Systems Development Ambidexterity: Explaining the Complementary and Substitutive Roles of Formal and Informal Controls

AMRIT TIWANA

Amrit Tiwana is an Associate Professor at the University of Georgia's Terry College of Business. He previously served on the faculty of Emory University and held the Union Pacific Professorship at Iowa State University. His research on systems development and information technology governance has appeared in *Information Systems Research, Strategic Management Journal, Decision Sciences Journal, Journal of Management Information Systems, ACM Transactions on Software Engineering & Methodologies, California Management Review, IEEE Transactions on Engineering Management,* and other journals. He currently serves as an associate editor at *Information Systems Research,* where he received the journal's outstanding associate editor award in 2009, and has also served as a special associate editor at *MIS Quarterly.* He serves on the editorial boards of *Journal of Management Information Systems* and *IEEE Transactions on Engineering Management.*

Abstract: Although formal and informal control mechanisms are often simultaneously used to govern systems development projects, considerable disagreement exists about whether the use of one strengthens or diminishes the benefits of the other. In other words, are they complements or substitutes? Competing theoretical perspectives favor both sides of the argument, and neither the information systems (IS) controls literature nor the information technology (IT) outsourcing literature has addressed this issue. This study theoretically develops the idea that these competing perspectives are mutually compatible rather than contradictory because informal and formal control mechanisms can simultaneously be complements *and* substitutes. Using data from 120 outsourced systems development projects, it is shown that informal control mechanisms strengthen the influence of formal behavior control mechanisms on systems development ambidexterity (complementary effects) but weaken the influence of formal outcome control mechanisms (substitutive effects). The key contribution of the paper therefore lies in exploring interactions among control mechanisms in a project's control portfolio to reconcile the competing theoretical perspectives on whether formal and informal controls are complements or substitutes. The findings provide managers guidance on how to carefully combine formal and informal control mechanisms in a project. Combining informal with formal process-based control mechanisms can simultaneously enhance the fulfillment of project goals and development flexibility. However, combining informal with formal outcome-based control mechanisms can instead impair these objectives.

Journal of Management Information Systems / Fall 2010, Vol. 27, No. 2, pp. 87–126.

0742–1222 / 2010 $9.50 + 0.00.
DOI 10.2753/MIS0742-1222270203

Key words and phrases: ambidexterity, control mechanisms, interaction effects, outsourcing, project governance, signaling, software project control, systems development.

Organizations that outsource systems development often use a variety of formal and informal control mechanisms to align vendors' interests with their own. Such mechanisms are intended to ensure that systems development progresses along a project plan that leads to the fulfillment of the client's project objectives. In short, control mechanisms are intended to enhance alignment in outsourced systems development. However, changing user needs, evolving client priorities, and competitive pressures can introduce new requirements in the midst of development [51, 68, 90]. Accommodating them requires flexibility in the systems development process, which can be at odds with the intent of control—adherence to a predefined project plan [90]. The need for such flexibility is strongly emphasized by proponents of agile software development methods [42]. In other words, systems development projects must simultaneously exhibit alignment with client needs and adaptiveness to evolving client requirements. This ability to be simultaneously aligned and adaptive is what Gibson and Birkinshaw [30] call *ambidexterity.*

Clients, under a "more control is better" presumption, often hedge their bets by simultaneously using formal and informal control mechanisms to govern outsourced systems development. The absence of previously asserted links between control and systems development performance found in Tiwana and Keil's [90] recent study brings this assertion into question, and it also raises an important but neglected question about the consequences of combining formal and informal control mechanisms *within* the same project control portfolio. In other words, do formal control mechanisms amplify or attenuate the benefit of simultaneously using informal control mechanisms? Or, more broadly, are formal and informal control mechanisms complements or substitutes?

The simple but powerful notion of complements and substitutes formally originated in economics [60] and has been widely invoked for theory development in prior information systems (IS) [9, 86] and management literature [4, 82, 94]. Two things are complements if more of one increases the benefits of using the other. They are substitutes if more of one diminishes the benefits of using the other. In the present context, if formal and informal control mechanisms are complements, then using more of one should increase the benefits of using more of the other. If they are substitutes, then using more of one should decrease the benefits of using more of the other.

This issue of how formal and informal control mechanisms interact within a single project ("portfolio-level interactions") remains neglected despite the simultaneous prevalence of both. Neither the IS controls literature (focused primarily on explaining the choice of control mechanisms [16, 46, 62, 80] and to a lesser extent their effect on performance [40, 90]) nor the information technology (IT) outsourcing literature (focused on outsourcing decisions and the effect of interfirm processes [49, 53, 84, 88]) has attempted to address this question. This is problematic in practice because when managers use both formal and informal control mechanisms without understanding how they interact, they will diminish each other's benefits if they act as substitutes.

The question about whether informal control mechanisms strengthen or weaken the benefits of formal control mechanisms is muddied further by two theoretical perspectives in prior research that take opposing positions. Transaction cost economics (TCE) and relational governance perspectives view formal and informal controls as substitutes, an assertion that subsequent empirical tests have failed to support. The controls literature also implicitly takes the substitutes position by emphasizing that formal and informal controls are appropriate under different circumstances [23, 65]. A competing interfirm adaptation perspective takes the opposite position, which asserts complementarities and suggests that they are "not simply substitutes" [14]. These contradicting positions led Anderson and Dekker [1] to surmise that the complementarities and substitution effects among different forms of control remain theoretically underdeveloped. This paper addresses this research gap, guided by the following research question:

> *RQ: Do informal control mechanisms increase (complement) or decrease (substitute) the benefits of formal control mechanisms in enhancing systems development ambidexterity in outsourced projects?*

The discussion begins by emphasizing that appreciating the nuanced, multiple roles of formal and informal control mechanisms requires thinking of performance in terms of systems development ambidexterity. Systems development ambidexterity, which conceptually builds on Gibson and Birkinshaw's [30] notion of ambidexterity, refers to the capacity to *simultaneously* exhibit alignment with the client's needs and adaptiveness to changes in those needs in systems development activities. The key here is that both alignment and adaptiveness must be simultaneously achieved for the systems development process to be characterized as ambidextrous. Here the emphasis is that the notion of systems development ambidexterity is a useful complement to—not a replacement for—the classical efficiency and effectiveness measures of systems development performance. (It is subsequently shown that greater ambidexterity enhances both systems development efficiency and effectiveness.)

The idea is developed that formal and informal control mechanisms simultaneously act as complements *and* substitutes. Here *complements* means that the simultaneous use of an informal control mechanism strengthens the benefits of a formal control mechanism; *substitutes* means that the simultaneous use of an informal control weakens the benefits of a formal control mechanism. The paper explains how informal control mechanisms will complement a specific type of formal control mechanism when it facilitates acquiring *reliable* information needed to enforce that type of formal control.

Tests using data from 120 outsourced projects demonstrate that while informal control mechanisms complement formal behavior control mechanisms, they have a substitutive relationship with formal outcome control mechanisms. Thus, this study shows that the competing complementarities and substitution perspectives among formal and informal control mechanisms are mutually compatible, not contradictory. The theoretical reconciliation of the complementarities and substitution between formal and informal control mechanisms therefore forms the central contribution of this paper.

The paper first reviews the competing theoretical perspectives in prior research, isolates the theoretical root of this contradiction, and develops hypotheses that reconcile these competing views by proposing that formal and informal control mechanisms are both complements and substitutes. Then the methodology and analyses are described. The paper closes with research implications and contributions of our findings.

Theory and Hypothesis Development

Control in Outsourced Systems Development Projects

Control refers to how the actions by the vendor are governed in a manner that furthers the interests of the client [16].[1] Control over the vendor (the controllee) is implemented by the client (the controller) through a variety of concurrently used formal and informal control mechanisms that collectively constitute a project's control portfolio. Formal control mechanisms can take two forms: (1) *outcome control,* which refers to the prespecification by the client of desired final and intermediate vendor outputs without regard to how they are achieved, and (2) *behavior control,* which refers to the client explicitly prescribing methods, procedures, and techniques to the vendor for accomplishing project activities [64]. The key form of informal control is clan (or social) control, which refers to control through the promulgation of common values, beliefs, and shared goals between the client and vendor and through identifying and reinforcing norms of acceptable behavior [16, 65]. Therefore, clan control relies on the values and beliefs shared by the client and vendor to align their interests and objectives in the context of a project. Formal control mechanisms therefore rely on information and informal control mechanisms rely on a system of shared norms, values, and goals that encourage desirable behaviors.

Although the IS literature explicitly recognizes vendor-driven self-control as another informal control mechanism [47], it was not included in this study for three reasons. First, because it is vendor-driven rather than client-driven, unlike other control mechanisms, it is analogous to noncontrol [16, 17]. Second, it is less widely recognized in the broader controls literature, especially in interfirm settings [67, 91]. Third, a study by Choudhury and Sabherwal [16] found it to be conspicuously absent in outsourced IT projects (this study's context). Recent empirical work has also confirmed that it is likely to be used to a much greater degree in internal projects than in outsourced projects [90]. Therefore, the focus in this study is on the more broadly accepted form of informal control—that is, clan control.

A Summary of Contradictory Theoretical Perspectives in Prior Research

Prior theory and empirical research is contradictory about whether formal control mechanisms complement, substitute, or operate independently of informal control mechanisms within a control portfolio. Proponents of two competing theoretical perspectives favor opposite types of control strategies and agree that their preferred choice leaves little room for the other. For example, the TCE perspective advocates formal control, emphasizing that explicit contractual safeguards are necessary to align the divergent objectives of clients and vendors in interfirm outsourcing [1, 93, 95]. In contrast, the relational governance perspective—grounded in sociopsychology—advocates trust-based informal control mechanisms as a less costly, self-enforcing alternative to formal control mechanisms [21, 33, 36, 59, 92]. Proponents of this perspective argue that informal controls constrain opportunism while offering greater flexibility and lower implementation costs vis-à-vis formal control mechanisms. Therefore, both TCE and relational governance perspectives view formal and informal control mechanisms as substitutes—an assertion that subsequent empirical tests have failed to confirm (e.g., [43]). Such substitution is also implicitly asserted in the organizational controls literature, where formal and informal control mechanisms are deemed appropriate under different circumstances [23, 65].

