From Sustainable Finance to Real Transition*

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Abstract

We develop a theory of sustainable transition in which real change requires multi-level coordination among investors, within firms, and across firms. Investor support matters only when a sufficiently large coalition forms, while firms must build costly transition capability to turn support into operational change. Because these two margins are strategic complements, fragmented investor support discourages capability investment, and weak capability discourages investor support. This can generate a low-support, low-capability trap in which sustainable finance generates commitments and rhetoric but little real transition. The paper's theoretical contribution is to trace this complementarity across four coupled coordination margins. First, endogenizing capability transforms standard coordination failure into a trap sustained by both beliefs and fundamentals: firms are genuinely underprepared, not merely unlucky in coordination. Second, when capability accumulates over time, the complementarity propagates intertemporally—early support lowers future costs, creating momentum, while organizational inertia can make the trap absorbing and front-loaded intervention strictly more effective than late intervention. Third, at the industry level, cross-firm participation spillovers embed the investor–firm complementarity in a multi-sided structure where under-provision arises at three margins simultaneously. Fourth, disclosure, assurance, and certification improve equilibrium selection by making capability more observable and discouraging mimicry, while greenwashing raises the coordination threshold faced even by genuinely capable firms.

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Keywords: Sustainable Transition, Two-sided Coordination, Organizational Capability, Dynamic Capability Accumulation, Symbolic Implementation, Greenwashing, Temporal Coordination, Path-dependent Trap.

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1 Introduction

Sustainable finance has expanded rapidly, and firms increasingly announce climate targets, transition plans, and ESG-related commitments. Yet real transition remains uneven. In many settings, external support generates commitments, disclosures, or plans without producing substantial operational change. This suggests that the central challenge is not simply whether investors care about sustainability, but when sustainable capital can be translated into real organizational and operational transition. We therefore ask: *when does sustainable capital lead to real transition rather than merely symbolic sustainability commitment?*

This paper argues that the answer depends on the alignment of two forces. On the investor side, support for sustainability is subject to a coordination friction: isolated support has limited effect, while sufficiently broad support can alter governance pressure, financing conditions, and the viability of long-term transition. On the firm side, real transition requires costly organizational preparation. Firms must build monitoring systems, reporting discipline, internal governance, and cross-unit implementation capacity in order to convert sustainability commitments into operational change. We refer to this firm-side margin as *transition capability*. Once observability is imperfect, a further distortion arises: firms may also devote resources to appearing transition-ready rather than becoming transition-ready. This creates a greenwashing margin that weakens the informational content of sustainability signals.

The central idea of the paper is that investor coordination and firm transition capability are strategic complements. Coordinated investor support is valuable only when firms have the capability to translate that support into implementation. Conversely, firms have weak incentives to build costly capability when investor support is expected to remain fragmented. This interaction generates a two-sided coordination problem. In the low-transition equilibrium, firms underinvest in capability, investors fail to coordinate, and sustainability remains largely symbolic. In the high-transition equilibrium, firms build capability, investors coordinate support, and real transition occurs.

We formalize this idea in a theory of investor coordination, endogenous firm capability, equilibrium selection, and strategic greenwashing. We begin with a benchmark model in which capability is exogenous. The benchmark shows that investor coordination and capability are complementary and that, even with capability fixed, the economy may exhibit both a low-support equilibrium and a high-support equilibrium. We then endogenize capability and show that this additional margin generates a *transition-capability trap*: firms rationally remain underprepared when investor support is expected to be weak, and weak preparation

in turn validates investor pessimism. We next study an extension in which investors observe capability only imperfectly. In that environment, disclosure, assurance, and certification improve equilibrium selection by making genuine capability more visible and credible. We then show that, once firms can choose symbolic projects, greenwashing can arise endogenously and can raise the coordination threshold faced even by genuinely capable firms. Finally, we show that under-provision can arise not only within firms, through underinvestment in capability, but also across firms, when each firm fails to internalize how its participation improves the industry transition environment. More broadly, the paper studies coordination at three levels: among investors, within firms, and, in the industry extension, across firms, while also highlighting a distinct credibility distortion created by symbolic sustainability.

We also extend the endogenous-capability model to a dynamic setting in which the firm builds capability incrementally over two periods and investors observe intermediate progress before deciding whether to sustain support. The key new feature is that effective early investor support lowers the cost of further capability-building—for instance, through access to patient capital, stakeholder validation, or reduced internal resistance to organizational reform. This creates a support-capability momentum effect: early coordination facilitates later investment, which in turn sustains later coordination. The dynamic extension strengthens the static trap in two ways. First, the same feedback that sustains the good equilibrium can work in reverse: the absence of early support leaves capability-building costs unchanged, depressing investment and raising the likelihood of a support collapse. Second, when organizational inertia makes late investment increasingly costly, the trap can become absorbing—firms that miss an early investment window may find no profitable catch-up path, regardless of expectations. These results imply that the timing of transition support matters, not just its level: front-loaded capability subsidies and early-stage stewardship engagement have effects that delayed intervention cannot replicate.

The paper delivers a simple but important message: sustainable finance does not fail only because investors may be unwilling to support transition, and it does not fail only because firms face internal implementation frictions. It can fail because real transition requires these two margins to arise together. Coordinated investor support is effective only when firms are organizationally prepared to implement transition, while firms have weak incentives to build costly transition capability when investor support is expected to remain fragmented. This complementarity creates a two-sided coordination problem and can trap the economy in an equilibrium with weak support, low capability, and largely symbolic sustainability outcomes.

This perspective generates four main implications. First, the effectiveness of sustainable capital is conditional rather than automatic: external support must be matched by internal

implementation capability. Second, transition capability is endogenous. Firms may rationally remain underprepared when investor backing is expected to be limited, even when transition would be collectively valuable. Third, visibility matters because investors coordinate under imperfect information about firm preparedness. Disclosure, assurance, and certification therefore do more than improve transparency: they help investors coordinate around firms whose sustainability commitments are backed by real implementation capacity. Fourth, imperfect observability creates a greenwashing distortion. When firms can cheaply generate favorable sustainability signals without building real capability, those signals become less credible, coordinated support becomes harder to sustain, and certification acquires an additional anti-greenwashing role.

Our contribution is to connect investor coordination, endogenous organizational capability, equilibrium selection, and strategic greenwashing in a unified framework and to show that the complementarity between support and capability generates coordination failures at four coupled margins. Existing theoretical work on sustainable finance either studies investor stewardship in bilateral or frictionless settings (Broccardo et al., 2022; Gryglewicz et al., 2025), takes the firm's implementation capacity as given, or maps transmission channels without studying their equilibrium properties (Caldecott et al., 2022). Empirical work documents the importance of investor coordination (Slager et al., 2023) and organizational preparedness (De Haas et al., 2025) separately. We integrate these margins in a single model and show that their interaction is the source of both the trap and the policy leverage. In particular, the transition-capability trap arises not from either friction alone but from their mutual reinforcement: investors cannot coordinate profitably around unprepared firms, and firms cannot justify costly preparation when support is expected to remain fragmented. The dynamic extension further shows that this mutual reinforcement propagates across time, generating absorbing traps and irreversibility results that have no counterpart in static models. The industry extension shows that the same complementarity creates participation externalities across firms, embedding the two-sided investor–firm problem in a three-sided coordination structure.

This mechanism also helps distinguish our paper from several nearby literatures. Relative to the stewardship and collaborative-engagement literature, our focus is not only on whether investors support sustainability, but on when such support becomes effective in changing real operations. Relative to work on managerial and organizational barriers to green transition, our contribution is to endogenize capability-building and embed it in a strategic interaction with investor expectations. Relative to recent theories of investor activism and the green transition, our emphasis is not on activist effort or contracting, but on coalition coordination,

firm preparedness, observability, and equilibrium selection. Finally, the industry extension shows that under-provision can also arise across firms, when each firm fails to internalize how its own participation improves the broader transition environment.

Beyond its theoretical contribution, the paper speaks directly to practice. For managers, the results imply that sustainability commitments are unlikely to gain durable investor support unless firms invest in the internal systems needed for execution, and that symbolic signaling can backfire by weakening credibility if not backed by capability. For investors, the results imply that stewardship is most effective when firms are organizationally capable of responding and when investors can distinguish genuine implementation capacity from cosmetic sustainability activity. For institutions and policymakers, the model highlights the complementarity between coordination mechanisms, capability-building support, visibility-enhancing devices such as assurance and certification, and anti-greenwashing institutions that preserve the credibility of sustainability signals.

The rest of the paper proceeds as follows. Section 2 positions the paper in the literature. Section 3 presents the benchmark model with exogenous capability. Section 4 endogenizes firm capability and characterizes the full equilibrium. Section 5 studies visibility, certification, strategic greenwashing, and equilibrium selection under noisy observation of capability. Section 6 presents a continuum industry extension with under-provision across firms. Section 7 discusses managerial and policy implications. Appendix A collects the proofs. Appendix B contains extended discussions, including a microfoundation of transition capability as internal coordination, a richer greenwashing extension, and a finite-firm counterpart to the industry extension. Section 8 concludes.

Theoretical contribution. The paper's main theoretical contribution is a framework in which coordination failures at multiple margins—among investors, between investors and the firm, across firms, and over time—are coupled through a single underlying complementarity between investor support and firm transition capability.

In the benchmark model (Section 3), investor coordination operates one-sidedly: investors face a collective action problem with a participation threshold, and the firm is passive given exogenous capability. This isolates the core complementarity $p_{cS} > 0$ in its simplest form. In the main model (Section 4), endogenizing the firm's capability choice makes the coordination problem genuinely two-sided. The firm's preparation decision determines whether the investors' coordination game admits a high-support equilibrium (through the capability threshold $\bar{c}$), while the expected outcome of the investors' game determines whether the firm's preparation investment is worthwhile. The resulting equilibrium multiplicity is qualitatively

richer than standard one-sided coordination failure. In particular, the transition-capability trap (Proposition 2) is not merely an expectational coordination failure in which agents happen to coordinate on a bad outcome. It is sustained by a real channel: pessimistic expectations lead to genuinely zero capability investment, which makes the firm objectively unable to implement transition even if support were to materialize. The trap is therefore self-reinforcing through both beliefs and fundamentals.

The industry extension (Section 6) embeds the investor–firm complementarity in a multi-sided coordination structure. Each firm's capability choice feeds into the industry participation rate, which affects support effectiveness, which feeds back into every firm's capability and participation decisions. The participation externality—that each firm's entry improves conditions for others—operates through the same complementarity channel that generates the investor–firm trap. A firm that fails to participate does not just reduce the industry average; it weakens the conditions under which other firms' capability investments are rewarded by investor coordination. This creates a multiplier on the standard participation externality, producing at least three equilibria (Proposition 6) when the cross-firm spillover is sufficiently strong.

The dynamic extension (Appendix C) adds temporal coordination. In the static model, the trap is an expectational equilibrium that coexists with a good equilibrium; a sufficiently powerful belief shift or policy intervention could, in principle, flip the economy to the good outcome. In the dynamic model with organizational inertia and support facilitation ($\sigma > 0$), the trap can become absorbing: a firm that fails to invest early faces escalating costs and receives no cost discount from missing early support, so the good equilibrium may cease to exist for firms that miss the early investment window. This is a fundamentally different kind of failure. The static trap could be resolved by changing beliefs; the absorbing trap is a path-dependence result in which history constrains the feasible set. The dynamic model also generates an irreversibility result for policy: early subsidies activate the support-facilitation channel by raising the probability of period-1 coordination and triggering the cost discount in period 2, while equivalent late subsidies cannot retroactively generate early coordination.

Taken together, the paper studies a single complementarity—between investor support and firm capability—as it propagates across four coordination margins. This architecture yields several results that do not arise in models studying any one margin in isolation: the real (not merely expectational) character of the trap, the absorbing nature of dynamic traps under inertia, the multiplier effect of participation externalities operating through the support–capability channel, and the strict dominance of front-loaded over back-loaded policy interventions.

2 Related Literature

First, our paper connects to work on sustainable finance, investor stewardship, and the role of capital-market support in shaping firm sustainability behavior. A large and growing literature studies whether investors value sustainability, whether sustainable capital affects financing conditions, and whether investor stewardship changes firm behavior. This literature has generated important insights into green finance, shareholder support for sustainability, and the pricing of environmental commitment (Flammer, 2021; Pástor et al., 2021). Related work emphasizes that investors may influence firms through different channels, including exit and voice, and that voice can be especially important when investors seek to promote socially desirable corporate behavior (Broccardo et al., 2022). Collaborative shareholder engagement and active ownership can likewise be important mechanisms through which investors influence firms' climate-related and ESG decisions (Dimson et al., 2015; Slager et al., 2023; Hoepner et al., 2024). More broadly, the recent sustainability agenda in *Management Science* highlights the need to understand how private-sector sustainability initiatives translate into meaningful operational outcomes rather than remaining at the level of aspiration or market rhetoric (Flammer and Loch, 2024).

Our paper complements this literature by shifting attention from support itself to implementation. The question in our setting is not simply whether investors support sustainability, but when such support translates into *real transition*. We show that investor support becomes effective only when it reaches sufficient scale and when firms possess the organizational capability to convert support into implementation. This perspective helps explain why sustainable capital can coexist with uneven operational change, a concern that is also reflected in recent evidence on the disconnect between ESG-oriented narratives and concrete green innovation outcomes (Cohen et al., 2020, 2026).

Detailed comparison with Broccardo, Hart, and Zingales (2022). Broccardo et al. (2022) develop one of the most prominent recent theories of how investors affect firm behavior on social and environmental dimensions. They compare two channels—exit (selling shares of socially harmful firms) and voice (voting or engaging to change firm behavior)—and show that voice can be more effective than exit at inducing firms to internalize externalities, particularly when firms are large relative to the economy. Our paper takes a fundamentally different angle. First, Broccardo et al. study which channel investors should use, taking the firm's ability to respond as given. In our framework, the firm's ability to respond—its transition capability—is the central endogenous variable. An investor coalition may exercise

voice, but voice is ineffective unless the firm has built the governance, monitoring, and execution systems needed to translate external pressure into operational change. Second, their model is essentially bilateral: a representative investor (or investor population) interacts with a representative firm. Ours features a collective action problem among investors (who must reach a participation threshold $\bar{x}$ before support becomes effective) and an endogenous preparation decision by the firm (which must invest in capability above the threshold $\bar{c}$). The coordination failure we identify arises from the interaction of these two thresholds, a mechanism that has no counterpart in the exit-versus-voice comparison. Third, they focus on the steady-state comparison between exit and voice. We instead study the dynamic interaction between support and capability accumulation, showing that timing matters: early voice can reduce future capability costs (the support-facilitation channel), while delayed voice cannot. In sum, our paper complements Broccardo et al. by studying *when* and *under what conditions* investor voice translates into real outcomes, rather than comparing which channel investors should use.

Detailed comparison with Slager, Chuah, Gond, Furnari, and Homanen (2023). Slager et al. (2023) provide detailed empirical evidence on collaborative shareholder engagement on climate-related issues. Their central finding is that the effectiveness of investor coalitions depends on how coalition design is tailored to the receptivity of the target firm. Coalitions that match their engagement strategy to the firm's existing governance structures, openness to dialogue, and sector-specific context achieve better outcomes than coalitions that apply uniform pressure. This finding maps directly onto the core mechanism of our model. In our framework, investor coordination (reaching the support threshold $\bar{x}$) is necessary but not sufficient for real transition; the firm must also have built transition capability above $\bar{c}$. The Slager et al. result that coalition effectiveness depends on firm receptivity can be read as empirical support for our complementarity: the return to investor coordination depends on the firm's organizational preparedness, precisely as captured by $p_{cS} > 0$. However, Slager et al. do not formalize this interaction or study its equilibrium consequences. They show that coalition design matters *conditional on engagement*, whereas we show that the anticipated match between support and capability shapes both sides' ex ante incentives—generating the transition-capability trap under pessimistic expectations and the high-transition equilibrium under optimistic ones. Our model therefore provides a theoretical framework within which findings of the type documented by Slager et al. can be understood as equilibrium phenomena.

A second related literature studies the organizational foundations of strategy implemen-

tation. In the sustainability context, recent work increasingly emphasizes that firms face not only financial frictions, but also managerial and organizational barriers to green transition (De Haas et al., 2025). More generally, prior research in management has long stressed that implementation depends on internal systems of control, coordination, and learning rather than on high-level strategic intent alone (Kirsch et al., 2002; Argote and McGrath, 1993). Work on stakeholder orientation and corporate social responsibility also suggests that internal organizational choices can shape firms' ability to innovate and sustain socially oriented strategic change (Flammer, 2015; Flammer and Kacperczyk, 2016). At the same time, evidence that CSR initiatives can sometimes backfire underscores that sustainability-oriented actions need not translate mechanically into better outcomes (List and Momeni, 2021).

Our paper contributes to this line of work by modeling firm-side transition capability as an endogenous strategic choice. Transition capability in our framework summarizes the internal systems needed to turn sustainability commitment into real implementation, including monitoring, governance discipline, reporting infrastructure, and cross-unit coordination. In a dynamic extension, we further allow capability to accumulate over time, with early investor support reducing the cost of subsequent organizational preparation. This connects to the broader organizational-learning literature, which emphasizes that implementation capacity is built incrementally and that early conditions shape long-run organizational outcomes (Argote and McGrath, 1993). This emphasis distinguishes the paper from approaches that treat firm capability as exogenous or that focus only on the external pressure to transition. In our model, capability is the missing link between sustainability support and sustainability outcomes.

Detailed comparison with de Haas, Martin, Muuls, and Schweiger (2025). De Haas et al. (2025) provide large-scale empirical evidence that both weak green management practices and financial constraints impede firms' green investment. Using survey data from thousands of firms across emerging and developing economies, they document that managerial and organizational preparedness is at least as important as access to finance in determining whether firms undertake green investment. Firms with weak internal management systems fail to invest even when external financing is available. Their findings map closely onto the firm-side margin of our model. What de Haas et al. call "green management" corresponds to our transition capability c: the internal governance, monitoring, and execution systems that determine whether external resources translate into real operational change. Their finding that firms with weak management fail to invest even when finance is available is consistent with our trap result (Proposition 2): in the bad equilibrium, firms remain at $c = 0$ not

because capital is unavailable but because the expected return to capability-building is too low when investor support is anticipated to be fragmented. However, de Haas et al. study the firm side in isolation. They do not model the investor coordination problem or the feedback from firm capability to investor behavior. Our contribution is to embed the firm-side capability margin in a strategic interaction with investor coordination, showing that the two frictions reinforce each other. In their data, weak management and weak financing coexist; our model explains why this coexistence is not coincidental but is an equilibrium outcome of strategic complementarity. Moreover, our dynamic extension provides a theory of *why* management capability remains weak: the absence of early investor support leaves capability-building costs unchanged, making it rational for firms to postpone investment, which in turn sustains the absence of support.

Detailed comparison with Gryglewicz, Mayer, and Morellec (2025). The closest recent theory paper is Gryglewicz et al. (2025), which studies investor activism, engagement effort, and optimal contracting in the green transition. In their model, an activist investor exerts costly engagement effort to induce a firm to adopt a green technology, and the interaction is governed by a contracting problem between the activist and the firm's management. Our paper differs from theirs along several dimensions, each corresponding to a distinct modeling choice and a distinct set of results. First, their investor side features a single activist whose effort is a continuous choice variable. Ours features a continuum of investors facing a collective action problem with a discrete participation threshold $\bar{x}$. This difference is consequential: in their model, the activist's effort choice is a standard optimization problem; in ours, investor support is subject to a coordination friction that can generate multiple equilibria even when capability is fixed. The threshold structure also creates a role for equilibrium selection and for policies that reduce coordination costs, neither of which arises in their bilateral setting. Second, their firm side is essentially passive: the firm's green technology adoption is governed by the activist's effort and the contract terms. In our model, the firm actively chooses transition capability c at a cost, and this choice determines both implementation quality and investor willingness to coordinate. This two-sided endogeneity generates the transition-capability trap, which has no counterpart in their framework because their firm does not make a costly preparation investment that feeds back into investor behavior. Third, their model is static, whereas our dynamic extension shows that the complementarity between support and capability propagates across time, generating absorbing traps, support-capability momentum, and a strict policy-timing result (front-loaded subsidies dominate back-loaded ones). Fourth, they do not study observability, greenwashing, or

industry-level coordination, which are central to our analysis. In sum, while Gryglewicz et al. provide important insights into the contracting problem between an activist and a firm, our paper studies a qualitatively different problem: the multi-level coordination failure that arises when investor support requires coalition formation, firm capability is endogenous and costly, and both margins interact through strategic complementarity.

The paper is also related to the broader literature on coordination and implementation failure. In many strategic environments, individually rational behavior can lead to inefficient outcomes because actions are complementary and expectations are self-fulfilling. Our setting features this logic on both sides of the sustainability problem. Investor support is subject to a coalition friction, while firm capability-building is costly and depends on expected investor response. When capability accumulates over time, this coordination problem acquires a temporal dimension: early support facilitates later capability-building, creating a momentum effect, while the absence of early support can generate path-dependent traps in which late catch-up investment is prohibitively costly. More broadly, our emphasis on the interaction between private incentives and social externalities is related to recent work in corporate finance and governance that studies how shareholders and control transactions respond to socially relevant externalities (Bond and Levit, 2025).

