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COMPETITIVE HETEROGENEITY, COHORTS, AND PERSISTENT ADVANTAGE

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Research summary: *Juxtaposing competing theories of whether superior profits endure, this article investigates differences in the rates at which firms' profit advantages persist following a significant regulatory change in the rules governing industry competition. Such a change creates two cohorts of firms, Entrants that lack experience in the industry and Incumbents that competed in the industry before the regulatory shift. The findings show that both cohorts' profit advantages persist, but at different rates: Superior performing Incumbents sustain an advantage longer than superior performing Entrants. This result is counterintuitive since Entrants are not constrained by a legacy of competing under the prior regime. Overall, the findings indicate that stages of a firm's development and of an industry's evolution are critical to understanding how long superior profits persist.*

Managerial summary: *State and federal institutions employ regulations in an attempt to address market failures and to create a stable set of market and nonmarket relationships among relevant actors. A byproduct of this stability is decreased competition, and in turn, reduced incentives for firms to develop efficient operations. One might expect then that deregulation would fundamentally disrupt incumbent firms' abilities to develop and sustain a profit advantage. We find the reverse: Over time, some firms in the Incumbent cohort develop persistent, albeit temporary, profit advantages despite an onslaught of Entrants. Thus, while deregulation shakes out inefficient firms, it may strengthen, rather than threaten the profit trajectories of incumbent firms over time. Advantages developed by superior performing Entrants also endure, but for a shorter duration relative to Incumbents.*

> *So if you really want to understand the way the market system and the feedback from the marketplace provides the selective force that operates to shape what is actually happening, the examples that are really powerful are examples from a historical context of relatively early stages in industry evolution or, of course, later stages where there is some innovation which renews the whole process.* ("The Progress of Evolutionary Thinking in Economics and Management," *Journal of Management Inquiry*, Winter, 2003: 19)

INTRODUCTION

A fundamental objective of firms is to sustain profits superior to those of competitors (e.g., Barney, 1991; Lippman, and Rumelt, 1982). Many scholars have studied whether firms' superior profits (profits above an industry's norm) tend to

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persist or to converge to the mean (e.g., Cubbin and Geroski, 1987; Dosi, Lechevalier, and Secchi, 2010; Jacobsen, 1988; Knott, 2003; McGahan and Porter, 2003; Mueller, 1977, 1986; Roberts, 1999; Rumelt, 1991; Waring, 1996; Wiggins and Ruefli, 2002). A widely-held view on this topic is that competition and free entry will make profit differences temporary rather than enduring (e.g., Hopenhayn, 1992; Schumpeter, 1934). Yet, there is a remarkable amount of empirical evidence to the contrary, indicating the theory and empirics are not congruent (e.g., Cubbin and Geroski, 1987; Dosi, 2005; Jacobsen, 1988; Knott, 2003; Madsen and Leiblein, 2007, 2015; McGahan and Porter, 1999; Mueller, 1977, 1986; Roberts, 1999; Villalonga, 2004). A possible reason for this inconsistency is that the trend in profits has not been examined in the context of significant industry change. Such an analysis is our purpose here.

In this article, we examine the profit differences among cohorts following a major deregulatory shock to an industry in its mature stage. A cohort is a group of firms that enters an industry at roughly the same time or during the same era in an industry's history, where an era is defined by distinct historical, institutional, technological, and competitive conditions (Haveman and Rao, 1997; Walker, Madsen, and Carini, 2002). The environment encountered at entry shapes the capabilities that entering firms must build in order to compete. These capabilities stamp the cohort with a common imprint based on its initial experiences (Stinchcombe, 1965). In addition to this imprint, the firms in a cohort encounter roughly the same opportunities and constraints after the period of entry, and thus, are likely to have similar developmental patterns (Madsen and Walker, 2007). Cohort effects thus explain part of the competitive heterogeneity in an industry, analogous to the influence of birth cohorts on life outcomes studied in demography (Knoke and Hout, 1974; O'Brien, Stockard, and Issaacson, 1999; Ryder, 1965).

By examining profit persistence or convergence in cohorts, this study contributes to research on profit persistence in three ways. First, many empirical studies have assumed that the influence of unique industry events on the persistence of superior profits is captured by two parameters, a generic industry effect, and a temporal or year effect. While this approach seems reasonable, particularly for studies spanning multiple sectors over time (McGahan and Porter, 1999, 2003; Villalonga, 2004), it may obscure how specific shocks affect the persistence of superior profits in an industry. Also, studies investigating persistence rarely tie their starting points to a particular event or stage of industry evolution. But examining how abnormal profits evolve, above or below the industry norm, requires that we identify a set of firms that lack experience in an industry and begin competing at roughly the same time, in other words, a discrete cohort. Finally, ignoring industry life cycles is patently inconsistent with research on industry evolution that demonstrates substantial heterogeneity among firms across life cycle stages, including disruption in the mature stage (Abernathy and Utterback, 1978; Klepper, 1996; Klepper and Graddy, 1990). Heterogeneity after disruption is in part determined by differences between Entrant and Incumbent cohorts, which need to be examined explicitly in order to test whether firm abnormal profits persist or converge.

To assess persistence or convergence in a single cohort, the initial part of our study focuses on the first group of firms to enter an industry after a shock that redefines the rules of competition. We label these firms Early entrants to distinguish them from firms that enter the industry after the competitive implications of the shock have become clearer. This separation of cohorts reflects the imprinting of era-specific managerial practices and sunk cost investments on firms that enter the industry in each evolutionary stage (Madsen and Walker, 2007; Stinchcombe, 1965). Early entrants, the first cohort of Entrants coming into the industry after the shock, have been shown to be significantly more heterogeneous than incumbents (Walker *et al.*, 2002) and can be viewed as restarting the evolution of the industry. In this way, they are a logical and promising choice for testing convergence versus persistence. Convergence is observed when the profit heterogeneity of members of the Early entrant cohort erodes over time. The alternative pattern is that profit differences among members of the Early entrant cohort persist.

Next, we compare the rates at which profit heterogeneity converges (or persists) for the Incumbent and Entrant cohorts separately (the latter includes all firms that entered the industry after deregulation, not just Early entrants). If Incumbents are unable to overcome the legacy of competing in the earlier regime, compared to Entrants that do not have this constraint, we would expect to find differences in the persistence of profit advantages held by superior

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performing Incumbents and Entrants over time. Because the environmental conditions present at a firm's entry shape its subsequent behavior, the two cohorts' developmental patterns differ. In our study, Incumbents developed their strategic positions in the regulated environment, whereas Entrants' positions stem solely from competing in the deregulated environment. As a result, the cohorts' strategic positions stem from different competitive experiences.[1] In contrast, firms that enter an industry at its inception are imprinted with similar opportunities and constraints, and thus, as noted above, have common developmental patterns. Thus, competitive heterogeneity present in an industry after a significant shock differs from the conditions present at an industry's inception (for instance, see Thomas and D'Aveni, 2009; Walker *et al.*, 2002). Given these differences, a significant shock to an industry is likely to fundamentally alter its existing pattern of profit persistence or convergence (McGahan and Porter, 1999; Walker *et al.*, 2002).

We explore these competing perspectives—convergence versus persistence—by comparing the profit patterns of different cohorts of firms following a major change in the institutional environment of the U.S. trucking industry in 1980. This change entailed the deregulation of pricing and entry.[2] The trucking industry is an excellent example of an industry where a significant institutional change threatened incumbent firms' performance and viability, and induced new firms to enter with the prospect of becoming strong competitors (see also Boyer, 1993; Tye, 1987). Figure 1 shows the drop in the number of Incumbents and the rise in Entrants in the 10 years following deregulation, trends that represent the emerging coexistence of the two cohorts. Figure 2 demonstrates that, during this period, the exit rate of Incumbents is substantially greater than the rate for Entrants, indicating a meaningful difference between the cohorts in their viability.

