



DEPARTMENT OF MANAGEMENT
ORGANIZATIONAL DECISION-MAKER BIAS
SUPPORTS MARKET WAVE FORMATION:
EVIDENCE WITH LOGICAL FORMALIZATION

GÁBOR PÉLI & HANS SCHENK



THE BEST BUSINESS SCHOOLS
IN THE WORLD

UNIVERSITY OF ANTWERP
FACULTY OF APPLIED ECONOMICS, DEPT. OF MANAGEMENT
KIPDORP 61 (S.Z.105) BE-2000 ANTWERPEN
TEL. +32 (0)3 265 50 64 | FAX +32 (0)3 265 50 79
[HTTP://WWW.UA.AC.BE/ACED](http://www.ua.ac.be/ACED)

A^ACED

FACULTY OF APPLIED ECONOMICS

DEPARTMENT OF MANAGEMENT

**Organizational Decision-Maker Bias
Supports Market Wave Formation:
Evidence with Logical Formalization**

Gábor Péli & Hans Schenk

RESEARCH PAPER 2011-006
ACED 2011-011
MAY 2011

University of Antwerp, City Campus, Kipdorp 61, B-2000 Antwerp, Belgium
ACED Administration – room S.Z.105
phone: (32) 3 265 50 64 - fax: (32) 3 265 50 79
e-mail: anne.vanderplanken@ua.ac.be

The papers can be also found at website:
<http://www.ua.ac.be/aced> & <http://www.ua.ac.be/TEW>
(research > working papers)

D/2011/1169/006
A^ACED/2011/011

**Organizational Decision-Maker Bias Supports Market Wave Formation:
Evidence with Logical Formalization**

Gábor Péli

School of Economics, Utrecht University, Janskerkhof 12, 3512 BL Utrecht, The Netherlands
and Antwerp Centre of Evolutionary Demography, University of Antwerp
g.peli@uu.nl

Hans Schenk

School of Economics, Utrecht University, Janskerkhof 12, 3512 BL Utrecht, The Netherlands
e.j.j.schenk@uu.nl

Key words: mergers; perception bias; adaptation; logical formalization

Abstract

Imitation of first-mover firms in opting for a merger or acquisition (M&A) facilitates merger-wave formation. Empirical evidence suggests that, under uncertainty of outcomes, firms regret more not following their rivals' strategy than possibly failing jointly by copying it. We explore the outcomes and look for underlying behavioral assumptions in that decision-making framework by modal logic. Biased expectations, represented by the **B** (belief) modal operator, filter out relevant scenarios from managerial consideration. The theorems highlight the drive to imitate first-mover M&As. Our approach goes against the view that human behavior, being non-logical in many respects, defies logic-based rendering. Logic is a flexible representation tool that can model even faulty behavior in a transparent way, also exploring the consequences of the cognitive mistakes made. Our findings suggest that threats to wealth creation may not necessarily find their origins in morally dubious organizational behavior, but rather in modalities of decision making under uncertainty.

1. Introduction

How does the behavior of influential individuals in organizations aggregate into robust macro-level market outcomes? Strategy choice depends on the interplay between top management team members' personality traits and functional background, managerial self evaluation (Hambrick 2007; Hiller and Hambrick 2005), and also on the distribution of internal/external loci of control (Boone and Hendriks 2009). But firms breaching the social codes of their organizational form are likely to suffer retributions from their task environment (Pólos et al. 2002). Norm-making processes (DiMaggio and Powell 1983) can set the individual compasses of decision-makers pointing into the same direction, delimiting what they are likely to do or even perceive. Our paper does not address the delicate institutional and cognitive processes via which prevalent managerial norms and decision-making patterns, develop. Our paper explores by means of logical modeling macro-level consequences of biased managerial perception and decision-making on the example of market wave formation.

Empirical studies have repeatedly shown that most large mergers and acquisitions (M&As) fail to generate wealth relative to the counterfactual (Schenk 2006, Scherer 2006). Six large merger waves have been documented in modern history including the one observed during the current decade (Town 1992, Gugler et al. 2005). M&A performance drops with increasing merger incidence so that we observe significantly more failures towards the peak of the wave (Figure 1). Following such merger waves we typically observe deteriorating economic fortunes (i.e. recessions) and heightened demerger activity. This pattern suggests that merger-active firms might be aware of the dubious prospective for success (Schenk 2008). Still, this does not appear to hold them. Why would firms undertake more M&As even if the chances for wealth creation are in question?

--- Figure 1 is about here ---

The *minimax-regret model* captures the managerial behavior underlying dubious merger-decisions by putting a floor under how bad a decision-maker would feel if things go wrong (Schenk 1996). It applies in small-number rivalry conditions, i.e. when a significant gain for firm *A* may have severe repercussions for firm *B*. Such conditions, while recognized as special cases in textbook economics, are typical for several relevant sectors of developed economies. Less than ten firms dominate world car markets, drugs markets, oil markets and telecom markets (Pryor 2001). Similar conditions apply in the banking industry (Bikker and Haaf 2002).

Suppose that firm A announces the acquisition of firm C . Competitor firm B will now have to contemplate what the repercussions for its own position might be. A 's competitive position vis-à-vis its peers may be ameliorated as a result of that move, say, in terms of a first-mover advantage. But then again, it may not. What is B , the focal firm in our investigation, to do? Suppose that A 's move succeeds but that B has not reacted by imitating that move itself (scenario α). Alternatively, suppose that A 's move will fail but that B has imitated it solely inspired by the possible prospect of A 's move being a success (scenario β). B 's regret attached to scenario α is expected to be higher than its regret attached to β . For in α , B will experience a loss of competitiveness, while in β its competitive position vis-à-vis A may not have been harmed. Of course, B could have realized a gain by not wasting time and assets on reorganizing, had it refrained from imitating A . But in markets of high competitive pressure, B 's regret of forgoing this potential gain is likely to be small relative to the regret concerning the expected robust decay in its competitive position when A succeeds. The qualitative implication is that a strategic move by firm A is likely to elicit an imitative countermove by its rival B , even if the economic payoffs are dubious.

