Corporate Management Review
Vol. 36 No. 1, 2016
pp. 1-36

Latent trajectories of competitive heterogeneity: Bridging the gap in theories between persistent performance and value creation

競爭異質性之潛在軌跡：連結持續性績效與價值創造

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Abstract: The paper aims to connect the theories of persistent performance and value creation for identifying long-term superior performers. The performance trajectories of firms are quantified using binary, annual series of seven financial indicators representing different capabilities of resource employment. We applied Latent Class Growth Analysis to the US computer-based services industry from 2000-2012, and identify two or three heterogeneous performance groups for each financial indicator. The results support the notion that outsiders can identify winners by their performance trajectories even if they are not privy to within-firm strategies or their sources. We also find that winners identified by this method are likely to continue to effectively manage resources and enhance value creation over the long term.

Keywords: Sustained competitive advantage, Present value growth opportunity, Latent class growth analysis

1. Introduction

Is the value of a firm predictable *from a series of historical performance indicators*? This is the core question of financial and strategy research. From the

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Acknowledgements: The paper is a part of the research outcome of a three-year research project, which is financially supported by the National Science Council, Republic of China (NSC 99 -2410-H-263 -008 -MY3).

perspective of financial research, the answer is clear. While the short-term market price of an asset is an unpredictable random walk (Fama, 1969), it still has an intrinsic value based on future cash flows that makes the prediction of a long-term price possible (Shiller, 1981). Such a prediction can be made using a series of historical performance indicators. This technique is used in finance and in strategy management research, though with different focuses.

Financial theories and valuation models are built on investor behavior, or equivalently on the interactions of demand and supply for underlying assets in the financial market. Strategy scholars do not predict value directly[2], even though value creation is the core of strategic management (Collis and Montgomery, 1998: 5). Rather, the primary goals of strategic management research are explaining firm performance and the determinants of strategic choices (Grant, 1996: 110). This literature connects the value created by a firm to a latent construct of sustained competitive advantage (e.g., Porter, 1985: 2; Barney, 1991: 102), and posits that sustained competitive advantage leads to superior performance (e.g., Porter, 1985: 65; Barney, 2002: 9), that is, above normal financial (or economic) profit is taken for granted as the consequence of sustained competitive advantage (Ghemawat and Rivkin, 1999: 49; Besanko *et al*., 2007: 346). Although sustained competitive advantage does not depend upon calendar time (Barney, 1991: 102), empirical studies use long-term series of performance data taken from accounting books to detect persistent superior performance, which is taken as evidence for sustained competitive advantage (e.g., Henderson, Raynor, and Ahmed, 2012; McGahan and Porter, 1997, 2003; Powell, 2003; Powell and Lloyd, 2005; Powell and Reinhardt, 2010; Ruefli and Wiggins, 2003; Wiggins and Reufli, 2002, 2005).

Unlike the previously cited literature, our paper adopts the value-price-cost (VPC) framework to examine performance heterogeneity (Hoopse, Madsen, and Walker, 2003). We posit that financial indicators reflect a firm's effective

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[2] The concepts of value creation (Adner and Zemsky, 2006) and value capture (Lippman and Rumelt, 2003a, 2003b; MacDonald and Ryall, 2004) focus on the observed cash flows that determine value. They have been used successfully to explain the dynamics of competition (e.g., Chatain and Zemski, 2011; Costal and Cool, 2013). However, they rely on a game model that is complex and hard to operate when there are hundreds of players in the industry or performance is tracked over a long time.

application of a bundle of resources on a yearly basis, while sustained competitive advantage is the outcome of the process of a firm undertaking value creating strategies that allow the firm to capture the residual value from whatever it sources, retain the residual value, and continue to do so over a long period of time. By capturing the long-term growth path of year-to-year financial performance, one can infer the presence or absence of sustained competitive advantage, and at the same time, this growth path can be used to determine the intrinsic value of a firm. Hence, on the one hand, a latent growth path of strong financial performance implies the presence of sustained competitive advantage, and on the other hand this growth path also determines the intrinsic value of a firm.

The literature usually quantifies "superior performance" in terms of profitability, yet the meaning of the term is vague. Most studies select a single book ratio or market indicator (other ratios/indicators may be investigated, but usually just for robustness tests) to divide the sample into comparable groups of advantaged and disadvantaged firms, and then examine yearly changes in the two groups. However, this approach implies that one measure of profitability is enough to capture competitive advantage, and the choice of measure is known to affect the sample grouping (e.g., Carey, 1974; Powell, 2003; Wiggins and Ruefli, 2002). This paper broadens the VPC framework from the product level to the firm level, and avoids these limitations by modeling latent growth patterns in time series of seven different financial indicators to capture different aspects of resource employment by the sample firms.

The present value of the growth opportunity model (PVGO) is used in finance to predict stock/firm value. PVGO decomposes the long-term value of a firm into the value of its assets in place and the value of its growth opportunities (Miller and Modigliani, 1961). The value of a growth opportunity is in turn determined by hidden assumptions regarding the firm's persistent competitive advantage (Myers, 1984: 130). In this paper, we replace the value of assets in place with the profit rate (π), and replace the value of growth opportunities with the long-term growth rate (g). Sustained competitive advantage is incorporated into the model as the determinant of g, and is predicted by the performance trajectory over time.

To infer sustained competitive advantage, we adopt a group-based,

multi-parametric approach to capture the heterogeneity of firms' performance trajectories in a specific industry. This approach lets us identify the long-term superior performing firms from the grouping results where competitive heterogeneity among groups is latent and unobservable. The approach we use, Latent Class Growth Analysis (LCGA), was developed by Nagin (1999, 2005). LCGA is widely used in social and psychological science, but is relatively new to management research. It models the probability of membership in the observed distinct (performance) trajectory groups where the grouping variable is unavailable or unknown (Jung and Wickrama, 2008; Nagin, 2001, 2005; Nagin and Tremblay, 1999); LCGA thus provides an appropriate procedure to capture information about interindividual differences in intraindividual change (Nagin, 1999).

We apply LCGA to the computer-based business services industry and successfully identify two or three subgroups with distinct latent performance trajectories for each of the seven indicators. Entry status and lagged performance are included in the models to examine the effects of luck and cumulative advantage on the model (Denrell, 2004; Denrell, Fang, and Zhao, 2013; Henderson, Raynor, and Ahmed, 2012). We also control for economic growth, which is believed to be positively correlated with performance for all firms. Hence, each latent trajectory identified by the model reflects the average dynamic capability of a group of firms to improve or sustain a specific performance indicator.

Many of the firms that are classified in the group with the strongest performance trajectory by one financial indicator actually fall into other groups when classified by other indicators. We define a set of winners as those firms classified in the highest-performing group by all seven indicators. There are 37 such companies (around 2% of 1533) in the sample. Many companies in the winners' club, such as Adobe, Google, IBM, McGrew-Hill, Microsoft, and Oracle, have demonstrated strong capabilities and long-term success. These results imply that even though the public is not privy to the strategies or resources of a firm, it can detect the persistent superior performance that results from effective resource management and value creation. The results may be useful for a follow-up study to estimate growth rates for different groups of firms and to ultimately determine the intrinsic value of individual firms.

