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Effects of sticky reputation in organizational learning

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Dmitry Alabyan BSc

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1. Abstract (German)

Diese Arbeit untersucht, wie „klebrige Reputationen“ – hartnäckige und manchmal veraltete Vorstellungen von Expertise – das Lernen und die Anpassungsfähigkeit von Organisationen beeinflussen. Aufbauend auf James G. Marchs (1991) grundlegendem Explorations- und Exploitationsmodell führt die Forschung einen aktualisierten Simulationsrahmen ein, der zwischenmenschliche Kommunikation, Reputationsträgheit und Expertenhierarchie berücksichtigt. Das überarbeitete Modell zielt darauf ab, Organisationsdynamiken zu erfassen, die in der sich ständig verändernden realen Welt besser anwendbar sind.

Eine Reihe von Experimenten untersucht, wie Organisationen unter verschiedenen Konfigurationen lernen: unterschiedliche Sozialisationsgrade und die Mechanismen selbst, Expertenbeförderungen, Umweltschocks und deren Zeitpunkt. Die Ergebnisse veranschaulichen, wie zwischenmenschliche Netzwerke die kurzfristige Wissensverbreitung beschleunigen, aber auch unkontrolliert mit den Organisationszielen kollidieren können. Darüber hinaus kann die Förderung von Experten zur Stabilisierung des Wissensprozesses beitragen, allerdings nur, wenn der Einfluss gut dosiert und zeitgerecht erfolgt. Umweltstörungen, selbst moderate, zeigen langfristige negative Auswirkungen, und ein strategischer Zeitpunkt interner Umstrukturierungen erweist sich für eine effektive Erholung als entscheidend.

Die Ergebnisse bieten praktische Auswirkungen auf die Organisationsgestaltung und unterstreichen die Bedeutung eines Gleichgewichts zwischen horizontalen und vertikalen Lernstrukturen sowie die Notwendigkeit einer kritischen Neubewertung von Fachwissen in sich schnell verändernden Umgebungen.

2. Abstract (English)

This thesis investigates how “sticky reputations” — persistent and sometimes outdated perceptions of expertise — influence organizational learning and adaptability. Drawing on James G. March’s (1991) foundational model of exploration and exploitation, the research introduces an updated simulation framework that incorporates interpersonal communication, reputational inertia, and expert hierarchy. The revised model aims to capture organizational dynamics that are more applicable in the constantly changing real world.

A series of experiments explore how organizations learn under different configurations: varying degrees of socialization and the mechanisms themselves, expert promotions, environmental shocks and their timing. Results illustrate how interpersonal networks can accelerate short-term knowledge diffusion, but also misallign with organizational goals when left unchecked. Additionally, expert promotion can assist in the stabilization of the knowledge process, but only when influence is well-calibrated and timely. Environmental disruptions, even moderate ones, demonstrate long-term negative effects, and strategic timing of internal restructuring proves essential for effective recovery.

The findings offer practical implications for organizational design, highlighting the importance of balancing horizontal and vertical learning structures and the need for critical re-evaluation of expertise in fast-changing environments.

3. Introduction

Reputation has a significant impact on both individual and organizational processes. Over time, it has ceased to be a simple concept formed by public opinion, becoming a key strategic asset shaping the organization's success. People considered experts in certain fields often gain significant influence within organizations, which empowers them to set the course of strategic development at their discretion and will. However, this raises the question of the quality and relevance of such expertise, especially in a modern economy, dynamic and highly dependent on information flows. And this is what brings us to the concept of “sticky reputations”, resistant to change over time. Such reputations can serve both as a strategic advantage as well as a significant risk for organizations operating in volatile market conditions. (Fombrun, 1996). This problem poses even a greater issue, when a person's authority exceeds his actual expertise or when his knowledge becomes irrelevant. (Tetlock, 2005; Flynn et al., 2006). Along with extensive previous research on organization's ability to balance exploration and exploitation by the academia, this thesis aims to look at it at a different angle, mimicking real-world scenarios, to examine the effect of such a reputational phenomenon on organizational learning.

To reveal it for further analysis, the simulation model of March was taken as a basis, modified by including mechanisms illustrating the stability of individual reputations and their influence on decision-making processes in organizations. This extended model analyses the impact of reliance on so-called 'experts' on organisational learning processes, which some scholars beleive to lead to inefficiency, resistance to change and reduced adaptability of organisations (Argote, 2012; Levitt & March, 1988). Retaining the key functions of its predecessor, the model also allows for the simulation of different scenarios to explore how organizations can effectively balance exploration and exploitation in the face of varying degrees of reputational resilience and market volatility.

This paper thus seeks to link theoretical approaches with practical applications of the concepts of reputation and organizational learning, trying to imitate use-cases of a more realistic environment, highlighting the complex interaction between individual influence and collective learning outcomes.

Organizations that fail to critically evaluate the foundations of their learning process risk stagnation and missed opportunities for innovation. Though the paper does not seek to introduce a universal optimal solution, the findings aim to contribute to the long-ongoing question of organizational optimization, mitigating or, at the very least, pinpointing the risks associated with over-reliance on established reputations, while ensuring a more balanced and dynamic approach to learning and adaptation.

4. Literature Overview

4.1. Problem of "Sticky Reputations"

Reputation is an important resource in an organizational setting, often serving as an indicator of competence and trustworthiness. Researchers in fields ranging from organizational behavior to general psychology have studied the dynamics of reputations and their impact on the behavior of individuals and groups. Pfeffer and Salancik back in 1978 note that people with significant accumulated reputational capital tend to be perceived as more authoritative and influential, regardless of their current performance. Such reputational inertia can lead to the increased risk of relying on obsolete knowledge, even more so in organizations where reputational hierarchies have a measurable impact on decision-making process. And this is one of the first touchpoints in managerial science, where "sticky reputations" are defined.

This reputational phenomenon has been examined in multiple studies, aiming to uncover the psychological and cultural mechanisms behind it. Mentioned in this section are but only a few, illustrating the variety of factors found to be influential in forming such a precedent in the first place. Kahneman and Tversky's (1979) prospect theory states that people are prone to an anchoring bias, making it difficult for them to revise their assessments of others even in light of new information. Similarly, Hofstede's (1980) research emphasizes that certain types of organizational cultures (notably hierarchical and collectivistic ones) further enhance the entrenchment of reputations due to authority figures and established norms being essential elements of these cultures. Another significant factor that helps to strengthen reputations is related to the role of social networks. Research by Burt (1992) shows that people occupying central positions in social networks maintain their reputational status even when their direct contribution declines. This concept leveraging of network connections to create an influence on the processes has been used as one of the mechanisms in the elaborated model described further in the paper.

As becomes visible, the concept is not unheard of and can be looked at from different angles, primary ones being sociological and phsychological. Needs to be mentioned, of course, that managerial science has also taken an interest to this phenomenon, but rather as a corporate asset to take leverage of. As such, meta-review by Lange (2011) suggests that generalized favourability of long-existing corporations can create a “halo effect”, leading to consumers overlooking flaws in the produce, which would not be the case for less prominent companies. Pollock (2015) elaborates on this topic, providing research about VC firms and their “blockbuster deals”. The paper confirms that these deals can serve as an elevator for small and young companies, earning them status and acknowledgment, access to new information, opportunities and resources. And it can also act as an enhancer of a reputation for established funds with known performance track record.

Stepping away from the macro perspective, the same phenomenon among people has become known as the Matthew effect (Merton, 1968). The idea in focus was that high-status scientists will get more credit for a new discovery than a low-status scientist with an equivalent result. This paper will take a deeper look at the more narrowed understanding of professional reputation, the one connected with individual’s expertise and exerted during interpersonal communications.

The problem of sticky reputations becomes especially relevant in dynamic and knowledge-intensive industries where changes occur rapidly. Efforts to mitigate the impact of sticky reputations have focused on promoting transparency, accountability, and continuous learning. Organizations adopt multiple practices such as peer reviews, performance audits, and rotational leadership roles - all to ensure that reputations align more closely with current contributions and capabilities (Cross & Prusak, 2002). Yet, it is still a vibrant topic in modern society and organizational culture.