Detailed comparison with Bond and Levit (2025). Bond and Levit (2025) study how control transactions in corporate governance respond to socially relevant externalities, showing that takeovers can reduce social welfare even when they increase private value because acquirers do not internalize social costs of restructuring. Our paper shares the emphasis on the gap between private and social incentives but differs in mechanism: Bond and Levit study a bilateral control transaction in which one party ignores social costs, whereas we study a multilateral coordination problem in which the welfare wedge arises from the complementarity between distributed support and distributed preparation, and in which under-provision results from the failure of multiple parties to coordinate around mutually reinforcing investments.

Detailed comparison with Caldecott, Clark, Harnett, Koskelo, Wilson, and Liu (2024). Caldecott et al. (2022) develop a comprehensive framework mapping the transmission mechanisms—cost of capital, risk management, stewardship, information provision—through which sustainable finance affects real outcomes. Our paper can be understood as formalizing one such mechanism (stewardship and engagement) and studying its equilibrium properties. Whereas Caldecott et al. (2022) map channels descriptively, we show that the ef-

fectiveness of the stewardship channel depends on an endogenous variable—firm capability—that is itself shaped by expectations about the channel's effectiveness, generating multiplicity and the transition-capability trap. Our dynamic extension further shows that transmission is path-dependent: early activation of the channel reduces future capability costs, a feature that a static channel-mapping framework does not capture.

Relation to the coordination and complementarities literature. The theoretical structure connects to the broader literature on coordination, strategic complementarities, and implementation failure. In standard global-games models of coordination, agents face a one-sided coordination problem in which each agent's payoff depends on aggregate participation, and equilibrium selection is governed by information structure. In our benchmark model, investors face a similar threshold problem. The departure comes in Sections 4–6, where the firm's costly preparation decision and the industry participation margin introduce additional strategic choices that interact with the investors' coordination game. The resulting multiplicity is driven not only by self-fulfilling beliefs about participation, but also by the feedback between preparation and coordination. This places the paper in the tradition of models with endogenous fundamentals in coordination games, where agents' prior investments shape the coordination environment. Our contribution is to apply this logic to sustainability, where the "endogenous fundamental" is the firm's transition capability, and to trace its consequences across multiple interacting margins.

The interaction of these margins generates what we call a transition-capability trap. Firms underinvest in capability when they expect investor support to remain fragmented, and investors withhold support when firms appear organizationally unprepared. The result is a low-capability, low-support equilibrium in which sustainability remains largely symbolic. By contrast, when firms build capability and investors coordinate support, the economy can sustain a high-capability, high-support equilibrium with real transition.

The paper's main contribution is to link sustainable finance with organizational implementation capability in a single theory of sustainable transition. Existing work often studies investor support, firm sustainability choice, or implementation frictions in isolation. We instead emphasize their complementarity. In our framework, sustainable capital does not automatically generate sustainable outcomes because real transition requires both coordinated external support and internal organizational preparation.

Taken together, these literatures suggest that sustainable transition depends on both external pressure and internal implementation capacity, but they have rarely been integrated in a single formal framework. Our paper does so by modeling investor coordination and firm

transition capability as strategic complements, both in a static setting and in a dynamic environment in which early support shapes subsequent capability-building costs. This perspective is consistent with a broader shift in sustainability research toward understanding the private sector's practical constraints, opportunities, and implementation challenges (Flammer and Loch, 2024; De Haas et al., 2025). The paper therefore offers a theory of when sustainability commitments remain symbolic, when they become operationally meaningful, and how greenwashing can further distort investor coordination by diluting the credibility of favorable sustainability signals.

3 Benchmark Model: Exogenous Capability

We begin with a benchmark model in which the firm's transition capability is exogenous. This benchmark isolates the core mechanism of the paper in its simplest form. In the core model, we focus on two levels of coordination: investor coordination and within-firm coordination, the latter summarized by the firm's transition capability. Investor support becomes effective only when a sufficiently large coalition forms, while the probability that a sustainability project leads to real implementation depends on both investor support and firm capability. Even when capability is fixed, these two margins are complementary and can generate multiple equilibria.

Setup. There is one firm and a unit mass of investors indexed by $i \in [0, 1]$.[1]

The firm has access to a sustainability project, such as decarbonization, operational upgrading, or a costly long-term transition initiative. If the firm undertakes the project, it incurs a fixed cost $K > 0$. If the project is successfully implemented, it yields gross payoff $R > 0$.

In the benchmark, the firm's transition capability

$$c \in [0, 1]$$

is taken as exogenous. We interpret c as the firm's organizational ability to convert sustainability commitment into real implementation. It captures internal governance, monitoring, verification, reporting discipline, and cross-unit execution capacity. Appendix B.1 provides a microfoundation in which c summarizes the firm's ability to align a sufficiently large internal

[1] In the core model, investors are best interpreted as shareholders—especially long-term institutional shareholders—whose support may take the form of voting, stewardship, engagement, or tolerance of short-run transition costs.

coalition behind transition.

Each investor chooses whether to support the project. Support may represent stewardship, voting, engagement, monitoring, tolerance of short-run costs, or the provision of patient capital. Let

$$s_i \in \{0, 1\}$$

denote investor i's support decision, and let aggregate support be

$$x = \int_0^1 s_i \, di.$$

Investor support is effective only if support reaches a critical mass $\bar{x} \in (0, 1)$. Define the support-effectiveness indicator

$$S(x) = \begin{cases} 1, & x \geq \bar{x}, \\ 0, & x < \bar{x}. \end{cases}$$

Thus, fragmented investor support has limited effect, whereas sufficiently broad support forms an effective coalition.

If the firm undertakes the project, the probability of *real implementation* is

$$p(c, S) = p_0 + p_c c + p_S S + p_{cS} cS,$$

where

$$p_c > 0, \qquad p_S > 0, \qquad p_{cS} > 0,$$

and parameters are such that $p(c, S) \in [0, 1]$.

The term $p_c c$ captures the direct effect of transition capability on implementation quality. The term $p_S S$ captures the direct effect of coordinated investor support. The interaction term $p_{cS} cS$ captures complementarity: capability is more valuable when investor support is effective, and investor support is more valuable when capability is stronger.

Let

$$a \in \{0, 1\}$$

denote the firm's project choice, where $a = 1$ means that the firm undertakes the sustainability project. The firm's expected payoff is

$$\Pi_F(a; x, c) = \begin{cases} p(c, S(x))R - K, & a = 1, \\ 0, & a = 0. \end{cases}$$

Each investor has idiosyncratic support cost m_i, drawn from a strictly increasing cdf F on $[0, \bar{m}]$ with density $f > 0$ on $(0, \bar{m})$. By convention, extend F by $F(y) = 0$ for $y \leq 0$ and $F(y) = 1$ for $y \geq \bar{m}$. If investor i supports, he incurs cost m_i. Let $\tilde{v} > 0$ denote the investor payoff from a successfully implemented sustainability transition. Then investor i's expected payoff is

$$\Pi_i(s_i; x, a, c) = \begin{cases} S(x)\, a\, p(c, S(x))\tilde{v} - m_i, & s_i = 1, \\ 0, & s_i = 0. \end{cases}$$

Thus, investors care about the same implementation probability that governs firm payoffs. In the benchmark, low values of $p(c, S)$ correspond to sustainability action that is largely symbolic, whereas high values correspond to real operational transition.

Continuation equilibrium. We study the continuation game for a fixed capability level c. Investors move first, aggregate support determines whether backing is effective, and the firm then decides whether to undertake the project.

Because aggregate support affects the firm's payoff only through the effectiveness indicator S, the firm's continuation strategy can be written as a map from $S \in \{0, 1\}$ into $\{0, 1\}$.

Given c and S, the firm undertakes the project if and only if

$$p(c, S)R \geq K.$$

Hence the firm's optimal continuation action is

$$a^*(S; c) = \begin{cases} 1, & p(c, S)R \geq K, \\ 0, & p(c, S)R < K. \end{cases}$$

In particular:

$$a^*(0; c) = 1 \iff p(c, 0)R \geq K,$$

and

$$a^*(1; c) = 1 \iff p(c, 1)R \geq K.$$

Next consider investor behavior. Suppose investors expect support to be effective and expect the firm to undertake the project. Then $S = 1$ and $a = 1$, so investor i supports if and only if

$$p(c, 1)\tilde{v} - m_i \geq 0.$$

Equivalently,

$$m_i \leq p(c,1)\tilde{v}.$$

Hence the induced mass of supporters is

$$x = F\big(p(c,1)\tilde{v}\big).$$

This expression will determine whether the candidate high-support equilibrium is self-sustaining.

We restate the benchmark complementarity with an explicit lemma.

Observation 1 (Complementarity)**.** *The implementation technology exhibits strategic complementarity between investor support and firm transition capability:*

$$\frac{\partial^2 p(c,S)}{\partial c\,\partial S} = p_{cS} > 0.$$

Observation 1 states the core mechanism of the paper in its simplest form, which is micro-founded in Appendix B.1. Higher capability increases the marginal impact of effective investor support, while effective investor support increases the marginal value of capability.

Equilibrium characterization. We now characterize the continuation equilibrium for a fixed capability level c.

A continuation equilibrium consists of investor support decisions $\{s_i\}_{i\in[0,1]}$, aggregate support

$$x = \int_0^1 s_i\, di,$$

the induced support-effectiveness state $S(x)$, and the firm's continuation action $a^*(S;c)$, such that investors optimize given the induced outcome, the firm's continuation action is optimal, and aggregate support is consistent with investor behavior.

We begin with the low-support outcome.

Lemma 1 (No-Support Continuation Equilibrium)**.** *For a given capability level c, if*

$$p(c,0)R < K,$$

then there exists a low-support, no-project continuation equilibrium with

$$x = 0, \qquad S = 0, \qquad a = 0.$$

We next characterize the high-support outcome.

Lemma 2 (High-Support Continuation Equilibrium)**.** *For a given capability level c, a high-support, project continuation equilibrium exists if*

$$p(c,1)R \geq K$$

and

$$F\big(p(c,1)\tilde{v}\big) \geq \bar{x}.$$

In such an equilibrium,

$$x = F\big(p(c,1)\tilde{v}\big), \qquad S = 1, \qquad a = 1.$$

We can now state the multiplicity condition.

Proposition 1 (Benchmark Continuation Multiplicity)**.** *For a given capability level c, the continuation game admits both a low-support/no-project equilibrium and a high-support/project equilibrium if*

$$p(c,0)R < K \leq p(c,1)R$$

and

$$F\big(p(c,1)\tilde{v}\big) \geq \bar{x}.$$

The benchmark characterizes private equilibrium outcomes and the resulting coordination logic. In later sections, we show that these private outcomes need not be socially efficient once successful transition creates broader surplus beyond firm profits.

Proposition 1 identifies the benchmark tipping region. When

$$p(c,0)R < K \leq p(c,1)R,$$

fragmented investor support is insufficient to make the project viable, while coordinated support is sufficient. In this region, investor coordination can tip the firm from non-adoption to adoption.

The benchmark also highlights the role of capability. A higher capability level c raises the probability of real implementation directly and also increases investor willingness to support by raising

$$F\big(p(c,1)\tilde{v}\big).$$

Thus, even when capability is taken as fixed, stronger capability shifts the economy toward the high-support equilibrium.

Finally, the benchmark provides a simple interpretation of the difference between symbolic and real sustainability outcomes. When $p(c, S)$ is low, sustainability action is best viewed as largely symbolic. When $p(c, S)$ is high, the same project is more likely to deliver genuine operational transition. The benchmark therefore shows, in reduced form, why external support alone does not guarantee real transition: support must be matched by sufficient firm capability.

The benchmark model delivers the basic mechanism of the paper. However, in practice firms do not take capability as fixed. They choose whether and how much to invest in the organizational systems required for transition. The next section endogenizes capability and shows how this additional margin generates a transition-capability trap in which firms rationally remain underprepared when investor support is expected to be weak.

4 Main Model: Endogenous Capability

We now endogenize the firm's transition capability. This is the main model of the paper. The benchmark in Section 3 showed that investor coordination and capability are complementary even when capability is fixed. In practice, however, firms choose whether and how much to invest in the organizational systems required for transition. Once this margin is introduced, the model delivers a richer form of multiplicity: the economy may become trapped not only in a low-support equilibrium, but also in a *low-capability* equilibrium.

Capability choice. At stage 0, before investors move, the firm chooses transition capability

$$c \in [0, 1]$$

at cost $g(c)$, where

$$g(0) = 0, \qquad g'(c) > 0, \qquad g''(c) \geq 0.$$

After the firm chooses c, the continuation game is exactly the benchmark model analyzed in Section 3. For any given capability level c, the continuation game may admit a low-support/no-project equilibrium, a high-support/project equilibrium, or both.

To make this link explicit, let $\mathcal{E}(c)$ denote the set of continuation equilibrium outcomes

at capability level c. Each continuation equilibrium outcome can be represented as a triple

$$e = (x, S, a),$$

where x is aggregate support, S is the support-effectiveness state, and a is the firm's project choice.

From Lemma 1, Lemma 2, and Proposition 1, we know that:

- $(0, 0, 0) \in \mathcal{E}(c)$ whenever
$$p(c, 0)R < K;$$
- $\big(F(p(c, 1)\tilde{v}), 1, 1\big) \in \mathcal{E}(c)$ whenever
$$p(c, 1)R \geq K \qquad \text{and} \qquad F\big(p(c, 1)\tilde{v}\big) \geq \bar{x}.$$

Thus the continuation equilibrium set $\mathcal{E}(c)$ may be single-valued or multi-valued, depending on the capability level c and the primitive parameters.

Capability thresholds. The benchmark analysis implies two natural capability thresholds.

First, define the minimum capability level required for project viability under effective support:

$$c_A = \inf\{c \in [0, 1] : p(c, 1)R \geq K\}.$$

Second, define the minimum capability level required for investor coordination:

$$c_I = \inf\{c \in [0, 1] : F\big(p(c, 1)\tilde{v}\big) \geq \bar{x}\}.$$

Because $p(c, 1)R$ and $F\big(p(c, 1)\tilde{v}\big)$ are continuous in c on the compact set $[0, 1]$, these infima are attained whenever the corresponding feasible sets are nonempty.

Let

$$\bar{c} = \max\{c_A, c_I\}.$$

The threshold $\bar{c}$ summarizes the minimum organizational preparation required for a high-support/project continuation equilibrium to be feasible. The first component, c_A, ensures that the project is worth undertaking under effective support. The second component, c_I, ensures that enough investors are willing to support once they expect the firm to undertake the project.

We formalize this observation next.

Lemma 3 (Capability Cutoff for High-Support Feasibility)**.** *A high-support/project continuation equilibrium can exist only if*

$$c \geq \bar{c}.$$

Lemma 3 is important because it links organizational preparation to equilibrium feasibility. Investor support alone cannot sustain real transition unless capability exceeds the threshold needed both for implementation and for investor coordination.

Full equilibrium. Because the continuation game may be multi-valued, the firm's stage-0 capability choice depends on which continuation equilibrium is expected to prevail after any chosen c.

A *full equilibrium* consists of:

1. a capability choice $c^* \in [0, 1]$;
2. for each feasible capability level c, a selected continuation equilibrium $e(c) \in \mathcal{E}(c)$;

such that c^* maximizes the firm's ex ante payoff induced by the selected continuation outcome.

Given a selected continuation outcome

$$e(c) = (x(c), S(c), a(c)),$$

the firm's ex ante payoff is

$$V(c; e(c)) = \begin{cases} p(c, S(c))R - K - g(c), & a(c) = 1, \\ -g(c), & a(c) = 0. \end{cases}$$

We distinguish two useful selection rules.

Optimistic selection. Whenever a high-support/project continuation equilibrium belongs to $\mathcal{E}(c)$, the selected continuation outcome is the high-support/project equilibrium.

Pessimistic selection. Whenever a low-support/no-project continuation equilibrium belongs to $\mathcal{E}(c)$, the selected continuation outcome is the low-support/no-project equilibrium.

These selection rules are useful because they capture the idea that, when continuation multiplicity exists, firms choose capability based on what they expect investors to do after observing that capability.

The transition-capability trap. We now characterize the central new force created by endogenous capability. Under pessimistic continuation selection, firms may rationally remain underprepared because they expect investor support to be ineffective. This in turn validates investor pessimism.

To make this logic transparent, we first consider a simple case in which the project is not viable without effective investor support at any capability level:

$$p(c, 0)R < K \qquad \text{for all } c \in [0, 1]. \tag{1}$$

Condition (1) says that capability alone is not enough to make transition privately worthwhile; coordinated investor support is also required.

Proposition 2 (Transition-Capability Trap)**.** *Suppose condition* (1) *holds. Under pessimistic continuation selection, the firm optimally chooses*

$$c^* = 0.$$

The resulting full equilibrium is a low-capability, low-support, no-project equilibrium.

Proposition 2 identifies a transition-capability trap. Firms remain underprepared because they anticipate fragmented support; support remains fragmented because firms are underprepared. In this equilibrium, sustainability remains largely symbolic.

High-capability equilibrium. The next result shows that, under optimistic continuation selection, a high-capability equilibrium can also exist.

Proposition 3 (High-Capability Full Equilibrium)**.** *Suppose there exists some capability level $c_H \geq \bar{c}$ such that*

$$p(c_H, 1)R - K - g(c_H) \geq 0. \tag{2}$$

Then, under optimistic continuation selection, there exists a full equilibrium in which the firm chooses some capability level $c^* \geq \bar{c}$, investors coordinate on support, and the firm undertakes the project.

Proposition 3 shows that the same economy can support a high-capability, high-support equilibrium when firms expect capability to be rewarded by coordinated investor backing.

Full-equilibrium multiplicity. Combining the previous two propositions yields the main multiplicity result of the endogenous-capability model.

Theorem 1 (Full-Equilibrium Multiplicity)**.** *Suppose condition* (1) *holds and there exists some* $c_H \geq \bar{c}$ *satisfying condition* (2)*. Then the full game admits both:*

1. *a low-capability, low-support, no-project equilibrium under pessimistic continuation selection; and*

2. *a high-capability, high-support, project equilibrium under optimistic continuation selection.*

Theorem 1 is the central result of the main model. The full-game multiplicity is not merely about whether investors support sustainability. It is also about whether firms build the organizational capability needed for real transition. In the bad equilibrium, firms underinvest in capability and investors withhold support. In the good equilibrium, firms build capability, investors coordinate, and transition becomes viable.

Discussion. The main model strengthens the benchmark in two ways. First, it makes the firm's internal preparation endogenous rather than fixed. Second, it shows that weak sustainability outcomes can arise not only because investors fail to coordinate, but also because firms rationally remain underprepared when external support is expected to be ineffective.

The endogenous-capability model therefore gives a more complete account of why sustainable finance may fail to produce real transition. Firms may announce goals or face pressure to transition, yet still refrain from building the organizational systems required for implementation. In that sense, the model identifies a capability-based source of sustainability failure that complements the investor-coordination friction highlighted in the benchmark.

At the same time, the model also points to a natural role for visibility and credibility. If investors cannot easily observe whether firms have built genuine transition capability, then even capable firms may fail to attract support. The next section introduces this informational friction and studies how assurance, certification, and other visibility-enhancing institutions improve equilibrium selection.

4.1 Dynamic Capability Accumulation

The main model treats capability as a one-shot choice. In practice, transition capability is built incrementally: firms invest in monitoring systems, governance reforms, reporting infrastructure, and cross-unit coordination sequentially, and investors observe intermediate progress before deciding whether to sustain or withdraw support. Appendix C develops a

two-period extension that allows capability to accumulate over time and, crucially, allows the period-1 support outcome to affect the cost of period-2 capability-building. We summarize the main findings here.

Setup. The firm invests in capability over two periods, with period-1 investment Δ_1 bringing capability to $c_1 = \Delta_1$ and period-2 investment Δ_2 bringing capability to $c_2 = c_1 + \Delta_2$. After each investment, investors observe a noisy signal of capability and decide whether to support. The key new feature is that the cost of period-2 investment depends on the period-1 support outcome S_1:

$$g_2(\Delta_2, c_1, S_1) = g(\Delta_2)\,\phi(c_1)\,\psi(S_1),$$

where $\psi(1) = 1 - \sigma < 1 = \psi(0)$ and $\sigma \in [0, 1)$ is a *support-facilitation parameter*. When $S_1 = 1$, effective early support reduces the cost of further organizational preparation—for instance, through access to patient capital, stakeholder validation, investor guidance, or reduced internal resistance to reform. When $\sigma = 0$, the extension nests the static model as a special case.

Support-capability momentum. The support-facilitation channel creates a dynamic feedback loop that is absent from the static model. In the static model (Theorem 1), the complementarity between support and capability operates at a single point in time: investors coordinate once, the firm invests once, and outcomes are determined. In the dynamic extension, complementarity propagates across periods. Effective period-1 support lowers period-2 costs, which raises the firm's period-2 investment, which in turn raises the probability that period-2 coordination succeeds. Conversely, the absence of early support leaves period-2 costs unchanged, depressing further investment and raising the likelihood of a support collapse. This momentum effect amplifies the multiplicity identified in Theorem 1: both the low-capability trap and the high-capability equilibrium remain, but the distance between them is now widened by the cumulative effect of support on costs.

Absorbing traps and transition windows. In the static model, the transition-capability trap (Proposition 2) is a coordination failure: it arises under pessimistic continuation selection but coexists with a good equilibrium under optimistic selection. The dynamic extension shows that, when organizational inertia is present, the trap can become *absorbing*—a firm that fails to invest early and loses period-1 support may find that no profitable catch-up path exists in period 2, regardless of how expectations are selected. This occurs because the cost of late investment escalates under inertia, and the absence of early support ($S_1 = 0$)

means the firm receives no cost discount. More generally, the set of initial capability levels from which real transition remains feasible—the *transition window*—is strictly wider when the firm receives early support than when it does not. This creates a new form of path dependence: history, not just expectations, determines whether transition is achievable.

