On Strategic Choice and Organizational Ambidexterity: An agent-based modeling approach

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Organizational ambidexterity, defined as the simultaneous pursuit of exploitation and exploration, has become a very important topic in the study of organizations. Yet, as a recent and comprehensive review notes, "Despite the rapidly expanding number of studies referring to organizational ambidexterity, empirical tests of the ambidexterity–performance relationship remain scarce." The contribution of this paper is to introduce an agent-based model that captures many of the key aspects and tradeoffs, which have been identified in the literature, of the exploration–exploitation dilemma faced by firms. When data become available, the model can be calibrated to the data. Until then, the model serves as a useful tool for exploring hypotheses and revealing surprising aspects of the subject.

Keywords: organizational ambidexterity, agent-based modeling, organizational learning, exploration, exploitation

1. Introduction

Organizational ambidexterity, defined as the simultaneous pursuit of exploitation and exploration, has become a very important topic in the study of organizations. In a recent very comprehensive and extensive literature review, Raisch and Birkinshaw[1] propose that despite the increasing number of studies on organizational ambidexterity, the concept is still in the process of developing into a new research paradigm in organization theory. In fact, as Raisch and Birkinshaw note [1, page 393], "Despite the rapidly expanding number of studies referring to organizational ambidexterity, empirical

tests of the ambidexterity–performance relationship remain scarce."

The contribution of this paper is to introduce an agent-based model (ABM[2]), Ambidextrous.nlogo, that captures many of the key aspects and tradeoffs, which have been identified in the literature, of the exploration–exploitation dilemma faced by firms. It is this fundamental dilemma that the organizational ambidexterity literature addresses. Our model is hardly complete, but it is public, it is extensible, and it can be used to gain insight into the general domain and into specific hypotheses. Because it is a model, its assumptions are explicit and accessible. In virtue of being a computational model, the assumptions are readily modified. A draft version of the model, made anonymous for refereeing, is available on the Web as a Java applet at `http://128.91.104.199/nlogo/Ambidextrous.html`.

We turn now to a review of the essential background for understanding organizational ambidexterity.

2. Literature review

Duncan[3] first introduced the concept of organizational ambidexterity and asserted that a dual organizational structure is needed to initiate innovation and implement innovation. As a further step, March's[4] influential paper proposed exploitation and exploration as two different learning activities which should be pursued in balanced way but, at the same time, may compete for organizationally scarce resources. Based on March's work, many scholars applied exploitation and exploration concepts into their research in different contexts such as organizational learning, technological innovation, organizational adaptation, strategic management, and organizational design (Ancona et al.,[5] Atuahene-Gima,[6] Benner and Tushman,[7] Burgelman,[8] Gupta, Smith and Shalley,[9] He and Wong,[10] Katila and Ahuja,[11] Levinthal and March,[12] Raisch and Birkinshaw,[1] Tushman and O'Reilly,[13] Tushman and Smith[14]).

In spite of conflicting, or at least varying, definitions, the literature agrees that exploitation and exploration refer to very different learning activities within an organization. Exploitation includes activities associated with refinement, extension or improvement of current components, competences, and technologies; exploration includes activities including experimentation, innovation or a shift to different technological trajectory (Benner and Tushman,[7] March[4]). A combination or simultaneous pursuit of exploitation and exploration in an organization is defined as ambidexterity (Tushman and OReilly,[13] He and Wong,[10] Lubatkin et al.[15]). Studies including concepts such as 'reconciling exploitation and exploration', the

'simultaneity of induced and autonomous strategy processes', 'synchronizing incremental and discontinuous innovation', and 'balancing search and stability' belong to the same stream of literature (Raisch and Birkinshaw[1]).

Because of the complex nature of organizational ambidexterity, the linkage between organizational ambidexterity and performance remains controversial. On one hand, following March's assertion that firms run the risk of being mediocre at both exploitation and exploration resulting from the inherent challenge of doing both, some scholars propose to pursue only one direction instead of both (Barny,[16] Ghemawat and Ricart i Costa,[17]). Firms simultaneously pursuing both activities are likely becoming internally inconsistent so as to lead to inferior performance (Wernerfelt and Montgomery[18]). The knowledge processes of exploitation and exploration are contradictory because they tap different administrative routines and managerial behaviors. As suggested by Lubatkin, Simsek, Ling, and Veiga[15] , exploitation primarily involves learning from top-down process because managers are used to those organizational routines, while exploration involves a bottom-up process which managers are persuaded to abandon their old routines and make a change or innovative action.

