Aspiration Adaptation: A Test and Comparison of the Cyert and March Model

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ABSTRACT

This study compares the original Cyert and March (1963) aspiration adaptation model with three other frequently-used aspiration adaptation models. Using actual aspirations and performance data gathered from student teams in simulated organizations, our research setting enables direct observation of self and social aspiration comparison reference points that are theorized to impact aspiration adaptation. Our results support the separate and weighted average aspiration models over the original Cyert and March (1963) aspiration adaptation formulation. Though both the Cyert and March (1963) model and the separate model include similar explanatory variables, the separate aspirations model allows for varying influences of performance above and below aspirations, as does the weighted average aspirations model. We conclude with implications for future research concerning both aspiration adaptation and influences of aspirations on firm behavior.

Keywords:

Decision making, structural modelling, organizational processes, aspiration adaptation, behavioral theory of the firm, reference points, social comparison, aspirations

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INTRODUCTION

Based on the Carnegie School (March & Simon, 1958; Cyert & March, 1963) and motivated by an interest in how firms respond to performance relative to aspirations (goals or reference points that indicate a desirable performance level outcome for the focal organization), a substantial literature has developed using aspiration adaptation models (cf. Shinkle, 2012). According to Cyert and March (1963), aspirations adapt over time as a function of prior aspirations, performance relative to those aspirations, and performance of competitors (Cyert & March, 1963; Blettner, He, Hu, & Bettis, 2015). Organizations then compare performance or expected performance to this aspiration level (Cyert & March, 1963). Performance below aspirations in a specific dimension – variously called attainment discrepancy (Lant, 1992), relative performance (Bromiley, 1991), and performance relative to aspirations (Greve, 2003a) – directs attention to that dimension, stimulates search for ways to raise performance above the aspiration level (Posen, Kim & Meissner, 2018), and prompts updating to the aspirations (Bromiley & Harris, 2014).

Although research on organizational aspirations has deepened our understanding of the various influences of attainment discrepancy on firm behavior, two issues have limited our understanding of how aspirations adapt. First, with few exceptions (e.g., Bromiley, 1986a; 1986b; Washburn & Bromiley, 2012; Lant, 1992; Mezias, Chen & Murphy, 2002; Blettner, He, Hu, & Bettis, 2015; Hu, He, Blettner & Bettis, 2017), studies lack direct measures of aspirations and instead use various proxy measures (Shinkle, 2012). Typically, researchers construct these aspiration proxies from some dimension of past performance (such as ROA),historical aspirations (often recursively estimated from prior performance), and the performance of comparable other firms. Most studies consider the effects of attainment discrepancy on firm behavior rather than allowing for separate effects of aspirations and performance (see Bromiley, 1991).

Second, in the absence of actual aspirations measures, researchers have estimated alternative models that may reflect different theoretical assumptions than the Cyert and March conceptualization (Bromiley & Harris, 2014). This may explain conflicting findings on, for example, whether industry comparison (Greve, 2003a), attainment discrepancy (Greve, 2003b; Lant, 1992), or past aspirations (Mezias *et al.,* 2002) have greater influence on subsequent aspirations. Results of the impact of social aspirations on overall aspiration adaptation, similarly, show inconsistent results on effect size and significance (Verver, Zels, Lucas & Meeus, 2019). This may occur because most studies use broad industry definitions to construct social aspirations measures, which may not reflect the performance level which decision makers actually attend to (Posen *et al*, 2018).

We advance understanding of aspiration adaptation by estimating and comparing the original Cyert and March (1963) functional formulation with three other aspirations models prominent in the behavioral theory of the firm (BTOF) literature. This is a departure from prior studies that use actual aspirations data but do not compare the different models. For example, Lant (1992) estimates a single model based on an attainment discrepancy measure of aspirations adaptation rather than as an additive function as in the Cyert and March (1963). Washburn and Bromiley's (2012) nested model addresses the different formulations using actual aspirations but selects among models based on estimated parameter values rather than ability to explain subsequent aspirations measured by fit indices. More recent studies use actual aspirations data to estimate models mathematically equivalent to and extensions of the Cyert and March (1963) formulation (e.g., Blettner *et al*, 2015; Hu, He, Blettner & Bettis, 2017). Blettner *et al* (2015) consider shifts in attention allocation from own to social aspirations as contingent on the firms' life cycle stage. Hu *et al* (2017) explores conditions under which firms switch attention from own aspirations to social referents in aspiration adaptation. However, neither of these studies compare alternative models and hence do not address their explanatory power. Bromiley and Harris (2014), a study that compares different aspiration model formulations, lacks direct aspiration measures and, hence, does not incorporate the original Cyert and March model.

In this paper, we use actual aspirations and performance data gathered from MBA student teams in simulated organizations to estimate the original formulation and compare it with other prominent models in terms of fit criteria. Simulations provide serve as effective tools for replicating practitioner scenarios since they focus on strategic decision-making in a specific firm and environment (Zantow, Knowlton & Sharp, 2005; Haro & Turgut, 2012). As a quasi-experimental approach (Jung, Vissa & Pich, 2017), simulations offer benefits in measurement, control as well as replication that are limited with other methods (Chen *et al*, 2010). Their use provides an important alternative to more conventional archival and survey methods due, in part, to advantages of easy replication (Newbery *et al.,* 2018). The simulation let us model observable past and social aspirations data with minimal ambiguity about managerial construction and interpretation of these reference points and without confounding factors such as macroeconomic shocks, inter-firm heterogeneity in other factors, and government interventions (Chen, Katila, Mcdonal & Eisenhardt, 2010). No manipulation of the participants was required (or desired) because we seek to isolate various aspiration formation variables to contrast existing methodologies with actual behavior (Lant and Montgomery 1992; Levine, Bernard and Nagel 2017; Chen *et al*, 2010; Jung, Vissa & Pich, 2017). In addition, MBA student teams behave similarly to managers in such environments (Fréchette 2015, 2016). Indeed, Lant (1992) using data from a marketing simulation provides one of the first empirical efforts to model aspiration adaptation. Researchers have also used simulations to assess team learning as well as decision-making (e.g., Boies, Lvina & Martens, 2011; Dutton, 1988).

