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ABSTRACT
In recent years, beliefs about entrepreneurial spinoffs have coalesced around several "stylized facts," including the perspective that knowledge is transferred from parent-firms to progeny in hereditary fashion, such that spinoffs emanating from high-quality parent-firms outperform the spinoffs from low-quality parent-firms. This emerging orthodoxy has found some support in fast- changing and technologically complex sectors, but it is less clear whether parental endowments are a key determinant of operational success in the context of service-oriented sectors, which comprise more 80% of many developed economies. Through the discovery and analysis of a complete industry population, the results of this study suggest that extant perspectives may not fully account for the extreme heterogeneity of performance that is often exhibited by entrepreneurial spinoffs, especially differences among firms spawned by the same parent. These findings contribute to the ongoing discussion of intra-industry entrepreneurial spinoffs by establishing much-needed boundary conditions and by revealing underlying logics that govern the hereditary transfer of knowledge and capabilities among service sector spinoffs.

Keywords: Entrepreneurial spinoffs, Spinouts, Knowledge transfer, Spillovers, Hereditary endowments, Entrepreneurship, Market entry, New ventures

*Hunt is corresponding author. Earlier versions of this work appeared in the Babson Conference Frontiers of Entrepreneurship Research, the Academy of Management Best Paper Proceedings, and was previously accepted for presentation at the SMS annual conference, where it was awarded a best paper prize.

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In recent years, beliefs about entrepreneurial spinoffs have coalesced around several "stylized facts," including the perspective that knowledge is transferred from parent-firms to progeny in hereditary fashion, such that spinoffs emanating from high-quality parent-firms outperform the spinoffs from low-quality parent-firms. This emerging orthodoxy has found some support in fast-changing and technologically complex sectors, but it is less clear whether parental endowments are a key determinant of operational success in the context of service-oriented sectors, which comprise more 80% of many developed economies. Through the discovery and analysis of a complete industry population, the results of this study suggest that extant perspectives may not fully account for the extreme heterogeneity of performance that is often exhibited by entrepreneurial spinoffs, especially differences among firms spawned by the same parent. These findings contribute to the ongoing discussion of intra-industry entrepreneurial spinoffs by establishing much-needed boundary conditions and by revealing underlying logics that govern the hereditary transfer of knowledge and capabilities among service sector spinoffs.

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1. Introduction

New ventures are often spawned from existing organizations, (Klepper 2009; Stinchcombe 1965). When this occurs, common wisdom and prevailing theories of organizational knowledge transfer (Agarwal, Audretsch and Sarkar 2010; Connor and Prahalad, 1996; Franco and Filson, 2006; Kogut and Zander, 1992, 1996) generally support the view that parent-firm endowments confer performance advantages and improved prospects of survival for the spawned entity. This view is particularly prominent among scholars examining intra-industry entrepreneurial spinoffs (e.g. Agarwal, Echambadi, Franco and Sarkar, 2004; Chatterji 2008; Dick, Hussinger, Blumberg, and Hagedoorn, 2011; Dyck 1997; Eriksson and Kuhn, 2006; Franco and Filson 2006; Garvin 1983; Gompers, Lerner and Sharfstein, 2005; Klepper, 2001, 2009; Klepper and Sleeper 2005). Sometimes called "spinouts" or "spawn," entrepreneurial spinoffs occur when employees leave a parent-firm 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. As Klepper and Sleeper asserted, "Spinoffs inherit general technical and market-based knowledge from their parents that shapes their nature at birth" (2005:1303). In common parlance, two key assumptions form the foundation of spinoff theory: (a) apples fall extremely close to the tree, and (b) all the apples falling from the same tree are essentially the same quality.

With such a tightly linked conception of inter-generational coupling, the specter of bad apples lying beneath good trees poses a serious challenge. In recent years, spinoff studies have coalesced around several "stylized facts" (Agarwal et al. 2015; Klepper 2009; Klepper and Thompson 2010) including the perspective that knowledge is transferred from parent-firms to progeny in hereditary fashion, such that spinoffs emanating from high-quality parent-firms outperform the spinoffs from low-quality parent-firms. The problem is: How can one explain the relatively common occurrence of spawned entities that bear no resemblance to their parents? And, more specifically, how can one explain heterogeneous outcomes for spinoffs spawned by the same parent-firm, especially in the realm of service-oriented industries?

The purpose of this investigation is to reassess the stylized facts surrounding entrepreneurial spinoffs by taking up the issue of performance heterogeneity among service sector spinoffs. Using novel data from a complete population of 612 firms that arose through legislative action related to the regulation of a specific service sector context (asbestos abatement), this study makes three contributions to existing conceptions of spinoffs. First, the approach offers much-needed boundary conditions to parent-progeny models that have been built primarily on observations of high-tech manufacturing, where the transferability of parental knowledge stocks to spinoffs is ex ante highly congruent with theories of knowledge spillover (e.g. Agarwal, Audretsch and Sarkar 2010). As Klepper wrote: "The few spinoff studies that have been conducted cover a very narrow range of industries" (2001: 671). The high-tech focus, noted by Garvin as far back as 1983, has created an as yet unresolved need to study "a broader range of industries" (Klepper 2001: 655). With the service sector constituting nearly 80% of the U.S. economy (Cleveland 2012; Lee and Wolpin 2006), the characteristics, behaviors and outcomes of service sector spinoffs are far too material in number and influence to be excluded from the formulation and critical assessment of hereditary-based models of knowledge transfer.

Second, the study offers the first detailed, intra-cohort analysis within the spinoff and knowledge-transfer literature (e.g. Agarwal et al. 2004; Agarwal, et al. 2010; Connor and Prahalad, 1996; Franco and Filson, 2006; Kogut and Zander, 1992, 1996; Teece and Pisano, 1994). Prior to this study there have been no large-scale investigations of intra-cohort heterogeneity; that is, analyses of the similarities and differences among spinoffs emanating from the same parent. Aside from anecdotal discussions of special situations such as the "Fairchildren," spawned by Fairchild Electronics in the 1960s and 1970s (Klepper 2009; Low and McMillan 1988; Moore 1996), theories parent-progeny knowledge tranfers have not been stress tested in the context of intra-family performance. There is no test that is more directly germane to hereditary endowments than to scrutinize the varied effects of parental knowledge stocks across a cohort of spinoff siblings. In so doing, this research provides the first meaningful response to the caution issued by Agarwal et al. that "past authors have assumed an underlying process of knowledge inheritance without explicitly testing whether inheritance from an incumbent parent actually occurs" (2004: 502).

Finally, the study contributes to scholars' understanding of the complete spinoff life-cycle. Few studies have addressed both spinoff operating performance and survival, and none have examined performance across a complete industry population for its entire history. Absent the panoramic assessment of a complete population, spinoff studies are susceptible to the adverse effects of survivor's bias (Freeman 1986; Hekman 1979). "Very little is known about how spinoffs evolve over time," noted Klepper (2001:671), and the confounding effects of left-side truncation (Yang and Aldrich 2012) has limited what little is known to solely the observations of surviving spinoffs. In providing important refinements to this view, I demonstrate that the existence of spillover benefits is dependent upon the specific industry context. Knowledge is far from homogenous in its content and impact (Helfat et al. 2009). Through the use of detailed, project-level and founder-level data drawn from a service sector industry, I demonstrate that if parent quality plays any role at all in determining spinoff performance heterogeneity among the service sector spinoffs, that role is subordinate to founder-specific variables and is, at a minimum, subject to strict boundary conditions.

In the following section, I provide additional context regarding extant spinoff theory while developing a set of four hypotheses. After detailing the context, dataset and methods used in the study, I present the results and conclude by reflecting on the implications for spinoff theory development and the opportunities for future study.