Whereas March’s model of organizational learning emphasizes the need to balance between exploration and exploitation, this “stickiness” of reputation can easily disrupt this balance, creating a bias in favor of exploitation and use of established knowledge and authorities. Doing so discourages exploration by limiting the introduction of new ideas. This imbalance may lead to stagnation, reduced innovative potential, and the inability of the organization to respond effectively to changes in the external environment.

4.2 March's Model

March's (1991) model of organizational learning provides a basic framework for understanding how organizations balance exploration and exploitation to successfully adapt and grow. The central elements of the model are individual agents (employees) and organizational code (general knowledge level of the organization). External reality exists independently of individuals and organizational code and is characterized by a set of dimensions (M), each represented by a binary vector. Individuals have their own beliefs about the external world, which are expressed as arrays of values along these dimensions, while the organizational code reflects collective knowledge after incorporating the beliefs and is also expressed as an array. The interaction between these elements determines the process of learning and adaptation within the organization.

The model has several key parameters. The speed of socialization (P1) determines the probability of individuals adopting the perception of external reality by the organizational code, while the speed of organizational learning (P2), on the contrary, regulates the degree of adaptation of the most successful individuals' beliefs by the code. The speed of exploration (P3) illustrates the turnover of personnel, simulating an ecosystem where the knowledge base in the company is updated by the emergence of new individuals in place of the old ones, thus bringing new perspectives. Finally, the parameter of external turbulence (P4) reflects changes in the environment, changing the "correct" values of knowledge and requiring the organization to constantly adapt.

At the beginning of the simulation, the external reality, individual beliefs, and the initial array of zeros for the organizational code are generated. The complexity of reality can be controlled by the number of dimensions M, and the depth of the analysis is provided by the number of simulation iterations. Each iteration can be thought of as a separate company with its own growth cycle, aiming to get as close as possible to the external reality. The more iterations are carried out, the more detailed the picture becomes, although this also increases the duration of the simulation. Such complexity, though, is essential to test the stability of the organization settings in conditions close to the real world, dynamic and unstable, which is why the paper raises the bar from 80 (in the core model) to 200.

At each period of the iteration, individuals adjust their beliefs with probability P1 to those of the organizational code, and randomly in the case of uncertainty. The organizational code learns in its own turn, adopting knowledge from the most successful individuals at a rate of P2. Here, success, or expertise is determined by a history of individuals outperforming others in their beliefs about the external reality in a given period. Parameters P3 and P4 can additionally introduce variability through changes in the composition of employees and the external environment. Over time, the organization can reach an equilibrium in which individual and organizational knowledge coincide, but the quality of this equilibrium depends on the balance between exploration and exploitation. The model structure, its parameters and processes are described in more detail in the appendix. Main takeaway from this brief description should be that focal in any simulation is not just the equilibrium itself, but rather how it is characterized, e.g. by the speed of achieving or the accuracy of knowledge at an equilibrium point. Naturally, these characteristics strongly depend on the model configuration and the focal points of one or the other simulation.

The original model illustrates the difficulties that organizations face in finding the optimal balance. High exploration, driven by P3 and P4, enhances adaptability but can lead to instability. On the other hand, high exploitation, driven by P1 and P2, ensures organizational coherence but carries the risk of stagnation. Thus, March highlights the impact of these processes on the quality of organizational learning, a research that remains a robust foundation for understanding a) the interplay between individuals and the organization and b) the latter's adaptability and resilience in complex and changing environments.

It needs to be noted though, that other adaptations of this model exist, one of the relevant ones to the current topic being that by Simon Rodan in 2005 for the Scandinavian Journal of Management. Though seemingly similar at first glance, the proposed adaptation differs from the current research in its core, as it is centralized around the idea of convergence of individual beliefs (and as such, the possible organizational knowledge level) on those of the policy-making elite. Essentially, the entirety of organizational knowledge, in this manner, comes down to the beliefs of the few, which makes the paper question the mechanisms behind promotion itself, investigating the benefits of different approaches and trying to find a universally desirable one.

On the other hand, this thesis questions not the mechanisms, but the effect of the promotion itself, its variability under different circumstances and the social aspect within the process of organizational learning.

For this research, an open-source recreation of the original model in Python by Maciej Workiewicz (2019) was used as a basis for the model, consisting of a take on the processes mentioned in March's paper as well as some notes by Rodan (2005) and Michael Christensen (2015).

5. Updated Model

The influence of “sticky reputations” on the process of organizational learning is examined in this paper by comparing March’s 1991 basic model, which considers the balance between exploration and exploitation, and its updated version, which introduces interpersonal communication between agents. March's research focuses exclusively on the interaction between the organization (represented by the organizational code) and individual employees, identifying the trade-off between acquiring new knowledge (exploration) and improving existing knowledge (exploitation). This concept plays a key role in understanding the mechanisms of learning and adaptation of organizations (Levinthal & March, 1993; Cohen & Levinthal, 1990).

However, the original model assumes that learning occurs in isolation between the organization and its employees, without explicitly considering interpersonal communication and social dynamics within the team. Although robust and fundamental in its entirety, the research considers an idyllic computing-empowered algorithm of evaluation, foregoing any social aspects, which is far from the setting of the real world. It is in those constant communications within the company that reputations are formed and strengthened, whether justified or not, making space for possible significant changes to the dynamics of learning.

March’s model predicts that organizational performance is primarily a function of the balance between exploration and exploitation, with learning outcomes largely determined by the interplay between the organizational code and individual beliefs. The updated model extends March's approach by integrating mechanisms of communication between agents that allow individuals to interact, share and influence each other's beliefs and knowledge. This approach more accurately reflects real-world contexts in which adaptation and learning occur not only along the vertical organization-to-employee axis but also horizontally within teams and social networks (Nonaka, 1994; Argote & Ingram, 2000). The inclusion of interpersonal communication and social dynamics between employees provides depth and complexity to the picture of organizational learning. Through the addition of perceived experts’ influence, it is possible not only to observe knowledge emerging from collective interactions, but also to understand its distribution among participants. Insights gained from this development tend to suggest that organizations that fail to manage interpersonal dynamics and reputational effects may struggle to achieve optimal learning outcomes, regardless of how effectively they balance exploration and exploitation.

Further research in the paper is, therefore, structured as a set of experiments investigating the model’s behavior under several chosen circumstances, adjusting the levels of stress the organization is going through and the degree of interplay the social interactions bring to the process. The experiments try to consecutively build up on the results of prior findings, gradually adding complexity to the system and analyzing the outcomes along the way.

One of the cornerstone mechanisms in the updated model is the introduction of socialization probabilities. They determine the extent of employees’ inclination to validate their beliefs either with the organizational code or through communication with colleagues. By adjusting these indicators, one is able to explore different scenarios - from the dominance of the organizational code to the prevalence of interpersonal communication. In March's original model, the organizational code is the only source of knowledge and learning for the individuals, simplifying the social reality in which personal relationships play a critical role.

An additional innovation is the inclusion of “sticky reputations” and the role of influential “experts.” In March’s model, all employees are considered equal in their ability to influence the learning process, primarily having influence only over the organizational code, based on their performance in the given period. In the updated version, the influence of individual employees depends on their reputational status, gained at a particular point in time and retained until re-evaluation, and affects other individuals in the organization at a higher rate than that of the communication with the code. Through retention of the “expert” status, the model also takes into account the inertia of reputations, where authority is unelastic regardless of its basis becoming obsolete with time, effects of which will be examined in one of the experiments further. March's original model operates in a more abstract, centralized manner, without regard for the network structure, whereas the revised dynamic aims to reflect the reality in which influential people can exert disproportionate influence more accurately.