We contribute to the BTOF literature by offering a best fit comparison of the various models, including the Cyert and March model, proposed for aspiration adaptation. We also formally test a long-held assumption derived from the seminal text – whether the coefficients in the Cyert and March model sum to one. This assumption has driven most of the aspiration adaptation model estimation methodology in BTOF literature, however, only Washburn and Bromiley (2012) empirically tests this assumption. They had inconclusive findings as they failed to reject the null hypothesis, that the parameters sum to one, when performance is below aspirations.

We find that the model with independent and additive effects of parameters with different parameters for performance above and below aspirations provide the best fit. Conversely, models with combined or weighted average single measures of aspirations show poorer fit indices. We see the poorest fit values for the Bromiley (1991) single attainment discrepancy measure of aspirations, which does not allow for independent effects for performance above and below aspirations.

In the next section, we discuss the key aspects of modeling aspirations, and outline the Cyert and March model and three other prominent aspirations models. We then discuss our research setting, data, and model estimation, and compare the models based on fit to explain aspiration adaptation. We conclude with theoretical and empirical implications of our findings.

ASPIRATION ADAPTATION MODELS

March and Simon (1958) introduces the concepts of organizational aspirations and aspiration adaptation; Cyert and March (1963) provides the most cited model of aspirations. These works inspired a long tradition of research recognizing that boundedly rational decision makers often categorize continuous performance as discrete outcomes (March & Simon, 1958). Aspiration levels serve as a dividing line between perceived success and failure. If performance exceeds aspiration levels, decision makers tend to stay with the status quo rather than searching for ways to increase performance. However, if performance falls below aspirations, decision makers search in the area of the performance failure for ways to raise expected performance above the aspiration (Posen et *al.,* 2018). Attainment discrepancy (performance minus aspirations), therefore, serves as an activation mechanism that provides cognitively constrained decision makers with a signal on when to initiate search for ways to improve performance and when to adjust their aspiration levels (Lant, 1992).

According to Cyert and March (1963: 123), organizational aspirations adapt as a function of three values: 1) firms' prior aspirations; 2) experience with respect to those aspirations, interpreted as past performance in subsequent studies; and 3) experience of comparable firms in the same goal dimension, as shown in equation (1).

$$A_{i,t} = a_1 \, A_{i,t-1} + a_2 \, P_{i,t-1} + a_3 \, C_{i,t-1} \qquad (1)$$

Where, $A_{i,t}$ is aspirations for firm i in time period t, $A_{i,t-1}$ is aspirations in time period t-1, $P_{i,t-1}$ is firm performance in that aspiration dimension in time t-1, and $C_{i,t-1}$ is the comparison with the performance of other comparable firms in t-1, and $a_1 + a_2 + a_3 = 1$. Generally, aspirations rise when firm performance exceeds past aspirations and decrease when it falls short.

Most aspiration models refer to this formulation but not having actual measures of aspirations cannot directly implement the model. Researchers typically estimate proxies for $A_{i,t}$ to overcome the difficulty of obtaining direct aspirations measures, and generally only test models based on attainment discrepancy as determined by the aspirations proxy. These proxies are variables researchers claim influence aspirations, even though they reflect different behavioral assumptions regarding managerial decision-making (Bromiley & Harris, 2014). For example, substituting for past values of aspirations in equation (1) results in aspirations being a weighted sum of prior firm and industry performance with the most recent year having maximum influence (Washburn & Bromiley, 2012). Such mathematical derivations based on proxies and attainment discrepancy result in theoretically varying aspirations models.

That said, the few studies that estimate models using actual aspirations disagree on which factors most strongly influence aspirations. For example, Mezias *et al.* (2002), using planning and outcome data from a large bank's branches, finds that previous aspirations have the greatest influence on aspiration adaptation. Alternatively, Washburn and Bromiley (2012), using planning and outcome data from an automaker, finds varying factors influence aspirations, contingent on attainment discrepancy. Results on the influence of social comparison are equally mixed (Posen *et al*, 2018; Verver *et al,* 2019) due, most likely, to lack of access to internal firm metrics used for social comparison in most studies.

Blettner *et al* (2015) and Hu *et al* (2017) use a novel sample of the magazine industry where they measure business unit aspirations as the number of magazines printed. Backup interviews with executives in a few companies confirmed that these were fair proxies for aspirations in their studies. By directly estimating and even extending the Cyert and Match model, the studies collectively enhance our understanding of differences in aspiration adaptation over time within firms and across firms in an industry. However, they do not compare different models to explain the extent to which conflicting findings in BTOF literature regarding aspiration adaptation can be attributed to the use of different, theoretically varying proxy models of aspiration adaptation.

We compare the Cyert and March model with the three models of aspiration adaptation most commonly used in the literature (summarized in Figure 1). First, the weighted average model offered by Greve (2003a) uses a weighted average of social- and self (or historical)-referents in determining overall aspirations with a specific function for weighting. Second, the separate model, a variant of the weighted average model, uses separate measures of social- and self-aspirations (Greve, 1998; 2003b; Harris & Bromiley, 2007). Third, Bromiley's (1991) switching model sets aspirations equal to industry performance for firms below industry mean and slightly above past performance for those above.