2. Theory and Hypotheses

The inter-generational features of entrepreneurial spinoffs offer a fruitful domain for scholars to test theories related to the transfer of advantageous knowledge and capabilities (e.g. Agarwal et al., 2004; Agarwal et l. 2015; Klepper and Sleeper, 2005). Scholars have been highly motivated to link the spinoff phenomenon to seminal management theories, including: evolutionary theory (Nelson and Winter, 1982), organizational learning (Cyert and March, 1963; Fiol and Lyles, 1985; Leavitt and March, 1988), tacit and explicit knowledge transfer (Kogut and Zander, 1992; Teece and Pisano, 1994; Franco and Filson, 2006), and a variety of economic-based (Geroski, 1995) and sociology-based (Aldrich and Fiol, 1994; Hannan and Freeman, 1977; 1989) explanations for market entry.

It is common for scholars studying intra-industry entrepreneurial spinoffs to invoke the language of procreation and genetics as an explanatory model for spinoff births, survival and operational performance. An expanding set of studies supporting a progeny model (Phillips, 2002) variously refer to the parent-child ties (Klepper, 2001) as "spawning" (Chatterji, 2009; Gompers et al., 2005), "inheritance" (Agarwal, et al., 2004; Nelson, 1991), "organizational births," "children" and "offspring" (Dyck, 1997), "parenting" (Klepper and Sleeper, 2005), "heritage" (Cheyre, Kowalski, and Veloso 2015), and "heredity" (Dick et al., 2011).

The increasing use of proto-biological speak closely parallels the accumulating empirical support for a widening set of "stylized facts" (Klepper, 2009) that together form the theoretical foundation for the study of entrepreneurial spinoffs, 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. Central among these "stylized facts" is the widely held belief that high-performing parent-firms serve as a wellspring for high-performing spinoffs (Elfenbein et al., 2010; Eriksson and Kuhn, 2006; Gompers et al., 2005; Klepper, 2009). 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). Simply put, the common wisdom has become: "Better-performing firms have better-performing intra-industry spinoffs" (Klepper and Thompson, 2010: 5).

Spinoff Performance Heterogeneity

On the face of it, these formalized assertions present a formidable case in support of a hereditary theory of entrepreneurial spinoffs. And yet, the theory of parental endowments is vexed by a stubborn fact: *most spinoffs fail to become substantively operational.* In fact, even among the high-tech manufacturing firms that form the bulwark of prior scholarship (e.g. Agarwal et al. 2004;

Klepper 2009; Neck et al. 2004), spinoff failure rates often exceed those exhibited by the general population of firms (Garvin, 1983; Klepper, 2002). The sheer number of entrepreneurial spinoff failures raises important questions: Why do so many spinoffs fail? Is it true that the great preponderance of failures emanate from low-achieving parent-firms? If not, then what explanation can be offered when *high*-performing parents spawn *low*-performing spinoffs, or *low*-performing parents spawn *high*-performing spinoffs? How far can the apple fall from the tree before extant theory fails to provide a suitable framework?

Prior studies have largely attributed 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. Also: Franco and Filson, 2006). The essence of this parent-progeny clustering is depicted in Figure 1a.

Given the effects of left-side truncation, in which a large number of failed firms are never included in the analysis (Yang and Aldrich, 2012), this case for hereditary clustering is based more on conjecture than empirical observation. Absent from previous spinoff studies is an industry-wide, fine-grained analysis of cohort variance, consisting of the variance within the group of spinoffs spawned from a shared parent-firm. If the performance 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 always tend to spawn better-performing spinoffs. This contrasting perspective is depicted in Figure 1b.

[Insert Figures 1a and 1b About Here]

If it is true that service sector spinoffs bear little or no resemblance to their respective parents, then this finding clearly contradicts prior studies that demonstrate significant parent-spinoff linkages; but ironically, contradictory empirical findings do not necessarily contradict existing beliefs about spinoffs and transferable knowledge. Extant theory, heavily influenced by observations drawn from high-tech sectors, has predicted that the potential benefits of knowledge spillover are directly related to the amount of beneficial parental knowledge that is actually generated (Agarwal, et al. 2010; Audretsch and Lehmann 2006).

Extending this line of thought, the absence of beneficial parental knowledge should generate little of no spillover benefit to be accrued by spinoffs. High-tech manufacturing firms, operating in the knowledge-intensive environments of lasers (Klepper and Sleeper 2005), hard disk drives (Agarwal et al. 2004), automobiles (Klepper 2002), and medical devices (Chatterji 2008), exhibit this bounty of spillover opportunities. However, in service sector industries, where there may be little advantageous, parent-generated knowledge, there is little reason to expect that spinoffs will closely resemble their respective parents. In fact, the prediction would be precisely the opposite: spinoff performance should be largely unrelated to parental lineage when there is no advantageous parental knowledge to harvest. Spinoff performance heterogeneity, in the absence of advantageous knowledge spillovers, must occur as a consequence of factors that are unrelated to parent-progeny linkages. This, in turn, means that the heterogeneity of performance within spinoff cohort groups should be equal to or greater than the performance differences exhibited by the entire population of spinoffs in a given industry.

Data limitations have hindered scholars' ability to address questions regarding nascent-stage events (Yang and Aldrich, 2012). While the methods used in prior studies have identified successful spinoffs among high-tech manufacturers, these same methods have produced a spinoff theory that does not explain the heterogeneity evident in other sectors, most notably those that are service-related, such as retail, transportation, distribution, restaurants, healthcare, education, tourism, and public service (Triplett and Bosworth 2004). Because of this, there is reason to question the extent to which existing research has accurately captured the heterogeneous performance outcomes of spinoffs in industries exhibiting radically different sources and uses of knowledge. 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.

If the transfer of knowledge and capabilities from parents 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. That is, there should exist a relatively tight grouping of spawned entities in the same proximity of the performance level achieved by the parent-firms. For the hereditary-based conception of knowledge transfer from parents to spinoffs to be robust across industry contexts, high-achieving entrepreneurial spinoffs should be grouped around high-achieving parents, and low-achieving parents spinoffs should group around low-achieving parents (Figure 1a).

[Insert Figures 1a and 1b About Here]

However, equipped with a complete population of spinoffs from an industry sector that is not suggestive of parentally generated knowledge stocks, one would not expect to see hereditary-driven performance clustering (Figure 1b). As Agarwal et al. posited, "An organization context rich in scientific knowledge would be expected to generate a high degree of knowledge spillover entrepreneurship. By contrast, an organization context low in knowledge would not be expected to generate significant knowledge spillover" (2010: 275). Accordingly, I predict that cohort group heterogeneity for service sector spinoffs will exhibit variance equal to or greater than the variance for the entire population of spinoffs (Figure 2):

> *H1: Variation in performance within a parent-firm's cohort of service sector spinoffs will, on average, equal or exceed the variation in performance for the population of all spinoffs, regardless of parent-firm quality.*

[Insert Figure 2 About Here]

Hypothesis 1 (i.e. the triangular region denoted as H_1) 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, represents no difference in variance. A result of H_1 functionally indicates that both low and high-performing parents produce both low and high-performing spinoffs – with considerable variance and high-low mismatches being the rule more than the exception.

Founder-Specific Experience

In addressing the high degree of performance heterogeneity outside the realm of high-tech manufacturing, the refinements to extant frameworks based on stylized facts necessarily gravitate towards non-hereditary explanations. The theory advanced here is not that prior experience and the knowledge obtained through prior employment is unimportant to future success or failure; rather, the applicable prior knowledge does not arise as a consequence of hereditary endowments conferred by spinoff parents. The knowledge that determines survival in service sectors is theorized to come from someplace other than one's parent.

This perspective is initially at odds with prevailing conceptions. Prior research has clearly focused on hereditary linkages: "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 (Connor and Prahalad, 1996; Kogut and Zander,

1992) 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, as noted earlier, Agarwal and colleagues (2004) presciently foresaw the peril in these blanket assertions by cautioning that knowledge inheritance has been more of a working assumption than an empirical finding. Nonetheless, on the weight of evidence derived from the disk drive industry, the authors concluded 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).

