovative and long-lived parents will have more innovative and long-lived spinoffs" (Klepper, 2001:646; Franco & Filson, 2006). Given the effects of left-side truncation, in which a great preponderance of failed firms are never included in the analysis (Figure 1), this assertion is based more on speculation than empirical observation. Absent from all previous spinoff studies is an analysis of the variance within the group of spinoffs spawned from a shared parent-firm. If the variance is greater within the cohort of spinoffs for a parent-firm than for the population of spinoffs, then this would cast doubt upon the conclusion that better-performing parents spawn better-performing spinoffs.

Data limitations have hindered scholars' ability to address this critical question. Meanwhile, the methods used in prior studies have identified successful spinoffs across multiple industries, but these same methods have produced a spinoff theory that is unable to explain the high failure rate. Because of this, there is reason to doubt the extent to which existing research has accurately captured the performance outcomes of spinoffs. Instead, by linking the spinoff story primarily to technological know-how (Agarwal et al., 2004) and knowledge appropriation (Eriksson & Kuhn 2006; Klepper & Thompson, 2010), existing theory explains the few success stories, while failing to account for the far-larger legion of failed firms.

The only meaningful way to directly test the purported linkages between parent-firm quality and spinoff quality is by examining the extent to which high-quality parents produce high-quality spinoffs, and low-quality parents produce low-quality spinoffs. Doing so requires the availability of a complete, non-truncated population of industry actors. The natural experiment involving the Colorado asbestos abatement industry provides such data. From its inception in 1986, through 2010, 100 parent-firms spawned 448 spinoffs. Among these, 35 parent-firms produced five or more spinoffs, and thirteen of those firms produced ten or more spinoffs. The presence of several dozen parent-firms, each producing statistically a significant spinoff cohort group, provides an unprecedented opportunity to scrutinize spinoff performance heterogeneity. If the transfer of knowledge and capabilities from parent to spinoffs is a critical source of performance advantage, then the variance in performance for the cohort of spinoffs spawned by any given parent should be less than the overall performance variance. In directly challenging the dominant association between parent quality and spinoff quality, we predict that cohort group heterogeneity will exhibit variance exceeding the variance for the entire population of spinoffs (see Figure 2):

H2: Variation in performance within a parent-firm's cohort of spinoffs will, on average, exceed the variation in performance for the population of all spinoffs, regardless of parent-firm quality.

Founder-Specific Experience

If it can be demonstrated that spinoffs exhibit extreme heterogeneity, then one must ask: What is the driver of this variance, particularly in light of the hereditary-based theory of spinoffs? Prior research has clearly focused on parent-firm quality: "Apparently the key to the performance of the spinoffs is the quality of the environment in which founders worked and not the positions held by the founders," wrote Klepper (2002: 660). Others have agreed, noting that "prior employment affiliations may influence not only new venture formation, but also product-market strategies and firm survival" (Agarwal et al., 2004: 501). Knowledge creation, replication and transfer (Kogut & Zander, 1992; Connor & Prahalad, 1996) are basic to the belief that parent-firms with large stocks of knowledge will be a wellspring of successful spinoffs (Agarwal et al., 2004; Klepper, 2009). "Pre-entry experience," argued Klepper, "including experience in incumbent firms, impart(s) an enduring advantage" (2002: 662). And yet, Agarwal and colleagues caution that "past authors have assumed an underlying process of knowledge inheritance by a progeny firm, without explicitly testing whether inheritance from an incumbent parent actually occurs" (2004: 502). In looking at the disk drive industry, the authors nonetheless conclude that "knowledge is in fact inherited, and a firm's founder is a potentially more effective agent of transfer than a hired employee" (Agarwal et al., 2004: 519).

Ultimately, however, the presence of extreme heterogeneity erodes the credibility of assertions that lineage influences performance outcomes. Absent a clear linkage between parent-firm performance and spinoff performance, founder-specific experience takes center stage. Extending the findings of Chatterji's study of the medical device industry (2008), we predict that spinoffs founded by technical experts will perform demonstrably worse than spinoffs founded by non-technical experts, who will have a higher success rate in obtaining market-based repricing of their knowledge and capabilities. By dissecting the particulars of spinoff foundings, we predict that founder experience will be a significant moderator of spinoff performance:

H3a: Spinoffs led by founders possessing only technical knowledge will exhibit lower survival rates and performance levels than spinoffs led by founders possessing non-technical, general market knowledge.