*** Insert Figure 1 about here ***

Weighted-average model (e.g., Greve, 2003a): Greve (2003a) analyzes a model calculating a single measure of aspirations; a weighted average of prior industry performance and historical aspirations. Prior industry performance is typically calculated as one lag of average performance of all firms in the industry (represented below as $IndustryPerformance_{i,t-1}$). The historical aspirations measure (as self-aspirations are termed in this model) is calculated as an additive function of own prior aspirations and performance:

$$HA_{i,t} = a_2 \; HA_{i,t-1} + (1 - a_2)\, P_{i,t-1} \qquad (2)$$

Where $HA_{i,t}$ is firms' historical aspirations in year t, $P_{i,t-1}$ is firms' own performance in year t-1, and a_2 is an empirically estimated parameter. Repeatedly substituting for past values of HA, results in HA as a function of past performance levels:

$$HA_{i,t} = (1 - a_2) \sum_{s=0}^{\infty} a_2^s \; P_{i,t-1-s} \qquad (3)$$

Overall aspirations are then calculated as the weighted average of $IndustryPerformance_{i,t-1}$ and $HA_{i,t-1}$ giving:

$$A_{i,t} = a_1 \, Industry\ Performance_{i,t-1} + (1 - a_1)(1 - a_2) \sum_{s=0}^{\infty} a_2^s \; P_{i,t-1-s} \qquad (4)$$

Here, $A_{i,t}$ represents overall aspirations, $IndustryPerformance_{i,t-1}$ is average industry performance in year t-1, and a_1 and a_2 are empirically estimated parameters.

The values of parameters a_1 and a_2 are non-negative and sum to one. Greve (2003a) estimates them by a grid search method and uses the combination that results in the highest maximum likelihood in the final modelling arriving at a_1 = 0.8 and a_2 = 0.2. A high a_1 means that industry performance has a much stronger influence on aspirations than the firm's past performance. Bromiley and Harris (2014) estimates a model similar to (4) and finds that performance in t-1 has a much stronger influence than performance in previous years.

Finally, the model is splined to allow for a kink for when attainment discrepancy changes signs, that is, when firms performing below aspirations in t-1, meet or exceed aspirations in t or vice-versa. This results in the model having four parameters: a_1 and a_2 along with the influences of attainment discrepancy both above and below aspirations.

Separate social and self-measures (e.g., Greve, 1998; 2003b and Harris and Bromiley 2007): This model allows for social- and self (or historical) aspirations to have individual effects on aspiration adaptation, in contrast to weighted average models which combine the two. With separate measures, researchers can observe separate parameters for the influences of attainment discrepancy based on social- and self-aspirations allowing different parameters depending on sign (positive vs negative), leading to a total of four parameters (Bromiley & Harris, 2014).

Greve (1998; 2003b) calculates self-aspirations as an exponentially weighted moving average of cumulative prior performance, and social-aspirations as prior year industry performance. Harris and Bromiley (2007) treats self-aspirations as firms' prior year's performance, and social-aspirations as prior year's industry average performance. Consistent with Greve (2003a), they find that self- and social aspirations operate independently, with the latter dominating overall aspirations.

Switching model (e.g., Bromiley, 1991): In laying out the theory of aspiration level adaptation, Cyert and March (1963: 123) argue that the attention firms give to their own versus industry's reference points depends on firms meeting prior aspirations (level of attainment discrepancy). However, their formulation in equation (1) does not reflect this theoretical argument. The switching model captures this change in aspirations as a function of attainment discrepancy, arguing that "firms with performance above the industry would not be satisfied with lower performance even if they performed above the industry average" (Bromiley & Harris, 2014). This gives aspirations adapting as a function of industry performance if the firm is below industry, but as a function of past performance if the firm is above the industry performance:

$$A_{i,t} = Industry\ Performance_{i,t-1} \quad if \quad P_{i,t-1} < Industry\ Performance_{i,t-1}$$

$$A_{i,t} = a_1\, P_{i,t-1} \quad if \quad P_{i,t-1} \geq Industry\ Performance_{i,t-1} \qquad (5)$$

Here a_1 is greater than 1. Bromiley (1991) fixes this at 1.05, noting that modest changes in a_1 do not change the empirical results.

All three of these models share several similar properties with the Cyert and March model. They all recognize the importance of prior (self or historical) aspirations. This dimension reflects an assumption that recent performance strongly influences current aspirations compared with temporally distant performance. In addition, they all include social aspirations, and thereby assume that comparison with relevant peers influences aspirations (Lewin, Dembo & Festinger, 1944). In studies of social aspirations, most strategy studies define social aspirations by industry average performance (e.g., Bromiley, 1991; Fiegenbaum & Thomas, 1988). These studies reflect an assumption that decision makers use an external comparison (e.g., average performance across competitors) to evaluate whether the performance of their firms is satisfactory (above the average) or unsatisfactory (below the average).

However, differences also exist among the models. Only Cyert and March (1963) explicitly incorporates both a prior aspiration level and a separate attainment discrepancy parameter, recognizing that organizational goals provide both a purpose toward which organizational attention and decisions are directed, and a set of performance requirements against which decision makers may evaluate their efforts (see, for instance, Simon, 1964; Keum & Eggers, 2018). These models also differ in their assumptions of how firms update aspirations based on experience. For example, only the switching model allows different factors to influence aspirations as a function of attainment discrepancy. The separate model assumes managers maintain more than one aspiration for a given performance dimension while the other three offer different functional expressions of the possible ways in which managers would determine a single aspiration level for a dimension.

