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Whom should a leader imitate? Using rivalry-based imitation to manage strategic risk in changing environments

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Abstract

Research Summary: We study the performance implications of dynamic environments for a leader's rivalry-based imitation efforts in a setting with multiple rivals. We disentangle competitive interactions from environmental changes to show that a leader's simple rules to either imitate the closest rival in terms of attributes (her neighbor) or the closest rival in terms of rank (her challenger) can help to maintain the performance gap to her competitors. Using a computational model and an empirical test, we find that environmental changes alter the trade-offs between imitation accuracy and the responsiveness to threats from distant rivals. Consequently, when environmental changes are infrequent and minor, neighbor imitation is more effective in maintaining the lead, whereas challenger imitation prevails as environmental changes become more frequent and substantial.

Managerial Summary: By showing that imitating a lower-ranked rival can help a leader to stay ahead, recent research has overturned the common thinking that imitation is only useful for those trying to catch up with the leader. However, these insights come from contexts in

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which the leader has only one competitor. Can imitation also be effective for a leader competing against multiple rivals, and whom should the leader imitate? We find that imitation can indeed help the leader to maintain their lead against multiple rivals, but that the choice of imitation target matters and should take the competitive environment into account. In relatively stable environments, imitating your most similar rival works best, while imitating whoever is in second place is a more effective approach in changeable environments.

KEYWORDS

competitive dynamics, environmental shocks, rivalry-based imitation, search, strategic risk

1 | INTRODUCTION

Staying ahead is a key organizational goal of a market leader (D'Aveni, 1999; Smith, Ferrier, & Grimm, 2001), one that is particularly challenging to achieve in dynamic and uncertain environments (D'Aveni, Dagnino, & Smith, 2010; Wiggins & Ruefli, 2005). Such environments are often characterized by uncertainty about opportunities arising from sudden environmental shifts and by competitive threats of rivals aiming to catch up. As a potential defensive strategy for a leader to maintain her advantage, imitating a rival's moves can neutralize threats to the leadership position in head-to-head competition (Aron & Lazear, 1990; Cabral, 2002; Ross & Sharapov, 2015).[1] However, as many settings comprise of multiple rivals striving for market leadership using diverse strategies, the leader faces different potential targets for such "rivalry-based imitation" (Lieberman & Asaba, 2006), raising the question of which rival *should* such imitative efforts be focused on, if the leader chooses an imitation strategy.

For example, in an attempt to defend its lead in the overall processor market, Intel chose to make investments estimated at $10bn in low-energy processors, such as those designed by the strategically dissimilar ARM (Fried, 2016), who had come to dominate the growing smartphone and tablet market niches and was perceived to be well-positioned to benefit from expected growth in demand for Internet of Things applications. Alternatively, instead of matching ARM's bet on the market for low-energy processors continuing to grow strongly, Intel could have maintained its focus solely on high-performance processors, either by using those funds to pursue its own path independently of the actions of its rivals, or by imitating its more strategically similar rivals in this domain, such as AMD. By contrast, Coca Cola seems to have imitated a strategically similar rival as part of efforts to maintain its dominance of the Japanese soft-drink industry. Rather than being the first to introduce new products into the market, Coca Cola instead appears to have quickly imitated new products introduced by a rival with similarly broad product lines (Suntory), while rarely imitating the new product introductions of Otsuka,

[1]Imitation refers to the actions or attributes of one rival being observed and subsequently copied by another (Giachetti, Lampel, & Li Pira, 2017; Posen, Lee, & Yi, 2013).

which had a much narrower set of product lines, despite it having similar market share to Suntory (Asaba & Lieberman, 2011, pp. 25–26, 28, 33, 39).

Such targeting choices relate to the risk of ignoring a severe threat from a dissimilar rival, especially when the performance effects of imitating a rival's moves in dynamic environments are a priori uncertain. Due to bounded rationality and resource constraints, organizations select a focal rival as a referent for their competitive decisions, leaving others unnoticed (Chen, 1996) and increasing the risk of performance erosion relative to competitors (Zahra & Chaples, 1993). Yet, the literature provides few normative insights for a leader on how alternative targets of imitation shape the likelihood and magnitude of performance shortfall relative to competitors, defined as strategic risk (Baird & Thomas, 1990, p. 43; Collins & Ruefli, 1992, 1996; Miller & Reuer, 1996, p. 674). As prior work has commonly assumed the industry leader, a strategic group, or the industry average as competitive referent (Fiegenbaum, Hart, & Schendel, 1996), and assumed (sets of) competitors to be homogenous, the link between the focus of attention on specific rivals and performance remains unexplored. Since in many settings rivals increasingly compete at the long-tail of the distribution (Brunner, 2014), rivalry-based imitation may become more important, especially in times that are characterized by unexpected changes in the environment (Wiggins & Ruefli, 2005).

Building on competitive dynamics research that suggests that firms search in the context of other competing firms (Chen, Katila, McDonald, & Eisenhardt, 2010; Katila, Chen, & Piezunka, 2012), we seek to address these issues by exploring the effectiveness of alternative rivalry-based imitation strategies, if these are pursued by the leader. As established incumbents do imitate rivals pursing different strategies in high-velocity environments (Smith, Grimm, Wally, & Young, 1997), we define imitation strategies as set of "decision rules" that guide action in unpredictable environments in a competitive process (Lieberman & Asaba, 2006, p. 373; MacCrimmon, 1993, p. 115). Such strategies consist of a series of moves which can be either tactical or strategic in nature. As alternative targets of imitation imply different repositioning costs (e.g., due to interdependencies among the activities being rearranged; MacMillan, McCaffery, & Van Wijk, 1985), and because outcomes of moving from one to another position are contingent on changes in the environment (McGee & Thomas, 1986; Rumelt, 1984), the effectiveness of imitation strategies in limiting a leader's strategic risk may be contingent on the environmental conditions.

Studying this form of imitation requires disentangling competitive reactions from simultaneous but independent responses to external events (Chen & Miller, 2012; Lieberman & Asaba, 2006) and involves the complexity of unfolding interactions between rivals in varying environmental conditions over time (Sutton, 2007). We therefore follow a stepwise procedure of developing theory (see Davis, Eisenhardt, & Bingham, 2007), by first using a simulation model followed by an empirical test. The nature of our "what should be" question motivates the use of different laboratories in our research design (Burton, 2003, p. 98; McGrath, 1982): First, we develop of a computational simulation to explore the mechanisms at work. This allows us to understand how the path through which performance is achieved in multi-competitor settings is influenced by the intertwined processes of imitation strategy choice, competitive interactions, and environmental variations. We then develop propositions and empirically test the insights from our simulations by making use of data from multi-competitor (fleet) sailing races from the America's Cup World Series 2011–2013. This context provides a unique opportunity of a natural laboratory with a full population of identically equipped competitors, who make decisions in the absence of cooperative behavior, reputational concerns, and social pressures—typical alternative motives for imitation (Lieberman & Asaba, 2006). Using fine-grained data on rival moves and environmental changes, the setting allows us to disentangle endogenous and exogenous sources of environmental change in competitive interactions, and empirically test and triangulate propositions that emerged from our simulation.

Both our simulation and our empirical context present a stylized competitive setting in which at every point in time rivals must decide on a single course of action with uncertain performance consequences and cannot use multiple bets to hedge their risk. Consequently, as in most settings firms can use diversification, acquisitions, and spin-outs to potentially benefit from imitation without completely giving up their competitive position, our tests of how alternative imitation strategies affect the leader's strategic risk profile are conservative ones: if risk mitigation through the proposed forms of rivalry-based imitation holds in our stylized multi-competitor settings, the benefits of such imitative strategies are likely to be greater still in other contexts.

We find that a leader's imitation strategy focusing on a competitor with relatively similar characteristics, either in terms of attributes (i.e., neighbor) or in terms of overall performance (i.e., the second-placed rival, or “challenger”), can outperform an independent search strategy in a multi-competitor setting. The relative effectiveness of these imitation strategies is driven by the trade-offs between imitation accuracy and responsiveness to threats from distant rivals throughout a competitive process, with the balance of these trade-offs depending on the frequency and magnitude of environmental changes. When environmental changes are infrequent and minor, neighbor imitation is more effective in maintaining the lead, whereas challenger imitation prevails as environmental changes become more frequent and substantial. By clarifying the trade-offs in the strategic risk profiles of alternative imitation strategies under different environmental conditions, we contribute to the literatures on competitive dynamics, rivalry-based imitation, and strategic risk management.

2 | BACKGROUND

In a competitive process, rivals engage in an “incessant race to get or to keep ahead of one another” (Kirzner, 1973, p. 20) by sensing and seizing opportunities (Roberts & Eisenhardt, 2003), and buffering against uncertain changes in the environment that could turn out favorably for competitors (D'Aveni, 1999). In such settings, the Austrian school of strategy (Jacobson, 1992) provides a useful theoretical foundation by complementing traditional theories of strategy that build on the logic of positioning in relatively stable environments (Barney, 1991; Porter, 1980). This perspective views the coevolution of rivals' competitive trajectories as being driven by sequences of competitive moves, with performance outcomes being determined through lagged interactions with the environment (e.g., Ferrier, 2001; Katila et al., 2012). Consequently, while competitors aiming to catch up with the leader may try to make disequilibrating moves that increase their chances of benefiting from future environmental changes, the leader may pursue a defensive strategy to maintain her advantage in the event that such changes occur.

Competitive dynamics research suggests that rivalry-based imitation could be used as one of these defensive strategies. Specifically, rivals imitate a competitor's moves in order to defend the status quo (Chen & MacMillan, 1992), protect a superior position (Gimeno, Hoskisson, Beal, & Wan, 2005), and neutralize the risk of becoming worse off relative to others (Lieberman & Asaba, 2006), with competitive imitation undermining the durability of first mover advantages

(Lee, Smith, Grimm, & Schomburg, 2000) and being more effective in uncertain environments (Giachetti et al., 2017; Ross & Sharapov, 2015).