We translate this argument into logical formulae. First providing a natural language reconstruction of the decision-making problem, we seek for behavioral assumptions, beliefs, managers share. Then, we formalize these beliefs as model premises in order to derive the qualitative *minimax-regret* conclusion that follower firm B attaches higher regret to idleness (scenario β) than to joining the merger bandwagon and risking failure (scenario α). Building-up a logic machinery to solve a single problem might seem shooting on a sparrow with cannon. But we make further use of the logic model at extending the theory and deriving yet unexplored consequences. The core premise set extended with bits of new information gets strong enough to survey the complete set of strategic outcomes that possibly occur in the decision-making framework. The implying generalized theorems indicate that managers tend to overlook those scenarios that suggest not joining the merger bandwagon.

2. Logic

We use symbolic logic as our modeling tool (Gamut 1991ab). We briefly introduce the logic machinery in order to make our argument accessible for the non-logic-expert reader. Logical formalization is a qualitative formal method that allows drawing conclusions from natural language arguments with the rigor of mathematical derivations (Bruggeman and Vermeulen 2002). By translating the focal concepts (definitions, meaning postulates), facts and

considerations (assumptions) into formal logical sentences, the goal is to derive the conclusions of the theory under investigation as theorems. Logic is a flexible and accurate formal tool even for investigating erratic human behavior. Theorizing about illogical steps can be, and should be, put forward logically. As psychiatrists describe mental disorders in clear-cut sentences, organizational analysts should describe organizational flaws in a flawless logical manner.

Different logical languages can be chosen for modeling tasks like mainstream First-Order Logic (FOL, Hannan 1998, Kamps and Pólos 1999, Péli et al. 2000, Péli 2009), or possible extensions such as non-monotonic logic (Hannan et al 2007; Kuilman et al. 2009) and modal logic (Herzig and Longin 2003; Pólos et al. 2010, Hsu et al. 2011). Non-monotonic logic is a powerful tool to build theories ‘in the move’ thanks to its ability of tolerating exceptions from the rules distilled from empirical generalizations (Lakatos 1976). We specified our current model on the behavioral background of merger wave formation without such knowledge update. Therefore to keep the presentation simpler, we built our modal construction upon FOL. Non-monotonic logic would be a very helpful tool, for example, when modeling how merger waves phase out as decision-makers learn from failures and update their beliefs accordingly.

Modal logics increase FOL’s expressive power by introducing operators that attach modalities to statements. Examples for modalities are ‘*being necessary, possible, known, believed*’, etc. Our representation makes distinction between two epistemic layers: what agents *know* (correctly, per definitionem) and what they *believe* (correctly or not). Beliefs act as perception-filters preventing decision-makers from considering the full set of outcomes of their choices. We employ two modal operators, the **B** *belief* operator with its standard axiomatisation and the **K** *knowledge* operator (Herzig and Longin 2003). **B** φ denotes that the managers of our prospective follower firm *B* believe sentence φ to hold, while **K** φ denotes that they *know* that φ holds. We put the formal characterization of **B** and **K** into the Appendix for the interest of the technically oriented reader. The application-oriented reader finds an introduction to social science modal logic applications in Pólos et al. (2010). Note however that understanding our formalization does not require specific logic skills, just like studying a simulation paper does not require being a programmer.

2. Logical Formalization

We proceed with the formalization by first motivating our definitions and assumptions in natural language and then spelling them out in logic. Then, we derive theorems from our premise set. A conclusion can be challenged in two ways: either by showing that its derivation is incorrect or by

showing that some of its premises are. We checked the FOL core of the derivations with the *Prover9* and *Mace4* theorem-prover softwares (McCune 2007). So our conclusions are as good as the premises from which they derive. Logical formalization has the ‘polite’ property for its critiques that its arguments can effectively be challenged by pointing out the premises cannot be taken for good. After replacing the disliked premises with acceptable ones, the conclusions the modified premise set supports can be formally explored. The latter job, however, requires formalization practice, while ‘simply’ scrutinizing the premises for validity requires only a sharp eye.

Logical formalizations, just like those in mathematics, build on a bulk of background knowledge. We took as given, without formalization, that firms *A* and *B* are in rivalry in a high uncertainty market. Their managers of bounded rationality resort to beliefs to patch up information gaps (Simon 1955). Firm *A* has already opted for merger what *B* can imitate or not. The improved market position caused by a successful merger is captured by the organizational fitness it brings about or maintains. Since even successful mergers involve substantial reorganizations costs, the general ‘well-being’ of our firms depends on the difference between their fitness and reorganization cost scores. In order to keep the focus on the interplay between logical formulae and organizational content, we put only the definitions and assumptions closely related to the theory upfront in the main text. The so-called background premises, like those on the elementary arithmetic, are placed into the Appendix. Table 1 displays the denotations of the logical language and the vocabulary of proper names, predicates and functions the formalization applies. Table 2 displays the focal assumptions.

- Tables 1 and 2 are about here -

Following their natural language descriptions in section 1, scenarios α and β are defined as follows. The ‘reads’ instantiate the verbal descriptions of notations and vocabulary elements from Table 1.

DEFINITION 1. Scenario α .

$$\text{Holds}(\alpha) \leftrightarrow \text{Opts}(A) \wedge \text{Fit}(A) \wedge \neg \text{Imitates}(B, A)$$

(*Read.* Scenario α holds, if and only if *A* opts for merger and *A* is fit and *B* does not imitate *A*.)

DEFINITION 2. Scenario β .

$$\text{Holds}(\beta) \leftrightarrow \text{Opts}(A) \wedge \neg \text{Fit}(A) \wedge \text{Imitates}(B, A)$$

(*Read.* Scenario β holds, if and only if *A* opts for merger and *A* is not fit and *B* imitates *A*.)

Now, we are going to derive the core predictions of the minimax-regret argument that firm B prefers scenario β over α . In formal terms: $Prefers(B, \beta, \alpha)$. Definition 3 fixes that preferring an outcome over another is expecting being better off with the former. For brevity, from now on we use the shorthand ‘firm B believes’ instead of the longer term ‘decision-makers of firm B believe’.

DEFINITION 3. Firm B ’s preference.

$Prefers(B, x, y) \leftrightarrow \mathbf{B}\{Better_off(B, x, y)\}$

(*Read.* B prefers x over y , if and only if, B believes to be better off with x than with y .)