Although evidence from high-tech manufacturing supports the strong case scenario for advantageous parental endowments, there is reason to believe that contexts involving weak or non-existent parental endowments should elicit the opposite prediction; that is: performance heterogeneity is driven by non-hereditary factors, even if prior experience is instrumental to spinoff performance outcomes (Garvin 1983; Greenberger and Sexton 1988).

Absent a clear linkage between parent-firm performance and service sector spinoff performance, alternative explanations of performance heterogeneity may need to focus on elements of founder-specific experience (Bruderl, Preisendorfer and Ziegler, 1992; Delmar and Shane, 2006). Heterogeneity of performance and the absence of parental endowments would suggest that founders vary in their respective abilities to read market signals, identify mission critical resources and deploy resources in a successful fashion (Alvarez and Barney, 2002; Colombo and Grilli, 2005; Lee, Lee and Pennings, 2001; Winter, 1987). In precisely this vein, Chatterji (2008) tested the bifurcation between technical specialists and management generalists among spinoff founders in the medical device industry, finding that generalists displayed superior acumen in obtaining key resources, particularly venture financing (Chatterji, 2008).

In some respects, this hearkens to the work of Lazear (2004, 2005) and Wagner (2003), which identified the value-generating capacity of well-rounded, jack-of-all-trades entrepreneurs. In this sense, Chatterji's argument that founder-specific differences play a material role in driving spinoff performance heterogeneity are interesting, but his final conclusions that founder differences emanate from "silver spooned" hereditary linkages between parents and spinoffs are weakened by the absence of within-cohort evidence. Therefore, in extending the founder-centric findings of Chatterji's study (2008), I predict that spinoffs founded by technical experts will under-perform spinoffs founded by non-technical experts when examined through the lens of parent-firm cohorts. However, in correcting the underlying logics as they pertain to service sector contexts, I predict that the founder-centric effect is independent of parent-firm quality. By dissecting the particulars of spinoff foundings, founder experience is predicted to be a significant moderator of spinoff performance (Figure 3), regardless of parental lineage:

> *H32a: Service sector spinoffs 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.*
>
> *H2b: Service sector spinoffs by founders possessing non-technical, general market knowledge will exhibit survival rates and performance levels comparable to de novo firms.*
>
> *H2c: Service sector spinoffs 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.*

[Insert Figure 3 About Here]

3. Service Sector Context: The Asbestos Abatement Industry

A significant impediment to a generalizable theory of spinoff creation and survival is the singular emphasis on high-tech manufacturing contexts (Klepper 2001). In order to harvest data from a dramatically different, yet broadly relevant set of circumstances, this study intentionally shifts focus from manufacturing to the service sector. The requirements for the availability of a complete industry population and richly detailed data led to the asbestos abatement industry.

Asbestos Properties, Risks and Public Policy

For most of human history the use of asbestos was synonymous with wondrous product durability, safety and aesthetic quality. So fundamental was the presumed indispensability of asbestos that government-mandated product specifications were implemented setting asbestos-containing materials (ACM) as the gold standard for safety and performance (Virta 2002). In time, more than 5,500 documented uses of asbestos were developed in products that circumscribed the entirety of human existence, including: asphalts, cement, resilient flooring, fire-proofing, sound proofing, children's pajamas, bed sheets, toasters, blow driers, pipe insulation, electrical wiring, roofing, siding, insulations, water pipes, funeral pyre shrouds, reusable napkins, pottery, ovens, and thousands of others.

Unfortunately, the glass-like, barbed structures emanating from asbestos crystals are a scourge to the human respiratory system. Though highly inert in its manufactured state, disturbed asbestos-containing material (ACM) releases tiny fibers that become lodged in the lungs, potentially causing asbestosis, lung cancer and mesothelioma. Until the mid-1980s, concern regarding human exposure to asbestos in existing buildings progressed slowly, until the passage of the Asbestos Hazards Emergency Response Act (AHERA) in 1985. Originally devised to address the removal of asbestos from aging public schools, the Act broadly established standards for the professional abatement of asbestos in all existing structures. Functionally, the enforcement of AHERA was delegated to state-level agencies. Colorado adopted a stance of strict monitoring and enforcement through the Colorado Department of Public Health and Environment (CDPH&E).

Technical Demands. Asbestos-containing building materials can be separated into two broad categories: friable and non-friable. Regulations define friable ACM as that which can be pulverized with hand pressure, while non-friable has a tight, crystalline structure that makes pulverization by hand impossible. Friable ACM is found in surfacing and texturing materials, spray-applied sound proofing (i.e. "popcorn ceilings"), fire-proofing and thermal insulation for ducts and pipes. These types of ACM are highly prone to significant fiber release if they are disturbed, thereby creating the need for sophisticated removal techniques, including a fully enclosed workspace that is kept under continuous negative air pressure. These engineering controls are costly to construct and maintain and require experienced supervisory oversight to design and implement. Non-friable ACM is found in resilient flooring, cementitious siding and various asphalts. Though still tightly regulated, non-friable abatement requires somewhat less sophisticated, and considerably less costly, engineering controls than those associated with the abatement of friable ACM.

Industry Characteristics. Technically and commercially, asbestos abatement is highly specialized, with relatively few profitable cross-applications to other commercial domains. Although the work practices simply involve the methodical demolition of pre-existing structures under highly prescribed conditions, the engineering controls associated with asbestos abatement are extensive and the monitoring by the regulatory authorities is intense. So, while the service itself is a routinized commodity service, the skill sets necessary to perform fully compliant abatement are highly specialized and, for successful firms, highly profitable.

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.

With only rare exception, the companies participating in Colorado's asbestos abatement industry started as "pure-plays," with a singular focus on asbestos abatement. The abatement industry was formed through an initial group of *de novo* specialists and, soon after, spinoffs from existing firms. Through this, there ensued a series of spinoffs begetting spinoffs in successive fashion. An example of this phenomenon is illustrated in Figure 5, exhibiting the genealogy of the most prolific parent-firm in the Colorado abatement industry, Dominion Services.

[Insert Figure 4 About Here]

Dominion was one of the most successful firms in the history of the industry, ranking #8 (out of 612 total firms) in projects completed per firm-year and #4 in number of directly spawned entities (16). Though Dominion itself closed operations in 1998, its progeny continued to spawn. By 2013, the Dominion family tree spanned five generations and 43 separate spinoffs, virtually all of which were failed firms. Only six firms from the Dominion tree were operational in 2011, representing 13% of the extended family. The average lifespan in the Dominion family is 3.4 years and the average number of projects per firm-year is 8.8. There is little to distinguish Dominion's spawn. Most were abject failures that died young without achieving a commercial presence. Of the firms comprising the Dominion Services family tree, at least 19 firms (43%) would be truncated from typical spinoff studies for having had no operational activity. Yet, in the context of this complete population and given the highly compressed nature of successive generations, the Colorado asbestos abatement data generally and prolific parents such as Dominion specifically, offer an unprecedented analytical portal.

4. Data and Methods

As noted from the outset, there are three primary impediments to the development of a more generalizable spinoff theory: the focus on high-tech manufacturing (e.g. Neck et al. 2004), the absence of parent-cohort analyses (Agarwal et al. 2004), and the lack of studies assessing long-term operational performance and survival (Klepper 2009). Adequately addressing each of these issues required the development of a dataset consisting of a complete, non-truncated population of service sector industry actors, including exceptionally high data fidelity related to the prior industry experience of spinoff founders. The complete population of firms and founders comprising the Colorado asbestos abatement industry provides such data. From its inception in 1986, through 2013, 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 an adequately large spinoff cohort group, provides an unprecedented opportunity to scrutinize spinoff performance heterogeneity.

Data

This empirical analysis of the Colorado asbestos abatement industry involves a quantitative research design based on archival data comprised of the untruncated population of firms and founders having ever entered or exited the market. The methodology employed in this study is an event-history analysis (Delacroix and Carroll, 1983; Tuma, Hannan and Groeneveld, 1979) of a comprehensive database hand-collected from records at the CDPH&E, covering the industry from its inception in 1986 through 2013. This 28-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 350 million square feet of asbestos-containing material, for revenue exceeding $2 billion.