Early investment and reputation. The dynamic model identifies a strategic motive for early capability investment that has no counterpart in the static model. In the static framework, the firm chooses c to balance the direct implementation benefit against cost. In the dynamic extension, the marginal return to period-1 investment includes two additional channels: a *reputation channel*, through which a favorable early signal relaxes the period-2 coordination threshold, and a *support-facilitation channel*, through which higher Δ_1 raises the probability of period-1 coordination and thereby activates the period-2 cost discount. When $\sigma > 0$, the support-facilitation channel raises the marginal return to early investment relative to the static benchmark. Under standard regularity conditions, this implies that the firm invests weakly more in period 1 than the static model would predict.

Gradualism versus front-loading. The dynamic framework also speaks to the optimal sequencing of capability investment. Under organizational learning (where early investment reduces later costs), spreading investment across periods exploits the learning discount and is reinforced by support facilitation. Under organizational inertia (where deeper structural change is increasingly costly), front-loading investment avoids cost escalation. However, when the support-facilitation parameter σ is sufficiently large, the cost discount from early support can offset the inertia penalty, making gradual investment viable even in rigid organizations. This result provides a formal rationale for transition strategies that combine early stakeholder engagement with incremental capability-building.

Policy timing. The static welfare analysis (Proposition 8) shows that firms underinvest in capability because they do not internalize the broader social value of transition. The dynamic extension adds a temporal dimension to this result: the planner values the support-facilitation premium at social returns rather than private returns, creating an additional welfare wedge in period 1. Because only early subsidies can activate the support-facilitation channel—a period-2 subsidy cannot retroactively generate period-1 coordination—interventions that reduce the cost of early capability-building are more effective than equivalent late interventions. More broadly, the dynamic model suggests that the timing of transition support matters, not just its level: front-loaded capability subsidies and early-stage stewardship

engagement have welfare effects that delayed intervention cannot replicate.

5 Visibility, Greenwashing, and Certification

The benchmark and main models assume that investors observe firm transition capability perfectly. In practice, however, organizational preparation is often only partially visible. Investors may observe sustainability reports, governance structures, third-party assurance, certification, or other public signals, but not the firm's true implementation capability itself. This section introduces a simple informational friction and shows how visibility, assurance, and certification improve equilibrium selection.

Noisy observation of capability. The timing is the same as in Section 4, except that after the firm chooses capability c, investors do not observe c directly. Instead, before choosing whether to support, they observe a public signal

$$z = c + \varepsilon,$$

where ε is a mean-zero noise term with distribution F_ε. We interpret higher signal precision as a mean-preserving contraction of F_ε (and, in particular, as a reduction in the dispersion of ε).

Investors condition their support decisions on the signal z, not on the true capability level c. The firm's true capability still governs implementation through

$$p(c, S) = p_0 + p_c c + p_S S + p_{cS} cS,$$

but support decisions are now based on posterior beliefs about c.

Investor support under noisy capability signals. Given signal z, investors form a posterior belief over the firm's capability and therefore over the probability of real implementation under effective support. Let

$$\hat{p}(z) \equiv \mathbb{E}[p(c, 1) \mid z]$$

denote the posterior expected implementation probability when support is effective.

Suppose investors expect support to be effective and expect the firm to undertake the

project. Then investor i supports if and only if

$$\hat{p}(z)\tilde{v} - m_i \geq 0,$$

or equivalently,

$$m_i \leq \hat{p}(z)\tilde{v}.$$

Hence the induced support mass is

$$x(z) = F\big(\hat{p}(z)\tilde{v}\big).$$

Investor support becomes effective if and only if

$$F\big(\hat{p}(z)\tilde{v}\big) \geq \bar{x}. \tag{3}$$

Condition (3) is the noisy-information analog of the coordination condition in the benchmark model. The difference is that investors now coordinate on the basis of expected rather than true implementation probability. As a result, even firms with genuinely high capability may fail to attract support when capability is poorly observed.

Signal threshold. Because F is increasing, there exists a posterior threshold $\hat{p}^*$ such that effective support is feasible if and only if

$$\hat{p}(z) \geq \hat{p}^*, \qquad \text{where} \qquad \hat{p}^* = \frac{F^{-1}(\bar{x})}{\tilde{v}}.$$

If $\hat{p}(z)$ is increasing in the signal z, then there exists a corresponding signal threshold z^* such that investors coordinate on effective support if and only if

$$z \geq z^*.$$

This signal-threshold formulation is useful for interpretation. When observed capability appears sufficiently strong, investors coordinate and support becomes effective. When observed capability appears too weak, support fragments and the project is not undertaken.

Firm incentives under noisy observation. The informational friction affects the firm's capability choice because capability now influences not only implementation directly, but also the probability that investors recognize the firm as capable enough to support.

Let

$$\Pr(z \geq z^* \mid c)$$

denote the probability that the firm receives a sufficiently favorable public signal conditional on choosing capability level c.

The firm's expected payoff from choosing capability c is then

$$V(c) = \Pr(z \geq z^* \mid c)\big(p(c,1)R - K\big) + \big(1 - \Pr(z \geq z^* \mid c)\big)\max\{p(c,0)R - K, 0\} - g(c).$$

In the most interesting region, where

$$p(c,0)R < K \leq p(c,1)R,$$

this simplifies to

$$V(c) = \Pr(z \geq z^* \mid c)\big(p(c,1)R - K\big) - g(c). \tag{4}$$

Equation (4) makes the role of visibility transparent. Capability affects firm value through two channels:

1. a direct channel, by increasing the probability of real implementation if support is effective;

2. a visibility channel, by increasing the probability that investors recognize the firm as capable and therefore coordinate on support.

Selection implications. We now summarize the extension's main implications.

Proposition 4 (Signal Precision and Investor Coordination)**.** *Fix a capability level c such that*

$$p(c,1)R > K > p(c,0)R.$$

For sufficiently capable firms, an increase in the precision of the public signal weakly raises the probability that investors coordinate on effective support.

Proposition 4 formalizes the idea that assurance, certification, and visible governance structures can improve equilibrium selection. Their role is not merely to reduce uncertainty in a standard sense, but also to help investors coordinate on supporting firms that have genuinely built the capability required for real transition.

Corollary 1 (Signal Precision and Capability Incentives)**.** *In the tipping region, an increase in signal precision weakly raises the ex ante payoff from sufficiently high capability choices.*

Under standard distributional assumptions, it also raises the marginal return to capability-building in that region.

Corollary 1 identifies a second role for visibility. Better observability of capability improves not only support allocation ex post, but also the ex ante attractiveness of capability investment for firms that are already near the region in which support can be coordinated.

To summarize, this extension gives a natural interpretation of assurance, certification, and related institutions. In the model, these mechanisms improve the public visibility and credibility of transition capability. By doing so, they make it easier for investors to distinguish firms with real implementation capacity from firms whose sustainability commitments are largely symbolic.

The extension also clarifies why disclosure and certification should be understood as *selection-improving* rather than merely *fundamental-shifting* interventions. They do not necessarily eliminate multiplicity altogether. Instead, they increase the likelihood that sufficiently capable firms are recognized and supported, thereby moving the economy toward the high-capability, high-support equilibrium.

Strategic greenwashing. The visibility framework above treats symbolic sustainability as a reduced-form outcome: when capability is weak, investor support may generate commitments or rhetoric without real implementation. We now briefly endogenize this margin. The key idea is that a firm may choose not only how much transition capability to build, but also whether to pursue a symbolic project that is cheaper than real transition but can still generate favorable public signals.

At Stage 0, the firm chooses a project type $a \in \{r, s\}$, where r denotes a real transition project and s denotes a symbolic project. If the firm chooses $a = r$, it chooses transition capability $c \in [0, 1]$ and incurs capability cost $g(c)$. If the firm chooses $a = s$, it undertakes no real capability-building. In either case, the firm may choose disclosure effort $d \geq 0$ that affects how sustainability-oriented the project appears to outside investors.

At Stage 1, investors observe a public signal

$$z = \begin{cases} c + \beta d + \varepsilon, & \text{if } a = r, \\ \beta d + \varepsilon, & \text{if } a = s, \end{cases}$$

where ε is a mean-zero noise term and $\beta \geq 0$ measures the extent to which disclosure, communication, or public-relations effort can inflate observed sustainability performance. Thus, favorable signals may arise either from genuine capability or from disclosure effort.

At Stage 2, investors simultaneously decide whether to provide sustainability-oriented support. Let

$$\mu(z) \equiv \Pr(a = r \mid z)$$

denote the posterior probability that the firm chose a real project after investors observe z. Define the posterior expected implementation value as

$$\hat{p}_G(z) \equiv \mu(z)\,\mathbb{E}[p(c,1) \mid z, a = r] + \big(1 - \mu(z)\big)p^s(1),$$

where $p^s(1)$ is the implementation probability of the symbolic project under effective support, with $p^s(1)$ small. Investor i with support cost m_i supports if and only if

$$\tilde{v}\,\hat{p}_G(z) \geq m_i.$$

Hence aggregate support is

$$x_G(z) = F\big(\tilde{v}\,\hat{p}_G(z)\big),$$

and support becomes effective whenever

$$x_G(z) \geq \bar{x}.$$

If the firm chooses a real project, its payoff is

$$\Pi_r(c, d; z) = \mathbb{1}_{x_G(z) \geq \bar{x}}\big(p(c,1)R - K_r\big) - g(c) - h(d),$$

where K_r is the fixed cost of real transition and h is the cost of disclosure effort. If the firm chooses a symbolic project, its payoff is

$$\Pi_s(d; z) = \mathbb{1}_{x_G(z) \geq \bar{x}}\big(p^s(1)R - K_s\big) - h(d),$$

where $K_s < K_r$ and h is increasing and convex. The symbolic project is cheaper, but it generates little real transition.

To state the next results cleanly, assume that disclosure effort is chosen from a compact set $D \equiv [0, \bar{d}]$, that g and h are continuous, and that $\hat{p}_G(z)$ is weakly increasing in z. Define the coordination cutoff

$$z_G^* \equiv \inf\left\{z : F\big(\tilde{v}\,\hat{p}_G(z)\big) \geq \bar{x}\right\},$$

and let

$$\Phi_r(c,d) \equiv \Pr\big(c + \beta d + \varepsilon \geq z_G^*\big), \qquad \Phi_s(d) \equiv \Pr\big(\beta d + \varepsilon \geq z_G^*\big)$$

denote the probabilities that a real or symbolic project induces coordinated investor support.

Observation 2 (Incentive to Greenwash)**.** *Suppose there exists $d_s \in D$ such that*

$$\Phi_s(d_s)\big(p^s(1)R - K_s\big) - h(d_s) > \sup_{(c,d)\in[0,1]\times D} \big\{\Phi_r(c,d)\big(p(c,1)R - K_r\big) - g(c) - h(d)\big\}. \quad (5)$$

Then the firm strictly prefers the symbolic project to any real transition project. In this sense, symbolic sustainability can dominate substantive transition at the level of the firm's private project choice.

Two comments are in order. First, Observation 2 is deliberately not stated as a full equilibrium result. Under full rational expectations, if investors were certain that all firms always chose the symbolic project, then favorable signals would lose their informational content about real implementation. A genuine greenwashing equilibrium therefore requires residual uncertainty on the investor side. Appendix B.3 constructs such a partial-pooling equilibrium by introducing a positive fraction of genuinely transition-oriented firms.

Second, Condition (5) has a simple meaning. A symbolic project becomes attractive when three forces line up: it avoids the capability cost $g(c)$, it bears the lower fixed cost $K_s < K_r$, and disclosure effort can generate a favorable signal often enough to attract coordinated support. The single disclosure-cost function $h(d)$ makes clear that the symbolic advantage need not come from cheaper disclosure per se. It is enough that symbolic projects economize on real capability-building while still allowing the firm to look sufficiently transition-ready to investors.

Proposition 5 (Greenwashing Raises the Coordination Threshold)**.** *Let*

$$\hat{p}_0(z) \equiv \mathbb{E}[p(c,1) \mid z, a = r]$$

denote posterior expected implementation value in the benchmark visibility model without symbolic projects, and define

$$z_0^* \equiv \inf\big\{z : F\big(\tilde{v}\,\hat{p}_0(z)\big) \geq \bar{x}\big\}.$$

Suppose that, for every signal z in the overlap region where both project types generate z with positive probability,

$$p^s(1) \leq \hat{p}_0(z).$$

Then

$$\hat{p}_G(z) \leq \hat{p}_0(z)$$

for every such z. If, in addition, $\hat{p}_0$ is weakly increasing, then

$$z_G^* \geq z_0^*.$$

The first inequality is strict whenever $\mu(z) < 1$ and $p^s(1) < \hat{p}_0(z)$.

Two comments are in order. First, the economic implication is that greenwashing is not only a firm-level deception problem. It imposes a negative externality on all firms by reducing the credibility of favorable sustainability signals and making investor coordination harder even for genuinely capable firms. Second, the key condition $p^s(1) \leq \hat{p}_0(z)$ says that, conditional on any signal that can be produced by both project types, a symbolic project is weakly less likely to generate real implementation than a genuine project. Under that condition, introducing symbolic projects dilutes the meaning of a favorable signal. Investors rationally discount observed sustainability performance because some of it may reflect disclosure effort rather than real capability, so the signal required to coordinate support rises.

We next formalize the role of certification. Let certification intensity be denoted by $\chi \geq 0$. We model certification as reducing the effectiveness of disclosure effort in generating favorable signals. Specifically, suppose that under certification the signal becomes

$$z = \begin{cases} c + \beta d + \varepsilon^c, & \text{if } a = r, \\ \beta_c d + \varepsilon^c, & \text{if } a = s, \end{cases} \qquad \text{with } \beta_c \leq \beta,$$

and ε^c weakly more precise than ε in the sense of a mean-preserving contraction. Let $\hat{p}_C(z)$ and z_C^* denote the posterior implementation value and coordination cutoff in the certified environment, and let

$$\Phi_s^C(d) \equiv \Pr\big(\beta_c d + \varepsilon^c \geq z_C^*\big)$$

denote the symbolic project's support probability under certification.

Corollary 2 (Certification as a Filtering Device)**.** *Suppose that, for every z, $\hat{p}_C(z) \geq \hat{p}_G(z)$ and, for every $d \in D$,*

$$\Phi_s^C(d) \leq \Phi_s(d).$$

Then $z_C^* \leq z_G^*$ *and*

$$\sup_{d \in D} \left\{ \Phi_s^C(d) \big(p^s(1)R - K_s \big) - h(d) \right\} \leq \sup_{d \in D} \left\{ \Phi_s(d) \big(p^s(1)R - K_s \big) - h(d) \right\}.$$

Hence stronger certification weakly lowers the coordination threshold and weakly reduces the profitability of symbolic projects.

This extension strengthens the role of visibility and assurance. In the baseline visibility model, certification improves equilibrium selection by making capability more observable. With endogenous symbolic action, certification plays a second role: it filters greenwashing by making favorable signals more tightly linked to real capability.

Furthermore, the two conditions in Corollary 2 correspond to the two economic channels through which certification operates. The inequality $\hat{p}_C(z) \geq \hat{p}_G(z)$ captures the *precision channel*: certification makes a given signal more informative about real implementation. The inequality $\Phi_s^C(d) \leq \Phi_s(d)$ captures the *filtering channel*: certification makes it harder for purely symbolic projects to obtain support through disclosure effort alone. Together, these forces lower the coordination threshold and compress the payoff advantage of greenwashing.

A genuine partial-pooling greenwashing equilibrium, with a positive fraction of genuinely transition-oriented firms and a positive fraction of symbolic firms, is constructed in Online Appendix B.2. In addition, several broader implications of the greenwashing extension—including capability crowd-out, welfare losses, and sectoral credibility externalities—are developed in the online appendix in Section B.2.

6 Industry Participation & Multi-Level Coordination

The previous sections focused on a single firm's transition problem and showed that real transition requires alignment between investor coordination and firm capability. We now generalize the framework to allow coordination across firms at the industry level. The key idea is that broader industry participation may improve both the transition environment faced by participating firms and the effectiveness of investor support. This creates a third coordination margin, in addition to investor coordination and within-firm coordination.

To preserve consistency with the baseline model, we continue to let investor support be summarized by the support variable x. In the benchmark and main model, support effectiveness depends only on investor participation and is written as $S(x)$. In the generalized industry extension, support effectiveness may also depend on industry participation. We

therefore write

$$\Sigma(x, m),$$

where $m \in [0, 1]$ is the industry participation rate. The baseline is nested as the special case $\Sigma(x, m) = S(x)$.

Generalized framework. There is a unit mass of firms indexed by $f \in [0, 1]$. Each firm chooses whether to participate in sustainable transition. Let

$$m \in [0, 1]$$

denote the aggregate participation rate.

If a firm participates, it chooses transition capability $c \geq 0$ at cost $g(c)$ and obtains expected payoff

$$p(c, \Sigma(x, m), m)R - g(c) - \kappa,$$

where:

- $R > 0$ is the gross return from successful transition,
- κ is the firm's idiosyncratic fixed participation cost,
- $g'(c) > 0$ and $g''(c) \geq 0$,
- $p(c, \Sigma, m)$ is increasing in capability and in support effectiveness.

We assume κ is distributed according to a strictly increasing cdf G on $[0, \bar{\kappa}]$. Here, κ can be interpreted as the heterogeneous counterpart of the fixed transition cost K in the baseline model, allowing firms to differ in their private cost of joining the transition coalition.

The generalized support-effectiveness function $\Sigma(x, m)$ captures the idea that broader industry participation may make investor support more effective or easier to sustain. We assume

$$\Sigma_x(x, m) > 0, \qquad \Sigma_m(x, m) \geq 0.$$

Thus, support becomes more effective when investors coordinate more strongly and, weakly, when more firms in the industry participate.

A participating firm solves

$$\max_{c \geq 0} \{p(c, \Sigma(x, m), m)R - g(c) - \kappa\}.$$

Define the optimized participation surplus

$$\Psi(x, m) \equiv \max_{c \geq 0} \{p(c, \Sigma(x, m), m)R - g(c)\}.$$

Then a firm participates if and only if

$$\kappa \leq \Psi(x, m).$$

Hence the industry participation rate satisfies

$$m = G\big(\Psi(x, m)\big). \tag{6}$$

Equation (6) is the industry participation condition. It shows that industry participation is determined by the interaction of investor coordination, within-firm capability, and across-firm participation.

Optimal capability choice. Let $c^*(x, m)$ denote the optimal capability choice of a participating firm. For an interior solution, it satisfies

$$p_c(c, \Sigma(x, m), m)R = g'(c). \tag{7}$$

Assume the second-order condition

$$p_{cc}(c, \Sigma(x, m), m)R - g''(c) < 0. \tag{8}$$

Equation (7) makes the central interaction in the extension transparent. The return to capability depends on both support effectiveness and industry participation. We next state comparative statics that link the three coordination margins.

Lemma 4 (Investor Coordination and Capability Choice)**.** *Suppose*

$$p_{c\Sigma}(c, \Sigma, m) > 0 \qquad \textit{and} \qquad \Sigma_x(x, m) > 0.$$

Then the optimal capability choice of a participating firm is increasing in investor coordination:

$$\frac{\partial c^*(x, m)}{\partial x} > 0.$$

Lemma 4 implies that stronger investor coordination raises the return to within-firm coordination. External support therefore crowds in internal capability-building.

Lemma 5 (Industry Participation and Capability Choice)**.** *Suppose*

$$p_{cm}(c, \Sigma, m) \geq 0, \qquad p_{c\Sigma}(c, \Sigma, m) \geq 0, \qquad \Sigma_m(x, m) \geq 0,$$

with at least one strict inequality. Then the optimal capability choice of a participating firm is increasing in industry participation:

$$\frac{\partial c^*(x, m)}{\partial m} > 0.$$

Lemma 5 is the key internal–industry link. Broader industry participation raises the return to internal capability both directly, by improving the transition environment, and indirectly, by making investor support more effective.

Participation surplus and industry coordination. We now turn to the optimized participation surplus

$$\Psi(x, m) \equiv \max_{c \geq 0} \{p(c, \Sigma(x, m), m)R - g(c)\}.$$

Assume that the maximizer $c^*(x, m)$ is unique and interior, and that Ψ is continuously differentiable. By the envelope theorem,

$$\Psi_x(x, m) = p_\Sigma(c^*(x, m), \Sigma(x, m), m)\, \Sigma_x(x, m)R,$$

and

$$\Psi_m(x, m) = \Big[p_m(c^*(x, m), \Sigma(x, m), m) + p_\Sigma(c^*(x, m), \Sigma(x, m), m)\, \Sigma_m(x, m)\Big]R.$$

Therefore, if

$$p_\Sigma > 0 \qquad \text{and} \qquad \Sigma_x > 0,$$

then

$$\Psi_x(x, m) > 0.$$

Likewise, if

$$p_m \geq 0, \qquad p_\Sigma \geq 0, \qquad \Sigma_m \geq 0,$$

with at least one strict inequality, then

$$\Psi_m(x, m) > 0.$$

These comparative statics imply that stronger investor coordination raises firms' participation surplus directly through more effective support, while broader industry participation raises participation surplus either directly through the transition environment or indirectly through support effectiveness.

