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Strategic Commitment in Interdependent Technology Portfolios under Uncertain Complement Availability, Unequal Switching Costs, and Competing Innovation Trajectories

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Abstract

Technology-portfolio decisions become difficult when the value of one technological commitment depends on complements whose future availability is uncertain, when alternatives differ in the cost of later switching, and when competing technological trajectories continue to evolve after an initial choice. This article develops a Path-Dependence / Trajectory Theory account of that problem. The central argument is that strategic commitment becomes path dependent when early portfolio choices do more than allocate current resources: they alter the accessibility, value, and organizational feasibility of later alternatives through reinforcing technological, ecosystem, capability, and governance relationships. Complement uncertainty can accelerate or weaken such reinforcement, while unequal switching costs make reversibility differ across portfolio branches. Competing trajectories further complicate commitment because the opportunity cost of persistence changes as alternative technologies develop. The resulting account distinguishes genuine path-dependent persistence from observationally similar outcomes produced by current technological superiority, static switching costs, or rational option-preserving behavior. It also treats lock-in as conditional rather than inevitable and specifies how multihoming, external connections, retained capabilities, and critical-juncture interventions can preserve or restore redirection possibilities. The contribution is a portfolio-level explanation of how commitment timing and interdependence jointly reshape later strategic option value.

Keywords Ecosystem interdependence, Strategic commitment, Path dependence, Switching costs, Technology portfolios, Complementary assets

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Introduction

Organizations rarely choose consequential technologies in isolation. A technology may depend on complementary infrastructure, software, standards, suppliers, skills, data, distribution channels, or ecosystem participants whose future availability cannot be determined at the moment of commitment. The theoretical difficulty is therefore temporal as well as structural. A current choice may change the set of options available later, and that alteration can become self-reinforcing. Organizational path dependence provides a demanding criterion for interpreting such persistence because it requires more than historical continuity: preceding choices must progressively alter subsequent alternatives through reinforcing processes that narrow the practical option set [1]. Ecosystem strategy adds a second dimension by showing that

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organizational outcomes often depend on the alignment of activities and actors beyond the focal firm's formal boundaries [2].

The combination creates a problem that neither perspective resolves fully on its own. Ecosystem research explains how complementarities and interdependence organize value creation across multiple actors [3], whereas path-dependence research explains how sequences of choices can make later outcomes increasingly contingent on earlier ones. Digital settings complicate the conventional assumption that increasing commitment necessarily produces irreversible lock-in. Longitudinal evidence from connected-car business models shows that digital technologies can expand design possibilities and permit organizations to move away from previously entrenched trajectories under some conditions [4]. Persistence and reversibility therefore have to be explained rather than assumed.

Platform research makes these tensions especially visible because network effects, complementors, standards, and governance rules couple strategic choices across actors. Yet platform competition itself is heterogeneous, with different architectures and governance arrangements producing different strategic consequences [5]. The present article consequently treats platform studies as evidence about mechanisms that can occur within interdependent portfolios, not as a claim that every technology portfolio is a platform.

The research question is: How do early commitments in interdependent technology portfolios change the future value and feasibility of alternative technological paths when complement availability is uncertain, switching costs are unequal, and rival innovation trajectories continue to evolve? The theoretical issue is narrower than technology adoption and broader than platform dependence. The focal phenomenon is the recursive modification of later option value. A portfolio becomes path dependent when commitment to one branch changes the organization's ability to evaluate, combine, maintain, or redirect toward alternatives, and when those changes themselves reinforce subsequent commitment. This formulation preserves an important distinction: continuing with a technology because it remains the best available option is different from continuing because previous choices have progressively made other options less accessible.

Technology Portfolios as Interdependent Strategic Systems

Technology portfolios are often represented as collections of projects or assets whose individual expected returns can be compared. That representation becomes incomplete where technologies share interfaces, complementary capabilities, standards, data structures, suppliers, or ecosystem partners. Network and platform strategy research demonstrates that value creation can depend on actors whose choices are only partly controlled by the focal organization [6]. Dynamic-capability research similarly emphasizes the need to integrate and reconfigure resources across organizational boundaries when innovation depends on platform-based ecosystems [7]. Portfolio value is therefore relational: changing one technological commitment can alter the usefulness or feasibility of several others.