Accordingly, the models differ in their assumptions concerning the attention of managers. The switching model differs from the Cyert and March (and other models) in that it suggests attention switches from past to social comparison (although seldom cited passages in Cyert and March (1963; e.g., pp 123) do mention this possibility). The separate model assumes managers have two distinct aspiration levels; making feedback potentially inconsistent (Baum, Rowley, Shipilov & Chuang, 2005) or ambiguous (Joseph & Gaba, 2015). Signals of performance from multiple indicators may vary, and when they do, may further confound the feedback process.

METHODS

Research setting

We estimate the four aspiration models using actual aspirations, and firm and industry performance data collected from MBA student teams competing with Harvard Business Publishing's strategic innovation simulation *Back Bay Battery* (Christenson & Shih, 2008), hereafter the 'simulation'. In the simulation, student teams assume the role of business unit managers of a firm manufacturing batteries, hereafter, 'firm', for up to eight periods (nominally, each period is a year, hereafter `year'), allowing us to estimate, using direct measures, the original Cyert and March (1963) aspirations model and compare it with the three others.

The simulation requires firms manage investment trade-offs between an established battery technology (Nickel-Metal Hydride or NiMH) and a new, potentially disruptive, battery technology (Ultracapacitors or UC). Firms allocate resources to various research and development (R&D) activities across the two battery technologies, set unit sales goals (aspirations) in each battery technology and aim to achieve aspirations each simulated year. Figure 2 displays all the decisions firms make each year across the two battery technologies. Firms compete with the simulation, rather than compete against each other.

*** Insert Figure 2 about here ***

The context of the two technologies is important for the simulation. The established NiMH technology requires lower R&D investment than the new technology, UC. for performance improvements. However, UC sales grow at a high rate than NiMH in the simulated industry firms face. Higher immediate returns to R&D coupled with slower growth rates in NiMH compared to UC makes the trade-off between the two technologies complicated. R&D investment across multiple R&D dimensions (i.e., energy density, recharge cycles, self-discharge rate, recharge time, and manufacturing process improvements, as displayed in Figure 1) in the two technologies lead to variation in technical as well as market performance in the sample. Thus, many possible permutations ensure that there is no one way to 'win' the game (i.e. survive for eight periods while meeting aspirations with positive net income), while providing enough variation in our dependent and independent variables to compare models.

Similarly, aspirations have two functions in the simulation. First, they limit the resources that firms can allocate to R&D (up to 3% of aspirations). This encourages the firms to set reasonably high aspiration levels to ensure access to financial resources for R&D investments that boost future sales. Second, the simulation compares subsequent performance to the self-defined aspirations for that year and eliminates (bankrupts) firms with repeated small negative variances between aspirations and actual performance or one extreme negative variance. Firms also go bankrupt if they post consecutive net income losses. Bankruptcy leads to firms exiting from the simulation since the objective of the 'play' is to survive eight periods and have high performance over the periods. Together, these impositions on the relations between aspirations, R&D investment levels, and survival ensure that firms have strong incentives to set realistic aspirations.

All firms start with identical internal and external contexts and performance histories. This eliminates many forms of heterogeneity that make cross-unit comparisons difficult using actual firm data. Since firms compete with the simulation rather than each other, the outcomes for each team are independent of those for other teams. The setting controls for "the influences on strategy and firm evolution" that prevent meaningful comparison (Noda & Collis, 2001), providing us with a controlled environment as well as the ability to observe information flow to firms which helps in ruling out competing explanations of constructs, such as, performance dimensions and social comparison reference points (Chen *et al*, 2010).

The simulation provides the firms with substantial data across multiple dimensions. Firms start out with three years of prior performance history, which updates annually. Subsequent years' data includes aspirations, sales performance, R&D investments and product performance improvements. The data also includes market size and penetration along with updates such as changes in customer preferences and demand. The simulation also provides firms with overall industry size and annual growth in terms of number of adopters, which serves as the only social performance measure available in the game (since players do not compete directly with each other).

As seen in Figure 2, the simulation allows firms to define their sales targets (aspirations). It further reports and keep tracks of past performance and aspirations as well as the industry comparison measure - the key variables needed for estimating the different aspiration adaptation models.

Data and estimation

We use data collected at two major research universities where core strategy classes required the simulation for all first year MBA candidates. Students competed in randomly assigned teams of three to five and had to finish the simulation in two hours. All students received the same instructions. Some teams attempted the simulation twice (two plays until they either complete the simulation or go bankrupt). To test for learning effects between attempts, we tested models individually for teams' first and second attempts, and then both combined. We found no difference across the models with different attempts and consequently report results using the full sample. A manipulation or control group is not required for our research question since we seek to isolate processes and contrast theory (Lant and Montgomery 1992; Levine, Bernard and Nagel 2017; Chen *et al*, 2010; Jung, Vissa & Pich, 2017) using different mathematical formulations of the same theoretical construct behavior. Thus, our quasi- experimental setting (Jung, Vessa & Pich, 2017) with multiple decisions rounds or trials (Shilke, 2018) provides participants with information for each simulated year based on which they make their decisions for the next. The decision rounds represent common strategic problems faced by real-life organizations, thus providing ecological validity (Lant & Montgomery, 1992), while allowing for the randomization and universality of observation that enables a good causal test of our full model (Jung, Vissa & Pich, 2017).