2. Performance as the provision of value creation

2.1 Broaden VPC framework to entire firm

In the VPC framework, value is measured as the surplus between consumers' maximum willingness to pay and the firm's supply cost (Besanko *et al*., 2007: 354-355). The VPC model suggests that the firm producing the largest surplus between value and cost has an advantage over its rivals, regardless of the appropriation between the firm and the buyers. The key variables of the model are therefore value (V), the benefits perceived by the consumers for using a product/service; market price (P), the willingness of a marginal buyer to pay for the product/service; and cost (C), the value of the resources employed to produce the product/service and provide it to the market. All buying consumers must enjoy a higher V than P. The difference between V and P is the consumer surplus (CS); the difference between P and C is the producers' surplus (PS). The firm (and by extension its shareholders) receives positive profits only when PS is positive. Therefore, the value created by the managers is V - C = CS+PS.

This framework has proved useful in cross-section case studies for single products. It is more difficult to use in a setting where each firm has multiple products or businesses, or to examine performance differences across industries and over time. Yet the VPC framework can be used to examine performance heterogeneity among firms over time by using V to denote the aggregated value of all products/services created by a firm. In this context, V signifies the willingness of an acquiring investor to pay for the firm given its expected future cash flows (Shyu, 2010), P is the transaction price, and C is the cost of creating the expected cash flows.

This version of the VPC model can be used to describe Porter's (1980, 1985) differentiation and low-cost strategies, as well as the concepts of value creation and capture. The differentiation strategy pursues a high V associated with a high P, given that C is lower than P. However, a firm must do more than just create value; it must also capture the value it creates to prosper (Saloner, Shepard, and Podolny, 2001). A higher value of V - C does not guarantee better performance, unless PS is also positive (Besanko *et al*., 2007: 357). The low-cost strategy pursues effective operations to reduce the cost of delivering a product/service to

customers. A firm pursuing low cost may have a lower P - C than its rivals if P is low due to a lower level of V. These hypothetical cases show that adopting a differentiation or low-cost strategy alone does not necessarily lead to superior performance. A firm that has a negative PS for an extended period is dead in the long run, even if its CS is large. Likewise, V - C is an effective indicator of competitive advantage only if PS is positive. In other words, for any given V a firm created, the firm must retain PS as the minimum requirement for superiority.

Yet another example is the price discrimination strategy used by airline companies and hotels, who apply different rates to different groups of consumers and in different seasons. In effect, they vary the price according to the value perceived by the consumers. For the extreme case of complete price discrimination, CS is zero and the firm captures all value it creates (P - C = V - C).

To conclude, the value captured by the firm can be a basis for value estimation. We suggest using P - C to approximate V - C, partly because financial data is easy to assess for time-series cross-section analysis, but more importantly because financial performance is the top concern of shareholders (Ramaswami, Srivastava, and Bhargava, 2009; Rappoport, 1986; Srivastava, Shervani, and Fahey, 1998, 1999).

2.2 Profit returns reflecting capabilities in resource employment

Positive P - C as the minimum requirement for measuring the competitiveness of a firm can be divided into different types of inputs and hence performance indicators. The indicators most commonly used in the literature are shown in the first row of Table 1. They include physical assets-based returns (e.g., return on assets (ROA), return on equity (ROE), and return on invested capital (ROIC)), dollar-specified indicators (e.g., profit margin (PM) and earnings per share (EPS)), and market-based indicators (e.g., market-to-book ratio (MTB), price-earnings ratio (PE), and Tobin's q). Note that Tobin's q can be approximated by MTB (Chung and Pruitt, 1994).

All such indicators represent the effective application of a bundle of resources, or one aspect of the firm's particular capability in resource employment. ROA and ROIC both measure a company's efficiency and

Table 1
Performance indicators, definitions of superior and persistent performance, methodologies, and grouping approaches in previous studies

Performance indicators	1. Net profit margin = net income after taxes / sales (Carey, 1974) 2. Return on assets (ROA): gross/net-of-tax profits plus interest / total assets (Mueller, 1977, 1986); net income after taxes / tangible assets (Carey, 1974); return on total assets before (or after) taxes (Geroski and Jacquemin, 1988; articles collected in Mueller, 1990; Roberts, 1999; Wiggins and Ruefli, 2002; Henderson *et al*., 2012) ; operating income / total assets (Schmalensee, 1985); operating income / assets held by business segment (MaGahan and Porter, 1999; Choi and Wang, 2007); operating income / identifiable assets (Ruefli and Wiggins, 2003) 3. Return on equity (ROE) = net income after taxes / common equity (Carey, 1974; Goddard *et al.*, 2011) 4. Excess value = (market value - book value)/sales (Connolly and Schwartz, 1985) 5. Expected return on investment (ROI) = riskfree rate + beta × (market return - riskfree rate) (Jacobsen, 1988) (CAPM model) 6. Return on sales; rate of profit on sales (ROS): (Kessides, 1990; Bentzen *et al*., 2005) 7. Profit rate = (firm profit - sample average)/sample average (Schohl, 1990) 8. Profit rate = value added - depreciation - wages/capital + wages (Droucopoulos and Lianos, 1993) 9. Profit rate = (value of output - wages - raw material cost - interest) / gross fixed assets 10. Return on capital employed (ROC): Goddard and Wilson, 1996 11. Tobin's q: market value of equity and debt securities / book value of equity (Wiggins and Ruefli, 2002); market value of stock / book value of assets (McGahan and Porter, 1999; Choi and Wang, 2007; Henderson *et al*., 2012) 12. No specific indication on calculations: profit rate (Cubbin and Geroski, 1987, 1990); ROA (Waring, 1996; Powell and Reinhardt, 2010); ROE (Denrell, *et al*., 2013); total profit, return on equity, return on assets, 1-year yield to investors, and 10-year yield to investors in Fortune 500 (Powell, 2003)
Superior performance (by year)	1. Above industry average in the given year (Waring, 1996; Wiggins and Ruefli, 2002, 2005; Ruefli and Wiggin, 2003; Denrell, *et al*., 2013) or in the selected year(s) (McGana and Porter, 1999; 2003; Choi and Wang, 2007) 2. Above the long-term average of the specific industry (Cubbin and Geroski, 1987; Schohl, 1990; Roberts, 1999; Goddard *et al*., 2011) or above the mean across industries (Mueller, 1986) 3. Deviation of return from its expected return (Jacobsen, 1988) 4. Positive lagged normalized profit (Roberts, 1999) 5. Profitability Ranking (Powell and Reinhardt, 2010; Henderson *et al*., 2012)

Table 1
(Continued)

Persistent performance	1. Persistent rents or above-average returns (Mueller, 1977; 1986; 1990; McGahan and Porter, 1997, 1999, 2003) 2. Consistency of staying in the above-modal performance stratum over time (Wiggins and Ruefli, 2002; 2005; Ruefli and Wiggins, 2003) 3. Consistency of profitability ranking: Carey, 1974; Powell and Reinhardt, 2010 (Spearman's distance); Henderson *et al.*, 2012 4. Consistency of winning: Powell, 2003 (Gini coefficient); Powell and Lloyd, 2005 (Gini, Entropy, Herfindahl, Pearson, Likelihood) 5. Distinguishing superiority generated by capabilities from luck and cumulative advantage (Denrell, 2004; Denrell, *et al.*, 2013)
Methodology	1. Autoregressive models (Mueller, 1977; 1986; Cubbin and Geroski, 1987, 1990; Connolly and Schwartz, 1985; Jacobsen, 1988; Goddard and Wilson, 1996; Waring, 1996; Geroski and Jacquemin, 1988; McGahan and Porter, 1999; Roberts, 1999; Choi and Wang, 2009; Goddard et al., 2011; articles collected in Mueller (ed.), 1990) 2. Rank (ordinal) approaches (Powell, 2003; Powell and Lloyd, 2005; Powell and Reinhardt, 2010; Henderson *et al.*, 2012 with Markov Chain process) 3. Bayesian approach with lag information (Denrell, *et al.*, 2013) 4. Stratifying approach (Wiggins and Ruefli, 2002, 2005; Ruefli and Wiggins, 2003) 5. Full information maximum likelihood (Cubbin and Geroski, 1987) 6. Panel unit root tests (Bentzen *et al.*, 2005); 7. Structural equation modeling (Bou and Satorra, 2007); 8. Trend analysis: polynomial time trends (Mueller, 1986); Structural time series (Cable and Jackson, 2008)
Grouping approach	1. Rank and divide firms into n groups by profitability rate (quantiles- Mueller, 1986; percentiles- McGahan and Porter, 1999; Powell and Reinhardt, 2010; Henderson *et al.*, 2012; Powell, 2003; Powell and Lloyd, 2005; Roberts, 1999; Choi and Wang, 2007 (lagged)); 2. Non-parametric approach- Kolmogorov-Smirnov iterative technique (Wiggins and Ruefli, 2002, 2005; Ruefli and Wiggin, 2003)