Assumptions 1-3 describe expectations of B ’s managers concerning outcomes. These expectations are well-known in the business world in the sense that they recur in mainstream management textbooks. The first belief puts that organizational adaptation is a must; idleness under rapidly changing external conditions bears failure (Assumption 1). Managers are hired to take action. So those who stay idle in turbulent times can be perceived way more negatively than those who have ‘at least tried to do something’, even when rationality would not have justified their actions. In the current context, embarking upon M&A is the adaptive move organizations can make.

ASSUMPTION 1. $\mathbf{B}\{Firm(x) \wedge \neg Opts(x) \rightarrow \neg Fit(x)\}$

(*Read.* B believes that if x is a firm and x does not opt for merger, then x is not fit.)

Assumption 2 is about what textbooks call benchmarking: the imitation of good practices, if done properly, is expected to lead to similar good results (here, to fitness). The analogue statement is that imitation of bad practice breeds failure.

ASSUMPTION 2.

$\mathbf{B}\{Firm(x) \wedge Firm(y) \wedge Imitates(y, x) \rightarrow (Fit(x) \rightarrow Fit(y)) \wedge (\neg Fit(x) \rightarrow \neg Fit(y))\}$

(*Read.* B believes that if x and y are firms, and y imitates x , then x is fit implies that y is fit, and that x is not fit implies that y is not fit.)

Mergers and acquisitions normally involve fundamental reorganizations that affect the organization’s technical core (Thompson 1967). Fundamental reorganization reshuffle basic routines (Nelson and Winter 1982) and disrupt tacit agreements upon which personal and

systemic trust is based (Lane and Bachmann 2000). Reorganizations involve costs on two accounts (Barnett and Carroll 1995). If a firm fails to achieve the reorganization goals, or achieves wrongly set goals so that the adaptation effort does not bring about or maintain fitness, then the firm faces the *content* costs of reorganization. We represent content costs of failed M&As by not having the $f_i > 0$ fitness advantage associated to being successfully adapted to extant market conditions. While content costs are only paid in case of adaptation failure, firms always pay the $rc > 0$ *process* cost of their adaptation. Our focal firm B lacks insider information on the ongoing merger of its rival A . Therefore we assume that B expects, by default, the same rc reorganization process costs for itself as for A . Similarly, B expects the same f_i fitness improvement after successful mergers. Having respectively different f_i -s and rc -s for A and B gets importance at the phasing out of the wave (Appendix). Expecting high f_i reflects hopes of better strategic positioning and efficiency improvement. Empirical data reveal that such expectations fall far from being justified: the overwhelming majority of the largely-publicized mega-mergers of the last decades failed to improve productive efficiency (Scherer 2006). Still, there are systematic managerial tendencies to underestimate the costs relative to the fitness improvement a successful adaptation might bring about (Hannan and Freeman 1984). Assumption 3 formalizes this (mis)belief for firm B .

ASSUMPTION 3. $\mathbf{B}\{f_i > rc\}$

(*Read.* B believes that the f_i fitness advantage a successful merger brings about is larger than the rc reorganization process costs.)

We assume furthermore that B 's beliefs are not biased in any relevant sense beyond Assumptions 1-3. So with these exceptions, B knows also knows the facts on the context captured by our premise set S (Assumption 4). $X \setminus Y$ denotes the set theoretic difference of sets X and Y .

ASSUMPTION 4. $\forall \varphi [\varphi \in S \setminus \{A1, A2, A3\} \rightarrow \mathbf{K}\varphi]$.

(*Read.* For all formula φ , if φ is the element of premise set S minus Assumptions 1, 2 and 3, then firm B knows that φ holds.)¹

¹ Assumption 4 is expressed in *second-order logic* as quantifier 'for all' (\forall) ranges over the set of formulae φ , while in FOL it can only range over variables (Gamut 1991b). Assumption 4 is a shorthand: one by one applying \mathbf{K} to each premise in the set specified in A4 brings back to FOL.

In general, firm B behaves rationally, as far as its perception bias captured by Assumptions 1-3 allows for rational behavior. Rationality also involves believing what one knows: $\mathbf{K}\phi \rightarrow \mathbf{B}\phi$. Thus B knows and believes Assumptions 5–8 (Table 2), the scenario definitions (Table 1), and also the rules of elementary arithmetic (Appendix). The next Assumption 5 adds that opting for M&A involves reorganization process costs to the premise set.

ASSUMPTION 5. $Firm(x) \rightarrow (Opts(x) \leftrightarrow ReorgCost(x))$

(*Read.* If x is a firm, then: if x opts for merger, then x has reorganization process costs, and vice versa.)

The bi-conditional (\leftrightarrow) in Assumption 5 is a shorthand for the fact that implication (\rightarrow) also holds in the opposite direction (\leftarrow). The ‘if and only if’ construction indicates a practical model simplification: merger/acquisition is the only source of reorganization cost in our model. From now on, we do not consider contexts when reorganization is triggered by something else like diversification, obsolescence, or factor price change. The next assumption is that once firm A has opted for M&A, firm B ’s analogue choice qualifies as imitation.

ASSUMPTION 6. $Opts(A) \rightarrow (Opts(B) \leftrightarrow Imitates(B, A))$.

(*Read.* If A opts for merger, then: if B opts for merger, then B imitates A , and vice versa.)

Assumption 6 constrains the model in a reasonable sense. Its left-to-right reading (\rightarrow) fixes that once first-mover A has opted for M&A, B ’s similar move does not happen independently; it is an act of imitation in our context of small number conditions and face-to-face competition. The right-to-left reading (\leftarrow) fixes that the B ’s imitation always involves its embarking upon an M&A. With stating that $Firm(A) \wedge Firm(B)$ also hold, the premises listed up till now support two ‘intermediate’ theorems. Lemmata 1–2 constitute a springboard for the theorems to come.

LEMMA 1. $\mathbf{B}\{Holds(\alpha) \rightarrow Fit(A) \wedge \neg Fit(B) \wedge ReorgCost(A) \wedge \neg ReorgCost(B)\}$

(*Read.* B believes that if scenario α holds, then A is fit, B is not fit, A has reorganization costs, and B has no reorganization costs.)

LEMMA 2. $\mathbf{B}\{Holds(\beta) \rightarrow \neg Fit(A) \wedge \neg Fit(B) \wedge ReorgCost(A) \wedge ReorgCost(B)\}$

(*Read.* B believes that if scenario β holds, then A is not fit, B is not fit, A has reorganization costs, and B has reorganization costs.)

