Behavioral Microfoundations of New Practice Adoption: the Effects of Rewards, Training and Population Dynamics

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Organizations face challenges when trying to effectively introduce new operational practices that substitute for existing ones. We study how the dynamics due to *social comparisons* between employees give rise to individual strategic considerations, and eventually shape the organizational adoption outcome. We develop an evolutionary game theory model that accounts for these micro-level individual adoption decisions and their impact on macro-level population adoption equilibria. Social comparisons invoke dynamics that expand the possible outcomes beyond the traditional non-adoption versus full-adoption dichotomy. Specifically, *ahead-seeking* social comparisons drive the long-term coexistence of practices, because employees seek to *differentiate* their choices from those of others. Meanwhile, *behind-averse* comparisons create a *bandwagon* effect that determines adoption depending on the initial fraction of adopters, i.e., employees who are trained upfront. These dynamics are robust to various settings: different conceptualizations of social comparisons; each employee responding to more than one kind of social comparison; and non-homogeneous social comparisons across employees. Moreover, they are material to organizations that seek to maximize their profit when introducing a new practice, by setting the levels of upfront training and adoption rewards. Our results call for senior managers to account for such behavioral traits when managing the introduction of new practices. Profitable adoption critically relies upon matching rewards and training to the type of social comparison.

Key words: Adoption processes, Social comparisons, Population dynamics, Evolutionary game theory

1. Introduction

The adoption of innovative practices by large organizations has been coined as a classic and complex management challenge (Centola 2019, Jacobs et al. 2015). Such practices comprise sets of procedural steps which conform to specific rules and oftentimes utilize new technologies to execute organizational tasks effectively. Examples of such practices can be found in total quality management (TQM), agile project management, or design thinking and creativity sprints. Their adoption challenges have been manifested across several cases (Chao et al. 2009, Fitzgerald and Russo 2005, Adler et al. 1997), which document that new practices face uncertain fates during their rollout as a result of the organizational dynamics (e.g., Vermeulen 2018, Barley 1986). A recent review of the past twenty years of research on practice diffusion, Naumovska et al. (2021), calls for more research on the social and behavioral dynamics determining adoption decisions in organizations.

The extant literature has identified the importance of the social context in the adoption of new practices (Centola 2019). Researchers have captured these social dynamics through either the concept of economic *externalities* (e.g., Eckles et al. 2016), which is the added (or reduced) value obtained by individual adopters given the fraction of peers that adopt the same practice; or the effects of *social learning* (Chamley 2004), where individuals adopt a new practice because their peers have done so. Overall, the literature has argued convincingly about the important role that the social context and associated social dynamics play in the organizational adoption outcomes.

Whereas social dynamics have been shown to affect adoption outcomes at an aggregate organizational level (Cornelius et al. 2021), the specific mechanisms by which they determine the individual adoption choices, and collectively shape the overall organizational outcome, remain an open research topic. Recent studies from practice allude to such a key mechanism: the *social comparisons* between peer adopters (Kramer et al. 2011, Song et al. 2017). Social comparisons presume that, while individuals care about the consequences of their own actions, they also experience additional value (or cost) from the relative choices and/or outcomes of their social peers (Festinger 1954, Sobel 2005, Bault et al. 2011, Ashraf and Bandiera 2018).

We discuss one instance of the effects of social comparisons on the organizational outcome, as presented in one of these studies: Song et al. (2017) look into practices used in hospital emergency settings, such as the process of discharging patients (when to initiate the process, the timing of ordering tests, etc.). They document how communicating the relative performance of different physicians affects the adoption of those practices. In their setting, the value of the new practice is measured by the patient's length of stay, and possible failure of the new practice implementation might have severe consequences, e.g., discharging a patient "too fast" and increasing the risk of either readmission or even a fatal incident. The authors observe that low-performing physicians adopt the practices used by the top performers, once these practices are communicated, and they *conjecture* a social mechanism at play: low-performing physicians might adopt to avoid *staying behind* their high-performing peers. In effect, their reasoning alludes to the influence of social comparisons on decision-makers (here physicians) when they make their adoption decisions. Moreover, it suggests that social comparisons trigger *strategic* individual behaviors; i.e., individuals account explicitly for peer choices when they make their own adoption decisions.

Social comparisons are manifestations of social and organizational cultural norms (Baldwin and Mussweiler 2018), which shape employee behaviors (Chun et al. 2018). For example, Ren Zhengfei's encouragement of Huawei employees to stay ahead of their peers[1] reflects his preference for certain cultural norms in Huawei, and may influence employees to compare themselves to their peers. In this instance, these preferences would be consistent with the so-called *ahead-seeking* social comparisons. In contrast, other organizations may promote the stack ranking policies popularized by General Electric in the 1980s, whereby employees whose attempts at innovation fail, relative to peers, may face career consequences and lower social standing. These contexts represent cultural norms that align with another type of social comparison, namely, *behind-averse* social comparisons.[2]

Despite these observations on how the cultural norms of organizations influence the social dynamics of the adoption of new practices, these influences have not been formally accounted for in the individual decision-making that determines adoption. In this paper, we consider a specific manifestation of such cultural norms through the social comparisons that arise between employees. We explore three important research questions: How does the type of social comparison affect the adoption of new practices at the firm level? How should a firm optimize its profit from the adoption of new practices in the presence of social comparisons? What are the consequences of managerial unawareness of social comparisons for optimal adoption and profits?

To answer these questions, we build an evolutionary game theory model, which helps us to investigate the role of social comparisons as a mechanism that influences the adoption of new but risky practices in organizations. The model accounts explicitly for two important factors of new practice adoption settings. The first factor is the strategic considerations of the potential adopters, in which economic considerations are mediated by social comparisons. Our model accounts for individual utilities that comprise two distinctive components: an economic component in the form of rewards offered by the organization to induce adoption, which is one lever that senior management can use to induce the adoption of new practices; and a behavioral component (benefit or loss) that arises as a result of social comparisons. The second factor is the population-level dynamics that recognize the boundedly rational and asynchronous decisions taken by the individual adopters. These factors combined determine how adopters interact and decide to adopt (or not) the new practices, at any given point in time.

We derive the *evolutionary stable strategy* (ESS) equilibria that describe how different adoption outcomes emerge under different types of social comparison, and the economic rewards established by the firm. Given the possible ESS equilibria, we determine the optimal reward scheme and initial amount of training that maximizes firm profits, i.e., optimizes the introduction of the new practice.

Our results offer several guidelines to organizations faced with the challenge of introducing new practices. First, we delineate and characterize the richer set of adoption *regimes* that emerge in the presence of social comparisons. Contrasted with settings where social comparisons are negligible, we show that two new adoption regimes might happen: *coexistence* and *bistability*. Coexistence represents outcomes where, in equilibrium, different practices are used by different employees. Bistability describes instances where the emergence in equilibrium is either full adoption or no adoption at all, depending, critically, on the fraction of employees that are upfront primed toward the new practice (e.g., because of training offered by senior management, or through recruitment of staff with prior exposure to the practice). These results reveal the key role that social comparisons play in practice adoption: introducing the same new practice with the same reward scheme in two different organizations may result in drastically different adoption outcomes *because of* the different social comparison norms that exist within these organizations.

Second, we offer a "map" that describes and explains how the existing types of social comparison within an organization give rise to the different equilibrium adoption regimes. Behind-averse social comparisons give rise to a bandwagon effect, which eventually drives the bistability regime. In contrast, ahead-seeking social comparisons push employees to differentiate their actions from those of their peers. Therefore, they end up adopting differing practices, as a reaction to the peer choices, which leads to practice coexistence within the organization. Notably, these findings prove robust to three departures from the base concept of social comparisons: a different structural formulation of social comparisons (Festinger 1954) where social comparisons arise as a result of *any* payoff differential and not only when payoff differentials emerge as a result of different choices; the simultaneous presence of both types of social comparison in an organization, whereby employees exhibit different levels of intensity for each type of social comparison; and, finally, the existence of non-homogeneous social comparisons across the employees of the organization, where we assume that only some of the employees care about these comparisons.

Finally, we derive how senior management (as a proxy for the firm's interests) should set the optimal reward scheme, and/or any necessary upfront training, to maximize the firm's return from the new practice in the presence of different types of social comparison. We highlight three important messages: first, the fact that under optimal actions from senior management, firms may pursue a profitable partial adoption, i.e., a coexistence regime, and avoid an uneconomical full adoption of the new practice. Moreover, under behind-averse social comparisons, senior management may benefit from leveraging the upfront training to exploit the population-level bandwagon dynamics, instead of offering higher adoption rewards. This is of great importance for managers, because diagnosing and accounting for the exact type of social comparison, when managing the introduction of a new practice, can help them to pursue full adoption more effectively. Second, we describe the conditions under which a firm could benefit from the presence of certain social comparisons in the organization. This informs senior management about when to work toward establishing specific social comparison norms. Finally, we show the performance shortfall that results when management is unaware of the underlying social comparisons. While such cultural unawareness can be forgiving in an ahead-seeking organization, it can be disastrous in a behind-averse organization.

The rest of the paper is organized as follows. After reviewing the relevant literature (Section 2), we present the model setup (Section 3). Section 4 describes the adoption regimes that can emerge in an organization and defines how social comparisons interact with economic rewards to drive adoption. Section 5 provides robustness extensions of our equilibrium analysis. In Section 6 we look at the firm's problem of optimizing the new practice introduction, i.e., the optimal reward scheme and upfront training investments that maximize profits, as well as discussing the consequences of management cultural unawareness for optimal adoption and profits. We conclude with our theoretical contributions to the literature and the implications for managers (Section 7).

2. Literature Review

The adoption of new practices by organizations falls under the broader topic of the adoption of technologies and innovations (Ellison and Fudenberg 1993), since new practices engage novel technologies and methods to perform existing organizational tasks. Given the importance of this topic in the literature, research studies use different disciplinary lenses, which range from sociology (Burt 1987), to organizational behavior (Henderson and Clark 1990), economics (Griliches 1957, Hannan and McDowell 1984), marketing (Bass 1969), technology management (Loch and Huberman 1999), and the history of the technology (Rosenberg 1972). These methodologically diverse streams study the outcomes and/or dynamics of adoption efforts (Hall and Khan 2003), e.g., the beliefs and information that prompt individuals to adopt or not, the fraction of adopters at any point in time or at steady state, etc. Predominantly, they focus on *how* decisions at the individual (micro) level shape adoption patterns and outcomes at the organization or population (macro) level.

Overall, these studies recognize a key trade-off in individual adoption decisions between a new practice, whose success is uncertain but more rewarding on average, and the riskless, but lower-return, existing practice, i.e., the "way we do things around here." The resolution of this fundamental risk–return trade-off relies on two key factors: the individual utility from successful adoption; and the uncertainty associated with the successful implementation of the new practice.

Early research into individual adoption decisions shows how this risk–return trade-off changes dynamically as the uncertainty around the utility from adoption resolves (McCardle 1985). The individual utility from adoption is uncertain, and a costly (to the decision-maker) uncertainty resolution mechanism determines the minimum threshold of expected utility that justifies adoption (Smith and Ulu 2012, Ma 2010, Cho and McCardle 2009). Aggregating this micro-level analysis to a population of individuals who hold heterogeneous expectations about the utility from adoption, and resolving the adoption uncertainty through a standard Bayesian updating mechanism, give rise to the standard Bass diffusion curve (Chatterjee and Eliashberg 1990). These studies recognize the core adoption trade-off of the individual decisions, but they treat the resulting population adoption outcomes as the sum of individual and independent choices. Any social, or organizational, context plays a secondary role, if at all. Moreover, these studies concentrate on *when* a population reaches full adoption, without considering whether full adoption is preferable or attainable.

Subsequent research recognizes that these key factors (utility and uncertainty) are strongly influenced by the social context, i.e., the decisions of other individual adopters. Literature in economics and innovation notes the influence of *externalities* that increase or decrease the individual utilities from adoption proportionally to the adopter population (Peres et al. 2010, Loch and Huberman 1999, Jovanovic and Nyarko 1994). Further work in economics, organizational theory, and sociology points out that the uncertainty about the utility from a new practice is rarely resolved in an ad hoc manner. Instead, it is the peer adoption choices that resolve this uncertainty; i.e, uncertainty resolution happens *because* of the social context.

Some studies assume that individuals update their prior beliefs about the utility from adoption based on the adoption decisions of their peers (i.e., resolution through *social learning*, see Chamley 2004, Banerjee 1992). Other studies assume that individual adopters resolve uncertainty[3] through *imitation* of the peer adoption choices (Levinthal and March 1981, Abrahamson and Rosenkopf 1993, Granovetter 1978), oftentimes in a myopic, boundedly rational fashion (Cyert et al. 1963). Such a propensity to imitate is attributed to inherent traits of the potential adopters (e.g., "innovators" vs. "imitators" in the classic Bass (1969) model), but sociologists demonstrate that imitation happens even in homogeneous populations (Strang and Soule 1998, and references therein). All these studies manifest the role of the social context in shaping the adoption outcomes, while assuming that full adoption is the optimal outcome. Moreover, they presume that individual utilities depend on peer decisions only at an aggregate level, i.e., by including a constant externality effect.

Recent evidence, though, suggests otherwise. Individuals in organizations are concerned not only with the absolute output from their actions but also with their performance as *socially compared* to their peers[4] (Alpizar et al. 2005, Rabin 1998). These observations highlight a gap in the literature. Individual utilities, at the micro level, may be payoffs from *strategic interactions* between adopters (Rabin 1993), since each adopter decides *given* peer choices. As a result, the conceptualization of the adoption process, and its methodological analysis should be adapted to reflect some form of dynamic strategic interactions between peers, to represent more elaborate cognitive mechanisms that determine adoption decisions (Naumovska et al. 2021).

Our paper addresses this gap. We recognize the existence of *social comparisons*,[5] a well-established phenomenon conceptually founded in the psychology and economics literature (Festinger 1954), which motivates individual adoption choices based on dynamic strategic considerations. Social comparisons give rise to utility gains (losses) that individuals realize when their outcomes are superior (inferior) to those of their peer adopters. Notably, these utility interdependencies differ from the classic concept of externalities. Since the social comparison effects depend on the peer choices, they can act as positive *and* negative externalities.

Our consideration of the social comparisons between different decision-makers goes beyond the few studies in operations management and economics that have explicitly accounted for them (Long and Nasiry 2020, Momot et al. 2020, Ashraf and Bandiera 2018, Avcı et al. 2014, Roels and Su 2013, Loch and Wu 2008, Sobel 2005). First, we consider the effect of social comparisons on a distinctively different topic that has not been previously addressed, i.e., the adoption of new practices. Second, we model social comparisons through an evolutionary game theory framework (Sandholm 2010, Weibull 1997) that captures how micro-level strategic interactions, which arise as a result of social comparisons, determine the long-run adoption equilibria of new practices at the level of an organizational population. Prior studies have treated the effect of social comparisons on agents' utilities as static (Long and Nasiry 2020, Avcı et al. 2014, Roels and Su 2013). Third, we model a more nuanced conceptualization of social comparisons as triggered by differences in both choices and outcomes, based on recent experimental evidence in neuroscience and social psychology (Lahno and Serra-Garcia 2015, Bault et al. 2011, Corcoran et al. 2011, Coricelli and Rustichini 2010). Prior studies conceptualized social comparisons as per the original Festinger (1954) theory, i.e., when individuals observe that their outcomes differ from those of their peers. Lastly, we break new ground, by formally accounting for the firm's optimal new practice introduction (as defined by the combination of reward and upfront training) in the presence of different types of social comparisons. Moreover, to our knowledge, our study is the first to recognize and conceptualize a firm optimization problem which embeds an evolutionary (employee) population game. This analysis better represents economic and management settings whereby there is agency in selecting the parameters of the "environment", as opposed to biology settings (that originally gave rise to evolutionary game theory) where the environmental parameters are assumed exogenous.

Overall, our study contributes to the extant literature in the adoption of new practices as follows: first, we consider the dynamic behavioral utility effects of social comparisons on adoption. We depart from the traditional fixed externalities, as discussed in the literature, and we analyze a more realistic context where decision-makers account *strategically* for peer choices. As a result, second, we identify a richer set of possible adoption outcomes that extend beyond the classic "adopt" vs. "not adopt" dichotomy and are robust to different settings. We show that the coexistence of different practices in organizations can be an equilibrium outcome in such dynamic games, or that the eventual adoption outcomes critically depend on the upfront training on the new practice offered to employees. Third, our firm's optimization analysis allows for partial adoption to be the best possible outcome under certain conditions, an occurrence that has rarely been addressed in the literature. Moreover, we identify cultural contexts where the presence of social comparisons boosts the level of adoption of the new practice relative to a benchmark firm without social comparisons.

3. Adopting New Practices: A Model Setup

Consider an organization where employees choose to either adopt a new practice, represented by the subscript N, or continue to use the old (conventional) practice, denoted by subscript O. The employees decide whether to adopt or not by comparing the expected utility they will accrue through each option (e.g., McCardle 1985). Their utility depends on both an economic component paid by the organization on the basis of the outcome of the chosen practice, and a behavioral component driven by the adoption choices and respective outcomes of their peers.