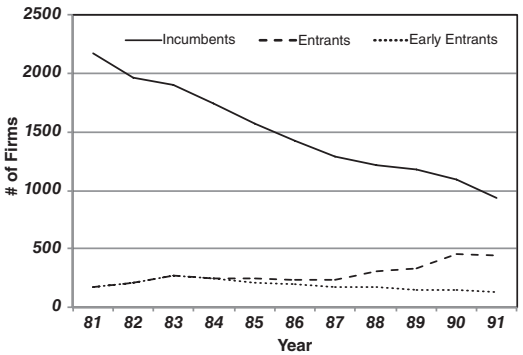

Figure 1. # of firms (density) by cohort, 1981–1991

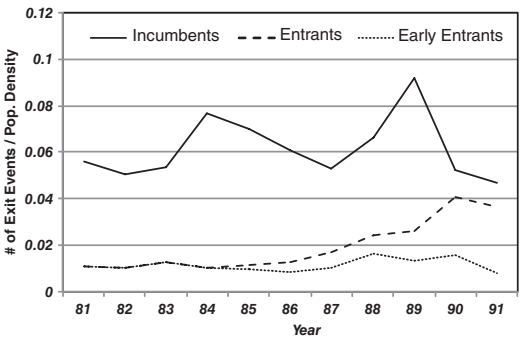

Figure 2. # of exit events/population density by cohort, 1981–1991

EVOLUTION OF PROFIT ADVANTAGES AFTER AN INDUSTRY SHOCK

Convergence or persistence of abnormal profits in Early entrants

Research on the convergence (persistence) of abnormal profits examines whether the relative profitability of firms tends to a common value in the long run. The focus is on the gap between a firm's profits compared to competitors rather than on absolute (nonrelative) profits per se. Although some support for the convergence pattern exists (Jacobsen, 1988), numerous studies demonstrate that superior profits tend to persist, but also that persistence rates vary among firms (Geroski and Jaquemin, 1988; Goddard and Wilson, 1999; McGahan and Porter, 1999; Powell and Reinhardt, 2010). Wiggins and Ruefli (2002) find, for example, that a small portion of firms enjoy persistent superior profits, but not for long periods of time. We examine here whether the abnormal profits of Early entrants converge or persist.

[1] For instance, the incumbent cohort, collectively, accrued more than 3,200 years of cumulative experience competing under regulation, whereas the entrant cohort lacks any experience from the regulated regime.

[2] This form of industry deregulation was common in the United States at both the national and state levels in the 1970s and 1980s. Six major transportation and service industries were deregulated: airlines [1978], trucking [1980], railroads [1980], telecommunications [1985, 1996], natural gas [1985], and banking [interstate, 1994; intrastate, 1970–1994]) (see Winston, 1998).

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First, as the industry ages after an institutional shock, differences among Early entrants may decrease as customer preferences become more well formed, weaker firms exit, stable market segments emerge, innovations become more incremental, and the surviving Entrants become more similar in their operations, typically focusing more on price competition (Klepper and Graddy, 1990). As Entrants' idiosyncratic differences in routines and practices erode, so do their differences in profitability. *It follows that, after deregulation, the profit advantages of superior performing Early entrants will converge.*

The alternative argument is that inimitable firm-level characteristics prevent convergence from occurring. If firms evolve through path dependent learning, their idiosyncratic contributions to performance differences should persist or endure over time (Dierickx and Cool, 1989). When the causal relationships underlying these contributions are unobservable, rivals have difficulty identifying the sources of a competitor's superior profits, limiting imitation and factor mobility (Lippman and Rumelt, 1982). Under these conditions, imperfect imitation will give rise to differences in profits among firms (Lippman and Rumelt, 1982). These conditions are likely to persist as leaders continue to refine their positions and rivals proliferate their imitation efforts.

This argument depends on industry conditions as well as firm characteristics. The conditions necessary for uncertain imitability are typically present in industries where the rules of competition have changed (Lippman and Rumelt, 1982). For example, in the trucking industry, deregulation removed power from the industry's rate bureaus—cartels that established price and service terms for trucking firms under regulation. This opened the door for firms to experiment with different sales and service activities focused on gaining and retaining customers (Johnson and Schneider, 1990). Firms also varied in their stocks of logistics and communications technologies and in their abilities to leverage these resources to improve reliability and quality. The tacit properties of these factors coupled with the organizational constraints that slow incumbent firms' abilities to adjust to the post-shock competitive conditions suggest that the first cohort's most successful members might accumulate and maintain a performance level exceeding that of rivals. *It follows that, after deregulation, the profit advantages of superior performing Early entrants will persist.*

Entrants versus Incumbents

In a seminal article, Stinchcombe (1965) showed that an organization develops and retains routines that are matched to the environmental conditions present in the early part of its history. Firms align their practices with these conditions in order to reduce costly conflict regarding compliance mandates and to improve the organization's performance and viability through heightened legitimacy and reliability (Meyer and Rowan, 1977; North, 1990). Moreover, when these practices are central to an organization's functioning, they are likely to change slowly on average, typically lagging shifts in environmental opportunities and constraints (Hannan and Freeman, 1984).

An incumbent's attachment to the practices it developed under regulation contributes significantly to the dilemma it faces regarding how to compete in the new deregulated regime. A firm may maintain its existing operating routines because doing so is less risky than exploring alternatives. Yet, only some of these practices may be useful in the new institutional environment; the rest are rendered obsolete by the onset of Entrants and price competition. Over time, this self-reinforcing bias toward existing routines may inhibit an incumbent firm's adaptation (Madsen and Walker, 2007). These conditions lower the likelihood that an incumbent firm will achieve and sustain profits superior to those of Entrants, which lack a legacy of competing under regulation.

In contrast, Entrants' initial practices are formed solely in the new regime (post-industry shock), and should therefore be more responsive than incumbent firms to the regime's more intense competitive conditions (Peteraf and Reed, 2007). This heightened responsiveness is produced by more effective search, decision-making, and implementation processes, especially regarding projects involving cost reducing innovations, new business combinations, and quality improvement programs (Klepper and Graddy, 1990; Madsen and Walker, 2007; Mitchell, 1989). Thus, Entrants may develop practices relevant to deregulation earlier than Incumbents and be able to imitate rivals' practices sooner and more efficiently. Such imitation will lower the variation in behavior among Entrants, contributing to convergence. Therefore, *after deregulation, the profit advantages of superior performing Entrants may*

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erode at a faster rate (persist for a shorter time or at a lower rate) than those of incumbent firms.

THE U.S. FOR-HIRE TRUCKING INDUSTRY

Industry background

The for-hire trucking industry is primarily segmented into two motor carrier or trucking firm types: less-than-truckload (LTL) and truckload (TL). LTL carriers use complex terminal network systems (similar to hub and spoke systems) and sophisticated information technology to support shipments weighing less than 10,000 pounds over standard service routes (Glaskowsky, 1986; Tye, 1987). In contrast, TL carriers move truckload shipments (typically 10,000 pounds or more) door-to-door and do not require terminals for shipment consolidation or substantial investments in information technology for managing logistics (Tye, 1987). The sections below provide background on the potential implications of regulatory reform and on the industry pre- and post-deregulation.