productivity in using its visible assets or invested capital. ROE can be enhanced by choosing an appropriate capital structure (i.e., debt-equity ratio) as part of the corporate strategy (Barton and Gordon, 1988). PM and EPS denote the efficiency of profit generation from sales to shareholders. MTB and PE measure investors' willingness to pay for shares of the firm's book value and earnings respectively. Younger, growing firms tend to have higher MTB ratios than older firms (Pástor and Pietro, 2003). Finally, Tobin's q measures the firm's ability to accumulate intangible assets.

3. Bridging persistent performance to value with sustained competitive advantage

Sustained competitive advantage is the bridge that links firm value to persistent performance. Given a causal (or probabilistic) relationship between sustained competitive advantage and superior performance, it follows that evaluation of the firm's historical performance can identify the presence or absence of sustained competitive advantage. Furthermore, given the positive connection between value and sustained competitive advantage, the finding that a firm enjoys sustained competitive advantage can be a determinant of its value. The PVGO model can be used to express this relationship.

The PVGO model decomposes long-term value into two terms: a static value generated by the firm's operations at time *t*, and a dynamic value representing future growth opportunities (*GO*) (Myers and Turnbull, 1977). The value of *GO* depends both on financial factors such as ongoing investment in new projects (Myers, 1984), and organizational factors such as capabilities and competitive advantage (Hazhir, 2012). The static value is measured using current financial profits, and represents the rewards from employing assets in place. The value of *GO* depends on latent factors such as permanent competitive advantage (Myers, 1984).

The profits at time *t* and the value of *GO* can both be expressed in unit terms (π_t and go_t) by dividing them by the amount of resources employed (such as total assets, equity, and sales). That is:

$$iv_t = \pi_t + go_t,\ t = 1, \cdots, T, \tag{1}$$

where *iv* denotes the (unit) intrinsic value and T is the total number of time points. The static firm value equates to the realized profit rate at time t (π_t), which is unpredictable over the short term as it follows a random-walk process (Fama, 1970). Strategy scholars (e.g., Denrell, Fang, and Zhao, 2013) suggest that π_t is a linear combination of the entry status (π_0), the profit rate of the previous period, and the capabilities.

The term go_t in Equation (1) can be obtained from the long-term growth rate ($\bar{g}$) by $go_t = (1+\bar{g})\pi_t$. $\bar{g}$ is heterogeneous among firms (Kogan and Papanikolaou, 2010), and it is higher for firms with sustained competitive advantage than those without. From the probabilistic view (Powell, 2000, 2001, 2002; Tang and Liou, 2010), those firms with profit rates higher than a hurdle level ($\pi_t > \bar{\pi}$) are more likely to have competitive advantage at time *t*. We name this yearly status temporary competitive advantage (TCA_t) to distinguish it from sustained competitive advantage (*SCA*), which is a series of temporary advantages (Eisenhardt and Martin, 2000; D'Aveni, 1994; Morrow *et al.*, 2007). *SCA* may be defined by placing conditions on the trajectory of *TCA* as follows:

$$\bar{g} = h(SCA) = h\left(f\left(TCA_0, TCA_1, \ldots, TCA_{T-1}, TCA_T\right)\right), \tag{2}$$

where h relates *SCA* and $\bar{g}$, and f indicates that *SCA* is determined by $TCA_0, TCA_1, \cdots, TCA_{T-1}$, and TCA_T. Based on longitudinal performance data, we can assess sustained competitive advantage by an appropriate time series methodology. We adopt the latent class growth model, a special type of growth mixture model (Muthén, 2004: 349). Using Equations (1) and (2), we see that firms with higher $\bar{g}$ are associated with higher intrinsic value, given their entry status, cumulative advantage, and capabilities. Therefore, firms can be differentiated in terms of *SCA*, a dynamic index describing the change of *TCA* over time, rather than in terms of TCA_t measured at specific time points.

4. Operational definitions for empirical studies

A firm that outperforms its rivals is said to have superior performance, and is seen as being the most likely to have competitive advantage (Powell, 2000, 2001, 2002; Tang and Liou, 2010), or *TCA* as defined above. If such a firm continues to enjoy superior performance over a long period of time, it is said to have persistent superior performance. This is seen as effective evidence of having a sustained competitive advantage. Yet there is no universally accepted definition of "persistent superior performance." This ambiguity has encouraged strategy scholars to develop many different methodologies for testing their theories and identifying long-term outperformers. Table 1 lists some of the different definitions and methodologies used in prior studies.

Some empirical studies define "competitive advantage" as the "abnormal returns enjoyed by a firm"; others define it as the returns of a firm superior to those of its rivals or to the industry average. *Sustained* competitive advantage has been operationally defined as "the *tendency* of abnormally high or low profits *to continue in subsequent periods*" (McGahan and Porter, 2003).

Thus, "persistent superior performance" includes two qualities: superiority and sustainability. Whatever methods are used to measure sustained superior performance must quantify and satisfy both qualities (McGahan and Porter, 2003). While superior performance is measured using yearly data, sustainability is usually examined by statistical methodologies with longitudinal data.

4.1 Superior performance

Depending on their specific research objectives, prior studies variously define superior performance as: (1) profits above the annual average for a specific industry or segment, either in a single year (Waring, 1996; Wiggins and Ruefli, 2002, 2005; Ruefli and Wiggin, 2003; Denrell, Fang, and Zhao, 2013) or over selected years (McGana and Porter, 1999; 2003; Choi and Wang, 2007); (2) profits above a long-term average for a specific industry (Cubbin and Geroski, 1987; Schohl, 1990; Roberts, 1999; Goddard *et al.*, 2011) or across industries (Mueller, 1977, 1990); (3) positive lagged normalized profits (Roberts, 1999); (4) deviation of the realized return from a firm's expected return (Jacobsen, 1988);

and (5) being in a predefined percentile based on profitability ranking (Powell and Reinhardt, 2010; Henderson *et al*, 2012). Because we wish to observe trends in firm performance over consecutive years during the study period, we define annual superior performance using the first definition: realized profits above the industry average in the corresponding year.