Interdependence also has a governance dimension. Ecosystem orchestration under uncertainty requires continuing adjustment among actors whose actions cannot simply be specified through hierarchical authority [8]. Platform ecosystems have accordingly been described as meta-organizational arrangements in which coordination occurs without complete organizational integration [9]. For a technology portfolio, this means that the relevant unit of commitment extends beyond owned technological assets. Commitments may include standards, integration routines, specialized human capability, data formats, supplier relationships, developer communities, and governance arrangements that determine what other technologies can subsequently be combined with the installed base.

These dependencies evolve after the initial choice. Longitudinal evidence from a digital ecosystem shows reciprocal relationships among product scope, product innovation, and collaborative-network position [10]. The strategic significance is that portfolio configuration is not necessarily an exogenous backdrop to innovation. Participation choices alter ecosystem position, while changing ecosystem positions alter which innovation choices are feasible or attractive. Evidence from mobile application ecosystems likewise shows that complementor performance depends on ecosystem position and configuration rather than on product characteristics alone [11].

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This interdependence creates the substrate for path dependence but does not establish it. A portfolio may be highly interconnected while remaining readily reconfigurable if interfaces are modular, capabilities are transferable, and alternative complements remain available. Path dependence begins only when the consequences of previous choices feed back into subsequent choice conditions. An organization that trains employees around one architecture, accumulates data in one technical format, attracts complements optimized for one stack, or adjusts governance around one ecosystem may gradually change the comparative attractiveness of technologies that were originally viable alternatives. What matters is not simply that the components are connected; the theoretical question is whether those connections progressively alter later option value.

Complement Availability Uncertainty

Complement uncertainty concerns more than whether a needed input will exist. In interdependent systems, organizations may face uncertainty about which complements will emerge, whether they will remain compatible, which actors will supply them, whether they will achieve sufficient adoption, and whether their providers will continue participating. Firms operating under poor ecosystem visibility therefore make strategic moves before the future configuration of partners and complementary activities is fully known [12]. Because ecosystem elements are interconnected, uncertainty can propagate across linked activities rather than remaining confined to a single component [13].

The consequences emerge through coordination. Platform diffusion and ecosystem formation can depend on social coordination processes that bring otherwise dispersed actors into compatible patterns of participation [14]. Ecosystem architects may also alter their strategies as an ecosystem moves from emergence toward later development [15]. A complement regarded as peripheral at the moment of commitment can consequently become central, while a complement expected to stabilize the focal trajectory may fail to materialize, be delayed, or migrate toward a rival architecture.

Organizations respond to such uncertainty partly through inference. Complementors can interpret visible investments by a platform owner as costly signals about the platform's expected direction, using those signals to guide their own entry or withdrawal decisions [16]. This mechanism is important for trajectory theory because expectations can become self-reinforcing even before the uncertain future is resolved. Early investment can attract complements, growing complement availability can increase the perceived value of continued commitment, and that continued commitment can further strengthen the ecosystem supporting the initial path. Yet complementarity also creates interdependence costs. Research on business ecosystems shows that firms can face a value-creation trade-off in which stronger complementarities generate opportunities while simultaneously increasing exposure to other actors [17].

Complementary assets therefore modify the meaning of technological attractiveness. Empirical work on open innovation shows that complementary assets condition the value that organizations obtain from innovation strategies [18]. A technically promising portfolio branch can remain strategically weak when the organization lacks access to complementary manufacturing, distribution, data, capabilities, or ecosystem support. Conversely, a technology of only moderate intrinsic superiority can acquire an increasingly favorable strategic position once complementary resources accumulate around it.

The transition from uncertain complement conditions to path dependence occurs when those conditions begin to alter the feasibility of later redirection. A temporary complement shortage need not produce lock-in if substitutes remain accessible. The same shortage becomes path-relevant when coping responses—specialized integration, exclusive partnerships, proprietary data conversion, capability investment, or governance commitments—make the selected branch progressively easier to continue and competing branches progressively more expensive to recover.