Prior work on targets of imitation and uncertainty has instead largely built on information-based motives for imitation decisions, arguing that firms imitate others because of the (perceived) superiority of their information. Consequently, a competitor's uncertainty about causal relationships that lead to performance increases imitation of firms with certain traits (e.g., size and success) or of practices that are frequently used by others (Haunschild & Miner, 1997). However, when uncertainty stems from changing environments that are common to all competitors, firms tend to rely less on information-based imitation (Gaba & Terlaak, 2013). As studies observe imitation even in those dynamic and unpredictable environments (Giachetti et al., 2017; Ozmel, Reuer, & Wu, 2017; Smith et al., 1997), such imitation behavior may be driven by rivalry-based motives. However, the literature lacks normative insights for a leader seeking to manage risk exposure on *which* rival to imitate given the environmental conditions.

2.1 | Alternative rivalry-based imitation strategies for a leader

In uncertain environments, "where quick action is necessary, imitating others becomes an attractive decision rule" (Lieberman & Asaba, 2006, p. 373). "Decision rules" include properties that deal with the relationship between the decision maker and the environment (MacCrimmon, 1993, p. 115), such as focusing the strategy on a rules-based process to manage risk in uncertain environments (Eisenhardt & Sull, 2001, p. 110; Roberts & Eisenhardt, 2003). Given limited resources and cognitive constraints, decision rules restrict the consideration set of potential targets for imitation (Haunschild & Miner, 1997; Mezias & Lant, 1994; Posen et al., 2013), and support the process of competing in uncertain environments when there is little prior information on which to base decisions (Lieberman & Asaba, 2006).

The competitive dynamics research suggests that competitive response depends on the focal firm being aware of competitor actions, having the motivation to respond, and the capability to do so (AMC) (Chen, 1996; Chen, Su, & Tsai, 2007), and that these factors are crucial for understanding the performance outcomes of competitive interactions (Chen & Miller, 2012). Making use of decision rules proactively shapes the focal firm's awareness and motivation in the AMC framework (including awareness of and motivation to respond to potential threats and opportunities outside the focal competitive domain). Since alternative targets of imitation also imply different repositioning costs, such rules also have implications for the capabilities required. Following a specific decision rule could reduce the degree to which a firm assesses the capabilities needed to effectively imitate competitor moves, making the choice of the "right" decision rule nontrivial for a decision maker.

Perhaps the most intuitive target for such imitation in a competitive process is the rival who is most similar to the leader, either in terms of attributes or in terms of overall performance. Research suggests that a defending firm is more likely to respond to actions from firms that are similar in terms of attributes (i.e., neighbor imitation) (Chen, 1996; Garcia-Pont & Nohria, 2002). Imitating a rival that has a similar organizational configuration will take less time and is less costly, leading to low mobility barriers (McGee & Thomas, 1986). This may enable the leader to effectively increase correlation between her path and that of the neighbor, and reduce the chance of dethronement (Ross & Sharapov, 2015). However, a neighbor imitation strategy increases the risk of overlooking opportunities that have been discovered by rivals who are more dissimilar in terms of their attributes (Zahra & Chaples, 1993).

Alternatively, a leader could select a rival that is closest in terms of performance rank as competitive referent (Ferrier, Smith, & Grimm, 1999). For example, referring to motives of risk mitigation, studies find that firms imitate rivals with similarly high market share (Asaba & Lieberman, 2017; Gimeno et al., 2005). Following a decision rule of imitating the second-placed rival (i.e., challenger imitation) in a competitive process, however, can imply having to imitate a rival that is dissimilar in terms of organizational configuration—this can be result of discontinuities in the environment and successful climbs in performance rank of laggards that previously created variance (Chen, Katila, et al., 2010). Though established incumbents do imitate dissimilar rivals in high-velocity environments (Smith et al., 1997), switching from one organizational configuration to a distant one takes time and is likely to be imperfect. Assuming bounded rationality, challenger imitation can force the leader into a lengthy imitation process, providing time for the challenger to further improve her configuration.[2]

Building on prior work (Chen, Katila, et al., 2010; Lieberman & Asaba, 2006; Stieglitz, Knudsen, & Becker, 2016), we explore the implications of alternative rivalry-based imitation strategies by a leader (*neighbor* and *challenger* imitation) for strategic risk mitigation by making use of environmental dynamics (i.e., *frequency* and *magnitude* of environmental change). Because frequent environmental changes constrain the time window available to effectively neutralize a rival's threat, and changes of high magnitude cause volatility in firm performance, increasing the chance of having to concede leadership position to rivals over time (Chen, Lin, & Michel, 2010; Wiggins & Ruefli, 2005), a leader's effective use of different competitive strategies may be contingent on the environmental dynamics (D'Aveni, 1999).

Given the interactions between strategies, environmental variations, and rivals, previous competitive dynamics research promotes the use of simulations in the research design (Chen, Katila, et al., 2010; Katila et al., 2012). A computational simulation provides the benefits of producing a distribution of possible outcomes as a result of repeated competitive interactions over time, including scenarios that are unlikely to be observed in reality but that are theoretically important (Harrison & Walker, 2012). Making use of this method, our model relates to prior work that employed computational simulations to study the process of imitation, but also has important differences: First, by exploring the role of environmental variations for alternative imitation strategies, we relax the assumption of static environments in prior research on imitation strategies (Ethiraj, Levinthal, & Roy, 2008; Posen et al., 2013). Second, in line with the motivation to use imitation in order to constrain a rival's opportunity to expand upon an initial action, even at some (short-term) cost (Boyd & Bresser, 2008), we allow a leader to move to a configuration that is inferior to her current configuration, in contrast to work exploring imitation targeted at superior performers (Ethiraj et al., 2008; Posen & Martignoni, 2018; Rivkin, 2000).

3 | MODEL

To investigate how different leader-rival imitation strategies in a changing environment affect the leader's performance over time, we use an adapted version of an *NK* simulation model (Levinthal, 1997). *NK* fitness landscapes are particularly helpful when studying the role of

[2]Some scholars argue that imitation may *not* be a viable strategy "as it implies both waiting and jumping into an occupied niche" (Bourgeois & Eisenhardt, 1988, p. 833). This suggests that a leader may avoid decline by continually carrying out new actions that disrupt the status quo (Smith et al., 2001), or may benefit most from relying on her own capabilities and competing without consideration for rival actions (Teece, Pisano, & Shuen, 1997). While this is not the focus of our theorizing, we allow for this possibility in both our model and in the empirical test.

incremental moves, long jumps, and environmental jolts for the performance of different search strategies (Davis et al., 2007). In such models, agents (commonly taken to represent firms) use boundedly rational search heuristics to traverse a fitness landscape. The landscape represents payoffs to configurations of N binary choices, each of which is interdependent with K other decisions (drawn randomly). For instance, airlines make choices regarding pricing, airplane fleet, flight paths, schedules, maintenance activities, etc., and the interdependencies between some of these choices have been argued to have prevented legacy carriers from effectively imitating low-cost carrier strategies (Ethiraj et al., 2008; Rivkin & Therivel, 2005). Increasing the number of interdependent decisions (K) increases the "ruggedness" of the landscape, with a smooth ($K = 0$) landscape having only a single peak, while rugged landscapes have numerous performance peaks and valleys, making it difficult for boundedly rational agents to find the global optimum (Rivkin, 2000).

We use a moderately rugged landscape with $N = 12$ and $K = 6$ to reflect important interdependencies between choices, which are present in many settings. The payoff to any of the 4,096 possible configurations is the average of the payoffs to all of the choices the configuration contains, and these payoffs are drawn from a uniform distribution. As $K = 6$, the payoff to any given choice is redrawn when either the choice itself or one of the six choices that it is interdependent with is altered. To introduce environmental changes into our simulation, we alter the landscape at regular intervals by changing the payoffs associated with each configuration—we generate another landscape using the same N and K parameters and define the payoffs of the landscape at period $t + 1$ as the weighted average of the payoffs at time t and those of the newly generated landscape (Csaszar & Siggelkow, 2010). The weight w used in this updating reflects the magnitude of environmental changes, while the frequency f of changes corresponds to the length of intervals between periods in which the landscape is altered. The agents in our simulation are affected by these changes but have no foresight regarding future changes.

3.1 | Performance

We explore the performance implications of alternative search strategies in settings of rivalry between three competitors on changing performance landscapes. A strategy is effective for the leader when it results in her performance gap over her rival(s) being maintained or extended throughout the course of the competition, where performance is defined as the sum of payoffs generated until the current period. Because a leader is concerned about the relative position and about the chance and magnitude of loss when thinking about strategic risk (Baird & Thomas, 1990; Collins & Ruefli, 1992, 1996), we are interested in the extent to which these strategies help avert an erosion of the gap between the leader and rivals. Whereas previous studies use changes in the performance gap between the leader and the second-ranked rival (Ferrier, 2001), we account for the possibility of a leader's advantage being threatened by any one of her rivals in our measure of strategy effectiveness. Specifically, we take the minimum of the (pairwise) changes in the performance gaps between the leader and all other rivals in the system.[3] This measure of

[3]This measure takes positive values for increases in the performance gap and negative ones for its erosion. For instance, consider an example with three competitors in which the leader has extended her lead over all rivals, resulting in the change in performance gap Δg_{ij} between leader i ($i = 1$) and rival j ($j = 2$–3) of $\Delta g_{12} = 5$, $\Delta g_{13} = 10$ units. Consequently, the change in performance gap is 5 ($\min(\Delta g_{12}, \Delta g_{13}) = 5$), which is a gain in this case. Consider also an alternative example, in which Δg_{ij} takes the values: $\Delta g_{12} = 5$, $\Delta g_{13} = -15$ and the $\min(\Delta g_{12}, \Delta g_{13})$ takes the value -15. In this case, the leader has extended the distance to rival $j = 2$ but lost 15 units to $j = 3$.

performance captures the largest erosion of these relative performances and is a function of environmental changes and strategic interactions, while removing changes in performance that are common to all competitors in the system.