We form an organizational (macro) view through a bottom-up analysis as follows. We assume that each individual faces different expected utility payoffs depending on the micro-level social dynamics. In line with past literature, we capture these micro-level social dynamics through *pair matchings*.[6] An employee's overall expected utility accounts for all possible pair matchings between themself and their peers. Thus, employees weigh up their micro utility payoffs by the likelihood of these matchings occurring given the state of adoption in the organization, i.e., the share of employees $x_N = x$ that use the new practice, versus the $x_O = 1 - x$ who don't, at a point in time.

3.1. Payoffs at the micro level

Economic component: individual rewards

The economic reward from attempting adoption is determined by a combination of factors. First, successful adoption of the new practice offers a fixed value V_N to an employee, e.g., compensation paid by the organization upon successful adoption of the new practice; but it is risky, with probability $p \in [0, 1]$ of successful adoption. In the case of failure, the employee receives a value V_F. Hence, the expected economic reward from attempting the new practice is $pV_N + (1 - p)V_F$. By contrast, sticking with the conventional practice bears no risk (success probability is 1), and the value received by an employee is denoted by V_O. We assume $V_N > V_O$ and $V_F < V_O$ as follows: $\delta = V_N - V_O > 0$ captures the *individual economic reward*, e.g., a bonus that the organization uses to induce the adoption of the new practice, only paid if the new practice is successfully implemented. Next, $c = V_O - V_F$ is the personal *cost of failure* incurred by the employee whose attempt at the new practice fails, e.g., a negative impact on career progress (Siemsen 2008). Similar cost considerations have been studied in the innovation literature (Manso 2011, Hutchison-Krupat and Kavadias 2015). We assume that this cost is non-negligible ($c > 0$), management cannot alter it credibly during the time horizon of a new practice deployment, and that it represents an important dimension of an organizational culture (Hutchison-Krupat and Kavadias 2015, p.395).

Behavioral component: social comparisons

A key contribution of our study is that we explicitly account for the behavioral component of individual utilities realized as a result of the social comparison dynamics prevalent in social settings (Sobel 2005). We define these behavioral individual utilities as follows: each employee cares whether they have made the "right" choice of practice, where "right" means that their outcome is better than that of a peer's. Critically, the extent to which they care is significantly heightened when a peer has chosen an observably different practice to reach their outcome. This effect was highlighted in recent research describing the fundamental neurology of social comparisons (Bault et al. 2011).[7] Thus, we consider that social comparison effects arise only when employees choose different practices, whereas the effects are negligible for the same choice of practice.[8]

We conceptualize the social comparisons as *strategic interactions* between employees, with specific effects on their utilities that depend on the type of social comparison observed in the organization. Formally, these are captured through the interactions at a matching-pair level as these are represented by all four quadrants of Table 1. For example, consider the utility of adopting the new practice that a focal employee will anticipate when comparing themself to a peer who uses the conventional practice. In the presence of ahead-seeking comparisons, if the focal employee's attempt succeeds, then because their economic reward, $V_N = V_O + \delta$, exceeds that of a conventional choice, V_O, they receive a utility uplift $\alpha(V_N - V_O) = \alpha\delta$. This uplift is proportional to the difference between the economic rewards the employees receive. In the presence of behind-averse social comparisons, if the focal employee fails, their economic reward is $V_F = V_O - c$, and their total utility is further reduced by a behind-averse-driven loss of $\beta(V_O - V_F) = \beta c$, leading to an outcome from failed adoption of $-\beta c$. Given that successful adoption is uncertain, with probability p, the focal employee's overall expected utility, including both economic reward and social comparison effects, is $p[V_N + \alpha(V_N - V_O)] + (1-p)[V_F - \beta(V_O - V_F)]$. A mirror utility calculation applies in the case of a focal employee who sticks to the conventional practice in comparison to a peer who attempts the new practice. They enjoy an ahead-seeking utility uplift of $\alpha(V_O - V_F)$ if the peer fails, while, if the peer succeeds, they suffer a utility loss of $\beta(V_N - V_O)$ because of the behind-averse comparisons, giving an expected utility of $V_O + (1-p)\alpha(V_O - V_F) - p\beta(V_N - V_O)$.

The parameters $\alpha > 0$ and $\beta > 0$ represent the intensity of the effects from ahead-seeking and behind-averse social comparisons, respectively. Motivated by the literature (Chun et al. 2018, Baldwin and Mussweiler 2018), we posit that α and β are organizational-level parameters. They reflect the firm's broader social norms that underpin social comparisons. Table 1 summarizes the utility payoffs realized by the focal employee depending on the peer choices across the possible pair matchings, with some additional simplifying algebra. We replace V_N with $V_O+\delta$ and V_F with V_O-c, and set $V_O=0$, since this is effectively a reference point that doesn't affect the micro-level decision.

Table 1 Payoff Matrix Game

	N	O
N	$U_{NN}=p\delta-(1-p)c$	$U_{NO}=p\delta(1+\alpha)-(1-p)c(1+\beta)$
O	$U_{ON}=(1-p)c\alpha-p\delta\beta$	$U_{OO}=0$

3.2. The population game

In this subsection we define the following population game, which builds upon the utility payoffs defined in Table 1: $\mathbf{U(x)}=\begin{pmatrix}U_N(x)\\U_O(x)\end{pmatrix}$ to describe the eventual adoption outcome at the macro level of the entire organization. The utility of adopting the new practice, $U_N(x)$, or continuing with the conventional practice, $U_O(x)$, incorporates the social comparison effects that arise given the state of the entire population, as captured by the fraction of adopters x. $U_N(x)$ and $U_O(x)$ are linear combinations of Table 1 payoffs that each individual employee gets from all possible pairings:

$$\mathbf{U(x)}=\begin{pmatrix}U_N(x)\\U_O(x)\end{pmatrix}=\begin{bmatrix}U_{NN}\ U_{NO}\\U_{ON}\ U_{OO}\end{bmatrix}\times\begin{pmatrix}x\\1-x\end{pmatrix}=\begin{pmatrix}xU_{NN}+(1-x)U_{NO}\\xU_{ON}+(1-x)U_{OO}\end{pmatrix} \tag{1}$$

Aligned with standard assumptions in the literature of population games, we consider that employees choose when and which practice to adopt by following a time-asynchronous *revision protocol* ρ. This is defined by decision events that arise through a Poisson process with rate R.[9] At each of these decision points, a focal employee compares the utilities $U_N(x)$ and $U_O(x)$ of the two practices and switches to a higher utility practice with a probability that is proportional to the gain, which is called the *switching rate*, and inversely proportional to R. For example, if the current practice is old (respectively, new), then the switching rate to the new (resp., old) practice is $\rho_{ON}=x[U_N(x)-U_O(x)]_+$ (resp., $\rho_{NO}=(1-x)[U_O(x)-U_N(x)]_+$). This means that each employee receives R opportunities, on average, during a fixed time horizon,[10] to execute a task according to either the new or old practice, taking into account that the chance of meeting someone undertaking the new or old practice is x or $1-x$, respectively.[11]

3.3. The stochastic evolutionary process and its deterministic approximation

Building on earlier work in evolutionary games (Sandholm 2010, Weibull 1997), our population game U, its revision protocol ρ, the rate R of each employee's decision events (which satisfies the condition $\max_{x,i\in(O,N)}\sum_{j\neq i}\rho_{ij}(U(x),x)\leq R<\infty$), and the finite size n of the population define a Markov process $\{X_t^n\}$ on the set of feasible social states, $\{0,1/n,2/n,\ldots,1\}$, with a jump rate nR and transition probabilities:

$$P^n_{x,x+z} = \begin{cases} x(1-x)\dfrac{[U_N(x)-U_O(x)]_+}{R} & \text{if } z = \dfrac{1}{n} \\ x(1-x)\dfrac{[U_O(x)-U_N(x)]_+}{R} & \text{if } z = -\dfrac{1}{n} \\ 1-(1-x)x\dfrac{|U_N(x)-U_O(x)|}{R} & \text{if } z = 0 \end{cases} \quad (2)$$

For the Markov process $\{X^n_t\}$, we can then prove an asymptotic result that allows us to calculate and analyze the adoption equilibria from the population game we have defined.

Theorem 1 (Sandholm 2010). *When the population size n is sufficiently large, the Markov process $\{X^n_t\}$ is well approximated over a finite horizon by solutions of the following differential equation:*

$$\frac{dx}{dt} = x(1-x)(U_N(x) - U_O(x)) \quad (3)$$

Proof: All proofs are listed in a separate appendix to enhance the readability of the paper.

In the following section, we analyze the deterministic approximation, (3), of the finite-state stochastic model. A stationary equilibrium state implies a zero on the left-hand side of (3). So we deduce from the right-hand side that an equilibrium implies one of three possible outcomes: no adoption ($x = 0$), full adoption ($x = 1$), or an intermediate level of adoption ($0 < x < 1$) that results from the equality of the utilities of new and old practices ($U_N(x) = U_O(x)$). The above differential equation embeds the intuition that $x(t)$ is increasing ($dx/dt > 0$) if $U_N(x) > U_O(x)$; this is clear from the above equation for any $0 < x < 1$. Note that upfront training, offered by the organization, may set the fraction of employees initially *primed* to adopt to $x(t = 0) = x_0$.

We study the asymptotic stability of the mean dynamic (a strong form of stability). We establish our results through the analysis of the asymptotic stability of the possible adoption equilibria, i.e., equivalent to the *evolutionary stable states* for symmetric 2×2 population games (Weibull 1997) that emerge from the dynamic system (3). In particular, we focus on settings where the population game may have more than one evolutionary stable state.

In order to enhance the readability of the rest of the paper, we introduce a nomenclature table for the main parameters that will be important later.

Table 2 Key parameter notations for equilibrium analysis (Section 4), extensions (Section 5), and firm-level analysis (Section 6)

Parameters	Description	Appearance
$\delta = V_N - V_O$	*Economic reward* bonus received by the employee when successfully adopting the new practice	§4,5 and 6
$c = V_O - V_F$	*Cost of failure* incurred by the employee whose attempt at the new practice fails	§4,5 and 6
p	Probability of successful adoption of the new practice	§4,5 and 6
α	Intensity of the utility effects from ahead-seeking social comparisons	§4,5 and 6
β	Intensity of the utility effects from behind-averse social comparisons	§4,5 and 6
R_O	Economic value received by the organization per employee who uses the conventional practice	§6
R_N	Economic value received by the organization per employee who successfully uses the new practice	§6
c_t	Organizational cost c_t per employee primed toward the new practice	§6
$\Pi_{sc=\{B,AS,BA\}}$	Firm profit in the benchmark (B), ahead-seeking (AS) or behind-averse (BA) cases	§6

4. Adoption of New Practices: Equilibrium Analysis

In this section, we analyze the (asymptotically stable) adoption equilibria that emerge within organizations as a result of the influence of the micro-level dynamics of social comparisons. We focus on asymptotic equilibria in order to understand the adoption output for the organization. We use the standard theory of population and evolutionary games.

Impact of social comparisons on equilibria outcomes

We consider either an ahead-seeking context ($\alpha > 0 = \beta$) or a behind-averse ($\beta > 0 = \alpha$) one. This allows us to clearly determine the effects of each type of social comparison in isolation. We extend our analysis to a setting where both types of comparison exist simultaneously in Section 5.2.

Our key finding in this section is that social comparisons lead to four archetypal adoption regimes. They are exhaustive in that the associated equilibria comprise all possible asymptotically stable states of the population game. Some depend on x_0, which is the initial fraction of employees who are upfront primed or trained to undertake the new practice, and some do not: i) a *full-adoption regime*, $x^* = 1$, where the entire organization adopts the new practice, *independently* of x_0, ii) a *non-adoption regime*, $x^* = 0$, where everyone eventually forgoes the adoption of the new practice, *independently* of x_0, iii) a *bistability regime*, where either full adoption ($x^* = 1$) or no adoption ($x^* = 0$) emerges, depending on x_0, and iv) a *coexistence regime*, $x^* \in]0, 1[$, in which a positive fraction of both new and old practices are in use at equilibrium, *independently* of x_0.

Note that some of the equilibrium outcomes rely on having a sufficient initial fraction of employees primed to undertake the new practice. The value of this distinction is material to a manager, as becomes apparent in Section 6.

Our analysis of equilibrium regimes and outcomes in Sections 4 and 5 focuses on generic cases (no payoff ties, similar to the treatment of Weibull (1997), p75) of our population game and avoids consideration of parameters δ, p, and c at "boundaries," e.g., see Lemma 1, below, in which δ is taken to be strictly either above or below a breakpoint $\frac{c(1-p)}{p}$. This entails no loss of generality, see Appendix B.2 for a treatment of the boundary cases of Proposition 1 (which appears below) and the management response at the boundary cases in Section 6 and in Appendix D, in particular.

In order to rigorously establish the impact of social comparisons, we consider a benchmark organizational setting without social comparisons, i.e., $\alpha = \beta = 0$. Table 1 thus collapses to a single column with respective utilities : $U_N^{benchmark} := U_{NN} = p\delta - (1-p)c$ and $U_O^{benchmark} := U_{OO} = 0$.

Lemma 1 shows that this benchmark organization either ends up fully adopting the new practice or not adopting at all. Unsurprisingly, the outcome depends on whether the expected individual reward from adopting the new practice, $p\delta$, exceeds the expected cost of failure, $(1-p)c$. Moreover, the individual choices are independent of the state of adoption in the organization, because the actions of peer employees do not matter when a focal employee makes their choice.

Lemma 1. (Benchmark Organization) *In the absence of social comparisons ($\alpha = 0 = \beta$), full adoption occurs when $\delta > \frac{c(1-p)}{p}$; otherwise no adoption occurs.*

Propositions 1 and 2, below, show the impact of social comparisons on new practice adoption.

Proposition 1. (Ahead-seeking Organization) *In the presence of ahead-seeking comparisons ($\alpha > 0$, $\beta = 0$), the following adoption regimes emerge:*

- *Full adoption occurs when $\delta > \frac{c(1-p)(1+\alpha)}{p}$*
- *Coexistence occurs when $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)(1+\alpha)}{p}$, with the equilibrium share of adopters in the organization being $x^* = \frac{p(1+\alpha)\frac{\delta}{c}-(1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}$*

Otherwise no adoption occurs.

Proposition 1 says that ahead-seeking comparisons result in adoption regimes that are independent of the fraction of employees upfront primed in the new practice, x_0. This is not the case, however, when social comparisons are behind-averse: Proposition 2, below, shows that the adoption equilibrium depends on x_0. We establish a *critical mass* x_0^*, below which there is zero adoption, while $x_0 > x_0^*$ ensures full adoption (bistability). Ensuring that x_0 exceeds the critical mass could result from investment in training or recruiting new staff (we elaborate on this in Section 6). Our shorthand for having such an initial critical mass is the phrase "with upfront training," or indeed "without upfront training" if the level of x_0 plays no part, in the next and subsequent results.

Proposition 2. (Behind-Averse Organization) *In the presence of behind-averse social comparisons ($\beta > 0$, $\alpha = 0$) the following adoption regimes emerge:*

- *Full adoption without upfront training occurs when $\delta > \frac{c(1-p)(1+\beta)}{p}$*
- *Full adoption with upfront training occurs when $\frac{c(1-p)}{p(1+\beta)} < \delta < \frac{c(1-p)(1+\beta)}{p}$ and the initial fraction of trained employees, x_0, exceeds the critical mass, $x_0^*(\delta) = \frac{(1-p)(1+\beta)-p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))}$*

Otherwise, no adoption occurs.

For completeness, we note the following intuitive comparative statics about the equilibrium outcome x^*, in the ahead-seeking case, and initial training threshold x_0^*, in the behind-averse case.

Lemma 2. *In an ahead-seeking organization, $\alpha > 0$ and $\beta = 0$, x^* is strictly increasing in p and δ and strictly decreasing in c. In a behind-averse organization, $\alpha = 0$ and $\beta > 0$, x_0^* is strictly decreasing in p and δ and strictly increasing in c.*

The first key insight from Propositions 1 and 2 is that the existence of social comparisons creates more regimes of adoption than in the benchmark situation; see Figure 1 for a comparison of equilibrium regimes across the types of organization. Before any detailed justification for the two new regimes, namely, coexistence and bistability, it is valuable to describe the effects of the social comparisons on the adoption choices of the employees, as captured by Table 1 in Section 3.

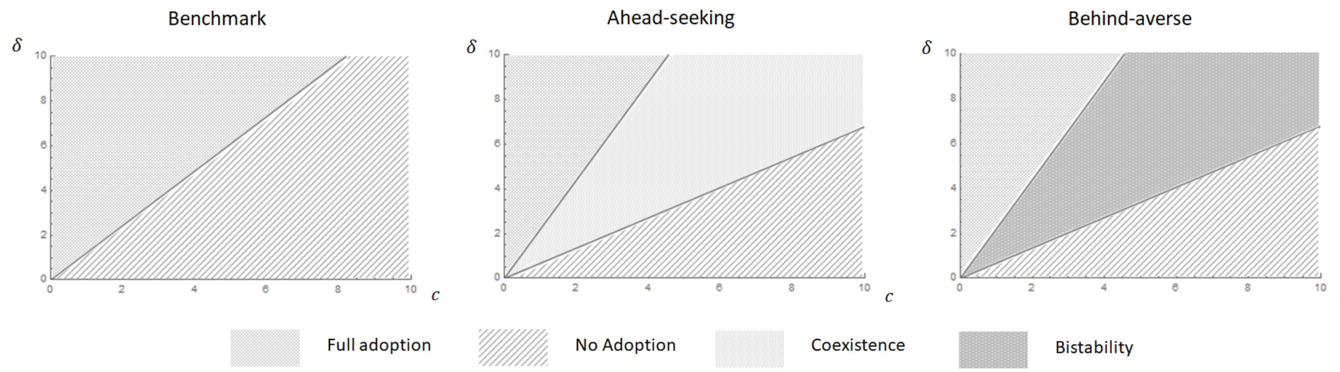

Figure 1 How equilibrium regimes in a benchmark organization (no social comparisons), an ahead-seeking organization, and a behind-averse organization depend on the economic reward δ and the cost of failure c ($p = 0.45; \alpha = 0.8; \beta = 0.8$)

In the case of ahead-seeking comparisons ($\alpha > 0, \beta = 0$), it is clear by inspection of Table 1 that more intense social comparisons (higher α) widen the gap between U_{NO} and U_{NN}, and also U_{ON} and U_{OO}. Thus, the higher α is, the more utility individuals gain by *differentiating* their choices.