Paradoxically, the limited empirical research on this issue contradicts the substitution argument [56, 61, 74]. In a thought-provoking synthesis of these perspectives, Poppo and Zenger [74] empirically demonstrate that contract-driven formal controls *complement* informal controls, contrary to the frequent assertion of TCE and relational contracting theorists. (It should be noted that they arrived at this conclusion by testing the relationship between the two mechanisms rather than the effect of their interaction term on performance.) They argue that formal and informal relational control mechanisms overcome each other's inherent limitations, promoting cooperation while protecting both parties and in turn amplifying their mutual benefits. This perspective is consistent with the implicit assertion in the IS project control literature that formal and informal control mechanisms serve different roles [16, 47]. More recently, Das and Teng [17] observed that formal control and trust-based control are not linked by a "strictly complementary relationship," suggesting that their relationship might be more complex than previously assumed. Recent empirical work similarly suggests that formal and informal control mechanisms are "not simply substitutes," because each has specific advantages and disadvantages [14]. However, the theoretical details of such relative merits remain neglected, leading Anderson and Dekker [1] to surmise that the complementarities and substitution effects among different forms of control remain theoretically underdeveloped. These bodies of work have not directly addressed portfolio-level interactions, where both formal and informal control mechanisms are simultaneously used in a project's control portfolio.

The present paper contends that such apparent contradictions in the literature arise from three sources. First, empirical work on the complements–substitutes issue has rarely distinguished—perhaps unwittingly—between different *types* of formal control; that is, control that is based on evaluating outputs on predetermined criteria (outcome control) versus control over the processes through which a vendor achieves them (behavior control). As Das and Teng [17] lament, the diverse formulations of control have led scholars to simultaneously refer to an organizational setup, a process of regulating behaviors, and an outcome. For example, several empirical studies have combined outcome and behavior control into a unidimensional conceptualization of formal, contract-based control [56, 61, 74]. This is surprising because the IS project control literature has long distinguished among different forms of control, both theoretically and empirically [16, 46].

Second, prior work has viewed trust and cooperation as being isomorphic with informal control (e.g., [12, 56, 74]). However, trust itself is not a control mechanism [17]; a client can trust the vendor yet not rely on informal control mechanisms to govern a particular project.

Finally, while the broader alliances literature recognizes the simultaneous need for alignment of partners' activities and the need for interfirm adaptation, it has implicitly treated them as trade-offs rather than a necessary tension. Therefore, the substitutes (e.g., TCE and relational contracting) and the complements perspectives invoke—without directly incorporating—the alignment-adaptiveness tensions associated with formal and informal control mechanisms.

Recognizing their simultaneity—or shifting from an either/or view to a both/and perspective [85]—can potentially yield new insights. Conceptualizing performance in a manner that considers alignment and adaptation metrics simultaneously would therefore be more consistent with both the IS project control and broader interfirm control literatures, which have invoked both the need for client–vendor alignment and adaptation during the development process. This underappreciated dual role of control mechanisms is discussed next.

Recognizing the Dual Role of Control Mechanisms in Systems Development

The role of controls in facilitating alignment of vendor activities with client objectives is explicitly recognized, whereas their role in facilitating adaptation in systems development projects is pervasive but implicit in prior research. For example, Henderson and Lee [40] have shown that formal controls are associated with project efficiency and effectiveness. Similarly, Tiwana and Keil [90] have recently shown how different controls differ in their impact on performance in internal and outsourced projects. However, besides alignment, both the interfirm governance literature [16, 17, 44, 50] and the TCE and relational contracting perspectives (e.g., [52, 95]) implicitly recognize the need for adaptiveness to correct misalignments with evolving client imperatives. While this simultaneous need for alignment and adaptation is pervasive in theorizing about interfirm control mechanisms [56], few empirical studies have directly and simultaneously assessed both facets. Similarly, the requirements analysis literature has also emphasized the need for software projects to meet requirements that are representative of actual user needs [58], which themselves might evolve over the course of systems development. Inattention to flexibility in the systems development process is also an explicitly recognized theoretical gap in the IS controls literature [90]. Systems development ambidexterity is therefore a theoretically useful representation of software development performance, which is subsequently demonstrated in this paper as also being associated with classical efficiency and effectiveness measures of performance.

Following Gibson and Birkinshaw [30], *systems development ambidexterity* is defined as the capacity to simultaneously exhibit alignment and adaptiveness in project activities. *Alignment* is defined as the degree to which the work of the vendor fulfills the project objectives (e.g., the client's requirements, outsourcing objectives, and quality expectations). *Adaptiveness* is defined as the degree to which the vendor is able to rapidly reconfigure its project activities to correct misalignments with evolving project objectives. The need for such adaptiveness can arise from changes in the needs of the client, refinement of project requirements, and technological or environmental changes.

Systems development ambidexterity is therefore a multidimensional construct, with alignment and adaptiveness constituting "separate, but interrelated, nonsubstitutable" elements [30]. In other words, greater alignment cannot substitute for lack of adaptiveness, or vice versa. Recent intrafirm empirical studies have shown—and are confirmed here in an interfirm outsourcing context—that ambidexterity is an important predictor of traditional measures of performance (e.g., meeting cost, schedule, and performance targets) [30, 39]. Our conceptualization of outsourcing performance in terms of systems development ambidexterity aligns well with the spirit of Sundaramurthy and Lewis's [85] recommendation for adopting a "both/and" rather than an "either/or" perspective for managing governance paradoxes by recognizing the simultaneous need for alignment and adaptiveness. This perspective therefore emphasizes creating a context in which alignment and adaptiveness can simultaneously flourish. It also faithfully captures the underlying intent of interfirm control—that is, the actual attainment of partnership goals [14, 17, 21, 44].

To be effective, the deployed formal control mechanisms must be effectively enforced [16, 89, 90]. For formal control mechanisms to be effective sanctioning devices, deviations from the prespecified goals and prescribed processes must be *accurately verifiable* [14, 66]. As Das and Teng [17] caution, organizations do not achieve effective control simply by implementing control mechanisms. Drawing on the recent theoretical distinction between attempted and realized control introduced by Tiwana and Keil [90], they argue that it is not the extent to which control is attempted but rather the extent to which it is realized that affects systems development outcomes. (They define attempted control as the degree to which a controller implements a specific control mechanism in an attempt to influence controllee behavior and realized control as the degree to which the controller is able to successfully exercise it during the systems development process.) Enforcing/realizing both forms of formal control—which are information based [23, 65, 90]—requires *different types* of information to evaluate the vendor's compliance with the criteria set by the outcome and behavior control mechanisms. In this study, information required for enforcing either type of formal control is referred to as the "evaluation information" associated with it. Tiwana and Keil [90], building on Ouchi's work, refer to this as the informational requirements for realizing any form of attempted formal control. Carson et al. [14] describe the difficulty of reliably acquiring such evaluation information as the "metering" problem, which remains largely neglected in the literature [18]. Formal control can therefore be viewed as control through information; the client interprets evaluation information to appraise the vendor's accomplishment of the prespecified goals (for outcome controls) or compliance with the prescribed methods and procedures (for behavior controls) and then imposes the corresponding penalties/rewards. Informal control mechanisms, unlike formal control mechanisms, rely on social underpinnings (e.g., client–vendor trust, and shared values and beliefs) rather than information [65].

Conceptual Underpinnings of Complementarities and Substitution

The notion of complements and substitutes formally originated in economics [60] and has been widely invoked for theory development in prior IS [9, 86] and management studies [4, 82, 94]. Complementarities exist between two things when doing more of one thing increases the returns from doing more of another [60]. Substitution effects exist when doing more of one thing decreases the returns from doing more of another [60]. From a statistical testing standpoint, complements are characterized by a positive interaction effect and represent the conceptual opposite of substitutes, which are characterized by a negative interaction effect [74, 82]. In the context of our study, a significant positive interaction effect between informal control and a given type of formal control would suggest that they are complements and a negative one would suggest that they are substitutes.

From a theory development perspective, complementarities and substitution effects between formal and informal (clan) control mechanisms can be predicted by considering the effect of clan control mechanisms on the cost of acquiring information needed to enforce either type of formal control. Informal control mechanisms, logically, can increase, decrease, or simply have no effect on acquiring reliable evaluation information for a specific type of formal control mechanism. The central thesis of our theory development is the following: clan controls will complement a specific type of formal control when they facilitate acquiring *reliable* evaluation information needed to enforce that type of formal control. The two types of formal control have different informational requirements for enforcing them, and therefore interact with informal control in different ways. Table 1 summarizes the forthcoming theoretical logic for the interactions of informal clan control with the two forms of formal control. This logic, which expands the notion of information requirements of formal control in Tiwana and Keil [90], is next developed in detail separately for both outcome and behavior control mechanisms.