3.2 | Strategies

As the baseline, we consider the strategy of independent search (Teece et al., 1997). In this case, rivals pay no attention to one another and simply consider the performance of all locations on the landscape that are within their immediate neighborhood, that is, those locations that can be reached by changing only one of their 12 choices. Rivals then move to the neighborhood location with the highest performance, provided that its fitness is superior to that of their current configuration, and begin the search again in the next period (i.e., "greedy" local search; see Csaszar & Siggelkow, 2010; Ganco & Hoetker, 2009).[4]

The second strategy takes the leader's challenger (Ferrier et al., 1999), that is, the second-placed rival, as the target for imitation. In this case, the leader takes the challenger's prior period configuration as a reference point in a distant search process. To capture the increasing difficulty of imitating a challenger who is dissimilar (MacMillan et al., 1985), the number of points in the neighborhood of the rival that the leader can choose from decreases with the number of choices that the leader must alter in order to move to the rival's configuration. Thus, a leader aiming to imitate a challenger whose configuration differs by only one choice will be able to choose among 12 points in the challenger's immediate neighborhood, whereas a leader imitating a challenger whose configuration differs by 11 choices will only be able to choose among two points in the challenger's immediate neighborhood. The leader then proceeds to move to the best performing of these configurations, even if its performance is inferior to that of the leader's current configuration. This is in line with the idea of following the same path of uncertain success as the challenger, even in absence of efficiency improvements (Ross & Sharapov, 2015) and at a cost related to an imitative response (Boyd & Bresser, 2008, p. 1083).[5]

Finally, the third strategy we explore is that of the leader imitating the rival that is closest to her on the landscape (i.e., her neighbor), the rival that is most similar to the leader in terms of their configuration (e.g., Chen, 1996; Garcia-Pont & Nohria, 2002). The prior period configuration of this rival is then taken as the leader's reference point for a distant search process proceeding in the same manner as described above.

While the leader always aims to imitate one of her rivals in the imitation strategies described above, rivals perform "greedy" local search as long as their configuration is different to that of the leader. This assumption builds on competitive dynamics research, which suggests that rivals should pursue different strategies to catch up with the leader (D'Aveni, 1999; Smith et al., 2001). If the configurations of the leader and a rival are the same, the rival tries to reposition away from the leader. We operationalize this by having the rival perform an undirected

[4]An alternative baseline could be the agents searching independently using a mixture of local and distant search. However, if all agents follow the same search rule, the rule chosen should not affect the relative performance of the leader versus the other rivals. We thus chose independent greedy local search as our baseline for simplicity.

[5]Imitating only a part of the rival's configuration is another potential strategy available to a leader. However, in our model, this approach is inferior to imitating the rival's whole configuration as partial imitation would leave open the possibility of the rival benefiting from an environmental change while a leader does not. It would also not necessarily lead to improvements in the leader's absolute performance as payoffs to particular choices are interdependent with other choices in the configuration.

distant search process, similar to the leader's search process described above, with the differences that a random point on the landscape is chosen as a reference configuration, and that the rival chooses to move *only* if the best-performing of the alternative configurations (i.e., those "visible" to the rival in the neighborhood of the reference configuration; see distant search process defined above) has a higher performance value than her current configuration. Otherwise, the rival maintains her current configuration. Consequently, we assume that rivals do not aim to imitate the leader in race-like competitions as otherwise, absent any differences in terms of resources and capabilities in the model, there is no chance of them catching up and overtaking the leader.

4 | SIMULATION RESULTS

4.1 | Implementation

Agents are randomly seeded on the landscape at the start of each run of the simulation, with the agent whose configuration generates the highest payoff being identified as the initial leader.[6] The ranking of the agents is updated in every simulation period. Our simulations last for 50 periods, and we perform 1,000 runs of each simulation. Alongside the three strategies, we vary the frequency ($f = 10$, 5, or 2, corresponding to the landscape changing every f periods) and magnitude ($w = 0.1$, 0.5, and 0.9, corresponding to the weight given to the newly generated performance landscape, with $1 - w$ being the weight assigned to the previous one) of environmental changes. Note that high levels of environmental variations are associated with *low* values of f and *high* values of w. For every combination of f and w, we run the simulations for the independent search strategy, the challenger imitation strategy, and the neighbor imitation strategy. Each simulation contains three agents, and we preclude exit and entry. To evaluate the effectiveness of challenger and neighbor imitation relative to the baseline of independent search and to one another, we compare the average performance of each strategy over 1,000 runs of the simulation for each combination of environmental conditions.

4.2 | Analysis

The results of our simulation suggest that, on average, an independent search strategy never outperforms both challenger and neighbor imitation strategies, with either challenger or neighbor imitation strategies, or both, leading to less performance gap erosion at the end of the simulation's 50 periods than does the independent search strategy.[7] This suggests that rivalry-based imitation strategies, despite the short-term performance losses that they may produce, mitigate strategic risk more effectively than independent search. However, which imitation strategy is most effective is contingent on the environmental conditions. Figure 1, top row, illustrates the relative attractiveness of the challenger imitation strategy under different *magnitudes* of environmental change, holding the frequency of changes fixed. Positive values indicate that the

[6]To ensure that our results are driven by differences in strategies rather than by random differences in initial positions or sequences of environmental changes, we use the same sequence of random number generator seeds for each strategy × frequency × magnitude combination of the simulation.
[7]Detailed figures illustrating these results are available on request from the authors.

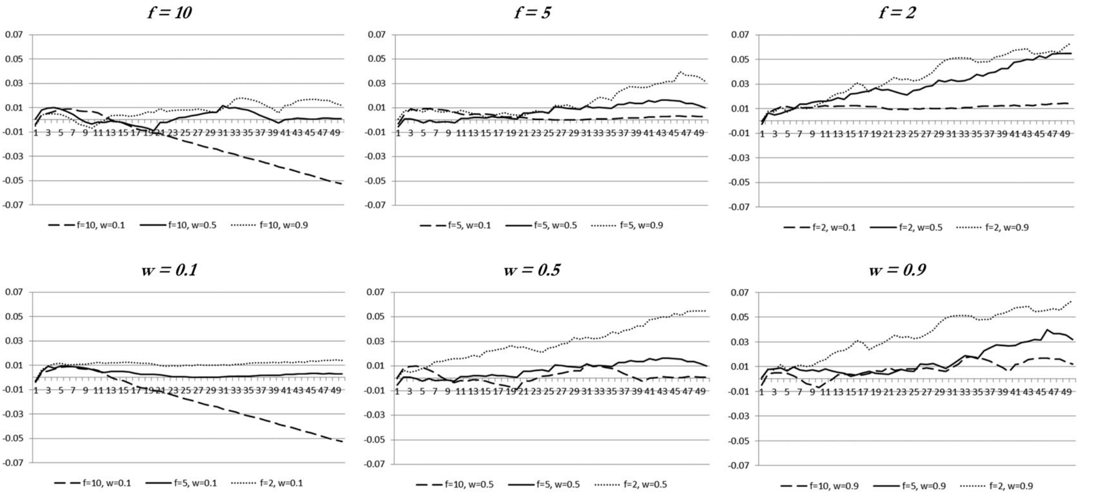


FIGURE 1 Relative performance of challenger imitation strategy in environments changing with different magnitude (w) and frequency (f) (averages from 1,000 simulation runs)

challenger imitation yields higher performance than neighbor imitation and a negative value indicates the opposite. An increase in the magnitude of environmental changes appears to increase the effectiveness of a challenger imitation strategy relative to a neighbor imitation one regardless of the frequency of environmental changes, with this effect being most pronounced when magnitude increases from low to moderate ($w = 0.1$–0.5) and frequency of changes is low or high ($f = 10$ or 2). A neighbor imitation strategy outperforms a challenger imitation one only when environmental changes are infrequent and of low magnitude ($w = 0.1$ and $f = 10$).

Figure 1, bottom row, shows the differences in the average performance of the challenger and neighbor imitation strategies under different *frequencies* of environmental change, holding the magnitude of changes fixed. An increase in the frequency of environmental changes increases the effectiveness of a challenger imitation strategy relative to a neighbor imitation one, regardless of the magnitude of these changes. However, this effect is most pronounced when magnitude is moderate ($w = 0.5$) and frequency increases from moderate to high ($f = 5$ to 2), and when magnitude is low ($w = 0.1$) and frequency increases from low to moderate ($f = 10$ to 5).

The above findings can be explained by considering two mechanisms that define the performance differences between the two imitation strategies. The first mechanism concerns the trade-off between imitation accuracy and responsiveness to threats from distant rivals. As a consequence of the challenger imitation decision rule, the risk of losing ground relative to a lower-ranked (third-placed in the simulation), more distant rival decreases, because the leader's imitation focus will change to this rival should she benefit from a change in the environment and move up to second place in the performance ranking. However, as a result of this displacement and as a consequence of the increased distance between the configurations of the leader and the (new) imitation target, the leader faces a smaller set of points in the rival's neighborhood to choose from. This increases the average number of periods that it takes to move to the same location on the landscape as that of the targeted rival. Because the rival's configuration is likely to be at, or closer to, the local optimum, the leader usually suffers losses in relative performance in this increased time period. Pursuit of a neighbor imitation strategy, by contrast, means that the leader will be quicker to accurately imitate her rival, resulting in an increased likelihood of the leader benefiting from making local improvements to the imitated rival's configuration while that rival searches for more attractive distant neighborhoods.

While such ratcheting dynamics can occur as a result of either imitation strategy, Figure 2 confirms that they are, on average, observed in a higher proportion of simulation periods when a leader follows a neighbor imitation strategy than a challenger imitation strategy. An additional analysis of the simulation results reveals that, for those leaders who retain the lead throughout, the performance at the end of the simulation is greater when following a neighbor imitation strategy, regardless of the magnitude and frequency of environmental changes. However, the risk of the neighbor imitation strategy is that any performance gains achieved through this process will be wiped out by a more distant rival benefiting from either being on the slope to a higher local maximum or from a change in the environment. An increase in the magnitude or frequency of environmental changes increases the likelihood of the initial challenger being overtaken by the rival initially in third place, as shown in Figure 3, making the ability of the challenger imitation strategy to respond to such threats more valuable and leading to its performance relative to neighbor imitation increasing with these two dimensions of environmental change.