Define the industry best-response mapping

$$\Phi(m; x) \equiv G\big(\Psi(x, m)\big).$$

An industry participation equilibrium is a fixed point of

$$m = \Phi(m; x).$$

Proposition 6 (Multi-Level Industry Coordination)**.** *Suppose G is continuously differentiable with density $g > 0$ on the relevant range, and suppose $\Psi(x, m)$ is continuously differentiable and weakly increasing in m. Then firms' participation decisions are strategically complementary. Moreover, if there exists an interval $I \subset (0, 1)$ such that*

$$g\big(\Psi(x, m)\big)\Psi_m(x, m) > 1 \qquad \text{for all } m \in I, \tag{9}$$

and if there exist $m_1 < m_2$ in I such that

$$\Phi(0; x) > 0, \qquad \Phi(m_1; x) < m_1, \qquad \Phi(m_2; x) > m_2, \qquad \Phi(1; x) < 1, \tag{10}$$

then the industry participation condition

$$m = G\big(\Psi(x, m)\big)$$

admits at least three equilibria, and hence multiple equilibria.

Proposition 6 gives the industry-level analogue of the coordination logic in the benchmark model. A low-participation industry equilibrium may coexist with a high-participation equilibrium when broader participation raises the private return to participation strongly enough.

Discussion. This generalized framework links the paper's three coordination margins in a unified way. First, investor coordination raises support effectiveness through $\Sigma_x > 0$. Second, within-firm coordination is captured by the capability choice $c^*(x, m)$, which responds positively to both investor coordination and industry participation under Lemmas 4 and 5.

Third, industry participation is determined by a fixed point in which the return to participation depends on both investor support and the capability choices that firms make in response to the broader transition environment.

Taken together, the extension implies that investor coordination, within-firm capability, and industry participation are mutually reinforcing. Stronger investor support raises firms' incentives to build capability. Broader industry participation raises the return to capability and may also make investor support more effective. These forces can produce low-x, low-c, low-m outcomes as well as high-x, high-c, high-m outcomes.

This section therefore generalizes the main model from two-sided coordination between investors and a single firm to a broader multi-level coordination framework. Appendix B.3 provides a finite-N counterpart that makes the under-provision force across firms explicit.

7 Welfare and Policy Implications

The model yields a simple but important lesson: sustainable capital does not automatically generate real transition. External investor support must be matched by internal organizational capability, and the effectiveness of each side depends on the other. Section 6 shows that sustainable transition may also be under-provided across firms, because each firm's participation improves the industry's transition environment without being fully internalized. Section 5 adds a further distortion: when firms can generate favorable sustainability signals symbolically, investor support becomes harder to coordinate even for genuinely capable firms. These forces imply that both welfare analysis and policy design must address coordination at multiple levels: between investors and firms, within firms, across firms, and in the credibility of sustainability signals.

A useful distinction emerging from the model is between two classes of interventions. Some interventions *shift fundamentals* by changing capability-building costs, investor coordination frictions, or the private return to participation. Other interventions *improve equilibrium selection* by making firm capability and participation more visible and credible. In a complementary environment, the two classes reinforce each other. With greenwashing, selection-improving interventions also have a screening role: they do not merely help investors see more, but help them see whether favorable signals are backed by real capability rather than disclosure effort.

Welfare analysis. To sharpen the normative content of the model, we introduce a welfare benchmark that values *real transition* rather than firm payoff alone. Let

$$E \geq 0$$

denote the external social value created by a successfully implemented sustainability transition. This term captures environmental and broader social benefits that are not fully internalized by private agents.

In addition, when the project is undertaken and support is effective, supporting investors obtain private surplus. For a given capability level c and support state $S \in \{0, 1\}$, define aggregate investor net surplus as

$$\mathcal{V}(c, S) \equiv S \int_0^{p(c,S)\tilde{v}} \big(p(c, S)\tilde{v} - m\big)\, dF(m).$$

This object is the aggregate net benefit accruing to investors who optimally choose to support when the project is undertaken.

The social value of undertaking the project is therefore

$$W(a, c, S) = a\Big[p(c, S)(R + E) - K + \mathcal{V}(c, S)\Big] - g(c).$$

This welfare benchmark differs from the firm's private objective in two ways. First, it includes the external transition benefit E. Second, it includes aggregate investor surplus $\mathcal{V}(c, S)$, which individual firms do not internalize.

We begin with the benchmark model, taking capability c as given.

Proposition 7 (Decentralized Under-Adoption)**.** *For any given capability level c and support state S, the socially efficient adoption condition is*

$$p(c, S)(R + E) - K + \mathcal{V}(c, S) \geq 0.$$

Hence the socially efficient set of states in which transition should be undertaken weakly contains the privately induced set

$$p(c, S)R \geq K.$$

Proposition 7 gives the baseline welfare wedge in its simplest form. Even before capability is made endogenous, private adoption is too low relative to the social benchmark because the firm does not internalize either investor surplus or the broader social value of successful transition.

The welfare wedge becomes sharper once capability is endogenous. Recall that a participating firm chooses capability to solve

$$\max_{c \geq 0} \{p(c, S)R - g(c)\},$$

whereas a planner chooses capability to solve

$$\max_{c \geq 0} \{p(c, S)(R + E) + \mathcal{V}(c, S) - g(c)\}.$$

The next result shows that private capability investment is generally too low.

Proposition 8 (Underinvestment in Capability)**.** *Fix a support state S and suppose the private and social capability problems are strictly concave with interior solutions. Let $c^P(S)$ denote the privately optimal capability level and let $c^W(S)$ denote the socially optimal capability level. Then*

$$c^W(S) \geq c^P(S),$$

with strict inequality whenever

$$E > 0 \quad \textit{or} \quad \mathcal{V}_c(c, S) > 0$$

at the private optimum.

Proposition 8 identifies a central normative implication of the model: firms underinvest in transition capability even conditional on undertaking the project, because they do not internalize the broader transition value created by more reliable implementation.

The same welfare logic extends to the industry level. In Section 6, firms participate according to the private participation surplus

$$\Psi(x, m) = \max_{c \geq 0} \{p(c, \Sigma(x, m), m)R - g(c)\}.$$

A planner, by contrast, internalizes that higher industry participation raises the participation surplus of other firms, may increase support effectiveness through $\Sigma(x, m)$, and increases the social value of successful transition. Thus the decentralized industry participation rate is generally below the socially efficient level.

Taken together, the welfare analysis implies that transition may be inefficiently low along three margins:

1. project adoption is too low relative to the social benchmark;

2. transition capability is underprovided conditional on adoption;

3. industry participation is underprovided when firms do not internalize participation spillovers.

Policy implications. The policy logic follows directly from the model's cross-side coordination externality. Individual investors do not internalize that their support raises the return to firm capability-building. Likewise, firms do not internalize that stronger capability raises investors' willingness to coordinate. Because each side takes the other side's response as given, decentralized behavior may exhibit underinvestment in both support and capability.

The industry extension adds a further externality across firms. A firm's participation may improve transition conditions for other firms by strengthening investor support, facilitating standard-setting, deepening assurance and supplier infrastructure, and raising industry legitimacy. Yet each firm internalizes only its own payoff. Hence sustainable transition may be under-provided not only within firms, through insufficient capability-building, but also across firms, through insufficient participation.

This logic implies that one-sided intervention is often insufficient. Measures aimed only at firms may fail if investor support remains fragmented. Measures aimed only at investors may fail if firms remain organizationally unprepared. Likewise, support targeted only at a small set of firms may have limited effect if the broader industry remains below the participation threshold needed to activate strong investor support.

A first class of interventions lowers the cost of building transition capability. In the model, such interventions reduce the cost function $g(c)$, making capability investment more attractive ex ante. In practice, these interventions include support for transition planning systems, internal monitoring and verification infrastructure, managerial training, reporting systems, and cross-unit implementation mechanisms. Because capability affects both implementation success and investor willingness to support, such interventions have multiplier effects. Lower capability cost makes it easier for the firm to choose a capability level above the threshold required to sustain the high-support equilibrium, and this in turn makes investor coordination more likely.

Corollary 3 (Capability-Building Policies)**.** *A reduction in the cost of capability-building weakly expands the set of parameters under which a high-capability, high-support, project equilibrium exists.*

Corollary 3 implies that interventions supporting organizational preparation can improve

sustainability outcomes through two channels: by increasing implementation capability directly and by crowding in coordinated investor support.

A second class of interventions targets the investor side. In the model, these interventions reduce the coordination threshold $\bar{x}$, lower investor support costs, or increase the investor payoff from successful transition $\tilde{v}$. In practice, examples include stewardship platforms, voting coordination mechanisms, common engagement standards, and institutional arrangements that lower the frictions of collective support. These interventions relax the investor-coordination condition

$$F\big(p(c,1)\tilde{v}\big) \geq \bar{x}.$$

By making coordinated support easier to sustain, they also increase the return to firm capability-building.

Corollary 4 (Investor-Coordination Policies)**.** *A reduction in investor coordination frictions weakly expands the set of parameters under which a high-capability, high-support, project equilibrium exists.*

Corollary 4 highlights a key feedback effect: investor-side reforms do not merely affect capital-market behavior; they also change firms' incentives to invest in organizational capability.

Because capability-building and investor coordination are complements, interventions on one side are more effective when the other side is also addressed. This follows directly from the threshold

$$\bar{c} = \max\{c_A, c_I\},$$

where one component reflects project viability under effective support and the other reflects the investor-coordination condition. Policies that reduce $g(c)$ work by making $c \geq \bar{c}$ privately optimal. Policies that lower investor coordination frictions work by reducing the investor-side component of $\bar{c}$. These two effects reinforce each other.

Corollary 5 (Joint Policy Complementarity)**.** *Joint capability-building and investor-coordination interventions are weakly more effective than either intervention in isolation.*

The corollary implies that piecemeal reform may have limited effect in a complementary environment. By contrast, modest interventions on both sides of the market can jointly move the economy across the thresholds needed for real transition.

Section 5 showed that visibility and credibility play a distinct role. When investors observe capability only noisily, sufficiently capable firms may still fail to attract support. Once

firms can also choose symbolic projects, the policy role of disclosure, assurance, certification, and anti-greenwashing enforcement becomes stronger still. Their role in the model is not merely to reduce uncertainty in a generic sense. Rather, they operate through two channels: they improve the precision with which investors infer genuine capability, and they reduce the ability of symbolic firms to mimic real preparedness. By improving the recognition of capable firms and filtering mimicry, these institutions raise the probability that investor support becomes coordinated when it should.

Corollary 6 (Visibility and Anti-Greenwashing Policies)**.** *When firm capability is imperfectly observed, interventions that improve the visibility and credibility of capability weakly increase the likelihood that sufficiently capable firms receive coordinated investor support.*

Corollary 6 implies that disclosure, assurance, certification, and anti-greenwashing enforcement should be understood as *selection-improving* interventions. They do not necessarily change fundamentals directly, but they improve the likelihood that the economy coordinates on the high-capability, high-support equilibrium. In the greenwashing extension, they also restore the credibility of favorable signals by making symbolic mimicry more difficult or less rewarding.

Section 6 shows that sustainability may also be under-provided across firms. Each firm's participation can improve the transition environment for the industry as a whole by raising investor support, strengthening common standards, deepening assurance and supplier infrastructure, and increasing industry legitimacy. Because these benefits are not fully internalized, equilibrium participation may be inefficiently low. This extension suggests a role for industry-wide transition platforms, collective certification systems, common reporting standards, and shared transition infrastructure.

In the notation of Section 6, such interventions can operate through three channels. First, they can raise the private return to participation by increasing the participation surplus

$$\Psi(x, m) = \max_{c \geq 0} \{p(c, \Sigma(x, m), m)R - g(c)\}.$$

Examples include shared reporting systems, sector-specific subsidies, common assurance infrastructure, and technical support that reduces the cost of building credible transition capability. Second, they can make investor support more effective at a given level of investor participation by improving the industry-level support environment encoded in $\Sigma(x, m)$. Examples include sector-wide stewardship coalitions, common taxonomies, and collective engagement platforms. Third, they can improve the visibility of participation and participation

quality, making it easier for both investors and peer firms to coordinate on higher industry participation.

Corollary 7 (Industry-Wide Participation Policies)**.** *Industry-wide interventions that raise the private participation surplus $\Psi(x, m)$, strengthen support effectiveness through $\Sigma(x, m)$, or condition benefits on credible participation weakly increase equilibrium industry participation.*

An important subtlety is that not all industry-wide interventions necessarily improve outcomes. If a policy mainly increases the benefits available to firms regardless of whether they participate, then it may weaken private participation incentives. Industry-wide policy is therefore most effective when it raises the private return to credible participation, lowers the cost of participation, or conditions benefits on participation itself.

The model also yields several managerial implications. Sustainability strategy should not be viewed purely as a commitment or communication problem. Public commitments may attract attention, but they do not guarantee real transition. What matters is whether the firm builds the underlying capability needed for implementation. Transition capability has strategic value beyond operations because it affects not only execution quality, but also how external stakeholders respond. Investors are more willing to coordinate around firms whose sustainability commitments are backed by visible organizational systems. The greenwashing extension adds a further warning: communication effort that is not backed by capability can damage credibility and tighten the support threshold faced by the sector as a whole. Disclosure and assurance should therefore be understood as strategic complements to capability-building rather than substitutes for it. By making capability more visible, and by limiting the return to symbolic mimicry, they help firms attract the external support needed to make capability valuable.

The model also sheds light on the difference between hard mandates and enabling institutions. A regulator or standard-setting body could impose a minimum capability requirement

$$c \geq \underline{c}.$$

If $\underline{c} \geq \bar{c}$, then a high-support continuation equilibrium becomes feasible whenever investors coordinate. Such mandates can therefore eliminate some low-capability outcomes. More generally, industry-level standards and participation requirements may help move sectors above the threshold needed for stronger coordination. However, minimum standards may be blunt. If firms differ in project return R, project cost K, or capability cost $g(c)$, a uniform requirement may induce excessive investment in some cases. By contrast, enabling institutions—

such as certification, assurance, capability-building support, investor-coordination platforms, and shared industry infrastructure—can help the market reach the high-transition equilibrium while preserving greater flexibility across firms.

Overall, the policy implications are fivefold. First, sustainable capital does not automatically generate sustainable outcomes; external support must be matched by internal organizational capability. Second, capability-building and investor coordination are complements, so interventions on one side become more effective when the other side is also addressed. Third, visibility matters: disclosure, assurance, and certification help move the economy from symbolic or ineffective sustainability action toward real transition by improving the recognition of genuine capability. Fourth, once greenwashing is possible, anti-greenwashing institutions create an additional social benefit by restoring the credibility of favorable sustainability signals and lowering the coordination threshold faced by genuine firms. Fifth, sustainable transition may also be under-provided across firms, so industry-wide institutions are most effective when they improve the private return to credible participation rather than merely generating diffuse spillovers to all firms.

8 Conclusion

This paper develops a theory of sustainable transition as a coordination problem between investors and firms, and, in an extension, across firms at the industry level. On the investor side, support becomes effective only after reaching critical mass. On the firm side, real transition requires costly organizational capability. These two margins are strategic complements. As a result, the economy may exhibit both a low-capability, low-support equilibrium in which sustainability remains largely symbolic and a high-capability, high-support equilibrium in which real transition occurs.

The paper delivers four main insights. First, sustainable finance does not automatically generate sustainable outcomes. External support matters only when firms have the organizational systems needed to convert that support into implementation. Second, capability-building is endogenous. Firms may rationally underinvest in transition capability when investor support is expected to remain fragmented, generating a transition-capability trap. Third, visibility and credibility matter. When capability is difficult to observe, even capable firms may fail to attract support. In that environment, disclosure, assurance, and certification improve equilibrium selection by making genuine capability more visible. Fourth, once firms can pursue symbolic projects, greenwashing creates an additional coordination distortion: favorable signals become less informative, the signal threshold for coordinated support

rises, and certification acquires an additional anti-greenwashing role by making symbolic mimicry harder.

Taken together, these results suggest that the central challenge in sustainability is not only to induce firms or investors to care about transition, but also to create the institutional and organizational conditions under which they can coordinate around credible implementation. More broadly, sustainability failure can arise at multiple levels: within firms, through insufficient organizational preparation; between investors and firms, through coordination failure; through distorted signal environments created by greenwashing; and across firms, through under-provision of industry participation. Real transition requires more than commitment. It requires capability, coordination, and credible observability.

Empirical Implications. The model also delivers several empirical implications. Investor sustainability support should be more effective in firms with stronger transition capability, while firms should invest more in capability when investor support is more coordinated. When capability is weak or difficult to observe, sustainability pressure should generate more symbolic responses—such as disclosure campaigns, target-setting, or communication effort—than real operational change. In environments where symbolic signaling is cheap, favorable sustainability signals should become less informative about subsequent real transition, so the same disclosure signal should attract weaker investor support in sectors with more greenwashing risk. Assurance, certification, and anti-greenwashing enforcement should therefore matter most where firm capability is hard to observe and symbolic mimicry is easy; in those settings, they should both improve the allocation of investor support and strengthen ex ante capability investment. Finally, transition should display industry spillovers, with firms more likely to participate when peer participation strengthens the broader transition environment and when sectoral institutions preserve the credibility of participation signals.

Several extensions are left for future research. One direction is to enrich the dynamic interaction between capability-building, symbolic signaling, and investor learning over time. Another is to introduce heterogeneity across firms in transition costs, project returns, or capability-building technologies. More broadly, the paper suggests that a fruitful way to study sustainability is to connect capital-market support, organizational design, implementation frictions, and signal credibility within a single framework. We hope the model provides a useful starting point for that agenda.

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A Proofs

A.1 Proof of Lemma 1

Proof. Consider the candidate outcome in which no investor supports, so that $x = 0$ and hence $S = 0$. Under the condition

$$p(c, 0)R < K,$$

the firm's optimal continuation action is $a = 0$.

Given $S = 0$ and $a = 0$, investor i's expected payoff from supporting is $-m_i$ for any investor with positive support cost, whereas not supporting yields 0. Investors with $m_i = 0$ are indifferent; because F is continuous and strictly increasing on $[0, \bar{m}]$, this set has measure zero and does not affect aggregate support. Hence no profitable deviation changes the aggregate outcome, and the candidate outcome is a continuation equilibrium. □

A.2 Proof of Lemma 2

Proof. Consider the candidate profile in which investor i supports if and only if

$$m_i \leq p(c, 1)\tilde{v}.$$

The implied support mass is

$$x = F\big(p(c, 1)\tilde{v}\big).$$

If $p(c, 1)\tilde{v} > \bar{m}$, this expression simply yields $x = 1$ by the convention $F(y) = 1$ for $y \geq \bar{m}$. If

$$F\big(p(c, 1)\tilde{v}\big) \geq \bar{x},$$

then support is effective, so $S = 1$. If also

$$p(c, 1)R \geq K,$$

then the firm's optimal continuation action is $a = 1$.