For research purposes, the revised model is also updated with another knowledge tracking and depiction mechanism. In the original version, March looked solely at the average equilibrium knowledge level of the organization at different P1 rates, investigating how well the organization can perceive the external reality. The updated model borrows the mechanism of recording knowledge from the Multi-armed Bandit Model, examining the averaged individual knowledge levels at every period within the life cycle of the company, since this is where the effect of interpersonal communications is most visible. For the sake of optimal insight these graphs are limited by 50 periods to capture dynamics of various P1 levels. This has been chosen due to the fact that, by introducing multiple factors to the system, average time until reaching equilibrium levels may increase, but ever so prominently for the lower levels of P1 like 0,1 or 0,2, whereas the middle levels are best observed within the 50-period corridor.

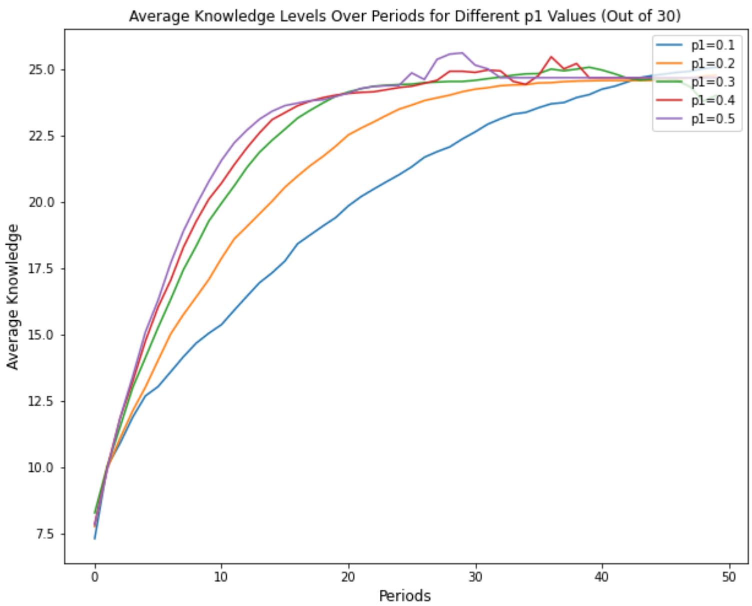

Figure 1. Average Knowledge Levels over time

Although if run in the baseline settings, the revised model provides visibly similar results to the March's original version, once the new variables are taken into account, the results differ significantly, emphasizing additional factors: the strength and structure of interpersonal communication, the role of influential employees, highlighting the reputational inertia. Organizations that do not take these factors into account risk not achieving optimal learning outcomes, even if the balance between exploration and exploitation is formally observed. Thus, the updated model significantly expands March's original concept, supplementing it with social factors and network effects, which makes it more realistic and applicable to real organizational situations.

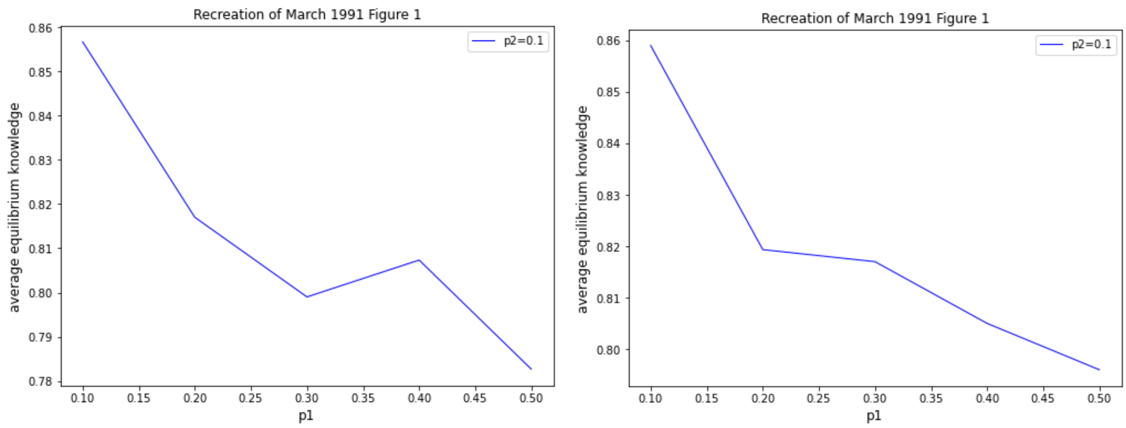

Figure 2. Comparison between Average Equilibrum Knowledge Data in original model (left) and in recreation (right)

6. Analysis

6.1. Introducing Socialization

The original model of organizational learning proposed by March (1991) describes the process as an interaction between the organizational code and employees, in which employees adjust their beliefs to the organizational code and the organization, in turn, learns from the employees with the most performance levels. This first experiment introduces a new dimension, socialization, which allows employees to directly influence each other's beliefs. The updated model includes a new parameter that regulates the likelihood of socialization between employees. It determines whether employees choose to socialize with an organizational code or with each other, denoted as social_prob_org_code and social_prob_groups, respectively. The likelihood of belief appropriation is determined by the same P1 rate, with the levels being the same for both cases of socialization. The baseline scenario sets these probabilities to 0.5, creating a balance between vertical and interpersonal learning. Additionally, an alternative scenario is considered in which the focus is shifted towards interpersonal communication, setting social_prob_groups to 0.9 and social_prob_org_code to 0.1. The organizational learning rate P2 is kept constant at 0.1 (also throughout any further experiment), while the socialization rate P1 is systematically varied from 0.1 to 0.5 to assess its impact on knowledge diffusion and learning outcomes, just as the baseline model did.. March's original setting allowed for variability from 0.1 to 0.9, but higher socialization rate parameters have an inverse relationship with the count of periods before the simulation stabilizes at the equilibrium point, reducing their number. At higher levels of socialization of individuals, this number fluctuates on average around 16-17. Which is why these options will not be considered in this study, since they do not allow sufficient implementation of several intervention mechanisms into the system in a way that it would allow to capture a tangible effect. This is most pronounced in the later experiments, observing a combination of external turbulence and the mechanism of expert promotion.

In the baseline scenario with equal probabilities of socialization, interpersonal communication improves the average level of equilibrium knowledge to some extent compared to March's original model. The effect is particularly pronounced at low values of the P1, supposedly compensating for the slow spread of beliefs through the organizational code. As the socialization rate increases, hierarchical learning mechanisms begin to dominate and the additional benefits of horizontal interactions decrease. These results indicate the complementary nature of hierarchical and interpersonal learning.

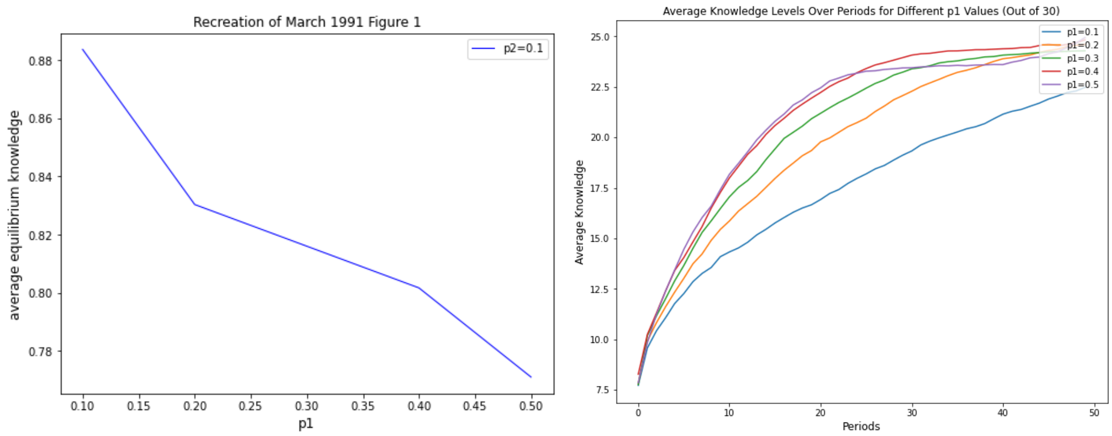

Figure 3. Data from 50/50 socialization scenario

In the 90/10 case (scenario with an emphasis on peer-to-peer communication), the results of the equilibrium level of organizational knowledge are ambiguous. At a marginally low indicator P1 = 0.1, the average level of equilibrium knowledge noticeably drops, while for subsequent indicators the model shows results better than the original one. However, as can be seen from the graph of the individual level of knowledge, this leads to a decrease in the overall role of hierarchical learning and limits the maximum level of knowledge achievable in comparison to the case of an equal probability distribution.Thus, the balance between these two types of socialization appears to be the optimal approach, since an excessive emphasis on interpersonal learning may limit the dissemination of knowledge received from the organizational code. As a result, the knowledge alignment process slows down and agents achieve lower performance values.