Calls for regulatory reform

Regulations governing industry operations tend to limit competition, reduce firms' incentives to develop efficient operations, prevent optimal asset allocation, and in turn, position firms as slow responders to external shocks, such as a recession (Jayaratne and Strahan, 1998; Joskow, 1974; Posner, 1974; Stigler, 1971; Winston, 1998). In the United States, actions during the 1940s to 1970s set the stage for regulatory reforms in the transportation (trucking, rail, airlines) and service (banking, telecommunication, natural gas) sectors. For example, in 1948, Congress introduced the Reed-Bulwinkle Act, exempting the cartel-like collective rate (price) making bureaus of the trucking and rail industries from antitrust laws. The rate bureaus calculated and published collectively defined tariffs that established prices and terms for trucking firms' services. In the trucking industry, this immunity inhibited "independent pricing decisions" by trucking firms, dampening firms' incentives to reduce prices, and in turn, limiting competition (Felton and Anderson, 1989: 31).[3] By the late 1950s and early 1960s, research emerged citing the unproductive outcomes of industry regulation and advocating a reliance on market forces to shape competition (Felton and Anderson, 1989: ch. 2; Sampson and Farris, 1966). For instance, even though firms operating in regulated industries could make choices about assets and operating practices, these choices were made to align with regulatory policies and in the absence of unrestricted competition. As a result, managers' incentives to search for and develop stronger efficiencies differed from those present under free market conditions (Winston, 1998). For instance, before regulatory reform in the airline industry, few firms employed efficiency-enhancing strategies (Johnson, Sambharya, and Bobko, 1989). In the banking industry, restrictions on geographic scope raised costs and inhibited expansion, constraining firms' abilities to make efficient use of their resources (Stiroh and Strahan, 2003). In the trucking industry, regulation required all services to be made available to all shippers either for an ancillary charge or at no charge, regardless of whether a shipper used a service or not. Drawing attention to these issues, in a 1962 special message to congress, President Kennedy "called for a lower regulatory profile" (Felton and Anderson, 1989: 38), and in 1966, President Johnson emphasized the need for establishing a federal department of transportation (DOT). By the mid-1970s, the DOT began proposing legislation to Congress that would significantly change the trucking industry's regulatory profile. Other events in the 1970s, such as the OPEC oil crisis (1974), regulatory changes in the railroad industry (due to the Railroad Revitalization and Reform Act, 1976), and recommendations from the National Transportation Policy Commission (a congressional commission established in 1976), added fuel to the fire. As a result, and in an effort to break down noncompetitive practices and advance efficient operations, deregulation in the trucking industry began in 1978, when the Interstate Commerce Commission (ICC) made a series of minor regulatory changes, and was formalized in the Motor Carrier Act of 1980.

[3] In the U.S. trucking industry, publication requirements associated with regulation allowed the rate bureaus to be informed about rate cuts and to distribute this information to firms before a new rate was introduced in the market. The resulting immediate price matching dampened firms' expectations about the potential rent generation from cutting rates, and in turn, decreased incentives to cut rates. Since information on rate cuts was made available to firms prior to a rate's effective introduction date, firms also were in a position to protest rate cuts. By 1962, 90 percent of all rate decreases in the trucking industry were formally protested as compared to 40 percent in 1946 (Nelson, 1965: 406).

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Institutional change

Deregulation dramatically influenced trucking firm operations and the industry structure by easing restrictions on entry, reducing service controls and the rate bureaus' power, and eliminating (geographic) operating authority restrictions (Johnson and Schneider, 1990; Rakowski, 1990). For one, by removing the rate bureaus' abilities to collectively set rates (prices) and modifying service controls, deregulation created a market situation where negotiations for rates reflected the service mix provided. These conditions increased competition among trucking firms by allowing shippers (buyers of trucking services) to make trade-offs in services and rates in the bargaining process. Shippers began to evaluate carriers on various dimensions (e.g., transit time, reliability, quality, financial stability, delivery service, willingness to negotiate) and became more involved in the carrier selection process. Firms responded by investing in, and developing, resources and capabilities associated with service promotion (Johnson and Schneider, 1990). These activities, aimed at customer acquisition and retention, were new ways of doing business for incumbent firms.

Shifting attention to geographic restrictions, under regulation, trucking firms transported specific types of freight from point to point based on approval by the Interstate Commerce Commission (ICC). Geographic constraints prohibited trucking firms from pursuing traffic that would allow them to balance their truckloads; in turn, productivity and operating efficiency suffered (Ying and Keeler, 1991). In addition to opening the industry's doors to Entrants, deregulation allowed incumbent firms to expand geographically and to realign their route structures. These conditions enabled firms to grow in ways not feasible under regulation. For instance, under regulation, an incumbent's hub and spoke system was limited to serving a specific ICC authorized territory; after deregulation, firms were able to grow by expanding their existing systems to serve the entire nation. As a result, the LTL sector's four-firm concentration ratio grew from 23 percent in 1978 to 42 percent in 1987 (Boyer, 1993). Geographic expansion and route realignment also contributed to gains in firms' long-run technical efficiency and productivity (Corsi and Stowers, 1991). For instance, carriers increased their annual vehicle miles per truck, average load, and average length of haul during the first seven years of deregulation (Corsi and Stowers, 1991). Despite these benefits, the combination of geographic expansion, route restructuring and entry gave rise to excess capacity post-1980. Consequently, the exit rates of small and large members of the Incumbent cohort were substantial (Johnson and Schneider, 1990; Rakowski, 1990). As Figure 2 shows, the number of exit events for the Incumbent cohort first peaked in 1984, then declined for three years. The exit rate began to increase again in 1987, and by 1989, the Incumbent cohort's mortality reached its highest level when incumbent exit events accounted for nine percent of the industry's population. By 1991, only 42.9 percent of the Incumbent cohort remained (see Figure 1). During the same time period, the exit rate of the Entrant (all entrants) cohort and Early entrant cohort was substantially lower than that of the Incumbent cohort. The exit rate for the Entrant cohort was relatively stable until 1987 when it began a gradual ascent peaking in 1990. The Early entrant cohort followed a similar pattern, experiencing a higher exit rate from 1987 to 1990 as compared to the pre-1987 time period.

In response to the increased competition and pricing pressure after deregulation, trucking firms also invested in process innovations in order to maintain tight operational control. For instance, there was a steady increase in computer usage for traffic analysis, cost analysis, equipment scheduling, and equipment maintenance. At the truck level, technologies new to trucking such as automatic vehicle identification, bar coding, EDI, in-vehicle navigation systems, on-board computers, and two-way communication systems helped firms reduce production costs and increase customer service (Organisation for Economic Co-operation and Development [OECD], 1992). While some of these technologies were adopted in the early 1980s, others became more widespread in the mid-to-late 1980s. For example, on-board computer usage rapidly diffused across the industry beginning in 1987, whereas the use of automatic vehicle location (AVL) and long-distance, two-way communication technologies grew exponentially in the late 1980s. These technologies eliminated the costs associated with "frequent driver check calls" between drivers and dispatchers, allowed firms to match shipment loads with equipment more efficiently, and in turn, reduced the number of empty miles traveled by as much as eight percent (Organisation for Economic Co-operation and Development [OECD], 1992:

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109).[4] In addition to cost savings, these process innovations enabled firms to provide more accurate delivery and service information to shippers.

Summary

On the surface, the service and operational investments needed for competing under deregulation seemed readily available to both Entrants and Incumbents. One might even suggest that Incumbents had time to anticipate the types of investments required for success under deregulation. However, piecemeal plans made by the ICC in late 1970s coupled with the chance that the U.S. courts or Congress could step in and modify or reverse these plans created substantial uncertainty for both Incumbents and Entrants regarding how deregulation ultimately would roll out (Derthick and Quirk, 1985). Additionally, incumbent firms often inaccurately estimate how deregulation will unfold (Leone, 1986). In the trucking industry, CEOs of several incumbent firms were surprised by how difficult it was for other incumbent firms to adjust their operations to the new regime (Johnson and Schneider, 1990). These conditions reinforce our question regarding what types of firms are able to sustain an advantage following the industry shock.