Given $S = 1$ and $a = 1$, investor i's expected payoff from supporting is

$$p(c, 1)\tilde{v} - m_i,$$

so exactly those investors with

$$m_i \leq p(c, 1)\tilde{v}$$

prefer to support. Hence the candidate profile is self-consistent and constitutes a continuation equilibrium. □

A.3 Proof of Proposition 1

Proof. The first inequality,

$$p(c,0)R < K,$$

ensures by Lemma 1 that a low-support/no-project equilibrium exists. The second inequality, $p(c,1)R \geq K$, together with $F\big(p(c,1)\tilde{v}\big) \geq \bar{x}$, ensures by Lemma 2 that a high-support/project equilibrium exists. Therefore, both continuation equilibria coexist. □

A.4 Proof of Lemma 3

Proof. A high-support/project continuation equilibrium requires both $p(c,1)R \geq K$ and $F\big(p(c,1)\tilde{v}\big) \geq \bar{x}$. By definition of c_A, the first inequality can hold only if $c \geq c_A$. By definition of c_I, the second inequality can hold only if $c \geq c_I$. Because the relevant objects are continuous on the compact set $[0,1]$, these cutoff values are attained whenever the corresponding feasible sets are nonempty. Hence both conditions can hold only if $c \geq \max\{c_A, c_I\} = \bar{c}$. □

A.5 Proof of Proposition 2

Proof. Under pessimistic continuation selection, whenever a low-support/no-project continuation equilibrium is feasible, the selected continuation outcome is

$$e(c) = (0,0,0).$$

Condition (1) implies $p(c,0)R < K$ for every $c \in [0,1]$, so by Lemma 1 we have $(0,0,0) \in \mathcal{E}(c)$ for every c. Hence pessimistic selection is well defined everywhere and the firm's ex ante payoff is

$$V(c; e(c)) = -g(c).$$

Since $g(0) = 0$ and $g'(c) > 0$, this expression is uniquely maximized at

$$c = 0.$$

Thus the firm chooses zero capability. Given $c = 0$, support remains ineffective, the firm does not undertake the project, and the resulting full equilibrium is low-capability, low-support,

and no-project. □

A.6 Proof of Proposition 3

Proof. Under optimistic continuation selection, whenever a high-support/project continuation equilibrium belongs to $\mathcal{E}(c)$, the selected continuation outcome is that equilibrium. By Lemma 3, such an equilibrium can exist only if $c \geq \bar{c}$. For any $c \geq \bar{c}$ supporting a high-support/project continuation equilibrium, the firm's ex ante payoff is

$$V(c; e(c)) = p(c, 1)R - K - g(c).$$

On the interval $[\bar{c}, 1]$, this payoff is continuous, so by Weierstrass the maximum over the high-support branch is attained. For $c < \bar{c}$, a high-support/project continuation equilibrium is infeasible, so under optimistic selection the firm obtains at most the low-support payoff $-g(c) \leq 0$, with equality at $c = 0$. Condition (2) implies that at c_H the high-support payoff is weakly nonnegative. Hence the firm weakly prefers some maximizer on $[\bar{c}, 1]$ to the low-support branch, and the firm's maximization problem under optimistic selection admits an optimal solution $c^* \geq \bar{c}$. At that capability level, investors coordinate, support is effective, and the firm undertakes the project. □

A.7 Proof of Theorem 1

Proof. By Proposition 2, condition (1) implies the existence of a low-capability, low-support, no-project equilibrium under pessimistic selection. By Proposition 3, condition (2) implies the existence of a high-capability, high-support, project equilibrium under optimistic selection. Hence both full equilibria coexist. □

A.8 Proof of Proposition 4

Proof. Investor coordination occurs when the realized signal satisfies

$$z \geq z^*.$$

Since $z = c + \varepsilon$, we have

$$\Pr(z \geq z^* \mid c) = 1 - F_\varepsilon(z^* - c).$$

Interpret a rise in signal precision as a mean-preserving contraction of F_ε. For sufficiently capable firms, in particular for $c \geq z^*$, we have $z^* - c \leq 0$. A mean-preserving contraction

shifts probability mass toward zero and therefore weakly lowers $F_\varepsilon(z^* - c)$ at such thresholds. Hence

$$1 - F_\varepsilon(z^* - c)$$

weakly rises with signal precision for sufficiently capable firms, so the probability that investors coordinate on effective support weakly increases. □

A.9 Proof of Corollary 1

Proof. In the tipping region, the firm's expected payoff is given by Equation (4). Proposition 4 implies that, for sufficiently capable firms, greater signal precision raises

$$\Pr(z \geq z^* \mid c).$$

Because $p(c, 1)R - K > 0$ in the tipping region, this weakly raises the level of the expected payoff associated with such high-capability choices. Under standard distributional assumptions ensuring that the precision improvement also raises the derivative of $\Pr(z \geq z^* \mid c)$ with respect to c in that region, the marginal return to capability-building likewise increases. □

A.10 Proof of Proposition 5

Proof. Fix a signal z in the overlap region. In the benchmark visibility model without symbolic projects, Bayes' rule implies

$$\hat{p}_0(z) = \mathbb{E}[p(c, 1) \mid z, a = r].$$

In the greenwashing environment,

$$\hat{p}_G(z) = \mu(z)\,\mathbb{E}[p(c, 1) \mid z, a = r] + \big(1 - \mu(z)\big)p^s(1).$$

Subtracting yields

$$\hat{p}_0(z) - \hat{p}_G(z) = \big(1 - \mu(z)\big)\left(\mathbb{E}[p(c, 1) \mid z, a = r] - p^s(1)\right).$$

By assumption, $p^s(1) \leq \hat{p}_0(z) = \mathbb{E}[p(c, 1) \mid z, a = r]$, so the right-hand side is nonnegative. Hence $\hat{p}_G(z) \leq \hat{p}_0(z)$ for every z in the overlap region. The inequality is strict whenever $\mu(z) < 1$ and $p^s(1) < \hat{p}_0(z)$.

Because F is increasing, $\hat{p}_G(z) \leq \hat{p}_0(z)$ implies

$$F\big(\tilde{v}\,\hat{p}_G(z)\big) \leq F\big(\tilde{v}\,\hat{p}_0(z)\big)$$

for every z in the overlap region. If $\hat{p}_0$ is weakly increasing, then both support rules admit cutoff representations with thresholds z_0^* and z_G^*. The pointwise inequality above implies that the set of signals for which coordination is feasible under greenwashing is contained in the corresponding set without greenwashing. Therefore $z_G^* \geq z_0^*$. □

A.11 Proof of Corollary 2

Proof. Because $\hat{p}_C(z) \geq \hat{p}_G(z)$ for every z and F is increasing,

$$F\big(\tilde{v}\,\hat{p}_C(z)\big) \geq F\big(\tilde{v}\,\hat{p}_G(z)\big)$$

for every z. Hence the set of signals that sustain coordination under certification contains the corresponding set without certification, so the cutoff weakly falls: $z_C^* \leq z_G^*$.

Next, for every $d \in D$,

$$\Phi_s^C(d) \leq \Phi_s(d).$$

Multiplying by the constant payoff term $p^s(1)R - K_s$ and subtracting the same disclosure cost $h(d)$ on both sides yields

$$\Phi_s^C(d)\big(p^s(1)R - K_s\big) - h(d) \leq \Phi_s(d)\big(p^s(1)R - K_s\big) - h(d).$$

Taking suprema over $d \in D$ proves the profitability comparison in the statement. □

A.12 Proof of Lemma 4

Proof. Let

$$\Theta(c, x, m) \equiv p_c(c, \Sigma(x, m), m)R - g'(c).$$

By the first-order condition, $\Theta(c^*(x, m), x, m) = 0$. Differentiating with respect to x yields

$$\Theta_c \frac{\partial c^*(x, m)}{\partial x} + \Theta_x = 0.$$

Now

$$\Theta_c = p_{cc}(c, \Sigma, m)R - g''(c) < 0$$

by (8), and

$$\Theta_x = p_{c\Sigma}(c, \Sigma, m)\Sigma_x(x, m)R > 0.$$

Hence

$$\frac{\partial c^*(x, m)}{\partial x} = -\frac{\Theta_x}{\Theta_c} > 0.$$

□

A.13 Proof of Lemma 5

Proof. Using the same notation as above, implicit differentiation of

$$\Theta(c^*(x, m), x, m) = 0$$

with respect to m yields

$$\Theta_c \frac{\partial c^*(x, m)}{\partial m} + \Theta_m = 0.$$

Again $\Theta_c < 0$. Moreover,

$$\Theta_m = \Big[p_{cm}(c, \Sigma, m) + p_{c\Sigma}(c, \Sigma, m)\Sigma_m(x, m)\Big]R.$$

Under the maintained assumptions, $\Theta_m > 0$, so

$$\frac{\partial c^*(x, m)}{\partial m} = -\frac{\Theta_m}{\Theta_c} > 0.$$

□

A.14 Proof of Proposition 6

Proof. Because G is weakly increasing and $\Psi(x, m)$ is weakly increasing in m, the composition

$$\Phi(m; x) = G\big(\Psi(x, m)\big)$$

is weakly increasing in m. Thus a higher conjectured participation rate weakly increases the fraction of firms willing to participate, which is strategic complementarity.

Since G is continuously differentiable with density g, the derivative of Φ with respect to m is

$$\Phi_m(m; x) = g\big(\Psi(x, m)\big)\Psi_m(x, m).$$

Condition (9) implies that $\Phi_m(m; x) > 1$ on the interval I, so on that interval the graph of

$\Phi(m;x)$ is steeper than the 45-degree line.

Now define

$$H(m;x) \equiv \Phi(m;x) - m.$$

Then H is continuous on $[0,1]$. By condition (10),

$$H(0;x) > 0, \qquad H(m_1;x) < 0, \qquad H(m_2;x) > 0, \qquad H(1;x) < 0.$$

Therefore, by the intermediate value theorem, H has at least one zero in each of the intervals $(0, m_1)$, (m_1, m_2), and $(m_2, 1)$. Hence H has at least three zeros on $[0,1]$, implying at least three fixed points of Φ. □

A.15 Proof of Proposition 7

Proof. For fixed c and S, the firm's private payoff from undertaking the project is

$$p(c,S)R - K.$$

Hence the firm undertakes the project if and only if

$$p(c,S)R \geq K.$$

By contrast, the social welfare gain from undertaking the project is

$$p(c,S)(R+E) - K + \mathcal{V}(c,S).$$

Therefore the socially efficient adoption condition is

$$p(c,S)(R+E) - K + \mathcal{V}(c,S) \geq 0.$$

Since

$$E \geq 0 \qquad \text{and} \qquad \mathcal{V}(c,S) \geq 0,$$

it follows that whenever

$$p(c,S)R \geq K,$$

the social condition also holds. Hence the socially efficient adoption region weakly contains the privately induced adoption region. □

A.16 Proof of Proposition 8

Proof. The firm's private first-order condition is

$$p_c(c, S)R = g'(c). \tag{A.1}$$

The planner's first-order condition is

$$p_c(c, S)(R + E) + \mathcal{V}_c(c, S) = g'(c). \tag{A.2}$$

It remains to show that

$$\mathcal{V}_c(c, S) \geq 0.$$

Let

$$z(c, S) \equiv p(c, S)\tilde{v}.$$

Then

$$\mathcal{V}(c, S) = S \int_0^{z(c,S)} (z(c, S) - m)\, dF(m).$$

Because F has density f on $(0, \bar{m})$ and is extended continuously outside its support, Leibniz differentiation yields

$$\frac{\partial \mathcal{V}}{\partial z} = S\, F(z) \geq 0.$$

Since

$$\frac{\partial z}{\partial c} = \tilde{v}\, p_c(c, S) \geq 0,$$

we obtain

$$\mathcal{V}_c(c, S) \geq 0.$$

Comparing (A.1) and (A.2), the planner's marginal benefit of capability weakly exceeds the firm's marginal benefit for every c. Under strict concavity, this implies

$$c^W(S) \geq c^P(S),$$

with strict inequality whenever the planner's marginal benefit is strictly larger at the private optimum, that is, whenever

$$E > 0 \quad \text{or} \quad \mathcal{V}_c(c, S) > 0.$$

□

A.17 Proof of Corollary 3

Proof. A reduction in $g(c)$ raises the firm's ex ante payoff from any capability level $c > 0$. In particular, it makes it easier for the firm to choose some $c \geq \bar{c}$, where $\bar{c}$ is the minimum capability level consistent with a high-support/project continuation equilibrium. Since the investor-coordination and project-viability conditions are unchanged, the set of parameter values under which a high-capability, high-support, project equilibrium exists weakly expands. □

A.18 Proof of Corollary 4

Proof. A reduction in the coordination threshold $\bar{x}$, a reduction in effective support costs, or an increase in $\tilde{v}$ relaxes the investor-coordination condition

$$F\big(p(c,1)\tilde{v}\big) \geq \bar{x}.$$

Hence the set of capability levels for which investor coordination is feasible weakly expands. This in turn enlarges the set of parameter values under which a high-capability, high-support, project equilibrium exists. □

A.19 Proof of Corollary 5

Proof. Corollary 5 follows from Corollaries 3 and 4. A reduction in capability-building costs makes it easier for firms to choose capability above $\bar{c}$, while a reduction in investor-coordination frictions relaxes the condition for support to become effective and can lower the investor-side component of $\bar{c}$. Because the two margins are complementary, combining them weakly expands the high-capability, high-support region by at least as much as either intervention in isolation. □

A.20 Proof of Corollary 6

Proof. From Section 5, investor support becomes effective when the public signal exceeds the threshold z^*. For sufficiently capable firms, greater signal precision weakly raises the probability

$$\Pr(z \geq z^* \mid c).$$

Hence the likelihood that investors coordinate on effective support weakly increases. □

A.21 Proof of Corollary 7

Proof sketch. In Section 6, equilibrium participation satisfies

$$m = G\big(\Psi(x, m)\big).$$

Policies that raise the private return to participation increase $\Psi(x, m)$ directly. Policies that strengthen support effectiveness through $\Sigma(x, m)$ also raise $\Psi(x, m)$ by improving the implementation value of participation. Hence the fixed-point condition shifts upward, weakly increasing equilibrium industry participation. □

B Online Appendix

B.1 Microfoundation of Transition Capability as Internal Coordination

In the main text, transition capability is modeled in reduced form as a scalar that raises the probability of real implementation. This appendix provides a microfoundation in which capability captures the firm's ability to align a sufficiently large internal coalition behind transition. The microfoundation shows how the reduced-form implementation probability in the main text can be interpreted as a local approximation to an underlying internal coordination problem.

Internal units and alignment. Suppose that, in addition to investors, the firm contains a unit mass of internal units indexed by $j \in [0,1]$. These units may represent operating divisions, managers, compliance functions, reporting teams, procurement units, or other organizational actors whose participation is necessary for real transition.

If the firm undertakes the sustainability project, each internal unit chooses whether to align with implementation:

$$y_j \in \{0,1\}.$$

Let aggregate internal alignment be

$$y = \int_0^1 y_j \, dj.$$

Real transition requires that internal alignment reach a critical mass $\bar{y} \in (0,1)$. Define the internal-effectiveness indicator

$$Y(y) = \begin{cases} 1, & y \geq \bar{y}, \\ 0, & y < \bar{y}. \end{cases}$$

Thus, even if the firm formally undertakes the project, transition becomes real only when a sufficiently large internal coalition aligns behind implementation.

Capability as an internal coordination technology. The firm chooses transition capability

$$c \in [0,1]$$

at cost $g(c)$, as in the main text. In this appendix, capability has a more explicit organizational interpretation: it improves the firm's ability to coordinate internal units behind transition.

Examples include monitoring and reporting systems, internal governance and oversight, implementation discipline, cross-unit coordination mechanisms, and verification and accountability systems. Thus, higher c makes internal alignment more likely.

Internal unit payoffs. Let $S \in \{0, 1\}$ denote whether investor support is effective, exactly as in the main text. If the firm undertakes the project, internal unit j receives a gross benefit from successful transition that depends on both investor support and capability, but incurs an idiosyncratic alignment cost k_j. Assume k_j is drawn from a strictly increasing cdf H on $[0, \bar{k}]$.

Specifically, suppose the payoff from aligning is

$$\Pi_j^{\text{align}} = \alpha_0 + \alpha_c c + \alpha_S S + \alpha_{cS} cS - k_j,$$

while the payoff from not aligning is normalized to zero. We assume

$$\alpha_c > 0, \qquad \alpha_S > 0, \qquad \alpha_{cS} > 0.$$

Internal unit j aligns if and only if

$$k_j \leq \alpha_0 + \alpha_c c + \alpha_S S + \alpha_{cS} cS.$$

Hence the fraction of aligned internal units is

$$y = H(\alpha_0 + \alpha_c c + \alpha_S S + \alpha_{cS} cS)\,.$$

This equation captures the two-sided complementarity at the organizational level. Investor support facilitates internal alignment, capability facilitates internal alignment, and the two reinforce each other.

Real transition. Real transition occurs only if enough internal units align, that is, if

$$y \geq \bar{y}.$$

Equivalently,

$$H(\alpha_0 + \alpha_c c + \alpha_S S + \alpha_{cS} cS) \geq \bar{y}.$$

Define the real-implementation probability as

$$p(c, S) = \Phi(\alpha_0 + \alpha_c c + \alpha_S S + \alpha_{cS} cS)\,,$$

where Φ is an increasing function. One interpretation is that Φ maps the latent level of internal alignment into the probability that the internal threshold is met. Another is that Φ is a smooth approximation to the threshold event

$$Y(y) = \mathbf{1}\{y \geq \bar{y}\}.$$

Under either interpretation, the implementation probability is increasing in c, increasing in S, and exhibits complementarity between the two:

$$\frac{\partial^2 p(c, S)}{\partial c\, \partial S} > 0.$$

Connection to the main text. The reduced-form implementation probability in the main text is

$$p(c, S) = p_0 + p_c c + p_S S + p_{cS} cS.$$

This can be interpreted as a local linear approximation to the microfounded implementation probability above.

To see this, take a first-order expansion of

$$\Phi(\alpha_0 + \alpha_c c + \alpha_S S + \alpha_{cS} cS)$$

around an interior reference point (c_0, S_0), and let

$$\beta_0 \equiv \alpha_0 + \alpha_c c_0 + \alpha_S S_0 + \alpha_{cS} c_0 S_0.$$

The resulting approximation has the same form:

$$p(c, S) \approx p_0 + p_c c + p_S S + p_{cS} cS,$$

with coefficients that inherit the signs

$$p_c > 0, \qquad p_S > 0, \qquad p_{cS} = \Phi'(\beta_0)\alpha_{cS} > 0.$$

Thus, the main-text specification can be viewed as a reduced-form representation of a richer organizational environment in which successful transition requires alignment of a sufficiently large internal coalition.

Interpretation. This microfoundation sharpens the firm side of the model in two ways.

First, it gives transition capability an explicit coordination interpretation. Capability is not merely a generic productivity shifter; it is the firm's ability to align internal units behind implementation.

Second, it shows why investor support and firm capability are natural complements. Investor support can strengthen the incentives of internal units to align, while capability makes that alignment easier to achieve. As a result, real transition requires coordination on both sides: an external coalition of investors and an internal coalition within the firm.

In this sense, the reduced-form model in the main text can be understood as a tractable representation of a deeper two-sided coordination problem.

B.2 Strategic Greenwashing Extension

This subsection develops a more rigorous version of the greenwashing extension in Section 5. The goal is to preserve several broader implications while keeping the main text focused on the cleanest comparative statics. In particular, unlike the main-text discussion of incentives and threshold effects, this appendix constructs a genuine partial-pooling equilibrium in which some firms undertake real transition while others pursue symbolic projects.

Setup. At Stage 0, the firm chooses project type $a \in \{r, s\}$, where $a = r$ denotes a real transition project and $a = s$ denotes a symbolic project. If $a = r$, the firm chooses capability $c \in [0, 1]$ and disclosure effort $d \in D \equiv [0, \bar{d}]$. If $a = s$, the firm sets $c = 0$ and chooses disclosure effort $d \in D$. Investors do not observe (a, c, d) directly.

The public signal is

$$z = \begin{cases} c + \beta d + \varepsilon, & a = r, \\ \beta d + \varepsilon, & a = s, \end{cases}$$

where ε is mean-zero noise and $\beta \geq 0$ measures the extent to which disclosure effort inflates

observed sustainability performance. Let

$$\mu(z) = \Pr(a = r \mid z)$$

denote the posterior probability that the firm is genuine. Posterior expected implementation quality is

$$\hat{p}_G(z) = \mu(z)\,\mathbb{E}[p(c,1) \mid z, a = r] + (1 - \mu(z))p^s(1),$$

where $p^s(1)$ is the implementation probability of the symbolic project under effective support.

Investor i supports if and only if

$$\tilde{v}\,\hat{p}_G(z) \geq m_i,$$

so aggregate support is

$$x_G(z) = F\big(\tilde{v}\,\hat{p}_G(z)\big).$$

Assume throughout that $\hat{p}_G$ is weakly increasing, so the support rule admits a cutoff representation. Define

$$z_G^* \equiv \inf\left\{z : F\big(\tilde{v}\,\hat{p}_G(z)\big) \geq \bar{x}\right\}.$$

For any candidate cutoff z_G^*, let

$$\Phi_r(c, d; z_G^*) \equiv \Pr\big(c + \beta d + \varepsilon \geq z_G^*\big), \qquad \Phi_s(d; z_G^*) \equiv \Pr\big(\beta d + \varepsilon \geq z_G^*\big)$$

denote the probabilities that a real or symbolic project induces coordinated investor support.

The real-project payoff is

$$V_r(c, d; z_G^*) = \Phi_r(c, d; z_G^*)\,[p(c,1)R - K_r] - g(c) - h(d),$$

and the symbolic payoff is

$$V_s(d; z_G^*) = \Phi_s(d; z_G^*)\,[p^s(1)R - K_s] - h(d).$$

We assume g and h are continuous, with h increasing and convex, and that $p(c,1)$ is continuous in c.

A genuine greenwashing equilibrium with a fraction of genuine firms. To construct a genuine equilibrium, suppose there are two ex ante firm types. A fraction $\lambda \in (0,1)$

of firms are *genuine* type G, and a fraction $1-\lambda$ are *opportunistic* type O. Type G firms face capability cost $g_G(c)$, while type O firms face capability cost $g_O(c)$, where both functions are continuous and

$$g_O(c) \geq g_G(c) \qquad \text{for all } c \in [0,1],$$

with strict inequality for some c. Both types face the same disclosure cost $h(d)$ and the same symbolic-project payoff

$$V_s(d; z_G^*) = \Phi_s(d; z_G^*)\,[p^s(1)R - K_s] - h(d).$$

If type $\theta \in \{G, O\}$ chooses a real project, its payoff is

$$V_r^\theta(c, d; z_G^*) = \Phi_r(c, d; z_G^*)\,[p(c,1)R - K_r] - g_\theta(c) - h(d).$$

Assume further that ε has a continuous density f_ε with full support on $\mathbb{R}$.

Proposition B.1 (Partial-Pooling Greenwashing Equilibrium)**.** *Fix $\lambda \in (0,1)$. Suppose there exist actions $(c_G, d_G) \in [0,1] \times D$, $d_O \in D$, and a cutoff $z_G^* \in \mathbb{R}$ such that:*

(i) ***Type-G incentive compatibility:***

$$V_r^G(c_G, d_G; z_G^*) \geq \sup_{d \in D} V_s(d; z_G^*) \quad \textit{and} \quad V_r^G(c_G, d_G; z_G^*) \geq \sup_{(c,d) \in [0,1] \times D} V_r^G(c, d; z_G^*).$$

(ii) ***Type-O incentive compatibility:***

$$V_s(d_O; z_G^*) \geq \sup_{d \in D} V_s(d; z_G^*) \quad \textit{and} \quad V_s(d_O; z_G^*) \geq \sup_{(c,d) \in [0,1] \times D} V_r^O(c, d; z_G^*).$$

(iii) ***Belief consistency:*** *investors assign posterior belief*

$$\mu(z) = \frac{\lambda f_\varepsilon(z - c_G - \beta d_G)}{\lambda f_\varepsilon(z - c_G - \beta d_G) + (1-\lambda) f_\varepsilon(z - \beta d_O)}$$

for every observed signal z.