The simulation results additionally reveal a second mechanism responsible for the superior performance of the neighbor imitation strategy when both magnitude and frequency of environmental changes are low ($w = 0.1$ and $f = 10$). The pursuit of a neighbor imitation strategy by a leader alters the dynamics that can lead to all three rivals sharing the same configuration,

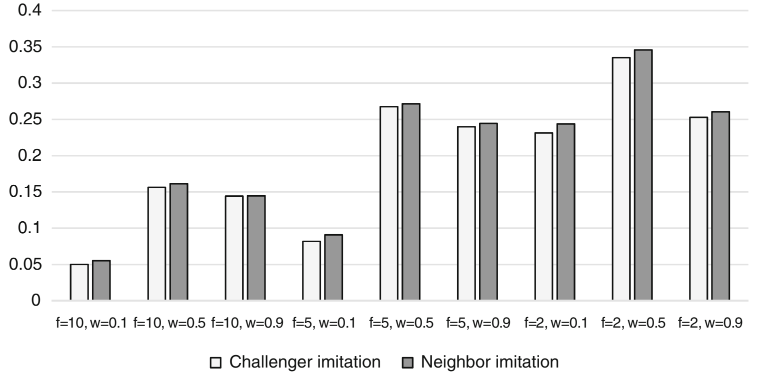


FIGURE 2 Proportion of periods in which ratcheting dynamics are observed

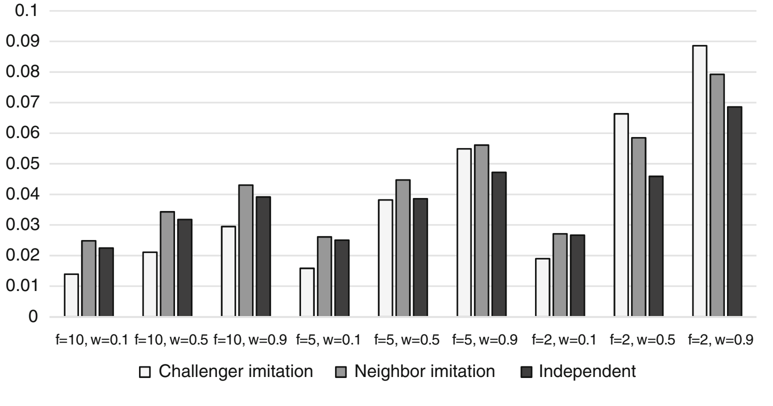


FIGURE 3 Proportion of periods in which a change of challenger is observed

especially in relatively stable environments. This occurs if the more distant rival, who is ignored by the leader, displaces the original leader and then proceeds to imitate one of the other two rivals who are in one another's neighborhood due to the original leader's imitation efforts. Once all three rivals share the same configuration, breaking out of the pattern of mutual imitation is only possible if both second- and third-placed rivals succeed in distant search efforts simultaneously. Such dynamics are less likely to occur in the challenger imitation case, as the likelihood of the third-placed rival taking the lead is lower than that of the more distant rival in the neighbor imitation case (for reasons outlined in the first mechanism). The situation of all three rivals sharing the same configuration is also less stable, as the success of only one of the second- or third-placed rivals in their distant search effort is sufficient to disrupt it. Figure 4 illustrates the differences between the challenger and neighbor imitation strategies in the proportion of periods in which all rivals share the same configuration.

In stable environments, this difference in group imitation dynamics implies that a leader who falls behind despite using a challenger imitation strategy will have few opportunities to regain the lead, due to becoming the new leader's imitation target, and will tend to fall further behind the new leader. By contrast, a leader who employs a neighbor imitation strategy but falls behind is more likely to end up in a situation of all rivals sharing the same configuration, and thus will have greater opportunities to retake the lead, while also suffering smaller further reductions in relative performance if they fail to do so. Indeed, as Figure 4 shows, the difference between challenger and neighbor imitation strategies in the occurrence of such dynamics is particularly pronounced when both magnitude and frequency of environmental changes are low, with all rivals sharing the same configuration in 16% of simulation periods, on average, under neighbor imitation, compared to 3% of simulation periods under challenger imitation. As a result of this second mechanism, leaders who follow a challenger imitation strategy but get overtaken, usually due to a small initial advantage that is wiped out by an inaccurate first imitation attempt, rarely recover and tend to suffer large performance losses relative to the new leader, while those who use a strategy of neighbor imitation, despite being more likely to lose the lead, tend to be more likely to recover it and suffer smaller performance losses relative to the new leader.

Overall, the simulation results and their analysis suggest two propositions:

Proposition 1 *An increase in the magnitude of changes to the competitive environment will increase the effectiveness of a challenger imitation strategy relative to a neighbor imitation strategy.*

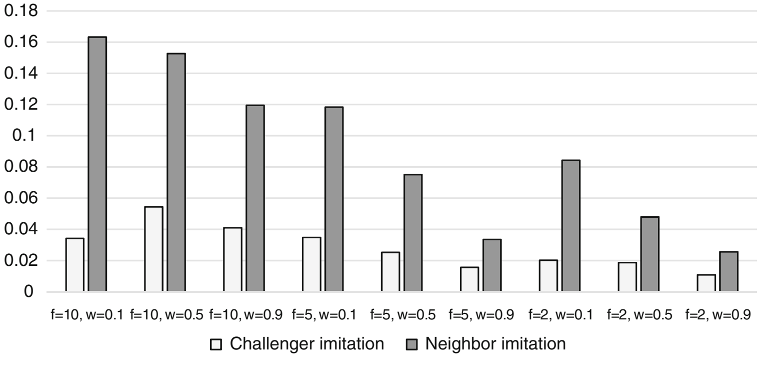


FIGURE 4 Proportion of periods in which all rivals share the same configuration

Proposition 2 *An increase in the frequency of changes to the competitive environment will increase the effectiveness of a challenger imitation strategy relative to a neighbor imitation strategy.*

5 | EMPIRICAL TEST AND TRIANGULATION

Linking computational research with real-world data by empirically testing the findings from simulation models helps strengthen the external validity of the developed theory (Davis et al., 2007). Though the precision with regard to measurement and manipulation in computational simulations can provide valuable insights for connections and expected covariations among different observable variables in systematic empirical tests (Harrison, Lin, Carroll, & Carley, 2007), the modeling of a concrete system via a simulation frequently excludes heterogeneity in the resources, capabilities and behaviors of actors (McGrath, 1982, p. 78). Such heterogeneities can dominate the role of moves and countermoves of rivals when explaining competitive outcomes (Kilduff, Elfenbein, & Staw, 2010; Teece et al., 1997, p. 512; Zajac & Bazerman, 1991, p. 52). Therefore, in order to test the developed propositions in a context that involves decisions by "real" competitors, we undertake a second, empirical, study and control for heterogeneity between rivals in our models.

5.1 | Study context

To test and triangulate the insights from our simulation, we require a setting that involves multiple rivals engaged in a race-like competition with environmental changes that have a material impact on performance outcomes, and in which imitation behavior can be observed over the course of the competition. Ideally, the context should also be such as to minimize the influence of possible alternative explanations of imitation behavior, such as social pressures, reputational benefits, and differences in tangible resource endowments (Lieberman & Asaba, 2006), and its effects. We therefore make use of data from multiple-competitor (fleet) sailing boat races during the America's Cup World Series (ACWS) 2011–2012 and 2012–2013, which included a series of nine regattas that took place at seven different international venues.[8]

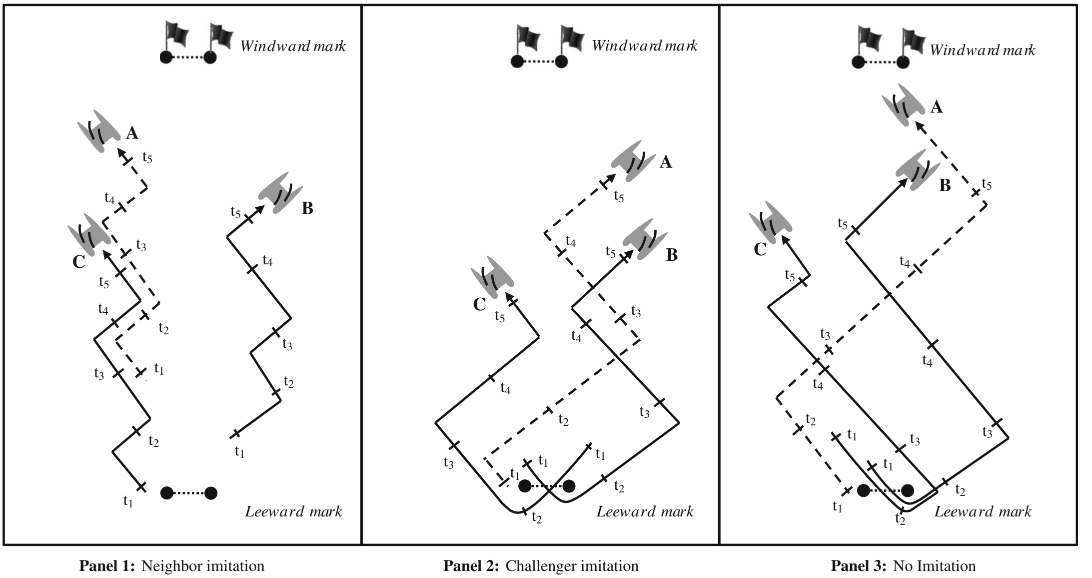
Strategy scholars have used sport as a study context to explore performance outcomes in competitive races (Hoisl, Gruber, & Conti, 2017; Marino, Aversa, Mesquita, & Anand, 2015). Sailing, in particular, has been used to illustrate the benefit for a leader of imitating her rival in head-to-head competition (Ross & Sharapov, 2015). The context offers the advantage of a controlled natural laboratory with pre-defined rules and boundary conditions (Day, Gordon, & Fink, 2012). Because each regatta consisted of multiple sailing teams competing on identical 45-ft long catamarans, the ACWS offers a setting where performance differences are based primarily on the team's ability to handle their boats, which requires coordinated action between the members of the team responsible for different sails and other boat systems, and on the decisions made during the race by the boat's helmsman. Fine-grained positional data allow us to

[8]Making use of data from sailing *fleet* races echoes prior work that suggests that outcomes of competitive interactions differ when more than two competitors are part of a competitive race (e.g., Ferrier et al., 1999, p. 384; Haleblian, McNamara, Kolev, & Dykes, 2012, p. 1048). Due to the focus on multiple rivals, this study differs from the special context of head-to-head sailing (*match*) races within the ACWS, which was the subject of Ross and Sharapov (2015).

observe the pattern of competitive moves over time. Detailed wind data provide the benefits to observe changes in wind direction and volatility, which influence competitive strategies and performance outcomes.