This distinction is summarized in **Table 1.**

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Table 1. Complement-state transitions that convert portfolio interdependence into asymmetric reversibility

Complement condition at commitment	How uncertainty enters the portfolio	Likely effect on later option value	Switching-cost asymmetry that can emerge	Path-dependence interpretation
Broadly available and substitutable complements	Uncertainty concerns price, quality, or provider selection more than basic availability	Alternative technology branches remain comparatively reachable	Low asymmetry where interfaces and capabilities remain transferable	Interdependence may remain strategically important without becoming strongly path dependent
Complement emergence is delayed but observable	The organization must decide whether to wait, stage commitment, or build provisional substitutes	Waiting preserves alternatives; premature specialization can reduce them	Asymmetry increases when temporary workarounds become architecture-specific	Early coping choices can become reinforcing even before complement uncertainty is resolved
Complements are concentrated among ecosystem-specific actors	Availability depends on a limited set of partners, standards, or governance arrangements	Commitment increases the value of ecosystem-specific relationships while weakening outside alternatives	Relationship-specific investment and integration effort make exit more costly than continuation	Dependence becomes path relevant when accumulated relationships change the relative feasibility of other branches
Competing complement ecosystems develop unevenly	Rival technological paths receive different rates of complementary investment and participation	Relative option value changes after the initial portfolio decision	The branch receiving stronger complement accumulation becomes easier to deepen while neglected branches become costly to reactivate	Reinforcement can arise from ecosystem development as well as internal organizational investment
A previously expected complement is withdrawn, restricted, or reconfigured	Uncertainty materializes after commitment	Existing commitments can either intensify dependence or create pressure for redirection	Switching costs depend on retained modularity, alternative relationships, transferable knowledge, and remaining migration options	A potential critical juncture arises; persistence is path dependent only if prior commitments materially constrain the feasible response

Taken together, complement uncertainty becomes trajectory-forming when early portfolio choices influence which future complements can be accessed, interpreted, substituted, or rebuilt. **Figure 1** represents that branching logic while retaining the possibility that an organization can preserve or recover alternative paths rather than inevitably entering lock-in.

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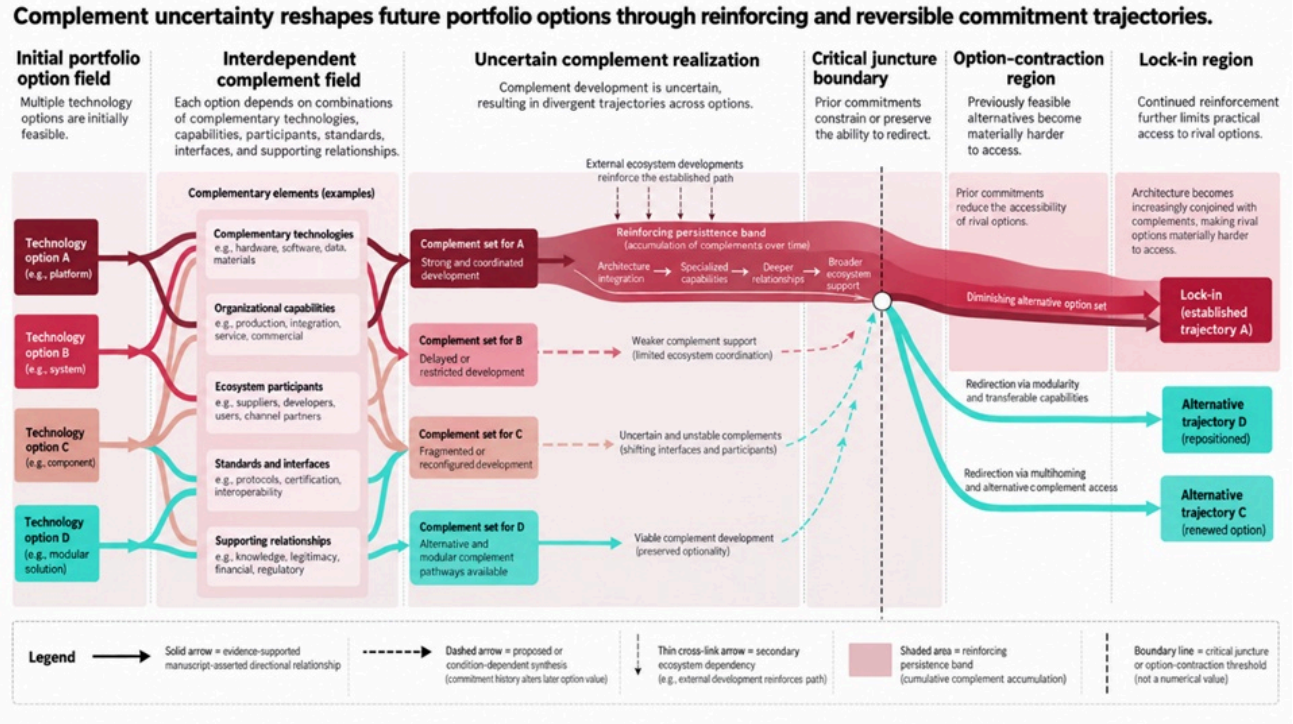