On the other hand, Tushman and OReilly[13] point out that firms capable of simultaneously pursuing exploitation and exploration are more likely to achieve superior performance than firms only emphasizing one. Levinthal and March[12] also argue that 'an organization that engages exclusively in exploration will ordinarily suffer from the fact it never gains the return of its knowledge ... an organization that engages exclusively in exploitation will ordinarily suffer from obsolescence.' In other words, the exclusive pursuit of exploration may end up with endless search efforts or R&D expenditure without appropriate return (Raisch and Birkinshaw[1]). In contrast, the exclusive pursuit of exploitation may enhance short-term return but may lead the organization to being incapable of adapting to a new environment (Levitt and March[19]). Firms should exploit existing competencies and explore new ones and these two activities are inseparable (Floyd and Lane[20]).

Besides these conceptual works, there are a few empirical studies regarding this topic. Knott[21] found that exploitation and exploration coexist in Toyota's product development, and concluded that these two activities are likely to be complementary. Katila and Ahuja[11] found a positive interaction between exploitation and exploration on new product development but did not test their effects on firm performance. In the empirical work of He and Wong,[10] they found that the interaction between explorative and exploitive innovation strategies is positively related to sales growth rate,

and the relative imbalance between explorative and exploitative innovation strategies is negatively related to sales growth rate at the firm level. Gibson and Birkinshaw,[22] focusing on the business unit level, found that the capacity to simultaneously achieve alignment and adaptability positively affects performance. Lubatkin et al.[15] suggest that the joint pursuit of an exploitative and exploratory orientation positively affects performance in small- and medium-sized enterprises. Other empirical work, however, did not support the ambidexterity-performance linkage. Rather, it found that temporal cycling between exploitation and exploration has a positive effect on firm performance.

Despite the rapid increasing studies concerning ambidexterity, the empirical data for the ambidexterity-performance remains relatively scarce (Raisch and Birkinshaw[1]), and the causal link has neither been theoretical clear nor empirically established (Lubatkin et al.[15]). The following section will establish and show an agent-based model to provide some simulation data so as to assist managers to make their decisions in terms of whether to adopt an organizational ambidexterity strategy.

3. Description of Agent Model

Our aim is to build and explore at first a very simple model of ambidexterity decisions and subsequently to articulate it in light of unfolding theory and experience. We report here on this first model. The salient aspects of the model, with comments, are as follows. Our aim in this paper is to present a model and a simulation tool to the research community. Again, a draft version of the model is available on the Web as a Java applet at `http://128.91.104.199/nlogo/Ambidextrous.html` and from there the source code can be downloaded.

(1) The industry consists of 2 supplier firms, producer 0 (red) and producer 1 (blue). Each produces and sells product 0 to the market.
(2) There are `NumberOfCustomers` customers in the market for product 0. Each customer has an inherent demand for product 0, which it seeks to satisfy each tick of the clock or *episode* of activity.
(3) Unit prices for product 0 are constant. The products of each vendor have a quality index, which may change over time. Vendors compete on quality and reduction of cost of manufacture.
(4) Each customer focuses on one of the two producers as its primary vendor, using a "greedy epsilon" choice policy.[23] During any given episode a customer seeks with probability $(1 - \varepsilon)$ to fulfill its requirements for

product 0 from its focal supplier. If the focal supplier has sufficient quantity on hand, the transaction is made; otherwise the customer attempts to purchase product 0 from the other supplier. Similarly, with probably ε the customer first attempts to purchase its supply of product 0 from the non-focal vendor. After each transaction each customer records the supplier(s) and product qualities it experienced with each vendor.

(5) Each supplier has a unit cost of manufacture and a price for its product 0. Profits (and losses) are accumulated after transactions occur.

(6) Each customer reconsiders its focal supplier after a number of episodes have occurred, called the `epochLength` for the customer. At the end of its epoch, a customer will probabilistically refocus on a supplier based on which of the suppliers has provided it higher quality on average. (See[24] for a full discussion of a related learning model, using epochs. We use a parameterized Boltzman distribution to determine the relevant probabilities.)

(7) Each customer also has a latent demand for product 1, which is not offered on the market at the inception of the simulation. If any vendor offers product 1 the market proceeds in a manner structurally identical to that for product 0.

(8) Vendors also organize their time (episodes, ticks of the clock) into epochs. At the end of its epoch a vendor considers whether to invest in R&D and if so, whether to invest in incremental innovation or in radical innovation. That is, whether to invest in cost or quality improvements in product 0 or in discovering an unknown new product (which we know as product 1). Each investment has a cost, a probability of success, and an incubation period (in number of episodes or ticks). The vendor must pay for the R&D from accumulated profits when the decision is made. Accumulated profits cannot go negative.