H3b: Spinoffs led by founders possessing non-technical, general market knowledge will exhibit survival rates and performance levels comparable to de novo firms.

H3c: Spinoffs led by founders possessing both technical and non-technical, general market knowledge will exhibit survival rates and performance levels higher than spinoffs led by founders possessing only non-technical, general market knowledge.

Methods and Data

This empirical analysis of the Colorado asbestos abatement industry involves a retrospective research design with archival data comprised of the complete population of firms having ever entered or exited the market. The methodology employed in this study is an event-history analysis (Tuma, Hannan & Groeneveld, 1979) of a comprehensive database hand-collected from more than 1 million records at the Colorado Department of Public Health & Environment, covering the period from industry inception in 1986 to the end of 2010. This 25-year period witnessed the entry of 612 firms, objectively documented through licensing data. At the project level, 56,465 permits were issued towards for the removal of 21 million lineal feet and 234 million square feet of asbestos-containing material (ACM), for revenue totaling $1.8 billion. Information is likewise available for annual supervisor and worker certificates issued by the state.

As a consequence of the strict monitoring and reporting requirements associated with the removal and disposal of ACM, an unusual level of detail is available. By law, companies must obtain (and annually renew) a State-issued license prior to commencing any abatement work. There is no reciprocity with other states for individual certificates or company licenses. Therefore, firms seeking to perform abatement must possess a Colorado state license. This allows for comprehensive tracking of every firm into and out of the industry-population. It also allows the capture of nascent-stage firms that fail to complete even one project or survive beyond their first annual license. This marks perhaps the first time that a dataset includes a statistically significant population of organizational forms that fail prior to becoming substantively operational.

Spinoffs are by far the predominant mode of entry for firms in the asbestos abatement industry, constituting 73% of the total market entrants. The widespread occurrence of spinoffs in the context of highly granular data makes it an ideal platform test the hereditary theory of spinoffs. The relatively small number of diversifying incumbents (just 9%) is also fortuitous because it allows for a more direct comparison of spinoffs and *de novo* entrants.

Dependent Variables

Three separate dependent variables were used to test the performance advantage that is posited by existing spinoff theory: Lifespan, Operational Performance and Performance Variance. *Firm Lifespan* refers to the total duration of operational existence measured in years. *Operational Performance* refers to the average projects per firm-year for each market entrant. *Spinoff Population Performance Variance* refers to the spinoff population performance standard deviation, recalculated for the exclusion of each parent-firm's finite population of spinoffs.

Independent Variables

Entry Mode – This is a categorical variable. "1" indicates spinoffs and "0" otherwise.

Spinoff Founder Experience - This variable is derived from a set of orthogonal codes in which a founder's Colorado asbestos certifications are used to determine whether a spinoff founder has technical experience, non-technical experience, or both.

Parent-Firm Spinoff Performance Variance - The variance in performance of spinoffs emanating from the same parent. This is represented by the standard deviation of cohort (i.e. off-spring) performance and is calculated separately for each parent-firm with five or more spinoffs.

Differences in Variation - The difference between the standard deviation in the performance of all spinoffs and the standard deviation in performance of each parent-firm's cohort of spinoffs.

Weighted Average Parent-Firm Spinoff Variation – This is a sum of the variance in performance for each parent-firm's finite population of spinoffs ("cohort"), divided by N firms. The parent-firm variances are weighted based on the total number of spinoffs spawned by each parent, so that the spinoff cohort performance variance is proportional to each cohort's size.

Controls & Model Analysis

Controls: Two separate vectors were developed model to control for macroeconomic and industry-specific variables at entry. The macroeconomic vector (CON_{macro}) contains Colorado-specific measures for construction, unemployment and economic activity. The Industry-specific measures (CON_{ind}) are comprised of the number of firms that entered the industry in a given year, the industry population for each year, and the entry group size relative to the population (Hannan & Carroll 1992). Dummy codes were used to control for unobservable year-specific effects.