Next, we assigned values $(0, rc, fi)$ to the pros and cons specified by Lemmata 1–2. The $f(x)$ and $r(x)$ functions yield, respectively, the fitness and reorganization cost values of x ; $score(x) = f(x) - r(x)$ gives the payoff for x , while $rel.score(B) = score(B) - score(A)$ indicates B 's overall competitive position relative to A (Appendix). Firms are better off with scenarios of higher relative scores. Assumption 7 that states this consideration concerning firm B .

ASSUMPTION 7.

$$Scen(x) \wedge Scen(y) \wedge (Holds(x) \rightarrow rel.score(B) = w_1) \wedge (Holds(y) \rightarrow rel.score(B) = w_2) \\ \rightarrow (w_2 > w_1 \rightarrow Better_off(B, y, x)) \wedge (w_2 = w_1 \rightarrow Indiff(B, y, x)).$$

(*Read.* If x is a scenario and y is a scenario, and if the fact that x holds implies having w_1 relative score for B , and if the fact that y holds implies having w_2 relative score for B , then when w_2 is larger than w_1 , B is better-off with x than with y , and when w_2 equals w_1 , B is indifferent with respect to the choice between y and x .)

The baroque syntax of Assumption 7 indicates that well-understood linguistic expressions like ‘being better-off’ can be shorthands for complex cognitive constructions. Now, we have all premises to derive the main conclusion of the minimax-regret model: follower firm B regrets more not imitating first-mover A 's merger move (scenario α), than failing their respective mergers jointly (scenario β). That is, B prefers β over α :

THEOREM 1. $Prefers(B, \beta, \alpha)$.

(*Read.* B prefers scenario β over scenario α .)

4. The Model at Work

We are going to use the logical formalization developed for theory extension purposes. We generalize the minimax-regret model's predictions, showing that a slightly extended premise set implies B 's preferences over the complete set of scenarios that can occur within the decision-making framework. B 's main dilemma is imitating A or not. Both choice can couple with the success/failure of A , and also of B . These give $2^3 = 8$ basic scenarios (Figure 2, Table 3). These scenarios mutually exclude each other. Table 4 displays B 's implying relative scores for each.

- Figure 2 and Tables 3-4 are about here -

Let $s_{i,j,k\dots}$ denote the *composite* scenario that holds, if and only if, one of the basic scenarios s_i , s_j , s_k , ... holds. The premise set implies that B believes basic scenarios s_2 , s_3 , s_5 and s_7 not to occur:

THEOREM 2. $\mathbf{B}\{\neg\text{Holds}(s_{2,3,5,7})\}$

(B believes that it cannot be the case that any of basic scenarios s_2 , s_3 , s_5 and s_7 hold.)

Comparing Definitions 1-2 with the basic scenario definitions in Table 3 reveals that $\alpha = s_{3,4}$ and $\beta = s_{5,6}$. But because of its perceptual bias (cf. Theorem 2), B identifies scenario with s_4 and scenario $\beta = s_{5,6}$ with s_6 (cf. Figure 2). One of the four scenarios B overlooks is well-known, even named, in organization science. The best-scoring s_7 (A fails its merger while the idle B stays/gets fit) is the selection outcome predicted by organizational ecological inertia theory (Hannan and Freeman 1984; Péli et al. 2000; Hannan et al. 2007). The inertia theorem, so much disdained by managers, puts the heretic view forward that organizations' being inert is a selection advantage under certain conditions. One of its explanations points out that adaptive moves do not affect average population fitness when environmental change lacks recognizable patterns. Since adaptation involves $rc > 0$ process costs, the advantage would be with those idle firms, if such exist, that match future environmental conditions by chance (s_3 , s_7 , Figure 2). For example, the anthrax threats after 9/11 might have boosted the fortunes of gas-mask suppliers even without their making any adaptive market moves (beyond, of course, increasing their production). Firms plagued with high structural inertia are more likely to refrain from adaptive moves; consequently, the happen-to-be-fit specimen from this group will be over-represented among the winners when unpredictable market conditions block rational adaptation moves (Hannan and Freeman 1984).

No belief assumption prevents B from seeing scenarios s_1 , s_4 , s_6 , and s_8 (Figure 2) From now on, we focus on these four outcomes. Note that scenario s_1 (B catches up by imitating A 's successful move) depicts an adaptive sequence of the *Red Queen competition* observed in many industries (Van Valen 1973, Barnett 2008, Barnett and Sorenson 2002, Barnett and Pontikes 2008). The Red Queen evolutionary theory posits that though surviving species/ organizations learn to adapt better with time, but as their rivals also adapt in the course of ongoing competition, relative positions between survivors sustain.

Table 4 displays that while B can count on a middle-of-the road result (0) when opting for imitation ($s_{1,6}$), it has either positive (s_8) or negative (s_4) relative score to A when it withholds, depending on the failure/success of first-mover A 's merger move. In the latter case, B compares

the *expected values* of the relative scores of s_4 and s_8 . Since B has no clue if A 's move will succeed, we assume that B assigns the same subjective probability to s_4 (A succeeds) and to s_8 (A fails) by default (Assumption 8). Consequently, the expected value is the average of the two scores. Formalizing these considerations brings Lemma 3 about, see the premise details in the Appendix.

ASSUMPTION 8. $\mathbf{B}\{p(s_4) = p(s_8)\}$

(*Read.* B believes that the probabilities of outcomes s_4 and s_8 are equal.)

LEMMA 3. $\mathbf{B}\{Holds(s_{1,6}) \rightarrow rel.score(B) = 0 \wedge Holds(s_{4,8}) \rightarrow rel.score(B) = (2rc - \bar{f}i)/2\}$

(*Read.* B believes that if either scenario s_1 or s_6 hold (engaging), then B 's relative score to A is 0, while if s_4 or s_8 hold (withholding), then B 's relative score to A is $\frac{2rc - \bar{f}i}{2}$.)