Outcome Control and Clan Control as Substitutes

Outcome control mechanisms prespecify what the vendor should accomplish in a project. They establish the evaluation criteria by which the outputs of the vendor will be judged (e.g., milestones, delivery timetables, and budgets). This establishes accountability for the vendor's intermediate outputs (deliverables at predetermined milestones) and final outputs (e.g., budget, deadlines, and quality of the finished

Table 1. Summary of Theoretical Logic for Interactions of Formal with Informal Control Mechanisms

	Formal control mechanism	
	Outcome control	Behavior control
Emphasis	What the vendor produces.	How the vendor produces it.
Evaluation question	Did the vendor meet the budget and schedule targets for final and intermediate project deliverables that were predefined by the client?	Did the vendor closely follow the systems development methods and procedures that the client recommended?
Negative signaling effects on the vendor resulting from the use of that formal control mechanism	Yes.	Yes.
Evaluation information needed to enforce it	Information about the timeliness and costs of the vendor's final and intermediate outputs.	Information about adherence to client-prescribed methods and procedures by the vendor.
How evaluation information is obtained by the client	*Objectively;* inspection of vendor outputs by client to assess how well they meet the objective metrics and targets prespecified by the client.	At least partially *vendor-self-reported* information about the methods and procedures followed by the vendor.
Informal clan control's role in reliably acquiring such evaluation information	*Little to none;* can be objectively assessed independent of clan control by comparing the timeliness, costs, and completeness of vendor outputs to predefined targets.	*Increases evaluation information reliability.* Socialization associated with clan control can foster bilateral cooperation and trust that can counter the negative signaling from using behavior control mechanisms; interaction associated with behavior control mechanisms can foster socialized acceptance of shared goals that are conducive to clan control. This decreases the likelihood that the vendor will misrepresent or withhold self-reported information about noncompliance with prescribed methods and procedures.
Relationship with clan control (statistical test)	Substitutive (negative interaction effect)	Complementary (positive interaction effect)

system). Enforcing outcome controls requires evaluation of information about vendor outputs—that is, judging whether the vendor outputs meet the prespecified goals (e.g., satisfying project requirements, budget, and deadlines). The evaluation information that is required to enforce outcome controls is reflected directly in the intermediate and final work delivered to the client by the vendor [90]. In other words, the evaluation information is directly discernible from vendor outputs. Examples include timeliness and cost compliance of the key deliverables. Since such evaluation criteria are clearly established at the outset, the vendor has limited discretion in interpreting or adjusting them. Such ex ante, objective metrics can by themselves induce the vendor to behave in ways that increase compliance with those metrics, which are the same ones that increase fit with the project's objectives. Furthermore, assuming that the client set the appropriate targets for the vendor, outcome control mechanisms create a strong extrinsic incentive and goal orientation that motivates the vendor to rapidly correct any misalignments with the client's needs. This reasoning is consistent with Kirsch and her colleagues' [46, 48] findings that greater outcome measurability is associated with greater use of outcome control mechanisms. In summary, the evaluation information needed to enforce outcome controls can objectively and reliably be acquired by the client directly from the vendor's outputs, without having to rely on clan control and independent of the degree to which clan control is used.

Although outcome control does not depend on clan control for acquiring reliable evaluation information needed to enforce it, the presence of outcome control can create a context that can be less conducive to clan control. The alliances literature has observed that the use of outcome control mechanisms can be perceived as a signal that the vendor is not deemed trustworthy enough to behave appropriately without such controls [17, 85]. Such negative signaling might be unintentional on the client's part because performance clauses are standard practice in outsourcing contracts and are intended to safeguard against opportunism. Nevertheless, a client's attempt to use clan control mechanisms under such conditions can send conflicting signals to the vendor, slowing the vendor's judgments about acceptable responses to new information, and overall impeding adaptation during the development process. Their mere use can blunt the value of social ties and impede the development of trust, undermining the effectiveness of clan control mechanisms [44]. It also raises the apprehension that some cooperative, well-intentioned acts of the vendor might incorrectly be sanctioned by the client as opportunistic, reducing vendor incentives to contribute beyond the scope of preexisting contractual stipulations [14]. The presence of detailed formal contracts can even exacerbate vendor opportunism in actions that are not explicitly covered by the formal contract [11]. Outcome control mechanisms can therefore undermine the client's capacity to employ informal governance devices such as clan control [29].

Recall that the client's acquisition of reliable evaluation information needed to enforce outcome controls does not rely on the conditions associated with clan control. Such information can be objectively assessed from the cost and schedule compliance of the completed project deliverables. Even with minimal trust, a client can have sufficient confidence if adequate and usable performance metrics are in place [17]. Kirsch et al. [48] provide some implicit support for this logic in showing a positive association between the ability to measure outputs in systems development projects and greater use of outcome control mechanisms. Clan control mechanisms are therefore likely to be ineffective—even counterproductive—in the presence of outcome controls. In summary, outcome control mechanisms do not need or depend on clan control, and their mere presence can create conditions that can be nonconducive to clan control. We therefore expect a negative interaction (i.e., substitution) effect of outcome and clan control mechanisms on systems development ambidexterity:

Hypothesis 1: Greater use of clan control mechanisms weakens the extent to which outcome control mechanisms enhance systems development ambidexterity.

Behavior Control and Clan Control as Complements

Behavior control mechanisms specify how the vendor should accomplish the project objectives, that is, they define a set of rules, methods, and procedures that the client expects the vendor to follow [65]. Enforcing behavior controls requires evaluation of vendor behavior, that is, how well the vendor, during the development process, adhered to the methods and procedures prescribed by the client. The evaluation information requirements for enforcing behavior control therefore differ from those of outcome control in one important way—they depend on information about the vendor's adherence to the methods and procedures prescribed by the client.

In internal projects, greater behavior observability is therefore associated with greater use of behavior control mechanisms [46, 90]. Because the client and vendor represent two distinct organizations in outsourced projects, there are usually no preexisting reporting relationships or natural conduits for acquiring such evaluation information or for readily observing vendor behavior [16, 90]. Therefore, evaluation information is typically obtained through direct monitoring and vendor self-reports (e.g., weekly progress reports, periodic meetings, conference calls, and ongoing documentation of work processes) [16]. Because the sanctioning mechanisms of behavior control rely heavily on monitoring vendor behavior [64], their effectiveness is tied directly to the reliability of such evaluation information. Unlike outcome controls, such evaluation information is not directly discernible from vendor outputs and depends, at least to some extent, on vendor self-reporting. Specification of behavior control mechanisms, by itself, cannot guarantee the reliability, integrity, and timeliness of the pertinent evaluation information from the vendor.

This is usually problematic in outsourced systems development because the weaker formal authority and organizational separation make it difficult for the client to cost-effectively monitor the vendor's compliance with the prescribed methods and procedures [16, 19, 76, 89]. Low observability due to geographical dispersion, coordination overhead, and loss of communication richness can further exacerbate such monitoring challenges [90]. Furthermore, the mere use of behavior control—such as for outcome control—can signal that the client does not trust the vendor's ability to accomplish the systems development activities without its guidance. Therefore, behavior control can also have a negative signaling effect about the vendor's perceived competence without readily providing the conditions conducive to honest information sharing necessary to enforce it. The vendor might therefore withhold critical information from the client, particularly about noncompliance with prescribed methods and procedures, due to apprehension of reprisal.

Because it is almost impossible to monitor every detail of vendor activities [17], the client relies to a large degree on the accurate self-reporting of evaluation information by the vendor. Agency theory would suggest that such self-reporting would increase the likelihood that the vendor (the agent) will act in ways that fit its own best interests, even if they conflict with the client's interests [7]. For example, the vendor might selectively communicate, conceal, or manipulate information that makes the vendor look bad in terms of the process control system [75, 98]. The difficulty of verification by the client lowers the risk of the vendor being caught engaging in such opportunism, which can encourage vendor employees to present inaccurate or invalid data about the completed processes or withhold relevant information that conflicts with scoring well on the behavior control system [34, 75].

Clan control, when used in conjunction with behavior control, provides an environment that is more conducive to acquiring reliable evaluation information that is needed to make behavior control work more effectively. Clan control mechanisms can enhance the reliability of the evaluation information that the client acquires from the vendor for enforcing behavior controls for two reasons. First, confidence in vendor cooperation is essential for effective behavior control but is by no means automatic [17]. Because trust is a basic social prerequisite for clan control, the deployment of clan control mechanisms signals that the client has confidence in and trusts the vendor to some degree [5, 31, 65]. This signals that the client holds a positive attitude toward the goodwill and reliability of the vendor [17]. This can mitigate or counteract some of the perceived negative signaling by the imposition of behavior controls. When the vendor realizes that the client has given the vendor considerable benefit of doubt in trusting the vendor, the vendor is more likely to be motivated to act in a cooperative manner [11, 17]. This creates conditions conducive to honest and open information sharing by the vendor [21, 44], which increases the likelihood that the client will receive accurate and reliable evaluation information pertaining to behavior controls. The presence of trust signaled by clan control mechanisms also encourages the firms to openly discuss and mutually agree upon any procedural adaptations and refinements that might become apparent after project activities have begun. It also lowers the need for the client to attempt to constantly verify information reported by the vendor, which can otherwise impede interfirm adaptation. In that sense, clan control fosters bilateralism [74].

Second, interfirm interaction during the process of exchanging behavior control evaluation information can foster social relations and strengthen the socialized acceptance of shared values and beliefs, in turn developing conditions that are more conducive to effective clan control [16]. This can reinforce vendor employees' beliefs that they are playing an integral role in collective goal achievement, mitigate some of the potential untrustworthiness-signaling effects of behavior control, and make the vendor less hostile toward the behavior control system [75]. Overall, this will increase the vendor's sense of ownership and commitment to following the prescribed methods and procedures. Thus, the use of clan control mechanisms in conjunction with behavior control mechanisms can lessen the tendency of the process control system to induce manipulative and dishonest behaviors. Therefore, greater use of clan control mechanisms enhances the effect of behavior control mechanisms on systems development ambidexterity, and vice versa. We therefore expect a positive interaction effect (i.e., complementarity) of behavior control mechanisms and clan control mechanisms on systems development ambidexterity:

> *Hypothesis 2: Greater use of clan control mechanisms strengthens the extent to which behavior control mechanisms enhance systems development ambidexterity.*

Methodology

Data Collection

THE HYPOTHESES WERE TESTED USING DATA COLLECTED through a field study of 120 outsourced IT application development projects in 120 firms conducted in 2006 in which a vendor developed a custom software application to solve an idiosyncratic client business problem. Such arrangements are widely used to access specialized technical capabilities in software development, where both formal and informal governance strategies are common. Further, they are characterized by high asset specificity because the software application is custom developed to meet the idiosyncratic needs of a particular client. We attempted to collect data from two informants: (1) the lead project manager in the vendor firm and (2) a client firm manager responsible for the project, complemented by archival secondary data. The objective was to increase the robustness of the findings and to mitigate the threat of common methods bias.