Our total dataset contains observations for 376 firms – each a unique attempt (or round) by a team interacting with the simulation. Though the simulation spans 8 years, we lose observations because many firms go bankrupt earlier, as well as while lagging various variables for our models. To incorporate two-level lags in our models, we only used data for firms that survived at least 3 years into the simulation (excluding the three-year historical data provided at the beginning). Thus, we have a common sample of 336 firms and 1,457 unique firm-year observations across the four models. On average, firms lasted 4.3 years in the simulation.

We estimate models using fixed firm and year effects since aspiration adaptation theories address change in aspirations over time within firms. Firms set aspirations in terms of unit sales, which does not have the normalization that ROA does for industry to firm comparison. We explain how we handle this in the detailed specification of each model, as outlined next.

Cyert and March (1963; 1992) aspirations model: We calculate a direct measure of the dependent variable (DV) and the first independent variable (IV), respectively *aspirations* at time-period t and *lagged aspirations* at t-1 as sales targets for t and t-1, by summing up the individual sales aspirations across the two battery technologies for each firm in the respective time periods. *Performance* is total units sold in t-1 across the two battery technologies. All measures of aspirations and performance in the subsequent models are also calculated as a sum of the corresponding metrics across the two battery technologies.

Social *comparison* is calculated as market size growth from time period t-1 to t multiplied by firm performance in t, indicating projected firm performance at industry growth rate. Thus, our industry measure assumes an industry reference equivalent to the industry growth rate, in line with Washburn and Bromiley (2012) which calculates *comparison* as the median percentage growth of the industry.

Lacking data on number of firms in the industry, it is reasonable to assume that managers will look towards annual change in industry sales as an indicator of social comparison or ignore the social aspiration level altogether if they feel it is too ambiguous.

We test for the hypotheses that these weights sum to one, an important assumption in the original model with which the descriptive theory in the same text seems to conflict (Cyert & March, 1963), but has been the basis of most of the quantitative research in the field. Only Washburn and Bromiley (2012) have attempted to test this assumption, but their results were inconclusive. Allowing the regression analysis to assign weights also enables like-for-like comparison with the rest of the models whose attention weights are determined by the regression analysis.

In our panel data regression, *lagged aspirations* (IV) affect *aspirations* in t (DV). We correct for resulting possible endogeneity by using instrumental variables in the model (Correia, 2019). We use the individual prices (for t-2) and performance (for t-2) in each of the two battery technologies as instruments (giving us a total of four instruments). These variables theoretically justify their viability as instruments since they do not influence the DV, aspirations in t, but do influence the endogenous IV, aspirations in t-1. Hansen J value, $p = 0.0787$, helps us reject under-identification and empirically supports the use of these instruments.

Greve (2003a) weighted average model: We measured *historical aspirations* using a two period lag on firm performance, since this provides better model fit over one or three years. *Industry reference* is calculated as market size growth rate multiplied by firm performance, consistent with the previous model. The IV *weighted aspirations* was calculated as a weighted average of the two above.

Following Greve (2003a), and Bromiley and Harris (2014), we assign values for a_1 and a_2 from 0 to 1 by increments of 0.1 to calculate the aspirations variable, selecting the parameters a_1 and a_2 with the highest log likelihood value: $a_1 = 0.9$ and $a_2 = 0.1$. A dummy variable indicated whether performance is above or below calculated aspirations.

Greve (2003b) and Harris and Bromiley (2007) separate measures with independent self- and social aspirations: We calculate *social-aspirations* as firms' past performance multiplied by market size growth, as in the above models, to enable comparison. We calculate *self-aspirations* as firms' past performance times its growth rate rather than just past performance, to maintain comparability with the *social aspirations* measure. We allow for different parameters depending on past performance being above or below *social- and self-aspirations*. Like Harris and Bromiley (2007), fit indices favored a one period lag on performance.

Bromiley's (1991) switching model with one year of industry and firm data: For firms below the industry growth, the industry reference (market size growth multiplied by firm performance) serves as the aspiration level. For those above industry growth, the aspiration level switches to 1.05 times firm's own prior year performance. As shown by Bromiley and Harris (2014), modest changes in the value of *a* above or below 1.05 do not affect model results. Industry and firm performance are calculated exactly as in the previous model for comparison.

Following Bromiley and Harris (2014), we compare the four models based on Akaike information criterion (AIC) and Bayesian information criterion (BIC) values. Lower values of either indicate better model fit (Long & Freese, 2000), although the most robust indication is when the two criteria agree (Kuha, 2004). With large sample sizes, such as in our study, significance tests are sensitive to quite small deviations from the null hypothesis. Penalized model selection criteria like AIC and BIC are suitable for comparing non-nested models and provide guidance for choosing between models that have not been rejected (Kuha, 2004)

RESULTS

Table 1 shows descriptive statistics and correlations for the variables in our models. Because the speed with which factors influence aspirations is unclear, we estimate models with multiple lag structures on the independent variables and choose the ones with maximum log likelihood, as specified separately for each model in the estimation methodology above.

*** Insert Table 1 about here ***

Table 2 shows regression results for the four models, 2SLS estimates with instrumental variables for past aspirations for Cyert & March (1963) and OLS estimates for the other three. All models include firm and year fixed effects. We next discuss the parameters before comparing the models based on fit indices.