Figure 1. Complement uncertainty reshapes future portfolio options through reinforcing and reversible commitment trajectories

Unequal Switching Costs

Complement uncertainty becomes more consequential once portfolio branches differ in reversibility. Switching costs are unequal when moving away from one technology requires materially different sacrifices from moving away from another. Those sacrifices may involve technical reintegration, data migration, retraining, contractual obligations, customer migration, loss of ecosystem standing, re-establishment of complementary relationships, or abandonment of specialized knowledge. Platform research provides useful evidence because multihoming makes alternative participation observable. Governance design can influence whether complementors participate across multiple platforms, thereby affecting the preservation of outside options [19]. Historical evidence on homing likewise shows that participation structures interact with competitive entry rather than remaining fixed [20].

Unequal switching costs also arise from market and governance conditions. Formal analysis of platform ecosystems demonstrates that user preferences can alter strategic interactions among platform actors [21]. Qualitative evidence further shows that power relationships in software ecosystems evolve through patterns of dependence between platform owners and complementors [22]. These mechanisms should remain analytically distinct. Market-side switching difficulty concerns the economic attractiveness of moving customers or demand; governance dependence concerns whether another actor can affect access conditions; technical switching costs concern migration of systems or capabilities. They can reinforce one another, but none should be used as a proxy for the others.

The path-dependent problem appears when asymmetry grows as a consequence of the organization's own preceding commitments. A firm may initially retain several usable alternatives, then concentrate developer expertise, integration routines, data structures, or complementary relationships around one architecture. Continued participation can itself follow different engagement trajectories rather than a stable level of dependence [23]. Governance interventions can also modify the use of alternatives: evidence from platform awards shows changes in complementor behavior, including

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greater multihoming among award winners in the studied setting [24]. Reversibility is therefore capable of moving in both directions.

For trajectory theory, the key distinction is between high switching cost and endogenously escalating switching asymmetry. A technology can be expensive to replace from the outset without being path dependent. Path dependence requires that preceding choices help create or magnify the later asymmetry. The analytical question becomes historical and counterfactual: would the rival branch have remained similarly difficult to reach if the earlier portfolio commitments had been different? If the answer is no because the organization allowed alternatives to decay while reinforcing one path, switching asymmetry becomes part of the self-reinforcing mechanism.

Competing Innovation Trajectories

Unequal switching costs would be easier to manage if alternative technologies remained static while an organization accumulated commitment. In practice, rival technological trajectories continue to change. Research on incumbent adaptation demonstrates substantial heterogeneity in responses to technological change, reflecting differences in capabilities, cognition, incentives, and organizational conditions [25]. Complementary-asset discontinuities further require adaptation across resources, demand, and ecosystem relationships rather than a single technological dimension [26]. The value of waiting, persisting, or switching can therefore change because both the focal path and its alternatives are moving.

Trajectory competition also interacts with prior technological experience. Evidence from China's wind-power industry shows that technological path dependence can condition how policy influences exploratory and exploitative innovation [27]. The broader implication is that past capability development and knowledge accumulation can alter how organizations respond to new technological opportunities. Yet path-based organizing does not imply permanent lock-in. A path-centric account of emerging technology emphasizes that the same process perspective can explain both stabilization and transformation [28].

This possibility is essential for distinguishing this account from a deterministic switching-cost account. A competing trajectory may initially be weaker because it lacks complementary assets or organizational familiarity, then become strategically superior as its ecosystem develops. Continued commitment to the incumbent branch can remain rational if the old trajectory still dominates after all relevant costs are considered. Path-dependent persistence arises when earlier commitments have changed the comparison itself—for example, because capabilities supporting the alternative have atrophied, ecosystem relationships have become one-sided, or compatibility decisions have made migration progressively more difficult.