Obviously, whether employees end up adopting the new practice, or not, also depends on the state of adoption in the population (x), as this determines the frequency of experiencing these payoffs, hence the utility of each practice. We highlight these utilities by expressing them as: $U_N^{AS}(x) = U_N^{Benchmark} + (1-x)\alpha p\delta$ and $U_O^{AS}(x) = U_O^{Benchmark} + x\alpha(1-p)c$.

Fixing α, δ, and c, we see that $U_N^{AS}(x)$ is decreasing in x, while $U_O^{AS}(x)$ is increasing, reflecting, in both cases, the tendency to differentiate. Also recall that, from the differential equation (3), whether x is increasing or decreasing depends on whether $U_N^{AS}(x) > U_O^{AS}(x)$ or $U_N^{AS}(x) < U_O^{AS}(x)$. Since a high value of x forces $U_N^{AS}(x) < U_O^{AS}(x)$, this drives x down, while a low x induces the opposite behavior. That is, ahead-seeking social comparisons can lead to a coexistence equilibrium.

It follows that the differentiation impact of ahead-seeking social comparisons reduces the part of the (c, δ) parameter space that results in either full- or no-adoption equilibria. This showcases that when senior managers approach the challenge of adoption of new practices through individual economic rewards, this could incur sizeable costs to the organization; e.g., looking at $U_N^{AS}(x)$, a relatively small p implies that a relatively large δ may be needed, and the total remuneration across all staff could be excessive.

Following a similar logic, the new practice has higher utility than in the benchmark case by as much as $\alpha p\delta$, when $x = 0$, while $U_O^{AS}(0) = U_O^{Benchmark}$. Thus, $U_N^{AS}(0) > U_O^{AS}(0)$ for a range of δ below the level at which benchmark full adoption occurs. As such, no adoption is the equilibrium outcome for lower values of the reward δ compared to the benchmark case. Notably, the differentiation effects discussed above arise from distinctively different quantities, namely, the cost of failure in the case of full adoption and the reward in the case of no adoption. Thus, the effects of δ and c are asymmetric on the adoption decision of the employees. This realization has important implications for senior managers, as these can be different parameters that they must influence.

In contrast, for behind-averse social comparisons ($\alpha = 0, \beta > 0$), inspection of Table 1 confirms that the individual employees are induced to *conform* to similar behaviors; the off-diagonal payoffs U_{NO} and U_{ON} are lower than U_{NN} and U_{OO} (the benchmarks). Thus, employees tend to be better off when conforming to the same choice of a practice.

Again, whether employees end up adopting the new practice, or not, depends on the state of adoption in the population (x). Similar to the previous discussion, the overall utilities for a behind-averse organization can be written: $U_N^{BA}(x) = U_N^{Benchmark} - (1-x)(1-p)c(1+\beta)$ and $U_O^{BA}(x) = U_O^{Benchmark} - xp\delta\beta$. The fact that $U_N^{BA}(x)$ is increasing in x, whereas $U_O^{BA}(x)$ is decreasing, reveals the key role that the initial fraction of adopters x_0 plays for the eventual equilibrium result. For example, if $U_N^{BA}(x_0) > U_O^{BA}(x_0)$ ($U_N^{BA}(x_0) < U_O^{BA}(x_0)$) then the dynamic process drives x to increase (decrease), preserving the dominance (inferiority) of $U_N^{BA}(x)$ and driving x to its upper (lower) bound, $x^* = 1$ ($x^* = 0$), a full- (no-) adoption equilibrium. Obviously, this bandwagon effect can be engineered by determining the initial share x_0 of employees primed to take up the new practice, yielding either the eventual full- or no-adoption outcome (bistability regime in Proposition 2).

Once more, we note that behind-averse comparisons introduce a wedge into the parameter space of (c, δ) pairs, corresponding to an equilibrium regime (here, bistability) that doesn't appear in the benchmark setting. This wedge reduces the part of the parameter space where the equilibrium outcome is *independent* of the initial population x_0.

Linking to organizational studies

We see from above that there are regions in the (c, δ) parameter space where social comparisons become the key determinant of the eventual adoption outcomes. Thus, economic rewards may play a role, but they may not be sufficient to ensure the adoption of new practices within organizations. Instead, our analysis offers plausible explanatory mechanisms for the persistent challenges regarding the adoption of new practices in organizations.

One can draw a parallel with examples mentioned in the literature. For example, in the context of adoption of best practices in hospitals, Song et al. (2017) observe that when top management highlighted best-performing physicians during weekly meetings, the lower-performing physicians sought to imitate the highlighted best practices (timing of radiology and laboratory test orders, and discharge instruction practices). One could argue that this setting may exemplify either an ahead-seeking environment, where physicians enjoy the additional utility from being highly ranked (as argued in Song et al. (2017)), or a behind-averse environment, where lower performers experience a utility drop because of being left behind. Our analysis suggests that this organizational behavior is more consistent with behind-averse social comparisons; i.e., imitation leads to conformance. Of course, additional research is needed to establish whether the utility differentials, described above, emerged from the pride of higher performance or the shame of a lower performance.

By contrast, individuals oftentimes differentiate their choices. When this comes at an economic cost, it could be interpreted as the result of ahead-seeking social comparisons. For example, consider the documented higher status enjoyed by farmers who adopt sustainable practices, despite the productivity challenges of these practices (Dessart et al. 2019, Michel-Guillou and Moser 2006). These instances indicate the emergence of a coexistence regime, when status seeking (a form of ahead-seeking comparisons) is present (p.437, Dessart et al. 2019). While these studies are conducted in short time windows, the differentiating effects that emerge and the presence of ahead-seeking social comparisons would suggest a persistent equilibrium outcome, as per our theory.

5. Equilibrium Analysis: Extensions and Robustness

In this section we provide three robustness extensions of our equilibrium analysis derived in Section 4, which we refer to as the *base* cases. These extensions represent different structural circumstances that relate to the concept of social comparisons.

5.1. Social comparisons as *only* differentiated outcomes – Festinger (1954)

In Section 4 the conceptual underpinnings of the social comparison effects stem from recent research in the neuroscience literature (Bault et al. 2011, Corcoran et al. 2011). However, the construct of social comparisons was originally introduced under different conceptual premises: Festinger (1954) had claimed that social comparisons emerge when peer individual decision-makers observe different outcomes in the same context. Note that this is conceptually different to social comparisons in our base model, where social comparison effects are triggered by *both* different choices and different outcomes. Adopting Festinger's original view in our model would manifest itself as in Table 3.

Table 3 Model payoff matrix with δ and c under (Festinger 1954) approach

	N	O
N	$U_{NN} = p\delta - (1-p)c + p(1-p)(\delta + c)(\alpha - \beta)$	$U_{NO} = p\delta(1+\alpha) - (1-p)c(1+\beta)$
O	$U_{ON} = (1-p)\alpha c - p\beta\delta$	$U_{OO} = 0$

We show that the novel regimes of coexistence and bistability continue to exist.[12] Moreover, as we argue in the following corollary (a direct consequence of Propositions C.1 and C.2 introduced in Appendix C.1), these two regimes are less likely to arise than in the corresponding base cases.

Formally, we introduce coexistence sets in δ space under different kinds of social comparison, either $sc = B$ (Base) or $sc = F$ (Festinger): $C_F(\alpha) = \{\delta \in [\frac{c(1-p)}{p(1+\alpha)}, \frac{c(1-p)}{p}]\}$ and $C_B(\alpha) = \{\delta \in [\frac{c(1-p)}{p(1+\alpha)}, \frac{c(1-p)(1+\alpha)}{p}]\}$. The two sets represent the regions where a coexistence adoption regime exists *given* that social comparisons might be modelled as per our base case or as per Festinger. In a similar vein, we can define $B_{sc}(\beta)$ as the equivalent regions for the bistability adoption equilibrium. The following corollary formally states our findings:

Corollary 1. (Adoption as per Festinger (1954)) *Under social comparisons as per Festinger (1954), the coexistence and bistability equilibrium regimes still emerge, and the respective adoption regions are such that $C_B(\alpha) \supset C_F(\alpha)$ and $B_B(\beta) \supset B_F(\beta)$ for all possible values of α and β.*

The intuition behind Corollary 1 is as follows: in the ahead-seeking case, Festinger's approach to social comparisons enables individual employees to pursue the new practice even when their peers do it (quadrant NN), and, on expectation, enjoy additional utility because of the possibility of a differentiated outcome. This additional utility makes continuing with the old practice less attractive. Therefore, overall, the value of differentiated choices reduces and, as a result, the coexistence region shrinks. A similar rationale applies to the behind-averse case of social comparisons, where Festinger's rationale results in a smaller bistability region. These results give rise to an important conjecture that could benefit from future empirical work. We find that should ahead-seeking social comparisons arise because of differentiated choices (and not only differentiated outcomes, as Festinger purported), then we should be observing fewer full-adoption instances as a result of these social comparisons. Thus, if a number of different practices is introduced within the same (ahead-seeking) organization, an empirical analysis should record fewer instances of full adoption.

5.2. Concurrent ahead-seeking and behind-averse social comparisons

In Section 4 we assumed that organizations exhibit one type of social comparison only, either ahead-seeking or behind-averse. However, one could expect that both types of social comparison might be present, albeit with different intensities, α and β, as discussed in Section 3. We show that, even in this case, our equilibrium regimes persist. Thus, Corollary 2 (a direct consequence of Proposition C.3 introduced in Appendix C.2) shows that in an organization where individuals exhibit both types of social comparison, the different adoption regimes are qualitatively the same as the cases where only one type of social comparison is present, provided that one type of social comparison dominates the other (i.e., $\alpha > \beta$ or $\beta > \alpha$).

Corollary 2. (Concurrent ahead-seeking and behind-averse social comparisons) *The coexistence regime only arises when the organization exhibits stronger ahead-seeking social comparisons ($\alpha > \beta$). The bistability regime only arises when the organization exhibits stronger behind-averse social comparisons ($\alpha < \beta$).*

This result highlights the robustness of our base equilibrium analysis. When both types of social comparison exist concurrently, their *net* effect determines the emerging equilibrium regime.

5.3. Heterogeneous presence of social comparisons

In this subsection, we explore the effects of social comparisons on the adoption of new practices when organizations comprise heterogeneous subpopulations; i.e., employees across subpopulations exhibit different types of social comparison. We assume that there exist two fixed and non-negative shares of the population X_1, X_2 ($X_1 + X_2 = 1$): subpopulation X_1 exhibits social comparisons, while the remaining subpopulation X_2 behaves as in the benchmark setting (see Lemma 1).

Once more, the regimes of bistability and coexistence established in Section 4 persist at equilibrium, despite the varying intensity of social comparisons within the population, captured by the size of X_1 relative to X_2. Moreover, the equilibrium outcomes present additional interesting properties, depending on the economic reward δ and the relative size of X_1 (see Figures 2 and 3). Corollary 3 summarizes the robustness of the coexistence result when the subpopulation X_1 exhibits ahead-seeking social comparisons, and Corollary 4 does the same for the behind-averse setting.[13]

Corollary 3. (Heterogeneous Ahead-Seeking Organization) *In the presence of a subpopulation X_1 which exhibits ahead-seeking social comparisons, there exists an adoption regime where both practices coexist for every value of p, and X_1.*

Corollary 3 states that coexistence is a persistent phenomenon, even when a limited share of the employee population exhibits social comparisons. However, depending on the share of the ahead-seeking subpopulation, different dynamics lead to the overall coexistence. These dynamics are explained because the coexistence regime appears in the X_1 share of the population, while for the X_2 subpopulation, the only possible regimes are no adoption and full adoption. We use Figure 2 to explain the detail of Corollary 3 by reference to the two possible cases that arise.

When the threshold of economic reward δ that triggers full adoption in the subpopulation X_2 is not reached, only the employees in the ahead-seeking subpopulation X_1 differentiate by adopting the new practice. This translates, as seen in Figure 2, into an initial *increase* of adoption (at equilibrium) in the ahead-seeking subpopulation, which may result in everyone adopting (depending on the exact δ value). Based on the relative size of the subpopulation X_1, the overall organization adoption level x^* may plateau (left panel) or smoothly increase (right panel) as δ increases.

When the threshold of the economic reward δ to trigger adoption in the benchmark subpopulation X_2 is surpassed, the entire subpopulation X_2 adopts the new practice. However, this triggers a different reaction to the new practice within the ahead-seeking subpopulation. This translates (Figure 2) into a *decrease* of adoption at equilibrium in the ahead-seeking subpopulation. Similar to above, depending on the relative size of the subpopulation X_1, the adoption may again plateau (left panel) or continue increasing as the reward for adoption δ increases.

Based on the above intuition, heterogeneity in the intensity of social comparisons may result in coexistence, not only because of the social comparison effects, as in our base case. Coexistence can also arise because the two subpopulations may exhibit different thresholds of the economic rewards necessary to trigger full adoption (see case $X_1 < X_2$ in Figure 2).

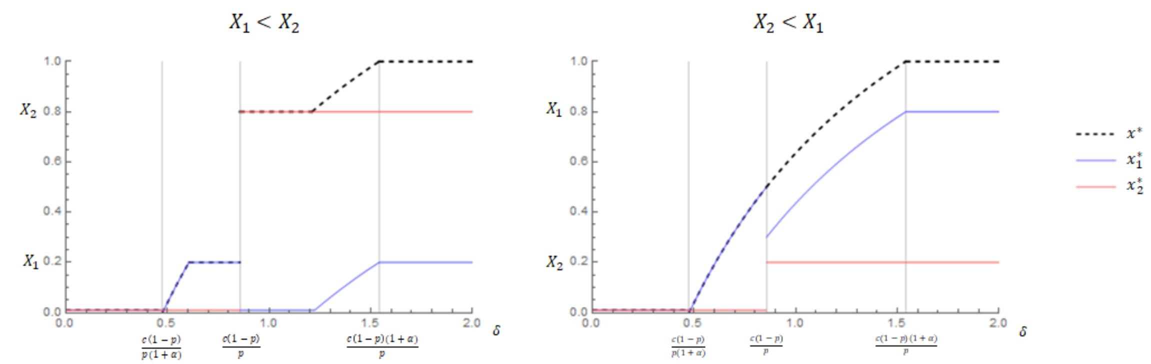

Figure 2 **Equilibrium outcomes (in blue, the fraction of adopters in the ahead-seeking subpopulation x_1^*, in red, the fraction of adopters in the benchmark subpopulation, x_2^*, and in black, the total fraction of adopters $x^* = x_1^* + x_2$) as functions of the economic reward δ when the ahead-seeking subpopulation (X_1) is smaller (left) / larger (right) than the benchmark subpopulation (X_2) (left: $p = 0.45; \alpha = 0.8; c = 0.7; X_1 = 0.2; X_2 = 0.8$; right: $p = 0.45; \alpha = 0.8; c = 0.7; X_1 = 0.8; X_2 = 0.2$)**

Corollary 4. (Heterogeneous Behind-Averse Organization) *In the presence of a subpopulation X_1 which exhibits behind-averse social comparisons, there exists a bistability adoption regime where the equilibria outcomes depend on the upfront training of the employees only when $X_1 > X_2$, and they are independent of the initial level of training when $X_1 < X_2$.*

Corollary 4 validates that a bistability adoption regime emerges even under varying intensity in the employees' social comparison behaviors. However, different dynamics take place, depending on the relative share of the subpopulation that exhibits behind-averse social comparisons. As before, these dynamics can be explained by the fact that subpopulation X_2 only fully adopts, or not (depending on δ), whereas bistability adoption outcomes may appear in the subpopulation X_1. In the latter, the critical mass of the upfront trained employees that determines the bistability adoption outcome depends on whether the subpopulation X_2 has adopted the new practice or not.

Given the above observations, a large subpopulation X_2 implies an irresistible bandwagon effect: either X_2 entirely adopts or X_2 does not adopt at all, and the X_1 population follows either way, irrespective of the level of initial training in that subpopulation (see left panel of Figure 3).

When the benchmark subpopulation X_2 is small, then a bistability adoption regime emerges (see right panel of Figure 3). In that case, an initial critical level of adoption is required for full adoption, as depicted by the x_0^* curve in Figure 3. Note that the need for upfront training is significantly reduced when the entire benchmark subpopulation has fully adopted. Yet, there also exists a range of individual reward values whereby only the behind-averse subpopulation fully adopts (subject to sufficient upfront training). Interestingly, in that range of values both practices coexist in the organization, despite the existence of behind-averse types of social comparison.