(iv) ***Threshold consistency:*** *if*

$$\hat{p}_\lambda(z) \equiv \mu(z) p(c_G, 1) + (1 - \mu(z)) p^s(1),$$

then

$$z_G^* = \inf\left\{ z : F\big(\tilde{v}\,\hat{p}_\lambda(z)\big) \geq \bar{x} \right\}.$$

Then there exists a partial-pooling equilibrium in which every type-G firm chooses the real project (c_G, d_G), every type-O firm chooses the symbolic project d_O, and investors support if and only if the realized signal satisfies $z \geq z_G^*$. Moreover, because f_ε has full support and $\lambda \in (0,1)$, investors assign strictly positive posterior weight to both project sources at every realized signal:

$$0 < \mu(z) < 1 \qquad \text{for all } z \in \mathbb{R}.$$

Interpretation. This proposition gives the appendix a genuine equilibrium version of greenwashing. A positive mass of genuine firms remains in the population, so investors never conclude that favorable signals must come from symbolic projects alone. That residual uncertainty is exactly what allows greenwashing to survive in equilibrium. The incentive conditions have a transparent meaning. Type G firms must find real transition worthwhile despite its capability cost, while type O firms must find symbolic projects more attractive than genuine capability-building. The posterior formula then follows from Bayes' rule, and the cutoff condition pins down the support rule that is consistent with investor coordination.

Greenwashing as coordination poison. Let $\hat{p}_0(z) \equiv \mathbb{E}[p(c,1) \mid z, a = r]$ denote posterior expected implementation value in the baseline visibility model without symbolic firms, and define

$$z_0^* \equiv \inf\left\{z : F\big(\tilde{v}\,\hat{p}_0(z)\big) \geq \bar{x}\right\}.$$

Let $\mathcal{O}$ denote the overlap region of signals generated with positive probability by both project types.

Proposition B.2 (Coordination Poison)**.** *Suppose that, for every $z \in \mathcal{O}$,*

$$p^s(1) \leq \hat{p}_0(z).$$

Then, for every $z \in \mathcal{O}$,

$$\hat{p}_G(z) \leq \hat{p}_0(z).$$

If, in addition, $\hat{p}_0$ is weakly increasing, then

$$z_G^* \geq z_0^*.$$

The first inequality is strict whenever $\mu(z) < 1$ and $p^s(1) < \hat{p}_0(z)$.

Interpretation. The condition $p^s(1) \leq \hat{p}_0(z)$ says that a symbolic project is weakly less likely to produce real implementation than a genuine project generating the same observable signal. Under that condition, the availability of symbolic projects dilutes the informational content of favorable signals. Investors therefore rationally discount a given signal, and the economy requires a higher signal realization to coordinate on support.

Certification and the dual dividend. Let certification reduce both signal noise and the effectiveness of disclosure effort for symbolic projects. Formally, under certification,

$$z = \begin{cases} c + \beta d + \varepsilon^c, & a = r, \\ \beta_c d + \varepsilon^c, & a = s, \end{cases} \qquad \beta_c \leq \beta,$$

with ε^c weakly more precise than ε. Let $\hat{p}_C(z)$ and z_C^* denote the posterior implementation value and coordination cutoff under certification, and let

$$\Phi_s^C(d; z_C^*) \equiv \Pr\big(\beta_c d + \varepsilon^c \geq z_C^*\big)$$

denote the support probability of a symbolic project under certification.

Proposition B.3 (Certification Reduces Greenwashing)**.** *Suppose that, for every z, $\hat{p}_C(z) \geq \hat{p}_G(z)$ and, for every $d \in D$,*

$$\Phi_s^C(d; z_C^*) \leq \Phi_s(d; z_G^*).$$

Then

$$z_C^* \leq z_G^*$$

and

$$\sup_{d \in D} V_s^C(d; z_C^*) \leq \sup_{d \in D} V_s(d; z_G^*),$$

where

$$V_s^C(d; z_C^*) \equiv \Phi_s^C(d; z_C^*)[p^s(1)R - K_s] - h(d).$$

Consequently, certification weakly lowers the coordination threshold and weakly shrinks the set of parameter values for which the partial-pooling greenwashing equilibrium in Proposition B.1 exists.

Corollary B.1 (Dual Dividend of Certification)**.** *Under the assumptions of Proposition B.3, certification weakly raises the probability that a genuine firm receives coordinated support at any given signal and weakly lowers the profitability of symbolic projects.*

Interpretation. Certification has a dual role. The condition $\hat{p}_C(z) \geq \hat{p}_G(z)$ captures the precision channel: certification makes a given signal more informative about real implementation. The condition $\Phi_s^C(d; z_C^*) \leq \Phi_s(d; z_G^*)$ captures the filtering channel: certification makes it harder for symbolic projects to secure coordinated support through disclosure effort alone. Together, these forces both help genuine firms and compress the payoff advantage of greenwashing.

Intermediate greenwashing equilibrium. The formal results above leave open the possibility of three distinct outcomes: a low-capability trap with little support, an intermediate greenwashing equilibrium with disclosure effort but limited real transition, and a high-transition equilibrium with real capability and coordinated support. We do not fully characterize the joint parameter region sustaining all three outcomes, so we treat this three-equilibrium coexistence as a suggestive implication rather than a proven theorem.

Capability crowd-out. The presence of greenwashing may reduce the privately optimal capability level for genuine firms by raising the support threshold they must clear. Because this comparative static requires additional monotonicity assumptions on the signal distribution and the objective's single-crossing properties, we do not promote it to a theorem here. The underlying mechanism is nevertheless clear: when symbolic projects raise z_G^*, they make it harder for genuine capability to be recognized and rewarded by investors.

Welfare and sectoral externality. Greenwashing also has broader consequences beyond the firm's private project choice. It reduces welfare by displacing real transition with symbolic activity. Moreover, when embedded in the industry extension, greenwashing can create a cross-firm credibility externality. If a larger fraction of firms engage in symbolic sustainability, then posterior beliefs $\mu(z)$ fall at every given signal, the support threshold rises for all firms, and even genuine firms face weaker participation incentives. We therefore interpret greenwashing as a sector-level credibility problem as well as a firm-level distortion.

Proposition B.4 (Sectoral Greenwashing Externality)**.** *Suppose a fraction $\lambda \in [0, 1]$ of firms are genuine and a fraction $1 - \lambda$ are opportunistic symbolic firms. Let $\mu(z; \lambda)$ denote the posterior probability that a firm with signal z is genuine. If $\mu(z; \lambda)$ is weakly increasing in λ for every z, then a reduction in λ weakly lowers posterior implementation value at every signal. Consequently, the coordination threshold weakly rises, the participation surplus of genuine firms weakly falls, and equilibrium industry participation weakly falls whenever participation is increasing in expected implementation value.*

The externality operates through investor beliefs rather than through direct product-market competition.

B.3 Industry Participation and Under-Provision: A Finite-Firm Counterpart

This appendix provides a finite-firm counterpart to the continuum industry extension in Section 6. The purpose is to make the participation externality visible as a more literal free-riding force. In the main text, industry under-provision arises because each atomistic firm takes aggregate participation as given and does not internalize the benefits its participation creates for the broader transition environment. In this appendix, each firm's action has a small but nonzero effect on aggregate participation, making the same force transparent in finite-firm terms.

There are $N \geq 2$ firms indexed by $f = 1, \ldots, N$. Each firm chooses

$$q_f \in \{0, 1\},$$

where $q_f = 1$ means that firm f participates in sustainable transition.

Let the number of participating firms be

$$k = \sum_{f=1}^{N} q_f,$$

and let the industry participation rate be

$$m = \frac{k}{N}.$$

To keep the extension focused, transition capability c is taken as fixed and common across firms.

Industry-level investor support is effective only if industry participation reaches a threshold $\bar{m} \in (0, 1]$. Equivalently, let $\bar{k} \in \{1, \ldots, N\}$ denote the minimum number of participating firms needed for effective investor support, and define

$$S(k) = \mathbf{1}\{k \geq \bar{k}\}.$$

A participating firm's gross return to transition depends on industry participation. Let

the payoff to a participating firm when total participation is k be

$$V^P(k; c, \kappa) = p(c, S(k), k/N)R - \kappa,$$

where:

- $R > 0$ is the gross return from successful transition,
- κ is the firm's idiosyncratic participation cost,
- $\frac{\partial p(c,S,m)}{\partial m} > 0$, so broader industry participation improves the transition environment.

A non-participating firm may still benefit from industry-wide spillovers generated by other firms' participation. Let the payoff to a non-participating firm when k firms participate be

$$V^N(k) = L\left(\frac{k}{N}\right), \qquad L'(m) \geq 0.$$

Assume that participation costs κ are distributed according to a strictly increasing cdf G on $[0, \bar{\kappa}]$.

Private participation incentives. Fix a firm f and suppose that k_{-f} of the other $N-1$ firms participate. If firm f participates, total participation becomes $k_{-f}+1$, and its payoff is

$$V^P(k_{-f}+1; c, \kappa).$$

If it does not participate, total participation remains k_{-f}, and its payoff is

$$V^N(k_{-f}).$$

Hence firm f participates if and only if

$$V^P(k_{-f}+1; c, \kappa) \geq V^N(k_{-f}).$$

Equivalently,

$$\kappa \leq \Delta(k_{-f}; c),$$

where the private gain from participation is

$$\Delta(k_{-f}; c) \equiv p\left(c, S(k_{-f}+1), \frac{k_{-f}+1}{N}\right) R - L\left(\frac{k_{-f}}{N}\right).$$

Thus, given k_{-f}, the fraction of firms willing to participate is

$$G\big(\Delta(k_{-f}; c)\big).$$

Equilibrium. A participation profile with exactly k participating firms is a Nash equilibrium if:

$$V^P(k; c, \kappa) \geq V^N(k-1) \quad \text{for all participating firms,} \tag{B.1}$$

$$V^N(k) \geq V^P(k+1; c, \kappa) \quad \text{for all non-participating firms.} \tag{B.2}$$

Lemma B.1 (Finite-Firm Strategic Complementarity)**.** *If the private gain from participation $\Delta(k; c)$ is weakly increasing in k, then firms' participation decisions are strategically complementary. In particular, the industry may exhibit both low-participation and high-participation equilibria.*

Proposition B.5 (Finite-Firm Under-Provision)**.** *Suppose a firm's participation raises the payoffs of other firms, either by increasing the return to participation through $p(c, S(k), k/N)$, by increasing spillover benefits through $L(k/N)$, or by making effective investor support more likely through the threshold $S(k)$. Then equilibrium participation is weakly below the socially efficient participation level.*

The finite-firm counterpart complements the continuum formulation in Section 6. The continuum formulation provides the cleanest equilibrium representation of under-provision through a participation externality, while the finite-firm version makes the same force visible as a more literal free-riding problem.

B.4 Proofs for the Online Appendix

Proof of Lemma B.1

Proof. A firm's participation decision depends on whether its idiosyncratic cost κ is below the threshold $\Delta(k; c)$. If $\Delta(k; c)$ is weakly increasing in k, then the set of firms willing to participate is weakly larger when more peer firms participate. Hence participation becomes weakly more attractive as industry participation rises, which is strategic complementarity. This is the standard supermodularity logic of Topkis and Milgrom-Roberts in this discrete setting. Standard fixed-point logic then implies that the industry may admit multiple participation equilibria. □

Proof of Proposition B.5

Proof sketch. A decentralized firm participates when its private gain from participation is nonnegative. A planner, however, also internalizes the effect of one more participating firm on all other firms. Specifically, additional participation may increase other firms' returns to participation, increase spillover benefits, and move the industry across the threshold $\bar{k}$, thereby activating effective investor support for all firms. Hence the social marginal gain from participation weakly exceeds the private marginal gain whenever participation creates positive externalities for others. Therefore decentralized participation is weakly below the socially efficient level. □

Proof of Proposition B.1

Proof. Fix $\lambda \in (0,1)$ and suppose conditions (i)–(iv) hold. Consider the following strategy profile. Every type-G firm chooses the real project with action pair (c_G, d_G). Every type-O firm chooses the symbolic project with disclosure choice d_O. Investors observe the public signal z and provide support if and only if $z \geq z_G^*$.

We verify sequential rationality. For type G, condition (i) implies that (c_G, d_G) yields at least as much payoff as any symbolic project and at least as much payoff as any alternative real project, both evaluated at the same cutoff z_G^*. Hence no deviation is profitable. For type O, condition (ii) implies that d_O maximizes the symbolic payoff and that even the best real project yields weakly lower payoff, so no deviation is profitable there either.

Investor beliefs are Bayes consistent under the proposed strategies. Conditional on the equilibrium actions, a signal z is generated by a type-G firm with density $f_\varepsilon(z - c_G - \beta d_G)$ and by a type-O firm with density $f_\varepsilon(z - \beta d_O)$. Since the prior probabilities are λ and $1-\lambda$, Bayes' rule gives exactly the posterior in condition (iii). Because f_ε has full support and $\lambda \in (0,1)$, both numerator and denominator are strictly positive for every z, which implies $0 < \mu(z) < 1$.

Given these beliefs, investors assign posterior expected implementation value

$$\hat{p}_\lambda(z) = \mu(z)p(c_G, 1) + (1 - \mu(z))p^s(1).$$

Since F is increasing, aggregate support is $F(\tilde{v}\,\hat{p}_\lambda(z))$, so condition (iv) implies that investors' cutoff strategy $z \geq z_G^*$ is exactly the threshold rule consistent with coordinated support. Therefore the proposed strategies and beliefs form a partial-pooling equilibrium. □

Proof of Proposition B.2

Proof. Fix a signal z in the overlap region. In the baseline environment,

$$\hat{p}_0(z) = \mathbb{E}[p(c,1) \mid z, a = r].$$

In the greenwashing environment,

$$\hat{p}_G(z) = \mu(z)\,\mathbb{E}[p(c,1) \mid z, a = r] + \big(1 - \mu(z)\big)p^s(1).$$

Therefore

$$\hat{p}_0(z) - \hat{p}_G(z) = \big(1 - \mu(z)\big)\left(\mathbb{E}[p(c,1) \mid z, a = r] - p^s(1)\right) \geq 0,$$

where the inequality follows from the assumption $p^s(1) \leq \hat{p}_0(z)$. This proves $\hat{p}_G(z) \leq \hat{p}_0(z)$, with strict inequality whenever $\mu(z) < 1$ and $p^s(1) < \hat{p}_0(z)$.

If $\hat{p}_0$ and $\hat{p}_G$ are weakly increasing, the associated support rules admit cutoff representations. Since F is increasing and $\hat{p}_G(z) \leq \hat{p}_0(z)$ pointwise, the set of signals that sustain coordination under greenwashing is contained in the corresponding set in the baseline environment. Hence $z_G^* \geq z_0^*$. □

Proof of Proposition B.3

Proof. For every $d \in D$, the assumption $\Phi_s^C(d; z_C^*) \leq \Phi_s(d; z_G^*)$ implies

$$V_s^C(d; z_C^*) = \Phi_s^C(d; z_C^*)[p^s(1)R - K_s] - h(d) \leq \Phi_s(d; z_G^*)[p^s(1)R - K_s] - h(d) = V_s(d; z_G^*).$$

Taking suprema over $d \in D$ yields

$$\sup_{d \in D} V_s^C(d; z_C^*) \leq \sup_{d \in D} V_s(d; z_G^*).$$

Therefore any parameter region that supports greenwashing before certification weakly contracts after certification. □

Proof of Corollary B.1

Proof. Because $\hat{p}_C(z) \geq \hat{p}_G(z)$ for every z and F is increasing, certification weakly enlarges the set of signals that induce coordinated support. Hence the coordination cutoff weakly falls. The same inequality also implies that, at any given realized signal, the probability that a genuine firm receives coordinated support weakly rises.

The second maintained assumption yields

$$V_s^C(d; z_C^*) \leq V_s(d; z_G^*) \qquad \text{for every } d \in D,$$

so the profitability of symbolic projects weakly falls. Combining the two inequalities gives the stated dual dividend. □

Proof of Proposition B.4

Proof. Let λ denote the fraction of genuine firms. A decline in λ reduces the prior probability that a firm generating signal z is genuine. By Bayes' rule, this lowers the posterior belief $\mu(z; \lambda)$ at every signal realization. Lower posterior credibility reduces the posterior expected implementation value of participation and therefore raises the support threshold faced by all firms. Since genuine firms' participation surplus is increasing in the probability of receiving coordinated support, their participation surplus weakly falls. In the industry extension, lower participation surplus shifts down firms' participation incentives and therefore weakly lowers the equilibrium industry participation rate. □

C Appendix C: Dynamic Capability Accumulation and Path-Dependent Transition Traps

This appendix develops a dynamic two-period extension of the main model in which the firm builds transition capability incrementally over time and effective period-1 investor support lowers the cost of subsequent capability-building. The extension introduces a support-facilitation channel that generates path dependence, support-capability momentum, transition windows, and front-loaded policy effects while nesting the static model as a one-period benchmark.

C.1 Setup

Timing There are two periods, $t \in \{1, 2\}$, followed by a terminal implementation stage. Each period contains a capability investment phase and an investor coordination phase.

Period 1.

(a) The firm chooses period-1 capability investment $\Delta_1 \geq 0$, bringing capability from the initial level $c_0 = 0$ to

$$c_1 = \Delta_1.$$

(b) Investors observe a public signal z_1 about c_1. Each investor i chooses whether to support. Aggregate support x_1 determines period-1 support effectiveness $S_1 = \mathbb{1}_{\{x_1 \geq \bar{x}\}}$.

Period 2.

(a) The firm observes the period-1 support outcome S_1 and chooses period-2 capability investment $\Delta_2 \geq 0$, bringing capability to

$$c_2 = c_1 + \Delta_2.$$

The cost of period-2 investment depends on both the inherited capability c_1 and the period-1 support outcome S_1.

(b) Investors observe a public signal z_2 about c_2 together with the signal history z_1. Investors also observe S_1 (which is public). Each investor chooses whether to support. Aggregate support x_2 determines period-2 support effectiveness $S_2 = \mathbb{1}_{\{x_2 \geq \bar{x}\}}$.

Terminal stage. The firm decides whether to undertake the project at final capability c_2 and support state S_2.

Capability accumulation technology The cumulative cost of building capability $c_2 = \Delta_1 + \Delta_2$ in two increments is

$$G(\Delta_1, \Delta_2, S_1) = g(\Delta_1) + \delta_F \, g_2(\Delta_2, c_1, S_1), \tag{C.1}$$

where $\delta_F \in (0, 1]$ is the firm's discount factor. The function g satisfies the same assumptions as in the main text: $g(0) = 0$, $g'(\cdot) > 0$, $g''(\cdot) \geq 0$.

The key new feature is that the period-2 cost function g_2 depends on the period-1 support outcome S_1. We specify:

$$g_2(\Delta_2, c_1, S_1) = g(\Delta_2) \, \phi(c_1) \, \psi(S_1), \tag{C.2}$$

where $\phi(c_1)$ captures the intertemporal cost structure (learning or inertia, as before) and $\psi(S_1)$ captures the effect of early investor support on subsequent capability-building costs.

Cost-structure component ϕ. As in the previous version of this extension, we consider two specifications:

- **Learning-by-doing (Case L):** $\phi^L(c_1) = 1 - \lambda \, c_1$, with $\lambda \in (0, 1)$.
- **Organizational inertia (Case I):** $\phi^I(c_1) = 1 + \iota \, c_1$, with $\iota > 0$.

Support-facilitation component ψ. We assume

$$\psi(1) = 1 - \sigma \qquad \text{and} \qquad \psi(0) = 1, \tag{C.3}$$

where $\sigma \in [0, 1)$ is the *support-facilitation parameter*. When $S_1 = 1$ (effective period-1 support), the cost of period-2 capability investment is reduced by a fraction σ. When $S_1 = 0$, period-2 costs are unchanged.

This specification captures several real-world channels through which early investor coordination reduces the cost of further organizational preparation:

(i) *Access to patient capital.* Effective investor support in period 1 may provide the firm with cheaper financing, longer time horizons, or reduced pressure for short-run returns, all of which lower the effective cost of building monitoring, governance, and reporting systems.

(ii) *Stakeholder validation.* Visible investor backing signals that the transition is credible, making it easier to recruit talent, secure supplier cooperation, and obtain board-level commitment for organizational reforms.

(iii) *Information and guidance.* Active investors may share knowledge about best practices, governance standards, and implementation strategies, reducing the cost of building capability from scratch.

(iv) *Reduced internal resistance.* When employees and managers observe that investors are committed, internal opposition to transition-related reforms diminishes, lowering the organizational cost of capability-building.

Remark (Nesting). The main paper's static model is nested by setting $\Delta_2 = 0$, $\delta_F = 1$, and $\sigma = 0$. In that case, $G(\Delta_1, 0, S_1) = g(\Delta_1) = g(c)$, recovering the static cost. The previous version of this extension (without S_1 in the cost) corresponds to $\sigma = 0$.

Implementation technology If the firm undertakes the project at terminal capability c_2 and support state S_2, the implementation probability is

$$p(c_2, S_2) = p_0 + p_c\, c_2 + p_S\, S_2 + p_{cS}\, c_2\, S_2,$$

with $p_c > 0$, $p_S > 0$, $p_{cS} > 0$, exactly as in the main text.