Critical junctures occur when changing external conditions reopen the comparison among trajectories. Comparative research on organizational path transformation suggests that breaking an established lock-in and creating a new reinforcing path are separate tasks [29]. Redirection therefore cannot be equated with abandonment. Organizations may exit one technology yet fail to construct a viable replacement trajectory. Successful redirection requires sufficient resources, knowledge, complements, and organizational legitimacy to make another branch capable of sustaining continued development.

The resulting portfolio problem is dynamic. A commitment made when two technological branches had similar future potential may become difficult to reverse precisely because the organization helped one path mature internally while allowing the other to become organizationally unfamiliar. Conversely, a rival ecosystem can advance rapidly enough that maintaining the incumbent path becomes progressively more expensive despite accumulated switching costs. Trajectory theory must therefore accommodate both reinforcement and reversal: past commitment matters, but its consequences depend on how competing paths evolve.

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Commitment Timing and Reversibility

Commitment timing determines how much uncertainty is resolved before an organization sacrifices alternatives. Some technology investments can be staged, expanded after favorable information, or abandoned when conditions deteriorate. Real-options reasoning offers a well-established explanation for such behavior in innovation portfolios. Multi-informant evidence shows that strategic and cultural context affects the use and consequences of real-options reasoning in innovation-portfolio management [30]. This provides an important rival explanation for observed persistence. A firm that postpones irreversible commitment, maintains experiments, or continues funding several technologies may simply be managing uncertainty rationally rather than exhibiting path dependence.

The distinction matters because option preservation can itself alter later trajectories. Waiting is not neutral when ecosystems develop through participation. Deferring commitment may preserve financial flexibility while sacrificing early access to complementary partners, standards, data, learning, or reputation. Early commitment may secure such benefits but expose the organization to escalating dependence. Timing decisions therefore influence not only when uncertainty is resolved but also the mechanisms through which the organization participates in producing the future environment it will later face.

Reversibility is consequently better treated as a portfolio capability with multiple sources. Technical modularity can reduce reintegration costs; multihoming can preserve live ecosystem alternatives; internal expertise can prevent complete knowledge erosion; contractual design can limit relationship-specific exposure; and external connections can keep otherwise declining technological knowledge accessible. Evidence on knowledge path dependence shows that external connections can alter the consequences of established knowledge trajectories for radical invention [31]. Although that evidence concerns knowledge development rather than technology-portfolio switching directly, it supports a cautious theoretical proposition: preserving meaningful external connections can prevent an internal trajectory from becoming the organization's only cognitively or technically feasible path.

Timing also changes the meaning of commitment. Early investment is potentially advantageous where complements are likely to coalesce around first movers or where learning accumulates through participation. The same early investment becomes dangerous when the organization converts uncertainty into architecture-specific obligations before the comparative direction of rival trajectories is sufficiently observable. Late commitment can preserve choice but may sacrifice ecosystem position. Reversibility therefore cannot be maximized independently of strategic opportunity; preserving every option indefinitely may itself destroy value.

The theoretical task is to identify when commitment crosses from deliberate exposure into self-reinforcing trajectory formation. That transition occurs when previous decisions begin to affect the cost, legitimacy, knowledge base, complement access, or organizational feasibility of subsequent alternatives. Before that point, an organization may still be choosing among paths. After it, the organization is increasingly choosing from within a path whose own history has altered the menu of feasible choices. The Portfolio Commitment Framework developed in the next section integrates this timing problem with complement uncertainty, unequal switching costs, and competing innovation trajectories.

The timing analysis implies that reversibility depends on how commitment changes while uncertainty is being resolved, rather than on a single adoption decision.

Table 2 presents commitment states that preserve, consume, or reconstruct reversibility across an evolving technology portfolio.

Table 2. Commitment states that preserve, consume, or reconstruct reversibility across an evolving technology portfolio

Commitment state	Information condition	Portfolio action	Relationship with complements	Effect on later reversibility	Trajectory-theory interpretation