These results further enrich our understanding of why multiple practices may coexist in organizations. We have already seen that coexistence may emerge as a result of the presence of ahead-seeking comparisons. However, as we show here, the same qualitative outcome may happen for a different reason: the prevalence but also heterogeneity of behind-averse social comparisons among staff. This insight calls for caution when senior management considers how to leverage economic rewards and upfront training to induce full adoption. For example, in a heterogeneous situation, even if management has identified that behind-averse social comparisons dominate, they may not know which employees are sensitive to behind-averse comparisons and hence which ones to train to ensure a bandwagon adoption effect. This may result in less effective training investments. More broadly, our results call for richer empirical designs, on the interplay between social comparisons and the heterogeneity of employee characteristics, to detail the mechanisms that drive adoption outcomes.

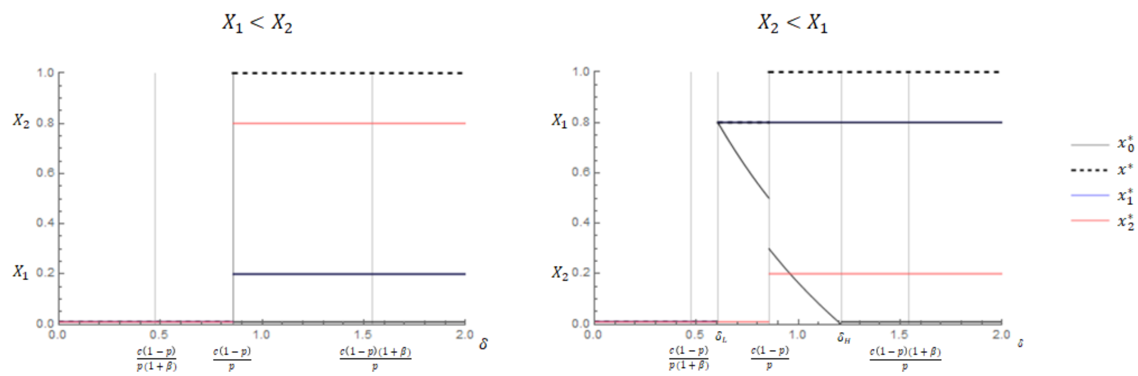

Figure 3 **Equilibrium outcomes (in blue, the fraction of adopters in the behind-averse subpopulation x_1^* when the critical mass x_0^* in grey is reached, in red, the fraction of adopters in the benchmark subpopulation, x_2^* and, in black, the total fraction of adopters $x^* = x_1^* + x_2$ when the critical mass is reached) as functions of the economic reward δ when the behind-averse subpopulation (X_1) is smaller (left) / larger (right) than the benchmark subpopulation (X_2) (left: $p = 0.45; \beta = 0.8; c = 0.7; X_1 = 0.2; X_2 = 0.8$; right: $p = 0.45; \beta = 0.8; c = 0.7; X_1 = 0.8; X_2 = 0.2$)**

6. The New Practice Introduction Problem

6.1. Optimizing rewards and training

Our equilibrium analysis in Section 4 has shown that the equilibrium outcome x^* depends on two key levers, namely, the economic reward, δ, received by an employee when they successfully adopt the new practice (which happens with probability p), and the initial fraction of adopters in the firm, x_0. In this section, we analyze the firm's problem, which is how to set those levers in order to achieve the most profitable adoption equilibrium outcome.[14] We term this the *new practice introduction problem*, since senior management has to determine the parameters (rewards and upfront training) that shape the employee individual adoption decisions and their respective population adoption outcome. We introduce the notation $x^*(\delta, x_0)$ to represent the equilibrium given δ and x_0. We explore how the culture of social comparisons within the firm affects the optimal levels of reward and initial training investment.

In our setup, the level of rewards, δ, and training, x_0, are provided by senior management only once during the time period under consideration. Offering rewards once corresponds to taking $R=1$ in the discrete version of the population game; i.e., on average each employee has one revision decision, at a randomly selected moment in the period, to choose between the new or old practice (see Appendix D for technical details behind this choice of R). We should note, though, that while δ is an output based reward upon successful practice implementation, the training x_0 is an input intervention from senior management to prime (motivate) employees to adopt the new practice. Then, at equilibrium, an average of $px^*(\delta, x_0)$ employees have successfully implemented the new practice with the corresponding cost to the firm of $px^*(\delta, x_0)\delta$. With respect to upfront training, the level is set at the start of the period given an exogenous organizational cost of c_t per employee, which translates into a total cost of $c_t x_0$ for the firm.

In terms of benefits, for each employee who successfully uses the new practice, the organization receives the economic value of R_N, while it only receives $R_O(< R_N)$ for employees who decide to stick with the old practice. On this basis, the firm attempts to maximize its payoff, notionally profit, by optimizing the level of the reward, δ, and the fraction of employees who are trained upfront, x_0:

$$\begin{aligned} \max_{\delta, x_0} \quad & \Pi_{firm} = px^*(\delta, x_0)(R_N - \delta) + (1 - x^*(\delta, x_0))R_O - c_t x_0 \\ \text{s.t.} \quad & 0 \leq \delta, \quad x_0 \in [0,1] \end{aligned} \tag{4}$$

We restrict our analysis to the settings where $pR_N - R_O > 0$; i.e., the per-employee performance improvement (productivity gain) is, on expectation, positive for the firm. Practices that would reduce the company output would not be pursued at the outset. We also anticipate that the process of optimization will tend to push δ^* toward boundaries. In Appendix D we explain how management can approach a boundary to best effect; hence, the firm's problem (4) is well defined.

As in Section 4, first we determine the firm's optimal reward scheme in the absence of social comparisons. This benchmark case allows us to delineate the effects of social comparisons on the optimal reward. Lemma 3 shows that a firm induces full adoption when the cost of failure c is sufficiently low, in which case full adoption is optimal and corresponds to the firm setting $\delta^* = c(1-p)/p$. For a higher cost of failure, however, it is uneconomical to set a positive reward. Thus, the firm does not pursue adoption of the new practice ($\delta^* = 0$) (see Figure 4).

Lemma 3. (OPTIMIZING A BENCHMARK ORGANIZATION) *In the absence of social comparisons ($\alpha = \beta = 0$): when $0 < c < \frac{pR_N - R_O}{1-p}$, the firm achieves full adoption of the new practice by offering* *the optimal (economic) reward* $\delta^* = \frac{(1-p)c}{p}$*. Otherwise, the firm does not reward the adoption of the new practice, i.e.,* $\delta^* = 0$*, and the practice is not adopted.*

The firm optimal reward seeks to achieve two things: on the one hand it offers sufficient economic utility to employees to induce them to adopt, but at the same time it ensures that, on expectation, the firm is profitable. The result complements our equilibrium analysis (Lemma 1 in Section 4).

Next, we explore the optimal firm decision to induce the adoption of a new practice in the presence of ahead-seeking social comparisons. We show that a favorable (to full adoption) decision is achievable, but also that a coexistence outcome cannot be optimally ruled out; i.e., for intermediate individual costs of failure, firms may pursue heterogeneity in the practices that are employed.

Proposition 3. (Optimizing an Ahead-Seeking Organization) *In the presence of ahead-seeking social comparisons* ($\alpha > 0$, $\beta = 0$)*, the firm optimally pursues the new practice as follows:*

- *When* $0 < c < \frac{pR_N - R_O}{(1+3\alpha+\alpha^2)(1-p)}$ *the firm induces and achieves full adoption through the optimal reward* $\delta^* = \frac{(1+\alpha)(1-p)c}{p}$*.*
- *When* $\frac{pR_N - R_O}{(1+3\alpha+\alpha^2)(1-p)} < c < \frac{(1+\alpha)(pR_N - R_O)}{1-p}$ *the firm induces and achieves partial adoption (coexistence) through the optimal reward* $\delta^*_{coex} < \frac{(1+\alpha)(1-p)c}{p}$*.*

In all other circumstances the firm decides not to pursue the new practice.

Proposition 3 advances important managerial implications, illustrated in Figure 4. Similar to Lemma 3, it is optimal for the firm to induce full adoption of the new practice only when the cost of failure is below a certain threshold. However, this threshold (i) depends on the intensity of the social comparisons α, and (ii) lies strictly below the benchmark case threshold. This result has two direct implications: first, the fact that ahead-seeking social comparisons limit the circumstances for which a firm can optimally achieve full adoption. As we have discussed, ahead-seeking comparisons create a differentiation social dynamic effect. Thus, individual rewards become increasingly unable to induce adoption as the differentiation effect becomes sizeable.

At the same time, ahead-seeking social comparisons open up an indirect benefit for organizations. A firm can optimally induce the *partial* adoption of the new practice; i.e., the coexistence adoption regime (Proposition 1) delivers the most profitable output. Moreover, this happens in settings where the cost of failure is higher than the benchmark threshold for full adoption. In other words, the dynamics of ahead-seeking social comparisons enable a firm to benefit from rolling out a new practice that would otherwise have been rejected by its employees. Instead, in such circumstances ahead-seeking comparisons induce the partial adoption of a new practice, an outcome that is impossible in the absence of these social comparisons. This result raises an important consideration, rarely addressed in the literature, with the recent exception of Naumovska et al. (2021): partial adoption of a practice might be a better option than complete retraction. Anecdotes abound of companies who declare failure to achieve full adoption of a new practice, eventually retracting the introduced practice. Our analysis indicates that, whereas full adoption might indeed be very costly to achieve, companies may still benefit from partial adoption outcomes.

For an organization with behind-averse comparisons, senior managers have two possible levers to induce adoption: individual rewards and upfront training, where the latter primes individual employees to adopt the new practice. Proposition 4 shows that such a firm optimally induces and achieves full adoption of the new practice without any upfront training effort when the cost of failure is low. However, for higher costs of failure, inducing and achieving full adoption happens *only* through a combination of rewards and training, provided the latter comes at reasonable cost c_t. We also provide the conditions under which senior managers are willing to institute upfront training for the *entire* population of employees, because that, together with a suitable economic reward, delivers maximum profit. Proposition 4 formalizes this (see Figure 4 for a graphical illustration).

Proposition 4. (Optimizing a Behind-Averse Organization) *In the presence of behind-averse social comparisons ($\alpha = 0$ and $\beta > 0$), a firm optimally pursues and achieves full adoption of the new practice as follows:*

- *Without upfront training ($x_0^* = 0$) through optimal reward $\delta^* = \frac{c(1-p)(1+\beta)}{p}$ when* $\begin{cases} 0 < c < \frac{pR_N - R_O}{(1+\beta)(1-p)} \\ c_t > \beta(2+\beta)c(1-p) \end{cases}$
- *With upfront training ($0 < x_0^*(\delta^*) < 1$) through optimal reward $\delta^* = \frac{\sqrt{\beta(2+\beta)cc_t(1-p)p^2} - \beta c(1-p)p}{\beta p^2}$ when* $\begin{cases} 0 < c < \frac{pR_N - R_O}{(1+\beta)(1-p)} \\ \frac{\beta(2+\beta)c(1-p)}{(1+\beta)^2} < c_t < \beta(2+\beta)c(1-p) \end{cases}$ *or* $\begin{cases} \frac{pR_N - R_O}{(1+\beta)(1-p)} < c < \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} \\ \frac{\beta(2+\beta)c(1-p)}{(1+\beta)^2} < c_t < c_{t_3} \end{cases}$
- *With full upfront training ($x_0^* = 1$) through optimal reward $\delta^* = \frac{c(1-p)}{p(1+\beta)}$ when* $\begin{cases} 0 < c < \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} \\ 0 < c_t < \frac{\beta(2+\beta)c(1-p)}{(1+\beta)^2} \end{cases}$ *or* $\begin{cases} \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} < c < \frac{(1+\beta)(pR_N - R_O)}{1-p} \\ 0 < c_t < \frac{(pR_N - R_O)(1+\beta) - c(1-p)}{1+\beta} \end{cases}$

In all other circumstances the firm does not optimally pursue adoption of the new practice.

Proposition 4 also points to a few important managerial insights. The presence of behind-averse social comparisons renders full adoption harder to achieve through rewards only, compared to the optimal benchmark result. This happens, however, for a different reason than in the ahead-seeking case. Behind-averse comparisons create an additional individual disutility upon failure beyond the individual cost of failure. This extra disutility requires a higher reward to be overcome, resulting in fewer circumstances where such a reward can be afforded. However, the firm could exploit the conformance dynamic of the behind-averse comparisons, and the possibility of training, to expand the set of circumstances where full adoption is optimally achieved. Upfront training creates the critical mass of individual employees, primed to adopt the new practice, which becomes the basis for a bandwagon effect to drive the rest of the employee population to adopt. Thus, training serves as a *complement* to the individual rewards in achieving full adoption.

This insight calls for establishing the right managerial priority in new practice adoption: Should emphasis be granted in training, and upfront priming, or in economic rewards? The answer is not straightforward, and it depends on the relative training costs and the individual costs of failure. In fact, for modest training costs, a firm optimally achieves full adoption even in settings where this would not be possible in the absence of social comparisons (i.e., benchmark case).

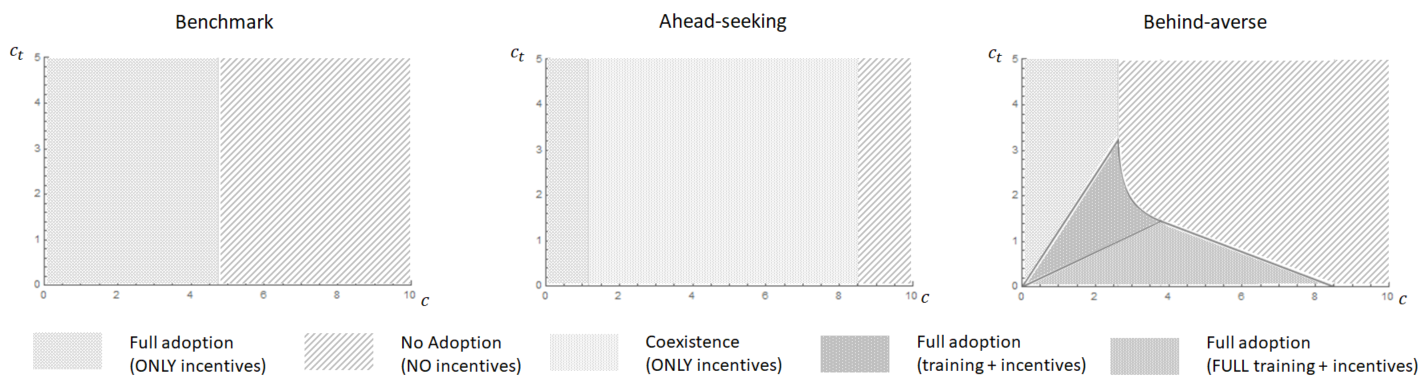

Figure 4 How equilibrium regions at optimality in a benchmark organization (no social comparisons), an ahead-seeking organization, and a behind-averse organization depend on the economic reward δ and the cost of failure c ($p = 0.45; \alpha = 0.8; \beta = 0.8; R_N = 8; R_O = 1$)

6.2. Do social comparisons reduce firm profitability?

We analyze further the firm profitability implications from social comparisons: when does the presence of social comparisons reduce the firm's *optimal* profitability from adopting a new practice? Propositions 5 and 6 and Figure 5 summarize our key insights. We denote the optimal profits as $\Pi^*_{setting}$, where *setting* can be AS (ahead-seeking), BA (behind-averse), and B (benchmark).

In a firm with ahead-seeking comparisons, we find a threshold $\bar{c}$ for the cost of failure, above which the social dynamics render the firm adoption efforts more beneficial. This happens because, for higher costs of failure, full adoption becomes uneconomical in a benchmark organization; i.e., very high δ is necessary. Thus, the benchmark firm profits are either positive but low, or negative, prompting no adoption. However, an organization with ahead-seeking comparisons exploits the differentiation effect and enables a coexistence adoption regime through a lower δ. Thus, it can reap higher profits despite achieving only partial adoption of the practice. In fact, for very high costs of failure, some form of adoption only happens under an ahead-seeking organizational culture.

Under behind-averse social comparisons, there also exist individual training cost thresholds *below* which the social dynamics render firm adoption more profitable. Interestingly, this is possible for almost all values of the cost of failure. When the costs of failure are relatively high, behind-averse comparisons lead to the highest optimal profits for any training cost c_t ($\Pi^*_{BA} \geq \Pi^*_B$). This happens

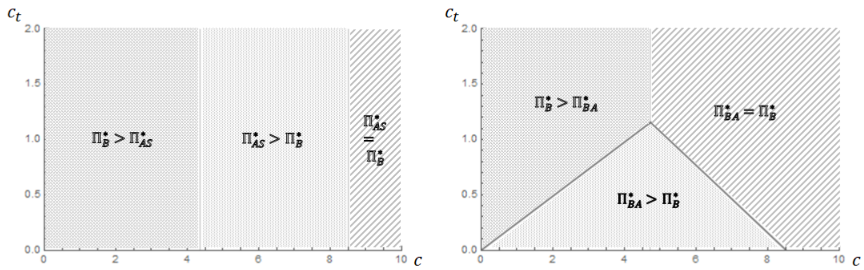

Figure 5 **How Optimal Firm Profits compare, depending on the cost of initial training c_t and the cost of failure c: ahead-seeking vs benchmark organization (left: $p=0.45; \alpha=0.8; R_N=8; R_O=1$) and behind-averse vs benchmark organization (Right: $p=0.45; \beta=0.8; R_N=8; R_O=1$))**

because the conformance effect of behind-averse comparisons exploits the reinforcement between rewards and training, and induces individual adoption through less overall cost.