4.2 Persistent superior performance

The fourth row of Table 1 lists methodologies for identifying persistent superior performance used in the literature. Among parametric studies, a vast number use an autoregressive model to examine the persistence of profits within and across industries (Choi and Wang, 2009; Connolly and Schwartz, 1985; Cubbin and Geroski, 1987, 1990; Geroski and Jacquemin, 1988; Goddard and Wilson, 1996; Goddard *et al*., 2011; Jacobsen, 1988; McGahan and Porter, 1999; Mueller, 1977, 1986; articles collected in Mueller (ed.), 1990; Roberts, 1999; Waring, 1996). With an autoregressive model, sustained performance refers to the persistence of profits, which are commonly defined as persistent rents or abnormal returns over time (Mueller, 1977, 1986, 1990; McGahan and Porter, 1999, 2003). The autoregressive model investigates the year-to-year movements of annual profits. This line of research aims to examine the loss of abnormal profits over time across industries as well as identify the effects of the industry and firm-specific factors. As a complementary analysis, the firms are often grouped by performance (in quantiles) so that sustained superiority can be compared between the highest and lowest performance groups. The ordinal importance of factors that influence persistence is inconclusive, but all these studies agree that *only a few firms show persistent superior financial performance in the long run*.

A limitation of the autoregressive model in examining sustained superior performance is that the cardinal data are not directly comparable across time periods, and the model requires assumptions about the true form of the unobserved performance distribution (Powell and Reinhardt, 2010). In addition, competitive advantage is essentially a property of outliers (Wiggins and Reufli, 2002), while the autoregressive model is based on the population mean. The autoregressive model statistically neutralizes the differences between firms and fails to account for their unique characteristics (Hansen, Perry, and Reese, 2004).

As a consequence, research results based on a normal distribution of performance might be misleading (Henderson, Raynor, and Ahmed, 2013).

In addition, the autoregressive model estimates just one growth pattern to describe the entire population. This approach oversimplifies the diversity of growth patterns found in real industries that describe continuity and change among members of different subpopulations with heterogeneous performance (Jung and Wickrama, 2008).

Rather than testing the trend of abnormal profits, Wiggins and Reufli (2002, 2005) and Reufli and Wiggins (2003) use a non-parametric approach to stratify firms into several groups with significant differences in annual performance. Persistence is then quantified by measuring the frequency of transitions among the ordered performance strata across years. Alternative approaches to measuring the consistency of profit ranking over time include the Gini coefficient (Powell, 2003), the Entropy, Herfindahl, Pearson, and Likelihood indicators (Powell and Lloyd, 2005), and the Spearman distance (Powell and Reinhardt, 2010). Note that all these indicators measure the persistence of performance at the industry level instead of identifying individual outperformers. In addition, they are estimated by the number of wins and ignore the sequence of wins throughout the sample period.

Recent studies are concerned with the effectiveness of financial indicators as evidence of firm performance driven by capabilities (Denrell, 2004; Denrell, Fang, and Zhao, 2013; Henderson, Raynor, and Ahmed, 2012). Denrell, Fang, and Zhao (2013) applied a Bayesian approach associated with the Markov chain process to distinguish financial performance driven by capabilities from performance driven by luck and accumulative advantage. Henderson, Raynor (2012), and Ahmed recorded the frequency of a firm being superior (that is, ranked in the top 10^{th} percentile) across its observed life. This track record is compared with an expected frequency benchmark built by the Markov chain process on a rank-based percentile performance space. Thus, an observed long-term superiority is considered to be real (not solely a result of market randomness) if the firm's frequency of superiority is higher than the benchmark. Denrell, Fang, and Zhao (2013) and Henderson, Raynor, and Ahmed (2012) conclude that yearly performance indicators can be generated from luck or cumulative advantage, not just from capabilities. They also suggest that with

appropriate methodologies, financial indicators are useful for identifying firms with capabilities or sustained advantage.

Unlike cardinal approaches, ordinal (rank-based) approaches to investigating persistent profits do not require the researcher to know the underlying distribution of the performance indicator. However, these approaches do not specify the time sequence of shifts in ranking or wins, which is essential to recognize *growing* outperformers.

Consider, for example, two competitive firms A and B, both of which have 10 observed years of life and have achieved performance superior to their peers in all years. We recognize that both firms have superior performance and are the most likely in their sector to have sustained competitive advantage (Hansen, Perry, and Reese, 2004; Powell, 2000, 2001, 2002; Tang and Liou, 2010). If both firms only achieved superior performance six times in the past ten years, they are still regarded as outperformers if the benchmark frequency is less than six years. However, if firm A achieved superior performance from year 5 to year 10 while firm B achieved superior performance from year 1 to year 6, firm A is thought to be more competitive than firm B because the former has an upward trend. Therefore, to recognize whether a firm is more competitive than others in the long run, we need not only the frequency of outperformance but also the growth trajectory of the firm's performance relative to others. The LACG with logit model described in the next section captures the time-ordering performance trajectory of firms.

5. Latent class growth analysis

For a heterogeneous population (like the firms in an industry), it is appropriate to assume that distinct groups of individuals pursue qualitatively different trajectories (Muthen, 2004; Nagin and Land, 1993). LCGA is a statistical methodology originally developed by Nagin and Land (1993) in criminology, and was later adopted by other social science researchers for longitudinal data analysis (Bushway and Weisburd, 2006). LCGA models the developmental paths corresponding to individual characteristics and behaviors in a heterogeneous population (e.g., McLeod and Fettes, 2007; Sturgis and Sullivan, 2008; Syed and Seiffge-Krenke, 2013; Van den Akker *et al.*, 2013; see Nagin and

Odgers, 2010 for an overview).

LCGA is a multiple-group approach based on the semi-parametric group-based trajectory analysis (Jones, Nagin, and Roeder, 2001). Combining cluster analysis and latent trajectory analysis, this approach groups individuals in a way that the individual response trajectories within groups are homogeneous but those of different groups are heterogeneous (Berlin et al., 2014; Jung and Wickrama, 2008; Sturgis and Sullivan, 2008). LCGA fits each group with a different model and assigns different parameter values across unobservable subpopulations (Jung and Wickrama, 2008). It is particularly useful to identify and model the probability of membership in distinct trajectory groups where grouping variables are unobservable (Jung and Wickrama, 2008; Nagin, 2001, 2005; Nagin and Tremblay, 2001).

For competitive advantage analysis, LCGA can identify groups of firms with homogenous growth trajectories based on observable financial indicators (observable consequence variables). The group trajectory representing within-group members' long-term performance pattern is driven by unobservable antecedents such as organizational typologies (Miles and Snow, 1978; Mintzberg, 1979), generic strategies (Porter, 1980), heterogeneous resources (Barney, 1991), organizational configurations (Ketchen, Thomas, and Snow, 1993), and/or dynamic capabilities (Teece, Pissano, and Shuen, 1997).

5.1 LCGA approach

LCGA is used to group individual growth parameters rather than observed outcomes (Jones, Nagin, and Roeder, 2001). It identifies *K* latent classes (the latent trajectory groups) with distinct developmental trajectories depicted with different growth parameters (Sturgis and Sullivan, 2008). The growth trajectory identified for each group is based on the vector $Y_i = (y_{i1}, y_{i2}, \cdots, y_{iT}), i = 1, \ldots, n, ,$ which describes the longitudinal sequence of firm *i*'s performance over *T* points in time for *n* firms. In our case, the elements of *Y* are binary values indicating the presence or absence of superior performance in a given period. LCGA assumes that there are *K* unobserved trajectory subpopulations of firms within an industry, differing in parameter values. The maximum likelihood method is used to estimate these unknown parameter vectors that determine the shapes of the

trajectories (Jones, Nagin, and Roeder, 2001; Jones and Nagin, 2007; Haviland, Jones, and Nagin, 2011). The form of the likelihood function can be selected to conform to three types of data: count data, psychometric scale data, or binary data. For binary data, which we use in the present study, the likelihood function is based on the Bernoulli distribution.