(9) There is a "complexity cost" incurred in when investing in both an incremental innovation and a radical innovation at the same time. This is in addition to the base cost of each investment. Multiple investments of the same type are permitted without incurring the complexity cost. (`AmbidexterityCostMultiplier` is the program variable.)

(10) At the end of an investment's incubation period success or failure is probabilistically realized. In the case of success with an incremental innovation the result is an improvement in the quality index of product 0 and/or a reduction in the cost of manufacture. In the case of success with a radical innovation the result is that the vendor may sell product

1 and realize profits, which by default are set quite high.

4. Discussion

The parameters of Ambidextrous.nlogo are not calibrated to real data because (as noted in the review by Raisch and Birkinshaw[1]) real data do not exist that are suitable to this purpose. Even so, an ABM and our model in particular, can serve a number of useful purposes. If real data are not available, subjective data can be used to "ballpark" the model, to gain insights into the phenomena, and to provide something of a "sniff test" for the entirely informal models or hypotheses in the literature. Space limitations prevent a full discussion of this point and the results we have obtained. The following remarks should be taken as indicative or representative. The model handles arbitrary mixtures of incremental and radical R&D projects, which succeed only probabilistically and with differing costs and consequences.

Using plausible parameterizations, the program can replicate all the main phenomena we have seen identified in the literature. For example, a firm investing in a number of incremental R&D projects will probabilistically improve the value of its product 0 and gradually take over the market at the expense of a competing firm that does not make investments. What is brought out clearly in the model, and what is not much discussed in the literature, is that the success of the investing firm depends very much on its relative competitive position (Is its product more or less valuable than the competition's? By how much? etc.), the probabilities and benefits of success, and on the amount of time it takes for the investment costs to be recovered. (Looking ahead in making a decision, a real manager would have to consider discounting the investment returns.)

The prospect of examining these and related issues in detail, and of obtaining some reasonable degree of calibration of the model is, we find, quite an exciting one. We hope others will build on the model we have begun and reported on here, however briefly.

References

1. S. Raisch and J. Birkinshaw, *Journal of Management* **34**, p375 (20080601).
2. M. J. North and C. M. Macal, *Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation* (Oxford University Press, Oxford, UK, 2007).
3. R. B. Duncan, R. H. Kilman, L. R. Pondy and D. Slevin, The ambidextrous organization: designing dual structures for innovation (1976).

4. J. G. March, *Organization Science* **2**, p71 (19910101).
5. D. G. Ancona, P. S. Goodman, B. S. Lawrence and M. L. Tushman, *Academy of Management Review* **26**, p645 (20010101).
6. K. Atuahene-Gima, *Journal of Marketing* **69**, 61 (2005).
7. M. J. Benner and M. L. Tushman, *Acad. Management Rev* **28**, p238 (20030101).
8. R. Burgelman, *Administrative Science Quarterly* **47**, p325 (20020101).
9. A. K. Gupta, K. G. Smith and C. E. Shalley, *Academy of Management Journal* **4**, p693 (20060101).
10. Z.-L. He and P.-K. Wong, *Organ. Sci* **15**, p481 (20040101).
11. R. Katila and G. Ahuja, *Academy of Management Journal* **45**, p1183 (20020101).
12. D. A. Levinthal and J. G. March, *Strategic Management J* **14**, p95 (19930101).
13. M. L. Tushman and C. O'Reilly, *California Management Review* **38**, p8 (19960101).
14. M. L. Tushman and W. K. Smith, Organizational technology, in *Companion to organization*, ed. J. Baum (Blackwell, Malden, MA, 2002) pp. 386–414.
15. M. H. Lubatkin, Z. Simsek, Y. Ling and J. F. Veiga, *Journal of Management* **32**, p646 (20060101).
16. J. B. Barney, *Journal of Management* **17**, 99 (1991).
17. P. Ghemawat and J. Ricart i Costa, *Strategy Management Journal* **15**, 91 (1993).
18. B. Wernerfelt and C. Montgomery, *American Economic Review* **78**, p246 (19880101).
19. B. Levitt, J. G. March, W. R. Scott and J. F. Short, **14**, p319 (19880101).
20. S. Floyd and P. Lane, *Academy of Management Review* **25**, p154 (20000101).
21. A. M. Knott, Exploration and exploitations as complements, in *The Strategic Management of Intellectual Capital and Organization Knowledge: A Collection of Readings*, eds. N. Bontis and C. W. Choo (Oxford University Press, New York, NY, 2002) pp. 339–358.
22. C. B. Gibson and J. Birkinshaw, *Acad. Management J* **47**, p209 (20040101).
23. R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction* (The MIT Press, Cambridge, MA, 1998).
24. S. O. Kimbrough and F. H. Murphy, *Computational Economics* **DOI 10.1007/s10614-008-9150-6** (2008).