*** Insert Table 2 about here ***

In the Cyert and March model, past aspirations (b = -0.213, p= 0.000), and performance (b = 1.313, p= 0.10) significant but opposing effects on aspiration adaptation. Comparison (b = -0.320. p= 0472) does not have a significant effect. We also find that sum of the parameters for the Cyert and March model are below 1 (b = 0.78, p= 0.001). Thus, the "sum to one" assumption in Cyert and March (1963) does not hold. This is not surprising since many of the qualitative discussions of aspirations argue that aspirations tend to exceed current performance (Cyert & March, 1963; March & Simon, 1958; Simon, 1991). The assumption that all parameters are non-negative in the model also does not hold true. While the comparison variable shows a negative but non-significant coefficient, the prior aspiration level has a significant negative influence in aspiration adaptation. In this setting decision makers tended to lower aspirations rather than raise them over time. Hence, our results throw a new light on the qualitative discussions of aspirations, arguing for inclusion of the possibility of a negative influence of past aspirations.

In the weighted aspirations model (Model 2) the weighted average aspirations measure (b = 0.846, $p= 0.000$) influences aspiration adaptation. The influence is slightly larger when performance is above aspirations (parameter on interaction, b = 0.037, $p= 0.002$).

In the separate aspirations model (Model 3), in contrast to the Cyert and March model, shows that social aspirations (b = 0.841, $p= 0.000$) and again the influence is larger when firm performance exceeds past aspirations (b = 0.026, $p= 0.087$). Self-aspirations (b = -0.056, $p= 0.289$) do not have a significant impact on aspiration adaptation even when allowed for separate effects of performance above and below aspirations (b = 0.026, $p= 0.101$). We cannot reject the hypothesis that the self-aspirations parameter equals zero. This is consistent with studies that find social aspirations dominate overall aspirations (e.g., Harris & Bromiley, 2007).

In the switching measure of attainment discrepancy (Model 4), the attainment discrepancy variable significantly influences aspirations, although the magnitude of the parameter is small (b = 0.153, $p= 0.000$).

These results show that even when models with past aspirations, performance, and social comparison independently do not show all variables to influence aspiration adaptions, models which estimate attainment discrepancy or a weighted average measure of aspirations combining the above variables can still yield significant results. Thus, the effects of attainment discrepancy and weighted average aspirations on both aspiration adaptation and subsequent firm behavior should be studied independently from the effects of actual aspirations and performance on similar firm behaviors.

When comparing fit indices, we see the separate aspirations model (AIC = 6307.1, BIC = 6354.7) with the best fit values followed by weighted average aspirations model (AIC = 6,324.2, BIC = 6,366.5). The Cyert and March model (AIC = 6,329.2, BIC = 6371.5) closely follows. The switching model (AIC = 6,896.1, BIC = 6927.8) has substantially poorer fit than the other models. R^2 comparison across models align well with the AIC and BIC, finding separate model having higher R^2 and better fits than the other models, in the same order as of the AIC and BIC values.

Overall, while our results show the differing influences of past aspirations, performance, social comparison, attainment discrepancy, and weighted average aspirations, fit statistics support models which allow for a spline that measures the influences of the variables independently for performance above and below their respective aspiration levels.

DISCUSSION AND CONCLUSION

This paper explores the drivers of aspiration adaptation and compares the Cyert and March model with three other common aspiration models. The influence of aspirations and attainment discrepancies on firm behavior and aspirations have been studied extensively by behavioral strategy scholars. Most research, though based on Cyert and March's (1963) aspirations formulation, uses proxies for attainment discrepancy as explanatory variables in the absence of actual aspirations measures. A few recent studies have estimated models using actual aspirations data and, as a result, have greatly enhanced our understanding of how aspirations adapt (Washburn & Bromiley, 2012; Blettner *et al*, 2015; Hu *et al*, 2017), but have yet to make direct comparisons across models as we do here.

Our methodology, using data from a simulation, allows a precise correspondence between the hypothesized variables deemed important by the theoretical models and the actual measures that decision makers pay attention to. Lant's (1992) paper set the precedent for the use of data derived from business simulation for aspiration models, and others have successfully followed in their use to answer varying research questions in strategy and management research (Chen, Katila, Mcdonal & Eisenhardt, 2010; Katila, Chen & Piezunka, 2012; Jung *et al*, 2017).

Our results show that while varying factors influence aspiration adaptation, models which consider the independent and additive effects of the parameters in the adaptation function have higher explanatory power. Both the Cyert and March model and the separate model consider, independently, prior (historical or self) aspiration and social aspiration along with performance along those dimensions. Models such as these, with disaggregated components, may better accommodate the variety of decision-making situations and attentional variation that arise in dynamic environments. The setting for our study reflects disruptive technological change, where the potential for performance problems, the need to detect them, and respond to them is especially high. Models with multiple independent parameters allow greater flexibility through the dual role of attention direction and evaluation ascribed to aspirations (Simon, 1964). Both roles are important for adaptation as it requires both the motivation and ability to change (Eggers & Kaul, 2017). At the same time, fit indices favoring models which incorporate a spline function to independently measure the effects of performance above and below aspirations substantiates prior research (Greve, 1998), underlying the importance of both multiple decision dimensions and differences in human behavior when above and below the reference point (Kahneman, 1992; Greve, 1998)

Limited support for the Cyert and March model points to the need for more studies that use actual aspirations data from real world settings to enable further testing. Apart from this study, only a few before (Washburn & Bromiley, 2012; Mezias *et al.,* 2002; Lant, 1992; Bromiley, 1986a; 1986b; Blettner *et al*, 2015; Hu *et al*, 2017) have estimated models using actual aspirations data or sophisticated proxies, as data availability and salience make such explorations rare. Only three of these studies (Washburn & Bromiley, 2012; Blettner *et al*, 2015; Hu *et al*, 2017) estimate aspiration models mathematically equivalent to the original Cyert and March formulation, but none compare the different formulations used in BTOF research. Direct measures of prior (historical or self) aspiration is a very prominent feature of the simulation used in our comparison of different model formulations.