LCGA allows one to incorporate variables other than time, including both time-dependent covariates and time-invariant predictors (Jones, Nagin, and Roeder, 2001). In the present study, we include lagged performance (Bollen and Curran, 2004, 2006, Sec. 7.5) and the annual economic growth rate, both time-varying variables, in order to partial out the effects of cumulative advantage and environmental changes. The adjusted latent trajectories of the firms better reflect their dynamic capabilities. We use the binary logit model to fit the dichotomous data (superior performance or otherwise) resulting from the 'above the industry average' criterion. Specifically, letting Y_{ijk} be the binary performance response (1 = superior; 0 otherwise) for firm i at time t in group k, we have

$$\Pr(Y_{itk}=1)=p_{itk}=\frac{\exp\left(\beta_{0k}+\beta_{1k}Time+\beta_{2k}Time^{2}+\ldots+\delta_{1k}Y_{i,t-1}+\delta_{2k}ecog_{t}\right)}{1+\exp\left(\beta_{0k}+\beta_{1k}Time+\beta_{2k}Time^{2}+\ldots+\delta_{1k}Y_{i,t-1}+\delta_{2k}ecog_{t}\right)} \quad (3)$$

where β_{0k}, β_{1k}, and β_{2k} denote the latent intercept, latent linear trajectory, and latent quadratic trajectory for group k, respectively. The observable variable $ecog_t$ is the economic growth rate at time t. The parameters δ_{1k} and δ_{2k} are the random coefficients associated with Y_{t-1} and $ecog_t$ for group k. The degree of the polynomial logit model is determined by trying different models and choosing the degree that best fits the data. The ellipsis in the formula represents these higher-order terms.

Grouping is based on the adjusted latent trajectories of the firms (reflecting their dynamic capabilities). Moreover, the entry status (luck), a time-invariant variable, is included to examine and to delineate its effect on the groups formed by using the multinomial logit model given by

$$\Pr\left(C_i=k\left|ENTRY_i=entry_i\right.\right)=\frac{\exp\left(\theta_k+\lambda_k entry_i\right)}{\sum_{k=1}^{K}\exp\left(\theta_k+\lambda_k entry_i\right)} \quad (4)$$

where $C_i = k$ means that firm i belongs to group k. θ_1 and λ_1 are taken to be zero for identifiability (Jones, Nagin, and Roeder, 2001).

5.2 Longitudinal missing data and model selection

Since entries and exits of firms are common in the free market, attrition and truncation of the performance series are unavoidable in the longitudinal data. Firms that were delisted because of bankruptcy, mergers, acquisitions, or going private disappear from the dataset partway through the study period, while newly listed firms are added to the dataset. For example, in the computer-based services industry, there are a total of 1533 listed companies from 2000 to 2012. Only 286 of these were active in 2000, and the number of active firms rose to 486 in 2011 and dropped dramatically to 357 in 2012.

It is reasonable to suggest that the attrition rate varies across groups, since financial ratios are effective indicators of pre-bankruptcy (Altman, 1968). The attrition rate affects group size over time and the parameter estimates in population-level projections (Haviland, Jones, and Nagin, 2011). In LCGA, all periods with missing performance values are retained; the missing data are regarded as random. Economists refer to this approach as exogenous selection (Little and Rubin, 1987). It is reasonable to include subjects with missing longitudinal data in the analysis of competitive advantage, because these firms account for a significant portion of activity in the industry and ought not to be ignored (McGahan and Porter, 2003).

To conduct LCGA, we need to determine the number of trajectory groups and the shapes of the trajectories. SAS Proc Traj software allows estimation of up to a fourth-order polynomial. As for the number of trajectory groups, no "correct" solution is available. However, the number of trajectory groups can be determined by statistical and/or theoretical criteria (Greenbaum *et al.*, 2004; Muthén, 2004; Nagin, 2005). The trajectory procedure in SAS (Jones, Nagin, and Roeder, 2001) uses the Bayesian information criterion (BIC) to determine the model. The model with the smallest BIC is the one that best fits the data and is therefore considered the best model.

6. Empirical study

6.1 Data source and sample

Our sample firms are computer-based business services companies. We identify these firms in the Compustat North America Database by SIC code 73, which includes 7370 (computer programming and data process), 7371 (computer programming services), 7372 (prepackaged software), 7373 (computer integrated system design), 7374 (computer processing and data preparation services), and 7377 (computer rental and leasing). This is a brave new industry that has enjoyed a high growth rate for the last decade, with a great many firms entering the market and disappearing (died or acquired by other firms) in the space of a few years. There are 1533 such companies in the Compustat database from 2000 to 2012. This period also covers at least two phases of the industry business cycle, if the five-year period depicted by McGahan and Porter (1999) and Rumelt (1991) is accurate.

Most studies in the strategy literature define superior performance operationally using the binary criterion that a firm's financial return is higher than the industry average. We further define *sustained competitive advantage* as a persistent pattern of superior performance during the study period. We choose seven indicators described in the previous section to measure sustained competitive advantage. They are ROA, ROE, ROIC, PM, MTB, EPS, and PE. In order to avoid biasing the industry average with severe negative outliers, we delete companies for which at least one of the seven performance indicators is smaller than the industry mean minus three standard deviations in any period of the study. The adjusted dataset has 1,333 companies. We include firms with incomplete series, but exclude those with less than 4 years of data. This cut leaves 776 companies for the trajectory analysis.

We turn each of the seven financial indicators into a binary yearly time series. A firm is defined as superior (value 1) if the performance indicator is both positive and above the industry average in that specific year; otherwise, its value is 0. We then fit the LCGA model to these series to identify the developmental trajectories of the different groups. The performance in the previous year and the US annual economic growth rate, measured as the percent change of gross

domestic product relative to the preceding period (U.S. Department of Commerce, 2001 to 2012) are used as time-variant covariates to control for the effects of cumulative advantage and external environmental changes on the trajectories. Furthermore, the firm's first observed performance is used as a risk factor to examine the effects of entry status on group membership. The full trajectory period is 12 years, since we lose the first period in order to include the lagged performance. We test several LCGA models with different group numbers and polynomial degrees, and select the one with the lowest BIC value.

6.2 The results

Figure 1(a) shows the performance trajectories (dynamic capabilities) identified by the best LCGA model, for each of the seven performance indicators. The solid lines are the average of the superior performance dummies within the group and the dashed lines are the predicted trajectories. Figure 1(b) displays the average values of the original financial indicators within each LCGA group. Table 2 reports the estimated parameters of the best model for each performance indicator, including the types and shapes of the trajectories. The effects of entry status on the trajectory memberships, lagged performance, and economic growth rate are also reported. Table 3 summarizes the percentage of firms classified in each group, and the average number of years that each group achieved above-average performance relative to the number of observed years.

Take the first model (ROA) as an illustration. ROA identifies three trajectory groups, all of which fit a linear growth pattern (Table 2). Group 3, which includes 22.0% of the population (Table 3), presents a persistent upward trajectory (Figure 1 (a-1)). This group achieved superior performance 9.4 times out of an average of 10.4 observed years (Table 3), and also has the highest ROAs over time (Figure 1 (a-2)). In contrast, firms classified in Group 1 (55.0%) achieved superior performance an average of only 0.1 times over 7.1 sample years; in terms of ROA, they operated on the axis of errors (Powell and Arregle, 2007). Group 2 (22.0%) achieved superior performance 4.2 times out of an average of 9.9 years.