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Exploratory exposure	Major technological and complement uncertainties remain unresolved	Maintain several technically meaningful experiments or connections	Complement relationships remain shallow and transferable	Alternative branches remain practically usable	Pre-path state in which historical choice has not yet substantially altered the feasible set
Staged commitment	Evidence begins to differentiate trajectories but remains incomplete	Increase investment while retaining migration interfaces, external knowledge, or parallel options	Selected complements deepen without complete exclusivity	Some options become costlier but remain recoverable	Early trajectory formation with deliberate option preservation
Asymmetric deepening	One branch accumulates stronger ecosystem, capability, and integration support	Concentrate resources around the increasingly attractive trajectory	Relationships and technical routines become architecture-specific	Reversal becomes materially more expensive than continuation	Potential self-reinforcement if previous commitment causes the asymmetry
Reinforced continuation	Portfolio history strongly conditions current capabilities and complement access	Continue investing within the established branch	Supporting relationships reproduce the incumbent configuration	Previously credible alternatives contract or become organizationally inaccessible	Path-dependent persistence where history has changed the feasible choice set
Redirected commitment	Disruption or rival-trajectory improvement reopens strategic comparison	Reallocate resources while building a replacement complement configuration	Old relationships are unwound while new ones are deliberately reinforced	Reversibility is reconstructed rather than merely exercised	Path transformation requires both weakening the old reinforcement and establishing a viable new trajectory

Portfolio Commitment Framework

The portfolio commitment account developed here integrates interdependence, complement uncertainty, switching asymmetry, trajectory competition, and reversibility without assuming that any one mechanism is sufficient. Platform research illustrates why this integration matters. Generativity can create value by enabling distributed innovation while simultaneously generating tension over control and coordination [32]. Selective promotion of complements can further alter which ecosystem participants receive visibility, resources, or strategic support [33]. The opportunity structure surrounding a technology is therefore partly produced by ecosystem decisions rather than fixed when the focal organization first commits.

The central theoretical mechanism is endogenous option-value change. At an initial decision point, several technological branches may be viable. Commitment to one branch creates learning, integration, complementary relationships, data structures, routines, and expectations. When those developments make continued investment in the selected branch more productive while simultaneously increasing the cost of maintaining or recovering alternatives, the portfolio begins to

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reinforce its own trajectory. Path dependence is present only where this recursive mechanism can be identified. Large sunk costs, technical superiority, or dependence on an important supplier are insufficient by themselves.

The framework also permits directional reversals. A platform owner's threatened entry may cause complementors to redirect innovation rather than simply cease innovating [34]. Actual owner entry can likewise produce outcomes contrary to a simple crowding-out prediction: in the Google Photos setting, affected complementors increased major product updates [35]. These findings show why ecosystem dependence cannot be translated mechanically into deeper lock-in. External actions can reinforce a portfolio path, destabilize it, redirect innovative effort, or make an alternative trajectory newly attractive.

Portfolio commitment therefore develops through conditional transitions. Reinforcement is most likely where accumulated investment improves the selected branch, complements increasingly organize around it, and alternatives lose usable capabilities or ecosystem connections. Redirection becomes more plausible where modular interfaces, multihoming, transferable knowledge, outside relationships, or retained experimentation keep rival branches alive. A critical juncture occurs when changes in technological or ecosystem conditions materially alter the relative viability of those branches. The theoretical outcome depends on what options previous commitments have preserved by the time that juncture arrives.

Strategic Propositions

The preceding synthesis yields propositions intended to discriminate path dependence from superficially similar persistence. Where uncertain complement availability and interdependence jointly intensify around an established branch, earlier commitment should increasingly influence later portfolio value because complement support and organizational specialization develop together [16, 17].

Proposition 1. Technology-portfolio persistence is more likely to become path dependent when early commitment increases access to branch-specific complements while simultaneously reducing the practical accessibility of competing technological alternatives.

High switching cost alone does not satisfy this condition. Genuine path dependence requires a reinforcing process through which prior choices alter later alternatives [1].

Proposition 2. Unequal switching costs should strengthen path-dependent persistence only when the asymmetry itself increases through preceding commitment rather than remaining a fixed characteristic of the technologies being compared.

A third proposition concerns redirection. Path transformation requires more than dissatisfaction with the incumbent technology. Evidence on path transformation indicates that breaking an established reinforcement pattern and constructing a replacement path are analytically distinct [28, 29].

Proposition 3. Portfolio redirection is more likely to succeed when organizations retain or reconstruct external technological, knowledge, and complement connections capable of supporting a replacement trajectory.

External connectivity is therefore relevant because it can moderate the restrictive consequences of established knowledge paths [31]. The proposed implication is not that external connections guarantee escape; they preserve resources from which an alternative trajectory may be rebuilt.