From Lemma 3 follows that B expects higher relative score in case of merger engagement ($s_{1,6}$) than for withholding ($s_{4,8}$) whenever B believes that $\bar{f}i > 2rc$ holds. This constraint is certainly not satisfied for all possible reorganizations. But it is likely to be satisfied in our context of investigation. The prominent mergers and acquisitions have been taking place in high profit margin markets (Scherer 2006). Note further more that if $\bar{f}i > 2rc$ does not apply in a given market, B still can believe it does. Psychological hypes associated with merger waves can increase expectations of reaping high benefits in an unrealistic manner while letting managers underestimate the difficulties. The hope that the cost of reorganization occur once while the induced fitness improvements last long may open the expected $\bar{f}i - rc$ gap even larger. Assumption 3*, a stronger version of Assumption 3, puts forward the result of these beliefs.

ASSUMPTION 3*. $\mathbf{B}\{\bar{f}i > 2rc\}$

(*Read.* B believes that the value of $\bar{f}i$ fitness advantage is more than two times larger than rc reorganization costs.)

The extended premise set implies B 's preferences over the four scenarios it perceives (Theorem 3): B prefers engaging in a merger ($s_{1,6}$) to withholding ($s_{4,8}$).

THEOREM 3. *Prefers*($B, s_{1,6}, s_{4,8}$).

(*Read.* Firm B prefers basic scenario s_1 or s_6 over if s_4 or s_8 .)

Now, we have started with the complete set of possible scenarios and have arrived to the same result as the original minimax-regret model with its focus limited to α and β . In summary, all outcomes that suggest withholding from imitation tend to be overlooked by prospective follower firm B , at least whenever our premise set holds. In times when market conditions are unpredictable, costly adaptive moves do not improve fitness probabilities, thus making abstaining the optimal strategy. But once perception bias has limited B 's consideration set, its rational calculations concerning the residual scenario set will suggest engagement. Finally, Theorem 4 informs what could be a better choice for B . Non-biased decision-makers of B would compare composite scenario $s_{1,2,5,6}$ ('engage' cases) to $s_{3,4,7,8}$ ('withhold' cases) and would find to be better off when withholding:

THEOREM 4. *Better_off*($B, s_{3,4,7,8}, s_{1,2,5,6}$)

(*Read.* B is better off with composite scenario $s_{3,4,7,8}$ (withhold) than with composite scenario $s_{1,2,5,6}$ (engage).)

4. Concluding Remarks

Separating beliefs from facts, the logical model helped identifying a possible dynamics that drives decision-makers towards ungrounded imitative moves, which in aggregation drive markets towards malfunctioning. Logical formalization normally does not provide the unique set of premises for a given outcome. But just like business tenders do, it sets a clear 'price' in terms of model constraints captured by the premises for getting certain outcomes as theorems. Taking our model as a basis, experimentation may continue to derive outcomes from alternative sets of premises that stand for possible alternative interpretations of the natural language theory under investigation. The application of our approach may also contribute to seeing malfeasance in and of organizations differently. Instead of thinking about malfeasance in terms of decision-makers morally dubious acts, our approach suggests that undesirable organizational behavior may simply be a consequence of the setting in which organizations live. Since the precise implications of organizational actions are sometimes largely unknown, organizations – be they firms, investment funds, or private equity partnerships – may end up focusing collectively on the 'wrong' side of the economy.

References

- Barnett, W. P. 2008. *The Red Queen Among Organizations: How Competitiveness Evolves*. Princeton University Press, Princeton.
- Barnett, W. P., G R. Carroll, 1995. "Modeling internal organizational change," *Annual Review of Sociology* **21**: 217-237.
- Barnett, W.. P., E. G. Pontikes, 2008. "The Red Queen, success bias, and organizational inertia," *Management Science* **54**(7): 1237-1251.
- Barnett, W. P., O. Sorenson, 2002. "The Red Queen in organizational creation and development," *Industrial and Corporate Change* **11**: 289-325.
- Bikker, J. A., K. Haaf, 2002. "Competition, concentration and their relationship: An empirical analysis of the banking industry," *Journal of Banking and Finance* **26**: 2191-2214.
- Boone, C., W. Hendriks, 2009. "Top management team diversity and firm performance: moderators of functional-background and locus-of-control diversity," *Management Science* **55**(2): 165-180.
- Bruggeman, J. P., I. Vermeulen, 2002. "A logical toolkit for theory (re)construction," *Sociological Methodology* **32**: 183-217.
- DiMaggio, P. J., W. W. Powell, 1983. "The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields," *American Sociological Review* **48**: 147-60.
- Gamut, L. T. F. 1991a. *Logic, Language and Meaning, Volume 1: Introduction to Logic*. Chicago University Press, Chicago.
- Gamut, L. T. F. 1991b. *Logic, Language and Meaning, Volume 2: Intensional Logic and Logical Grammar*. Chicago University Press, Chicago.

Gugler, K., D. C. Mueller, B. B. Yurtoglu, 2005. „The determinants of merger waves,” Research paper, Utrecht University, School of Economics.

Hambrick, D. C. 2007. “Upper echelons theory - an update,” *Academy of Management Review* **32**(2): 334-343.

Hannan, M. T., J. Freeman. 1977. “The population ecology of organizations,” *American Journal of Sociology* **82**: 929-964.

Hannan, M. T., J. Freeman, 1984. “Structural inertia and organizational change,” *American Sociological Review* **49**: 149-164.

Hannan, M. T., L. Pólos, G. R. Carroll, 2007. *Logics of Organization Theory: Audiences, Codes, and Ecologies*. Princeton University Press, Princeton.

Herzig, A, D. Longin, 2003. “On modal probability and belief,” in. *Symbolic and Quantitative Approaches to Reasoning with Uncertainty, Lecture Notes in Computer Science*, Volume 2111. J. G. Carbonell, J. Siekmann (eds), 62-73. Springer, Berlin, Heidelberg.

Hiller, N. J., D. C. Hambrick, 2005. “Conceptualizing executive hubris: The role of (hyper) core self-evaluations in strategic decision-making,” *Strategic Management Journal* **26**: 297-319.

Hsu, G., M. T. Hannan, L. Pólos, 2011. “Typecasting, legitimation, and form emergence: A formal theory,” *Sociological Theory* In press.

Kamps, J., L. Pólos, 1999. “Reducing uncertainty: A formal theory of ‘Organizations in Action’,” *American Journal of Sociology* **104**(6): 1774-1810.