Model Specifications: OLS regression analysis and significant mean differences are employed to derive and explicate the focal effects. Prior studies in support of a spinoff performance advantage primarily have used lifespan as the determinant. Because of the uniquely detailed dataset we have discovered, for the sake of robustness, both *Firm Lifespan* and *Operational Performance* were used to compare spinoffs and *de novo* firms in testing Hypotheses 1a and 1b. The generalized OLS equation for the population is represented by:

$$Firm\ Lifespan_{pop} \text{ or } Oper\ Perf_{pop} = \beta_0 + \beta_1 CON_{ind} + \beta_2 CON_{macro} + \beta_3 YEAR + \beta_4 ENTRYMODE \quad (1)$$

Hypothesis 2 predicts that the average variance in spinoff performance for each cohort of sibling firms spawned from the same parent will exceed the performance variance for the entire population of spinoffs in this industry. Each parent-firm cohort performance variance was subtracted from spinoff population variance through which we derived a function predicting that the resultant difference from the population variance will be greater than zero (Figure 3):

$$\begin{aligned} H_{null}&: \quad VAR_{avg} = VAR_{pop} \quad (2) \\ H_2&: \quad VAR_{avg} > VAR_{pop} \end{aligned}$$

Hypotheses 3a, 3b and 3c predict that Spinoff Founder Experience will be a significant predictor of Firm Lifespan and Operational Performance (Figure 2). The hypothesized model proposes that:

$$Firm\ Lifespan_{spin} \text{ or } Oper\ Perf_{spin} = \beta_0 + \beta_1 CON_{ind} + \beta_2 CON_{macro} + \beta_3 YEAR + \beta_4 FOUNDER \quad (3)$$

The generalized relationships are formulated as:

$$Performance_{Tech+GeneralExperience} > Performance_{GeneralExperience} > Performance_{TechExperience} \quad (4)$$

Results

In light of extant theory, our analysis of the natural experiment data produced findings that are surprising and significant, with noteworthy effect sizes and a high degree of confidence. Bivariate correlations and descriptive statistics are provided in Tables 1 and 2. In support of Hypothesis 1a and 1b, we found that after accounting for a complete, non-truncated population of industry entrants, there is no spinoff performance advantage. On the contrary, a head-to-head comparison between spinoffs and *de novo* entrants (Table 3) shows that the average lifespan for entrepreneurial spinoffs was less than half that of *de novo* entrants ($t_{1,558}$= 15.03, $p < 0.001$). On average, spinoffs annually completed fewer than half the number projects as de novo firms ($t_{1,558, 558}$= 9.66, $p < 0.001$), a fact that certainly contributed to the lower lifespan. Consistent with these mean differences, the OLS regression model predicted that a *de novo* firm would live 1.2 years *longer* than a spinoff ($p < 0.001$), as shown in Table 4. *De alio* firms, though not the focus of the analysis, similarly underperformed de novo firms by a substantial margin (Table 3).

Hypothesis 2 predicted that the average performance variance for spinoff cohorts (i.e. siblings sharing the same parent-firm) would exceed the performance variance for the complete population of all spinoffs. If correct, this prediction would suggest that both low-achieving and high-achieving parent-firms produce spinoffs of varying quality. The data in Table 6 shows that spinoff performance is highly heterogeneous. The standard deviation for projects annually completed by the entire population of spinoffs is 17.5. This is significantly lower than the weighted average standard deviation for all spinoff cohorts, which is 22.8 ($t_{1,448}$= 9.25, $p < 0.001$). The thirteen parent-firms that spawned ten or more spinoffs are listed in Table 6, as well. The weighted average standard deviation for cohorts from this group of highly prolific parents is 24.26, also exceeding the population variance ($t_{1,168}$= 7.48, $p < 0.001$). Therefore, Hypothesis 2 finds strong support.