The sample was drawn from the entire membership base of the National Association of Software Services Companies, a consortium of Indian IT services firms with a significant U.S. clientele. The chief executive officer/president of all 719 member firms that specifically listed software services outsourcing as their specialty was approached to identify the lead project manager for a project outsourced by a U.S. company. Of these, 69 firms declined to participate for a variety of reasons (e.g., no U.S. clients, changes in business model, or unwillingness to participate) and an additional 23 firms were unreachable. Of the remaining 627 firms, 120 responded (19.1 percent response rate). Following this phase, dependent variable assessments were requested from the client-side manager for these 120 projects. Nineteen of these requests were refused. Thirty responses were obtained, for a 29.7 percent (30/101) response rate. The sole purpose of collecting these matched responses was to assess common methods bias, as described later. The client firms represented a diverse variety of industries, including financial services (18 percent), manufacturing (15 percent), retail (5 percent), and other industries. All vendor firms specialized in custom software development, so objective data for all firm-level control variables were collected from the Indian consortium's records. The consistent use of Indian vendors and U.S. clients in the sample mitigates the potential confounding effects of other variables (e.g., sociocultural distance) that are not included in the model.

We followed Armstrong and Overton's [2] procedure of comparing the early (first 25 percent) and late (last 25 percent) respondents on all key independent variables. t-tests on all independent variables (outcome control, $t = 0.070$; behavior control, $t = -0.343$; clan control, $t = 0.524$, all nonsignificant [ns]) and project characteristics (such as project duration, team size, project scope, client–vendor history, contract structure type, multinational vendor origin) comparing the early (first 30) and late (last 30) respondents showed no significant differences, providing assurance against nonresponse bias. Even though this analysis revealed no significant differences, caution is warranted because we were not able to directly compare data from respondents and nonrespondents.

Construct Measures

Existing scales were adapted to the study's context (the items appear in the Appendix). The scales for the principal theoretical constructs in the study were multi-item, seven-point Likert scales operationalized at the unit of analysis of the theoretical model, which was the outsourced project. The study focused on the outsourced project as the unit of analysis, recognizing that the governance structure used in a specific project does not necessarily mirror the broader interfirm governance structure [28]. Several control variables were based on objective, archival records. Gibson and Birkinshaw's [30] approach was adopted for measuring systems development ambidexterity as the multiplicative term of alignment and adaptiveness, which they characterize as the two interrelated, nonsubstitutable dimensions of ambidexterity (which they examined at the organizational unit level rather than the project level). Alignment was measured using four items adapted from Faraj and Sproull [25] to assess the extent to which the outsourced project development process was effective in successfully fulfilling the client's project needs, quality expectations, functional requirements, and project objectives. Adaptiveness was measured using four items to assess the extent to which it was possible to incorporate new requirements and design changes in response to changing client needs during each of the major project stages—requirements analysis, high-level design, detailed design, development, and coding [97]. Kirsch et al.'s [48] scales for outcome, behavior, and clan control were used with minor adaptations. The control variables and their sources are described in the next section. The construct measures exhibited discriminant validity verified through exploratory factor analysis of all the items for all the independent and dependent variables in the model as shown in the Appendix. One item from Kirsch et al.'s scale for outcome control (client's emphasis on meeting project requirements) was deleted in the scale purification process due to high cross-loadings. The remaining items (including one item that loaded slightly below Nunnally's [63] recommended threshold of 0.6) have been used in several prior studies in the work of Kirsch and her colleagues and were retained to maintain the theoretical coverage of their original measure. As the Appendix shows, the pattern of item to construct loadings and cross-loadings is acceptable, and the extracted factors had eigenvalues ≥ 1. The measures also had adequate reliability, which is indicated by scale alphas ranging from 0.63 to 0.9. Construct correlations, means, standard deviations, and alphas are summarized in Table 2.

Control Variables

Control variables of four different types were included in the model to account for alternative explanations: (1) partnership characteristics (client–vendor ties, client–vendor collaborative history, project scope, duration, contract structure, and the knowledge that the two firms had of the other's domain), (2) project characteristics (such as software platform), (3) firm effects (vendor capability maturity level, age, scale, and national origin), and (4) industry effects that can potentially explain systems development ambidexterity independent of our model. These were used to rule out four overarching types of rival explanations for systems development ambidexterity independent of the formal and informal control mechanisms in our model.

Partnership characteristics were used to rule out the rival explanation that clients and vendors with close ties, a long-standing history, greater knowledge of each other's domains, and with time-and-materials contracts (as opposed to fixed price contracts) are more likely to exhibit greater project ambidexterity independent of the formal and informal control mechanisms that our model focuses on. Project characteristics were included to account for the possibility that certain project characteristics such as project scope, length, and software platform could explain ambidexterity in systems development independent of the explanatory variables in our model. Similarly, firm effects account for other plausible rival explanations that vendors might exhibit greater systems development ambidexterity because of greater capability maturity, greater scale of operations, veteran presence in the software industry, and multinational backgrounds rather than the key explanatory variables in our model. Finally, whether the client is in the services, retail, or manufacturing industry could also account for differences in systems development ambidexterity. Next, each of the 13 control variables in each of these four broad types of rival explanations is discussed in detail.

Close client–vendor ties are conducive to higher performance [13, 70]; therefore, *client–vendor ties* was controlled for. Hansen's [38] three-item scale was adapted to assess the extent to which the overall working relationship between the client and vendor was characterized by regular interactions, frequent communication, and close working relationships. Similarly, a client and vendor with a history of collaboration are likely to better align project activities; therefore, a dummy variable was included for interfirm *relationship history* [69]. *Project scope* was also controlled for because projects with atypically larger scope (e.g., greater size, complexity, or person-months of development effort) can lower vendor effectiveness [3, 78, 96]. This roughly corresponds to the notion of project complexity in the Scandinavian dynamic model of requirements analysis [58]. Three items adapted from Barki et al. [8] were used to assess the project relative to others previously completed by the vendor on person-months of development work, project duration, and dollar budget (anchors: "much smaller"

Table 2. Construct Correlation Matrix and Descriptive Statistics

Construct	Mean	SD	α	1	2	3	4	5	6	7	8	9
				Construct correlations								
1. Systems development ambidexterity	33.03	8.45	[a]	—								
2. Client–vendor ties	6.17	0.71	0.85	0.49***	—							
3. Partnership history+	—	—	—	–0.01	0.08	—						
4. Project scope	4.13	1.43	0.89	0.18	0.12	0.08	—					
5. Project duration	11.14	8.85	—	–0.03	–0.10	0.15	0.26*	—				
6. Contract type+	—	—	—	0.02	0.00	–0.04	–0.22*	–0.37***	—			
7. Client technical knowledge	4.49	1.31	0.90	0.10	0.18	0.09	0.09	0.18	–0.19	—		
8. Vendor domain knowledge	4.91	1.34	0.89	0.16	0.26*	0.18	0.05	–0.01	–0.11	0.28**	—	
9. Platform: mainframe+	—	—	—	–0.17	0.05	–0.08	0.01	–0.16	0.13	–0.06	0.12	—
10. Platform: Unix+	—	—	—	–0.15	–0.03	–0.16	0.08	–0.14	0.01	0.13	0.13	0.22*
11. Platform: Web+	—	—	—	0.04	0.23*	0.06	0.05	0.12	–0.10	–0.02	–0.12	–0.01
12. Vendor CMM level	0.99	1.87	—	–0.23*	–0.06	–0.02	–0.15	–0.16	–0.02	–0.10	–0.05	–0.11
13. Vendor age	10.0	6.56	—	0.00	0.14	0.06	–0.30	–0.28**	0.19	–0.11	–0.01	–0.20
14. Vendor employee count	600	2,175	—	0.02	0.09	0.15	–0.02	–0.09	0.09	–0.06	0.00	–0.06
15. Indian+	—	—	—	0.23*	0.00	–0.17	–0.06	–0.09	0.17	–0.18	0.09	–0.04
16. Industry: financial services+	—	—	—	–0.01	0.12	0.12	–0.04	0.11	0.05	0.05	–0.06	–0.11
17. Industry: manufacturing+	—	—	—	0.02	–0.07	–0.22*	0.01	–0.12	0.08	–0.06	0.13	–0.09
18. Industry: retail+	—	—	—	0.22*	0.12	–0.01	–0.28**	–0.15	0.15	–0.08	–0.10	–0.05
19. Project goal codifiability	5.28	1.20	0.83	0.14	0.17	0.11	0.00	–0.09	0.22*	0.07	0.32***	0.08
20. Outcome control	6.01	0.72	0.63	0.42***	0.56***	0.05	–0.01	–0.13	–0.01	0.05	0.37***	0.00
21. Behavior control	5.70	1.05	0.87	0.37***	0.40***	–0.07	–0.01	0.08	–0.21*	0.27**	0.46***	0.09
22. Clan control	5.28	1.23	0.85	–0.01	0.30**	0.26**	0.18	0.23*	–0.02	0.19	0.01	–0.07

Construct	10	11	12	13	14	15	16	17	18	19	20	21
1. Systems development ambidexterity												
2. Client–vendor ties												
3. Partnership history+												
4. Project scope												
5. Project duration												
6. Contract type+												
7. Client technical knowledge												
8. Vendor domain knowledge												
9. Platform: mainframe+												
10. Platform: Unix+	—											
11. Platform: Web+	–0.34***	—										
12. Vendor CMM level	0.28**	0.02	—									
13. Vendor age	0.04	0.15	0.29**	—								
14. Vendor employee count	–0.07	0.27**	0.39***	0.24*	—							
15. Indian+	0.09	–0.17	–0.09	0.14	0.06	—						
16. Industry: financial services+	–0.02	–0.01	0.20	0.09	–0.01	0.05	—					
17. Industry: manufacturing+	0.23*	–0.08	0.17	0.24*	–0.08	0.08	–0.22*	—				
18. Industry: retail+	–0.14	–0.06	–0.13	0.00	–0.06	0.15	–0.13	–0.11	—			
19. Project goal codifiability	–0.18	0.07	–0.13	–0.09	0.02	0.01	0.01	–0.16	0.03	—		
20. Outcome control	–0.04	0.19	–0.04	0.15	0.09	–0.05	–0.10	–0.02	0.06	0.28**	—	
21. Behavior control	0.17	–0.07	–0.10	0.11	0.04	0.00	0.00	0.19	–0.01	0.04	0.33***	—
22. Clan control	–0.10	0.27	–0.21*	–0.05	–0.16	–0.22*	0.00	–0.12	–0.02	0.24*	0.23*	0.18