DATA

Data sources

The data stem from annual reports, or "Form M" reports, provided to the Interstate Commerce Commission (ICC) from 1976 to 1993. Since we are interested in the how abnormal profits of different cohorts evolve following deregulation, we focus on firms' histories from 1980 to 1993. Prior to 1980, all firms with revenues exceeding $500,000 (referenced as Class I and II) were required to file comprehensive annual reports. The reports include data on firm income, asset base, revenues, equipment, operating expenses, revenue from equipment, organizational relationships, general operations, and location. Carriers with revenues between $100,000 and $500,000 (Class III) were permitted to file less comprehensive reports. Data on firm age were provided separately by the ICC and confirmed using archival sources. After 1980, the ICC's reporting threshold changed to $1,000,000. Even though the ICC's reporting requirements changed after deregulation, five percent of the firms we observe earned revenues less than $1,000,000. In the mid-1980s, a truck running at average productivity generated between $100,000 and $130,000 in annual revenues (Silverman, Nickerson, and Freeman, 1997). The tail end of our size distribution thereby includes firms operating between 1 and 10 trucks. The core of the distribution however represents, on average, firms generating more than $1,000,000 in revenues. The generalizability of our findings is thereby limited to firms of a minimum size. This approach, however, is consistent with prior studies of profit persistence.

We take several steps to ensure the representativeness of our sample. First, the size floor must be considered when defining firm exit and identifying *de novo* entrants. It is possible that a firm that is missing from the ICC's database did not exit the industry, but is still alive with revenues below $1,000,000. To verify our data, we examined the Verizon Yellow Pages by state for the existence of firms that had exited the ICC's database. If a firm did not exist in the Yellow Pages for two consecutive years, we cross-checked the Internet and trucking industry periodicals for postings in the firm's name. A firm was considered to have exited the industry when: (1) it was absent from the industry, based on these sources, for at least two years and never returned; and (2) when it had not been acquired by another firm. We also investigated merger activity in the industry following deregulation. Overall, the frequency of mergers was fairly low (Boyer, 1993; Rakowski, 1990). Firms chose to purchase bankrupt carriers' assets rather than acquire the carriers as organizations. When acquisitions did occur, the acquired firms tended to continue operations as stand-alone entities and continued to file separate Form Ms with the ICC. We include these stand-alone firms in our sample. As mentioned above, we used multiple resources to verify the event histories of the firms in our sample, and in the case of Entrants, to confirm that each new firm was *de novo*. The subsequent paragraphs

[4] On average, drivers made three check calls to the dispatcher per day and calls often took up to 45 minutes because drivers were frequently put on hold while the dispatcher was speaking to other drivers. AVL and long distance, two-way communication technology allowed a dispatcher to identify a vehicle's location so the driver did not have to stop to make a check call. Messages also could be transmitted to drivers en route and drivers could notify the dispatcher if they needed additional route information.

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specify the samples, constructs, methods, and robustness checks used in our analyses.

Defining cohorts

As previously noted, our analysis focuses on three cohorts of firms: (1) Incumbents: firms that entered before the institutional change and continue to compete in the new environment; (2) All entrants: all firms that started up in the industry after the institutional change; and (3) Early entrants: the set of firms that entered the trucking industry during the early (first four) years following the institutional change (1981–1984). We use multiple years, instead of one year, to define the Early entrant cohort because research suggests that firms that enter during the early years of an industry's development play a crucial part in shaping future competition (Geroski, 1995; Klepper, 2002). We conducted sensitivity analyses to examine alternative cohort definitions using firms that entered (1) in the first year after deregulation, (2) in the first and second years, and (3) during the first three years. The results using these other definitions are consistent with those reported here. We first test whether the advantages of Early entrants with superior profits persist or converge. Next, we examine whether the profit advantages of the Full cohort of entrants erode at a faster rate (persist for a shorter time or lower rate) than those of the Incumbent cohort.

MODEL SPECIFICATION AND ESTIMATION

We use two methods to test the theory. The two-method design allows us to offer robust theoretical tests while also suggesting alternative approaches for exploring whether superior profits are temporary or more enduring after a fundamental industry change. We describe each method in turn.

Method 1

Following prior research on profit persistence, we estimate the rates at which superior profits persist (or converge) separately for each cohort using a first order autoregressive process as follows:

$$r_{it} = \alpha_0 + \rho r_{it-1} + \boldsymbol{\beta X}_{it} + \varepsilon_{it}, \qquad (1)$$

where the abnormal profit of firm i in period t, r_{it}, is defined as the return on sales (ROS) for firm i in period t minus the industry average ROS; $\boldsymbol{X}$ denotes a set of control variables and $\boldsymbol{\beta}$ represents the corresponding coefficients. The control variables include firm size defined as the natural log of a firm's assets; efficiency, defined using operating costs per revenue mile (this item is reverse scored); and a selection parameter, λ, to control for the impact of sample selection bias (Heckman, 1979). We use Lee's (1979) generalization of Heckman's (1979) two-stage sample selection model. The selection model includes an organization's size and net income as well the density and mass of Incumbents and Entrants.

Most work on profit persistence uses average industry profitability as an indicator of an industry's "norm" (e.g., McGahan and Porter, 1999, 2003; Mueller, 1986). In Equation 1, the coefficient on the lagged dependent variable, ρ, is the persistence rate. Since we are interested in the extent to which firms in a cohort are able to sustain a profit advantage, persistence is defined as the percentage of total abnormal profits in any period before t that remain in period t.[5] In other words, the coefficient ρ indicates the rate at which abnormal profits approach a common level (converge) or endure (persist) in the short run. A value greater than zero and less than 1 suggests the persistence of abnormal profits; a value less than zero and greater than (-1) indicates convergence. A persistence rate that is positive and small in magnitude suggests that an advantage is more transient, whereas a persistence rate that is positive and large in magnitude suggests that an advantage is more enduring. Consistent with prior work, we reference firms with abnormal profits greater than zero as superior, or above average,

[5] Early work applied a narrower definition for persistence that excluded permanent or stable effects, focusing attention on the percentage of the transient or incremental component of abnormal profits (see McGahan and Porter, 2003; Mueller, 1986; Waring, 1996). In this approach, abnormal profits consist of two components: a permanent or stable component representing the portion of abnormal profits that is unchanged over time and a transient or incremental component, representing the portion of abnormal profits that are unique to a given year, and thus, temporary. Scholars argued that it was necessary to focus on the incremental portion of abnormal profits that persists rather than the total percentage of abnormal profits that persists in order to overcome potential issues that might arise due to arbitrary starting points for analyses. This approach also required special interpretation of the effects. In contrast with prior work, the starting point for our analysis is not arbitrary, but instead, defined by a fundamental institutional change. As a result, and given our interest in understanding whether firms within a cohort are able to sustain a profit advantage, persistence is defined as the percentage of total abnormal profits in any period before t that remain in period t.

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performers and firms with abnormal profits less than zero as poor, or below average, performers.

Equation 1 is a dynamic panel model. Several econometric issues may arise when estimating Equation 1. One, firm fixed effects may be correlated with the explanatory variables. The fixed effects are contained in the error term, which consists of the unobserved firm-specific effects and the observation-specific errors. Two, the presence of the lagged dependent variable may give rise to autocorrelation. Further, the panel data for each cohort has a large number of firms (N) and a shorter time dimension (T = 14 years). Given these conditions, consistent estimation of Equation 1 can be achieved using the generalized method of moments (GMM) estimator (Arellano and Bond, 1991). The method removes panel-specific heterogeneity (e.g., firm fixed effects) by first differencing the regression equation, accommodates unbalanced panel data, allows for the specification of endogenous variables, and is viewed as superior to alternative estimation methods for fixed effects models with a lagged dependent variable (Mileva, 2007; Roodman, 2009). Controlling for firm fixed effects also mitigates concerns about other firm-specific drivers of persistence. Consistent with GMM requirements, our data do not suffer from second or higher order serial correlation of the idiosyncratic errors and all estimations pass the Sargan test (see Arellano and Bond, 1991).