Upwind legs in sailboat racing can involve the boat that is ahead during the upwind (i.e., the leader, Ross & Sharapov, 2015) imitating a rival. The upwind leg begins with a rounding of the leeward mark, and the leg ends when the boats reach the windward mark (Figure 5). Since sailing boats cannot sail directly into the wind toward the windward mark, they have to tack (turn) to sail a zig-zag pattern. The sailed trajectory of a boat is influenced by the positioning, timing, and frequency of tacking maneuvers. The leading sailboat can copy the moves of any following boat or sail its own course, independent of what its rivals do—see the three panels of Figure 5 for examples of neighbor imitation, challenger imitation, and no imitation in this setting—but the performance consequences of doing this are contingent on future changes in the environment. Similar to other sports, the sailing boats have to remain within the boundaries of the course at all times during a race.

The interdependent nature of decisions taken during a race and the multiple coordinated physical actions required to successfully execute them can be thought of as a moderately coupled system. Similar to the parameter N of our NK-simulation model, in the empirical context competitors have to make different types of decisions, for instance, whether or not to change heading relative to the wind direction, whether or not to adjust the sails, and whether or not to position the boat on a certain side of the course. Decisions are to a certain degree interdependent (e.g., sailing at a closer angle to the wind requires an adjustment of the main sail and rudder, but does not necessarily require a decision to relocate the boat to the other side of the course), which reflects the parameter K in our simulation, making this sport setting a reasonable one in which to test propositions resulting from the simulation. In this empirical



Panel 1: Neighbor imitation

At t_1, A is ahead of B (challenger) and C (neighbor). Over time, A changes tack when C does and stays on same side of the course as C.

Panel 2: Challenger imitation

At t_1, A is ahead of B (challenger) and C (neighbor). Over time, A moves to the same side of the course as B and changes tack when B does.

Panel 3: No Imitation

At t_1, A is ahead of B (challenger) and C (neighbor). Over time, A's trajectory shows a largely independent pattern relative to B and C.

FIGURE 5 Race course and example competitor trajectories setting, changes in wind direction, which are exogenous and vary in frequency and magnitude, can have a major effect on race outcomes, reflecting the environmental changes in our simulation. This is because the effective distance that the boats have to sail in order to complete each leg of the race is dependent on wind direction, and because changes in wind direction require the crew to make interdependent adjustments to the boat and their tactics. As opposed to our computational simulation, in which equally equipped agents search according to given rules, in the laboratory-like situation of sailing, competitors with different sailing abilities respond to naturally-driven exogenous shocks and to rival actions.

5.2 | Data and variables

Data on the full population of boats competing in multiple-competitor (fleet) races in the ACWS are constructed from three types of information made publically available by the America's Cup Race Management: GPS data on the position of the sailing boats and on the boundaries that define the course; information about the direction and the speed of the wind (both this and GPS data are recorded five times per second); and "chatter" files that offer information on the race start timing, the competing boats, the mark-rounding order and time, and the umpire decisions. The unit of analysis is the upwind leg. Over a total of nine events (all six regattas in the season 2011–2012 and all three regattas in the season 2012–2013), complete data is available on 62 fleet races, consisting of 138 upwind legs. Missing data on wind direction force us to exclude five of these upwind legs, resulting in a sample of 133 upwinds. With reference to our simulation, we consider an upwind leg to be similar to the 50 periods of each simulation run as the average duration of an upwind in the dataset is just over 5 min, while competitive actions and changes in wind direction take place on a second-to-second basis. While the races were contested by six to 11 teams, for the purposes of our empirical analysis, we consider only the four competitors that were ahead of the rest of the pack at the start of each upwind.[9]

5.3 | Measures

5.3.1 | Dependent variable

Analogously to the simulation (see "performance" discussion in the prior section), our dependent variable captures the *change in performance gap* of the leader (boat that is first in the race at the start of the upwind leg) over her rivals over the upwind leg, which is the minimum difference between the performance gap (in seconds, measured to tenths of a second precision) of the leader at the start of the upwind leg and her performance gap at the leg's end, relative to competitors who were second, third, and fourth at the start of the upwind. Specifically, if g_{12}, g_{13}, and g_{14} are the changes in the performance gap relative to rivals who started the upwind in second, third, and fourth place, respectively, then our dependent variable is calculated as min(g_{12}, g_{13}, g_{14}). This variable takes on positive values if the extent of the performance gap over the

[9]While competitors outside of the top four at the start of the upwind leg could theoretically be imitation targets for a leader, in our empirical context they are unlikely to be a competitive threat. Only two upwinds in our dataset see a boat that was outside of the top four at the start of the upwind overtaking the leader, and in both of these cases at least one of the other boats that started the upwind in the top four also finished the upwind ahead of the leader.

rivals was increased over the course of the upwind, and negative values if at least one of the rivals reduced the gap to the leader.

5.3.2 | Imitation measures

We operationalize the leader's imitation strategy by considering whether, and to what extent, the leader imitates her challenger (second boat around the mark at the start of the leg—boat B in Figure 5) or her neighbor (the boat that is closest to her in terms of position relative to the sides of the course, reflecting strategic similarity—boat C in Figure 5) over the course of the upwind leg. We measure both the extent to which the leader's actions during the upwind are correlated to those taken a second earlier by her rivals using lagged correlations between the compass headings of the boats,[10] and the similarity of the boats' positions relative to the sides of the course (Ross & Sharapov, 2015).[11] We then combine both in one measure of the leader's imitation of each of her rivals. This measure is the normalized correlation in headings ranging from 0 (correlation between headings is equal to −1 over the course of the upwind) to 1 (correlation between headings is equal to 1 over the course of the upwind) weighted by the normalized distance between the average positions of boats relative to the sides of the course over the upwind, ranging from 0 if the average lateral distance between the boats in question is the maximum observed during the race day to 1 if the average lateral distance between the boats is 0. The variable capturing imitation therefore ranges from 0 if the leader imitated neither the actions nor the positioning of a given competitor over the course of the upwind to 1 if both actions and positioning of a given competitor were fully imitated.

The binary variable *challenger focus* takes on a value of 1 if the leader's imitation of the challenger is higher than or equal to the leader's imitation of her neighbor (and of the other boat competing in the upwind). If the converse is true, we consider the leader to be using a neighbor imitation strategy, and the variable takes on a value of 0. To capture the extent to which the leader imitates lower-ranked rivals, we include an *extent of imitation* variable that takes on the maximum value of the leader's imitation of her rivals, corresponding to the extent to which the leader imitated the rival who was the focus of her imitation efforts during the upwind. Thus, while the *challenger focus* variable (in combination with the *other focus* control variable defined below) captures which rival the leader's imitation efforts were focused on, the *extent of imitation* variable measures how closely the leader imitated the rival chosen for imitation.

[10]In our context, rival actions, including preparations for tacking maneuvers, are easily observable and are major focuses of the leading team helmsman's attention, while both leader and rival teams consist of highly experienced sailors able to execute the full range of competitive moves, making a one second lag appropriate for capturing imitation in this setting.

[11]A typical concern in studies of imitation is how imitative behavior can be distinguished from common but independent response to environmental changes (Lieberman & Asaba, 2006). While imitation is a well-documented part of sailing strategy and tactics, and video footage of the races in our dataset often shows the helmsmen issuing imitation orders to their crew, to ensure that our measures capture imitation rather than independent common reactions to environmental changes, we added a variable for each leader-rival dyad measuring the extent to which the leader and her rivals made simultaneous tacks in the same direction over the course of the upwind. Results available on request from the authors show that these control variables are never significant at a 5% level and that the results presented below are robust to their inclusion.

5.3.3 | Environmental change measures

In order to measure the frequency and magnitude of changes to wind direction during the course of the upwind, corresponding to changes to the competitive environment in the simulation, we follow prior work on measuring environmental variations (Miller, Ogilvie, & Glick, 2006). Specifically, we use detailed data on wind direction during the upwind to calculate the *frequency* of environmental changes as the number of wind shifts—reversals of changes in wind direction of at least 2° over 15 s—over the upwind normalized by the upwind's duration. To measure the *magnitude* of environmental changes we take the average extent (in degrees) of wind shifts over the course of the upwind.[12]

5.3.4 | Control variables

To control for the possibility of the leader focusing her imitation efforts on a rival who is neither the leader's challenger nor her neighbor (Thatchenkery & Katila, 2017), we create a binary variable (*other focus*) equal to 1 if the leader's extent of imitation of the boat that is neither challenger nor neighbor is greater than her extent of imitation of these two boats, and 0 otherwise. Given that subjective drivers of rivalry can affect competitive behavior and performance outcomes, we also control for long-term similarity, repeated competition, and competitiveness between helmsmen (Kilduff et al., 2010). We calculated sailing *status dissimilarity* for each helmsman dyad as the absolute difference in their all-time winning percentages of head-to-head races in the America's Cup and the Louis Vuitton Cup (i.e., the competition that defines who will race against the current holder of the America's Cup in the final), while *geographic similarity* was captured by a binary variable equal to 1 if the competing helmsmen were from the same country. Elite sailors from the same country will more likely develop feelings of rivalry toward each other than toward athletes from different countries, because of selection pressures from national sport institutions and other organizations throughout experienced throughout their sailing career. *Repeated interaction* between competitors was measured by the number of races between them prior to ACWS 2011–2013, while the *competitiveness* of the match-up was calculated as the minimum of their head-to-head winning percentages in these prior races.

Imitation behavior and performance outcomes can depend on *environmental uncertainty* (Gaba & Terlaak, 2013; Giachetti et al., 2017; Ross & Sharapov, 2015), which may also affect the relative effectiveness of different imitation strategies in a manner differing from that of the magnitude and frequency of environmental changes (Miller et al., 2006). We control for this by using a GARCH (1,1) model with an autoregressive-dependent variable term to predict changes in wind direction over the course of an upwind, and take our measure of uncertainty as the average absolute percentage difference between the model's forecast of wind direction and its true value over the course of the upwind (Ross & Sharapov, 2015). Similar models have been used to predict wind fluctuations in weather forecasting (Cripps & Dunsmuir, 2003).