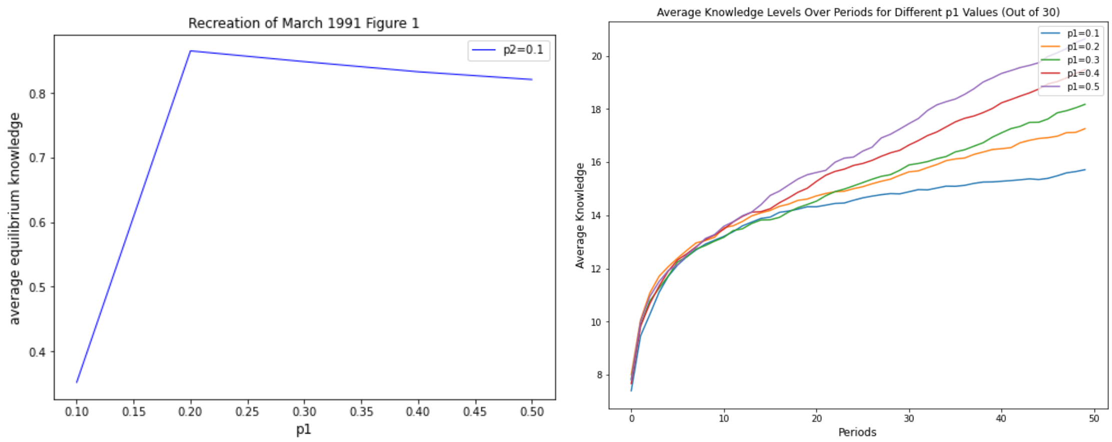

Figure 4. Data from 90(peers)/10(code) scenario

These results indicate that interpersonal communication can indeed accelerate knowledge acquisition in the short term and strengthen relationships between employees, but also warn that excessive use of this approach can hinder the long-term development of the organizational knowledge base. Comparing the scenarios (50/50 and 90/10) highlights the need to consider trade-offs when choosing an approach. Although interpersonal networks have the benefit of functioning independently of the organizational code, such autonomy reduces overall alignment with organizational goals. The same can be found in the foundational paper by Argote and Ingram (2000), which argues that while interpersonal networks facilitate the rapid and rich transfer of knowledge, such channels can lead to knowledge diffusion that bypasses formal structures and the organizational code. This is especially problematic when the organizational code - shared routines, norms, and formal procedures - serves to align local actions with global goals. As a result of this experiment, a balanced approach (50/50) appears optimal, ensuring effective knowledge dissemination and integrating formal and informal networks.

6.2. Promotion by Experience

The next stage of the model's refinement is the introduction of a mechanism for promoting employees with high performance to the role of "experts". These "experts" act as mediators in the learning process, influencing not only the organizational code, as in the original model, but also their fellow agents. The results are compared with the original model as well as the previous experiment, and the foundation is laid down to illustrate the stickiness of reputation.

The promotion mechanism is triggered at the 25th period, when employees with superior results become "experts". Two configurations are tested to assess the impact of "expert" group size: a small group of 5 and an extended group of 25 promoted agents (out of 50 overall, kept consistent with the original model). Having undergone the promotion, the agent begins to exert a stronger influence on his colleagues during socialization, since the influence factor is set at a constant level of 0.7. This means that the probability of accepting the "expert""s beliefs for an individual is significantly higher when interacting with one. Since the speed of socialization with an organizational code varies from 0.1 to 0.5 (leaving out further values until 0.9 from the original setting, as explained previously), the influence of the "expert" on individuals will be noticeable in any version of the scenario. Also, having received such a status, the agent retains it until the end of the iteration during all remaining periods. The P2 rate of organizational learning is held constant, and the remaining parameters are consistent with the baseline and socialization cases.

Compared to the original model, with equal contribution of agents to interpersonal education, the introduction of an expert hierarchy significantly improves knowledge integration. In the 5-expert scenario, the organizational level of knowledge reaches its highest equilibrium due to the focused influence of a small group of highly effective employees. We can also observe improvements in the 25-expert-case, but having a larger and more diverse group of experts also introduces variability, slowing down the knowledge consensus process and slightly lowering the final equilibrium level.

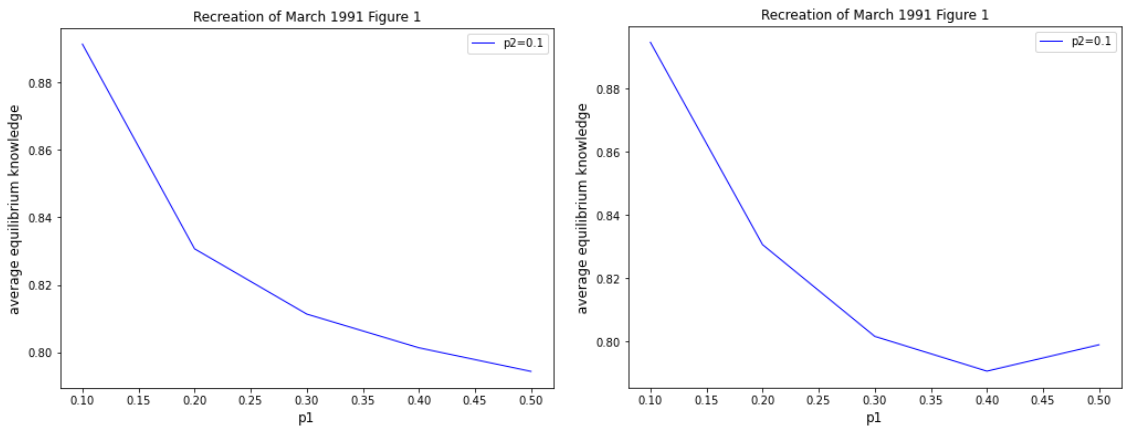

Figure 5. Comparison of Average Equilibrium Knowledge Levels between socialization with no promotion (left) and with promotion present (right)

The impact on individual knowledge levels also differs from both the baseline and socialization scenarios. In the base case, employee knowledge levels converge rapidly but exhibit greater volatility due to the lack of structured learning paths. Which, again, aligns with the statement by Argote in 2012: “Without institutional mechanisms to encode and transmit learning, individual insights are likely to remain isolated, leading to inconsistency across the organization. Structured systems increase reliability and reduce variance in how knowledge is applied”. The introduction of a promotion mechanism slows down the initial convergence, whilst supposedly reflecting a two-stage process: initally, employees are guided by the experts, with the organizational code taking the steering wheel later. In the 5-expert scenario, individual learning paths become smoother and more stable, whereas 25-expert case depicts a slower convergence due to the increased complexity of communication process.