The use of registration data as the indicator of market entry warrants discussion. Yang and Aldrich (2012) proffer several important caveats related to the use of registration data in the study of new ventures. However, the stringent regulatory regime governing the asbestos abatement industry substantively mitigates these concerns. First, an Act of Congress created the entire industry. As an exogenous event, the creation of the industry and all subsequent operational activity can be traced to a precise time, with well-understood founding conditions. Second, as a consequence of the strict monitoring and reporting requirements associated with the removal and disposal of ACM in Colorado, an unusual level of detail is obtained by governmental agencies, which is closely tracked and exhaustively made available to the public. By law, companies must obtain (and annually renew) a State-issued license prior to commencing any abatement work. This allows for comprehensive tracking of every firm into and out of the industry. It also allows the unusual ability to capture the existence of those firms that fail to complete even one project or that fail to survive beyond even their first annual license. This marks perhaps the first time that a dataset includes complete accounting of organizational forms that fail prior to becoming substantively operational.

Finally, the asbestos abatement data set is markedly different from other attempts to use registration data by virtue of the specific requirements implemented by the State of Colorado. As a state that adopted a comprehensive regulatory regime more stringent than that required by AHERA, Colorado situated itself as a domain in which every abatement-related "footprint" was clearly recorded. In the wake of AHERA, the Colorado legislature commissioned in 1986 an Asbestos Enforcement Group through the Air Quality Division of the CDPH&E, whereby regulations were adopted that required professional certifications, company licenses, specialized training, annual exams and project permitting that were specific to Colorado.

In the absence of any licensing and certification reciprocity with other states (i.e. Colorado neither recognized nor honored certificates and licenses obtained in any other state), a tightly specified, closed-system of regulatory compliance was created in Colorado. Coincidentally, this regulatory ardor created a well-structured, well-defined boundary for an exhaustive "natural experiment" stemming from the exogenous "legislative shock" and involving the complete population of firms and individuals entering and exiting the industry.

Dependent Variables

Three separate dependent variables were used to test the dominant premises posited by existing spinoff theory: Lifespan, Operational Performance and Performance Variance. The first two measures – lifespan and operational performance -- each provide a useful portal to conditions and outcomes. Although operational performance is positively correlated with lifespan, "survival is not strictly a function of performance" (Gimeno, Folta, Cooper and Woo, 1997: 750). In order to insure a comprehensive assessment, both outcomes are modeled.

Spinoff Lifespan refers to the total duration of operational existence measured in years.

Spinoff Performance refers to the average number of projects completed per firm-year for each market entrant. For instance, a firm completing 1,300 projects in 25 years of operation would have completed 52 projects per firm-year. A firm completing just six projects in three years would have completed two projects per firm-year. This metric creates a standardized basis for comparison regardless of how long a firm has been in business. Clearly, projects vary in both complexity and size, so that no two projects are precisely the same. To account for these differences, firm-level controls were used to capture averages for duration, staffing and total asbestos abated per project. These controls allow the average number of annual projects completed to serve as a prudent, easily interpretable metric of spinoff performance.

Spinoff Population Performance Variance is the measure used to address performance heterogeneity. It refers to the spinoff population performance standard deviation, recalculated for the exclusion of each parent-firm's finite population of spinoffs.

Independent Variables

Parent Performance is calculated as the average number of projects completed per firm-year.

Parent Longevity is measured as years of operation.

Founder Experience - This is a categorical variable that identifies whether a firm founder has solely technical experience, solely general market experience, or both.

Parent-Firm Spinoff Cohort Performance Variance – This variable is the variance in the performance of spinoffs emanating from the same parent. This is represented by the standard deviation of cohort performance and is calculated separately for each parent-firm with five or more spinoffs. Parent-firms with fewer than five spawned firms were excluded since the standard deviations are not meaningful for such small cohorts.

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: Separate vectors were used to control for macroeconomic, industry-specific and firm-specific variables at entry. The macroeconomic vector contains Colorado-specific measures for construction, unemployment and economic activity. Industry-specific measures consist of the number of firms that entered the industry in a given year (i.e. entry cohort), the industry population for each year, the entry group size relative to the population (Hannan and Carroll, 1992) and the total projects completed. Firm-specific controls consist of firm size, age and parent. Since the spinoffs emanating from each parent-cohort are non-independent, dummy variables were employed to control for shared lineage. Dummy codes were used also to control for unobservable year-specific effects.

Model Specifications

Hypothesis 1 predicts that the average variance in spinoff performance for each cohort of sibling firms spawned from the same parent will be greater than or equal to zero (Figure 2):

$$\begin{aligned} &\mathrm{H}_{null}: \quad VAR_{avg} < VAR_{pop} \\ &\mathrm{H}_{1}: \quad VAR_{avg} = or > VAR_{pop} \end{aligned} \tag{1}$$

Therefore, if the results demonstrate that the average performance variance among spinoffs emanating from the same parent-cohort exceeds the performance for the entire population of spinoffs, then the assertion that parent-firm performance is highly predictive of spinoff performance (Klepper and Sleeper 2005; Klepper 2009) requires reassessment. Towards that end, the parent-progeny linkage was further tested in the context of a complete set of controls, using a model that regresses parent performance onto progeny performance.

$$Spinoff\ Performance = \beta_0 + \beta_1 CON_{\mathrm{industry}} + \beta_2 CON_{\mathrm{macro}} + \beta_3 CON_{\mathrm{firm}} + \beta_4 Parent\ Performance \tag{2}$$

Hypotheses 2a, 2b and 2c assert that Spinoff Founder Experience will be a significant predictor of Firm Lifespan and Operational Performance (Figure 2). Both measures of fitness were tested since, as Gimeno, Folta, Cooper and Woo demonstrated, “survival is not strictly a function of performance” (1997: 750) since lower performing firms may persist for non-financial reasons related to each business owner’s unique utility function. In order to insure a comprehensive assessment of the potential effects of incoherence, both outcomes are modeled. Accordingly:

$$Performance_{Tech+GeneralExperience} > Performance_{GeneralExperience} > Performance_{TechExperience} \quad (3)$$

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

Firm survival is modeled using both a logistic regression and a Cox Proportional Hazard (PH) regression. The former assesses the significance of strategic coherence from birth as a function of founding conditions, while the latter examines the instantaneous probability of failure based on evolving conditions. The basic structure of the Logistic Regression Model is represented by:

$$Spinoff\ Performance = \beta_0 + \beta_1 CON_{\mathrm{industry}} + \beta_2 CON_{\mathrm{macro}} + \beta_3 CON_{\mathrm{firm}} + \beta_4 Founder\ Experience \quad (5)$$

The survival analysis approach employs the classic hazard rate model for use in Cox Proportional Hazard regressions, where each variable is exponentiated to provide the hazard ratio for a one-unit increase in the predictor:

$$\mathrm{h}(t) = \mathrm{h}_0(t)\exp(\boldsymbol{\beta}_1\ \mathrm{X} + \beta_0) \quad (6)$$

The equation states that the hazard of the focal event occurring at a future time t is the derivative of the probability that the event will occur in time t. Using SPSS and the R commander survival plug-in, coefficients were determined through the maximum likelihood function.

5. Results

In light of prevailing sentiment, the analysis of this complete service sector population produced findings that diverge markedly from prior empirical studies of parent-progeny linkages. Of the 612 firms entering the industry at any point in its history 73% were entrepreneurial spinoffs, thereby providing a statistically significant population of foundings and outcomes. Bivariate correlations and descriptive statistics are provided in Tables 1 and 2. The directionality of the correlations is consistent with the hypothesized relationships.