Notes: [a] Scale alpha for the alignment dimension of ambidexterity was 0.89 and adaptiveness was 0.85. * $p < 0.05$, ** $p < 0.01$, two-tailed test; + dummy variable; $n = 120$ projects.

and "much larger"). Effective software outsourcing requires the client to clearly and precisely communicate project requirements to the vendor at the outset of the project [20, 35, 41, 54, 72]; therefore, *project goal codifiability* was controlled for. This roughly corresponds to the outcome measurability construct in the IS project control literature [48]. Three items adapted from Hansen [38] were used to assess the extent to which the client's project requirements could easily be documented, explained to the vendor firm in writing, and communicated formally (e.g., via documents, requirements, code comments, and manuals). Also included was a control for *project duration* (measured in months), recognizing that longer projects are more prone to resource overruns [24]. Time-and-materials contracts—unlike fixed price contracts—do not penalize vendor firms for changes in client requirements [32], thereby facilitating adaptation. Therefore, a dummy variable for *contract type* (one for fixed price contract and zero for time-and-materials contracts) was included. The *client's technical knowledge* (i.e., knowledge about software design and development) can influence his or her ability to govern the outsourced project [89]. This roughly corresponds to *client knowledge of the transformation process* in the IS project control literature [48]. Five items from Tiwana and Keil [89] (anchors: "not at all" and "to a great extent") were used to tap into the client's understanding of system architectures, programming languages, detailed technical design, application development tools, and software development methodologies at the outset in the context of the outsourced project. Similarly, the vendor's understanding of the client's industry and business domain *(vendor domain knowledge)* can influence how effectively the vendor firm accomplishes project objectives [24]. Such domain knowledge is also recognized as an important input in the systems development process in the Scandinavian view of systems development (see [26]). This measure used four items to assess the vendor's understanding of the client firm's business rules and heuristics, business processes, day-to-day business routines, and a holistic understanding of the client's business at the outset of the project. The *software platform* on which the software is coded can also influence whether the vendor incurs a learning curve or can exploit existing economies of scale [24]. To account for this, four dummy variables were included to distinguish between *Windows, mainframe, Unix,* and *Web* platforms. The omitted category was *other*. Windows was subsequently dropped from the model due to a variance inflation factor of 5.06, which slightly exceeded the acceptable cutoff of 5.

In addition, firm effects and industry effects were controlled for to parcel out variance from such sources. We controlled for vendor capability maturity level *(CMM level),* which is a proxy for vendor project management capability [32]; *vendor firm age* (computed as 2006 year of founding); and a dummy for whether the vendor was an indigenous *Indian* firm or a joint venture or subsidiary of a foreign firm. To account for industry effects (e.g., technical and institutional variations across industry types, discussed in Lamb and Kling [51, p. 213]), three dummy variables used by Ethiraj et al. [24] for client industry—*financial services, manufacturing,* and *retail* (omitting *other*)—were included. As Table 2 shows, all multi-item control variables exhibited acceptable psychometric properties.

Descriptive Statistics

The primary respondents in the sample were highly experienced, as suggested by their average IT experience of 12.3 years (standard deviation [SD] 6.68). On average, 56.1 percent of the vendor firms in the study had previously collaborated on a different project with the client. The sample represented a diverse array of vendor capabilities, as suggested by their capability maturity model (CMM) levels. Approximately 72 percent of the vendor firms did not have CMM certifications; however, 11.7 percent had the highest possible CMM level of 5. Approximately half of the firms were also ISO 9001 certified. Seventy-three percent of the vendor firms were indigenous Indian firms, whereas the remaining were either joint ventures or subsidiaries of foreign firms. Twenty-six percent of the projects used a time-and-materials (variable price) contract and the remaining used a fixed price contract. The software platforms associated with the outsourced projects leaned toward Windows (46 percent), followed by the Web (32 percent) and Unix (19 percent). The average duration of the outsourced project was 12.8 months (SD 11.1) and the number of individuals assigned full-time to the project by the vendor averaged 25.8 (SD 49.5).

Analysis and Results

The analyses were conducted using a three-step hierarchical regression model. The control variables were introduced in step 1, followed by the main effects in step 2. The hypotheses were tested in step 3, where three interaction terms between outcome, behavior, and clan control were added to the model. Residual centering was used to reduce multicollinearity among the interaction terms and the main effects. This procedure corrects the problem of partial coefficient distortion encountered in the simultaneous analysis of main effects and interaction terms due to their correlation [45, p. 27]. The residual-centered terms, which can directly be interpreted as standardized product terms in the regression procedure, were used in the analyses.

Although the residual-centering procedure used for interaction effects regression models minimizes multicollinearity between main effects variables and interaction terms [45, p. 24], additional robustness tests were conducted to check for multicollinearity. The variance inflation factors (VIFs) are therefore also reported in the results in Table 3. VIFs are a regression diagnostic test for detecting multicollinearity problems [27, p. 11], to which models involving interaction effects can be particularly vulnerable. VIFs are akin to a ratio of “the strength of the signal relative to noise” in regression models [10, p. 191]. Both Belsley et al. [10, p. 93] and Hair et al. [37, p. 230] recommend using a cutoff of 10 for VIFs, suggesting that VIFs ≤ 10 indicate that multicollinearity is not a problem and those > 10 might be indicative of multicollinearity. Some researchers have recommended using a much more conservative cutoff of 5 instead of 10. All of the regression coefficients had VIFs below the 10 threshold. The highest VIF was 5.06 (i.e., ≥ 5 but ≤ 10) for a dummy control variable “Platform—Windows.” Therefore, this control variable was dropped from the final

Table 3. Effects of Interactions of Formal with Informal Control Mechanisms on Systems Development Ambidexterity

	Step 1 Control variables			Step 2 Main effects			Step 3 Interaction effects		
	β	*t*-value	VIF	β	*t*-value	VIF	β	*t*-value	VIF
Constant		–0.85			–1.97			–0.50	
Client–vendor ties	**0.47*** **	**3.72**	1.40	**0.35***	**2.65**	1.89	**0.31***	**2.37**	2.17
Relationship history	–0.04	–0.37	1.28	0.12	1.07	1.49	0.21	1.82	1.66
Project scope	0.17	1.32	1.41	**0.25***	**2.20**	1.47	**0.36****	**3.10**	1.65
Project duration	–0.04	–0.34	1.48	–0.03	–0.24	1.59	–0.06	–0.56	1.61
Contract type (fixed price = 1)	0.01	0.05	1.48	0.14	1.14	1.64	0.24	1.99	1.83
Client technical knowledge	0.03	0.28	1.31	0.06	0.55	1.34	0.07	0.60	1.51
Vendor domain knowledge	0.02	0.14	1.65	–0.23	–1.67	2.12	–0.24	–1.87	2.13
Platform—mainframe	–0.19	–1.58	1.32	**–0.24***	**–2.17**	1.39	–0.16	–1.43	1.50
Platform—Unix	–0.11	–0.81	1.64	–0.12	–0.94	1.70	–0.13	–1.06	1.78
Platform—Web	–0.07	–0.50	1.50	0.07	0.58	1.72	0.14	1.18	1.85
Vendor CMM level	–0.14	–0.96	1.82	–0.04	–0.32	1.98	–0.02	–0.17	2.12
Vendor age	–0.06	–0.46	1.63	–0.14	–1.13	1.70	–0.12	–0.99	1.72
Vendor employee count	0.05	0.38	1.52	–0.14	–1.08	1.80	–0.22	–1.73	2.02
Indian	0.19	1.54	1.32	**0.22***	**2.02**	1.38	**0.30****	**2.74**	1.46

Industry—financial services	–0.02	–0.15	1.34	–0.07	–0.59	1.43	–0.10	–0.94	1.49
Industry—manufacturing	0.08	0.60	1.47	–0.00	–0.001	1.59	–0.05	–0.44	1.65
Industry—retail	0.14	1.16	1.32	0.12	1.06	1.33	0.11	1.08	1.34
Project goal codifiability	0.03	0.27	1.40	0.10	0.87	1.49	0.10	0.87	1.66
Outcome control				0.19	1.54	1.71	0.01	0.02	2.43
Behavior control				**0.43****	**3.08**	2.14	**0.32***	**2.36**	2.35
Clan control				**–0.36****	**–2.86**	1.79	**–0.34****	**–2.76**	1.94
Outcome control × clan control							**–0.49****	**–2.71**	4.12
Behavior control × clan control							**0.30***	**2.03**	2.78
Outcome control × behavior control							0.11	0.82	2.42
R^2 (in percent)	**43.3***			**57.9****			**64.8*****		
(Model F)	**(2.12)**			**(3.08)**			**(3.38)**		
R^2_{Adj} (in percent)	**22.9**			**39.1**			**45.6**		
ΔR^2_{Adj} (in percent)	—			**16.2*****			**6.5****		
(F-change)				**(5.43)**			**(2.89)**		

Notes: Significant factors are shown in boldface. VIF = variance inflation factor; n = 120 projects. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; two-tailed test.

analysis, and doing so did not change the significance of the results in the main analysis or in the post hoc analyses. This ensured that all the final regression analyses for the main hypothesis tests as well as the post hoc tests met the more conservative cutoff of 5 for VIFs. This provides reasonable assurance against multicollinearity problems. The results of the hypothesis tests are summarized in Table 3.