To test for differences in the convergence or persistence of abnormal profits, we estimate the model using data on the superior performing firms (abnormal profits >0) in each cohort. Regarding the Early entrant cohort, support for convergence exists when $(-1) < \rho < 0$ and support for persistence exists when $0 < \rho < 1$. Next, we compare the persistence rates for the Full entrant cohort and the Incumbent cohort using a modified Wald statistic (the statistic adjusts for differences in sample sizes among the cohorts). Our prediction is supported if the persistence rate for the Incumbent cohort is larger in magnitude than the persistence rate for the Entrant cohort *and* the associated Wald statistic indicates that this difference is statistically significant.

Method 2

As a robustness check, we employ a second method to estimate how rapidly the cohorts adjust their abnormal profits following deregulation. A higher rate of adjustment will lower the *deviations* of firms' profits from the steady state. For instance, if firms, on average, adjust rapidly to deregulation, then one might expect to observe a convergence pattern, where profits above the industry norm decline toward it over time. This pattern would suggest that profit advantages are temporary or brief in duration. Lichtenberg (1994) suggests a conservative test for convergence that uses the coefficient on the lagged dependent variable and a partial adjustment model's R^2 (see also Carree and Klomp, 1997). Building on this work, we estimate firms' rates of change in ROS using a partial adjustment specification. We then test for convergence following Lichtenberg's approach. We begin with the theoretical representation of the model:

$$S_i(t + \Delta t) - S_i(t) = r\Delta t \left[S_i^*(t) - S_i(t)\right], \quad (2)$$

where S_i is return on sales (ROS), S_i^* is a target ROS value toward which forces are impelling S_i, and r is the speed or rate of adjustment (Davidson and MacKinnon, 1993; Greene, 1993; Tuma and Hannan, 1984). In this model, a higher value of r indicates a faster adjustment process and suggests that past shocks have a lower impact on current performance. In Equation 2, as $t \to 0$:

$$dS_i/dt = r\left[S_i^*(t) - S_i(t)\right]. \quad (3)$$

When r = 1, we observe full adjustment over t and, as r approaches 0, no adjustment occurs. The parameter r can be compared across populations or subpopulations such as cohorts (Hannan and Freeman, 1984). S_i^* in Equations 2 and 3 can be specified as a linear function of firm and industry level observables, $\boldsymbol{X}_i$:

$$S_i^* = \boldsymbol{\beta X}_i(t). \quad (4)$$

The firm level variables include the main components of Nelson and Winter's growth system (1982: ch. 12): *Size* is defined as the natural log of a firm's assets; *efficiency* is defined using operating cost per revenue mile (this item is reverse scored); *net income* is a line item on the ICC's annual reports; and *capacity expansion* is defined as the change in number of trucks operated by a firm over time. Capacity expansion captures the extent to which a trucking firm has expanded its primary units of production relative to the prior time period. We also include the natural log of firm age as a control

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variable. We model competitive pressures using density measures, the conventional approach in organizational evolution research (Hannan and Freeman, 1989). We define these effects separately for Entrants and Incumbents. The density of incumbent firms is defined as the number of incumbents competing in the industry minus 1 when the focal firm is an incumbent. Density of Entrants is defined in a similar fashion. Similar to the persistence model, the partial adjustment model includes a selection parameter. All variables are time varying and lagged one year.

Estimating the model requires substituting Equation 4 into Equation 3, $dS_i/dt = r[\boldsymbol{\beta X}_i(t) - S_i(t)]$ and solving for S_i:

$$S_i(t + \Delta t) = e^{-r\Delta t} S_i(t) + \left(1 - e^{-r\Delta t}\right)\left(\boldsymbol{\beta X}_i(t)\right). \quad (5)$$

Equation 5 cannot be estimated directly. Following Coleman's (1968) approach and that of prior studies, we assume linear change in the independent variables and integrate Equation 5 to generate an estimator that uses the level of each variable at *t* and its year over year change, Δt. In our data, Δt is one year; as a result, we can further simplify by substituting α for $e^{-r\Delta t}$ yielding:

$$S_i(t + \Delta t) = \alpha S_i(t) + (1 - \alpha)\left(\boldsymbol{\beta X}_i(t)\right). \quad (6)$$

Equation 6 can be restated in the general form:

$$S_i(t + \Delta t) = \alpha S_i(t) + \boldsymbol{\beta}_1 \boldsymbol{X}_i(t) + \boldsymbol{\beta}_2 \Delta \boldsymbol{X}_i(t). \quad (7)$$

We estimate weighted GLS coefficients in Equation 7. Specifically, we use the GLS estimates to calculate the parameters in the differential equation form of the model as follows:

$$r = -\ln(\alpha); \quad (8)$$

$$\boldsymbol{\beta} = -\boldsymbol{\beta_1} r \,/\, (\alpha - 1); \text{ and} \quad (9)$$

$$\boldsymbol{\beta} = \boldsymbol{\beta_2} r^2 / \,(\alpha - 1 - \ln(\alpha)). \quad (10)$$

Equations 9 and 10 define two approximations for $\boldsymbol{\beta}$ (Tuma and Hannan, 1984). Following Tuma and Hannan (1984: 344), we estimate $\boldsymbol{\beta}$ by taking the average of Equations 9 and 10. The significance levels are based on joint *F*-tests on the $\boldsymbol{X}_i$ and $\boldsymbol{\Delta X}_i$ parameters from Equation 7. This approach, however, does not yield standard errors for the estimated parameters.

We take several steps to ensure robustness. Given the dynamic nature of the model, OLS estimates may be biased due to correlation of the lagged dependent variable with a lag of the disturbance term. We correct for this potential bias by using a deviation from the firm means approach; mean centering removes unobservable firm-level fixed effects (Greene, 1993; Nickell, 1981). We also control for heteroskedasticity in the error term by using a proportionality variable based on firm size (Greene, 1993). In our framework, we divide each variable in the partial adjustment equations by the square root of firm assets. Third, as noted above, we include a selection parameter to control for the potential impact of sample selection bias (Heckman, 1979).

The degree of convergence depends on α, the coefficient on the lag dependent variable, and on the R^2 of Equation 7. Dividing R^2 by α^2 provides a test statistic for convergence that approximates to an *F* distribution (Lichtenberg, 1994).[6] A significant *F* value indicates support for the convergence logic. As noted above, our estimator is based on GLS, but this method does not generate an R^2 value. As a result, we use OLS with robust (e.g., Huber/White) variance estimates to generate the R^2 values.

RESULTS

Table 1 includes the correlation matrix and descriptive statistics for the population (all cohorts), and Table 2 provides additional descriptive details on the differences between the Entrant and Incumbent cohorts. Figure 3 charts the annual average abnormal ROS for each cohort. Table 3A and 3B present the results of GMM specification for each cohort and the population for two samples: (1) superior performing firms, and (2) all firms (superior and poor performing). Table 4 reports our comparison of the persistence rates for the Incumbent and Entrant cohorts and Table 5 presents the results of

[6] Research suggests that Lichtenberg's test is biased toward showing no convergence and notes that Lichtenberg incorrectly identifies the degrees of freedom for the denominator and numerator as N-2 instead of N-1. We adjust the df when defining significance levels for the test. Moreover, if the test is biased toward no convergence, and convergence is found, the result would seem to suggest a conservative test of convergence. It is important to note that this test augments the traditional autoregressive approach.