Given the finding that performance variance within spinoff cohorts is greater than the variance between spinoff cohorts, the question arises: What is driving this variance? Hypotheses 3a, 3b and 3c examined this question through the lens of founder-specific experience. Mean comparisons indicate that spinoffs founded by non-technical managers have double the lifespan of spinoffs founded by technical managers. The mean difference of three years is highly significant ($t_{1,448}$= 18.82, $p < 0.001$), as is the mean difference for firm performance, measured by completed projects per firm-year, which is nearly 400% higher for firms with non-technical founders ($t_{1,448}$= 8.99, $p < 0.001$). These findings provide strong support for Hypotheses 3a and 3b. On the other hand, it appears that founders possessing both technical and non-technical experience performed equivalently to founders possessing only non-technical management experience. This result requires the rejection of Hypothesis 3c, but confirms Chatterji's (2009) finding that general business acumen is the decisive component in spinoff performance, not technical knowledge.

Conclusions

The cornerstone of dominant spinoff theory is that spawned firms live longer and perform better than other entry modes due to knowledge acquired from parent-firms (e.g. Klepper 2009). Further, top-quality parents, possessing larger stocks of capabilities, are presumed to spawn more and better spinoffs than low-quality parents (Brittain & Freeman, 1986; Christensen, 1993; Agarwal et al., 2004; Klepper & Sleeper, 2005). This examination of a complete population of firms contradicts each of these theoretical assumptions. In fact, the only way to find support for the tenets of spinoff theory through this natural experiment is to truncate the vast preponderance of spinoff failures (Table 4, Models 2a, 2b & 2c). Contrary to the stylized facts that predominate in spinoff research (Klepper & Thompson, 2010), our data provides evidence that hereditary-based conceptions of entrepreneurial spinoffs significantly overstate the relationship between parent-firm performance and spinoff performance. Taking into account a complete, non-truncated population of firms, average spinoff performance is less than half that of *de novo's*. Specifically, the average lifespan for entrepreneurial spinoffs is 3.1 years versus 6.6 years for *de novo* firms; also on average, spinoffs completed 18.2 projects per firm-year versus 37.3 projects per firm-year for *de* *novo* entrants. Of the 448 spinoffs that entered the industry, 178 exited within one year and 116 exited without ever performing a single project.

This evidence shows that spinoff performance is highly heterogeneous, even among spinoffs emanating from the same parent-firm. In sharp contrast to prior studies using truncated data, we find that this heterogeneity is uncorrelated with parent-firm quality. If hereditary endowments were sources of a performance advantage, then one would largely expect to see high-performing parents spawning high-performing spinoffs and low-performing parents spawning low-performing spinoffs. In fact, however, there is no discernible relationship. Rather, the performance variance within cohorts from shared parent-firms is significantly larger than the population variance, indicating that high-performing parents spawn many low-performing spinoffs and low-performing parent-firms produce many high-performing spinoffs. If hereditary knowledge had been a vital source of performance advantage, then there would be relatively little variation in the performance of spawned entities emanating from the same parent. In fact, however, such variation is rampant.

Disaggregation of the spinoff data reveals a fuller story. Spinoff performance is clearly bifurcated between technical and non-technical founders. The average operational existence for firms founded by technical supervisors is less than half that of non-technical founders. On average, technical founders completed 6.8 projects per firm-year, versus 32.1 projects per firm-year for non-technical founders. These results suggest that contrary to extant theory, the key driver of spinoff performance is less a function of parental knowledge transfers (Klepper, 2001; Agarwal et al., 2004; Gompers et al., 2005; Klepper & Thompson, 2010) and more a function of differential outcomes based on founder-specific experience.

In addition to the empirical and theoretical contributions derived from this study, we also provide a valuable portal to the phenomenon of unobserved non-linear relationships. The study of nascent-stage organizations inherently confronts the fact that surviving firm data is readily available while failing firm data evaporates. Applying the techniques commonly used in prior spinoff studies, it is apparent that data truncation would exclude hundreds of early failures. An examination of the OLS results (Table 4) reveals the extent to which this is true. In our non-truncated model consisting of a complete population (Model 1c), *Entry Mode* is a significant predictor with by far the largest effect size in the model, indicating that a spinoff will, on average, survive 1.2 years less than a *de novo* firm. Meanwhile, a model reflecting the event truncation that is typical of prior spinoff studies (Model 2c), reverses the sign, indicating that a spinoff will survive 0.4 year longer than a *de novo* firm. Such are the pronounced effects of data truncation.

Overall, these results pose significant challenges to the dominant, hereditary-focused conceptions of intra-industry spinoffs. Through the lens of this natural experiment, our evidence suggests that the purported spinoff performance advantage requires reassessment.