The other six models identify either two (ROIC, MTB, EPS, and PE) or three (ROE and PM) trajectory groups, each of which fits either linear or quadratic shapes. Figure 1 and Table 2 and 3 present the shapes and the

performance information of these models. The model coefficients show that the effect of the initial performance (entry status) on group memberships is insignificant for the model trajectories identified by ROA, ROE, and PM, but significant for those identified by ROIC, EPS, MTB, and PE.

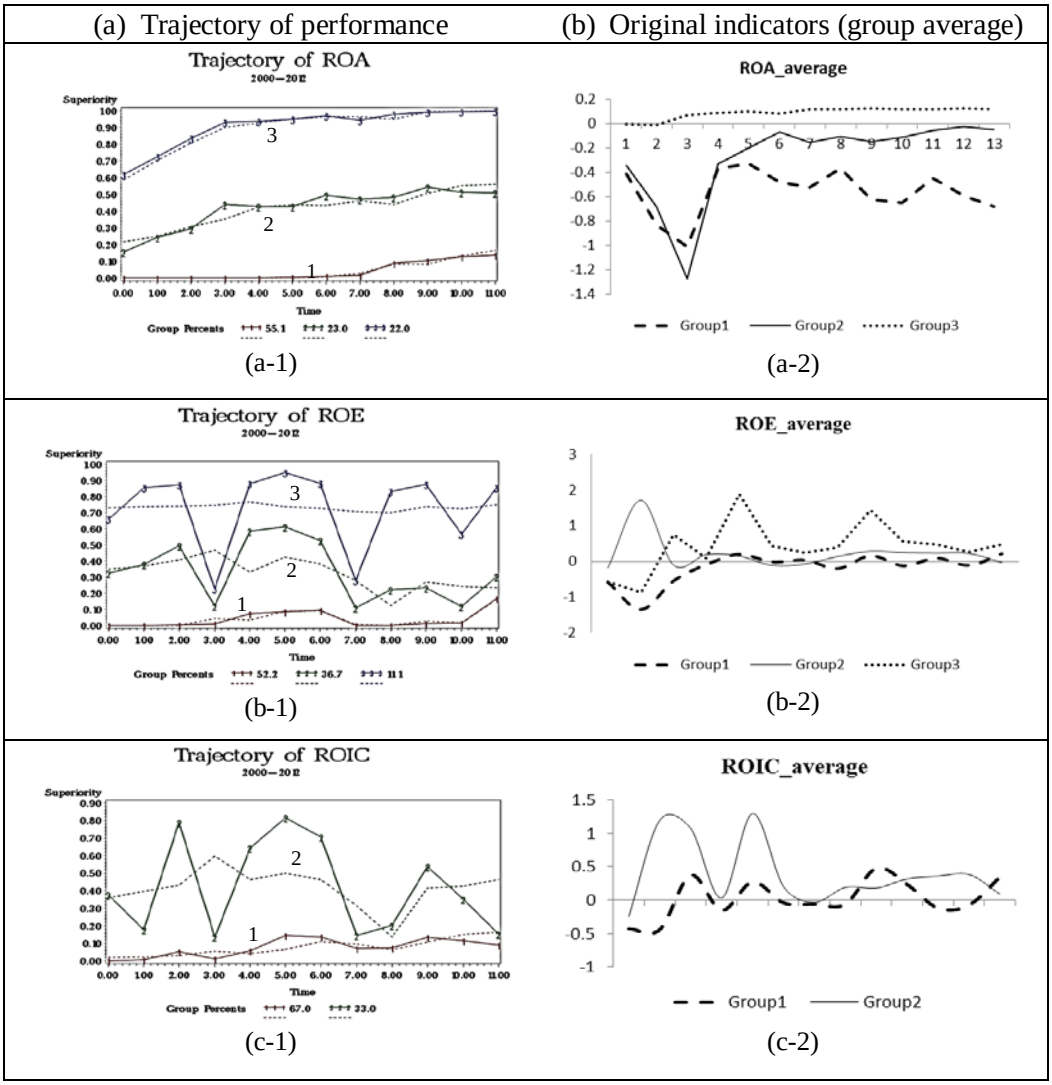

Figure 1
Latent groups based on growth trajectories with various performance indicators

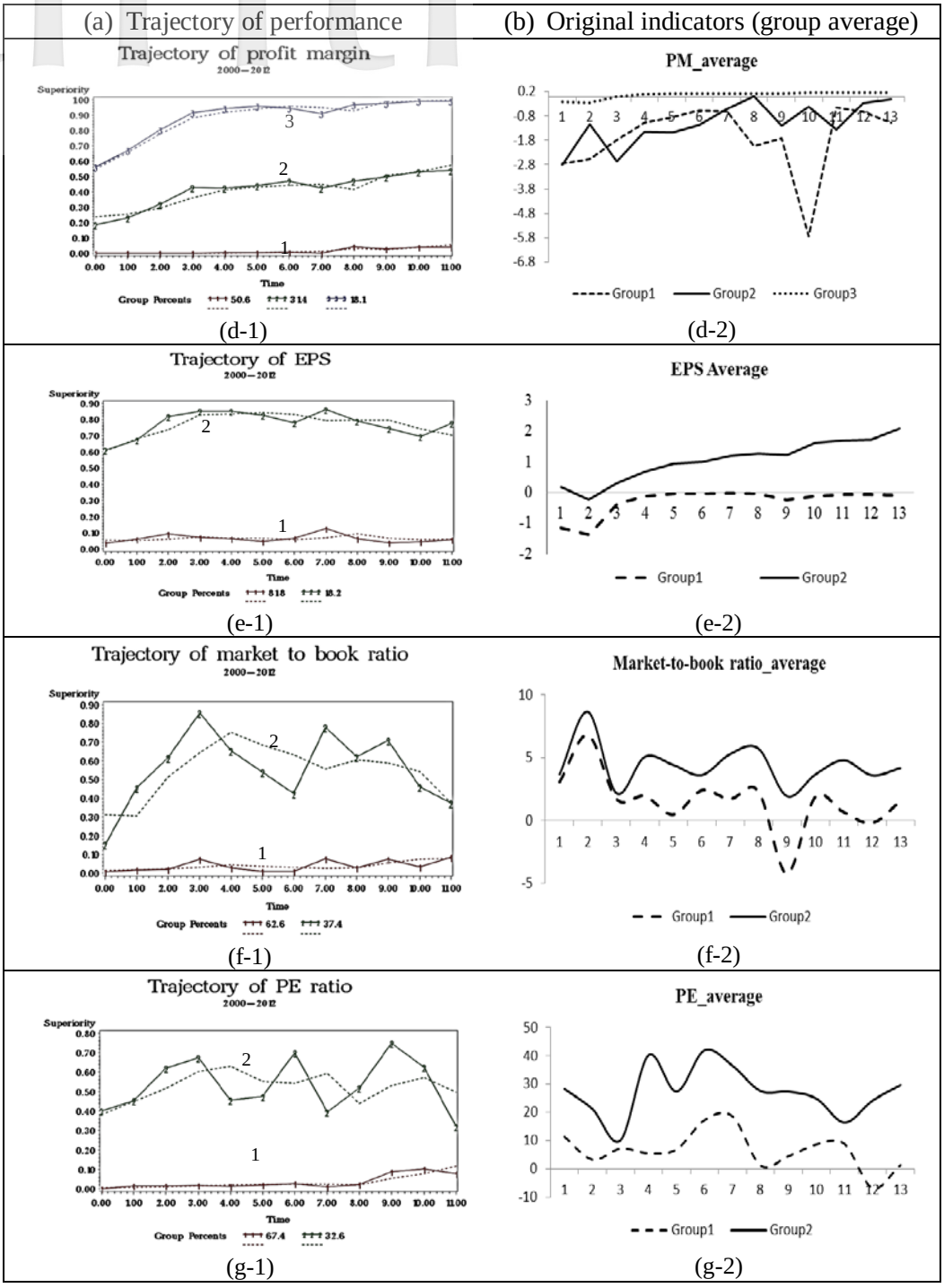

Figure 1
(Continued)