The propositions create observable distinctions between trajectory mechanisms and rival explanations, as summarized in **Table 3.**

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Table 3. Discriminating implications of the portfolio commitment propositions

Proposition-based pattern	Observation consistent with path dependence	Rival explanation requiring separation	Observation that would weaken the proposition	Strategic implication
Complement reinforcement around an early branch	Later continuation reflects complement and capability accumulation produced partly by earlier commitment	Current technological superiority	Alternatives remain fully accessible and would still be rejected after removing accumulated commitment effects	Monitor whether commitment changes alternatives, not only whether the chosen technology performs well
Increasing switching asymmetry	Migration becomes progressively harder because knowledge, interfaces, relationships, or governance arrangements specialize around one branch	High but static switching cost	Switching difficulty is equally high at the beginning and does not increase with portfolio history	Distinguish inherited structural cost from commitment-generated constraint
Alternative-path preservation	Multihoming, modularity, experimentation, or external connections keep rival branches practically usable	Indecision or inefficient duplication	Preserved alternatives provide no credible basis for later redirection	Evaluate option preservation by its ability to maintain actionable alternatives
Critical-juncture redirection	A disruption weakens incumbent reinforcement while resources are mobilized around another viable trajectory	Simple abandonment	The incumbent path is terminated but no replacement path acquires sustained support	Treat redirection as construction of a new reinforcing trajectory
Persistence after external change	The organization remains on the incumbent branch because previous commitment has narrowed feasible alternatives	Rational response to continuing superiority	The incumbent remains superior even when historical switching and capability effects are removed conceptually	Avoid classifying persistence as lock-in without a historical counterfactual

Discussion and Managerial Implications

The analysis changes the managerial question from “Which technology should be selected?” to “How will today's selection alter tomorrow's alternatives?” Real-options reasoning already demonstrates the value of preserving flexibility in innovation portfolios [30]. The path-dependence perspective adds that flexibility itself can erode endogenously. Managers therefore need to monitor whether integration choices, training investments, data architectures, contractual relationships, and ecosystem participation are progressively reducing the organization's ability to use alternatives.

Governance matters because practical reversibility depends on more than technical migration. Multihoming possibilities, power relationships, and complementor engagement can jointly determine whether an alternative remains strategically usable [19, 22, 23]. Preserving reversibility can consequently require maintaining external relationships, interoperability, transferable expertise, or limited parallel participation even when the incumbent trajectory currently performs well.

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Redirection should likewise be treated as a process of path construction. Transformation becomes credible when organizations both weaken reinforcing dependence on the incumbent configuration and mobilize resources behind a replacement trajectory [28]. Comparative evidence indicates that these tasks can fail separately [29]. Managers confronting a deteriorating technology path should therefore evaluate whether an alternative possesses sufficient complements, capabilities, internal legitimacy, and ecosystem support to become self-sustaining after the switch.

These implications remain conditional. Strong commitment can be strategically beneficial where complementary accumulation improves coordination and learning faster than it restricts valuable alternatives. The managerial risk arises when the organization interprets performance generated by accumulated path-specific support as proof that competing trajectories are intrinsically inferior. Historical commitment can influence both the observed success of the incumbent branch and the apparent weakness of alternatives.

Figure 2 separates the conditions under which continued commitment is consistent with genuine path dependence from circumstances better explained by rational continuation, static switching costs, or recoverable strategic flexibility.