CONTACT: Richard A. Hunt; University of Colorado – Boulder; Leeds School of Business, 419 UCB, Boulder, Colorado 80309-0419; richard.hunt@colorado.edu.

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FIGURE 1: Stylized Schematic of the Data Truncation Effect.
In compiling data related to new market entry by nascent-stage firms an unobserved, non-linear relationship results in the truncation of early-stage failures, dramatically changing the empirical and theoretical implications of the data. Spinoff data analysis is highly prone to these effects.

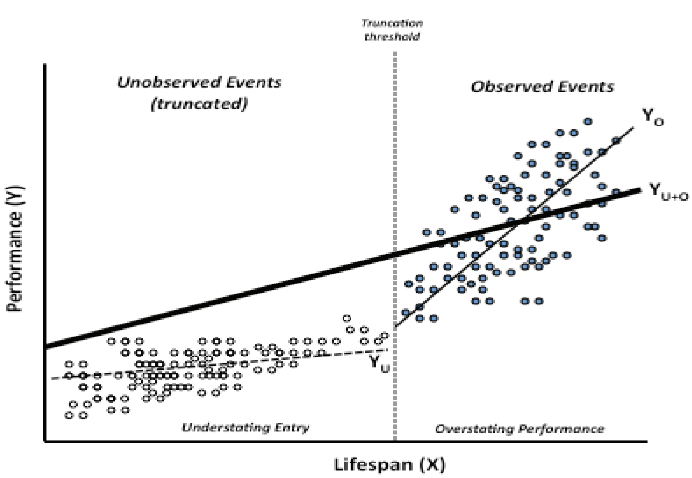

FIGURE 2: Hypothesized Model of Spinoff Performance.
In the context of a complete population, spinoffs are predicted to underperform *de novo* entrants. Spinoff founders possessing only technical knowledge will exacerbate this effect, while founders possessing general business knowledge will reduce the negative effect of being a spinoff. If correct, these predictions shift the attention away from parental lineage to individual spinoff founder attributes.

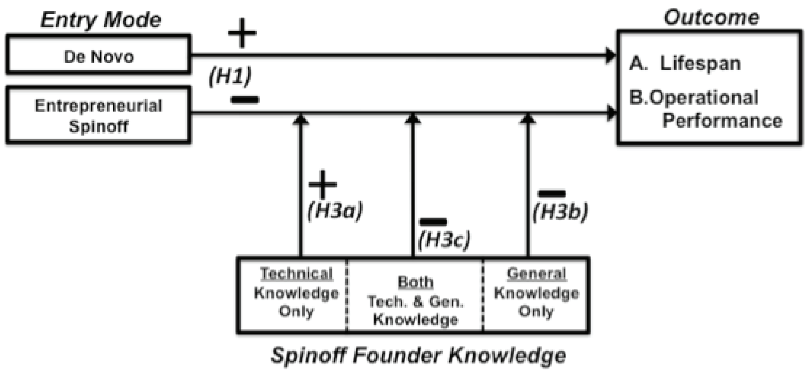

FIGURE 3: Hypothesized Model of Spinoff Performance Variance.
Hypothesis 2 (i.e. the triangular region denoted as H_2) predicts that the average performance variance for the cohort of spinoffs spawned *by the same parent* will exceed the performance variance for the entire population of spinoffs. Line H_0, the null hypothesis, involves no difference in variance. A result of $H_2 > H_0$, functionally indicates that low and high-performing parents produce both low and high-performing spinoffs.

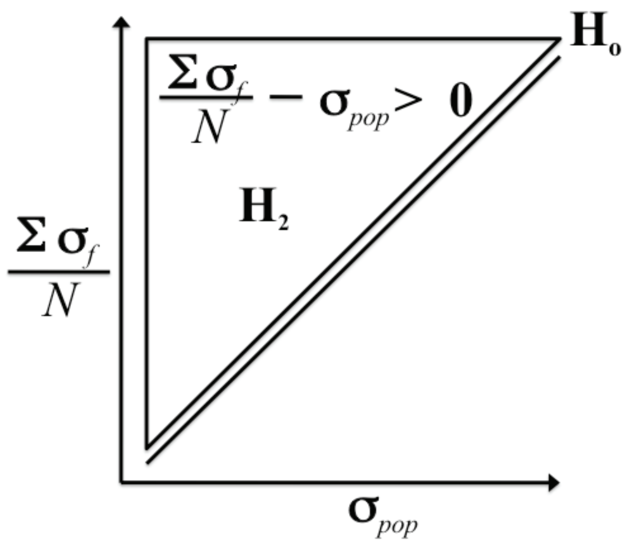

TABLE 1: Bivariate Correlations.