Signal technology In each period t, investors observe a public signal

$$z_t = c_t + \varepsilon_t, \qquad \varepsilon_t \sim F_\varepsilon, \qquad \mathbb{E}[\varepsilon_t] = 0, \tag{C.4}$$

where ε_1 and ε_2 are independent. At the start of period 2, investors observe the full history (z_1, z_2, S_1).

Payoffs The firm's payoff is

$$V = a\left[p(c_2, S_2)\, R - K\right] - G(\Delta_1, \Delta_2, S_1), \tag{C.5}$$

where $a \in \{0, 1\}$ is the terminal project decision. We focus throughout on the *tipping region*

$$p(c, 0)\, R < K \leq p(c, 1)\, R, \tag{C.6}$$

so that the project is undertaken only when period-2 support is effective ($S_2 = 1$).

Each investor i has idiosyncratic support cost m_i drawn from a strictly increasing distribution F on $[0, \bar{m}]$, and investor payoff from a successfully implemented transition is $\tilde{v} > 0$, exactly as in the main text.

C.2 Period-2 Analysis

We solve by backward induction, beginning with period 2. To avoid circularity, we proceed in three steps: first, we state the firm's optimization for a *given* coordination threshold; second, we compare firm behavior across support states holding the threshold fixed; third, we derive the equilibrium threshold and show it is lower following effective period-1 support.

Period-2 firm optimization for a given threshold Suppose investors coordinate on effective period-2 support if and only if $z_2 \geq \bar{z}_2$ for some threshold $\bar{z}_2$. Given c_1, S_1, and threshold $\bar{z}_2$, the firm solves

$$\max_{\Delta_2 \geq 0} \Pr(z_2 \geq \bar{z}_2 \mid c_1 + \Delta_2) \left[p(c_1 + \Delta_2, 1)\, R - K \right] - \delta_F\, g(\Delta_2)\, \phi(c_1)\, \psi(S_1). \tag{C.7}$$

Denote the optimal period-2 investment by $\Delta_2^*(c_1, \bar{z}_2, S_1)$.

Cost comparison: support raises investment at a fixed threshold The next result compares firm behavior across the two support states $S_1 \in \{0, 1\}$ *holding the coordination threshold $\bar{z}_2$ fixed*. This is the primitive step that breaks the logical cycle.

Lemma C.1 (Cost-channel effect of early support)**.** *Fix any coordination threshold $\bar{z}_2$ and any (c_1, z_1). If $\sigma > 0$, then*

$$\Delta_2^*(c_1, \bar{z}_2, 1) \geq \Delta_2^*(c_1, \bar{z}_2, 0),$$

with strict inequality whenever $\Delta_2^*(c_1, \bar{z}_2, 0) > 0$.

Proof. The first-order condition for an interior solution is

$$\underbrace{\frac{\partial}{\partial \Delta_2} \Pr(z_2 \geq \bar{z}_2 \mid c_2) \cdot [p(c_2, 1)R - K]}_{\text{visibility marginal benefit}} + \underbrace{\Pr(z_2 \geq \bar{z}_2 \mid c_2) \cdot p_c\, R}_{\text{implementation marginal benefit}} = \delta_F\, g'(\Delta_2)\, \phi(c_1)\, \psi(S_1). \tag{C.8}$$

The left-hand side is identical across $S_1 \in \{0, 1\}$ because the threshold $\bar{z}_2$ is held fixed. The right-hand side is $\delta_F\, g'(\Delta_2)\, \phi(c_1)\, (1 - \sigma)$ when $S_1 = 1$ and $\delta_F\, g'(\Delta_2)\, \phi(c_1)$ when $S_1 = 0$. Since $(1 - \sigma) < 1$, the marginal cost is strictly lower when $S_1 = 1$. Under the second-order

condition (the marginal benefit is decreasing in Δ_2 and the marginal cost is increasing), the solution Δ_2^* is weakly higher when $S_1 = 1$. □

Posterior inference: investors expect higher capability after early support Rational investors understand the cost structure. Given S_1, they anticipate the firm's optimal period-2 investment $\Delta_2^*(c_1, \bar{z}_2, S_1)$ and form the posterior expected implementation probability:

$$\hat{p}_2(z_1, z_2, S_1) \equiv \mathbb{E}\big[p(c_2, 1) \mid z_1, z_2, S_1\big],$$

where $c_2 = c_1 + \Delta_2^*(c_1, \bar{z}_2, S_1)$.

Lemma C.2 (Early support raises expected capability)**.** *For any (z_1, z_2) and any fixed threshold $\bar{z}_2$, if $\sigma > 0$ then*

$$\mathbb{E}[c_2 \mid z_1, z_2, S_1 = 1] \geq \mathbb{E}[c_2 \mid z_1, z_2, S_1 = 0],$$

and consequently $\hat{p}_2(z_1, z_2, 1) \geq \hat{p}_2(z_1, z_2, 0)$.

Proof. By Lemma C.1, for every realization of c_1 consistent with (z_1, z_2), we have $\Delta_2^*(c_1, \bar{z}_2, 1) \geq \Delta_2^*(c_1, \bar{z}_2, 0)$. Since $c_2 = c_1 + \Delta_2^*$, the posterior distribution of c_2 under $S_1 = 1$ first-order stochastically dominates that under $S_1 = 0$. Since $p(c_2, 1)$ is increasing in c_2, the result follows. □

Equilibrium coordination threshold In a period-2 coordination equilibrium, the threshold z_2^* is determined endogenously. As in the main text, investor i supports in period 2 if and only if

$$\hat{p}_2(z_1, z_2, S_1)\, \tilde{v} \geq m_i,$$

and aggregate support is $x_2 = F(\hat{p}_2\, \tilde{v})$. The coordination condition is

$$F\big(\hat{p}_2(z_1, z_2, S_1)\, \tilde{v}\big) \geq \bar{x}.$$

Since F is strictly increasing and $\hat{p}_2$ is (weakly) increasing in z_2, there exists a threshold $z_2^*(z_1, S_1)$ such that investors coordinate on effective period-2 support if and only if

$$z_2 \geq z_2^*(z_1, S_1). \tag{C.9}$$

We can now state the threshold comparison as a consequence of the preceding results.

Proposition C.1 (Period-1 support lowers the period-2 coordination threshold)**.** *The period-2 signal threshold satisfies*

$$z_2^*(z_1, 1) \leq z_2^*(z_1, 0)$$

for every z_1, with strict inequality whenever $\sigma > 0$.

Proof. By Lemma C.2, $\hat{p}_2(z_1, z_2, 1) \geq \hat{p}_2(z_1, z_2, 0)$ for every z_2. Hence $F(\hat{p}_2(z_1, z_2, 1)\,\tilde{v}) \geq F(\hat{p}_2(z_1, z_2, 0)\,\tilde{v})$. The coordination condition $F(\hat{p}_2\,\tilde{v}) \geq \bar{x}$ is therefore satisfied at a weakly lower z_2 when $S_1 = 1$. Since $\hat{p}_2$ is continuous and the inequality in Lemma C.2 is strict when $\sigma > 0$, the threshold inequality is strict. □

Remark (No circularity). The logical chain is: (i) lower cost under $S_1 = 1$ implies higher Δ_2^* at any fixed threshold (Lemma C.1); (ii) higher Δ_2^* implies higher posterior c_2 (Lemma C.2); (iii) higher posterior c_2 implies a lower equilibrium threshold (Proposition C.1). Each step uses only the conclusion of the preceding step, not the result being proved.

Combined effect on period-2 investment In equilibrium, the lower threshold under $S_1 = 1$ *reinforces* the cost-channel effect of Lemma C.1. We record this as a separate result.

Lemma C.3 (Early support raises equilibrium period-2 investment)**.** *For any (c_1, z_1), the equilibrium period-2 investment satisfies*

$$\Delta_2^*(c_1, z_1, 1) \geq \Delta_2^*(c_1, z_1, 0),$$

with strict inequality whenever $\sigma > 0$ and $\Delta_2^*(c_1, z_1, 0) > 0$.

Proof. By Lemma C.1, the cost channel alone (at a fixed threshold) raises Δ_2^*. By Proposition C.1, the equilibrium threshold is also lower under $S_1 = 1$, which weakly raises both the level and the marginal effect of $\Pr(z_2 \geq z_2^* \mid c_2)$ in the firm's first-order condition (C.8). Both forces push Δ_2^* upward. □

Reputation lowers the coordination threshold

Lemma C.4 (Reputation effect)**.** *For each $S_1 \in \{0, 1\}$, the period-2 signal threshold $z_2^*(z_1, S_1)$ is weakly decreasing in the period-1 signal z_1.*

Proof. A higher z_1 raises the investors' posterior mean of c_1 and hence of c_2 for any given z_2 and S_1. The coordination condition is therefore satisfied at a weakly lower z_2. □

Properties of the period-2 value

Lemma C.5. *The period-2 value $V_2(c_1, z_1, S_1)$ satisfies:*

(i) $V_2(c_1, z_1, 1) \geq V_2(c_1, z_1, 0)$*, with strict inequality when* $\sigma > 0$ *and the period-2 project is viable.*

(ii) V_2 *is weakly increasing in* z_1 *for each* S_1 *(reputation channel).*

(iii) Under learning-by-doing (Case L), V_2 *is weakly increasing in* c_1 *for each* (z_1, S_1)*.*

(iv) Under organizational inertia (Case I), V_2 *may be non-monotone in* c_1*.*

Proof. Part (i): Under $S_1 = 1$, the firm faces lower costs (Lemma C.1) and a lower coordination threshold (Proposition C.1). It can always replicate its $S_1 = 0$ strategy and achieve weakly higher payoff, so $V_2(c_1, z_1, 1) \geq V_2(c_1, z_1, 0)$. Part (ii): follows from Lemma C.4. Parts (iii)–(iv): under Case L, higher c_1 reduces ϕ and raises c_2; under Case I, higher c_1 raises ϕ, potentially offsetting the benefit. □

C.3 Period-1 Investor Problem and Firm Optimization

We now derive the period-1 investor support rule from primitives, and then characterize the firm's period-1 capability choice.

Period-1 continuation value for investors At period 1, investors observe signal z_1 and decide whether to support. A supporting investor incurs cost m_i in period 1 and, in return, may benefit from a successfully implemented project at the terminal stage. Because the project is undertaken only when $S_2 = 1$ (the tipping region), a period-1 investor's expected benefit depends on the probability that the entire chain of events—period-1 coordination, period-2 capability-building, period-2 coordination, and terminal implementation—leads to a successful outcome.

Define the *period-1 continuation probability* as

$$\hat{q}_1(z_1) \equiv \mathbb{E}\Big[\mathbb{1}_{\{S_2=1\}}\, p(c_2, S_2) \;\Big|\; z_1,\, S_1 = 1 \Big]. \tag{C.10}$$

This is the expected implementation probability, conditional on the period-1 signal z_1 and on period-1 support being effective. It integrates over: (a) the firm's period-2 investment $\Delta_2^*(c_1, z_1, 1)$, which determines c_2; (b) the period-2 signal $z_2 = c_2 + \varepsilon_2$; and (c) whether the

period-2 coordination condition $z_2 \geq z_2^*(z_1, 1)$ is met. Formally,

$$\hat{q}_1(z_1) = \int \Pr(z_2 \geq z_2^*(z_1, 1) \mid c_2(c_1))\; p\big(c_2(c_1), 1\big)\; d\Pr(c_1 \mid z_1), \tag{C.11}$$

where $c_2(c_1) = c_1 + \Delta_2^*(c_1, z_1, 1)$ is the terminal capability and the outer integral is over the posterior distribution of c_1 given z_1.

Lemma C.6 ($\hat{q}_1$ is increasing in z_1)**.** *The period-1 continuation probability $\hat{q}_1(z_1)$ is weakly increasing in z_1.*

Proof. A higher z_1 shifts the posterior distribution of c_1 upward (in the sense of first-order stochastic dominance). Higher c_1 weakly raises c_2 (since Δ_2^* is interior or at zero) and, by Lemma C.4, relaxes the period-2 coordination threshold $z_2^*(z_1, 1)$. Both effects weakly increase $\Pr(z_2 \geq z_2^*) \cdot p(c_2, 1)$, so $\hat{q}_1(z_1)$ is weakly increasing. □

Period-1 investor support rule Investors discount future payoffs at rate $\delta_I \in (0, 1]$. An investor who supports at $t = 1$ expects to benefit from a successful terminal transition. Investor i supports at $t = 1$ if and only if the expected discounted benefit exceeds the support cost:

$$\delta_I\, \tilde{v}\, \hat{q}_1(z_1) \geq m_i. \tag{C.12}$$

Equivalently, investor i supports if and only if

$$m_i \leq \delta_I\, \tilde{v}\, \hat{q}_1(z_1).$$

The aggregate mass of period-1 supporters is therefore

$$x_1(z_1) = F(\delta_I\, \tilde{v}\, \hat{q}_1(z_1))\,. \tag{C.13}$$

Period-1 support is effective if and only if

$$S_1(z_1) = 1 \qquad \Longleftrightarrow \qquad x_1(z_1) \geq \bar{x} \qquad \Longleftrightarrow \qquad F(\delta_I\, \tilde{v}\, \hat{q}_1(z_1)) \geq \bar{x}. \tag{C.14}$$

Period-1 signal threshold Since F is strictly increasing and $\hat{q}_1$ is weakly increasing in z_1 (Lemma C.6), the left-hand side of the coordination condition (C.14) is weakly increasing

in z_1. Hence there exists a *period-1 signal threshold* z_1^* such that

$$S_1(z_1) = \begin{cases} 1, & z_1 \geq z_1^*, \\ 0, & z_1 < z_1^*. \end{cases} \tag{C.15}$$

The threshold z_1^* is defined implicitly by

$$F(\delta_I \, \tilde{v} \, \hat{q}_1(z_1^*)) = \bar{x}, \tag{C.16}$$

or equivalently,

$$\hat{q}_1(z_1^*) = \frac{F^{-1}(\bar{x})}{\delta_I \, \tilde{v}} \equiv \hat{q}_1^*. \tag{C.17}$$

This parallels the period-2 threshold $z_2^*(z_1, S_1)$ derived in Section C.2 and the static signal threshold z^* in the main paper.

Lemma C.7 (Period-1 threshold comparative statics)**.** *The period-1 signal threshold z_1^* satisfies:*

(i) z_1^* is decreasing in investor patience δ_I. Patient investors tolerate a lower signal because they place more weight on future transition payoffs.

(ii) z_1^* is decreasing in the investor value $\tilde{v}$.

(iii) z_1^* is decreasing in the support-facilitation parameter σ, provided that σ raises $\hat{q}_1$ (which it does whenever σ increases period-2 investment and hence the probability of successful terminal transition).

Proof. From (C.17), $\hat{q}_1^* = F^{-1}(\bar{x})/(\delta_I \tilde{v})$. Parts (i)–(ii): Higher δ_I or $\tilde{v}$ reduces $\hat{q}_1^*$. Since $\hat{q}_1(z_1)$ is increasing in z_1, a lower target $\hat{q}_1^*$ is reached at a lower z_1^*. Part (iii): Higher σ increases $\hat{q}_1(z_1)$ at every z_1 (because it lowers period-2 costs, raising Δ_2^* and hence c_2 and $\Pr(S_2 = 1)$). Hence $\hat{q}_1(z_1)$ crosses the threshold $\hat{q}_1^*$ at a lower z_1. □

Period-1 support probability Given the threshold structure (C.15) and the signal $z_1 = \Delta_1 + \varepsilon_1$, the probability that period-1 support is effective, conditional on the firm's choice Δ_1, is

$$\Pr(S_1 = 1 \mid \Delta_1) = \Pr(z_1 \geq z_1^* \mid \Delta_1) = 1 - F_\varepsilon(z_1^* - \Delta_1). \tag{C.18}$$

This expression makes the dependence on Δ_1 explicit: higher capability investment raises z_1 in expectation, increasing the probability of clearing the coordination threshold. Its

derivative is

$$\frac{\partial}{\partial \Delta_1} \Pr(S_1 = 1 \mid \Delta_1) = f_\varepsilon(z_1^* - \Delta_1) > 0, \tag{C.19}$$

where f_ε is the density of ε_1. This is the object that enters the marginal-return decomposition below.

Firm's period-1 optimization At period 1, the firm chooses Δ_1 anticipating both the period-1 coordination outcome and the period-2 continuation. Because S_1 is deterministic given z_1 (by the threshold rule (C.15)), the firm's expected payoff is

$$V(\Delta_1) = \int_{z_1^*}^{\infty} V_2(\Delta_1, z_1, 1)\, dF_{z_1}(z_1 \mid \Delta_1) + \int_{-\infty}^{z_1^*} V_2(\Delta_1, z_1, 0)\, dF_{z_1}(z_1 \mid \Delta_1) - g(\Delta_1), \tag{C.20}$$

where $F_{z_1}(\cdot \mid \Delta_1)$ is the distribution of $z_1 = \Delta_1 + \varepsilon_1$. When $z_1 \geq z_1^*$, support is effective and the continuation value is $V_2(\cdot, 1)$; when $z_1 < z_1^*$, support fails and the continuation value is $V_2(\cdot, 0)$.

Define the *support-facilitation premium* as

$$\Pi^S(c_1, z_1) \equiv V_2(c_1, z_1, 1) - V_2(c_1, z_1, 0) \geq 0. \tag{C.21}$$

This is the incremental value to the firm of receiving effective period-1 support, holding capability and signals fixed. By Lemma C.5(i), $\Pi^S \geq 0$ with strict inequality when $\sigma > 0$ and the period-2 project is viable.

The firm's expected payoff can equivalently be written using the ex ante probability of effective support $\Pr(S_1 = 1 \mid \Delta_1) = 1 - F_\varepsilon(z_1^* - \Delta_1)$ from (C.18):

$$V(\Delta_1) = \mathbb{E}_{z_1}\big[V_2(\Delta_1, z_1, 0)\big] + \int_{z_1^*}^{\infty} \Pi^S(\Delta_1, z_1)\, dF_{z_1}(z_1 \mid \Delta_1) - g(\Delta_1). \tag{C.22}$$

Differentiating (C.20) with respect to Δ_1 and applying the Leibniz rule at the threshold $z_1 = z_1^*$ yields the following *marginal-return decomposition*:

$$\underbrace{\int_{-\infty}^{\infty} \frac{\partial V_2(\cdot, S_1(z_1))}{\partial c_1}\, dF_{z_1}}_{\text{direct effect}} + \underbrace{\int_{-\infty}^{\infty} \frac{\partial V_2(\cdot, S_1(z_1))}{\partial z_1}\, dF_{z_1}}_{\text{reputation}} + \underbrace{f_\varepsilon(z_1^* - \Delta_1)\, \Pi^S(\Delta_1, z_1^*)}_{\text{support-facilitation}} = g'(\Delta_1), \tag{C.23}$$

where $S_1(z_1) = \mathbb{1}_{\{z_1 \geq z_1^*\}}$ and f_ε is the density of ε_1. We refer to (C.23) as the *marginal-return decomposition* rather than a first-order condition, because $V(\Delta_1)$ depends on Δ_1 through the state $c_1 = \Delta_1$, the shifted signal distribution $z_1 = \Delta_1 + \varepsilon_1$, and the boundary

of the integration region at z_1^*; the decomposition captures all three channels but should be understood as a heuristic representation of the necessary condition rather than a literal derivative.

The first two terms arise from differentiating the integrands of (C.20) with respect to Δ_1 (which enters through $c_1 = \Delta_1$ and through the location shift of $z_1 = \Delta_1 + \varepsilon_1$). The third term is the Leibniz boundary term: a marginal increase in Δ_1 shifts the signal distribution to the right, converting a measure-$f_\varepsilon(z_1^* - \Delta_1)$ set of previously-failing signals into successes, each worth the premium $\Pi^S(\Delta_1, z_1^*)$.

The decomposition identifies three channels through which early investment raises the firm's payoff:

(i) **Direct effect.** Higher Δ_1 raises c_1, improving terminal implementation probability and (under Case L) lowering period-2 costs.

(ii) **Reputation effect.** Higher Δ_1 raises the expected period-1 signal z_1 (since $\partial z_1/\partial \Delta_1 = 1$), which relaxes the period-2 coordination condition.

(iii) **Support-facilitation effect.** Higher Δ_1 raises $\Pr(S_1 = 1 \mid \Delta_1)$ by shifting the signal distribution to the right relative to the fixed threshold z_1^*. The marginal gain is $f_\varepsilon(z_1^* - \Delta_1) \cdot \Pi^S$, which is the probability density at the coordination threshold times the value of receiving early support. When $\sigma > 0$, Π^S includes the direct cost reduction $(1 - \sigma)$, making this term strictly positive and large.

The support-facilitation effect creates a *positive feedback loop*: early capability investment $\to$ higher $\Pr(S_1 = 1)$ $\to$ lower period-2 costs $\to$ higher period-2 investment $\to$ higher $\Pr(S_2 = 1)$ $\to$ successful transition.

C.4 Main Results

Support-capability momentum The first result formalizes the positive feedback loop.

Proposition C.2 (Support-capability momentum)**.** *When $\sigma > 0$, effective period-1 support ($S_1 = 1$) triggers a* momentum effect*:*

(i) The firm invests strictly more in period-2 capability: $\Delta_2^*(c_1, z_1, 1) > \Delta_2^*(c_1, z_1, 0)$ (Lemma C.3).