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Table 1. Correlations and descriptive statistics

Variable	Mean	Std. dev.	1	2	3
1 Abnormal ROS	0.002	0.10	1.0		
2 Size	14.67	1.52	0.13	1.0	
3 Efficiency	2.13	1.63	0.05	−0.03	1.0

*p < 0.01.

Table 2. Comparison of means, Entrants and Incumbents

	Entrants	Incumbents	Comparison of means
Variable	Mean values		(t values)
Size (assets)	1,963,030.48	2,649,813.14	10.29****
No. of trucks	93.75	146.05	5.24****
Operating cost/revenue mile	1.96	2.17	6.84****

****$p < 0.0001$.

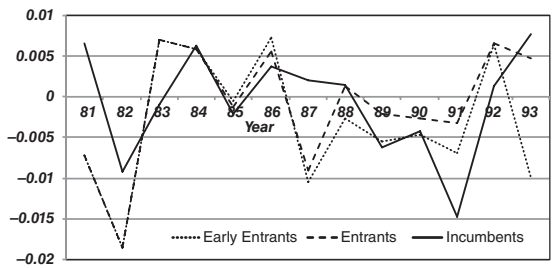

Figure 3. Average abnormal ROS by cohort, 1981–1993

our additional robustness check. We begin by discussing Figure 3 and the descriptive statistics.

Figure 3 suggests that there is a lack of convergence in the average abnormal performance among cohorts (superior and poor performing firms) during the first 10 years after deregulation. Considering the data in aggregate, the average abnormal performance is 0.002 for the Incumbent cohort, 0.003 for the Entrant cohort, and 0.001 for the Early entrant cohort. However, examining the averages over time reveals important differences among the cohorts. Figure 3 shows that the average abnormal performance of all three cohorts declined during for the first two years of deregulation and then rebounded from mid-1982 to 1984, with all three cohorts, on average, achieving positive abnormal performance. The data also show that, for 1983–1984 and 1985–1986, the average abnormal performance of the Entrant cohort overall, and the Early entrant cohort specifically, were greater than that of the Incumbent cohort. However, the average abnormal performance of Incumbents remains positive from mid-1985 to 1988, whereas both Entrant cohorts experience a decline in average abnormal performance from 1986 to 1987. After 1987, the data suggest that members of the Early entrant cohort and the Full entrant cohort struggle to achieve positive abnormal profits and from 1988 to 1991, members of the Early entrant cohort appear worse off than the cohort that includes Late entrants. During this same period, members of the Incumbent cohort also struggled to gain an advantage, and by 1991, the Incumbent cohort has the lowest average abnormal performance among all three cohorts. By 1992, all three cohorts have rebounded, but after 1992, the average abnormal performance for all three diverges again.

What factors might explain this heterogeneity? Table 1 shows low correlations among the variables of interest. Firm (ln)size is negatively correlated with operating efficiency, suggesting that after deregulation, large firms are less efficient. This finding is consistent with the descriptive statistics reported in Table 2. For example, after deregulation, the average Incumbent is 25 percent larger in size (total assets) and operates 36 percent more trucks than the average Entrant; the comparison of means tests reported in Table 2 indicates that these differences are statistically significant.

Does the incumbent firms' larger asset base contribute to greater operating efficiencies? Interestingly, the answer is no. After deregulation, incumbents' operating costs per revenue mile were about 10 percent greater than those of the average Entrant; the difference is statistically significant. In fact, incumbents' operating costs per revenue mile exceeded those of Entrants throughout our period of observation. Despite this higher cost structure, the average abnormal performance of superior performing incumbent firms surpassed that of superior performing Entrants from 1986 to 1990; this pattern reverses after 1991. In sum, these results suggest that even though the average Incumbent is larger than the average Entrant, the stock of physical resources may be less important for a firm's operating efficiency than the capabilities of managing them.

Shifting attention to our tests, the first part of our analysis focuses on the Early entrant cohort. The findings show that the advantages held by superior performing Early entrants persist at a rate

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Table 3. The persistence (convergence) of abnormal profits, U.S. trucking industry, 1980–1993[a–c]

	(A) Superior performing firms				(B) All firms (superior performing and poor performing)			
Variable	Early entrants 1	Entrant cohort 2	Incumbent cohort 3	Population 4	Early entrants 5	Entrant cohort 6	Incumbent cohort 7	Population 8
r_{t-1} (ρ)	0.21****	0.22****	0.28****	0.35****	0.30**	0.08****	−0.62****	−0.58****
	(0.01)	(0.002)	(0.08)	(0.08)	(0.12)	(0.003)	(0.17)	(0.19)
Size	−0.01	−0.003	0.001	0.001	0.01	0.02*	0.05****	0.04****
	(0.01)	(0.01)	(0.01)	(0.006)	(0.01)	(0.01)	(0.01)	(0.01)
Efficiency	0.002	0.0001	−0.00002	0.0001	0.0007	0.0001	0.0006*	0.0006*
	(0.001)	(0.0001)	(0.0001)	(0.0001)	(0.0008)	(0.0001)	(0.0003)	(0.0003)
Selection parameter	−0.05	−0.03**	−0.02****	−0.02****	−0.01	−0.005	0.006	0.005
	(0.03)	(0.01)	(0.004)	(0.004)	(0.01)	(0.01)	(0.004)	(0.003)
Firm effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald χ^2	46.89**	68.25****	245.50****	260.87****	32.51**	38.68**	150.54****	151.07****
N	623	929	5652	6581	1130	1630	9982	11612

[a] Robust standard errors are in parentheses.
[b] Generalized method of moments (GMM) estimation with dependent variable = abnormal ROS.
[c] Specification tests indicate no second order (or higher) serial autocorrelation in the first differenced idiosyncratic errors.
*$p < 0.05$; **$p < 0.01$; ****$p < 0.0001$.

Table 4. Comparison of persistence rates, superior performing firms

Comparison of persistence rates	*Wald* χ^2
$\rho_{\text{Entrants}} = 0.22 < \rho_{\text{Incumbents}} = 0.28$	56.27**

**$p < 0.01$.

of 21 percent (Table 3A, Model 1) and suggest that the first cohort plays a critical role in shaping the industry's evolution after a fundamental regulatory change. One might ask whether the advantages held by subsequent cohorts of entrants persist or converge. To explore this issue, we replicated the analysis for a cohort of Late entrants, defined as firms entering the industry from 1987 through 1990. The results indicate that any advantages held by superior performing Late entrants converge, albeit relatively slowly (rate = 2%). The difference in rates is statistically significant (Early entrants versus Late entrants, $X^2 = 515.62$, $p < 0.001$; results available from the authors on request). Consistent with this observation, from 1988 to 1991, the Late entrant cohort also experiences a higher exit rate as compared to the Early entrant cohort. These results reinforce the intense competition present in the industry as the time since deregulation accrues and suggest that entering the industry during the early years following deregulation may confer benefits, such as competitive, operating and customer relationship experience, that are less accessible to Late entrants.