[Insert Tables 1 and 2 About Here]

Consistent with prior research (Garvin 1983; Klepper 2001), the spinoff entrants in this study failed quickly and in large numbers. As Tables 3 and 4 reveal, there is ample evidence that the early failure of spinoffs is a common occurrence, raising the general question of what, if any, parental benefits are ever accrued by spinoffs. Of the 448 spinoffs that entered the abatement industry, 178 exited by the end of their first year (Table 3) and 126 exited without ever performing a single project (Table 4). The notion of a survival advantage hereditarily conferred to spawned entities appears to be inconsistent with the widespread failure to become substantively operational.

[Insert Table 3 and 4 About Here]

These results beg the question: If early failure is endemic to spinoffs, how does relate to the theories propounding the role of transferrable knowledge favoring spinoffs emanating from high-quality parents?

Performance Heterogeneity

Hypothesis 1 predicted that the average performance variance for spinoff cohorts (i.e. the cohort of siblings sharing the same parent-firm) would equal or 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. Consistent with this hypothesis, the data in Table 5 shows that spinoff performance is highly heterogeneous.

[Insert Table 5 About Here]

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 5, as well. The weighted average standard deviation for cohorts from this group of highly prolific parents is 24.3, also exceeding the population variance of 17.5 projects per firm-year ($t_{1,168}$= 7.48, $p < 0.001$). Only one of the thirteen parent-firms, (MDR Inc.) exhibits a progeny cohort group performance variance that is less than the variance for the entire population of spinoffs. This means that every other parent-firm cohorts varied exhibits greater performance variance than the full population. Figure 5 provides a graphical depiction of these results.

[Insert Figure 5 About Here]

Rather than seeing cohort-based clusters of spinoffs performing at a level similar to that achieved by their respective parents, spinoff performance appears to vary significantly, irrespective of the parent's quality. In fact, most spinoffs dramatically underperform their parents. This finding poses problems for extant theory in two respects. First, it defies predictions that spawned firms will substantively resemble their parents (Elfenbein et al., 2010; Eriksson and Kuhn, 2006; Gompers et al., 2005; Klepper, 2009). Second, it challenges key assumptions underlying the transferability of knowledge and capabilities (Agarwal, Audretsch and Sarkar, 2007). Either important knowledge is not transferrable to spinoffs or it is transferable, but cannot uniformly be operationalized successfully by spinoff founders.

In order to more fully stress test the robustness of these findings, I also performed multiple regression analysis measuring the significance of parental performance as a predictor of spinoff performance. As the results in Table 6 indicate, parental performance is not a significant predictor of spinoff performance. In fact, the coefficients for parental performance and lifespan are slightly negative, albeit not statistically significant. By virtue of the variance analysis and the regression model, Hypothesis 1 finds strong support.

[Insert Table 6 About Here]

Founder-Level Factors

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, if not parentally conferred advantageous knowledge endowments? Hypotheses 2a, 2b and 2c examined this question through the lens of founder-specific experience, while simultaneously testing for the influence of parental quality. Mean comparisons indicate that spinoffs founded by non-technical managers have double the lifespan of spinoffs founded by technical managers.

[Insert Table 7 About Here]

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 2a and 2b. 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.

The regression results in Models 2 - 4 (Table 6) reflect the same findings in the context of controls and other known predictors of operational performance and lifespan ($p < 0.01$). Further, the Cox PH Model 5 (Table 8) indicates that founders with technical experience face a 28% higher hazard of instantaneous failure than a founder with general management experience.

[Insert Table 8 About Here]

A comparison between spinoff founders with general management experience, spinoff founders with technical experience, and spinoff founders with both technical and general experience is provided in Figure 6.

[Insert Figure 6 About Here]

The Kaplan-Meier plot provides strong support for Hypothesis 2a, which predicted that founders with generalist skills face significantly less survival hazard than founders possessing only technical skills; and, Hypothesis 2b, which predicted GM spinoff founders would face a hazard rate statistically similar to that faced by *de novo* founders. 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 2c, but confirms Chatterji's (2008) finding that when parental knowledge endowments are not a consequential factor, general business acumen is the decisive component in spinoff performance, not technical knowledge.

Overall, it is apparent that prior experience and the knowledge it confers, is highly significant as a predictor of spinoff performance, but the benefits are not generated from spillovers of parental knowledge stocks. This finding stands in stark contrast to conclusions drawn from high-tech manufacturing contexts, such as Klepper's assertion that, "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). Under conditions of low knowledge intensity, exactly the opposite rings true: the specific position held is vastly more instrumental to performance than the place of employment. Hereditary effects, to the extent that they exist in the service sector, are eclipsed by founder-specific factors when transferable knowledge is virtually non-existent.

6. Discussion

The cornerstone of dominant spinoff theory rests on the presumption that higher-quality parents, possessing larger stocks of advantageous knowledge and capabilities, spawn more and better spinoffs than low-quality parents (Agarwal et al., 2004; Christensen, 1993; Klepper and

Sleeper, 2005; Klepper and Thompson 2010). While this appears to hold true for high-tech manufacturing spinoffs, the examination of a complete population of firms and a full complement of parent-firm cohort groups from a representative service sector industry contradicts this foundational assumption. The asbestos abatement industry data provides evidence that hereditary-based conceptions of entrepreneurial spinoffs may offer a poor predictive framework for spinoff performance when parent-generated knowledge spillovers are weak or even non-existent. It appears that industry-specific effects play a pronounced role in determining the extent to which advantageous knowledge, capabilities and routines can be transferred from parent-firms to spinoffs.

The evidence from this study shows that the operational performance of service sector spinoffs is highly heterogeneous, even among spinoffs emanating from the same parent-firm. In sharp contrast to prior studies focusing on high-tech firms and using truncated data, I find that spinoff performance heterogeneity is uncorrelated with parent-firm quality. If hereditary endowments were sources of a performance advantage among service sector spinoffs, 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 (Figure 5). Rather, the performance variance among cohorts from shared parent-firms is significantly larger than the population variance (Table 5), indicating that variation within parent-cohorts is the norm, meaning that either advantageous parentally generated knowledge does not exist or it simply cannot be uniformly transferred to progeny. Either eventuality suggests the need for the boundary conditions I have herein proposed.

Disaggregation of the spinoff data reveals an even fuller story of performance heterogeneity. As demonstrated above, spinoff performance within the asbestos abatement industry is clearly bifurcated between technical founders and generalist founders. The average lifespan for firms founded by technical supervisors is less than half that of generalists, with technical founders completing seven projects per firm-year, versus thirty-two projects per firm-year for generalist-founders (Table 7). These results suggest that among service sector spinoffs, the key driver of spinoff performance is less a function of parental knowledge transfers (Agarwal et al., 2004; Gompers et al., 2005; Klepper, 2001; Klepper and Thompson, 2010) than it is a function of differential outcomes based on founder-specific experience. Since professional experience is gained in the context of specific firms, scholars have erred in concluding that beneficial knowledge is a consequence of endowments related to parent-firm quality, when in fact the evidence from this study suggests that among service sector spinoffs operating performance is largely independent of parent quality.

While it is beyond the scope of this study to state definitively why generalists outperform technical experts by such a wide margin, I believe that future research may discover fruitful answers in the startling similarities between generalist spinoff founders and *de novo* founders; a fact that further reinforces the theory of parent-progeny disjunction in the case of industries for which advantageous knowledge has a weak role. It seems likely that these two groups of founders possess similar aptitudes and outlooks in two respects. First, the findings support the notion that generalist spinoff founders and *de novo* founders may identify and interpret market opportunities (Heil and Robertson,2006; Stevenson and Jarillo 1990) in a similar fashion, partially evidenced by the relative immunity to the effects of contagion-style entry (Greve, 1998) that is commonplace among technical spinoff founders. As Table 2 shows, the entry-year cohort size is positively and significantly correlated (0.383) with founders possessing technical experience, suggesting that this group may be more prone to contagion entry patterns (Hunt 2015) than are the generalist and *de* *novo* founders. Second, generalist and *de novo* founders may possess similar marketing and sales acumen, particularly in the sourcing of new customers. Conversely, the accurate interpretation of market signals and successful implementation of marketing initiatives may prove to be elusive for technical supervisors (Leonard- Barton, 2007), who possess more of a project-execution orientation and may therefore lack the ability to conceptualize and operationalize a viable sales strategy. Future opportunities abound to assess and extend these findings in further scrutinizing the multi-level relationships between founder-specific attributes, entry mode and firm performance.