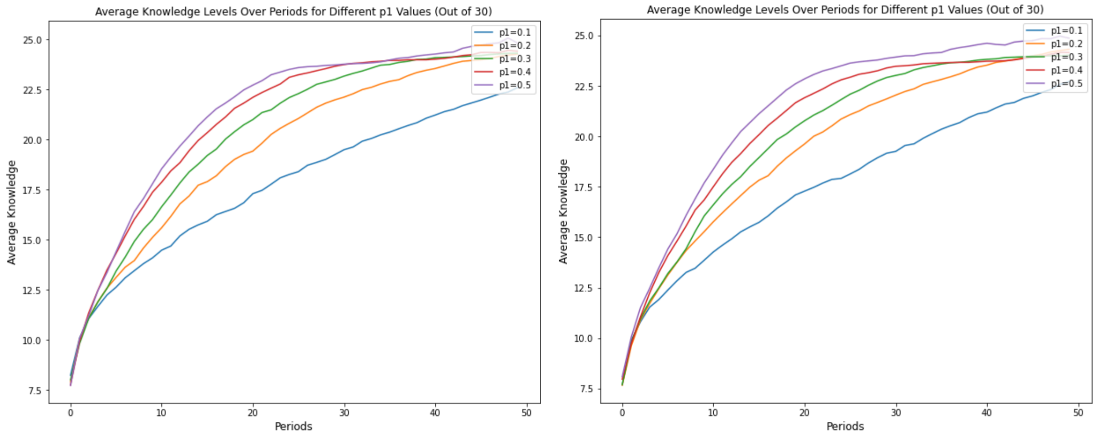

Figure 6. Comparison of Average Knowledge Levels without (left) and with (right) promotion

As for the comparison with the scenario with interpersonal socialization, here too some improvements can be observed, especially at the organizational level. Interpersonal learning allows for distributed adaptation, but lacks the focus and reliability of expert knowledge. It is more pronounced at higher levels of the parameter P1, where a greater group of experts demonstrates a visible jump in efficiency. As for individual knowledge levels, interpersonal learning leads to faster but less stable convergence, whereas the expert model provides an orderly, hierarchical learning process that aligns knowledge trajectories and reduces their fluctuations.

To sum it up, the 5-expert scenario provides a clear advantage by concentrating influence and minimizing variability, resulting in rapid and stable convergence of knowledge at the individual and organizational levels. The 25-expert scenario also provides benefit to some degree, but demonstrates the challenges of managing a larger expert network, where competing opinions can reduce the effectiveness of expert influence. These observations suggest that the effectiveness of expertise advancement depends on the concentration and coherence of the expert group.

6.3. Environmental Interventions

At this stage, the model will be expanded by introducing an external reality shock. Although the original model has a mechanism for this in the form of parameter P3, this parameter is absolute in nature, swapping the signs of all units of the binary array describing external reality. Unlike the original, here a one-time flip of a certain part of external reality is introduced in a pre-determined period during the life cycle of the company. Two scenarios with different intensity of intervention are considered: a moderate change, in which 30% of the parameters of external reality are swapped, and a serious change, with a change of 70% of the parameters. These conditions help in understanding how effectively an organization is able to recover after external shocks, how pronounced the effect is depending on the degree of intervention, and how long its influence lasts.

For this experiment, external interference is introduced once at the 15th period, changing a given percentage of the parameters of external reality, which requires adaptation from the organization, since the initial knowledge of the organizational code and individuals partially loses its relevance. Moderate interference implies a change in 30% of the parameters of the external environment, creating a somewhat controlled intervention, while severe interference changes 70%, causing significant inconsistency. The basic model without external interventions is used as a benchmark for measuring the sustainability of the organization. The absence of interventions in this case allows the organizational code to constantly align with the external reality, forming a stable learning environment where organizational knowledge gradually increases and stabilizes at a high level of equilibrium. Naturally, interventions change this state. After a moderate intervention at period 15, knowledge levels drop noticeably (e.g. 0.6 in the moderate intervention and 0.1 in the extreme case for P1=0.1 against the 0.88 in the stable state) due to the need to quickly adapt to the changed reality. Despite partial recovery, the equilibrium level of knowledge remains lower than in the baseline model, indicating that even moderate interventions negatively affect the organization's ability to recover. The decline in knowledge levels is much more severe and long-term pronounced for the 70%-flip intervention scenario. Since the level of equilibrium knowledge of the organization is calculated from the averaged matching to the state of external reality, in the case of more serious intervention we can observe negative numbers, indicating that the process of organizational learning suffers significantly without any means for restoration to viable levels.

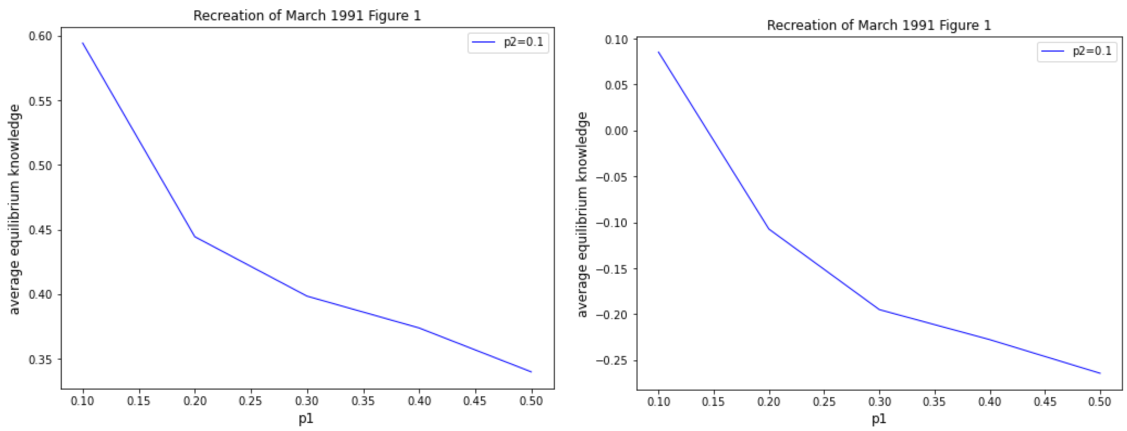

Figure 7. Average Equilibrium Knowledge Data for external interventions case moderate (left) and harsh (right)

Individual knowledge levels show similar trends. In the baseline scenario, employees' knowledge increases steadily, reflecting a stable consecutive alignment with the unchanging external reality. Moderate disruption causes a sharp decline in knowledge, and, although partial recovery occurs, knowledge levels remain below baseline values. Severe disruption causes an even greater decline in knowledge and a significant slowdown in recovery. The greater the intervention percentage, the greater the misalignment of individual beliefs with the new reality, preventing a return to the original state.

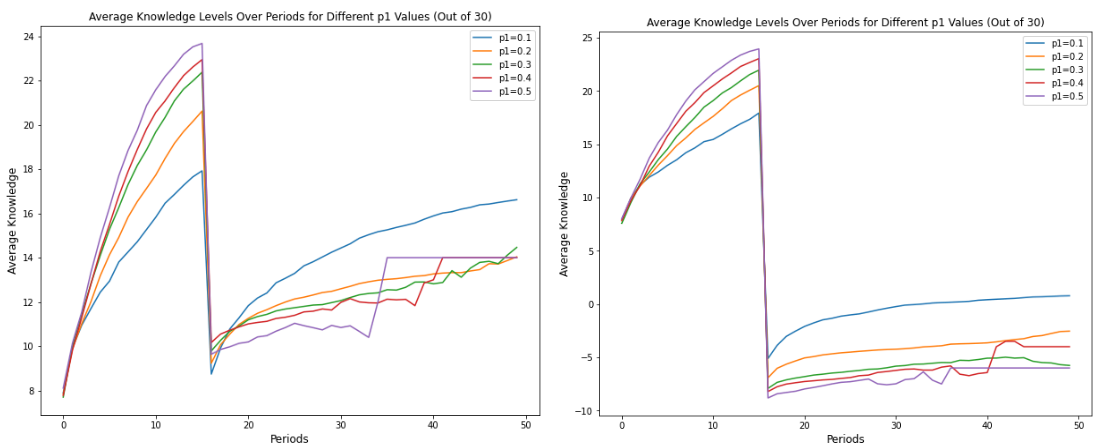

Figure 8. Average Knowledge Levels under effect of moderate (left) and harsh (right) external shocks

The results highlight the long-term effects of even moderate disturbances. The system does not fully recover to its original levels, indicating the persistent impact of external shocks on organizational learning. Comparisons of moderate and severe disturbances show that while moderate disturbances allow partial recovery, severe shocks can lock the organization into a state of lower coherence. The degree of recovery is inversely proportional to the severity of the disturbance, and the most extreme changes lead to long-lasting mismatches. These findings suggest that recovery from external shocks is rarely complete, especially in the face of severe disturbances that can fundamentally alter the learning trajectory.