Proposition 5. (Optimal profits Comparisons ahead-seeking)

- $\Pi_B^* > \Pi_{AS}^*$ *when* $0 < c < \bar{c}$
- $\Pi_{AS}^* > \Pi_B^*$ *when* $\bar{c} < c < \frac{(1+\alpha)(pR_N - R_O)}{1-p}$

In all other circumstances, no adoption occurs in both benchmark and ahead-seeking organizations resulting in the same optimal profits.

Proposition 6. (Optimal profits Comparison Behind-Averse)

- $\Pi_{BA}^* > \Pi_B^*$ *when* $\begin{cases} 0 < c < \dfrac{pR_N - R_O}{1-p} \\ 0 < c_t < \dfrac{\beta c(1-p)}{1+\beta} \end{cases}$ *or* $\begin{cases} \dfrac{pR_N - R_O}{1-p} < c < \dfrac{(1+\beta)(pR_N - R_O)}{1-p} \\ 0 < c_t < pR_N - R_O - \dfrac{c(1-p)}{1+\beta} \end{cases}$
- $\Pi_B^* > \Pi_{BA}^*$ *when* $\begin{cases} 0 < c < \dfrac{pR_N - R_O}{1-p} \\ c_t > \dfrac{\beta c(1-p)}{1+\beta} \end{cases}$ *or* $\begin{cases} \dfrac{pR_N - R_O}{1-p} < c < \dfrac{(1+\beta)(pR_N - R_O)}{1-p} \\ c_t > pR_N - R_O - \dfrac{c(1-p)}{1+\beta} \end{cases}$

In all other circumstances, no adoption occurs in both benchmark and behind-averse organizations, resulting in the same optimal profits.

6.3. Does managerial unawareness limit adoption?

Finally, we ask a different, but equally important, question: Does a senior manager's *lack* of knowledge of the existence of social comparisons drastically limit the possibility of adoption? We compare the adoption result for two cases: we contrast the overall adoption outcome of an "aware decision" by a manager who knows the particular type of social comparison in their organization, i.e., who chooses the firm's optimal policy δ and x_0, with an "unaware decision" by a manager who is unaware of social comparisons in the same organizational setting, hence setting δ to be the benchmark optimal. We present our comparisons in Table 4.

These comparisons reveal relevant managerial insights. First, and foremost, one can verify in Table 4 that ignoring the existence of social comparisons when pursuing the adoption of a new practice, and instead applying a benchmark reward scheme, guarantees that full adoption will never be achieved. Yet coexistence may ensue in some cases. This happens independent of the type of social comparison. The result cautions senior managers about the significance of accounting for the social dynamics when deciding the roll-out strategies for new practices or technologies. Moreover, in the presence of behind-averse comparisons the outcome is even more unforgiving: management is *never* able to achieve any level of adoption using the benchmark optimal policy. This is particularly challenging in the case of behind-averse comparisons, because the lack of training (determined by a manager operating under a benchmark policy) necessitates disproportionately higher individual rewards to induce adoption, compared to a benchmark scenario. As such, management fails to sufficiently reward new practice adoption, resulting in a persistent no-adoption outcome. Under ahead-seeking comparisons, the differentiation effect arises even under the suboptimal individual-benchmark-level rewards and enables a coexistence adoption regime.

Table 4 Comparison of adoption outcomes between aware and unaware decisions in a firm with ahead-seeking social comparisons and in a firm with behind-averse social comparisons

	Adoption outcome (aware decision)	Adoption outcome (unaware decision)
Ahead-seeking organization		
$0 < c < \frac{pR_N - R_O}{(1+3\alpha+\alpha^2)(1-p)}$	Full adoption	Coexistence
$\frac{pR_N - R_O}{(1+3\alpha+\alpha^2)(1-p)} < c < \frac{pR_N - R_O}{1-p}$	Coexistence	Coexistence
$\frac{pR_N - R_O}{1-p} < c < \frac{(1+\alpha)(pR_N - R_O)}{1-p}$	Coexistence	No adoption
$\frac{(1+\alpha)(pR_N - R_O)}{1-p} < c$	No adoption	No adoption
Behind-averse organization		
$0 < c < \frac{pR_N - R_O}{(1+\beta)(1-p)}$		
$0 < c_t$	Full adoption	No adoption
$\frac{pR_N - R_O}{(1+\beta)(1-p)} < c < \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)}$		
$0 < c_t < c_{t_3}$	Full adoption	No adoption
$c_t > c_{t_3}$	No adoption	No adoption
$\frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} < c < \frac{(1+\beta)(pR_N - R_O)}{1-p}$		
$0 < c_t < pR_N - R_O - \frac{c(1-p)}{1+\beta}$	Full adoption	No adoption
$c_t > pR_N - R_O - \frac{c(1-p)}{1+\beta}$	No adoption	No adoption
$c > \frac{(1+\beta)(pR_N - R_O)}{1-p}$		
$c_t > 0$	No adoption	No adoption

Overall, the lack of awareness brings negative consequences uniformly to the adoption of new practices, highlighting the need for tools and methods that allow the identification and measurement of social dynamics such as social comparisons. The situation of a behind-averse firm underlines this in extreme terms: properly accounting for social comparisons is a necessary condition for management to be able to achieve full adoption of the new practice.

7. Discussion and Conclusions

This study revisits a classic organizational challenge: the organization's ability to adopt new practices that increase their productivity and performance. The longstanding and interdisciplinary academic literature on the subject has highlighted the important role of social dynamics for successful adoption, with a particular emphasis on the effects of externalities; i.e., the more the adopters, the higher the value from adoption.

Yet, another key dynamic, which several industry examples reveal, has been overlooked: the social comparisons between employees. Social comparisons render the utility from adoption into a payoff relative to peer performance. Employees do not realize just absolute economic returns, which depend on the success of using the new practice; they also accrue (behavioral) utility as a result of their performance relative to their peers. This premise has two important–neglected from the literature implications (Naumovska et al. 2021): first, employees, naturally, include strategic considerations in their decision-making. Second, senior managers, who introduce the new practice, might set suboptimal policies, should they overlook or dismiss the presence of such social dynamics.

We study the effects of social comparisons on the eventual adoption of new practices through an evolutionary game theoretic model. Therein, boundedly rational employees decide whether to adopt a novel practice over time. Their decisions rely on the behavioral dynamics described above. We consider the two archetypes of social comparison introduced in the literature: ahead-seeking and behind-averse social comparisons (Roels and Su 2013, Bault et al. 2011, Sobel 2005). These behavioral utility payoffs motivate the strategic interactions of our formal game theoretic analysis. Furthermore, we analyze the optimal reward system that senior management may establish to induce the maximum profit for the overall organization. Our results make important contributions to the academic literature, and they motivate relevant managerial takeaways.

From a theoretical viewpoint, we show the fundamental role of social comparisons. Even when an organization faces homogeneous employee characteristics, comparisons suffice to give rise to a richer set of *long-run* adoption outcomes; e.g., practices coexist within the organization, or their adoption depends on additional actions from senior management, such as upfront training. Thus, the traditional dichotomy in the literature between full adoption and complete failure to adopt might have been overly restrictive. Our findings acquire further importance because of the assumed homogeneity of the employee behaviors. The few prior studies that advocate coexistence in organizational practices in steady state motivate their results through heterogeneous employee characteristics (Dokko and Gaba 2012, Rosenberg 1972), or heterogeneity in the connectivity between employees (Centola 2019). However, we show that, under complete homogeneity in characteristics and connectivity, an adoption outcome where old and new practices coexist may still emerge. The strategic interactions induced by certain types of social comparison (i.e., ahead-seeking) give rise to a differentiation dynamic between employees and to an eventual diversity in the adopted practices.

Moreover, we identify circumstances where adoption outcomes outside of the traditional full-adoption and no-adoption dichotomy may constitute the *optimal* objective pursued by an organization's senior management. These findings lead to three important insights: first, the fact that the richer set of adoption outcomes described in our equilibrium analysis is also prescriptively possible; i.e., a trichotomy of outcomes – full adoption, no adoption and coexistence – should be on the radar of senior management. Refining this, our second insight is that the enforcement of a full adoption logic (induced by sizeable rewards) might impose, oftentimes, suboptimality. Finally, third, our explicit consideration of the firm's new practice introduction problem has formally identified another important lever that can be engaged by senior management to induce adoption: upfront training to prime employees to attempt the new practice, at least initially.

Our analysis has also identified conditions that show whether the firm's optimal performance is higher under the existence of social comparisons or under their absence. Although these results are descriptive, they map out *when* social comparisons facilitate adoption. As such, they offer a basis for further literature discussion around the possibility that senior management could influence the social comparison culture in their organization toward a specific type.

Our study also sheds light on the managerial levers that organizations can pull to influence the adoption of new practices. First, our core theoretical result, i.e., the significant role of social comparisons on adoption at the population level, suggests an important management action: the development and use of methods and tools to identify the type and intensity of social comparisons present in an organization. This can happen through psychometric surveys, or other human resources data sets (e.g., Glassdoor see Sull et al. (2019)), which allow for estimating cultural traits such as the intention to socially compare with peers. Our theory posits that different cultures, in terms of social comparisons, might lead to drastically different outcomes when pursuing a new practice; thus, credible knowledge about these traits is paramount. Second, our analysis describes when training and investment in employee-development programs becomes beneficial. The business press, and also many consultancies, continuously advocate company investment in training to ensure adoption of the latest practices, and subsequent embedding of the practice "champions" inside the company ranks to enable diffusion of the practice. We show that such approaches are not a panacea. Training efforts may prove to be of limited value. In the presence of ahead-seeking comparisons, training fails to address the fundamental effect of differentiation across employee choices. In organizational settings with behind-averse social comparisons, upfront training investments are necessary to achieve full adoption, but they may be both sizeable and costly, and therefore uneconomical. We offer a contingency map as to when upfront training effectively complements the optimal reward scheme set out to induce adoption.

As with all models, ours has limitations that point to future research opportunities. Our current analysis assumes homogeneity in the interactions between employees. This allowed us to showcase the novelty and robustness of the mechanism identified in this paper. Still, in reality, organizations are better represented by sparse networks as opposed to fully connected graphs. Future research could examine how the structure of the organizational network of employees mediates the comparisons between individuals (e.g., see Feylessoufi (2020) for a treatment). In addition, we assume that the individual's ability to successfully adopt a new practice is uniform across the entire population. Further research could examine the adoption outcomes of new practices when employees learn over time, from one another, to master the new practice. In Appendix E we offer a rudimentary version of social learning (Boyd and Richerson 1988) that takes place through peer information exchanges and collaboration. More is definitely needed in that space.

Altogether, we believe that our study breaks new ground in the literature on practice adoption, in an era when most organizations are contemplating how to transform their performance through the adoption of digital technologies, tools, methods, etc. Achieving the so-called digital transformation requires the establishment of new practices, and employees must buy into those. Thus, understanding and accounting for the behavioral factors that determine employee choices becomes a valuable imperative for any organization's senior management. We hope that our work sheds useful light on such a direction.

Notes

[1]In his words: "*I will not judge whether each team has done a good job or not, because all of you are moving forward. If you run faster than others and achieve more, you are heroes. But, if you run slowly, I won't view you as underperformers*" (Chun et al. 2018).

[2]Overall, social comparisons are classified into two categories: *behind-averse* (also called *social regret* and *envy*) and *ahead-seeking* (also called *status-seeking* and *gloating*).

[3]In these studies, uncertainty resolves proportionally to the fraction or percentage of adopters, as in traditional epidemiology contagion models (Mahajan et al. 1990).

[4]Corcoran et al. (2011), and Dvash et al. (2010) note that "*even failures might suddenly appear to be successes in comparisons with others who performed even worse than oneself.*"

[5]Research in neuroscience, behavioral economics, and decision-making under uncertainty considers two broad archetypes of social comparison, namely, *behind-averse* and *ahead-seeking* (Ashraf and Bandiera 2018, Bault et al. 2011, Charness and Rabin 2002, Fehr and Schmidt 1999). Social comparisons have also been termed as *status-seeking* (Sobel 2005) or *gloating* (Coricelli and Rustichini 2010) instead of ahead-seeking, and *social regret* (Avcı et al. 2014) or *envy* (Lahno and Serra-Garcia 2015, Sobel 2005) instead of behind-averse.

[6]This random pairing framework has been widely employed in the population dynamics literature (Sandholm 2010, Schlag 1998). Moreover, dyadic (pair) interactions have been used to capture innovation phenomena in social networks, e.g., creativity in Sosa (2011), or task rework in Sosa (2014).

[7]Bault et al. (2011) show experimentally, by analyzing brain striatum activity and skin conductance, that individuals exhibit significant utility gains (losses) when their better (worse) outcomes are attributed to choices that are visibly different than their peers' choices.

[8]In Section 5.1 we show that our equilibrium results remain qualitatively similar even if we assume that social comparisons occur when the same adoption choices are made, similar to the traditional Festinger (1954) theory.

[9]R does not affect the evolution of the population, which is characterized by the differential equation (3); rather, it is a modelling artefact for the underlying discrete stochastic process that allows us to transform the switching rates ρ_{ij} into probabilities by dividing by R. This yields a Markov process, which can be approximated by a differential equation. If we fix $R = 1$ (as we will for narrative purposes in Section 6), then the switching rates $\rho_{i,j}$ have to be properly scaled such that they are between 0 and 1.

[10]This description represents a classic imitation protocol from the literature in evolutionary game theory, known as *pairwise proportional imitation* (Sandholm 2010, Schlag 1998). The choice made by employees at any moment is based on the state of the organization at the time of evaluation; decisions do not account for a forward-looking optimization mechanism such as dynamic programming. Employees act "myopically," an assumption consistent with the organizational literature (e.g. Levinthal and March 1993) wherein bounded rationality is a key characteristic of individual decision-makers. This setup allows for employees to change practice at the next revision opportunity, e.g., from the new practice back to the old, should $U_O(x)$ exceed $U_N(x)$ at that moment.

[11]We assume, however, that the uncertainty parameter p associated with successful implementation of the new practice at the micro level is not necessarily resolved or remediated by the population evolution. In our base analysis and throughout the rest of the paper, we assume that no learning takes place even though the employees attempt the new practice over time. This assumption is not overly restrictive when one takes into account that practices address complex tasks where success or failure might not easily translate into crisp insights for change and improvement (e.g., in healthcare contexts that involve patients practice outcomes rely heavily on patient idiosyncrasies and therefore success or failure cannot be directly attributed to the practice protocol). Still, in Appendix E we introduce a simple extension that accounts for a form of social learning (Boyd and Richerson 1988): employees who attempt the new practice and interact (compare) with peer adopters enjoy a higher probability of successful implementation. This is justified because of the information exchange and mutual learning (Özkan-Seely et al. 2015) that occurs through their social interactions (Crama et al. 2019, Sting et al. 2020).

[12]In Appendix C.1 we offer a detailed derivation of the equilibrium regimes under the Festinger (1954) conceptualization of social comparisons.

[13]We offer the full equivalent of Propositions 1 and 2 for the case of heterogeneous populations in Appendices C.3 and C.4, respectively.

[14]We should note that our analysis hereafter applies in the numerous circumstances where a firm cannot enforce the new practice *by decree*; we interpret this as the tasks and effort associated with the new practice being observed/monitored by a third party or mechanism, and verifiably documented by a legally binding process. In these cases our discussion becomes moot. We thank one of the referees for suggesting this clarification.

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Appendix. "Behavioral Microfoundations of New Practice Adoption: the Effects of Rewards, Training and Population Dynamics"

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A. Proof of Theorem 1

To prove that our differential equation approximates well the Markov process $\{X_t^n\}$, we adapt Sandholm (2010) (Theorem 10.2.3, pp. 372-374) using conditions from a theorem of Kurtz (1970) (Theorem 2.11, pp. 53-54) on approximations of Markov jump processes. Following Sandholm (2010), we calculate three functions of interest: the expected increment per unit of the Markov process $V^n(x)$, the expected absolute displacement per time unit, $A^n(x)$ and the expected absolute displacement per time unit due to jumps travelling further than δ, $A^n_{\delta^n}(x)$. A minor change in notation is that we use a scalar x to denote the fraction of adopters, rather than the more general vector notation of Sandholm which, in our setting with only two practices, would have appeared as $(x, 1-x)$ in the 2-dimensional simplex.

We define ζ_x^n to be a random variable whose distribution describes the stochastic increment of $\{X_t^n\}$, in the set of feasible social states given by $\{0, 1/n, 2/n, \ldots, 1\}$, from state x such that $P(\zeta_x^n = z) = P^n_{x,x+z}$. Each agent chooses the new or the old practice, thereby either incrementing or decrementing, respectively, the total fraction of adopters by $1/n$. Sandholm captures this using (e_N, e_O) which is either (1,0), if the agent chooses New, or (0,1) otherwise. Hence we compute the expected increment the Markov process $\{X_t^n\}$ with $\lambda_x^n = nR$ being the jump rate, as:

$$\begin{aligned}
V^n(x) &= \lambda_x^n E[\zeta_x^n] \\
&= nR \sum_{i\in(O,N)} \sum_{j\neq i} \frac{1}{n}(e_j - e_i) P(\zeta_x^n = \frac{1}{n}) \\
&= nR \sum_{i\in(O,N)} \sum_{j\neq i} \frac{1}{n}(e_j - e_i) \frac{x_i \rho_{ij}(U(x), x)}{R} \\
&= nR \sum_{i\in(O,N)} \sum_{j\neq i} \frac{1}{n}(e_j - e_i) \frac{x_i x_j [U_j(x) - U_i(x)]_+}{R} \\
&= (e_O + e_N)(x(1-x)(U_N(x) - U_O(x))
\end{aligned}$$

Thus, we have, $V^n(x) = x(1-x)(U_N(x) - U_O(x))$ (our differential equation) which is Lipschitz continuous so ensure existence and uniqueness of the solutions of the differential equation.