The control variables (step 1) were in the expected direction and explained 22.9 percent of the variance in systems development ambidexterity. Several of the control variables were nonsignificant, possibly because they have previously not been used to predict systems development ambidexterity but only one of its underlying dimensions, or used together in a single model. Of the main effects in step 2, outcome control ($\beta = 0.19$, *t*-value 1.54, ns) was nonsignificant and behavior control ($\beta = 0.43$, *t*-value 3.08, $p < 0.01$) was positive and significant, suggesting that behavior control independently enhances systems development ambidexterity. The significant main effect of behavior control is consistent with Henderson and Lee's [40] results using classical efficiency and effectiveness measures in the context of internal systems development projects. The nonsignificant main effect of outcome control is consistent with the nonsignificant relationship with performance observed in outsourced projects in Tiwana and Keil's [90] recent empirical study. One interpretation for the nonsignificant main effect of outcome control is that performance clauses encompassed by outcome control are a common practice in outsourced project contracts, and one whose intent might be to safeguard against opportunism rather than to enhance performance per se. Furthermore, vendors might have an intrinsic disincentive to be opportunistic because it might wipe out opportunities for future contracts from that client. Because opportunistic behavior by the vendor was not measured in this study, confirming that idea will have to await future work. The main effect of clan control was negative and significant ($\beta = -0.36$, *t*-value –2.86, $p < 0.01$), suggesting that greater use of clan control, by itself, is associated with lower systems development ambidexterity. The main effects explained an additional 16.2 percent variance beyond the control variables. Note that the main effects cannot be interpreted in the presence of the interaction terms in step 3, where they represent conditional simple effects [45, p. 24]. Such interpretations about the main effects must be restricted to step 2 and not extend to step 3, where interaction effects are present in the model.

The addition of interaction effects of clan control with outcome control and behavior control in step 3 tests the substitutes (H1) and complements (H2) hypotheses. Recall from our earlier discussion that a positive interaction effect indicates that the interacting variables are complementary, whereas a negative interaction indicates that they are substitutes. In step 3, the interaction term between outcome control and clan control was negative and significant ($\beta = -0.49$, *t*-value –2.71, $p < 0.01$), supporting Hypothesis 1 (which proposed that they are substitutes). This interaction was explored further by testing the relationship between outcome control and systems development ambidexterity using a subsample where clan control values fell at least one standard deviation (1.23) below the mean (5.28) for clan control (i.e., ≤ 4.05). This statistically represents a "low" level for clan control. Consistent with our theorizing, the relationship between outcome control and ambidexterity in a regression run for this subsample was positive and significant (β = 0.52, *t*-statistic 2.51, $p < 0.01$). Therefore, outcome control appears to enhance ambidexterity as long as the client does not simultaneously attempt high levels of clan control. However, as the results show, the simultaneous use of both diminishes the potential benefits of both. The interaction term between behavior control and clan control was positive and significant (β = 0.30, *t*-value 2.03, $p < 0.05$), supporting Hypothesis 2 (which proposed that they are complements). The interaction terms accounted for a statistically significant increase in explained variance of 6.5 percent beyond the main effects.

Additional tests were also conducted to address Ping's [71] concern that when the quadratic terms of interacting predictors are not explicitly modeled, the significance tests of interaction terms can be less reliable. This concern has also been raised in the IS methodological literature by Carte and Russell [15]. We therefore followed Ping's [71] (also Carte and Russell's [15, p. 483]) recommendation to add the quadratic terms of the interacting variables to the model in step 3. A change in the significance of the hypothesis tests from this step to a subsequent one where quadratic values of outcome, behavior, and clan control (the interacting variable) are included in the model would indicate that the significance tests of the interaction terms are not reliable. Adding these terms did not change the statistical significance or direction of the hypothesized relationships supported in step 3. Both outcome control × clan control (β = –0.51, *t*-value –2.65, $p < 0.01$) and behavior control × clan control (β = 0.36, *t*-value 2.25, $p < 0.05$) remained significant, consistent with step 3 in Table 3. Further, the quadratic terms of outcome control (*t*-value 0.58), behavior control (*t*-value 0.88), and clan control (*t*-value 0.96) were nonsignificant with a nonsignificant increase of 0.5 percent in explained variance (*F*-change for $\Delta R^2_{Adj} = 1.12$). Therefore, the results are robust to the inclusion of quadratic terms, which are excluded because the objective here was not to identify the functional form of the relationships, and to safeguard against model overspecification [45, p. 65].

Additional post hoc analyses were conducted by separately examining the alignment and adaptiveness dimensions of systems development ambidexterity to further explore these relationships (see Table 4). The results provide additional insights into how different control mechanisms influence the underlying dimensions of systems development ambidexterity. Independent of interaction effects (step 1 in Table 4), behavior control was associated positively and significantly only with adaptiveness (β = 0.39, *t*-value 2.66, $p < 0.01$; two-tailed test). A noteworthy insight here is that behavior control influences the adaptiveness dimension of ambidexterity. This directly complements Tiwana and Keil's [90] study that did not find behavior control to influence classic performance measures and shows that the benefits of this control mechanism lie primarily in enhancing flexibility (which they did not capture). The lack of a relationship between outcome control and adaptiveness refines Carson et al.'s [14] recent observation that contract-based formal governance can be inflexible and not particularly adept at accommodating change. Clan control had a negative relationship with adaptiveness (β = –0.49, *t*-value –2.94, $p < 0.01$) and had no relationship with alignment. The interaction effects for alignment (step 2, Table 4) are remarkably consistent with overall systems development ambidexterity, and explained a significant

Table 4. Post Hoc Analyses of the Effects of Formal and Informal Control Mechanisms on the Two Underlying Dimensions of Systems Development Ambidexterity

	Alignment dimension				Adaptiveness dimension			
	Step 1 Main effects and control variables		Step 2 Interaction effects		Step 1 Main effects and control variables		Step 2 Interaction effects	
	β	*t*-value	β	*t*-value	β	*t*-value	β	*t*-value
Constant		2.91		3.86		–0.12		0.99
Client–vendor ties	**0.33***	**2.29**	**0.29***	**2.00**	**0.3***	**2.20**	0.25	1.72
Relationship history	–0.02	–0.16	0.05	0.36	0.19	1.59	**0.26***	**2.05**
Project scope	0.11	0.83	0.20	1.60	0.23	1.91	**0.32***	**2.55**
Project duration	–0.07	–0.50	–0.10	–0.77	–0.01	–0.03	–0.04	–0.29
Contract type (fixed price = 1)	0.00	0.01	0.11	0.79	0.18	1.40	**0.27***	**2.05**
Client technical knowledge	–0.06	–0.50	–0.01	–0.09	0.08	0.68	0.09	0.71
Vendor domain knowledge	0.01	0.08	0.01	0.05	–0.29	–1.96	**–0.29***	**–2.06**
Platform—mainframe	–0.14	–1.13	–0.06	–0.48	**–0.24***	**–2.04**	–0.17	–1.44
Platform—Unix	0.12	0.88	0.09	0.70	–0.19	–1.49	–0.21	–1.64
Platform—Web	–0.05	–0.36	0.04	0.32	0.12	0.91	0.17	1.25
Vendor CMM level	–0.12	–0.79	–0.07	–0.49	–0.01	–0.07	–0.01	–0.07
Vendor age	–0.01	–0.08	0.01	–0.01	–0.19	–1.50	–0.18	–1.38
Vendor employee count	0.03	0.25	–0.07	–0.48	–0.19	–1.38	–0.24	–1.69
Indian	0.07	0.53	0.15	1.28	**0.25***	**2.13**	0.31*	2.59

Industry—financial services	–0.07	–0.53	–0.12	–1.02	–0.04	–0.31	–0.06	–0.50
Industry—manufacturing	–0.01	–0.04	–0.07	–0.51	0.03	0.21	–0.02	–0.18
Industry—retail	0.05	0.41	0.04	0.36	0.11	0.94	0.11	0.97
Project goal codifiability	0.23	1.76	0.18	1.43	0.02	0.20	0.03	0.22
Outcome control	0.13	0.95	–0.05	–0.29	0.20	1.57	0.03	0.21
Behavior control	0.28	1.80	0.17	1.08	**0.39****	**2.66**	**0.32***	**2.13**
Clan control	–0.14	–0.97	–0.14	–1.00	**–0.39****	**–2.94**	**–0.36***	**–2.64**
Outcome control × clan control			**–0.49***	**–2.44**			**–0.43***	**–2.18**
Behavior control × clan control			**0.42***	**2.55**			0.21	1.27
Outcome control × behavior control			–0.04	–0.24			0.08	0.55
R^2 (in percent)	**47.2***		**56.2***		**53.1***		**57.8***	
(Model F)	**(1.99)**		**(2.35)**		**(2.53)**		**(2.51)**	
R^2_{Adj} (in percent)	**23.5**		**32.3**		**32.1**		**34.8**	
ΔR^2 (in percent)	—		**8.7****		—		2.7	
(F-change)			**(3.01)**				(1.66)	

Notes: Significant factors are shown in boldface. $n = 120$ projects. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; two-tailed test.

level of incremental variance in alignment. These post hoc results are discussed in detail in the next section.

The positive and significant main effect of behavior control (step 2 in Table 3) and its nonsignificant interaction effect with outcome control (step 3) support our assertion that they might play distinctive roles in the systems development process. Nevertheless, the post hoc analysis (Table 4) does not fully support the expectation that outcome control would enhance alignment and behavior control would enhance adaptiveness. The increase in explained variance in each step in the model was statistically significant, suggesting that the concurrent complementarities and substitution effects between formal and informal control mechanisms contribute significant explanatory power to how project control portfolios engender systems development ambidexterity. Thus, the two central hypotheses developed in this paper were strongly supported.

This study also empirically confirmed that systems development ambidexterity positively influenced classical effectiveness and efficiency measures of software development performance. Systems development ambidexterity was significantly and positively related to meeting the project clients' assessments of systems development effectiveness, that is, whether the development process was effective in successfully fulfilling the client's project objectives ($r = 0.409$; $p = 0.038 < 0.05$) and the client's quality expectations for the project ($r = 0.465$; $p = 0.017 < 0.05$) (as assessed by a manager in the client firm; $n = 30$). Further, systems development ambidexterity was also significantly and positively related to classical measures of systems development efficiency, including project completion on schedule ($r = 0.181$; $p = 0.032 < 0.05$) and within budget ($r = 0.297$; $p = 0.01$). Systems development ambidexterity is therefore associated with enhanced interfirm partnership performance, consistent with a similar finding in Gibson and Birkinshaw's [30] work in intrafirm settings. This suggests the theoretical usefulness of using systems development ambidexterity as a complement to—not a replacement for—classical performance measures used in the systems development literature.