Kuilman, J., I. Vermeulen, J. Li, 2009. “The consequents of organizer ecologies: A logical formalization,” *Academy of Management Review* **34**: 253-272.

Lakatos, I. 1976. *Proofs and Refutations*. Cambridge University Press Cambridge.

Lane C., R. Bachmann (eds) *Trust Within and Between Organizations: Conceptual Issues and Empirical Application.*, Oxford University Press, US.

McCune, W. *Prover9 and Mace4*. Theorem-prover software manual and download.
<http://www.cs.unm.edu/~mccune/mace4>

Nelson, R. R, S. G. Winter, 1982. *An Evolutionary Theory of Economic Change*. Belknap Press, Cambridge, MA.

Péli, G. 1997. "The niche hiker's guide to population ecology: A reconstruction of niche theory using logic," *Sociological Methodology* **27**: 1-46.

Péli, G. 2009. "Fit by founding, fit by adaptation: Reconciling conflicting organization theories with logical formalization," *Academy of Management Review* **34**: 343-360.

Péli, G., L. Pólos, and M. T. Hannan, 2000. "Back to inertia: Theoretical implications of alternative styles of logical formalization," *Sociological Theory* **18**: 193-213.

Pólos, L., M. T. Hannan, G. R. Carroll, 2002. "Foundations of a theory of social forms," *Industrial and Corporate Change* **11**(1): 85-115.

Pólos, L., M. T. Hannan, G. Hsu, 2010. "Modalities in sociological arguments," *Journal of Mathematical Sociology* **34**(3): 201-238.

Pryor, F. L. 2001. "Dimensions of the worldwide merger boom," *Journal of Economic Issues* **35**: 825-840.

Thompson, J. D. 2003. [1967]. *Organizations in Action: Social Science Bases of Administrative Theory*. Transaction Publishers, New Brunswick, NJ.

Schenk, H. 1996. "Bandwagon mergers, international competitiveness, and government policy," *Empirica* **23**: 255-278.

Schenk, H. 2006. "Mergers and concentration policy," in. *International Handbook of Industrial Policy*. P. Bianchi, S. Labory (eds), 153-159. Edward Elgar., Cheltenham.

Schenk, H. 2008. "Firms, managers and restructuring: implications of a social economics view," in. *The Elgar Companion to Social Economics*. J. B. Davis, W. Dolfsma (eds), 348-369. Edward Elgar, Cheltenham.

Scherer, F. M. 2006. "A new retrospective on mergers," *Review of Industrial Organization* **28**(4): 327-341.

Simon, H. A. 1955. "A behavioral model of rational choice," *Quarterly Journal of Economics* **69**: 99-118.

Town, R. J. 1992. "Merger waves and the structure of merger and acquisition time-series," *Journal of Applied Econometrics* **7**: 83-100.

Van Valen, L. 1973. "A new evolutionary law," *Evolutionary Theory* **1**: 517-547.

Table 1 Denotations of the Logical Language

Logical connectives, in order of their decreasing binding strength

\neg (Negation), \wedge ('And'), \vee (Inclusive 'or'), \rightarrow (Implication, 'if ... then'),
 \leftrightarrow (Bi-implication, 'if and only if')

Quantors

\forall - Universal quantification ('For all')
 \exists - Existential quantification ('There exists')

Modal operators over sentence ψ

$\mathbf{B}\psi$ - B believes that ψ holds, $\mathbf{K}\psi$ - B knows that ψ holds

Proper names

A - First-mover firm A
 B - Potential follower firm B
 f_i - The fitness after successful M&A
 rc - The reorganization process costs of the M&A
 α, β - Scenarios α and β
 $s_i, s_{i,j}$ - Basic scenario i , composite scenario of s_i and s_j
 $0, 2, 4$ - Integers 0, 2, and 4.

Predicates

$Better_off(z, x, y)$ - z is better off with x than with y
 $Composite(x, y, z)$ - x is the composite scenario of y and z
 $Firm(x)$ - x is a firm
 $Fit(x)$ - x is fit
 $Imitates(x, y)$ - x imitates y
 $Indiff(z, x, y)$ - z is indifferent w.r.t. the choice between x and y
 $Holds(x)$ - x holds
 $Opts(x)$ - x opts for M&A
 $Prefers(z, x, y)$ - z prefers x to y
 $ReorgCost(x)$ - x has reorganization process cost
 $Scen(x)$ - x is a scenario
 $=, >, \in$ - Equal to, larger than, element of

Functions

$f(x)$ - The fitness of x
 $min(x)$ - Minus x
 $r(x)$ - The reorganization costs of x
 $rel.score(x)$ - The score of x relative to A
 $score(x)$ - The score of x
 $p(x)$ - The probability of x
 $+, -, \cdot, /$ - Arithmetic operations
 \setminus - Set theoretic difference

Note. We adopt the convention of omitting universal quantification from the beginning of formulae. Existential quantification (\exists) does not occur in the current model version.

Table 2 The Focal Logic Premises

ASSUMPTION 1. **B**{ $Firm(x) \wedge \neg Opts(x) \rightarrow \neg Fit(x)$ }

ASSUMPTION 2. **B**{ $Firm(x) \wedge Firm(y) \wedge Imitates(y, x) \rightarrow (Fit(x) \rightarrow Fit(y)) \wedge (\neg Fit(x) \rightarrow \neg Fit(y))$ }

ASSUMPTION 3. **B**{ $fi > rc$ }

ASSUMPTION 4. $\forall \varphi [\varphi \in S \setminus \{A1, A2, A3\} \rightarrow \mathbf{K}\varphi]$

ASSUMPTION 5. $Firm(x) \rightarrow (Opts(x) \leftrightarrow ReorgCost(x))$

ASSUMPTION 6. $Opts(A) \rightarrow (Opts(B) \leftrightarrow Imitates(B, A))$

ASSUMPTION 7. $Scen(x) \wedge Scen(y) \wedge (Holds(x) \rightarrow rel.score(B) = w_1) \wedge (Holds(y) \rightarrow rel.score(B) = w_2)$
 $\rightarrow (w_2 > w_1 \rightarrow Better_off(B, y, x)) \wedge (w_2 = w_1 \rightarrow Indiff(B, y, x))$