For the pair of new and old practice strategies, $|e_N - e_O| = \sqrt{2}$, thus leading the increments of the Markov process to be either of length $\frac{\sqrt{2}}{n}$ or 0. Define the expected absolute displacement per time unit as, $A^n(x) = \lambda_x^n E[|\zeta_x^n|]$ and the expected absolute displacement per time unit due to jumps travelling further than δ as, $A^n_{\delta^n}(x) = \lambda_x^n E[|\zeta_x^n 1_{|\zeta_x^n > \delta^n|}|]$. By setting, $\delta^n = \frac{\sqrt{2}}{n}$, we have that $A^n(x) \leq \frac{\sqrt{2}}{R}$ and $A^n_{\delta^n}(x) = 0$. Thus obtaining the conditions given by Kurtz (1970) proves that the Markov process is well approximated by $V^n(x)$.

B. Proofs of the Equilibrium analysis

In the rest of this Appendix, we rely on a well-established result in evolutionary game theory (see Weibull (1997), Chapter 3) showing that the asymptotic stable points (a strong stability concept in the study of dynamic systems) of our mean dynamic (deterministic approximation of the stochastic process) which arise from symmetric 2x2 population games are equivalent to evolutionary stable strategies (ESS) of the underlying game. Similar to Weibull (1997) (p. 75), we focus on generic cases (with no payoff ties) of our population game and we characterize below the conditions leading to these stable equilibria. This is without loss of generality (see proof of Proposition 1 in Appendix B.2. for the cases where payoff ties occur):

B.1. Proof of Lemma 1

In the benchmark case, $\alpha = 0$ and $\beta = 0$.

The full-adoption regime occurs iff $\begin{cases} U_{NN} > U_{ON} \\ U_{NO} > U_{OO} \end{cases} \Leftrightarrow \begin{cases} V_O + p\delta - (1-p)c > V_O \\ V_O + p\delta - (1-p)c > V_O \end{cases} \Leftrightarrow \delta > \frac{(1-p)c}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} < U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} V_O + p\delta - (1-p)c < V_O \\ V_O + p\delta - (1-p)c < V_O \end{cases} \Leftrightarrow \delta < \frac{(1-p)c}{p}$

B.2. Proof of Proposition 1

In an ahead-seeking organization, $\alpha > 0$ and $\beta = 0$. There exists a unique stable equilibrium which corresponds to a mix of adopters and non-adopters in the organization (i.e., coexistence) x^* iff two conditions hold,

$$\begin{cases} U_{NN} < U_{ON} \\ U_{NO} > U_{OO} \end{cases} \text{iff} \begin{cases} V_O + p\delta - (1-p)c < V_O + (1-p)c\alpha \\ V_O + p\delta(1+\alpha) - (1-p)c > V_O \end{cases} \Leftrightarrow \begin{cases} \delta < \dfrac{c(1-p)(1+\alpha)}{p} \\ \delta > \dfrac{c(1-p)}{p(1+\alpha)} \end{cases}$$

The stable equilibrium which is an interior fixed point of the mean dynamic is such that:

$$U_N(x^*) = U_O(x^*) \Leftrightarrow x^* = \frac{p(1+\alpha)\frac{\delta}{c} - (1-p)}{\alpha(1 + p(\frac{\delta}{c} - 1))}$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} > U_{ON} \\ U_{NO} > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{c(1-p)(1+\alpha)}{p} \\ \delta > \dfrac{c(1-p)}{p(1+\alpha)} \end{cases} \Leftrightarrow \delta > \frac{c(1-p)(1+\alpha)}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} < U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta < \dfrac{c(1-p)(1+\alpha)}{p} \\ \delta < \dfrac{c(1-p)}{p(1+\alpha)} \end{cases} \Leftrightarrow \delta < \frac{c(1-p)}{p(1+\alpha)}$

Looking at boundaries (non-generic cases where payoff ties occur), when $U_{NN} = U_{ON}$ and $U_{NO} > U_{OO}$, i.e., $\delta = \frac{c(1-p)(1+\alpha)}{p} > \frac{c(1-p)}{p(1+\alpha)}$, then an employee is indifferent between choosing the new practice or the old practice when meeting an adopter but will choose the new practice when meeting a non-adopter, thus, adopting the new strategy is evolutionary stable as it cannot be invaded by a non-adoption strategy and full adoption occurs in the organization. We verify that at that value of δ, we have continuity between the 2 regimes (full adoption and coexistence), i.e., $x^*(\delta = \frac{c(1-p)(1+\alpha)}{p}) = 1$.

Similarly, when $U_{OO} = U_{NO}$ and $U_{ON} > U_{NN}$, i.e., $\delta = \frac{c(1-p)}{p(1+\alpha)} < \frac{c(1-p)(1+\alpha)}{p}$ then sticking with the old practice is evolutionary stable and the organization will end up not adopting the new practice. We verify as well that at that value of δ, we have continuity between the 2 regimes (no adoption and coexistence): $x^*(\delta = \frac{c(1-p)}{p(1+\alpha)}) = 0$.

There is no loss of generality when looking at generic cases and in the rest of the Appendix, we focus on the generic cases of our population game and discuss the firm optimization occurring at boundaries in Appendix D.

B.3. Proof of Proposition 2

In a behind-averse organization, $\alpha = 0$ and $\beta > 0$. There exist two stable equilibria (bistability regime) which correspond to the whole organization adopting the new practice if a critical mass is initially adopting otherwise no one adopts in the organization iff

$$\begin{cases} U_{NN} > U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} V_O + p\delta - (1-p)c > V_O - p\delta\beta \\ V_O + p\delta - (1-p)c(1+\beta) < V_O \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{c(1-p)}{p(1+\beta)} \\ \delta < \dfrac{c(1-p)(1+\beta)}{p} \end{cases}$$

In this bistability regime, the unstable interior fixed point (a fixed point that does not correspond to an ESS of the game) is such that:

$$U_N(x_0^*) = U_O(x_0^*) \;\Leftrightarrow\; x_0^* = \frac{(1-p)(1+\beta) - p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))}.$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} > U_{ON} \\ U_{NO} > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{c(1-p)}{p(1+\beta)} \\ \delta > \dfrac{c(1-p)(1+\beta)}{p} \end{cases} \Leftrightarrow \delta > \frac{c(1-p)(1+\beta)}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} < U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta < \dfrac{c(1-p)}{p(1+\beta)} \\ \delta < \dfrac{c(1-p)(1+\beta)}{p} \end{cases} \Leftrightarrow \delta < \frac{c(1-p)}{p(1+\beta)}$

B.4. Proof of Lemma 2

This is a straightforward computation of the derivatives of the variables of interest.

C. Proofs of the Equilibrium Analysis: Extensions and Robustness

C.1. Proof of Corollary 1

We show below that the main insights of our base model qualitatively hold when social comparisons are as described by Festinger (1954) though the two regimes of interest, namely coexistence and bistability regimes, which are characterised by sets in the δ parameter space, shrink relative to those regimes in our base models. To prove this corollary, we introduce Propositions C.1 and C.2. We derive the equilibria regimes both in a ahead-seeking ($\alpha > 0, \beta = 0$) and behind averse ($\alpha = 0, \beta > 0$) organization following Festinger's approach. Consider all the problem parameters as in our base model setup, with the only difference being the additional utility gain/loss that takes place when employees adopt the same practice but they end up realizing different outcomes as shown in Table 3.

Proposition C.1. (Ahead-seeking Organization - Á la Festinger (1954)) *In the presence of ahead-seeking comparisons ($\alpha > 0$, $\beta = 0$), the following adoption regimes emerge:*

- *Full adoption occurs when* $\delta > \frac{c(1-p)}{p}$
- *Coexistence occurs when* $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)}{p}$*, with the equilibrium share of adopters in the organization being* $x^* = \frac{(1-p)-p(1+\alpha)\frac{\delta}{c}}{-\alpha((1-p)^2+\frac{\delta}{c}p^2)}$

Otherwise no adoption occurs.

Proof. In organizations with ahead-seeking social comparisons under the approach of Festinger (1954):

There exists a unique stable equilibrium which corresponds to a mix of adopters and non-adopters in the organization (i.e., coexistence) x^* iff two conditions hold, $\begin{cases} U_{NN} < U_{ON} \\ U_{NO} > U_{OO} \end{cases}$ iff

$$\begin{cases} p\delta - (1-p)c + p(1-p)(\delta+c)\alpha < (1-p)c\alpha \\ p\delta(1+\alpha) - (1-p)c > 0 \end{cases} \Leftrightarrow \begin{cases} p\delta(1+(1-p)\alpha) < (1-p)c(1+(1-p)\alpha) \\ p\delta(1+\alpha) - (1-p)c > 0 \end{cases} \Leftrightarrow$$
$$\begin{cases} \delta < \dfrac{c(1-p)}{p} \\ \delta > \dfrac{c(1-p)}{p(1+\alpha)} \end{cases}$$

The stable equilibrium which is an interior fixed point of the mean dynamic is such that:

$$U_N(x^*) = U_O(x^*) \Leftrightarrow x^* = \frac{(1-p)-p(1+\alpha)\frac{\delta}{c}}{-\alpha((1-p)^2+\frac{\delta}{c}p^2)}$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} > U_{ON} \\ U_{NO} > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{c(1-p)}{p} \\ \delta > \dfrac{c(1-p)}{p(1+\alpha)} \end{cases} \Leftrightarrow \delta > \frac{c(1-p)}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} < U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta < \dfrac{c(1-p)}{p} \\ \delta < \dfrac{c(1-p)}{p(1+\alpha)} \end{cases} \Leftrightarrow \delta < \frac{c(1-p)}{p(1+\alpha)}$

Proposition C.2. (Behind-Averse Organization - Á la Festinger (1954)) *In the presence of behind-averse social comparisons* ($\beta > 0$, $\alpha = 0$) *the following adoption regimes emerge:*

- *Full adoption without upfront training occurs when* $\delta > \frac{(1-p)c(1+\beta)}{p}$
- *Full adoption with upfront training occurs when* $\frac{c(1-p)}{p} < \delta < \frac{(1-p)c(1+\beta)}{p}$ *and the initial fraction of trained employees,* x_0*, exceeds the critical mass,* $x_0^*(\delta) = \frac{(1-p)(1+\beta)-p\frac{\delta}{c}}{\beta((1-p)^2+\frac{\delta}{c}p^2)}$

Otherwise, no adoption occurs.

Proof. In organizations with behind-averse social comparisons under the approach of Festinger (1954):

There exist two stable equilibria (bistability regime) which correspond to the whole organization adopting the new practice if a critical mass is initially adopting otherwise no one adopts in the organization iff $\begin{cases} U_{NN} > U_{ON} \\ U_{NO} < U_{OO} \end{cases}$ iff

$$\begin{cases} p\delta-(1-p)c-p(1-p)(\delta+c)\beta > -p\delta\beta \\ p\delta-(1-p)c(1+\beta)<0 \end{cases} \Leftrightarrow \begin{cases} p\delta(1+p\beta) > (1-p)c(1+p\beta) \\ p\delta < (1-p)c(1+\beta) \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{c(1-p)}{p} \\ \delta < \dfrac{(1-p)c(1+\beta)}{p} \end{cases}$$

In this bistability regime, the unstable interior fixed point (a fixed point that does not correspond to an ESS) is such that:

$$U_N(x_0^*) = U_O(x_0^*) \;\Leftrightarrow\; x_0^* = \frac{(1-p)(1+\beta)-p\frac{\delta}{c}}{\beta((1-p)^2+\frac{\delta}{c}p^2)}\,.$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} > U_{ON} \\ U_{NO} > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{c(1-p)}{p} \\ \delta > \dfrac{(1-p)c(1+\beta)}{p} \end{cases} \Leftrightarrow \delta > \frac{(1-p)c(1+\beta)}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} < U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta < \dfrac{c(1-p)}{p} \\ \delta < \dfrac{(1-p)c(1+\beta)}{p} \end{cases} \Leftrightarrow \delta < \frac{c(1-p)}{p}$

Proof of Corollary 1. Corollary 1 is a direct consequence of Propositions C.1, C.2 and Propositions 1, 2.

In the ahead-seeking base model (Proposition 1), the coexistence regime arises when $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)(1+\alpha)}{p}$. Given that $\forall(\alpha,p,c)$, $\frac{c(1-p)}{p} < \frac{c(1-p)(1+\alpha)}{p}$, the coexistence regime under Festinger's approach (Proposition C.1) is smaller than the one in the base model.

In the behind-averse base model (Proposition 2), the bistability regime arises when $\frac{c(1-p)}{p(1+\beta)} < \delta < \frac{c(1-p)(1+\beta)}{p}$. Given that $\forall(\beta,p,c)$, $\frac{c(1-p)}{p} > \frac{c(1-p)}{p(1+\beta)}$, the bistability regime under Festinger's approach (Proposition C.2) is smaller than the one in the base model.

C.2. Proof of Corollary 2

To show Corollary 2, we introduce the following Proposition,

Proposition C.3. *In the presence of both ahead-seeking and behind-averse social comparisons, a coexistence regime occurs when* $\frac{(1-p)c(1+\beta)}{p(1+\alpha)} < \delta < \frac{(1-p)c(1+\alpha)}{p(1+\beta)}$ *and a bistability regime occurs when* $\frac{(1-p)c(1+\alpha)}{p(1+\beta)} < \delta < \frac{(1-p)c(1+\beta)}{p(1+\alpha)}$

Proof. There exists a unique stable equilibrium which corresponds to a mix of adopters and non-adopters in the organization (i.e., coexistence) x^* iff two conditions hold,

$$\begin{cases} U_{NN} < U_{ON} \\ U_{NO} > U_{OO} \end{cases} \Leftrightarrow \begin{cases} p\delta-(1-p)c \;<\; (1-p)c\alpha-p\delta\beta \\ p\delta(1+\alpha)-(1-p)c(1+\beta) \;>\; 0 \end{cases} \Leftrightarrow \begin{cases} \delta < \dfrac{(1-p)c(1+\alpha)}{p(1+\beta)} \\ \delta > \dfrac{(1-p)c(1+\beta)}{p(1+\alpha)} \end{cases}$$

There exist two stable equilibria (bistability regime) which correspond to the whole organization adopting the new practice if a critical mass is initially adopting otherwise no one adopts in the organization iff

$$\begin{cases} U_{NN} > U_{ON} \\ U_{NO} < U_{OO} \end{cases} \Leftrightarrow \begin{cases} p\delta - (1-p)c \ > \ (1-p)c\alpha - p\delta\beta \\ p\delta(1+\alpha) - (1-p)c(1+\beta) \ < \ 0 \end{cases} \Leftrightarrow \begin{cases} \delta > \dfrac{(1-p)c(1+\alpha)}{p(1+\beta)} \\ \delta < \dfrac{(1-p)c(1+\beta)}{p(1+\alpha)} \end{cases}$$

Proof of Corollary 2. Corollary 2 is a direct consequence of the Proposition above. There exists δ such that the coexistence regime is nonempty iff $\alpha > \beta$, and there exists δ such that the bistability regime is nonempty iff $\beta > \alpha$.

C.3. Proof of Corollary 3

Corollary 3 is a direct consequence of the equilibrium analysis of the heterogeneous ahead-seeking organization case, which we present in full as Proposition C.4, next, with the proof of the Corollary thereafter.

Proposition C.4. (Heterogeneous Ahead-seeking Organization) *In the presence of ahead-seeking social comparisons ($\alpha > 0$, $\beta = 0$) for the X_1 subpopulation, and benchmark behaviour in X_2, the following adoption regimes emerge:*

- *Full adoption occurs when $\delta > \frac{c(1-p)(1+\alpha)}{p}$.*
- *Coexistence occurs when $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)(1+\alpha)}{p}$. At the lower end of that range, when $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)}{p}$, the equilibrium share of adopters in the organisation is*

$$x^* \ = \ \min\left\{\frac{p(1+\alpha)\frac{\delta}{c} - (1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}, X_1\right\}.$$

  At the upper end, $\frac{c(1-p)}{p} < \delta < \frac{c(1-p)(1+\alpha)}{p}$, the equilibrium is

$$x^* \ = \ \max\left\{\frac{p(1+\alpha)\frac{\delta}{c} - (1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}, X_2\right\}.$$

Otherwise, no adoption occurs.

Proof. Let $X_1 \in]0,1[$ be the share of the population that is ahead-seeking ($\alpha > 0$) and the remainder, X_2, be insensitive to social comparisons ($\alpha = 0$). The proof, hereafter, builds on proofs of Lemma 1 and Proposition 1.

The evolutionary stable strategy chosen by individuals in population X_2 is adoption when $\delta > \frac{(1-p)c}{p}$ or no adoption otherwise (Lemma 1).