Limitations, Alternative Explanations and Future Opportunities

As with all research, design decisions related to this study have limitations, some of which may foster concerns about robustness or elicit alternative explanations. A review of these potential issues will reinforce the central claims of this paper. First, the generalizability of asbestos abatement data might be questioned on the basis of the industry's relative anonymity. Despite its low-profile status, however, the industry represents an untapped, well-bounded, well-defined population, constituting a richly detailed data set that provides a full spectrum of organizational forms and near-perfect optics regarding the operational activity. Generalizability might also be questioned due to the modest technical demands associated with abatement versus prior empirical studies which have focused on capital intensive, technologically complex manufacturing industries, such as autos, disk drives, lasers and medical devices. Intuitively, capital intensive, technologically complex products would seem to involve more knowledge that may be relevant to the survival and comparative performance of entrepreneurial spinoffs. However, the sheer size and complexity of these industries create substantial research challenges, especially in the analysis of nascent-stage events related to new firms, industries and markets. Highly regulated service-sector industries with relatively low barriers to entry are more likely to provide access to more complete populations, including, as has been demonstrated here, early stage events. In the end, generalizability is a function of the research question under investigation. The central challenge in this inquiry was to investigate the efficacy of a hereditary approach within the context of a complete industry population drawn from the service sector. Boundary conditions that specify high-tech manufacturing sectors (e.g. Klepper, 2009) and complex parental knowledge stocks may produce results that appear to be more supportive of hereditary transfers, but with the concomitant pricetag of truncation and the potential for unobserved non-linear relationships (Cameron and Trivedi, 2005; Tsiatis, 2006). Either way, spinoff research is materially enriched by an open exploration of various industries, especially when it is possible to apprehend a complete population.

Another important characteristic of abatement industry data involves diversifying incumbents. Few successful and absolutely no dominant incumbent firms have entered the abatement industry through diversifying market entry. The limited presence of these *de alio* firms is likely to be less common in other industries. For the sake of this study, however, the limited presence of *de alio* firms provides an unusually good opportunity to directly compare spinoffs and *de novo* firms without the pervasive shadow of dominant incumbents that often characterize capital-intensive industries. Future studies can perhaps conduct similar analyses in the context of an industry that has more incumbent activity.

It is also worth noting the presence right-side truncation in this study by virtue of the fact that just 104 of the 612 industry entrants were still operational at the end of 2010. Additionally, there were 14 new entrants – 9 spinoffs and 5 *de novo* firms – in 2011 and early 2012. Although the details of this influx are not directly relevant to the central research questions, as a robustness check, right-side truncation tests were performed at three years and five years. Neither of these right-side truncation tests materially altered the effect size or the significance levels.

Finally, concerns might be raised that the 126 spinoff entrants failing to complete even one permitted project simply acquired an abatement license to create the option to become operational without possessing serious intent to compete. Several factors make this explanation implausible. First, the issuance of the $2,000 license is a matter of public record. Every license holder is listed on the CDPH&E web site. For a spinoff founder still working for an employer, this constitutes a signal of direct competitive intent, especially because all project permits are also a matter of public record. With approximately 100 current firms, mandatory project permitting, and a limited array of marketing options, the Colorado abatement milieu is, by any reasonable standard, an intimate universe. Second, abatement license issuance requires the submission of federal and state tax identification numbers as well as the registration with Secretary of the State of Colorado as a formal operating entity. The latter stipulation involves incorporation, publication of by-laws, and annual reports to the State. Thus, the administrative burden is not a cursory matter. Finally, if abatement licenses are conceptualized as being tantamount to an operational or strategic option, then the option only holds significant value for diversifying incumbents, such as specialty contractors, restoration experts or general contractors. Yet, there were only 54 *de alio* license-holders, through 2013 constituting just 9% of entrants.

Conclusion

Why do firms emanating from virtually identical circumstances often meet with such different fates? Even firms that employ similar strategies may end up exhibiting vastly different operational performance and survival prospects. As the first exhaustive investigation of service sector spinoffs through the lens of a complete industry population this study broadens and strengthens the literature on intra-industry entrepreneurial spinoffs. Contrary to common wisdom and extant conceptual frameworks, there are key sectors in which apples often fall very far from the tree, and often bear little resemblance to one another. Overall, these results pose significant challenges to the dominant, hereditary-focused conceptions of intra-industry entrepreneurial spinoffs. Contrary to findings from knowledge-intensive, high-tech industries, which form the bulwark of observations underpinning the stylized facts, it is far more typical for high and low-achieving spinoffs to emanate in random fashion from high and low-achieving parent-firms. By fracturing this central tenet of emerging frameworks to explain spinoff phenomena, this investigation actually offers a more tenable foundation for the evolution of spinoff research from stylized facts to a generalizable, broadly applicable theory of spinoff creation and survival.; one that explains the absence of hereditary linkages as well as it explains the presence of them.

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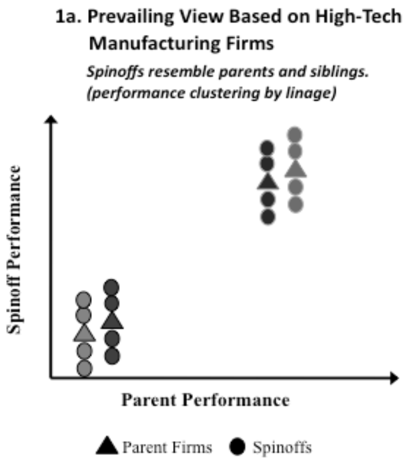
Figure 1. Models of Spinoff Performance – Hereditary Clustering and Non-Clustering



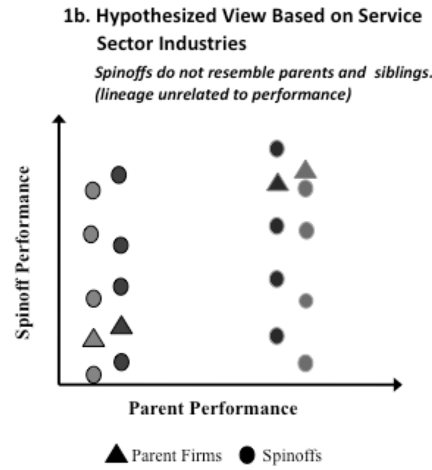


Figure 2. Hypothesized Model of Spinoff Performance Variance.

Hypothesis 1 (i.e. the triangular region denoted as H_1) 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 $H_1 \neq> H_0$, functionally indicates that both low and high-performing parents produce both low and high-performing spinoffs.

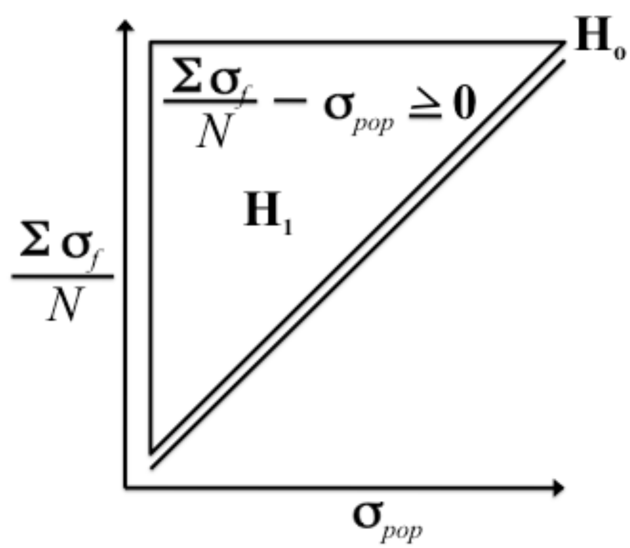


Figure 3. Hypothesized Model of Spinoff Performance.