Next, we compare the persistence (convergence) effects for the Full entrant cohort and the Incumbent cohort. The findings demonstrate that the advantages of superior performing firms in the Full entrant cohort persist at a rate of 22 percent (Table 3A, Model 2) whereas those of the Incumbent cohort persist at a rate of 28 percent (Table 3A, Model 3). The difference in persistence rates is statistically significant (Table 4, $X^2 = 56.27$, $p < 0.01$). When we pool cohorts, the persistence rate is 35 percent (Table 3A, Model 4, Population). Considering this result in light of the other findings suggests that *disaggregating the full population into cohorts reveals important differences in the duration of an advantage*. Indeed, ignoring cohort effects may lead scholars to overestimate how long an advantage may be sustained. The findings also allow us to estimate the duration of an advantage.[7] A persistence rate of 28 percent indicates that superior performing incumbents sustain their profit advantages for about three years and six months, whereas a persistence rate of 22 percent indicates that superior performing Entrants sustain their profit

[7] Defined as (ln(1 – p)/ln(b)), where p is the percent of advantage sustained and b is the persistence parameter (Clarke, 1976).

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Table 5. Results from partial adjustment (PA) models, U.S. trucking industry, 1980–1993[a]

	Superior performing firms			
Variable	Early entrants 1	Entrant cohort 2	Incumbent cohort 3	Population 4
α = coefficient on ros_{it-1}	0.09	0.065	0.268	0.257
R^2	0.22	0.19	0.20	0.19
Convergence test $F = R^2/\pi^2$	25.56*	45.65**	2.78*	2.94*
AdjR^2	0.20	0.18	0.19	0.19
Log likelihood	2191.62	3525.44	17948.82	21372.12
N	623	929	5652	6581

[a] The PA models (dep. variable = ROS) include fixed effects using a mean-centering approach and include year effects using year dummy variables (refer to the data section for a description of the additional independent variables). Weighted least squares estimation was used to correct for heteroskedastic errors.
*$p < 0.05$; **$p < 0.01$.

advantages for about three years. Consistent with the results for the Full entrant cohort, superior performing Early entrants sustain a profit advantage for roughly two years and 11 months; in contrast, the majority of the profit advantage held by Late entrants erodes within 12 months. In sum, the advantages held by superior performing firms in the Early entrant cohort and the Full entrant cohort are more temporary than those held by superior performing incumbent firms. While the findings are consistent with the traditional indicators of profit persistence, holding an advantage for 3.5 years or less suggests marginal persistence and a lack of sustained advantage.

Connecting these findings to the context, while the profit advantages of superior performing incumbent firms persists, only 42.9 percent of the incumbent population survived the transition to the new regime (see Figures 1 and 2). In contrast, 88 percent of the Early entrant cohort survived through 1991. Shifting attention to the Full entrant cohort, although the profit advantages of superior performing Entrants persist at a lower rate relative to the Incumbent cohort, the Entrant cohort grew approximately 2.5X during the course of deregulation. By 1991, the Entrant cohort was almost half the size of the Incumbent cohort; whereas in 1981, the size of the Entrant cohort was about 7.8 percent of the Incumbent cohort.

Regarding the control variables, the effects associated with size and efficiency are not significant in any of the models whereas the control for sample selection is negative and statistically significant, albeit small in magnitude, for the Entrant cohort, Incumbent cohort and the full population. The lack of statistical significance for efficiency suggests that, in the trucking industry after deregulation, increased competitive intensity may have threatened profits more than opportunities to reduce operating costs (Jayaratne and Strahan, 1998; Winston, 1993).

Recall that we use a partial adjustment model and an additional test for profit convergence as a robustness check. Table 5 reports parameters from the differential equation form of the partial adjustment model that inform the Lichtenberg convergence test. Models 1, 2, 3, and 4 in Table 5 report the test results for the superior performing firms in the Early entrant cohort, the Entrant cohort, the Incumbent cohort and the full population, respectively. As mentioned above, the F tests indicate convergence for all three cohorts and the population as a whole: Early entrant cohort: $F = 25.56$, $p < 0.05$; Entrant cohort: $F = 45.65$, $p < 0.05$; Incumbent cohort: $F = 2.78$, $p < 0.05$; and the full population of superior performing firms: $F = 2.94$, $p < 0.05$; we also find convergence for the Late entrant cohort ($F = 7.25$, $p < 0.05$). Recall that the Lichtenberg test is conservative. Given this and that the F value for the Incumbent cohort is near the lower bound for statistical significance, the findings imply that the profit advantages of superior performing Incumbent firms may persist rather than converge. This interpretation is consistent with the findings reported above.

Additional findings

Table 3B includes the persistence results for all firms (superior performing and poor performing pooled) in the industry by cohort and provides a naïve view of our analyses. Since this pooled

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analysis does not isolate superior performers (those with an advantage) from poor performers (those with a disadvantage), the interpretation of the parameters differs from our prior discussion. For instance, when we combine poor performing and superior performing incumbents, the findings suggest that the average profits of incumbent firms converge rather than persist. The pooled result implies that the effects of poor performing firms tend to dominate those of superior performing firms. This interpretation is consistent with the trends discussed above—a large portion of the incumbent population struggled to adjust after deregulation ensued, and by 1991, only 42.9 percent remained in the industry. Alternatively, we find that the average profits of Early entrants and the Full entrant cohort persist rather than converge.

DISCUSSION

Returning to one of the motivations for this study, we show that the stages of firm and industry evolution matter quite strongly in examining the persistence (convergence) of profit advantages. An institutional shock resets an industry's clock, segmenting an industry's population of firms into two cohorts—Incumbents with a legacy of competing in the prior institutional regime and Entrants with no history in the industry. We find that, after deregulation, the persistence rates for these two cohorts differ dramatically. Thus, following a fundamental disruption to an industry's development, differences in firms' histories are crucial to understanding the temporal dimension of advantage. While the resource-based view and organizational learning literatures emphasize that firm-specific cumulative experience contributes to differences in competitive behavior (e.g., Argote, 1999; Barney, 1991; Dierickx and Cool, 1989), empirical work on the persistence of a profit advantage ignores this important source of heterogeneity. It would be reasonable to presume that following a shock to an industry, firms that are not constrained by obsolete practices would be better positioned to gain and sustain an advantage. Yet, our findings show the opposite: after deregulation, superior performing Incumbents sustain an advantage longer than Entrants. This result is counterintuitive since Entrants are not constrained by a legacy of competing under regulation. Consistent with the traditional theory of industry evolution, the profit advantages of superior performing firms in the Early entrant cohort also are short-lived. Given the differences in persistence rates, it would seem prudent to consider the shocks an industry has experienced, and in turn, the stages of firm evolution and industry evolution in future empirical work examining the persistence of profit differences within and across industries.

What else might contribute to the differences in persistence rates among the Entrant and Incumbent cohorts? One explanation is that incumbent firms' experiences from regulation initially attenuate their adaptation to deregulation. During this period, Entrants might compete more intensely with other Entrants. As time since deregulation increases, however, Incumbents may eventually catch up to Entrants and become more formidable competitors. Thus, Entrants' initial advantages appear to be temporary. Cockburn, Henderson, and Stern (2000: 1141) find a similar result. In their study, firms that were initially behind "were able to catch up to their more advanced competitors." An additional alternative explanation for the differences in persistence rates of Entrants and Incumbents is that the sources of advantage in the aftershock period are more volatile (see Thomas and D'Aveni, 2009) and that entrants are more susceptible to this volatility relative to incumbent firms. If this logic holds, then entrants may struggle to sustain superior profits more than incumbent firms, and in turn, die at a faster rate than incumbent firms. When we compare cohort specific exit rates—the number of exit events in a cohort relative to cohort density (instead of the # of exit events relative to total population at risk, as reported in Figure 2)—we find that a larger proportion of the Entrant cohort exits the industry from 1981 to 1983, and from 1987 to 1990 as compared to the Incumbent cohort. It is not surprising that a larger proportion of entrants exit during deregulation's early years; however, from 1984 to 1986, the two cohorts experience a similar amount of attrition (~7–8%).