6.4. The Effect of Promotion Timing on Recovery

This final experiment analyzes how the timing of structural interventions, in particular the promotion of employees within the organization, affects the recovery of knowledge levels after an external shock. The baseline scenario in this context is a situation with the presence of promotion of agents before the onset of the external shock, as well as the shock itself. In the experiment simulations, additional promotions are introduced at different time periods to assess whether they facilitate adaptation to sudden changes or, on the contrary, make it more difficult. The results obtained aim to pinpoint an optimal time corridor for such measures as well as inspect the ability of the organization to restore equilibrium levels of knowledge for the respective cases. For clarity, this experiment studies exclusively individual levels of knowledge in the organization, since they are illustrative on within a time-dependent framework.

The initial promotion of employees occurs in period 10, before the effects of the external shock take effect, thus simulating the stickiness of reputations. A sudden external shock is introduced in period 15, causing an expected sharp drop in knowledge levels due to the organization's need to adapt to the new conditions.

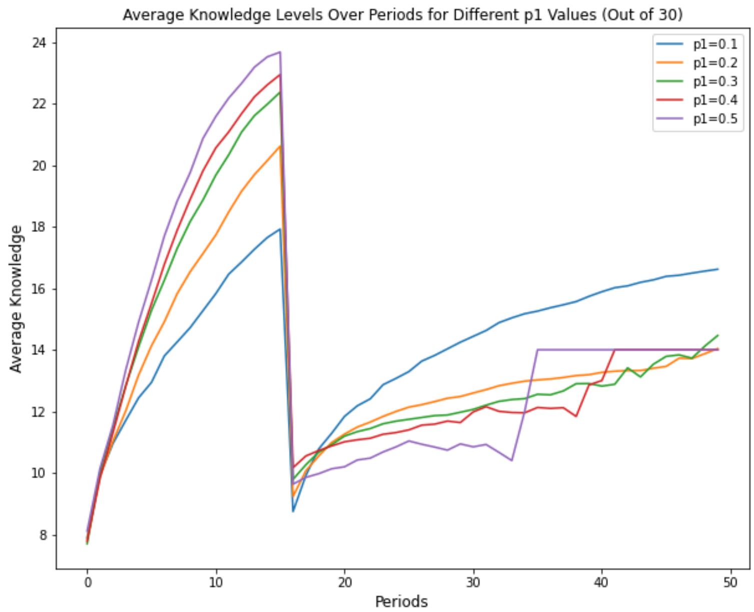

Figure 9. Average Knowledge Levels under shock, with preliminary promotions

To study the role of the timing of promotion within the organization, interventions are implemented in different periods (20, 25, 30, 35, and 40). At these stages the experts selected in period 10 are re-evaluated along with other agents, and a new batch is appointed based on their performance after the shock was introduced.

In the baseline case, knowledge levels rise and stabilize until the shock, after which they decline sharply. The recovery is slow and incomplete, and equilibrium knowledge levels remain below the stable-state levels (as uncovered in the previous experiment), showing the long-term impact of the shock and illustrating the effects of sticky reputations. Here, the experts appointed in period 10 before external shocks remain as such, which means that other individuals are susceptible to the influence of agents noted for merits that may no longer be relevant in light of changes in external reality. Introducing additional promotions at different periods results in different recovery trajectories. Additional promotions at period 20 improve performance relative to the baseline recovery scenario, but recovery is not as effective as with later interventions. Promotions in the 25th period display more noticeable improvement, ensuring better adaptation and retention of knowledge.

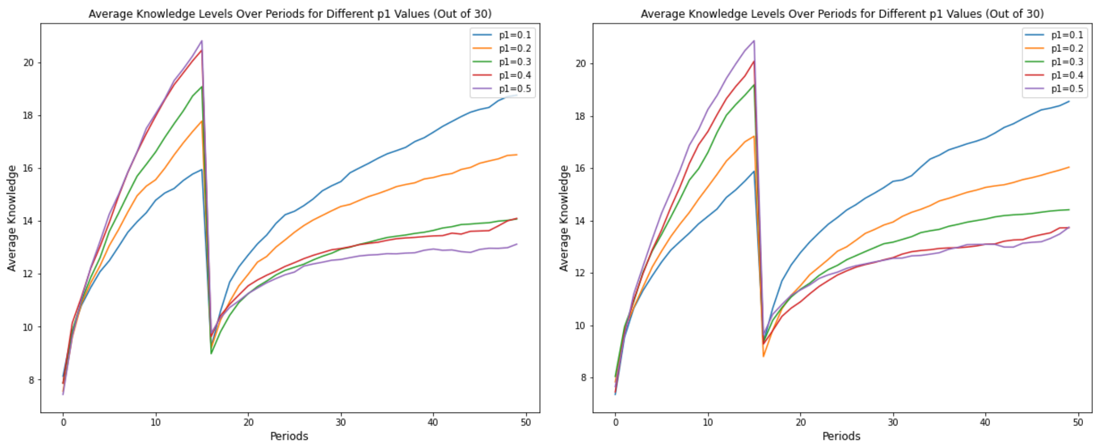

Figure 10. Re-evaluation (promotions) at 20th (left) and 25th (right) periods

The most effective is the 30th period, when knowledge levels stabilize at the highest equilibrium level. Promotions at period 35 show a similar result, suggesting that, perhaps, a plateau of effectiveness has been reached.

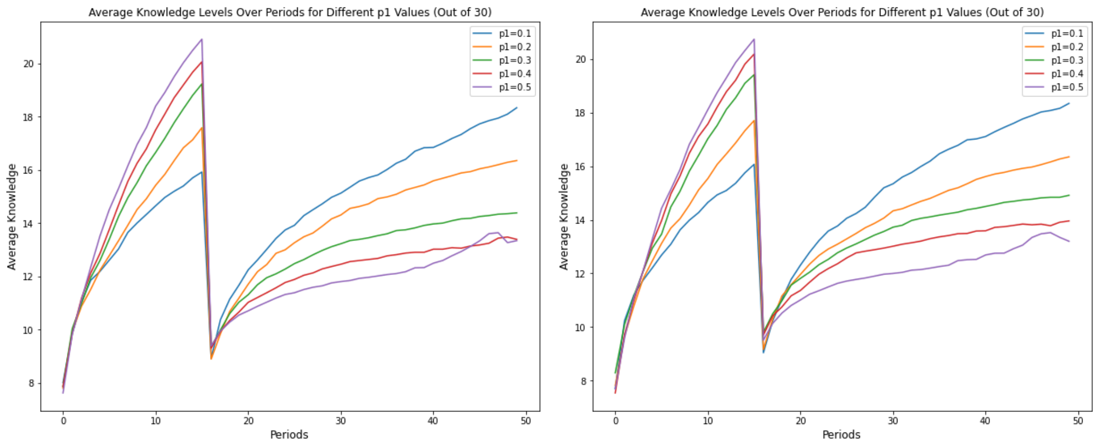

Figure 11. Re-evaluation (promotions) at 30th (left) and 35th (right) periods

Lastly, re-evaluation of experts at period 40, although still showing a positive effect, shows a decrease in effectiveness compared to optimal periods, indicating diminishing returns from interventions that are taking too much time to implement. One can argue that this observation is biased, since the graph is considering 50 periods' span in general. The same dynamic has been investigated on an increased span also - and 40-period case generally indeed depicts slower rates of recovery and final level of equilibrium convergence of the plots.