ASSUMPTION 8. **B**{ $p(s_4) = p(s_8)$ }

Table 3. Definitions for the Eight Basic s_i Scenarios

$Holds(s_1) \leftrightarrow Opts(A) \wedge Fit(A) \wedge Imitates(B, A) \wedge Fit(B)$

$Holds(s_2) \leftrightarrow Opts(A) \wedge Fit(A) \wedge Imitates(B, A) \wedge \neg Fit(B)$

$Holds(s_3) \leftrightarrow Opts(A) \wedge Fit(A) \wedge \neg Imitates(B, A) \wedge Fit(B)$

$Holds(s_4) \leftrightarrow Opts(A) \wedge Fit(A) \wedge \neg Imitates(B, A) \wedge \neg Fit(B)$

$Holds(s_5) \leftrightarrow Opts(A) \wedge \neg Fit(A) \wedge Imitates(B, A) \wedge Fit(B)$

$Holds(s_6) \leftrightarrow Opts(A) \wedge \neg Fit(A) \wedge Imitates(B, A) \wedge \neg Fit(B)$

$Holds(s_7) \leftrightarrow Opts(A) \wedge \neg Fit(A) \wedge \neg Imitates(B, A) \wedge Fit(B)$

$Holds(s_8) \leftrightarrow Opts(A) \wedge \neg Fit(A) \wedge \neg Imitates(B, A) \wedge \neg Fit(B)$

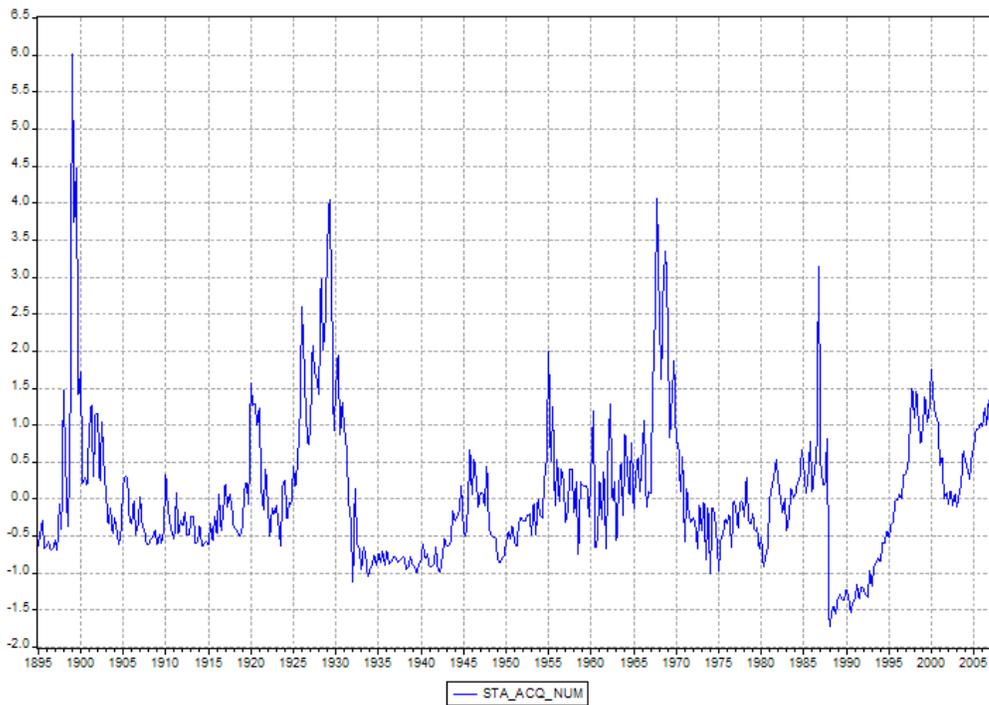
Note. Scenarios under which B opts for imitation (chooses M&A) are in bold.

Table 4 Relative Scores of B in the Eight Basic Scenarios in Decreasing Order ($f_i > rc$)

Scenario	s_7	s_5	s_8	s_3	s_6	s_1	s_4	s_2
B 's rel. score	$f_i + rc$	f_i	rc	rc	0	0	$rc - f_i$	$-f_i$

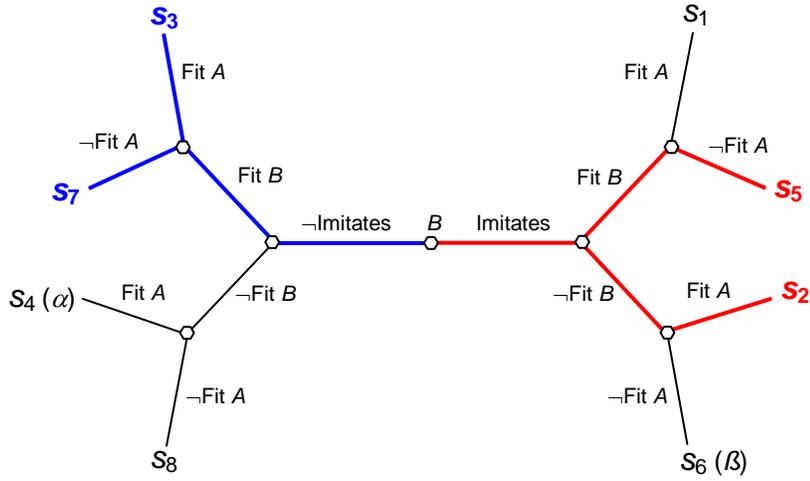
Figure 1

Spliced and Normalized Frequencies of Merger/Acquisition Series for the United States



Note. Data for 1895-1987 comes from Town (1992), while for 1988-2007 are based on the Thomson ONE Banker database: <http://banker.thomsonib.com>.

Figure 2 *B*'s Decision-Making Tree



Note. Beliefs captured by Assumption 1 and 2 exclude, respectively, the blue and red branchings, so that B perceives scenario $\alpha = s_{3,4}$ as s_4 , and $\beta = s_{5,6}$ as s_6 .