Correlations

		1	2	3	4	5	6	7	8	9	10	11
1	Currently Operating											
2	Lifespan	.549**										
3	Entry Mode	-.145**	-.292**									
4	Spinoff Frequency - Industry	-.112**	-.241**	.950**								
5	Spinoff Frequency - Parent	.278**	.662**	-.436**	-.445**							
6	Founder Prior Experience	.251**	.404**	.a	.a	.491**						
7	Cohort Size	-.199**	-0.015	-0.017	-0.009	.313**	-0.022					
8	Population at Entry	.166**	-.235**	.240**	.200**	-.258**	-0.033	0.033				
9	Cohort as Pct of Population	-.169**	.177**	-.280**	-.232**	.276**	-0.016	.496**	-.734**			
10	Cohort Avg Lifespan	.265**	-.090*	-.090*	-0.072	.214*	-0.053	.186**	.458**	0.017		
11	Total Completed Projects	.478**	.724**	-.235**	-.188**	.710**	.377**	-0.016	-.162**	.129**	-0.034	
12	Avg Annual Projects	.493**	.593**	-.158**	-.125**	.589**	.420**	-0.043	-0.071	0.048	-0.016	.882**

*** $p < 0.001$, ** $p < .01$, * $p < .05$

TABLE 2: Descriptive Statistics.

	N	Minimum	Maximum	Mean	s.d.
Year of Firm Founding	612	1986	2010	1997	7.38
Year of Firm Failures	508	1987	2011	2001	7.77
Currently Operating (Yes = 1)	612	0	1	0.17	0.37
Firm Lifespan (Years)	612	0	25	3.73	4.45
Entry Mode (Spinoff = 1)	612	0	1	0.73	0.21
Completed Projects (Lifetime)	612	0	2817	89	287
Completed Projects (Avg. Annual)	612	0	166	9	21
Spinoff Frequency - by Parent	100	1	20	4.48	4.41
Founder Experience (Non-Tech = 1)	448	0	1	0.26	0.44
New Firm Entry Cohort	612	14	41	26.49	7.41
Population at Entry	612	29	134	91	24.41
Entries as Percent of Population	612	13%	100%	33%	19%
Entry Cohort Average Lifespan	612	1	15	4	3

TABLE 3: Survival and Performance Comparisons by Entry Mode

Entry Mode	# Firms	% of Firms	Average Lifespan	Average Projects Completed Per Year
De novo	110	18%	6.6***	37.3***
Spinoffs	448	73%	3.1***	18.1***
De alio	54	9%	3.1	12.0
All Firms	612	100%	3.7	23.8

**** Focal mean differences (spinoff vs. de novo) were highly significant, $p < .001$.*

TABLE 4: Effect of Entry Mode on Lifespan (OLS Regression Estimation)

For ease of use, the units in this table are expressed in Years. When data is truncated *(Models 2a-c)*, spinoffs survive 0.362 years longer than de novo firms. But with complete, non-truncated data, the situation is reversed. Being a spinoff entrant actually reduces a firm's lifespan by 1.242 years.