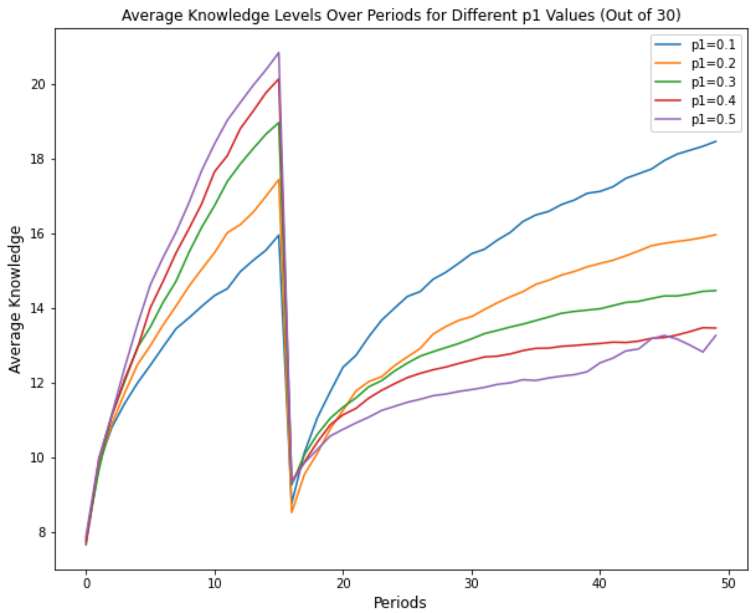

Figure 12. Re-evaluation (promotions) at 40th period

The highest levels of recovery are observed during re-evaluations on the 30th and 35th periods, confirming the optimality of these moments for structural changes.

The results show a nonlinear relationship between promotion timing and knowledge recovery performance after a shock, suggesting the possibility of an inverted U-shaped relationship. Indeed, resemblance of such a tendency is observed through visual approximation of the peak values of individual knowledge levels.

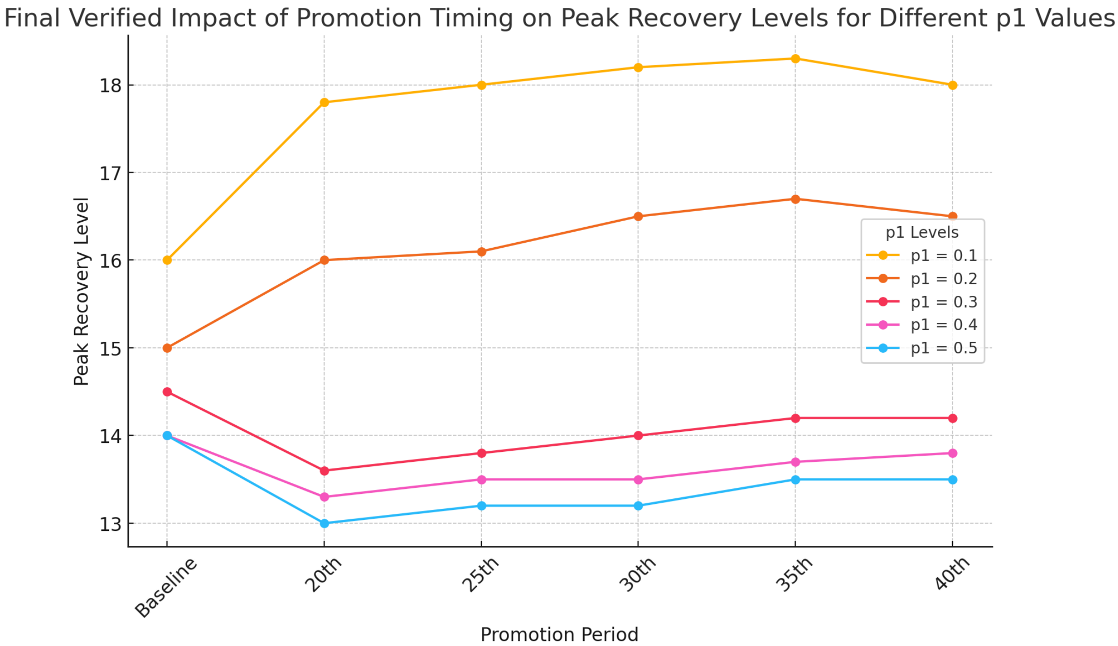

Figure 13. Impact of Promotion Periods on recovery across P1

This is most clearly expressed for lower values of the individual socialization speed parameter. Promotions in periods 30 and 35 demonstrate the best results in knowledge recovery. Early re-evaluations (e.g., at period 20) are less effective due to insufficient stabilization after the shock. Later appointments (at period 40) also have a positive effect on recovery, but their effectiveness is lower than during peak periods, which demonstrates the need to strategically plan structural interventions, avoiding their implementation too early or too late.

7. Discussion and Limitations

The experiments conducted demonstrate the visible impact of interpersonal communication, expert influence and the timing of reaction to structural interventions on the processes of organizational learning and adaptation. The introduction of socialization and the mechanism of employee promotion allows for a more realistic modeling of learning processes in organizations, taking into account both the horizontal and vertical interactions, which was not considered in the basic model of March (1991). In particular, one of the key findings point out that the formation of expert hierarchies and the strategic timing of structural changes can significantly affect the success of organizations' adaptation to external shocks.

An important conclusion is that interpersonal communication and expert influence can significantly accelerate the adaptation process after external disruptions take place and, moreover, increase the organization’s resilience towards such shocks in the short term. However, excessive emphasis on horizontal interactions can lead to decreased efficiency and speed of knowledge recovery in the long term, emphasizing the need for a balance between hierarchical (vertical) and informal (horizontal) communications. Another finding is the supposedly optimal corridor of time for a particular case of external shocks, suggesting that there is, in fact, a concept of reacting too early or too late.

As for the disturbances themselves, the results illustrate that even moderate changes in the external environment have a long-term negative impact on the level of organizational knowledge. The more severe the shocks are, the higher the probability of the organization being locked into a state of permanent misalignment with the external environment.

Despite the results obtained, a number of limitations of this study should be taken into account, which became visible during the development of the updated model and inclusion of multiple parameters, leaving plenty of space for further research and experimentation.

First of all, the updated mode reduces the complexity through omitting interactions between the parameters P3 (turnovers) and P4 (absolute turbulence of the external environment). Original model considered them having a joint effect and observed them in more detail. In this research, these parameters were not taken into consideration: turbulence was replaced by a more customizable intervention parameter, allowing for specification of time and degree of shock, whereas turnover was not a cornerstone in observing social interaction effect in the organization. In real life, these parameters not only interact with each other, but can also change over time, influencing organizational dynamics in a multidimensional way, so their inclusion might provide additional insights, should the research have such focus.

The second research gap is that the updated version analyzes only one fixed value of the parameter P2 (the speed of organizational learning), equal to 0.1. A more detailed study of different levels of this parameter could reveal a wider range of scenarios, since its change can significantly affect the adaptability of the organization, the speed of knowledge dissemination, and the effectiveness of recovery from shocks. But again, for the purpose of this research, it has been decided to focus on the aforementioned specific cases to build up a case for investigation.

A third important limitation is a byproduct of the additions to the model, when considering socialization processes. The current form allows for the division of employees into groups of different sizes and connectivity parameters, but, for valid comparison to the baseline model these were kept to a minimum, providing the same case as illustrated by March - absolute connectivity between every agent in the group. The expanded model possibilities, though, allow not only for agent segregation into groups, but also for determining even/uneven distributions, as well as connectivity parameters for the agents themselves, which could guide their interaction with the peers of the same group as well as, if at all, with other groups in the organization. Combining that with the introduction of experts within groups, one may observe some local authorities that compete with or complement each other in the learning process. For example, the presence of different group sizes may lead to the emergence of local subgroup dynamics that may have a significant impact on the overall picture of organizational learning, somewhere along the lines of research by Fang, Lee and Schilling (2010). The research investigates precisely whether organizational structure can be a mechanism to balancing exploration and exploitation as well as the depth of effect of subgroup dynamics on the learning process. In addition, the connectivity parameters between and within groups may significantly alter the trajectories of information dissemination and the process of adaptation, especially in times of crisis or rapid changes in the external environment. Introducing this level of detail may reveal new effects and complicate the model's behavior, bringing it closer to real organizational structures.