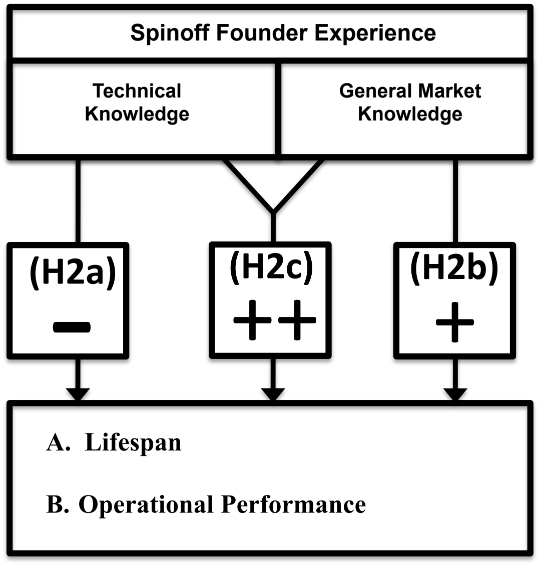


Figure 4. Dominion Services Family Tree

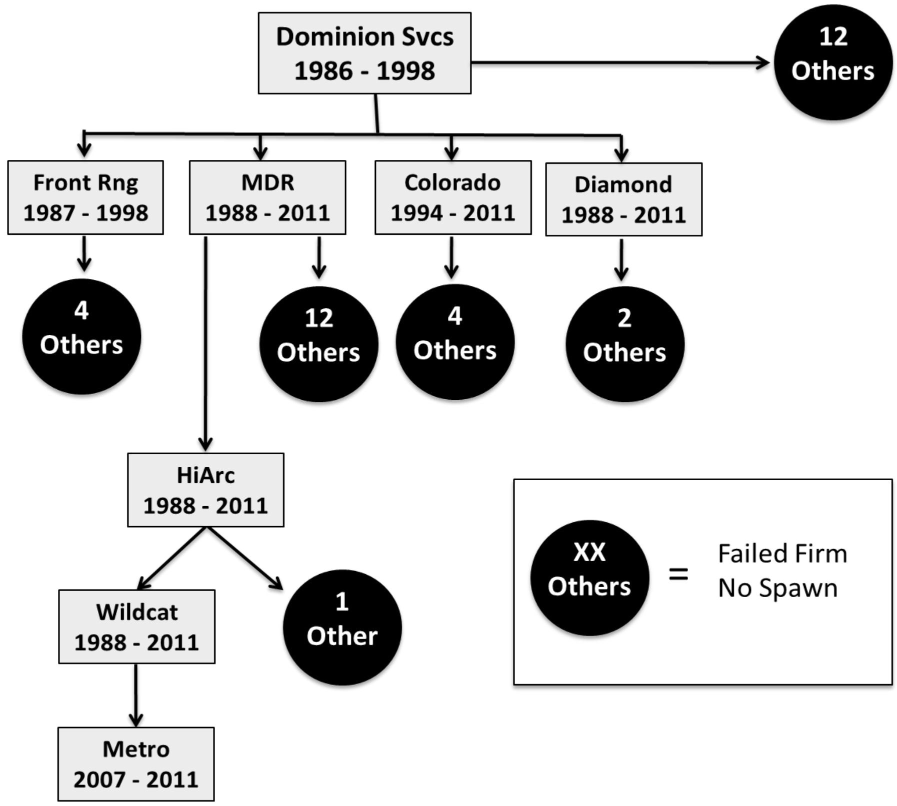


Figure 5. Operational Performance by Parent Cohort

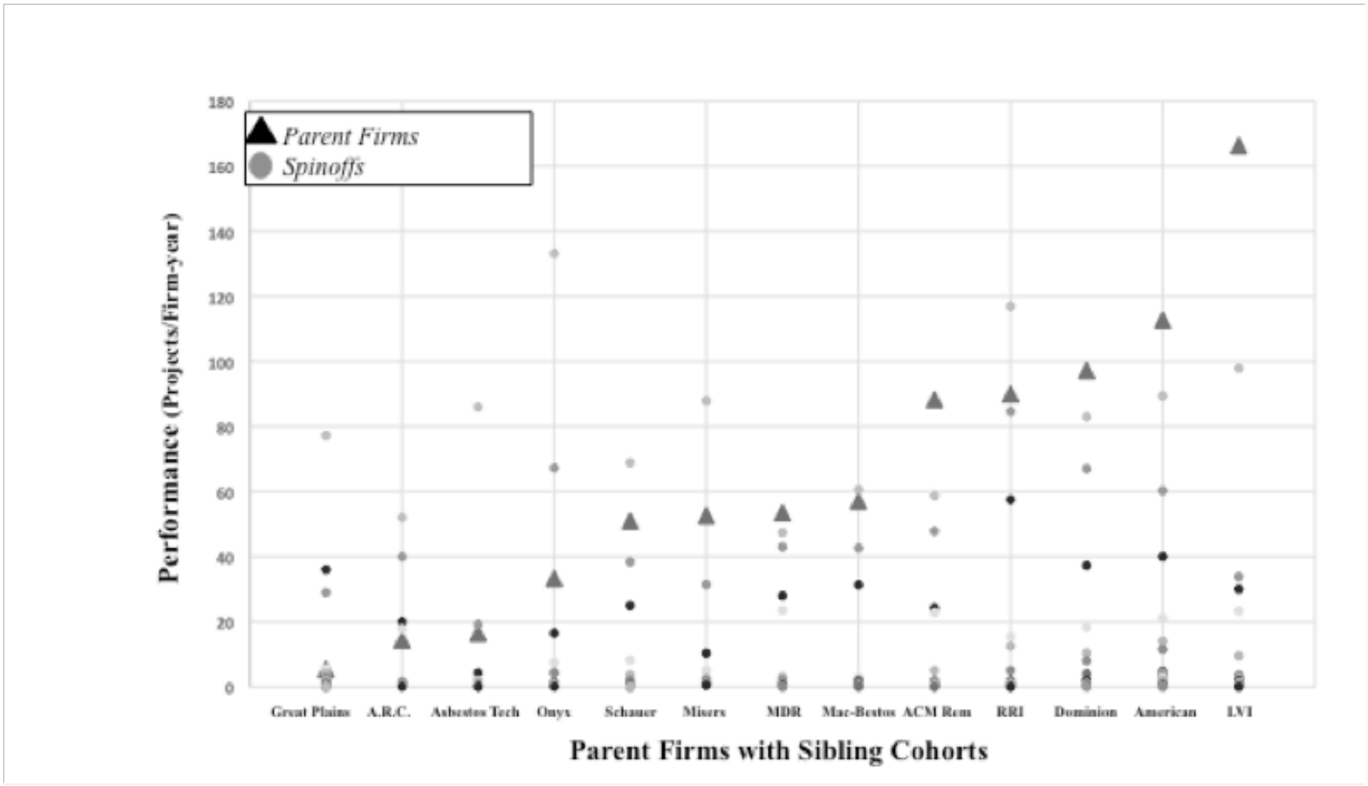


Figure 6. Kaplan–Meier Estimate of the Survival Function by Founder Experience

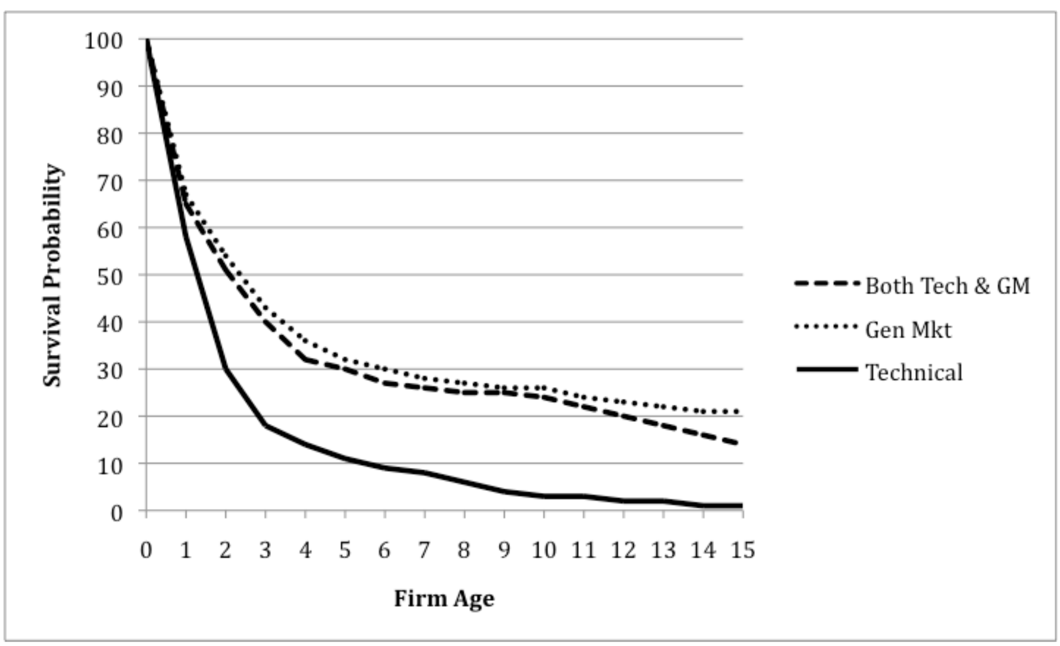


Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	s.d.
Firm Foundings (Year)	612	1986	2013	1997	7.38
Firm Failures (Year)	508	1987	2013	2001	7.77
Currently Operating (Yes = 1)	612	0	1	0.17	0.37
Firm Lifespan (Years)	612	0	28	3.73	4.45
Entry Mode (Spinoff = 1)	612	0	1	0.73	0.78
Total Completed Projects	612	0	2817	89	287
Average Annual Projects	612	0	166	9	21
Spinoff Frequency by Parent	100	1	20	4.48	4.41
Cohort Size	612	14	41	26.49	7.41
Spinoff Cohort Performance (Average Annual Projects)	100	0	23.5	11.8	22.8
Population at Entry	612	0	134	91	24.41
Cohort as Percent of Population	612	13%	100%	33%	19%
Cohort Average Lifespan	612	1	15	4	3

Table 2. Key Correlations

		1	2	3	4	5	6	7	8	9
1	Avg. Annual Projects	-*-								
2	Lifespan	*.317*	-*-							
3	Entry Mode - Spinoff	*-.366*	*-.292*	-*-						
4	Founder - Technical Experience	*-.312*	*-.284*	*.380*	-*-					
5	Entry Cohort Size	*-.148*	-.015	-.017	*.383*	-*-				
6	Entry Cohort as % of Pop	*-.132*	*-.177*	*.184*	*.245*	.115	-*-			
7	Entry Cohort Avg. Lifespan	*.220*	*.269*	*-.280*	*-.146*	*-.182*	-.120	-*-		
8	Total Completed Projects	*.415*	*.724*	*-.235*	*-.381*	*-.206*	*-.143*	*.458*	-*-	
9	Industry Population at Entry	*-.187*	*-.235*	*.158*	.012	.043	.007	.119	-.138	-*-

Italicized correlations are significant at p < 0.01 level (2-tailed).

Table 3. Spinoff Longevity (Lifespan in Years)

	Spinoff Firms	
Firm Lifespan	**# of Spinoff Firms**	**% of Spinoff Firms**
Up to 1 Year	178	39.7%
2 years	101	22.5%
3 years	72	16.1%
4 years	22	4.9%
5 years	15	3.3%
6 to 10 years	34	7.6%
11 to 15 years	21	4.7%
16 years or greater	5	1.1%
Total	448	100%
Firms Surviving 5 or Fewer Years	**388**	**86.5%**
Firms Surviving 6 or More Years	**60**	**13.5%**

Table 4. Spinoff Performance (Lifetime Projects Completed)

	Spinoff Firms	
Total Projects Completed	**# of Spinoff Firms**	**% of Spinoff Firms**
0	126	28.1%
1	63	14.1%
2	41	9.2%
3	25	5.6%
4	18	4.0%
5	9	2.0%
6 - 10	40	8.9%
11 - 20	22	4.9%
21 - 50	29	6.5%
51 - 100	18	4.0%
101 - 250	29	6.5%
251 - 500	16	3.6%
501 - 999	6	1.3%
1000+	6	1.3%
Total	**448**	**100%**
Firms Completing 10 or Fewer Total Projects	**322**	**71.9%**