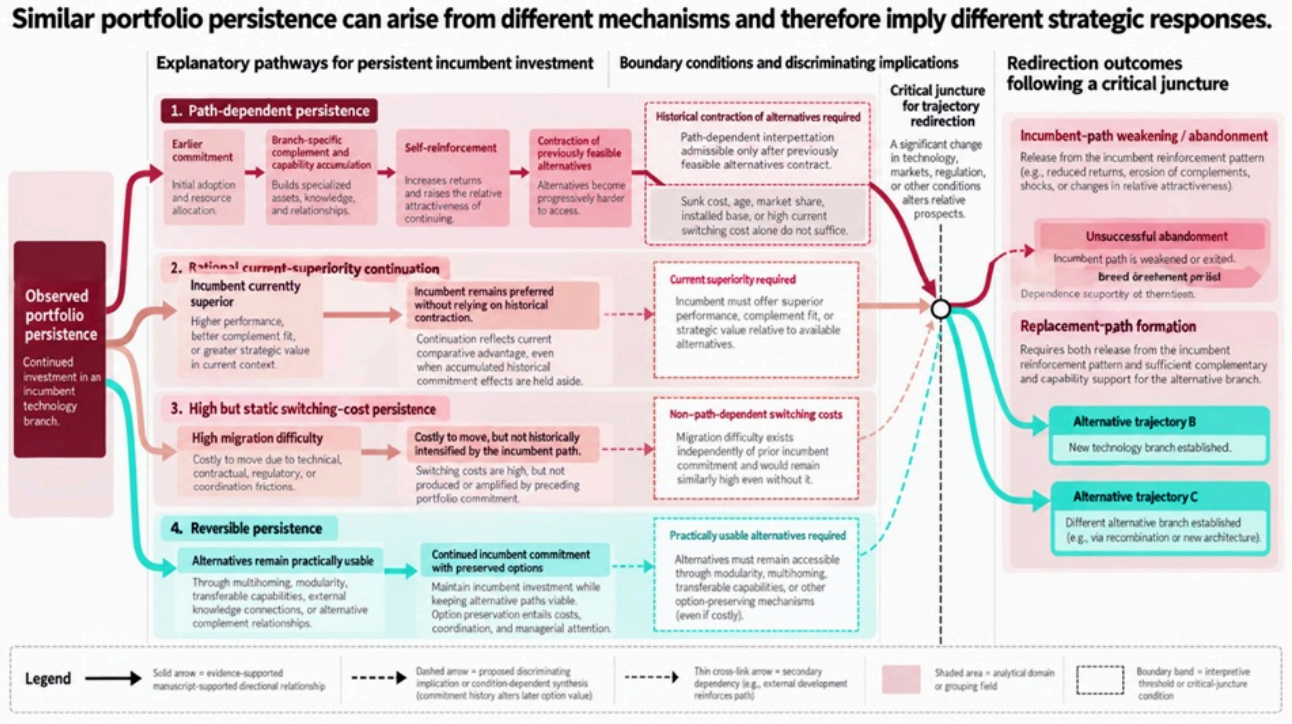

Figure 2. Similar portfolio persistence can arise from different mechanisms and therefore imply different strategic responses

Future Research

Future research should test path dependence with longitudinal designs capable of observing changes in the feasible alternative set rather than inferring lock-in from persistence alone. Studies of digital business-model evolution and ecosystem dynamics demonstrate the value of tracing configurations across time [4, 10]. Suitable designs should identify an initial option set, observe commitment and complement accumulation, and determine whether alternatives subsequently disappear because of self-reinforcement or because their underlying technological value declines independently.

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A second priority is direct comparison among lock-in, path transformation, and preserved alternatives [28, 29, 31]. Research could examine matched organizations facing similar technological discontinuities but differing in modularity, multihoming, retained expertise, or external knowledge connections. Such comparisons would clarify whether option-preserving practices delay commitment inefficiently or provide genuine strategic insurance.

Future studies should also investigate critical junctures prospectively. The strongest evidence would show not merely that organizations changed technologies after disruption, but how their previous portfolio choices affected which responses remained feasible when the disruption occurred. This would allow trajectory theory to generate falsifiable predictions about when commitment history matters and when current technological economics provides a sufficient explanation.

Conclusion

Strategic commitment in interdependent technology portfolios becomes path dependent when early choices recursively change later choices. Complement availability matters because portfolio value is produced through relationships and capabilities that can accumulate unevenly around competing technologies. Switching costs matter when their asymmetry grows through prior commitment. Competing trajectories matter because the alternatives being surrendered or preserved continue to evolve after the initial decision.

This account does not imply that strong commitment inevitably produces lock-in. Organizations can preserve meaningful alternatives through modularity, transferable capabilities, multihoming, external connections, and staged commitment, while disruptions can create critical junctures at which established paths are redirected. Nor does continued commitment establish path dependence by itself. Persistence may remain entirely consistent with rational choice when the incumbent technology continues to dominate independently of its history.

The central theoretical implication is therefore conditional: commitment becomes trajectory-forming when prior portfolio choices alter the future comparative value and practical accessibility of technological alternatives through self-reinforcing interdependencies. Strategic reversibility depends not simply on whether an organization can leave its current technology, but on whether it has preserved or can reconstruct a viable path to somewhere else.

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