Appendix

Table A1 Premises on Research Context and Arithmetic

A1.1	$Firm(A) \wedge Firm(B)$
A1.2	$Scen(A) \wedge Scen(B) \wedge Scen(s_i) \wedge Scen(s_{i,j}) \wedge Scen(s_{i,j,k,l})$ for $i, j, k, l = 1, \dots, 8$
A1.3	$fi > 0 \wedge rc > 0$
A1.4	$score(x) = f(x) - r(x) \wedge rel.score(B) = score(B) - score(A)$
A1.5	$Fit(x) \leftrightarrow f(x) = fi \wedge \neg Fit(x) \leftrightarrow f(x) = 0$
A1.6	$ReorgCost(x) \leftrightarrow r(x) = rc \wedge \neg ReorgCost(x) \leftrightarrow r(x) = 0$
A1.7	Symmetry of indifference. $Indiff(x, y, z) \leftrightarrow Indiff(x, z, y)$
A1.8	Transitivity, 'being better off'. $Better_off(x, y, z) \wedge Better_off(x, v, y) \rightarrow Better_off(x, v, z)$
A1.9	Composite scenarios. $Composite(s_{i,j}, s_i, s_j) \wedge Composite(s_{i,j,k,b}, s_{i,j}, s_{k,l})$
A1.10	Composite scenarios' relative score is the average of the pertaining, equally likely, basic scenarios' relative scores. $p(s_i) = p(s_j) \wedge Composite(s_{i,j}, s_i, s_j) \wedge$ $(Holds(s_i) \rightarrow rel.score(B) = x) \wedge (Holds(s_j) \rightarrow rel.score(B) = y)$ $\rightarrow (Holds(s_{i,j}) \rightarrow rel.score(B) = (x + y)/2)$
A1.11	$(Holds(s_i) \rightarrow rel.score(B) = x) \wedge (Holds(s_j) \rightarrow rel.score(B) = x)$ $\rightarrow (Holds(s_{i,j}) \rightarrow rel.score(B) = x)$
A1.12	Transitivity of inequality. $x > y \wedge y > z \rightarrow x > z$
A1.13	$\neg(x > y) \leftrightarrow y > x \vee y = x$
A1.14	$x \gg y \rightarrow x > y$
A1.15	$x + 0 = x \wedge x - x = 0$
A1.16	$x + y = x - y \leftrightarrow y = 0$
A1.17	$x = y \leftrightarrow x + z = y + z \wedge x > y \leftrightarrow x + z > y + z$
A1.18	$x + min(x) = 0 \wedge min(min(x)) = x$
A1.19	$x - y = x + min(x)$
A1.20	Addition is commutative. $x + y = y + x$
A1.21	Addition is associative. $(x + y) + z = x + (y + z)$
A1.22	Minus operation is distributive. $min(x + y) = min(x) + min(y)$
A1.23	On multiplication. $x + x = 2 \cdot x$
A1.24	On division. $0 > x \leftrightarrow 0 > x/2$

Table A2 Modal operators

For formulae φ and ψ :

- | | | |
|------|--|--|
| A2.1 | $\mathbf{B}\varphi \wedge (\varphi \rightarrow \psi) \rightarrow \mathbf{B}\psi$ | - Belief reports are closed under logical deduction. |
| A2.2 | $\mathbf{B}\varphi \rightarrow \neg \mathbf{B}\neg\varphi$ | - Beliefs are consistent. |
| A2.3 | $\mathbf{B}\varphi \wedge \mathbf{B}\psi \rightarrow \mathbf{B}(\varphi \wedge \psi)$ | |
| A2.4 | $\mathbf{B}\varphi \rightarrow \mathbf{B}\mathbf{B}\varphi \wedge \neg \mathbf{B}\varphi \rightarrow \mathbf{B}\neg \mathbf{B}\varphi$ | - Introspection. Agents are aware of their beliefs. |
| A2.5 | $\mathbf{K}\varphi \rightarrow \mathbf{B}\varphi$ | - Knowing involves believing what is known. |

Ending the Wave

How does the system get out the wave? Most likely: targets become too expensive as (a) market values become exuberant due to explosive activity; and (b) takeover premiums above market value increase along the wave (the number of remaining targets declines with increasing appetite) while real efficiency gains that could fuel ongoing “wrong” behavior remain at bay. Managers gradually adjust their expectations accordingly, so assigning a higher p subjective probability to failure than to success than they had done before. In model terms, B would only opt for imitation if it expects $f_{i_B} > \frac{rc_B}{1-p}$ to hold. The derivation is as follows.

Table A3 rewrites the data of Table 2 (main text) for the general case, i. e., when both f_i and rc can differ for A and B . The condition that $s_{1,6}$ (B imitates) has higher expected relative score value than $s_{4,8}$ (B withholds) at an observed merger success probability p is expressed as:

$$p(rc_A - rc_B) + (1-p)(f_{i_B} - f_{i_A} + rc_A - rc_B) > p \cdot rc_A + (1-p)(rc_A - f_{i_A}).$$

This gives: $f_{i_B} > \frac{rc_B}{1-p}$. For example, for $p = 2/3, 3/4$ and $4/5$, respectively, satisfying this

inequality, and so opting for imitation, requires that managers expect three, four and five times higher fitness benefits than reorganization. Expecting high $1-p$ failure probability is likely to block mergers beyond a threshold.

Table A3 Relative Scores of Firm *B* in the Eight Basic Scenarios when \tilde{f}_i or rc Can Be Different for *A* and *B*.

Scenario	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8
<i>B</i> 's Rel. score	$\tilde{f}_B - \tilde{f}_A - rc_B + rc_A$	$rc_A - rc_B - \tilde{f}_A$	$\tilde{f}_B - \tilde{f}_A + rc_A$	$rc_A - \tilde{f}_A$	$\tilde{f}_B - rc_B + rc_A$	$rc_A - rc_B$	$rc_A + \tilde{f}_B$	rc_A

Evaporating first-mover advantages may also make *B* realize that benchmarking on successful practices would not likely improve its chances. In model terms, the fitness-facilitating part of belief Assumption 2 would not hold, whilst its claim on the detrimental effect of imitating bad practice would sustain. This change would allow *B* to perceive s_2 , but not s_5 (Figure 2, main text). Comparing then *B*'s expected relative scores for the perceived $s_{1,2,6}$ (imitation) and $s_{4,8}$ (abstaining) for that case (and as before, keeping p equal in branches 1, 2, 6 and also in 4, 8) reveals that *B* must expect $\tilde{f}_i > 6rc$ to hold to choose imitation above abstaining.