These observations lead to us to ask: Under what conditions will entrants be more susceptible to volatility in the sources of advantage post-industry shock as compared to incumbents? Prior work emphasizes the differential impact of an industry shock on incumbents as well as entrants (Thomas and D'Aveni, 2009), but says less about how volatility in the sources of advantage may contribute to differences in cohorts' persistence rates after an industry shock. Adapting to a deregulated environment requires not only technical competence, but

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also robust relationships with institutional actors such as regulators. At the time of deregulation, each incumbent firm has an established position that represents its reputation, political influence, and other forms of legitimacy (Hannan, 1998), whereas entrants must build these relationships from scratch. If incumbents' positions are fragile, then after deregulation ensues, they would need to establish new interorganizational relationships to rebuild legitimacy. In contrast, if incumbents' positions are robust, they can devote less attention to developing legitimacy, freeing up resources to support adapting to the new technical environment. As the need to invest in legitimacy declines, the amount of competitive pressure firms can impose on rivals should increase since, according to Meyer and Rowan (1977), investments in building legitimacy and technical competence are substitutes. In comparison, entrants must invest in building legitimacy while adjusting to competition under regulation. Our findings suggest that after the industry shock, the positions held by superior performing incumbent firms were more institutionally robust than fragile. These firms retained some residual benefits from the institutional relationships they developed under regulation. As a result, superior performing incumbents may be less susceptible to volatility in the sources of advantage post-shock as compared to entrants. Future research might explore these dynamics in more depth to develop a comprehensive picture of how volatility in the sources of advantage affects the persistence (convergence) of superior profits among cohorts after an industry shock.

The findings also raise questions about the definition of temporary advantage. As noted above, after the shock, incumbent firms sustain their advantages for about three years and six months, six months longer than entrants. Are these temporary advantages? On the surface, one might answer yes. But, what defines temporary? The answers to these questions are unclear. Prior work shows that persistence rates vary by industry classifications. Our findings demonstrate that that persistence rates also vary by the stage of firm evolution and the stage of industry evolution. Thus, four conditions that inform the duration of profit advantages are the timing of an industry shock, the stage of an industry's evolution, the timing of a firm's entry to an industry (cohort effects), and the stage of a firm's evolution. Under what conditions is a temporary advantage sufficient, if at all? Previous studies control for industry effects, but future work might explore the time or history based origins of heterogeneity in each industry in more depth to inform our understanding of profit dynamics (Pacheco de Almeida and Zemsky, 2007). For instance, in industries where technology is continuously changing, such as the semiconductor industry, firms might succeed with a series of temporary advantages (Madsen and Leiblein, 2007, 2015). The duration of these advantages may be tied to the industry's rate of technological change. In less dynamic spaces, a temporary advantage might be longer in duration.

Our results also evoke questions regarding whether the outcomes of regulatory reforms align with their intent. State or federal institutions employ regulations in an attempt to address market failures and to solidify a stable set of market and nonmarket relationships among relevant actors. A byproduct of this stability is decreased competition, and in turn, reduced incentives for firms to develop efficient operations (Madsen and MacGregor, 2013; Winston, 1998). It follows that under regulation, firms' profits are somewhat protected. In the United States, six industries were subject to stringent regulation for decades (trucking, airlines, railroads, telecommunications, natural gas, and banking [interstate and intrastate]) prior to the introduction of price and entry deregulation in the 1970s and 1980s. After deregulation, incumbents gained opportunities to enhance operating efficiencies, but also experienced intense competition. One might expect then that deregulation would fundamentally disrupt incumbent firms' abilities to develop and sustain superior profits. We find the reverse—controlling for selection effects, a portion of the Incumbent cohort develops persistent profit advantages in the new regime. This counterintuitive result is consistent with a pattern observed in intrastate banking, where incumbent banks with market-based performance (ROE) above the median were able to capture 15–25 percent more market share after deregulation ensued (Stiroh and Strahan, 2003; Strahan, 2003). A study in the airline industry also shows that variation in the absolute profits of incumbent firms did not change substantially after deregulation (Walker *et al.*, 2002). Thus, while deregulation shakes out inefficient firms, it may strengthen, rather than disrupt, the profit trajectories of superior performing incumbent firms over time.

Shifting attention to the study's limitations, one question is whether including very small trucking firms, for which data were not available, might

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alter our results. One possibility is that very small incumbents endure because of size-based competition, which occurs when small firms occupy protected niche markets. Size-based competition is apparent when there is a persistent, abnormally high frequency of small firms in the size distribution of the population, which would otherwise be log-normal. This is not the case in the trucking industry after deregulation; the size distribution is consistent with log-normality and has no irregularity in the left tail. Therefore, we feel confident that our findings have broad generalizability. In addition, the omission of very small firms is consistent with prior studies exploring profit persistence (for example, McGahan and Porter, 1999, 2003). Additionally, future work might examine the profit persistence patterns of different types of entrants such as those spawned from incumbent firms. For instance, spin-outs, ventures started by employees of incumbent firms, typically benefit from their parent firm's knowledge stocks and operating practices (Franco, 2005; Klepper and Sleeper, 2005).[8] However, after deregulation, only some of this inherited content is useful, whereas the remainder is obsolete. Under these conditions, a spin-out's inheritance may be a disadvantage and lead them to suffer the same fate as incumbents that were unable to adapt to the new institutional regime. Future studies might investigate the conditions under which knowledge inherited by a spin-out is a disadvantage rather than advantage.

How well our results extrapolate to other industries spanning longer time periods depends on the number and severity of institutional changes over an industry's history, coupled with the amount of entry after each change. We analyze a period of 13 years after deregulation; this is similar to the time periods observed by existing research on profit persistence (McGahan and Porter, 1999, 2003; Villalonga, 2004). Nevertheless, studies of industry evolution, rather than profit persistence, often extend over a much longer time period, say 75–100 years. During this extended period, it is likely that at least several changes in the institutional environment have occurred. The results of analyses performed over such a long time frame are smoothed across these changes, blending incumbents and entrants as the importance of each institutional event fades. Understanding how our results might inform research on the effects of a shock on the persistence of superior profits therefore involves exploring several questions: For one: How many significant institutional or technological shocks occurred during the time period examined? If there were only one shock, then the results presented here might be replicated. If many changes were to occur, Incumbents' and Entrants' profit advantages may be more transitory. Second: How do the persistence effects vary across stages of an industry's life cycle and how do the effects at various stages compare to those observed after a significant industry shock? For instance, if a shock resets an industry's evolutionary clock, will the persistence effects observed at an industry's inception be similar or different to those observed after the industry shock? Third: How many firms entered the industry after each change? If few firms entered, then it would be clear that the industry was consolidating; and one might contend that the dramatic industry changes were virtually insignificant in their implications for incumbents' abilities to adapt, since there was no important challenge from new firms with innovative practices.

In conclusion, this study provides an important contribution to the literature on the persistence of superior profits. Our results show conclusively that studies examining the persistence or convergence of abnormal profits should consider the stage of an industry's evolution and differences in the histories of firms. Partial convergence in superior profits of Entrants after a major industry disruption illustrates the prominent role that exogenous forces play in the durability of profit differences and that Early entrants play in an industry's redevelopment. In sum, the stage of firm and industry evolution matters.

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[8] Scholars vary in the label they assign to ventures started by employees of incumbent firms. Recent work refers to employee-backed ventures from incumbent firms as spin-outs or spawns, and incumbent-backed ventures as spin-offs (for example, Anton and Yao, 1995; Cirillo, Brusoni, and Valentini, 2013; Filson and Franco, 2006; Franco, 2005). Klepper and Sleeper (2005) refer to employee-backed ventures from incumbent firms as spin-offs.

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insights. All errors are the responsibility of the authors.

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