(ii) Higher period-2 capability raises the probability of period-2 coordination: $\Pr(S_2 = 1 \mid c_1, z_1, S_1 = 1) \geq \Pr(S_2 = 1 \mid c_1, z_1, S_1 = 0)$.

(iii) Conversely, the absence *of period-1 support depresses period-2 investment and raises the probability of a support collapse:* $\Pr(S_2 = 0 \mid S_1 = 0) \geq \Pr(S_2 = 0 \mid S_1 = 1)$.

Proof. Part (i) is Lemma C.3. Part (ii): By Lemma C.3, c_2 is higher following $S_1 = 1$. A higher c_2 raises $z_2 = c_2 + \varepsilon_2$ in expectation, and by Lemma C.1, the threshold $z_2^*(z_1, 1) \leq z_2^*(z_1, 0)$. Both effects increase $\Pr(z_2 \geq z_2^* \mid S_1 = 1)$ relative to $\Pr(z_2 \geq z_2^* \mid S_1 = 0)$. Part (iii) is the contrapositive of part (ii). □

Remark. The momentum effect is the central new force introduced by letting S_1 enter the period-2 cost. In the previous version of this extension (with $\sigma = 0$), period-1 support affected period-2 outcomes only through the reputation channel (investors' updated beliefs about c_1). With $\sigma > 0$, period-1 support also has a *real* effect: it directly lowers the cost of further capability-building, creating a self-reinforcing virtuous (or vicious) cycle. Support begets capability, and capability begets support.

Equilibrium multiplicity The momentum effect amplifies the multiplicity from the static model.

Theorem C.1 (Dynamic equilibrium multiplicity)**.** *Suppose the trap condition*

$$p(c, 0)\, R < K \qquad \text{for all } c \in [0, 1] \tag{C.24}$$

holds, and suppose there exists $c_H \geq \bar{c}$ *such that*

$$p(c_H, 1)R - K - g(c_H) \geq 0 \qquad \text{and} \qquad F\big(p(c_H, 1)\tilde{v}\big) \geq \bar{x}.$$

Then:

(i) Under pessimistic continuation selection, there exists a low-capability, low-support, no-project equilibrium: $\Delta_1^* = 0$, $S_1 = 0$, $\Delta_2^* = 0$, $S_2 = 0$, $a = 0$.

(ii) Under optimistic continuation selection, there exists a high-capability, high-support, project equilibrium with $\Delta_1^* > 0$, $S_1 = 1$ *(on the equilibrium path),* $\Delta_2^* > 0$, $S_2 = 1$, $a = 1$.

(iii) When $\sigma > 0$*, support facilitation lowers continuation costs on the high path and therefore makes the high-path equilibrium easier to sustain than in the* $\sigma = 0$ *benchmark.*

Proof. Part (i): Under pessimistic selection and condition (C.24), $S_1 = 0$ is selected for every c_1. The firm's payoff is then $V(\Delta_1) = -g(\Delta_1)$, maximized at $\Delta_1 = 0$. Given $c_1 = 0$ and $S_1 = 0$, the period-2 problem is identical to the static trap: $\Delta_2 = 0$, $S_2 = 0$, $a = 0$.

Part (ii): Under optimistic selection, the firm anticipates $S_1 = 1$ and $S_2 = 1$ whenever the relevant capability thresholds are met. With $S_1 = 1$, the cost of the period-2 increment is $\delta_F\, g(\Delta_2)\, \phi(c_1)\, (1 - \sigma)$. The firm's problem on the high path is to choose (Δ_1, Δ_2) to maximize

$$p(c_1 + \Delta_2, 1)R - K - g(\Delta_1) - \delta_F\, g(\Delta_2)\, \phi(c_1)\, (1 - \sigma).$$

By assumption, there exists c_H making this nonneg (since the static condition $p(c_H, 1)R - K - g(c_H) \geq 0$ is sufficient, and the dynamic cost with $\sigma > 0$ is weakly lower). Hence an optimal (Δ_1^*, Δ_2^*) with $c_1^* + \Delta_2^* \geq \bar{c}$ exists.

Part (iii): On the high path, period-2 costs carry the factor $(1 - \sigma) < 1$. The low path is unaffected ($\psi(0) = 1$). Hence the nonneg payoff condition on the high path is strictly weaker when $\sigma > 0$ than when $\sigma = 0$. □

Path-dependent absorbing traps The capability trap can become absorbing when organizational inertia is combined with the absence of early support.

Proposition C.3 (Absorbing trap under inertia)**.** *Suppose organizational inertia holds (Case I), the trap condition* (C.24) *holds, and*

$$p(\bar{c}, 1)\, R - K < \delta_F\, g(\bar{c}). \tag{C.25}$$

Then there exists a threshold $\iota^* > 0$ such that, for all $\iota > \iota^*$: if $S_1 = 0$, then no profitable period-2 catch-up path exists.

Proof. When $S_1 = 0$, the period-2 cost is $\delta_F\, g(\Delta_2)(1 + \iota\, c_1)$ (since $\psi(0) = 1$). The cost of reaching the capability threshold $\bar{c}$ from initial level c_1 is therefore

$$\delta_F\, g(\bar{c} - c_1)(1 + \iota\, c_1).$$

A high-support/project continuation in period 2 requires

$$p(\bar{c}, 1)R - K \geq \delta_F\, g(\bar{c} - c_1)(1 + \iota\, c_1).$$

At $c_1 = 0$, the right-hand side equals $\delta_F\, g(\bar{c})$, which exceeds $p(\bar{c}, 1)R - K$ by condition (C.25). For $c_1 > 0$, the right-hand side grows without bound as $\iota \to \infty$, so the inequality fails for

ι sufficiently large. Hence there exists ι^* such that the inequality fails for all $c_1 \in [0, \bar{c}]$ whenever $\iota > \iota^*$.

Under condition (C.24), the project is never undertaken without effective support, so $\Delta_2^* = 0$ is the unique continuation. Since $\Delta_2^* = 0$ in period 2 regardless of c_1, the firm's period-1 payoff reduces to $V(\Delta_1) = -g(\Delta_1)$, maximized at $\Delta_1 = 0$. □

Remark (Role of σ). The threshold ι^* does not depend on σ, because the period-2 continuation problem following $S_1 = 0$ has $\psi(0) = 1$ regardless of σ. The parameter σ enters the model through a different channel: it affects the *relative attractiveness* of the two equilibrium paths. A higher σ makes the high path (which requires $S_1 = 1$) more attractive by reducing its period-2 costs, while leaving the low path (which has $S_1 = 0$) unchanged. Thus σ affects which equilibrium is selected, not the conditions under which the trap is absorbing. This distinction is formalized in the transition-window results (Proposition C.4), where σ expands $\mathcal{W}(\iota, 1)$ but leaves $\mathcal{W}(\iota, 0)$ unchanged.

Transition windows

Definition. The *transition window* conditional on period-1 support state S_1 is

$$\mathcal{W}(\iota, S_1) = \{c_1 \geq 0 : \exists\, \Delta_2 \geq 0 \text{ s.t. } c_1 + \Delta_2 \geq \bar{c} \text{ and } p(c_1 + \Delta_2, 1)R - K - \delta_F\, g(\Delta_2)\, \phi(c_1)\, \psi(S_1) \geq 0\}\,. \tag{C.26}$$

Proposition C.4 (Support expands the transition window)**.** *Under organizational inertia (Case I) with $\sigma > 0$:*

(i) The transition window following effective support contains the window following ineffective support:

$$\mathcal{W}(\iota, 1) \supseteq \mathcal{W}(\iota, 0).$$

(ii) The inclusion is strict whenever $\sigma > 0$ and $\mathcal{W}(\iota, 0) \neq \emptyset$: some capability levels that are insufficient for recovery without early support become sufficient with it.

(iii) The window $\mathcal{W}(\iota, 0)$ empties at a weakly lower inertia level than $\mathcal{W}(\iota, 1)$: early support delays the onset of the absorbing trap.

Proof. The payoff from reaching $\bar{c}$ conditional on S_1 is

$$\Pi(c_1; \iota, S_1) = p(\bar{c}, 1)R - K - \delta_F\, g(\bar{c} - c_1)(1 + \iota\, c_1)\, \psi(S_1). \tag{C.27}$$

Part (i): Since $\psi(1) = (1-\sigma) < 1 = \psi(0)$, we have $\Pi(c_1;\iota,1) > \Pi(c_1;\iota,0)$ for every $c_1 \in (0,\bar{c})$. Hence any $c_1 \in \mathcal{W}(\iota,0)$ also belongs to $\mathcal{W}(\iota,1)$.

Part (ii): At a c_1 where $\Pi(c_1;\iota,0)$ is slightly negative, $\Pi(c_1;\iota,1)$ may still be nonneg because of the lower factor $\psi(1) < \psi(0)$. Such c_1 values belong to $\mathcal{W}(\iota,1) \setminus \mathcal{W}(\iota,0)$.

Part (iii): $\mathcal{W}(\iota,S_1)$ empties when $\Pi(c_1;\iota,S_1) < 0$ for all c_1. Since Π is lower under $\psi(0) = 1$ than under $\psi(1) = 1-\sigma$, the $S_1 = 0$ window empties first. □

Remark. The strict inclusion $\mathcal{W}(\iota,1) \supsetneq \mathcal{W}(\iota,0)$ when $\sigma > 0$ measures the value of early support: some capability levels that leave the firm stranded without period-1 coordination become viable starting points for transition when early support is present.

Reputation and the support-facilitation premium

Proposition C.5 (Support facilitation raises the marginal return to early investment)**.** *When $\sigma > 0$, the support-facilitation channel raises the marginal return to period-1 capability investment relative to the $\sigma = 0$ case. In particular, if the firm's optimization problem has a unique interior solution, then Δ_1^* is weakly higher under $\sigma > 0$ than under $\sigma = 0$, holding all other parameters fixed.*

Proof. From the marginal-return decomposition (C.23), the support-facilitation term is

$$f_\varepsilon(z_1^* - \Delta_1)\,\Pi^S(\Delta_1, z_1^*).$$

When $\sigma = 0$, $\Pi^S = V_2(\cdot,1) - V_2(\cdot,0)$ arises only from the indirect effect of S_1 on period-2 coordination through investor beliefs (Proposition C.1), which may be small when signals are noisy. When $\sigma > 0$, the premium Π^S includes the direct cost reduction $(1-\sigma)$, which is independent of signal noise and strictly positive whenever the period-2 project is viable. The density $f_\varepsilon(z_1^* - \Delta_1) > 0$ by assumption (the noise distribution has full support). Hence the marginal return to Δ_1 is strictly higher when $\sigma > 0$. Under uniqueness and interiority, this implies Δ_1^* is weakly higher. □

Gradualism versus big push Define the two canonical paths toward the threshold $\bar{c}$:

- **Gradualist path:** $\Delta_1 = \Delta_2 = \bar{c}/2$, assuming $S_1 = 1$.
- **Big-push path:** $\Delta_1 = \bar{c}$, $\Delta_2 = 0$.

Proposition C.6 (Optimal sequencing with support facilitation)**.** *The optimal investment sequence depends on the interaction between the cost structure and the support-facilitation parameter σ:*

(i) Under learning-by-doing (Case L) with g strictly convex, the gradualist path is more likely to be favored: the learning discount $(1-\lambda c_1)$ and the support-facilitation discount $(1-\sigma)$ jointly reduce the period-2 cost, reinforcing the convexity saving from spreading investment across periods. Specifically, the gradualist path dominates under Case L if

$$(1-\sigma)(1-\lambda\,\bar{c}/2) < \frac{g(\bar{c})/g(\bar{c}/2)-1}{\delta_F}. \tag{C.28}$$

(ii) Under organizational inertia (Case I), the big-push path is favored when ι is large. However, when σ is large and ι is moderate, the gradualist path can dominate even under inertia: the support-facilitation discount $(1-\sigma)$ can offset the inertia penalty $(1+\iota\,c_1)$. Specifically, the gradualist path dominates under Case I if and only if

$$(1-\sigma)(1+\iota\,\bar{c}/2) < \frac{g(\bar{c})/g(\bar{c}/2)-1}{\delta_F}. \tag{C.29}$$

Proof. The total cost along the gradualist path (assuming $S_1 = 1$) is

$$C^{\text{grad}} = g(\bar{c}/2) + \delta_F\, g(\bar{c}/2)\,\phi(\bar{c}/2)\,(1-\sigma).$$

The big-push cost is $C^{\text{push}} = g(\bar{c})$. Graduation dominates iff $C^{\text{grad}} < C^{\text{push}}$, i.e.,

$$\delta_F\,(1-\sigma)\,\phi(\bar{c}/2) < \frac{g(\bar{c})}{g(\bar{c}/2)} - 1.$$

Part (i). Under Case L, $\phi(\bar{c}/2) = (1-\lambda\,\bar{c}/2) < 1$. The LHS is $(1-\sigma)(1-\lambda\bar{c}/2)\delta_F$, which is small when σ and λ are large. When it falls below $(g(\bar{c})/g(\bar{c}/2))-1 > 0$ (which is positive by strict convexity of g), the gradualist path dominates. This gives condition (C.28).

Part (ii). Under Case I, $\phi(\bar{c}/2) = (1+\iota\,\bar{c}/2)$, so the condition becomes (C.29). When σ is large (close to 1), the term $(1-\sigma)(1+\iota\,\bar{c}/2)$ can be small even for large ι, making graduation cheaper. Intuitively, when early support substantially reduces period-2 costs, it becomes worthwhile to spread investment across periods even under organizational inertia. □

Remark. This is a qualitatively new result relative to $\sigma = 0$. Without support facilitation, inertia always favors front-loading. With support facilitation, the graduated path exploits the cost discount from early support, creating a genuine trade-off even under inertia. This provides a formal rationale for "build gradually with sustained stakeholder engagement" strategies observed in practice.

Investor patience and support dynamics

Proposition C.7 (Patient capital facilitates early investment)**.** *Higher investor patience (larger δ_I) weakly increases the firm's optimal period-1 investment Δ_1^*. When $\sigma > 0$, the support-facilitation channel strengthens the effect of investor patience on early investment incentives.*

Proof. From Lemma C.7(i), higher δ_I lowers the period-1 signal threshold z_1^* via (C.17):

$$\hat{q}_1^* = \frac{F^{-1}(\bar{x})}{\delta_I \, \tilde{v}}$$

is decreasing in δ_I, so a lower target $\hat{q}_1^*$ is crossed at a lower z_1^*.

A lower z_1^* raises $\Pr(S_1 = 1 \mid \Delta_1) = 1 - F_\varepsilon(z_1^* - \Delta_1)$, increasing the expected support-facilitation premium in the firm's objective (C.22). The density $f_\varepsilon(z_1^* - \Delta_1)$ in the support-facilitation term of the marginal-return decomposition (C.23) also shifts, generally increasing the marginal return to Δ_1.

When $\sigma > 0$, the premium Π^S includes the direct cost reduction $(1-\sigma)$, which is strictly positive and independent of signal noise. Hence the support-facilitation term in (C.23) is larger when $\sigma > 0$, reinforcing the effect of δ_I on the marginal return to early investment. □

Fragility of transition paths

Remark (Discouragement from support withdrawal). Suppose $S_1 = 1$ in period 1 but the realized period-1 signal z_1 is unexpectedly low (due to adverse noise $\varepsilon_1 \ll 0$). If investors withdraw support in period 2 ($S_2 = 0$), then under the trap condition (C.24), the project payoff is $p(c_2, 0)R - K < 0$, so the firm sets $\Delta_2^* = 0$. The dynamic model thus admits *failed transition attempts*: paths along which the firm invests early, receives support, but then loses support due to an adverse signal and abandons the effort. When $\sigma > 0$, such failures are costlier than under $\sigma = 0$ because the firm's higher period-1 investment (driven by the anticipated support-facilitation premium) represents larger sunk costs that are not recovered when the period-2 cost discount fails to materialize.

C.5 Welfare and Policy Implications

This section discusses welfare and policy implications of the dynamic model. The results are presented at the level of proof sketches appropriate for an online appendix; full proofs would require additional regularity conditions on the planner's problem.

Dynamic welfare function Following the main text, let $E \geq 0$ denote the external social value of a successfully implemented transition. The dynamic social welfare function is

$$W = \mathbb{E}\big[a\left[p(c_2, S_2)(R + E) - K + \mathcal{V}(c_2, S_2)\right] - G(\Delta_1, \Delta_2, S_1)\big], \tag{C.30}$$

where

$$\mathcal{V}(c, S) = S \int_0^{p(c,S)\tilde{v}} \big(p(c, S)\tilde{v} - m\big)\, dF(m)$$

is aggregate investor surplus, as defined in the main text.

Dynamic underinvestment

Proposition C.8 (Dynamic welfare wedge)**.** *In the two-period model with $\sigma > 0$, the planner's marginal return to period-1 capability investment weakly exceeds the firm's along each of the three channels in the marginal-return decomposition* (C.23)*. In particular, the planner values the support-facilitation premium at social returns $(R + E, \mathcal{V})$ rather than private returns (R). Under standard concavity conditions, this implies private capability investment is weakly below the socially optimal level in both periods.*

Proof sketch. The firm's support-facilitation term values the premium at private returns:

$$\Pi^S_{\text{private}} = V_2(\cdot, 1) - V_2(\cdot, 0),$$

where V_2 is based on $pR - K$. The planner's counterpart values it at social returns:

$$\Pi^S_{\text{social}} = W_2(\cdot, 1) - W_2(\cdot, 0),$$

where W_2 is based on $p(R + E) - K + \mathcal{V}$. Since $E \geq 0$ and $\mathcal{V} \geq 0$, $\Pi^S_{\text{social}} \geq \Pi^S_{\text{private}}$, with strict inequality when $E > 0$ or $\mathcal{V}_c > 0$. This additional wedge, multiplied by $f_\varepsilon(z_1^* - \Delta_1) > 0$ from (C.19), raises the planner's marginal return above the firm's. Under strict concavity, the socially optimal Δ_1 weakly exceeds the private optimum. □

Front-loaded subsidy dominance

Corollary C.1 (Policy timing)**.** *Under organizational inertia (Case I) with $\sigma > 0$, a period-1 capability-cost reduction has welfare effects that a period-2 cost reduction cannot replicate, because only the former activates the support-facilitation channel: higher Δ_1^* raises $\Pr(S_1 = 1)$, triggering the cost discount $(1 - \sigma)$ in period 2 and the momentum effect of Proposition C.2.*

This suggests that front-loaded capability subsidies are more effective than equivalent late subsidies.

Support-side intervention The support-facilitation channel also creates a role for policies that directly raise σ.

Corollary C.2 (Policies that deepen early support)**.** *An increase in the support-facilitation parameter σ weakly raises:*

(i) the firm's optimal period-1 investment Δ_1^*;

(ii) the feasibility of the high-path equilibrium (Theorem C.1);

(iii) the width of the transition window (Proposition C.4).

Proof. Part (i): Higher σ raises Π^S, increasing the support-facilitation term in (C.23). Part (ii): Higher σ lowers costs on the high path but not the low path, making the high-path viability condition easier to satisfy. Part (iii): Higher σ lowers $\psi(1)$, expanding $\mathcal{W}(\iota, 1)$. □

Remark. In practice, policies that raise σ include stewardship codes that encourage active investor engagement, institutional arrangements for patient capital provision, knowledge-sharing platforms between investors and firms, and stakeholder coordination mechanisms that make early support more consequential for implementation capacity.

C.6 Connection to the Main Paper

Table 1 summarizes the connection with the baseline model.

Main paper result	**Dynamic counterpart**	**Nesting condition**
Capability trap (Prop. 2)	Absorbing trap (Prop. C.3)	$T = 1$ or $\iota = 0$
High-capability equil. (Prop. 3)	High path (Thm. C.1)	$T = 1$ or $\sigma = 0$
Full multiplicity (Thm. 1)	Dynamic multiplicity (Thm. C.1)	$T = 1$
Welfare underinvest. (Prop. 7)	Amplified wedge (Prop. C.8)	$T = 1$ or $\sigma = 0$
Visibility (Sec. 5)	Reputation + momentum (Props. C.5, C.2)	No signal history
—	Support-facilitation premium	$\sigma = 0$ (vanishes)
—	Gradualism under inertia	$\sigma = 0$ (impossible)

Table 1: Connecting dynamic model with baseline model

New mechanisms from letting S_1 enter the cost Beyond the mechanisms already present in the $\sigma = 0$ version (path dependence, reputation, support dynamics, investor patience, policy timing), the $\sigma > 0$ specification adds three qualitatively new forces:

1. **Support-capability momentum** (Proposition C.2). Early support reduces period-2 costs, raising period-2 investment, which raises the probability of period-2 support. This creates a self-reinforcing cycle that amplifies the static complementarity into a dynamic feedback loop.

2. **Gradualism under inertia** (Proposition C.6). Without support facilitation, organizational inertia always favors front-loading. With $\sigma > 0$, the cost discount from $S_1 = 1$ can offset the inertia penalty, making gradual investment optimal even in rigid organizations. This is a qualitatively new result.

3. **Support-depth policy channel** (Corollary C.2). Policies that deepen the impact of early investor support—stewardship codes, patient capital platforms, knowledge sharing—have first-order effects on capability investment and transition outcomes. This channel is absent when $\sigma = 0$.

However, the core complementarity between investor support and firm capability—the main paper's central mechanism—remains the engine. The dynamic extension with $\sigma > 0$ does not introduce a *new* complementarity; it *propagates* the existing complementarity across time, allowing support at one stage to directly facilitate capability-building at the next stage.