Speaking of matching the reality, the current study is limited to a single external shock, which does not correspond to real-world contexts where organizations often face multiple, sometimes sequential or even parallel, shocks. This leaves unexplored questions about how organizations adapt to repeated shocks, the role of accumulated experience in these processes, and how the frequency and pattern of shocks affect an organization’s ability to learn and recover. This topic has already been partially investigated by Posen and Levinthal in 2012, with the key finding being a suggestion that at high level of turbulence exploration may not be an optimal solution in the first place. As such, it might prove interesting to dive in on this discovery within the framework of the current model.

And another potential research direction is the influence of the initial level of employees' knowledge on the adaptation results. Both the original model of March and the updated model pre-generate the knowledge sets of the agents, leaving the further to explore and adapt. In reality, the initial level of employees' competencies and knowledge can vary significantly, affecting the ability of both individuals and the entire organization to adapt to external changes. Investigating states of the model with agents with prior expertise and the composition of the organization with regard to such experts can be a very complex yet intriguing investigation, especially when considering the inclusion of P3 parameter to the dynamic.

Thus, the updated model, though used extensively already for the current research, has a wide potential for further study, which may prove to be too multidimensional if one tries to encompass all the complexities within one work.With that taken into account, current research set its goal specifically to analyze the social and reputational aspects of the organizational learning, which proved fruitful, given the findings uncovered. Of course, given the above limitations, the results should be interpreted with caution and within the described contexts. Future studies can significantly complement the current findings by detailing the considered scenarios and including additional, more complex interactions and parameters.

8. Conclusion

Interpersonal communication, particularly the socialization between employees, introduces new dimensions of complexity to organizational learning, such as the role of influential individuals, group dynamics, and emergent knowledge from collective interactions (Cross & Cummings, 2004; Reagans & McEvily, 2003). This study took a look at this statement from another angle, whilst also going further to investigate the effect strategically chosen timing of structural interventions in the processes of organizational learning and adaptation. Expanding March's model by introducing horizontal communications and expert hierarchy allowed to investigate in depth the real mechanisms of organizational adaptation to external changes. The results show that an effective combination of formal and informal interactions is an important factor in the successful overcoming of external shocks by an organization.

However, optimal effectiveness is achieved by balancing these factors, since excessive or untimely implementation of changes can lead to a decrease in the adaptive capacity of the organization. Further research can expand the understanding of organizational learning by studying more complex scenarios and interactions, such as multiple external shocks and intra-group social structures, which will allow us to formulate practical recommendations for increasing the resilience of organizations in a dynamic and uncertain external environment.

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10. Appendix

The organizational learning model by March can be described as a state machine, where the system's behavior evolves over discrete time steps. The recreated model's parameter notations (N, M, p_1, p_2, etc.) are used to capture the interactions among organizational code, individual beliefs, and environmental factors.

States and State Variables

At the core of the model are the states, which define the system's configuration at any given period t. The primary state variables are:

- **Organizational Code (C):** Represented as a vector of length M, where each component

  $$c_m \in \{-1, 0, 1\}$$

  reflects the organization's perceprtion of dimension m. .

- **Individual Beliefs (B):** An $M \times N$ matrix, where each entry

  $$b_{m,i} \in \{-1, 0, 1\}$$

  represents the belief of individual i on dimension m. Beliefs evolve through alignment with the organizational code.

- **External Reality (R):** A static vector of length M, where

  $$r_m \in \{-1, 1\}$$

  represents the objective reality of dimension m. The vector **R** serves as the benchmark for evaluating performance.

Transitions and Rules

State transitions occur over discrete periods ($t = 0, 1, 2, \dots$) and are governed by deterministic and probabilistic rules. Transitions are modeled in three main stages:

Individual Action and Performance Evaluation

Each individual i generates an action vector $\mathbf{A}_i$ based on their beliefs $\mathbf{B}$. For each dimension m, the action is defined as:

$$a_{m,i} = \begin{cases} b_{m,i}, & \text{if } b_{m,i} \neq 0, \\ \pm 1, & \text{if } b_{m,i} = 0 \quad \text{(randomly chosen)}. \end{cases}$$

The performance of individual i, denoted P_i, is computed as:

$$P_i = \sum_{m=1}^{M} a_{m,i} \cdot r_m.$$

Socialization and Belief Updates

Socialization with the Organizational Code: With probability p_1, an individual i adjusts their belief $b_{m,i}$ to align with the organizational code c_m, provided that $c_m \neq 0$. The update rule is given by:

$$b_{m,i} = \begin{cases} 0, & \text{if } c_m \neq 0 \text{ and } b_{m,i} \neq 0 \quad \text{(towards neutrality)}, \\ c_m, & \text{if } b_{m,i} = 0 \quad \text{(align with code)}. \end{cases}$$

Peer Socialization: In the revised model each individual i interacts with peers to adjust their beliefs. The probability of adopting a peer's belief depends on the parameter p_1, and expert influence factor (denoted as p_1^*). Specifically, the probability is defined as:

$$\text{Probability of adopting peer belief} = \begin{cases} p_1^*, & \text{if the peer is an expert}, \\ p_1, & \text{otherwise}. \end{cases}$$

Organizational Learning

The organizational code **C** learns from "superior" individuals whose performance P_i exceeds the organization's knowledge score K_C, where:

$$K_C = \sum_{m=1}^{M} c_m \cdot r_m.$$

For each dimension m, if the majority of superior individuals agree on a belief that differs from c_m, the organizational code adopts their belief with probability p_2, scaled by the degree of agreement:

$$c_m = \begin{cases} -1, & \text{if } \sum(\text{actions favoring } -1) > \sum(\text{actions favoring } 1) \text{ and probability threshold met,} \\ 1, & \text{if } \sum(\text{actions favoring } 1) > \sum(\text{actions favoring } -1) \text{ and probability threshold met.} \end{cases}$$

Environmental and Structural Dynamics

Additional dynamics simulate real-world organizational complexities:

- **Employee Turnover (p_3):** With probability p_3, an individual i is replaced by a new entrant with random beliefs. This is introduced in the original model, but not used in the refined one, which the thesis focuses on.

- **Environmental Turbulence (p_4):** With probability p_4, the external reality **R** flips, i.e.,

  $$r_m \to -r_m.$$

  In the refined model, t intervals defined by `intervention_period`, a fraction (specified by `flip_percentage`) of the external reality dimensions are flipped.

- **Individual Promotion Mechanism:** At a designated time (e.g., period 25), the model identifies a set of top-performing individuals (in the same manner as "superior" individuals are picked by the organizational code) and promotes them to "expert" status. These experts retain their elevated influence for the remainder of the simulation, unless another promotion happens, causing a re-evaluation. The number of promoted individuals can vary (e.g., 5 or 25), and their influence on peer belief updating is weighted by a fixed p_1^* (for research purposes of the thesis set to 0.7). The mechanism introduces a hierarchy within the socialization process: beliefs of the experts have a higher probability of being adopted by other individuals, especially when compared to the organizational code, which has the maximum probability parameter p_1 value at 0.5. This models reputational inertia (unless set otherwise) - once an individual is recognized as an expert, their impact on others persists, regardless of whether their performance continues to justify it. The promotion mechanism thus embeds a dynamic feedback loop where past performance governs future influence, mimicking real-world organizational dynamics of status and authority.

Equilibrium and Termination

The system reaches equilibrium when no further significant updates are possible:

- **Code Opportunity:** No superior individuals are available to influence the organizational code.
- **Individual Opportunity:** No individual holds beliefs that differ from **C** on non-neutral dimensions.

If these conditions are met, or the universal termination period (denoted by `universal_termination_period`, used only in case of lower values of p_1, where the number of periods until equilibrium puts a strain on the computing powe) is reached, the simulation ends.