Table 2
Results of model fitting

	ROA	ROE	ROIC	PM	EPS	MTB	PE
Group 1							
Intercept	-7.10***	-13.95***	-4.05***	-7.34***	-3.15***	-4.54***	-5.37***
Linear	0.46**	0.49***	0.13***	0.43*	—	0.13**	0.23***
Quadratic	—	—	—	—	—	—	—
Time-varying covariates							
Lag	3.83***	8.51***	2.90***	1.34	2.82***	2.15***	1.92**
Growth	-30.56**	243.41***	9.24	-14.88	-1.60	16.00	14.23
Time-stable covariate							
Entry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Group 2							
Intercept	-1.61***	-1.18***	-1.17***	-1.64***	-0.74*	-1.67***	-1.03***
Linear	0.07**	-0.06***	—	0.07***	0.26**	0.49***	0.19**
Quadratic	—	—	—	—	-0.02**	-0.04***	-0.02***
Time-varying covariates							
Lag	1.95***	1.22***	0.67***	1.89***	2.24***	1.59***	1.41***
Growth	3.54	16.60***	27.70***	4.41	6.79	7.42**	6.19
Time-stable covariate							
Entry	14.78	14.75	4.38***	19.24	3.33***	3.54***	4.32***
Group 3							
Intercept	-1.12***	1.05**		1.03**			
Linear	0.33***	—		0.33***			
Quadratic	—	—		—			
Time-varying covariates							
Lag	2.84***	-0.19		2.16***			
Growth	14.36	5.25		19.39			
Time-stable covariate							
Entry	16.75	19.3		20.96			

***p<0.001; **p<0.01; *p<0.05

Table 3
Trajectory groups and performance

Indicator	No. of observations	Group percent			Times above average/year counts		
		1	2	3	1	2	3
ROA	775	55.0%	23.0%	22.0%	0.1/ 7.1	4.2/ 9.9	9.4/ 10.4
ROE	776	52.2%	36.7%	11.1%	0.2/ 6.9	3.6/ 10.3	7.4/ 9.9
ROIC	775	67.0%	33.0%	-	0.4/ 7.5	4.5/ 10.1	-
PM	760	50.6%	31.4%	18.0%	0.0/ 6.9	4.3/ 10.1	9.2/ 10.3
EPS	772	81.8%	18.2%	-	0.5/ 7.8	8.5/ 10.7	-
MTB	653	62.6%	37.4%	-	0.2/ 7.4	5.9/ 10.2	-
PE	697	67.4%	32.6%	-	0.1/ 7.2	5.8/ 10.6	-

6.3 Winners' club

Out of the 776 sample companies, from 85 (by ROE) to 256 (by ROIC) belonged to the highest-performing group, depending on the indicator used. A firm classified in the superior group by one indicator may be classified in a lower performing group by another indicator. We define firms with sustained advantage as those classified in the superior trajectory group for all seven models, reflecting different facets of profitability. There are 37 such companies (around 2% of the 1,533 companies initially identified) in this "winners' club." The number of winners increases to 84 (5%) and 124 (8%) if we relax the criteria to six or five models respectively.

Table 4 lists the firms in the winners' club, which includes several widely recognized names such as Adobe, eBay, Google, IBM, Microsoft, McGraw- Hill, and Oracle. In order to test the sustainability of their competitive advantage confronting environmental turmoil, Table 5 compares the percentage of years with superior performance among winners and non-winners, for the whole sample period and for the sub-period after the financial crisis in 2007. The winners present more sustained superior performance than non-winners, as expected.

7. Discussion and implications

A firm's internal resources, external resources, and external environment affect firm performance (Han, Chao and Chuang, 2012). Mainstream strategic management research attributes the persistence of superior performance to sustained competitive advantage, the sources of which lie in industrial structure (Porter, 1985) or firm-specific factors such as idiosyncratic and imitable resources (Barney, 1991), knowledge management (Grant, 1996), and capabilities (Teece, Pisano, and Shuen, 1997). Notwithstanding the diverse views of scholars regarding these sources, all suggestions share the characteristic of invisibility. Investigation of long-term observed outcomes, especially annual financial performance, is a feasible solution to investigate the latent sources of sustained competitive advantage (Tang and Liou, 2010). Empirical studies in this field have connected sustained competitive advantage to financial metrics, with

Table 4
Winners' Club in the Computer-based Business Services Industry

Company	Obs. years	Percentage of years achieving superior performance						
		ROA	ROE	ROIC	PM	MTB	EPS	PE
Adobe Systems	13	100%	67%	50%	100%	100%	83%	83%
Automatic Data Processing	12	100%	75%	58%	100%	100%	92%	67%
BMC Software	13	92%	67%	58%	83%	83%	92%	75%
Broadridge Financial Solutions	13	100%	71%	57%	100%	100%	80%	50%
Check Point Software	12	100%	69%	62%	100%	100%	77%	69%
Cognizant Technology	11	100%	85%	62%	100%	100%	100%	85%
Computer Programs and Systems	12	100%	85%	92%	100%	100%	100%	82%
Computer Services Inc.	13	100%	67%	67%	100%	100%	67%	33%
CSG Systems International	13	100%	69%	54%	92%	92%	77%	38%
DST System	12	100%	92%	54%	100%	100%	77%	31%
eBay Inc.	13	100%	62%	38%	100%	92%	69%	69%
Ebix Inc	12	92%	85%	62%	92%	92%	54%	46%
Elbit Systems Ltd.	12	100%	69%	46%	92%	92%	42%	62%
FactSet Research Systems	12	100%	83%	75%	100%	100%	92%	83%
Fiserv Inc.	13	100%	69%	46%	100%	100%	69%	62%
Global Payments Inc.	11	100%	75%	67%	100%	100%	73%	83%
Global Sources Ltd.	11	92%	69%	46%	92%	85%	77%	46%
Google	13	100%	73%	64%	100%	100%	89%	89%
IBM	11	100%	92%	85%	100%	100%	100%	54%
Intuit Inc.	12	100%	75%	58%	92%	92%	92%	75%
J2 Global Inc.	12	85%	62%	46%	85%	85%	62%	46%
Jack Henry & Associates	6	100%	67%	50%	100%	100%	67%	67%
Manhattan Associates	13	100%	77%	69%	100%	100%	77%	92%
McGraw- Hill Financial	7	100%	92%	77%	100%	100%	92%	77%
Mercadolibre	12	100%	88%	75%	100%	63%	100%	100%
Microsoft	13	100%	92%	83%	100%	100%	100%	50%
Microstrategy Inc.	12	85%	69%	69%	77%	77%	77%	31%
Oracle Corp.	13	100%	83%	67%	100%	100%	92%	75%
Priceline.com Inc.	8	85%	62%	62%	77%	77%	85%	46%
Quality Systems	13	100%	83%	67%	100%	100%	92%	100%
SAIC Inc.	8	100%	71%	57%	100%	86%	50%	50%
Solar Winds Inc.	10	100%	67%	83%	100%	83%	100%	100%
Syntel Inc.	11	100%	85%	85%	100%	100%	92%	69%
Teradata Corp.	10	100%	88%	75%	100%	100%	100%	67%
Travelzoo Inc.	7	100%	77%	77%	92%	77%	100%	82%
Tyler Technologies	13	92%	77%	46%	92%	92%	69%	92%
Value Click Inc.	12	77%	54%	31%	69%	69%	38%	38%
Average	11.46	97.3%	75.4%	62.7%	95.6%	92.9%	80.9%	66.6%

