IMPACT OF DELAYS AND NOISE ON STRATEGIES AND PERFORMANCE

INTRODUCTION. Understanding heterogeneity in strategies and performance outcomes of firms in similar markets has motivated multiple programs of research in strategic management, economics, and organizational sociology. The behavioral view on this question posits that identifying a profit-maximizing strategy is very complex and cannot be solved optimally. In this view heterogeneity emerges due to variations in organizational capabilities and managerial cognition (Gavetti, 2005) as firms adapt in the face of luck (Denrell, Fang, & Winter, 2003) and path dependence (Dierickx & Cool, 1989). However, as Simon (1990, p7) recognized long ago, "Human rational behavior… is shaped by a scissors whose two blades are the structure of task environments and the computational capabilities of the actor." Thus, to understand heterogeneous organizational strategies and performance we also need to better specify how features of managerial task environments influence adaptive behavior.

One prominent feature of organizational task environments is the presence of time delays between decisions and outcomes. Whether investing to develop and launch a new product, training personnel, or building a collaborative joint venture, delays between taking action and observing the payoffs are ubiquitous in organizations. The impact of actions on outcomes are often mediated through organizational resources and capabilities, creating delayed feedback and dynamic tradeoffs in adaptation (Denrell, Fang, & Levinthal, 2004; Sterman, 1994). Theoretical models have hypothesized that delays hinder learning (Rahmandad, 2008; Rahmandad, Repenning, & Sterman, 2009), and case studies have identified capability traps that arise with worse-before-better tradeoffs, in which the short term performance of a system is opposite from its long run response (Lyneis & Sterman, 2016; Repenning & Sterman, 2002).

The influence of delays on strategy adoption may be strongest when the short- and long-run performance outcomes of different strategies differ. For example, two common strategies observed in service firms (e.g., airlines and retail businesses) have different short- and long-run performance profiles. The High Road (HR) strategy relies on building a capable workforce and complex organizational capabilities through training, team-based work, higher performance-based pay, process improvement, employee voice, and engagement (Lepak, Liao, Chung, & Harden, 2006). The Low Road (LR) strategy focuses on minimizing labor costs through standardization, minimization of task complexity, just-in-time scheduling of labor, and fast, low-cost, recruitment. Managerial actions associated with the LR strategy can result in short-run improvements (e.g. reducing staff may increase profits with little delay), while the HR strategy requires sustained, long-term investment before the benefits can be realized in the long-run.

Learning in the presence of delays may be further complicated if, as in most real world settings, outcomes are noisy. Noise is generally known to slow and complicate learning (Denrell & March, 2001; Lave & March, 1975), but may also interact with delays by moderating the perception and reaction to delayed outcome feedback. For example, assigning credit to actions with immediate feedback may be straight-forward, but noise makes it harder to distinguish the diffused and delayed outcomes of past actions from outcomes not related to those actions. Thus noise and delays may interact to complicate managerial learning. Could adaptation biases due to delays and noise explain the under-adoption of the high road strategy (Ichniowski, Kochan, Levine, Olson, & Strauss, 1996)?

METHODS. Using a microworld with an empirically grounded simulation model of mass market service operations we measure how human subjects explore and learn on a strategy space defined by compensation (c) and work structure (w). The underlying performance landscape is bimodal, with local performance peaks at low-low (representing Low Road strategies) and high-high (i.e. the High Road strategy). We set the High Road (HR) strategy to be 50% more profitable than the Low Road (LR) strategy, but moving towards HR entails investments in underlying capabilities and employee quality with upfront costs and delayed benefits (i.e. worse-before-better tradeoff). Participants are randomized into four experimental conditions based on the length of time delays linking decisions to consequences (Short vs. Long) and the level of noise in outcomes (Deterministic vs. Noisy). Participants complete four rounds of training, making the two decisions (for c and w) in 24 consecutive simulated quarters for each round and observing the resulting profits over time. 859 subjects were recruited from Amazon Mechanical Turk; 33% qualified after a stringent screening test for attentiveness and task understanding and 249 of those completed the experiment attentively. Participants are diverse in education, gender, employment, income and age and are incentivized to find the strategy that maximizes the long-term performance of the simulated firm, elicited after training rounds.

RESULTS. Table 1 reports linear regression results predicting the final selected strategies, c_L (final compensation; column 1) and w_L (final work structure; column 2). We find significant reductions in the final selected compensation and work structure as a result of longer delays;

delays bias decision makers towards the Low Road strategy (i.e. away from the global optimum). The effect of noise, and its interaction with delays, is weak. Therefore, in columns 3 and 4 we report two additional regressions, one predicting distance to the HR peak, d_{HR}, and the other the performance of the adopted strategies, P_L. Not only delays have a strong impact shifting learners away from the profit maximizing HR peak and towards LR, but also that leads to a significant reduction in the performance of learners. Noise also has a negative effect on performance, but that effect is only significant with short delays and goes away in presence of long delays.

Table 1. Regressions predicting bias of adopted strategies. Controls for age, gender, service experience, education, employment, and income are included but not shown.

	(1)	(2)	(3)	(4)
VARIABLES	w_L	c_L	d_{HR}	P_L
Delay	-0.185**	-514.3**	0.191**	-3,448***
	(0.0772)	(242.2)	(0.0766)	(1,007)
Noise	-0.0290	-119.6	0.0286	-1,603***
	(0.0419)	(131.3)	(0.0415)	(545.9)
Delay*Noise	0.0293	149.6	-0.0421	1,373*
	(0.0578)	(181.2)	(0.0573)	(753.4)
Observations	249	249	249	249
R-squared	0.041	0.026	0.039	0.070

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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