Firms Completing 11 or More Total Projects	**126**	**28.1%**

Table 5. Heterogeneity of Performance – Cohort Variance vs. Population Variance
For parent-firms producing ten or more spinoffs, the standard deviation for each parent-firm's spinoff-cohort performance is compared to the standard deviation for the entire population of spinoffs, which was 17.5 projects per firm-year. In all but one case (MDR Inc.), the cohort standard deviation exceeded the population standard deviation.

Parent Name	**# of Spinoffs in Cohort**	**Parent Performance (# Projects per Firm-Year)**	**Average Spawn Performance (# Projects per Firm-Year)**	**Spawn Performance Range (# Projects per Firm-Year)**	**Cohort Std. Dev.**	**Cohort Std. Dev. Minus Population Std. Dev.‡**
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.*

Table 6. Effect of Parent Quality on Spinoff Quality (Regression Estimation)

	Models			
	Spinoff Performance (n = 448) Units: *Average Annual Projects*			
Predictors	1	2	3	4
(Constant)	34.6***	33.1***	33.6***	30.8***
	(17.9)	(19.0)	(19.5)	(16.4)
Macro-Level Controls	-4.0	-3.7	-3.8	-3.4
	(1.9)	(1.7)	(1.8)	(1.4)
Industry-Level Controls	-6.6**	-6.3*	-6.2*	-5.3*
	(2.4)	(2.2)	(2.2)	(1.9)
Firm-Level Controls	-10.2*	-8.8*	-8.9*	-4.8*
	(6.4)	(5.0)	(4.7)	(1.9)
Year Effects	-10.6*	-9.8*	-9.9*	-6.8*
	(4.1)	(3.3)	(3.2)	(2.6)
Parent Performance (Avg Annual Projects)		-1.2		
		(0.7)		
Parent Longevity (Years of Operation)			-1.4	
			(0.7)	
Founder Experience (1 = Tech Background)				-11.5***
				(3.7)
Adj. R2	0.374	0.382	0.390	0.552
F-value	27.4***	30.8***	31.4***	47.8***

Standard errors in parentheses.

**p* < .05

** *p* < .01

*** *p* < 0.001

Table 7. 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***	32.1***
Founders with Only Technical Experience	2.3***	6.8***
Founders with Both Tech & Non-Tech Experience	5.1	30.8
All Spinoffs	3.1	18.1

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

TABLE 8: RESULTS FROM COX PROPORTIONAL HAZARD MODEL (*N = 448*)

	Cox Proportional Hazard Model		
	Probability of Failure (95% CI)	*Std dev.*	*P Value*
Variables			
Colorado GDP Growth	0.98	0.05	0.01
Total Projects - Industry	0.99	0.06	0.18
Population at Entry	1.01	0.04	0.07
Entry Cohort Size	1.02	0.11	0.30
Cohort Lifespan	0.96	0.05	0.01
Firm Age (years)	0.98	0.02	0.01
Parent Quality	1.01	0.41	0.57
Founder Expeience (Technical)	1.17	0.02	< 0.001
Founder Expeience (Gen Mgmt)	0.89	0.02	< 0.001
Founder Expeience (Both GM and Tech)	0.93	0.02	< 0.001
χ^2	194.4		
P Value	< 0.001		