We suspect that the salience of different factors varies across contexts, which may explain why studies of different contexts produce different results on the relative quality of specific measures of aspirations. For example, firms may set aspirations very differently when failure to meet those aspirations presents a threat to their survival, as evidenced in our study than when failure to meet aspirations has a smaller impact. Context extends to organizational factors that impact relative performance and its influence on firm behavior that have been widely studies by strategy scholars, such as, firm size (Audia & Greve, 2006), structure (Gaba & Joseph, 2013), and experience within failure domains (Eggers & Suh, 2019).

Similarly, the availability of data for social comparison varies across industries. In industries populated with closely held firms, data for social comparison may be extremely hard or impossible to obtain. In others, like banking, regulatory demands make it easy to obtain data on competitors. In our simulation, while firms had readily available information on prior performance, data on competitors did not appear in an immediately comparable format – mean or total industry customer or sales numbers do not readily compare to firm sales as measures such as ROA which are normalized by asset base across firms in the industry (Washburn & Bromiley, 2012) . This may account for weak findings on social aspirations in the Cyert and March model.

The negative influence of lagged aspirations in the Cyert & March (1963) model may reflect this reward structure. The model holds lagged performance constant, so lagged aspirations reflects variation in aspirations not consistent with lagged actual performance. In a world that punishes negative deviations from aspirations severely, it makes sense that managers may react negatively to high aspirations that are not aligned with actual outcomes.

Use of actual aspirations allowed for testing of the sum to one assumption in the Cyert and March model, which has not been conclusively tested before. In doing so, we find that the imposed assumption - that the weights of each of the components sum to one - is not supported. This finding is not entirely unexpected since decision makers are likely to be striving above under various conditions (Bromiley & Harris, 2014) or even be downward striving in setting aspirations when faced by threat of survival as a result of not meeting prior, higher aspiration, as in our study. This finding (and the fact that the separate model has a better fit than the weighted model) suggests that the common practice of a grid search to sets relative weights on self and social factors in the weighted model should be evaluated against other (non-weighted) models which allow the beta coefficients to serve as the weighting.

Our research setting limits generalizability and comparability for two reasons. First, controlled data from a business simulation limits external validity. BTOF research would benefit from building a body of comparable work estimating models with actual aspirations while tracking the behavior of managers making these decisions. We could potentially discover nuances such as identifying which aspiration model works best in specific industries or specific settings. Second, the simulation does not provide us with data on total number of firms in the industry. We model social aspirations as a function of industry growth rate rather than average industry performance, similar to Washburn and Bromiley (2012), who use industry median growth rates as the social aspiration level. Our results showing significant influences of social aspirations in both the separate and weighted average measures models aligns with prior empirical findings using these models (e.g., Greve, 1998; 2003a; 2003b; Harris & Bromiley 2007) and hence points towards overall convergence of our data's external validity in relation to prior research.

In all, BTOF aspirations literature would benefit from richer theoretical designs on the influences of past aspirations, performance, and attainment discrepancy, as independent non-substitutable variables, on aspiration adaptation as well firm behavior. Our empirical contributions point to the differences in explanatory power in single proxy vis-à-vis disaggregated aspirations models, and that models which allow for independent influences of performance above and below aspirations are essential in theorizing influences of aspirations on firm behavior. Attainment discrepancy has differing effects on aspiration adaption than prior aspirations and performance individually, and hence they should not be automatically used as proxies for each other when estimating aspiration models. Furthermore, our study suggests that since measurement may play an especially prominent role in aspiration adaptation models, underlying theoretical behavioral assumptions and the setting's decision-making context should serve as important inputs to the particular models chosen to guide empirical testing.

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Model	Number of Parameters	Aspirations	Notes
Cyert and March Model	3	$A_{i,t} = a_1 A_{i,t-1} + a_2 P_{t-1} + a_3 C_{i,t-1}$	• *a_1, a_2, and a_3 are non-negative and sum to one*
Switching Model	1	$A_{i,t}$ = $IndustryPerformance_{i,t-1}$ if $P_{i,t-1}$ < $IndustryPerformance_{i,t-1}$ $A_{i,t}$ = 1.05 * $P_{i,t-1}$ if $P_{i,t-1}$ > $IndustryPerformance_{i,t-1}$	• *aspirations adapt as a function of industry performance if the firm is below industry, but as a function of past performance if the firm is above the industry performance*
Weighted-Average Model	4	$A_{i,t} = a_1 IndustryPerformance_{i,t} + (1 - a_1)(-a_2) \sum_{j=0}^{\infty} a_2^j P_{i,t-1-s}$	• *a_1, and a_2 are non-negative and sum to one* • *Model is splined for differing influences of attainment discrepancy above and below aspirations*
Separate Model	4	$Self_t = P_{t-1}$ $Social_t = IndustryPerformance_{t-1}$	• *Social- and self (or historical) aspirations have individual effects on aspiration adaptation*