As the initial performance gap influences the level of threat of getting dethroned (Ferrier et al., 1999), we control for the *leader's initial advantage* over her rivals by including a variable capturing the number of seconds that the leader was ahead of her respective competitors at the start of the upwind leg. Competitive dynamics research has shown that *difference in the number*

[12]Results using an alternative definition counting only reversals of changes in wind direction of at least 5° over 15 s as wind shifts are consistent with those presented here.

of actions and *difference in action timing* between leaders and rivals can affect the likelihood of a change in the extent of the lead (e.g., Boyd & Bresser, 2008; Ferrier et al., 1999; Lee et al., 2000). To control for these effects, we include a variable that measures the difference in the number of tacks made by the leader relative to each of her rivals, and a variable that measures the proportion of the upwind duration during which the leader tacked while the rival did not (and vice versa), which takes on a value of 0 if leader and rival make tacks simultaneously, and increases with increasing dissimilarity in the timing of leader and rival tacks to a maximum of 1.

To capture longer-term differences in capabilities, we control for *difference in performance to date* between the leader and her competitors, measured as the difference between the proportion of available fleet race points prior to the current race gained by the leader and those gained by her rivals. This variable is positive if the leader's performance to date is superior to that of a given competitor, and negative otherwise. Additionally, we control for *difference in America's Cup experience* between the helmsman of the leading boat and those of her rivals. This variable takes on a value of 1 if the helmsman of the leading boat has participated in a prior America's Cup competition while the helmsman of the rival boat has not, a value of −1 if the converse is true, and a value of 0 if both helmsmen have the same experience of participating (or not).

As competitive behaviors in the final part of a series of competitive interactions might differ significantly from those observed earlier (Lehman, Hahn, Ramanujam, & Alge, 2011), we control for the *final upwind* of a race using a binary variable equal to 1 if this is the case and 0 otherwise. Finally, we control for any *penalty* suffered by rivals during the course of the upwind and possible effects of short- and long-term learning from observing the racing strategies and tactics used by other teams by including variables capturing the *race number* of the focal race (its position in that day's racing order), and the *event number* (the position of the event in the series order).

5.4 | Empirical results

We log-transformed the continuous variables that are not normally distributed before proceeding with our empirical analysis. The details of these transformations and the resulting descriptive statistics are presented in Table 1.[13] On average, the leading boat appears to lose just over 6 s of its lead over the course of the upwind, and the leader's imitation efforts are focused on the challenger (second-placed boat at start of upwind) in around half of the upwind legs in our sample. The mean *magnitude* of wind shift is around 4.5°, while the maximum average *magnitude* of wind shift is 30.6°, representing a wide range of magnitudes, consistent with our simulation. The average magnitude of changes therefore varies widely, with greater average magnitude of changes than those observed likely to lead to race cancellations. The *frequency* ranges from 0 to over 3.5 wind shifts per minute of the upwind, with an average value of 1.6. In other words, our sample contains both upwinds in which significant changes to wind direction were absent as well as those upwinds in which such changes took place nearly every 15 s on average (given how the variable is calculated, the latter include changes that are close to the theoretical maximum). These ranges of average frequency and magnitude of environmental changes in our data thus correspond to the range of environmental changes in our model.

[13]Results using non-transformed variables are consistent with those presented here.

TABLE 1 Summary statistics

Variable	Obs	Mean	*SD*	Min	Max
Change in performance gap[a]	133	3.83	0.56	0	4.50
Challenger focus	133	0.54	0.50	0	1
Other focus	133	0.11	0.31	0	1
Magnitude[b]	133	1.60	0.44	0	3.45
Frequency[b]	133	0.88	0.35	0	1.51
Extent of imitation[b]	133	0.41	0.14	0.03	0.67
Initial advantage$_{12}$[b]	133	2.70	0.85	0.18	4.84
Initial advantage$_{13}$[b]	133	3.39	0.67	1.89	5.00
Initial advantage$_{14}$[b]	133	3.72	0.63	2.50	5.14
Penalty$_2$	133	0.03	0.17	0	1
Penalty$_3$	133	0.05	0.22	0	1
Penalty$_4$	133	0.04	0.19	0	1
Difference in AC experience$_{12}$	133	0.14	0.47	−1	1
Difference in AC experience$_{13}$	133	0.17	0.61	−1	1
Difference in AC experience$_{14}$	133	0.09	0.54	−1	1
Difference in performance to date$_{12}$	133	0.04	0.19	−0.37	0.63
Difference in performance to date$_{13}$	133	0.07	0.21	−0.44	0.72
Difference in performance to date$_{14}$	133	0.07	0.22	−0.39	0.72
Difference in no. of actions$_{12}$	133	0.15	1.76	−5	6
Difference in no. of actions$_{13}$	133	−0.28	2.56	−9	4
Difference in no. of actions$_{14}$	133	0.05	2.33	−6	4
Difference in action timing$_{12}$	133	3.04	0.99	0.62	6.51
Difference in action timing$_{13}$	133	3.16	1.04	0.79	6.65
Difference in action timing$_{14}$	133	3.23	0.96	1.32	6.88
Geographic similarity$_{12}$	133	0.07	0.25	0	1
Geographic similarity$_{13}$	133	0.06	0.24	0	1
Geographic similarity$_{14}$	133	0.11	0.31	0	1
Status dissimilarity$_{12}$	133	0.18	0.13	0	0.5
Status dissimilarity$_{13}$	133	0.21	0.14	0	0.57
Status dissimilarity$_{14}$	133	0.17	0.13	0	0.5
Competitiveness$_{12}$	133	0.44	0.12	0	0.5
Competitiveness$_{13}$	133	0.46	0.11	0	0.5
Competitiveness$_{14}$	133	0.44	0.13	0	0.5
Repeated interaction$_{12}$	133	5.02	8.85	0	26
Repeated interaction$_{13}$	133	2.16	6.22	0	22
Repeated interaction$_{14}$	133	3.34	7.18	0	22
Environmental uncertainty[b]	133	0.00	0.03	0	0.36
Last upwind of race	133	0.45	0.50	0	1

TABLE 1 (Continued)

Variable	Obs	Mean	*SD*	Min	Max
Race number	133	1.59	0.71	1	3
Event number	133	4.85	2.63	1	9

[a]Log-transformed by taking the logarithm of (original value plus the absolute value of the minimum change in change in performance gap observed in the dataset (|−55.9|) plus 1). The summary statistics for the untransformed variable are a mean of −6.13, *SD* of 16.86, minimum of −55.90, and maximum of 33.20.
[b]Log-transformed by taking the logarithm of (original value plus 1).

The pairwise correlations between our variables are available in File S1. These generally do not suggest any cause for concerns regarding multicollinearity, as the only high correlations are between variables measuring the same constructs for different leader-rival dyads, which are never included in the same model, as we explain in the discussion of our econometric approach below. The high correlation between the measures of *magnitude* and *frequency* (0.58), however, suggests that multicollinearity could arise if these variables and their respective interaction terms were to be simultaneously included in our econometric model.

To evaluate whether and to what extent a challenger imitation strategy is more effective than a neighbor imitation one while accounting for the multiple competitors present in our setting, we use a seemingly unrelated regression approach. Specifically, for each model we run three regressions, each with the same dependent variable (*change in performance gap* between the leader and rivals over the upwind leg, as defined earlier) regressed on different explanatory variables capturing differences between the leader and the respective (second-, third-, and fourth-placed) rival at the start of the upwind. These models are labeled second-, third-, and fourth in our regression tables. Correlations between the errors terms in these models were then taken into account by combining their estimates using the *suest* command in Stata and specifying heteroscedasticity-robust standard errors clustered by the leading boat.[14]

The results of the estimation can be seen in Table 2. Model 1 is the baseline specification that includes only the control variables. In line with competitive dynamics research (Chen, Lin, et al., 2010; Ferrier et al., 1999; Ross & Sharapov, 2015), the estimated coefficients on *environmental uncertainty* (β = −2.351 to −1.723, $p < .001$–.004) and *difference in action timing* (β = −3.150 to −1.721, p = .003–.032) have a negative influence while *extent of imitation* is consistently positive (β = 0.956–1.035, p = .006–.032), suggesting that a greater extent of imitation of the chosen rival by the leader tends to increase the performance gap during the course of the upwind. This insight echoes prior findings, suggesting that imitation as behavioral response to reduce risks enables a leader to stay ahead (Craig, 1996; Ross & Sharapov, 2015). Model 2 introduces the *challenger focus* and *other focus* variables into the specification. By itself, *challenger focus* does not appear to have much of an effect (β = 0.036–0.086, p = .083–.405), supporting the view that there is little, if any, unconditional advantage to imitation being focused on a

[14]As a robustness check, we also estimate the regression models using an alternative seemingly unrelated regression approach to accounting for correlation between the error terms of the two models (Giachetti et al., 2017), which we implement using the *sureg* command in Stata, and which should produce more efficient estimates if the data are homoscedastic. These results, those from individual regression models with heteroscedasticity-robust standard errors clustered by leading boat, and those from random-effect panel data models (Hausman test did not reject null hypothesis of no systematic differences between coefficients estimated using fixed- and random-effects [$p > .9149$]) are consistent with those reported below and are available on request from the authors.