Denote the evolutionary stable state of adopters in population X_2 by x_2^*. Hence, $x_2^* = X_2$ if $\delta > \frac{(1-p)c}{p}$ and $x_2^* = 0$ otherwise.

In population X_1, all employees will fully adopt if $\delta > \frac{c(1-p)(1+\alpha)}{p}$ and no one will adopt if $\delta < \frac{c(1-p)}{p(1+\alpha)}$ (Proposition 1). Denote the equilibrium state of adoption in population X_1 by x_1^*. So, when $\delta > \frac{c(1-p)(1+\alpha)}{p}$, $x_1^* = X_1$ and when $\delta < \frac{c(1-p)}{p(1+\alpha)}$, $x_1^* = 0$. When $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)(1+\alpha)}{p}$, the employees in population 1 differentiate their choice from the choices of their peers. The two evolutionary stable strategies are (N, O) and (O, N). And the equilibrium state in population 1 is such that those individuals will adopt if $U_N(x^* = x_1^* + x_2^*) > U_O(x^*)$ with $0 \leq x_1^* \leq X_1$ and stick with the old practice if $U_N(x^* = x_1^* + x_2^*) < U_O(x^*)$.

When $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)}{p}$, $x_2^* = 0$, employees in population 1 will reach equilibrium and stop differentiating if $x^* = \frac{p(1+\alpha)\frac{\delta}{c}-(1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}$ (i.e. $U_N(x^*) = U_O(x^*)$). Given that $x_1^* \in [0, X_1]$, $x_1^* = \min(\frac{p(1+\alpha)\frac{\delta}{c}-(1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}, X_1)$.

When $\frac{c(1-p)}{p} < \delta < \frac{c(1-p)(1+\alpha)}{p}$, $x_2^* = X_2$. Similar to above, employees in population 1 will reach equilibrium and stop differentiating if $x^* = \frac{p(1+\alpha)\frac{\delta}{c}-(1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}$ (i.e. $U_N(x^*) = U_O(x^*)$). So, $x_1^* = \max(\frac{p(1+\alpha)\frac{\delta}{c}-(1-p)}{\alpha(1+p(\frac{\delta}{c}-1))} - X_2, 0)$ and the overall adoption in the organization can be written: $x^* = \max(\frac{p(1+\alpha)\frac{\delta}{c}-(1-p)}{\alpha(1+p(\frac{\delta}{c}-1))}, X_2)$.

C.4. Proof of Corollary 4

Corollary 4 is a direct consequence of the equilibrium analysis of the heterogeneous behind-averse organization case, which we present in full as Proposition C.5, next, with the proof of the Corollary thereafter.

Proposition C.5. (Heterogeneous Behind-Averse Organization) *Given behind-averse social comparisons ($\beta > 0$, $\alpha = 0$) in the X_1 subpopulation, and benchmark behaviour in X_2:*

- *Full adoption, of the whole population, occurs either without upfront training when $\delta > \delta_H$ where*

$$\delta_H = \max\left\{\frac{c(1-p)}{p}, \frac{c(1-p)(1+\beta(1-X_2))}{p(1+\beta X_2)}\right\};$$

  or with upfront training when $\frac{c(1-p)}{p} < \delta < \delta_H$, i.e., for an initial critical mass in subpopulation 1 exceeding

$$x_0^* = \max\left\{\frac{(1-p)(1+\beta) - p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))} - X_2, 0\right\}.$$

- *Coexistence occurs, with upfront training, when $\delta_L < \delta < \frac{c(1-p)}{p}$ where*

$$\delta_L = \min\left\{\frac{c(1-p)}{p}, \frac{c(1-p)(1+\beta(1-X_1))}{p(1+\beta X_1)}\right\}$$

  and initial adoption exceeds

$$x_0^* = \frac{(1-p)(1+\beta) - p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))}.$$

  Coexistence results from full adoption in subpopulation 1 but no adoption in subpopulation 2.

Otherwise, no adoption occurs.

Proof. Let $X_1 \in]0,1[$ be the share of the population that is behind-averse ($\beta > 0$) and the remainder, X_2, be insensitive to social comparisons ($\beta = 0$).

Employees in the population X_2 fully adopt if $\delta > \frac{(1-p)c}{p}$ and no one adopts otherwise (Lemma 1). Denote the equilibrium state of adoption in population X_2 by x_2^*, so $x_2^* = X_2$ if $\delta > \frac{(1-p)c}{p}$ and $x_2^* = 0$ otherwise.

In population X_1, all employees fully adopt if $\delta > \frac{c(1-p)(1+\beta)}{p}$ and no one will adopt when $\delta < \frac{c(1-p)}{p(1+\beta)}$ (Proposition 2). Denote the equilibrium state of adoption in population X_1 by x_1^*. So $x_1^* = X_1$ if $\delta > \frac{c(1-p)(1+\beta)}{p}$ and $x_1^* = 0$ if $\delta < \frac{c(1-p)}{p(1+\beta)}$.

If $\frac{c(1-p)}{p(1+\beta)} < \delta < \frac{c(1-p)(1+\beta)}{p}$, the employees in population 1 imitate the choice of their peers due to the behind-averse social comparisons. The two evolutionary stable strategies, for this range of values δ, are

(N,N) and (O,O). The equilibrium state in population 1 is $x_1^* = X_1$ if the initial training in the organization $x_0^* > \frac{(1-p)(1+\beta)-p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))}$ and $x_1^* = 0$ if $x_0^* < \frac{(1-p)(1+\beta)-p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))}$.

It is straightforward to check that there exists $\delta_L \in [\frac{c(1-p)}{p(1+\beta)}, \frac{c(1-p)}{p}]$ such that $x_0^* > X_1$ when $\frac{c(1-p)}{p(1+\beta)} < \delta < \delta_L$ and $x_0^* < X_1$ when $\delta_L < \delta < \frac{c(1-p)}{p}$. Given that in these range of values, the employees in the population X_2 will not adopt, hence, $x_2^* = 0$, no adoption in the organization will occur when $\frac{c(1-p)}{p(1+\beta)} < \delta < \delta_L$ but full adoption can occur in the population 1 when $\delta_L < \delta < \frac{c(1-p)}{p}$ which leads to the fraction of adopters in the organization $x^* = X_1$ if enough employees in population 1 are trained.

When $\frac{c(1-p)}{p} < \delta < \frac{c(1-p)(1+\beta)}{p}$, everyone in population X_2 will adopt the new practice, $x_2^* = X_2$ while all employees in the population X_1 will adopt the new practice if $x_0 > x_0^*$. It is straightforward to check that there exists $\delta_H \in [\frac{c(1-p)}{p}, \frac{c(1-p)(1+\beta)}{p}]$ such that when $\frac{c(1-p)}{p} < \delta < \delta_H$, $x_0^* > X_2$, hence, full adoption in the organization can occur if at least an additional $\frac{(1-p)(1+\beta)-p\frac{\delta}{c}}{\beta(1+p(\frac{\delta}{c}-1))} - X_2$ employees in subpopulation 1 are trained. When $\delta_H < \delta < \frac{c(1-p)(1+\beta)}{p}$, $x_0^* \leq X_2$, hence given that all the employees in population 2 are adopting the new practice, no additional employees have to be trained to create full adoption in the organization.

D. Proofs of The New Practice Introduction Problem

Preliminary remarks to solving the The New Practice Introduction Problem

1. As noted at the start of Section 6, to set up the firm's optimization problem we assume that the level of rewards, δ, and training, x_0, are provided by senior management only once during the time period under consideration. This corresponds to taking $R = 1$ in the discrete version of the population game, i.e., on average each employee has one revision decision, at a randomly selected moment in the period, to choose between the new or old practice. From a technical standpoint, to be able to approximate this process by a differential equation, namely (3), we would need $\max_{x,i\in(O,N)} \sum_{j\neq i} \rho_{ij}(U(x),x) < R(=1)$, so that each propensity ρ_{ij} can be regarded as a transition probability. For this assumption to hold true, we can easily scale all the payoffs of the micro-level game in Table 1 by the same small positive factor, e.g., scale δ and c by the same factor. The subsequent differential equation and equilibrium outcomes are completely independent of such scalings (by the same argument presented when dividing by large R, Sandholm (2010)). Likewise the representation of the firm's problem, (4), is independent of the scaling factor applied to the micro-level game. The acute reader may be assured on one further point, which is that the optimal choice of δ is not unboundedly large, because unboundedness would bring into question existence of a (positive) scale factor. Boundedness of the optimal δ is explicitly shown in each of the cases considered in Appendix D, and is also evident *a priori* by observing that Π_{firm} in (4) becomes negative for large δ.

2. Anticipating that the process of optimization will tend to push δ^* toward boundaries, we may, without loss of generality, assume that adopting the new practice is preferred when breaking any payoff ties at boundaries. This makes sense because management can choose how to approach a boundary for best effect. For example, recall the situation of a behind-averse organization ($\beta > 0 = \alpha$) in Proposition 2: When there is no upfront training ($x_0 = 0$), the equilibrium outcome switches between no adoption and full adoption

depending on whether δ is either below or above the breakpoint $\frac{c(1-p)(1+\beta)}{p}$. Similarly, when there is full upfront training $x_0 = 1$, the equilibrium adoption switches between no adoption and full adoption at the breakpoint $\frac{c(1-p)}{p(1+\beta)}$. In the firm's problem (4), if the optimal δ is the breakpoint then management could set δ as the smallest discrete value of currency above the breakpoint, thereby ensuring full adoption with negligible effect on the firm's profit (e.g., in the bistability regime, $x_0^* = 1$ and the optimization drives δ to $\delta^* = \inf]\frac{c(1-p)}{p(1+\beta)}, \frac{c(1-p)(1+\beta)}{p}[$ which will lead to full adoption).

D.1. Proof of Lemma 3

In the benchmark case (Lemma 1), priming any share of employees x_0 does not have any effect on the adoption outcome. Since training is costly, at the rate $c_t > 0$, we obviously choose $x_0 = 0$. So the population equilibrium of adopters is a function only of δ, written $x^*(\delta)$, and the firm's maximization problem reduces to a single variable maximization problem in δ.

There are two possible equilibrium outcomes in the benchmark organization: full adoption if $\delta > \frac{(1-p)c}{p}$ and no-adoption otherwise. Since increasing δ increases the cost to the firm, it is optimal to take δ as small as possible. Hence if the firm wants to maximise profit in the full adoption case, it sets $\delta^* = \frac{(1-p)c}{p}$ (formally $\delta^* = \inf]\frac{(1-p)c}{p}, \infty[$ per Remark 2 above), whereas in the no adoption case, it sets $\delta^* = 0$. Given these two possible adoption scenarios, the firm will choose to set the δ^* that gives the overall optimal value for the firm.

The optimal incentive scheme is $\delta^* = 0$ iff

$$\Pi_{firm}(\delta^* = 0) > \Pi_{firm}(\delta^* = \tfrac{(1-p)c}{p}) \iff \begin{cases} 0 < p \leq \frac{R_O}{R_N} \\ 0 < c \end{cases} \quad \text{or} \quad \begin{cases} \frac{R_O}{R_N} < p < 1 \\ c > \frac{pR_N - R_O}{1-p} \end{cases}$$

The optimal incentive scheme is $\delta^* = \frac{(1-p)c}{p}$ iff

$$\Pi_{firm}(\delta^* = \tfrac{(1-p)c}{p}) > \Pi_{firm}(\delta^* = 0) \iff \begin{cases} \frac{R_O}{R_N} < p < 1 \\ 0 < c < \frac{pR_N - R_O}{1-p} \end{cases}$$

D.2. Proof of Proposition 3

In an ahead-seeking organisation (Proposition 1), adoption cannot be driven through the initial fraction of employees due to differentiation effects. Hence, similar to the benchmark case above, it is optimal to take $x_0 = 0$, the equilibrium outcome as $x^*(\delta)$, and then solve the firm's optimization problem in a single variable δ.

Per the equilibrium analysis, there are three potential adoption outcomes in the organization: full adoption when $\delta \geq \frac{c(1-p)(1+\alpha)}{p}$, no adoption when $\delta \leq \frac{c(1-p)}{p(1+\alpha)}$ and coexistence when $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c(1-p)(1+\alpha)}{p}$. It is straightforward that to drive full adoption, the firm optimally sets $\delta^* = \frac{c(1-p)(1+\alpha)}{p}$; and to drive no-adoption, it optimally sets $\delta^* = 0$ given that in these two respective scenarios, $\frac{d\Pi_{firm}}{d\delta} < 0$. In the case of coexistence, the first-order condition $\frac{d\Pi_{firm}}{d\delta} = 0$ implies that δ^* takes the value

$$\delta^*_{coex} = \frac{\sqrt{(2+3\alpha+\alpha^2)(1-p)p^2c(pR_N - R_O + c(1-p))} - (1+\alpha)c(1-p)p}{(1+\alpha)p^2}.$$

It can also be shown that $\frac{d^2\Pi_{firm}(\delta^*_{coex})}{d^2\delta} < 0$, so $\Pi_{firm}(\delta^*_{coex})$, is the maximum in the coexistence scenario. By comparing the values of $\Pi_{firm}(\delta^*=0)$, $\Pi_{firm}(\delta^* = \frac{c(1-p)(1+\alpha)}{p})$ and $\Pi_{firm}(\delta^*_{coex})$, we find the optimal incentive scheme for the ahead seeking organization as follows:

The firm derives the highest profit by setting $\delta^*=0$ when: $\begin{cases} 0<p\leq \frac{R_O}{R_N} \\ 0<c \end{cases}$ or $\begin{cases} \frac{R_O}{R_N}<p<1 \\ c> \frac{(1+\alpha)(pR_N-R_O)}{1-p} \end{cases}$

The firm derives the highest profit by setting $\delta^* = \frac{c(1-p)(1+\alpha)}{p}$ when: $\begin{cases} \frac{R_O}{R_N}<p<1 \\ 0<c< \frac{pR_N-R_O}{(1+3\alpha+\alpha^2)(1-p)} \end{cases}$

The firm derives the highest profit by setting $\delta^*=\delta^*_{coex}$ when: $\begin{cases} \frac{R_O}{R_N}<p<1 \\ \frac{pR_N-R_O}{(1+3\alpha+\alpha^2)(1-p)} < c < \frac{(1+\alpha)(pR_N-R_O)}{1-p} \end{cases}$

D.3. Proof of Proposition 4

In a behind-averse organization (Proposition 2), the equilibrium analysis establishes two possible adoption outcomes: full adoption and no adoption. Full adoption can be obtained through only economic rewards, δ, but no upfront training, or through a mix of rewards and upfront training of an initial fraction of adopters x_0. In order to find the optimal scheme for the organization, we proceed by backward induction. We determine the firm optimal reward scheme in each of the Equilibrium Scenarios: full adoption through only rewards (Equilibrium Scenario 1), full adoption through a mix of rewards and training (Equilibrium Scenario 2), and finally no adoption (Equilibrium Scenario 3) where we set the level of both rewards and training to zero. Then we choose the maximum of the three "optimal" profits that result as the value of Π^*_{firm}.

In Equilibrium Scenarios 1 and 3, the equilibrium outcomes do not depend on the initial critical mass x_0, hence, similar to the benchmark and ahead-seeking cases, it is optimal to set $x_0=0$ and the firm's problem reduces to maximization over δ. In Equilibrium Scenario 2, however, the bistability regime occurs and the equilibrium outcome $x^*(\delta,x_0)$ depends on δ and x_0. Per the equilibrium analysis, we see that for any $\frac{c(1-p)}{p(1+\beta)} < \delta^* < \frac{c(1-p)(1+\beta)}{p}$ (bistability regime), the full-adoption outcome relies on x_0 exceeding the critical mass $x^*_0(\delta)$, assuming $x^*_0(\delta^*)\in[0,1)$. Since training incurs a positive cost, it is optimal for the firm to train the smallest fraction of staff consistent with full adoption, i.e., $x_0 = x^*_0(\delta^*)$. Therefore, our 2-variable firm maximization problem again reduces to a single-variable optimization problem in δ.

Equilibrium Scenario 1: To drive full adoption through only rewards and no training ($x^*_0=0$), the firm is constrained to $\delta \geq \frac{c(1-p)(1+\beta)}{p}$ and the resulting profit is: $\Pi_{firm} = p(R_N-\delta)+R_O$. In this scenario, clearly it is optimal to minimize δ (formally, because $\frac{d\Pi_{firm}}{d\delta} = -p<0$) which results in setting $\delta^* = \frac{c(1-p)(1+\beta)}{p}$.

Equilibrium Scenario 2: When the reward is constrained to $\frac{c(1-p)}{p(1+\beta)} \leq \delta < \frac{c(1-p)(1+\beta)}{p}$ and the firm commits to full adoption via $x^*_0 = x^*_0(\delta)$, there exists δ^* that maximizes the firm's profit.

Equilibrium Scenario 3: The firm ends up in no adoption when the reward is constrained as $0\leq\delta<\frac{c(1-p)}{p(1+\beta)}$. In this scenario, the maximum profit for the firm is $\Pi_{firm}=R_O$, and it is optimal for the firm to set $\delta^*=0$ as well as $x^*_0=0$.