Table 5
Percentage of years achieving superior performance after millennium

Performers	Period	ROA	ROE	ROIC	PM	EPS	MTB	PE
Winners	2000-2012	97.3%	75.4%	62.7%	95.6%	80.9%	92.9%	66.6%
	2009-2012	95.9%	79.1%	56.1%	95.9%	75.0%	93.2%	56.1%
Non-winners	2000-2012	25.6%	18.4%	15.3%	24.4%	18.8%	13.9%	15.5%
	2009-2012	25.7%	9.9%	8.4%	23.7%	13.8%	9.7%	14.3%

performance as the interface. Denoting sustained competitive advantage as the attained position of a firm undertaking strategies to create, capture, and retain value over an extended time, thereby propelling growth, our paper strengthens the connection between sustained competitive advantage and observed long-term value, in order to better serve the major objective of strategic management research.

The proposition that competitive advantage determines the value created by a firm is not unique to strategy research; it also appears in financial studies. Financial scholars indicate that the value of *GO* depends on the permanent competitive advantage created as a result of strategy planning (Myers, 1984: 130), and provides a basis to explain the heterogeneity within an industry (Kogan and Papanikolaou, 2010: 532). In dynamic competition, the financial literature attributes sustained high stock returns during periods of environmental turmoil to invisible factors such as business model (Chen, Chu and Huang, 2012; Fahlenbrach, Prilmeier, and Stulz, 2012), entrepreneurship (Gompers *et al*., 2010), and other managerial explanations (Rouse and Daellenbach, 1999; Spanos and Lioukas, 2001; Qi, 2015).

Myers (1984: 130) states that '*Finance theory and strategic planning could be viewed as two cultures looking at the same problem.*' Sustained competitive advantage is about the ability of a firm to create future value. The future value will be generated from a firm's decisions and activities on new investment projects that bring products/services to the marketplace. These physical projects must both satisfy consumers' needs and generate positive net present value (NPV) to the firm. Although strategy theory refers to the value created in terms of consumers' willingness to pay (V), the value captured by the firm (i.e., P - C) could be a minimum measurement of competitive advantage. Just as financial

analysts evaluate whether the firm's investment projects meet positive-NPV criterion, managers should always check the valuation results with a strategic analysis before making a decision (Myers, 1984: 130). To extend the valuation of individual investment projects to growth opportunities of the entire firm, strategic management factors such as sustained competitive advantage should be incorporated into the valuation model.

In the PVGO model, the status of sustained competitive advantage should be determined before a firm can be evaluated. Strategy theory provides a theoretical background to infer the status of sustained competitive advantage by observing the long-term persistence of superior financial performance. Prior studies use performance changes between consecutive years to examine persistence. According to the proposition that sustained competitive advantage correlates with persistent superior performance, firms that present a smaller variation of financial performance are more sustained than others. Ironically, greater growth opportunities are usually associated with more volatile performance (Bartram, Brown, and Stulz, 2012). Examining the variation of annual performance changes therefore might not identify firms with great opportunities to grow, especially in emerging industries. Instead of using performance changes between two years, our paper uses the LCGA with logit model to derive the latent performance trajectories in the sample over the entire observed period. LCGA identifies the group of firms with persistent superior performance and a homogenous growth trajectory.

One of our main findings is that choosing a different financial variable to measure performance changes the memberships of the different groups identified by the LCGA model. This is because firm's strategic choices do not affect all financial indicators in the same way. For example, return-type indicators favor firms with low employment of fixed assets, while dollar-based indicators ignore tangible costs. The diverse results obtained using different financial indicators are also evident in previous studies. For instance, Powell (2003: 70) found that the frequency of wins changes depending on whether one measures performance in terms of profits or returns on sales, for IBM, Dupont, and entire industries. Wiggins and Ruefli (2002: 93) also identify different groups of persistent superior performers using the ROA and Tobin's q measures. Relying on a single

financial ratio to identify high performers can therefore lead investors to misleading inferences about the intrinsic superiority of firms.

To avoid this ambiguity, we define winners as firms classified in the superior trajectory group under all the seven performance indicators, each of which reflects a different aspect of resource employment. The market share of these 37 winners increased from 26% in 2000 to 58% in 2012, confirming their domination of the computer-based services industry.

The results of our paper imply that although one may not be privy to the strategies of a firm or the sources of superior performance, so long as the firm continues to effectively manage resources and create value it will display persistent financial superior performance. This implication supports the proposition of equifinality: even without knowing their underlying strategic differences, firms can be grouped simply by their observed performance (von Bertalanffy, 1968; Katz and Kahn, 1978).

Our research can be extended for various purposes. Firstly, we can use the performance trajectories of the groups to estimate the expected growth level of a firm and thereby determine its value. This approach can be complimentary to conventional financial valuation models. Secondly, the computer-based services industry is still new and has been growing fast since the millennium. The number of years in this study is only 12, after excluding the first year for the lagged performance. It is interesting to apply this analysis to mature industries with longer sample periods, such as food and beverage, airline, and telecommunications. With a longer series, the LCGA model can investigate transitions between value-creating strategies by incorporating a time-varying resource configuration factor. A longer study period can also be divided into phases corresponding to economic environmental shocks, such as the Internet bubble in 2000 and the financial crisis in 2007, in order to distinguish firms that successfully sustained their competitive advantage across phases from those with only a temporary advantage. Thirdly, the LCGA groups can be used as a basis for growth mixture models or other growth models in order to examine the common factors within groups and heterogeneous factors between different groups. This extension of the model would help identify sources for the observed differences in performance trajectories. Finally, the winners identified by LCGA are useful benchmarks for case studies to investigate the possible sources of competitive

advantage in individual firms. One of the constraints of LCGA is that it assumes that all individual differences in estimated suicidality trajectories are characterized by class membership. This assumption might underestimate the heterogeneity within class in a large sample size.

Appendix: Financial performance indicators

1. Return on assets: $ROA = \dfrac{\text{Earnings before interest and taxes (EBIT)}}{\text{Total assets}}$
2. Return on equity: $ROE = \dfrac{\text{After tax net income}}{\text{Total shareholders' equity}}$
3. Return on invested capital: $ROIC = \dfrac{\text{EBIT} \times (1 - \text{tax rate})}{\text{Invested capital}}$

   Invested capital given in Compustat = Total Book Value + Preferred Stock (Par Value) + Minority Interest in Consolidated Subsidiaries + Long-Term Debt Not Classified as Capital + Capital Notes and Debentures + Mortgage Indebtedness - Treasury Stock
4. Profit margin: $PM = \dfrac{\text{Net income}}{\text{Sales}}$
5. Market to book ratio: $MTB = \dfrac{\text{Market value of equity}}{\text{Book value of equity}}$

   $market\ value = \text{stock price at close of fiscal year} \times \text{common shares outstanding}$
6. Earnings per share: *EPS*= Earnings per share (basic) including extraordinary items
7. Price-earnings ratio: $\dfrac{\text{Price per share}}{\text{Earnings per share}}$

   Price per share: price at close of fiscal year

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