TABLE 2 Regression results

Dependent variable: Change in performance gap	(1) Second	(1) Third	(1) Fourth	(2) Second	(2) Third	(2) Fourth
Initial advantage	0.051	0.091	0.054	0.043	0.065	0.024
	(0.058)	(0.082)	(0.084)	(0.064)	(0.071)	(0.073)
Penalty	0.154	0.210	0.281	0.174	0.236	0.312
	(0.082)	(0.152)	(0.139)	(0.087)	(0.134)	(0.149)
Difference in AC experience	0.112	0.017	0.021	0.110	0.027	0.024
	(0.081)	(0.076)	(0.072)	(0.081)	(0.072)	(0.065)
Difference in performance to date	−0.040	−0.595	0.016	−0.097	−0.616	0.009
	(0.158)	(0.286)	(0.190)	(0.161)	(0.290)	(0.188)
Difference in no. of actions	−0.033	−0.013	−0.008	−0.030*	−0.013	−0.005
	(0.013)	(0.036)	(0.035)	(0.013)	(0.038)	(0.035)
Difference in action timing	−1.721	−3.131	−3.150	−1.779	−3.164	−3.013
	(0.576)	(1.463)	(1.453)	(0.568)	(1.465)	(1.477)
Geographic similarity	−0.098	0.229	0.189	−0.090	0.191	0.217
	(0.277)	(0.139)	(0.097)	(0.272)	(0.156)	(0.103)
Status dissimilarity	0.085	0.286	−0.070	0.174	0.422	0.008
	(0.274)	(0.419)	(0.217)	(0.269)	(0.419)	(0.204)
Competitiveness	0.915	0.617	0.026	0.908	0.601	0.063
	(1.087)	(0.262)	(0.341)	(1.127)	(0.236)	(0.355)
Repeated interaction	0.004	0.015	0.010	0.003	0.013	0.011
	(0.012)	(0.009)	(0.003)	(0.013)	(0.010)	(0.004)
Environmental uncertainty	−2.233	−1.723	−2.351	−2.149	−1.813	−2.372
	(0.392)	(0.573)	(0.817)	(0.456)	(0.622)	(0.852)
Last upwind of race	−0.058	−0.100	−0.067	−0.056	−0.107	−0.060
	(0.094)	(0.150)	(0.147)	(0.091)	(0.147)	(0.141)
Race number	−0.104	−0.070	−0.067	−0.090	−0.061	−0.063
	(0.086)	(0.070)	(0.082)	(0.084)	(0.069)	(0.078)
Event number	−0.004	0.011	0.017	−0.006	0.009	0.013
	(0.021)	(0.019)	(0.014)	(0.020)	(0.017)	(0.012)
Magnitude	0.149	0.096	0.186	0.144	0.101	0.178
	(0.085)	(0.106)	(0.104)	(0.077)	(0.094)	(0.100)
Frequency	0.007	0.081	−0.042	0.032	0.120	−0.009
	(0.092)	(0.081)	(0.141)	(0.085)	(0.082)	(0.137)
Extent of imitation	0.956	1.035	1.023	0.940	0.992	0.995
	(0.446)	(0.412)	(0.375)	(0.447)	(0.426)	(0.382)
Other focus				0.247	0.254	0.230
				(0.080)	(0.086)	(0.061)

TABLE 2 (Continued)

Dependent variable: Change in performance gap	(1) Second	(1) Third	(1) Fourth	(2) Second	(2) Third	(2) Fourth
Challenger focus				0.036	0.086	0.064
				(0.043)	(0.050)	(0.040)
Challenger focus × magnitude						
Challenger focus × frequency						
Constant	3.088	3.104	3.447	3.045	3.082	3.448
	(0.643)	(0.508)	(0.439)	(0.649)	(0.482)	(0.418)
R^2	0.18	0.25	0.20	0.20	0.26	0.21
N	133	133	133	133	133	133

DV change in performance gap	(3) Second	(3) Third	(3) Fourth	(4) Second	(4) Third	(4) Fourth
Initial advantage	0.027	0.047	0.004	0.040	0.067	0.037
	(0.058)	(0.066)	(0.061)	(0.057)	(0.072)	(0.061)
Penalty	0.217	0.189	0.270	0.145	0.179	0.166
	(0.076)	(0.155)	(0.137)	(0.110)	(0.146)	(0.158)
Difference in AC experience	0.136	0.049	0.056	0.131	0.044	0.065
	(0.080)	(0.070)	(0.052)	(0.087)	(0.066)	(0.049)
Difference in performance to date	−0.002	−0.589	−0.016	−0.018	−0.548	0.060
	(0.196)	(0.264)	(0.168)	(0.183)	(0.256)	(0.155)
Difference in no. of actions	−0.030	−0.015	−0.005	−0.029	−0.014	−0.012
	(0.014)	(0.037)	(0.034)	(0.011)	(0.039)	(0.036)
Difference in action timing	−1.785	−3.419	−3.009	−1.620	−3.021	−2.843
	(0.537)	(1.389)	(1.236)	(0.459)	(1.363)	(1.270)
Geographic similarity	−0.101	0.166	0.178	−0.105	0.136	0.175
	(0.277)	(0.147)	(0.110)	(0.266)	(0.142)	(0.096)
Status dissimilarity	0.143	0.357	0.045	0.204	0.332	0.023
	(0.254)	(0.422)	(0.188)	(0.282)	(0.437)	(0.191)
Competitiveness	0.963	0.568	0.162	1.163	0.730	−0.012
	(1.138)	(0.234)	(0.401)	(1.165)	(0.217)	(0.426)
Repeated interaction	0.004	0.012	0.013	0.009	0.016	0.010
	(0.013)	(0.010)	(0.004)	(0.015)	(0.009)	(0.005)
Environmental uncertainty	−2.365	−2.015	−2.642	−2.806	−2.271	−2.826
	(0.449)	(0.561)	(0.757)	(0.593)	(0.584)	(0.765)
Last upwind of race	−0.019	−0.072	−0.028	−0.050	−0.099	−0.062
	(0.093)	(0.151)	(0.142)	(0.088)	(0.157)	(0.148)
Race number	−0.096	−0.065	−0.066	−0.101	−0.072	−0.062
	(0.086)	(0.072)	(0.080)	(0.091)	(0.080)	(0.083)

TABLE 2 (Continued)

DV change in performance gap	(3) Second	Third	Fourth	(4) Second	Third	Fourth
Event number	−0.001	0.014	0.019	0.002	0.013	0.024
	(0.017)	(0.015)	(0.011)	(0.019)	(0.016)	(0.012)
Magnitude	−0.194	−0.198	−0.120	0.097	0.058	0.133
	(0.138)	(0.087)	(0.096)	(0.075)	(0.086)	(0.075)
Frequency	0.070	0.156	0.037	−0.336	−0.186	−0.349
	(0.100)	(0.090)	(0.144)	(0.145)	(0.120)	(0.165)
Extent of imitation	0.890	0.924	0.945	0.769	0.855	0.835
	(0.400)	(0.396)	(0.335)	(0.368)	(0.399)	(0.322)
Other focus	0.240	0.261	0.237	0.176	0.194	0.160
	(0.074)	(0.086)	(0.053)	(0.079)	(0.044)	(0.061)
Challenger focus	−0.814	−0.690	−0.696	−0.681	−0.505	−0.618
	(0.374)	(0.184)	(0.311)	(0.249)	(0.139)	(0.201)
Challenger focus × magnitude	0.527	0.485	0.475			
	(0.209)	(0.101)	(0.180)			
Challenger focus × frequency				0.796	0.659	0.753
				(0.227)	(0.137)	(0.204)
Constant	3.551	3.649	3.884	3.349	3.408	3.815
	(0.540)	(0.522)	(0.433)	(0.512)	(0.549)	(0.419)
R^2	0.23	0.29	0.24	0.25	0.30	0.26
N	133	133	133	133	133	133

Note: SUEST seemingly unrelated estimation; heteroscedasticity-robust standard errors clustered by leading boat in parentheses.

challenger rather than a neighbor, or vice versa.[15] Model 3 adds the interaction between *challenger imitation* and the *magnitude* of environmental changes to the specification in order to provide empirical evidence on Proposition 1. The proposition appears to be supported ($\beta = 0.475$–0.527, $p < .001$–$.012$). The sizes of the estimated coefficients on *challenger focus*, *magnitude*, and their interaction suggest that *challenger focus* becomes beneficial for maintaining the performance gap at a value of *magnitude* ranging from 1.96 to 2.44, between 1 and 2 *SD*s above the mean value. To test Proposition 2, the interaction between challenger imitation and *frequency* of environmental changes is included in Model 4. This proposition also appears to be supported ($\beta = 0.659$–0.796, $p < .001$). The sizes of the estimated coefficients on *challenger focus*, *frequency*, and their interaction suggest that *challenger focus* becomes beneficial for maintaining

[15]Interestingly, the *other focus* variable does seem to have a consistent positive effect across all specifications. This result appears to be driven by a small number of upwinds (11% of our dataset) in which two of the three rivals chasing the leader were substantially more likely to pursue similar strategies compared to the other upwinds in our dataset, potentially making the leader's choice of whom to imitate much easier as she could effectively imitate two rivals at once. Implications of this result for further research are addressed in the discussion.

the performance gap at a value of *frequency* ranging from 1.06 to 1.53, again within 1–2 *SD*s above the mean value. We thus also find support for Proposition 2.[16]

Insights from our simulation suggest that integrating dynamics among multiple competitors is crucial to explain the imitation–performance relationship. Hence, our empirical results should not hold if only the first- and second-placed rivals are included in our empirical model, because imitative activity of the leader may be focused elsewhere. Therefore, we ran a final test in which we replaced our change in performance gap and extent of imitation variables with separate ones for each rival. In results available on request from the authors, our estimates show that these variables have no influence across all specifications, including those that test for interactions between imitation and environmental uncertainty as discovered in head-to-head competitions (Ross & Sharapov, 2015). This suggests that findings of the extent to which the second-placed rival was imitated by the leader having no significant effect on performance outcomes in a multiple-competitor setting (Ferrier et al., 1999) may be due to imitation of another rival, and not due to the ineffectiveness of imitation per se. This insight echoes earlier work suggesting that multiple sources of risk determine the downside potential in a competitive process (Collins & Ruefli, 1996; Miller, 1998). Therefore, besides off-setting the inherent limitations of each methodology (McGrath, 1982), our research design allowed us to discover new facets of rivalry (i.e., the performance effects of targeting alternative competitive referents). We use the discussion section to lay out the implication of this for theory and further research.

6 | DISCUSSION

Building on the notion that imitating a rival's path, despite its performance being uncertain, can actually help a *leader* to stay ahead in head-to-head competition (Aron & Lazear, 1990; Cabral, 2002; Ross & Sharapov, 2015), we explore the performance implication of a leader's alternative imitation strategies in dynamic competitive environments with multiple rivals, seeking to answer the question: Whom *should* a leader imitate? When facing multiple rivals striving for market leadership using diverse strategies, such environments make it particularly challenging for a leader to identify the greater threat to target for imitation.

Making use of a simulation model and an empirical test, we examine how a leader's simple rule to imitate either the closest rival in terms of attributes (her neighbor) or of the closest rival in terms of rank (her challenger) can help avert an erosion of the gap between the leader and her rivals. We find that increases in the magnitude and frequency of environmental changes increase the attractiveness of a challenger imitation strategy over a neighbor imitation strategy. However, when environmental changes are infrequent and minor, neighbor imitation is more effective in maintaining the lead. We reveal that the relative effectiveness of these strategies is driven by the trade-offs between imitation accuracy and responsiveness to threats from distant rivals, with the balance of these trade-offs depending on the frequency and magnitude of environmental changes. Our insights extend research on the imitation–performance relationship, which has largely focused on legitimacy- and learning-based arguments (Lieberman & Asaba, 2006), and address calls to incorporate the notion of environmental uncertainty more

[16]Inclusion of both magnitude and frequency interactions in the same model does not change the sign of their coefficients but does result in the magnitude interaction being less influential ($\beta = 0.203$–0.275, $p = .167$–$.305$), while the frequency interaction remains so ($\beta = 0.466$ to 0.626, $p = .016$–$.044$). This is unsurprising given the high correlation between the variables. These results are available on request from the authors.

completely into management theory (Alvarez, Afuah, & Gibson, 2018). Our findings shed light on fundamental issues in the strategy literature: why sources of performance heterogeneity arise and how they can persist (Rumelt, Schendel, & Teece, 1994).