Figure 1: Alternative Aspirations models

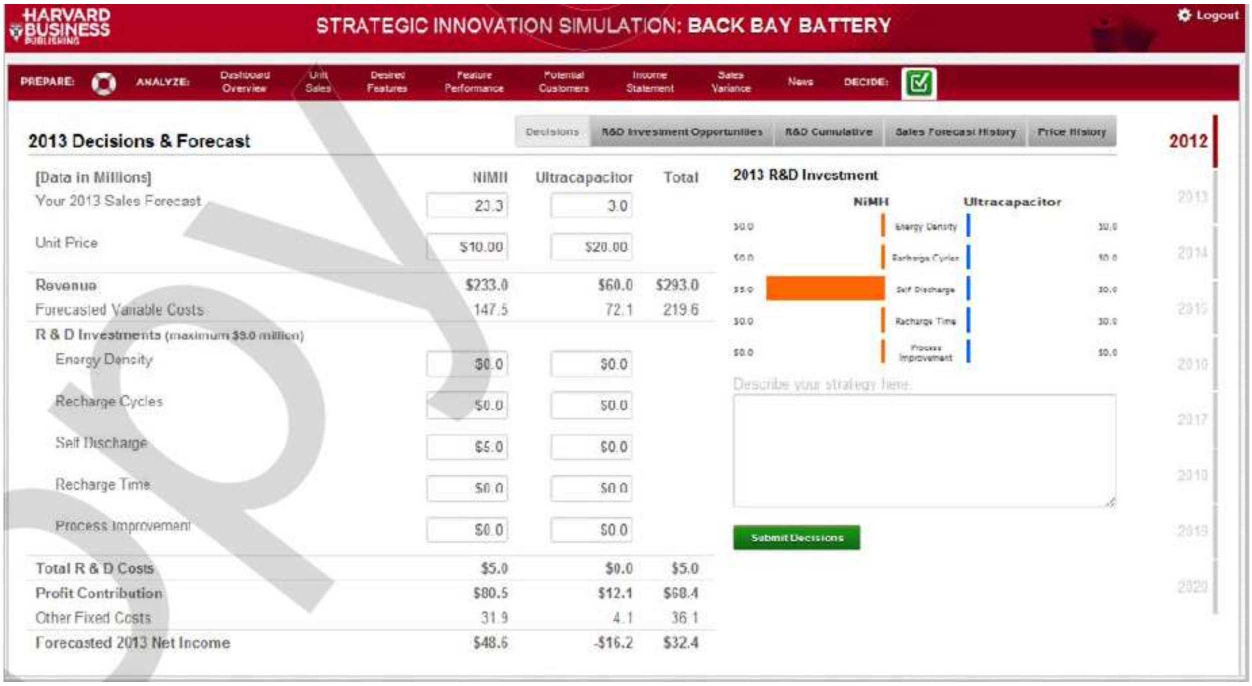

Figure 2: Back Bay Batter Simulation – Decisions and Forecasts

Table 1. Descriptive statistics and Correlation table

Variables	Mean	S.D.	Min	Max	1	2	3	4	5	6	7
1. Time-periods (years completed)	4.91	1.60	3.00	8.00	-	-	-	-	-	-	-
2. L2. Industry unit sales (USD Mn)	124.32	15.18	85.00	149.70	-	-	-	-	-	-	-
3. Unit sales aspirations (USD Mn)	21.87	5.55	4.00	38.00	-	-0.71 (*p*=0.000)	-	-	-	-	-
4. L. Firm unit sales (USD Mn)	22.93	5.37	9.90	36.90	-	-0.38 (*p*=0.000)	0.85 (*p*=0.000)	-	-	-	-
5. L2. Unit price (UC) (USD)	24.36	43.33	0.00	500.00	-	-0.01 (*p*=0.824)	-0.04 (*p*=0.094)	-0.05 (*p*=0.057)	-	-	-
6. L2. Unit price (NiMH) (USD)	9.18	1.02	0.00	12.00	-	-0.64 (*p*=0.000)	0.31 (*p*=0.000)	0.37 (*p*=0.000)	-0.01 (*p*=0.757)	-	-
7. L. Revenue (UC) (USD Mn)	79.16	38.75	0.00	265.70	-	-0.34 (*p*=0.000)	-0.04 (*p*=0.039)	0.11 (*p*=0.000)	-0.19 (*p*=0.000)	-0.09 (*p*=0.000)	-
8. L2. Revenue (NiMH) (USD Mn)	201.75	70.05	0.00	291.25	-	-0.15 (*p*=0.000)	0.38 (*p*=0.000)	0.63 (*p*=0.000)	0.02 (*p*=0.316)	0.61 (*p*=0.000)	-0.13 (*p*=0.000)

Table 2: Aspirations models - Two Stage Least Squares and Ordinary Least Squares Estimates

VARIABLES	**Model (1)** **Cyert and March Aspirations** *2SLS*	**Model (2)** **Weighted Aspirations** *OLS*	**Model (3)** **Separate Aspirations** *OLS*	**Model (4)** **Switching Aspirations** *OLS*
Lagged aspirations	-0.213 (p= 0.000) (0.059)			
Lagged performance	1.313 (p= 0.010) (0.509)			
Lagged comparison	-0.320 (p= 0.472) (0.444)			
Weighted aspirations		0.846 (p= 0.000) (0.038)		
Weighted aspirations (x dummy, performance> aspirations =1)		0.037 (p= 0.002) (0.012)		
Self-aspirations			-0.056 (p= 0.286) (0.053)	
Self-aspirations (x dummy, performance> aspirations =1)			0.026 (p= 0.104) (0.016)	
Social-aspirations			0.841 (p= 0.000) (0.071)	
Social-aspirations (x dummy, performance> aspirations =1)			0.026 (p= 0.077) (0.015)	
Attainment discrepancy				0.153 (p= 0.000) (0.020)
Observations	1,457	1,457	1,457	1,457
R-squared	0.790	0.791	0.794	0.689
Number of groups	336	336	336	336
AIC	6,329.2	6,324.2	6,307.1	6,896.1
BIC	6,371.5	6,366.5	6,354.7	6,927.8

Robust standard errors in parentheses. Year and firm fixed effects not reported.