Common Methods Bias Assessment

Four tests were conducted to assess the threat of common methods bias: Harman's one-factor test [73], Lindell and Whitney's [55] marker variable test, intraclass correlation [81] between client and vendor dependent variable evaluations, and pairwise correlation analysis [6]. First, we performed Harman's one-factor test, where the emergence of a single factor that accounts for a large proportion of the variance in factor analyses suggests a common methods bias [73]. A single factor did not emerge and the first factor accounted for 19.7 percent of the total 78.7 percent variance. Second, the marker variable test uses a theoretically unrelated "marker" variable to adjust the correlations among the principal constructs [55]. Any high correlation among any of the study's principal constructs and the marker variable would indicate common methods bias [57]. The test was separately repeated with two dummy marker variables theoretically unrelated to our principal constructs: (1) the count of vertical industry segments in which the controllee firm operated and (2) whether the project's software platform was

Microsoft Windows. The average correlation between this study's principal constructs for vertical segment count ($r = 0.003$, $t = 0.025$) and Windows ($r = -0.015$, $t = -0.084$) was low and nonsignificant, suggesting that common methods bias was not a problem. Third, client–vendor performance evaluations were cross-validated for the subsample for which matched pair data were collected. Because our attempt to collect matched pair performance data yielded only a 29.7 percent response rate ($n = 30$), the matched pair sample size was insufficient to directly rerun the model but sufficient to assess controller–controllee rater agreement using intraclass correlations. Shrout and Fleiss's [81] intraclass correlation coefficient (ICC) was used to measure consistency in the responses of client and vendor managers. The ICC value for the alignment dimension of systems development ambidexterity was 0.894 and the adaptiveness dimension of systems development ambidexterity was 0.879, suggesting high interrater agreement. Fourth, the pairwise correlation matrix (Table 2) did not indicate any exceptionally correlated variables. The highest correlation among the principal constructs is 0.42, which is below Bagozzi et al.'s [6] recommended 0.8 threshold. These four tests provide sufficient assurance that the results are not due to common methods variance. Given this, data from the primary respondents (project managers, $n = 120$) were used for the hypotheses tests.

Limitations

The results discussed in the next section should be interpreted with six limitations in mind. The cross-sectional design of the study precludes establishing causality or assessing the understudied dynamics of control. Future work using longitudinal or panel data should explore the dynamics of control, that is, how the use of specific control mechanisms changes as a project progresses through various stages of the systems development life cycle. It is theoretically possible that some forms of control are more heavily used in the earlier stages of a project and others in later stages (see [16]). Second, although both client and vendor firm knowledge were controlled for, the study did not control for collaborative know-how, which can also influence performance [83]. Third, consistent with the widely used classification of control mechanisms, outcome, behavior, and clan control were examined in the study [91]. However, the study did not include vendor-driven "self-control," which is less widely recognized in the broader controls literature and which some theorists view as being synonymous with noncontrol [16, 17]. Fourth, some of the control variables are proximate but not identical to explanatory variables in the IS project controls selection literature [16, 46, 48]. For example, we entirely failed to control for vendor behavior observability and used project goal codifiability as a proxy for outcome measurability and client technical knowledge as a proxy for client knowledge of the transformation process. Although none of these control variables have previously been established to explain systems development ambidexterity, this must be recognized as a limitation. Fifth, although the adjusted R^2 values take model complexity into account, the relatively small sample size of 120 projects must be recognized as another limitation in light of the complexity of the model. Although the use of regression models for testing interaction effects is commonly accepted, its limitations relative to structural equation modeling due to the exclusion of error terms for interactions described by Ping [71] should also be noted as a limitation. Finally, caution is warranted in generalizing the results given that the vendors in the study were Indian IT firms. However, because an increasingly large number of U.S. firms maintain offices and technical staff in India, the results are not likely to be entirely idiosyncratic to the sampling frame. However, this raises a promising question for future research: Does the cultural distance between the client and vendor influence whether formal and informal control mechanisms complement and substitute each other? Is the pattern observed in this study robust across cultural settings? It is plausible, for example, that the perception of distrust associated with outcome control mechanisms might be more pronounced in more collectivist cultures such as India and less so in more individualistic cultures. Similarly, clan control mechanisms might work better (i.e., a nonnegative main effect) when the client and vendor are less culturally distant.

Discussion

The central theoretical idea explored in this paper was that the seemingly contradictory TCE and relational contracting perspectives, which view formal and informal control mechanisms as substitutes, and the interfirm adaptation perspective, which views them as complements, are mutually compatible, once some critical subtleties overlooked in prior work are fully taken into theoretical consideration. The emphasis in this study was on theoretically understanding within-portfolio interactions—specifically complementarities and substitution—between formal and informal control mechanisms in systems development projects.

This study's theoretical development built on Ouchi's [65] neglected insight and Tiwana and Keil's [90] subsequent extension to systems development projects that formal control mechanisms depend on informational requirements. Although most prior work has considered only information that is required to put in place each type of formal control mechanism, this study built on the recent observations that controls must also be enforced after being put in place using what we labeled *evaluation information* in order to be effective [14, 16, 18, 89]. This subtle distinction has largely been overlooked in the controls literature with the exception of a recent study that used it to introduce a theoretical distinction between attempted and realized control [90].

It was theorized in this study that when informal control mechanisms facilitate the client's access to *reliable* evaluation information for a specific formal control mechanism, they will complement it; if informal control mechanisms play no such facilitating role or only contradictory signals to the vendor, they will exhibit a substitutive relationship. This idea is theoretically developed by building further on Tiwana and Keil's [90] interpretation of Ouchi's insight that enforcing formal outcome control and formal behavior control mechanisms requires different types of evaluation information, which was our subsequent conceptual basis for theorizing their interaction with informal control mechanisms.

The overarching contribution of this study is in reconciling the opposing complements versus substitutes perspectives by demonstrating that formal and informal control mechanisms can be *both* complements and substitutes in outsourced systems development projects. The focus of this study was on explaining the effects of such interactions among formal and informal control mechanisms on systems development ambidexterity, that is, the capacity to simultaneously exhibit alignment and adaptiveness in the systems development process. It was shown that systems development ambidexterity, which is positively related to classical efficiency-effectiveness measures of performance, is a theoretically useful complement to them. This is a noteworthy departure from prior studies that have focused theoretically only on the main effects of controls on performance but completely overlooked effects of the interactions among different types of controls used within a project's control portfolio.

Analyses of data from 120 outsourced systems development projects showed that informal clan control mechanisms substitute for outcome control mechanisms but complement behavior control mechanisms. The results offer new insights into effects of control-portfolio-level interactions—complementarities and substitution effects—among formal and informal control mechanisms used to govern outsourced systems development projects. While recent research recognizes that misfits between the choice of controls and their usage context impose performance penalties [1, 90], the author believes this is one of the earliest studies to directly examine within-portfolio interactions of formal with informal control mechanisms. It also complements the contingency perspective invoked in prior IS research (e.g., [58]).

Furthermore, the present conceptualization of outsourced systems development performance in terms of systems development ambidexterity embraces the call to shift from an either/or perspective to a both/and perspective for reconciling governance paradoxes [85]. This is a significant departure from prior work, where interfirm adaptation has been assumed but not directly examined in conjunction with alignment in assessing outsourced systems development performance. Although the shifting nature of project requirements is recognized in prior research [68], this paper complements that work with insights into how project control mechanisms also affect adaptation to such shifts. The present findings complement the IS project control literature, which has focused primarily on the choice of control mechanisms [46, 48, 62] and the effects of formal control separately on effectiveness and efficiency [40]. These results complement Tiwana and Keil's [90] study that contrasted differences in the usage of various control mechanisms between internal and outsourced projects and their effects on performance; the focus here was on the effects of interactions among formal and informal control mechanisms *within* a project's control mechanisms portfolio. Unlike Tiwana and Keil's work, the current results shed light on how chosen control mechanisms diminish and amplify each other's benefits. The findings of this study also complement the broader IT outsourcing literature, which has focused on the outsourcing decision [84, 88] and the performance effects of interfirm processes [49, 53]. This study is therefore distinctive in its focus on how the within-portfolio interactions among formal and informal control mechanisms influence outsourced systems development ambidexterity. The new insights into the concurrent complementarities and substitution effects between

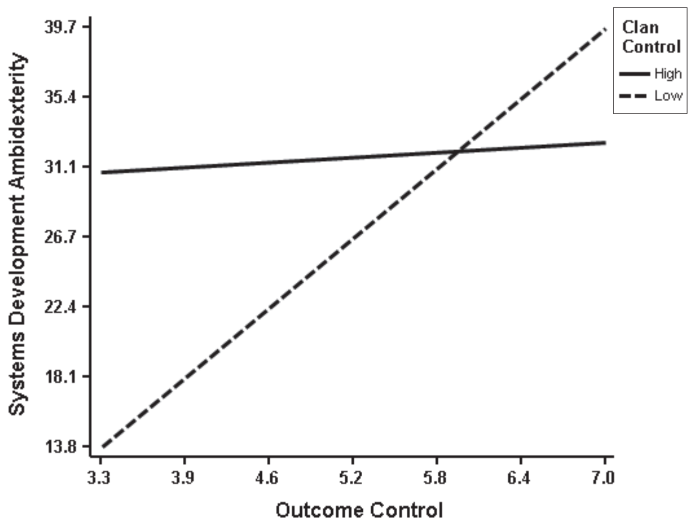

Figure 1. Interaction Effects of Clan Control Mechanisms with Outcome Control Mechanisms
Note: High and low represent +3 and –3 standard deviations.

formal and informal control mechanisms have two important theoretical implications for governing outsourced systems development projects.