6.1 | Theoretical implications

To our knowledge, this paper is the first study that explores how the path through which performance is achieved in multiple-competitor settings is influenced by the choice of imitation strategy, competitive interactions, and environmental variations. While prior research compared the role of two environmental conditions across two different contexts (Anand, Mesquita, & Vassolo, 2009; Chen, Katila, et al., 2010; Katila et al., 2012), our research design allowed us to explore the role of varying environmental conditions within a single context.

Further, whereas well-established research looks at whom competitors define as rivals (e.g., Chen, 1996; Porac, Thomas, Wilson, Paton, & Kanfer, 1995), we show in the context of rivalry-based imitation that such targeting choices actually matter for maintaining a leader's performance gap. By providing a framework that helps identify potential greater threats to a leader and providing normative insights about which laggard the leader's imitative efforts *should* be focused on, despite the absence of information about their ex-ante attractiveness, our findings add to the research on competitor analysis and blind spots (Chen, 1996; Zajac & Bazerman, 1991). As our imitation strategies build on decision rules that proactively shape the focal firm's awareness and motivation in the AMC model, we contribute to calls for research that explores the interaction of micro (AMC) and macro (environment) factors in competitive dynamics and the performance implication of such a rival-centric approach (Chen & Miller, 2012).

On a related issue, we find that insignificant results in prior empirical work on the imitation–performance relationship in head-to-head competition, which considered the action dissimilarity between the first- and second-placed rivals in an industry (Ferrier et al., 1999), may be driven by the leader focusing on another rival. Because imitation strategies shape competitive dynamics of multiple rivals in the system, which in turn determines a leader's performance gap erosion, our insight suggests that going beyond the common firm-dyadic view of competitive interactions (Chen & Miller, 2012) and integrating dynamics among multiple competitors is crucial for explaining performance heterogeneity. We contribute to work that suggests integrating the actions of multiple rivals into competitive dynamics research (Haleblian et al., 2012) by revealing that such integration has implications for the performance outcomes also when the success of imitating a rival's move is a priori uncertain.

While research suggests that uncertainty that is common to all competitors reduces information-based imitation (Gaba & Terlaak, 2013), our findings suggest that the competitive motive of imitating to neutralize the risk of becoming worse off relative to others (i.e., rivalry-based imitation; Lieberman & Asaba, 2006) in such environments can be beneficial. This insight complements scholarly debate on the role of uncertainty for imitation behavior (Cyert & March, 1963; DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Knickerbocker, 1973; Lieberman & Asaba, 2006) by showing the performance implications of imitation for a leading organization. Relating alternative imitation strategies to a leader's performance gap erosion in multi-competitor settings, and by relaxing assumptions of static environments and imitative search being targeted at superior performers in prior computational work on imitation processes, we find that the link between the targeting choice and the environmental changes alters the dynamics among multiple competitors over time. Revealing these new mechanisms enables us to develop contingencies for the effectiveness of using imitation as a risk mitigation strategy to coordinate actions of competitors in uncertain environments (Miller, 1998) and provide new insights on how stay ahead of the pack in a competitive process.

As prior work suggests that search strategies can lower longitudinal performance heterogeneity, which also translates into lower risk (Csaszar & Levinthal, 2016, p. 2044), we analyzed post-hoc the relationship between the mean and variance of strategic risk produced by the three strategies (i.e., decision rules) for different environmental conditions in our simulation. These results show that the mean strategic risk of the independent search strategy is always higher than that of at least one of the imitation strategies, and the variance is always much higher than that of the strategic risk resulting from the imitation strategies. Comparing the two imitation strategies, challenger imitation results in a lower mean strategic risk than neighbor imitation with lower variance, unless environmental changes are small in magnitude and relatively infrequent, in which case the neighbor imitation strategy is more effective than challenger imitation in reducing strategic risk. These insights emphasize the role of imitation as a risk-mitigating strategy and source of sustained performance in dynamic environments, which provides one answer for how high performers can achieve low performance heterogeneity (Fiegenbaum & Thomas, 2004). Hence, the findings on the effectiveness of alternative imitation strategies complement the stream of literature that examines the role of *imitator's focus of attention* on the risk arising from imitation (Posen & Martignoni, 2018).

While risk management practice commonly assumes competitor actions as being uncontrollable (MacCrimmon & Wehrung, 1986), and actions in the competitive dynamics literature are generally taken to be exogenous, with the focus largely being on characteristics of competitive response (Chen & Miller, 2012), our insights help to explain the endogenous nature of competitive actions. By exploring the process of how imitating rivals' moves can shape competitive dynamics and drive changes in a leader's strategic risk, we complement the stream of research that seeks to explain persistence of leadership in dynamic competitive environments with exogenous shocks and endogenous actions (e.g., D'Aveni, 1999; Sutton, 2007). As we find that the interactions between the unsystematic risk component (i.e., neutralizing competitive uncertainty by imitation) and the systematic risk component (i.e., environmental changes) determine performance outcomes, our study helps explain the effectiveness of firm activities in truncating upside opportunities of rivals and reducing the leader's downside risk. This insight adds to the literature on interrelated risk exposures and emphasizes the importance of *total* risk in strategic management (Bettis, 1983; Collins & Ruefli, 1996; Miller, 1998).

6.2 | Further research

Though the fine-grained data in our setting allow us to construct detailed measures of our core constructs for the empirical analysis, the small number of observations in the empirical setting prevents us from empirically investigating interesting conjectures arising from the simulation results, such as three-way interactions between imitation strategies and the two different dimensions of environmental change. To test our theory in different settings and explore its boundary conditions, potential areas of study require environmental changes, such as industry settings that are affected by changes in foreign exchange rates, regulatory changes, and changes in customer preferences or commodity-price movements. Competitive dynamics research could also use our insights in combination with the multi-plane vector approach developed in prior work to examine the different paths that multiple rivals take through a competitive landscape over time (Lamberg, Tikkanen, Nokelainen, & Suur-Inkeroinen, 2009). Another interesting opportunity for future research could be to look into how the strategies discussed in this paper affect different performance measures, for instance the change in performance gap between leader and challenger or the average change in performance gap between the leader and her rivals. While our simulation results illustrate some of the possible trade-offs, empirical work could further explore the likely effects of these strategies on maintenance of the performance gap between leader and challenger (assuming the third-placed rival is irrelevant; e.g., Ferrier et al., 1999; Sutton, 2007) and on the risk of the third-placed rival dethroning the leader. The average change in performance gap between the leader and her rivals could be another salient performance measure, particularly in settings in which strategic risk is considered to be less important than absolute performance. As imitation behavior and competitive blind spots under environmental uncertainty can put industries at risk, with potentially costly effects for industry and society (Lieberman & Asaba, 2006; Zajac & Bazerman, 1991), our insights may motivate future research to develop answers on relative and absolute performance effects of imitation strategies at firm and industry level.

The surprising finding of a consistently positive effect associated with leader imitation efforts being focused on neither her challenger nor her neighbor opens the door for future work on alternative targets than the two that are explored in this study (Thatchenkery & Katila, 2017). While our study is leader-centric, future work could relax our assumptions about competitor behaviors and study to what degree lower-ranked rivals focus on improving versus maintaining their rank position and the competitive dynamics implications of these choices. Future research could also examine persistence in performance heterogeneity (Rumelt et al., 1994) by looking at the interplay between imitation decisions of a leader and the extent to which rivals can effectively imitate each other. A leader who is able to imitate characteristics that could give rivals an edge (e.g., a new product), without these rivals being able to imitate the key resources and capabilities of the leader would stand to gain most from an imitation strategy, while a leader facing rivals that have superior capabilities that she cannot imitate or substitute for is likely to find imitation to be less effective.[17] Further, as organizations are often able to choose from a wider repertoire of moves than the agents in our simulation or the rivals in our empirical context, they may choose to hedge their bets, for example imitating through diversification, acquisition, spin-off activity, or even use resource diversion strategies, such as strategic feints, gambits, and thrusts in multimarket maneuvering (McGrath, Chen, & MacMillan, 1998). Our finding that imitation can be beneficial for a leader even in its starkest form (i.e., completely giving up the leader's prior position to imitate the chosen rival) gives us hope that these benefits may be even greater in settings in which organizations have a greater variety of ways in which imitation can be achieved and combined with other strategies.

A limitation of this study is that we observe only the behavior of rival teams, not the cognitive processes leading to this behavior. In light of the interest among strategy and organization scholars in the role of CEO characteristics in imitative behavior (Gupta & Misangyi, 2018; Zhu & Chen, 2015) and competitive dynamics (Hambrick, Cho, & Chen, 1996), future research could explore the relationship between executive cognition (Marcel, Barr, & Duhaime, 2010; Nadkarni, Chen, & Chen, 2016) and performance outcomes of imitation strategies. For instance, as rival-centric perceptions of decision makers shape market processes and influence market share gains or losses (Tsai, Su, & Chen, 2011), but as such perceptions may depend on

[17] We thank the editor for these points.

industry changes (Kilduff, 2019), future research could explore the performance implications of greater managerial attention paid to certain competitors and reduced attention to others in changing industry environments. Such work could also valuably extend our understanding of the sources of decision rules, rules updating in unstable environments (Eisenhardt & Sull, 2001; MacCrimmon, 1993), and potential organizational tensions when dynamically adjusting competitive referents (Fiegenbaum et al., 1996). Such work would contribute to the continuous debates on the ever-changing modern competitive environment, which suggest the need to advance our theories of strategy by relaxing their assumptions of stability and equilibrium in order to provide advice for decision makers who often face disequilibrium conditions (Wiggins & Ruefli, 2005).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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