Predictor	Models					
	Non-Truncated (n = 612)			Truncated Data (n = 380)‡		
	1a	1b	1c	2a	2b	2c
(Constant)	4.635***	4.737***	5.856***	4.113**	4.464***	4.935**
	(1.066)	(.906)	(1.113)	(.824)	(.807)	(.741)
Macro Controls	-0.034	-0.031	-0.022	-0.102*	-0.093	-0.091
	(.013)	(.010)	(.007)	(.117)	(.110)	(.110)
Pop at Entry	-0.021**	-0.022*	-0.023*	0.142*	0.137*	0.131*
	(.011)	(100)	(.011)	(.457)	(.452)	(.448)
Entry Cohort Size	0.002	0.002	0.018	(-.089)*	(-.033)*	(-.024)*
	(.028)	(.028)	(.028)	(.031)	(.017)	(.024)
Cohort Lifespan	0.011	-0.009	0.001	-0.001	-0.001	0.000
	(.025)	(.030)	(.025)	(.002)	(.001)	(.001)
Founder Experience		0.077*	0.049*		0.136	0.122
		(.051)	(.027)		(.034)	(.029)
Year of Entry		-0.079	-0.074		0.084	0.079
		(.060)	(.057)		(.055)	(.052)
Avg. Annual Projects		-0.044**	-0.030*		-0.075***	-0.069***
		(.021)	(.013)		(.018)	(.015)
Total Projects		0.014***	.012***		0.016***	0.014***
		(.001)	(.001)		(.002)	(.001)
Entry Mode (Spinoff =1)			**-1.242*** **			**0.362***
			(.361)			(.394)
Adj. R2	0.331	0.585	0.780	0.414	0.534	0.551
F-value	34.7***	111.2***	118.8***	50.8***	80.9***	57.7***

‡ - Truncation of firms failing to complete survive one year and/or complete at least five projects

Standard errors in parentheses. * $p < .05$, ** $p < .01$, *** $p < 0.001$.

TABLE 5: Spinoff Founder Comparison – Technical vs. Non-Technical Knowledge

Founder Type	Average Lifespan	Average Projects Per Firm-Year
Founder with Only Non-Technical Experience	5.3***	32.09***
Founders with Only Technical Experience	2.3***	6.75***
Founders with Both Tech & Non-Tech Experience	5.1	30.82
All Spinoffs	3.1	18.19

*** *Mean differences (Technical* vs *Non-Technical) were highly significant,* $p < .001$.

TABLE 6: Heterogeneity of Performance – Cohort Variance vs. Population Variance
For parent-firms producing ten or more spinoffs, the performance variance for each parent-firm's spawn-cohort is compared to the performance variance for the entire population of spinoffs, which was 17.5 projects per firm-year. In all but one case (i.e. MDR), the cohort performance variance exceeded the population variance. This provides strong support for Hypothesis 2, which predicted that both low and high-performing parent-firms spawned both low and high-performing spinoffs, a finding that confounds the attempt to link parent-firm quality to spinoff quality.

Parent Name	# of Spinoffs in Cohorts	Parent Performance (# Projects per Firm-Year)	Average Spawn Performance (# Projects per Firm-Year)	Spawn Performance Range (# Projects per Firm-Year)	Cohort Variance (Std. Dev.)	Cohort Variance Minus Population Variance‡
American	20	112.7	13.1	0 – 89.4	24.23	6.72
RRI	17	90.0	17.6	0 – 116.9	34.72	17.21
LVI	17	166.3	12.5	0 – 97.9	24.51	7.00
Dominion	16	97.2	14.8	0 – 53.5	25.57	8.06
Great Plains	15	5.4	10.7	0 – 77.2	21.43	3.92
ACM Removal	14	88.3	11.7	0 – 58.7	19.68	2.17
Mac-Bestos	10	57.1	10.5	0 – 60.6	18.85	1.34
MDR	10	53.5	11.5	0 – 47.4	16.59	(1.08)
Schauer	10	51.0	12.3	0 – 28.9	21.51	4.00
Asbestos Tech	10	16.5	10.4	0 – 86.5	26.76	9.25
Onyx	10	33.3	23.5	0 – 133.1	20.38	2.87
Misers	10	52.6	14.3	0 – 87.9	27.53	10.02
A.R.C.	10	14.4	13.6	0 – 52.8	17.79	0.28
13 Largest Cohorts (avg.)	**169**	**64.5**	**12.6**	**0 – 133.1**	**24.26*** **	**6.75*** **
All Spinoff Cohorts (avg.)	**448**	**30.3**	**11.8**	**0 – 133.1**	**22.78*** **	**5.27*** **

‡ *The standard deviation in projects completed per firm-year for all 448 spinoffs is 17.5*

*** *Mean differences (Average Cohorts Variance versus Population Variance) were highly significant, p < .001.*