By comparing the optimal profits in the three Equilibrium Scenarios, we derive the firm's optimal value and strategy. The firm derives the highest profit in Equilibrium Scenario 1 (with $\delta^* = \frac{c(1-p)(1+\beta)}{p}$, $x_0^* = 0$) when

$$\begin{cases} 0 < c < \frac{pR_N - R_O}{(1+\beta)(1-p)} \\ c_t > \beta(2+\beta)c(1-p) \end{cases} \quad \text{and} \quad (\delta^* = \frac{c(1-p)(1+\beta)}{p}, x_0^* = 0)$$

There are two cases when the firm derives the highest profit in Equilibrium Scenario 2. The first is when

$$\begin{cases} 0 < c < \frac{pR_N - R_O}{(1+\beta)(1-p)} \\ \frac{\beta(2+\beta)c(1-p)}{(1+\beta)^2} < c_t < \beta(2+\beta)c(1-p) \end{cases} \quad \text{or} \quad \begin{cases} \frac{pR_N - R_O}{(1+\beta)(1-p)} < c < \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} \\ \frac{\beta(2+\beta)c(1-p)}{(1+\beta)^2} < c_t < c_{t_3} \end{cases}$$

where $c_{t_3} = 2\beta^2 c(1-p) + \beta(3c(1-p) - pR_N + R_O) - 2\sqrt{\beta^2(2+\beta)c(1-p)((1+\beta)c(1-p) - pR_N + R_O)}$. Under these conditions, the optimal reward scheme is $(\delta^* = \frac{\sqrt{\beta(2+\beta)cc_t(1-p)p^2} - \beta c(1-p)p}{\beta p^2}, x_0^* = x_0^*(\delta^*))$ such that $\frac{d\Pi_{firm}(\delta^*)}{d\delta} = 0$ and $\frac{d^2\Pi_{firm}(\delta^*)}{d^2\delta} < 0$ with $\frac{c(1-p)}{p(1+\beta)} < \delta^* < \frac{c(1-p)(1+\beta)}{p}$ and $0 < x_0^*(\delta^*) < 1$. The second case is at the boundary $\delta^* = \frac{c(1-p)}{p(1+\beta)}$, as discussed earlier in preliminary Remark 2, where the optimal reward scheme is $(\delta^* = \frac{c(1-p)}{p(1+\beta)}, x_0^* = 1)$ (formally $(\delta^* = \inf]\frac{c(1-p)}{p(1+\beta)}, \frac{c(1-p)(1+\beta)}{p}[, \; x_0^* = 1)$), which happens when

$$\begin{cases} 0 < c \le \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} \\ 0 < c_t < \frac{\beta(2+\beta)c(1-p)}{(1+\beta)^2} \end{cases} \quad \text{or} \quad \begin{cases} \frac{(1+\beta)^2(pR_N - R_O)}{(1+3\beta+\beta^2)(1-p)} < c < \frac{(1+\beta)(pR_N - R_O)}{1-p} \\ 0 < c_t < \frac{(pR_N - R_O)(1+\beta) - c(1-p)}{1+\beta} \end{cases}$$

It is optimal to be in Equilibrium scenario 3 (no adoption) and the firm sets $(\delta^* = 0, x_0^* = 0)$ in all other circumstances.

D.4. Proof of Propositions 5 and 6

The closed form conditions derived are computed by comparing the optimal profits values computed in Lemma 3 (optimal profit for a benchmark organization), Proposition 3 (optimal profit in a ahead-seeking organization) and Proposition 4 (optimal profit in a behind-averse organization). Note $\bar{c} = \frac{(1+2\alpha)(pR_N - R_O)}{(1+5\alpha)(1-p)} + 2\sqrt{\frac{\alpha^2(2+\alpha)(pR_N - R_O)^2}{(1+\alpha)(1+5\alpha)^2(1-p)^2}}$ in the text of Proposition 5.

E. New practice adoption: a model of social comparisons with population social learning

In this extra Appendix, we build upon the basic model setup to explore another important factor influencing the adoption of new practices in organizations, namely the possibility of *learning* about the new practice as it is being tried by different individual employees. In this model extension we will focus on a particular source of learning, which better suits the context analyzed in our study: *social learning* as this has been discussed across different literatures (see e.g., Boyd and Richerson 1988, pp. 40-56). Such instances of learning may emerge, in our context, from multiple sources: first, they could represent the *imitation* of peers' choices that happens when employees consider their choice of practice and during this process observe their peers, and share knowledge about it (Özkan-Seely et al. 2015). Second, learning could reflect the additional knowledge that emerges from *collaborative problem solving* between employees who attempt the new practice over time (Crama et al. 2019, Sting et al. 2020).

In order to capture such instances we assume that a pairing between two individuals employees who have both decided to adopt the new practice implies a higher likelihood of successful adoption. Therefore, we introduce a likelihood p_c $(1 > p_c > p)$ of successful practice implementation in the (N, N) pairing which modifies our original payoff matrix (see Table E.1); the likelihood of successful adoption stays p for all other pairings. One could perceive p_c as the outcome of different forms of social learning described above. The two levels of the successful adoption likelihood end up capturing the phenomenon of learning as follows: without any relevant social input, any of the employees that attempts the new practice is faced with the same prior about their success, i.e. likelihood p. However, once the focal employee meets (observes) someone who has tried the practice before, they are able to benefit from the peer knowledge and increase their success likelihood to p_c. Eventually, we assume that this higher value cannot be 1 as there could be external (physical) limitations that make it impossible for the new practice application to always be 100 % successful.

Table E.1 Payoff Matrix Game

	N	O
N	$U_{NN} = p_c\delta - (1-p_c)c$	$U_{NO} = p\delta(1+\alpha) - (1-p)c(1+\beta)$
O	$U_{ON} = (1-p)\alpha c - p\beta\delta$	$U_{OO} = 0$

The following Lemma discusses the equilibria that emerge in the absence of social comparisons given the presence of social learning.

Lemma E.1. (Benchmark Organization with Social learning) *In a situation with social learning $(p_c > p)$ but no social comparisons $(\alpha = 0 = \beta)$, the following adoption regimes emerge:*

Full adoption occurs without upfront training when $\delta > \frac{c(1-p)}{p}$, and with upfront training when $\frac{c(1-p_c)}{p_c} < \delta < \frac{c(1-p)}{p}$; in the latter case the organization needs to train at least an initial fraction of employees $x_0^* = \frac{(1-p)c - p\delta}{(p_c-p)(\delta+c)}$. Otherwise, no adoption occurs.

Proof. In the benchmark collaboration, we have $\alpha = 0$, $\beta = 0$ and $p_c > p$. There exist a bistability regime in the organization iff $\begin{cases} U_{NN} & > U_{ON} \\ U_{NO} & < U_{OO} \end{cases}$ iff

$$\begin{cases} V_O + p_c\delta - (1-p_c)c & > V_O \\ V_O + p\delta - (1-p)c & < V_O \end{cases} \Leftrightarrow \begin{cases} \delta & > \frac{(1-p_c)c}{p_c} \\ \delta & < \frac{(1-p)c}{p} \end{cases}$$

In this bistability regime, the unstable interior fixed point is such that:

$$U_N(x_0^*) = U_O(x_0^*) \Leftrightarrow x_0^* = \frac{(1-p)c - p\delta}{(p_c-p)(\delta+c)}.$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} & > U_{ON} \\ U_{NO} & > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta & > \frac{(1-p_c)c}{p_c} \\ \delta & > \frac{(1-p)c}{p} \end{cases} \Leftrightarrow \delta > \frac{(1-p)c}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} & < U_{ON} \\ U_{NO} & < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta & < \frac{(1-p_c)c}{p_c} \\ \delta & < \frac{(1-p)c}{p} \end{cases} \Leftrightarrow \delta < \frac{(1-p_c)c}{p_c}$. (QED)

Interestingly, Lemma E.1 shows that despite the absence of social comparisons, a bistability regime emerges because of the assumed social learning. The existence of learning increases the utility payoff from adoption when paired with another adopter ($p_c > p$), which gives rise to a conformance effect. We can verify this by inspection of Table E.1 as there exist δ values which make an employee better off choosing the new practice when meeting an adopter ($U_{NN} > U_{ON}$), but sticking with the old practice when meeting a non-adopter ($U_{NO} < U_{OO}$). Hence priming upfront a critical mass of employees to adopt the new practice can induce full adoption, in circumstances where no adoption was taking place under a base case benchmark setting.

As before, Proposition E.1 looks at the adoption regimes in a setting where ahead-seeking social comparisons and social learning are concurrently present.

Proposition E.1. (Ahead-seeking Organization with Social Learning) *In the presence of both social learning ($p_c > p$) and ahead-seeking social comparisons ($\alpha > 0$ and $\beta = 0$), the following adoption regimes emerge:*

- *When $0 < \alpha < \bar{\alpha} = \frac{1}{2}\left(\sqrt{\frac{p_c^2 p + p^3 + 2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p}\right)$, full adoption, without upfront training, occurs when $\delta > \frac{c(1-p)}{p(1+\alpha)}$, and it occurs with upfront training when $\frac{c((1-p)\alpha+(1-p_c))}{p_c} < \delta < \frac{c(1-p)}{p(1+\alpha)}$ and at least a critical mass $x_0^* = \frac{(1-p)c - p\delta(1+\alpha)}{\delta(p_c - p(1+\alpha)) + c(p_c - p - (1-p)\alpha)}$.*
- *When $\alpha > \bar{\alpha}$, full adoption, without upfront training, occurs when $\delta > \frac{c((1-p)\alpha+(1-p_c))}{p_c}$, and coexistence of both practices occurs when $\frac{c(1-p)}{p(1+\alpha)} < \delta < \frac{c((1-p)\alpha+(1-p_c))}{p_c}$ with $x^* = \frac{(1-p)c - p\delta(1+\alpha)}{\delta(p_c - p(1+\alpha)) + c(p_c - p - (1-p)\alpha)}$ adopters.*

Otherwise, no adoption occurs.

Proof. In the ahead-seeking organization, we have $\alpha > 0$, $\beta = 0$ and $p_c > p$.

There exists a bistability regime in the organization iff $\begin{cases} U_{NN} & > U_{ON} \\ U_{NO} & < U_{OO} \end{cases}$ iff

$$\begin{cases} V_O + p_c\delta - (1-p_c)c & > V_O + (1-p)\alpha c \\ V_O + p\delta(1+\alpha) - (1-p)c & < V_O \end{cases} \Leftrightarrow \begin{cases} \delta & > \frac{((1-p)\alpha+(1-p_c))c}{p_c} \\ \delta & < \frac{(1-p)c}{p(1+\alpha)} \end{cases}$$

The above region of δ only exists iff $\alpha < \frac{1}{2}(\sqrt{\frac{p_c^2 p + p^3 + 2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p})$. In this bistability regime, the unstable interior fixed point is such that:

$$U_N(x_0^*) = U_O(x_0^*) \;\Leftrightarrow\; x_0^* = \frac{(1-p)c - p\delta(1+\alpha)}{\delta(p_c - p(1+\alpha)) + c(p_c - p - (1-p)\alpha)}\,.$$

There exists a coexistence regime with a mix of adopters x^* iff $\begin{cases} U_{NN} & < U_{ON} \\ U_{NO} & > U_{OO} \end{cases}$ iff

$$\begin{cases} V_O + p_c\delta - (1-p_c)c & < V_O + (1-p)\alpha c \\ V_O + p\delta(1+\alpha) - (1-p)c & > V_O \end{cases} \Leftrightarrow \begin{cases} \delta & < \frac{((1-p)\alpha+(1-p_c))c}{p_c} \\ \delta & > \frac{(1-p)c}{p(1+\alpha)} \end{cases}$$

This region of δ only exists iff $\alpha > \frac{1}{2}(\sqrt{\frac{p_c^2p+p^3+2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p})$. The stable equilibrium which is an interior fixed point of the mean dynamic is such that:

$$U_N(x^*) = U_O(x^*) \Leftrightarrow x^* = \frac{(1-p)c - p\delta(1+\alpha)}{\delta(p_c - p(1+\alpha)) + c(p_c - p - (1-p)\alpha)}$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} & > U_{ON} \\ U_{NO} & > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta & > \frac{((1-p)\alpha+(1-p_c))c}{p_c} \\ \delta & > \frac{(1-p)c}{p(1+\alpha)} \end{cases} \Leftrightarrow$ $\begin{cases} \alpha & < \frac{1}{2}(\sqrt{\frac{p_c^2p+p^3+2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p}) \\ \delta & > \frac{(1-p)c}{p(1+\alpha)} \end{cases}$ and $\begin{cases} \alpha & > \frac{1}{2}(\sqrt{\frac{p_c^2p+p^3+2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p}) \\ \delta & > \frac{((1-p)\alpha+(1-p_c))c}{p_c} \end{cases}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} & < U_{ON} \\ U_{NO} & < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta & < \frac{((1-p)\alpha+(1-p_c))c}{p_c} \\ \delta & < \frac{(1-p)c}{p(1+\alpha)} \end{cases} \Leftrightarrow$ $\begin{cases} \alpha & < \frac{1}{2}(\sqrt{\frac{p_c^2p+p^3+2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p}) \\ \delta & < \frac{((1-p)\alpha+(1-p_c))c}{p_c} \end{cases}$ and $\begin{cases} \alpha & > \frac{1}{2}(\sqrt{\frac{p_c^2p+p^3+2p_c(p^2+2-4p)}{p(1-p)^2}} - \frac{2-p_c-p}{1-p}) \\ \delta & < \frac{(1-p)c}{p(1+\alpha)} \end{cases}$ (QED)

Proposition E.1 reveals an important structural result: the presence of ahead-seeking comparisons *concurrently* with social learning creates a setting whereby two opposing forces clash. Ahead-seeking comparisons induce differentiation effects as discussed earlier (Proposition 1). Yet, social learning gives rise to a conformance effect as our earlier Lemma indicates. Therefore, putting those phenomena together leads to a setting where the strongest force drives the results. Formally, the increase in success probability $p_c - p$ relative to the level of α determines whether the additional utility obtained from adopting the new practice when paired with an adopter, in U_{NN}, is higher than the boost in utility received from differentiation in U_{ON}.

This result suggests that ahead-seeking comparisons and social learning offset each other and therefore act as strategic substitutes. Specifically, the differentiation effects of ahead-seeking comparisons may be mitigated by social learning; management may consider promoting collaborative problem solving, to increase the chance of successful adoption, and to shift the equilibrium closer to full adoption. That is, given strong ahead-seeking comparisons, the organization would not be able to attain full adoption unless they would commit to sizeable economic rewards.

Next, we turn to the behind-averse case.

Proposition E.2. (Behind-Averse Organization with Social Learning) *In the presence of both social learning ($p_c > p$) and behind-averse social comparisons ($\alpha = 0$ and $\beta > 0$), the following adoption regimes emerge: Full adoption, without upfront training, occurs when $\delta > \frac{c(1-p)(1+\beta)}{p}$, and it occurs with upfront training a critical mass $x_0^* = \frac{(1-p)(1+\beta)c - p\delta}{\delta(p_c - p(1-\beta)) + c(p_c - p + \beta(1-p))}$, when $\frac{c(1-p_c)}{p_c + p\beta} < \delta < \frac{c(1-p)(1+\beta)}{p}$. Otherwise, no adoption occurs.*

Proof. In the behind-averse organization, $\alpha = 0$, $\beta > 0$ and $p_c > p$

There exists a bistability regime in the organization iff $\begin{cases} U_{NN} & > U_{ON} \\ U_{NO} & < U_{OO} \end{cases}$ iff

$$\begin{cases} V_O + p_c\delta - (1-p_c)c & > V_O - p\beta\delta \\ V_O + p\delta - (1-p)c(1+\beta) & < V_O \end{cases} \Leftrightarrow \begin{cases} \delta & > \frac{(1-p_c)c}{p_c+p\beta} \\ \delta & < \frac{(1-p)(1+\beta)c}{p} \end{cases}$$

In this bistability regime, the unstable interior fixed point is such that:

$$U_N(x_0^*) = U_O(x_0^*) \Leftrightarrow x_0^* = \frac{(1-p)(1+\beta)c - p\delta}{\delta(p_c - p(1-\beta)) + c(p_c - p + \beta(1-p))}.$$

The full-adoption regime occurs iff $\begin{cases} U_{NN} & > U_{ON} \\ U_{NO} & > U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta & > \frac{(1-p_c)c}{p_c+p\beta} \\ \delta & > \frac{(1-p)(1+\beta)c}{p} \end{cases} \Leftrightarrow \delta > \frac{(1-p)(1+\beta)c}{p}$

The no-adoption regime occurs iff $\begin{cases} U_{NN} & < U_{ON} \\ U_{NO} & < U_{OO} \end{cases} \Leftrightarrow \begin{cases} \delta & < \frac{(1-p_c)c}{p_c+p\beta} \\ \delta & < \frac{(1-p)(1+\beta)c}{p} \end{cases} \Leftrightarrow \delta < \frac{(1-p_c)c}{p_c+p\beta}$. (QED)

Proposition E.2 reveals another interesting fact: social learning and behind-averse social comparisons reinforce each other to achieve full adoption. In effect they act as strategic complements. However, the mechanisms that take place in each case are different. Social learning implies a higher value for adopting; whereas behind-averse social comparisons lead to the same effect so that someone does not feel "left behind" vis-a-vis their peers. Full adoption eventuates with less training, as employees recognize greater benefit from the new practice (higher probability of successful adoption), and also want to avoid being left behind others. So they make the same choice as their peers. This result suggests that management may want to consider promoting the value of collaborative problem solving to reduce the level, and cost, of upfront training to achieve a critical mass of adopters.