Contributions and Implications for Research

Figures 1 and 2 show the interactions of formal controls with informal controls, which is the focus of our key contribution. First, the results show that formal outcome control mechanisms and informal clan control mechanisms have a substitutive effect on systems development ambidexterity in outsourced IT projects. The results show that outcome control decreases systems development ambidexterity with an increase in clan control. Figure 1 illustrates this interaction effect. The *y*-axis represents systems development ambidexterity and the *x*-axis represents outcome control. The two interaction lines represent the relationships between these two variables for high and low levels of clan control. Interpreting the interaction effect depends on comparing the slope of the plots for high and low levels of the interacting variable (clan control) [22]. The high and low lines in the plot represent +3 and –3 standard deviations from the mean, and 1 and 2 standard deviations produced similar relationships that were less visually pronounced. As the plot in Figure 1 shows, under greater clan control, the relationship between outcome control and systems development ambidexterity is weaker, as indicated by the less steep slope of the solid line. When clan control is lower, this relationship is stronger, as indicated by the steeper dotted line. Thus, clan control and outcome control are substitutes.

This finding directly refines the TCE [1, 93, 95] and relational contracting [21, 36] perspectives, which view contract-based formal controls and trust-based relational

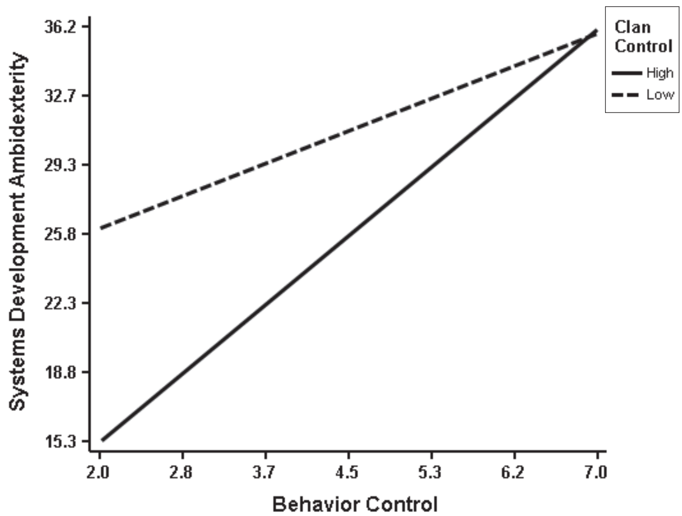

Figure 2. Interaction Effects of Clan Control Mechanisms with Behavior Control Mechanisms
Note: High and low represent +3 and –3 standard deviations.

forms of control as mutual substitutes. However, contrary to these relatively coarse arguments, clan control is not a substitute for all types of formal control mechanisms, only for formal outcome control. This is consistent with the logic that the evaluation information needed for a client to enforce outcome controls is directly embedded in, and can be objectively assessed from, the project outputs delivered by the vendor without requiring clan controls. Informal clan control mechanisms do not influence the client's ability to reliably obtain such evaluation information. This finding also contradicts the existing coarser empirical observations that all forms of formal control complement trust-based informal control such as clan controls (e.g., [56, 61, 74]); it is shown here that this is true of only formal behavior control mechanisms. Furthermore, the negative signaling effects of outcome controls about vendor trustworthiness and perception of reliability can potentially induce dysfunctional vendor behavior, leading their interaction to decrease systems development ambidexterity.

Second, the results show that behavior control mechanisms complement clan control mechanisms, that is, their simultaneous use increases systems development ambidexterity beyond their effects in isolation. The results show that behavior control increases systems development ambidexterity with an increase in clan control. These two forms of control therefore reinforce each other. Figure 2 illustrates this interaction effect. Under greater clan control, the relationship between behavior control and systems development ambidexterity is stronger, as indicated by the steeper slope of the solid line. When clan control is lower, this relationship is weaker, as indicated by the less steep dotted line. Thus, clan control and behavior control are complements.

This finding directly refines and supports the recent interfirm adaptation perspective that argues for clan control and behavior control complementarity, an assertion that is implicit in the IS project controls literature. However, it contrasts starkly with the prescriptions of the TCE and relational contracting perspectives, which view them as substitutes—an argument that holds true only for outcome control mechanisms rather than all forms of contract-driven formal control mechanisms. Relational contracts therefore do not necessarily preclude the existence of formal, process-oriented contracts. The current findings support the perspective that informal clan control mechanisms—at least in outsourced systems development with high asset specificity and nonequity arrangements—facilitate the client's access to reliable behavior control evaluation information. It was argued here that the lack of formal authority, low observability (e.g., due to geographical dispersion, coordination overhead, or loss of communication richness), and high costs of monitoring require the client to heavily depend on self-reported evaluation information from the vendor. In these circumstances, trust, shared norms and goals, and bilateralism fostered by clan control can trump the vendor's agency temptations, counter the sense of distrust that imposing behavior controls might signal, and motivate vendors to cooperate by providing reliable and accurate evaluation information to the client. As a corollary, clan control by itself matters little, but it is powerful when used in combination with behavior control. From a systems dynamics perspective [79], the results also show that informal controls represent the feedback loops that allow the detection and correction of problems in outputs of a "system" (here, the project team), which lubricates the effectiveness of formal process control. In the context of the notion of "place" in the Scandinavian view of systems development [87], these results contribute complementary insights into the management of work across both organizational and national boundaries. Overall, these results only partially agree with Ring and Van de Ven's [77] idea that relational (informal) contracts can replace market (outcome) *and* hierarchical (behavior) control mechanisms; support was found only for their first point. Carson et al. [14] observed that relational contracts, unlike formal contracts, enable adaptation. The present results, in showing that they do so only when complemented by formal behavior control, theoretically refine Carson et al.'s idea. These findings also refine Goold and Quinn's [31] observation about trust being a prime prerequisite of effective control by showing that this is true for behavior control and clan control but not for outcome control.

Although the interaction between outcome and behavior control mechanisms was not the focus of theory development here, its absence (lack of statistical significance) is noteworthy from a theory development standpoint. The expectation was that they would exhibit distinctive, independent effects on systems development ambidexterity (i.e., no interaction effect). It was expected that these two forms of formal control would serve distinctively different purposes because behavior control specifies *how* and outcome control specifies *what* the vendor should accomplish. Outcome control mechanisms evaluate vendor outputs without regard to the process through which they are achieved. In contrast, behavior control mechanisms evaluate vendor compliance with prescribed procedures and methods without regard to their outcomes. Along these lines, Ouchi and Maguire [67] have previously suggested that outcome control and behavior control are "not substitutes," implying that their effects are mutually independent. In other words, their effects on systems development ambidexterity should be statistically additive. Outcome control should enhance alignment in project activities and behavior control should enhance adaptation. The absence of a significant interaction in Table 3 supports their idea that outcome control and behavior control are not substitutes. However, the significant positive main effect of behavior control on adaptiveness but the absence of one for outcome control on alignment in the post hoc analysis in Table 4 fails to fully support the implicit notion that their benefits are also mutually independent.

Implications for Practice

Although the results show how managers charged with designing outsourced project control portfolios can effectively combine formal and informal control mechanisms to enhance project performance, they also point to a previously unrecognized dilemma. If formal outcome and behavior control mechanisms interact with clan control mechanisms in opposing directions, what is the appropriate combination of control mechanisms that is most likely to achieve the desired results? Because control is costly, rational managers ought to prefer governance mechanisms that successfully achieve project objectives at the least cost [1, 19]. Nevertheless, managers often attempt to hedge their risks in outsourcing arrangements by implementing a plethora of formal and informal control mechanisms—a strategy that this study's results caution can increase rather than decrease outsourcing nonperformance risk due to the unanticipated, negative interactions *within a control portfolio.* Simply put, more is not necessarily better. The author believes that the answer lies in limitedly invoking Ouchi's original insights about how contextual characteristics (such as measurability, observability, vendor knowledge) should guide the initial choice of formal control mechanisms. For example, behavior control mechanisms are attractive over outcome control mechanisms when any kind of output measurement is costly or difficult (e.g., in knowledge-intensive IT services outsourcing). Similarly, outcome control mechanisms are more attractive in contexts where outputs can be readily measured and the client lacks deep knowledge of the outsourced activity. Once the appropriate control mechanisms are put in place, they must also be enforced [90]. Because enforcing different types of formal control mechanisms requires specific types of evaluation information, managers can use the insights from this study to add complementary, nonsubstitutive combinations of informal control mechanisms to the control portfolio. These considerations must also be coupled with the costs of implementing control, failing which these costs might wipe out the potential economic benefits of outsourcing.

From a pragmatic perspective, the key practical implication for managers arises from the complementary relationship between behavior control and clan control. Managers must recognize that the performance benefits of behavior control are strengthened by clan control. Therefore, clients who attempt to have the vendor follow preferred methodologies, specific software development procedures, or prespecified practices (all behavior control mechanisms) should also simultaneously put in place informal control mechanisms to fully realize the potential benefits of the former. They can do this by actively participating in project meetings with vendor staff, arranging on-site visits to or by the vendor, or using dedicated project liaisons to interact with vendor employees (all clan control mechanisms) to ensure that the vendor better understands the client organization's goals, values, and norms.

In conclusion, the study shows that formal and informal interfirm control mechanisms can be both complements and substitutes. For managerial practice, this implies that within-portfolio interactions are perhaps as important as the initial choice of control mechanisms. The optimal configuration of control portfolios for outsourced projects is a matter of careful managerial judgment with cognizance of the complementarities and substitution effects described here. More broadly, the study advocates a shift in the debate about whether formal and informal control mechanisms can simultaneously be used in outsourced systems development to how they can be used in mutually reinforcing, nonconflicting combinations to enhance outsourced systems development.

Acknowledgments: The author thanks Ashley Bush, Lars Mathiassen, Eric van Heck, Steve Kim, Juhani Iivari, Arun Rai, Mark Keil, Magnus Mähring, Jonathan Wareham, Kevin Scheibe, and Vladimir Zwass for feedback. The author also gratefully acknowledges financial support from Iowa State University's Council on International Programs.

Note

1. Control in this study refers to control by a principal over an agent in the agency theory perspective along the lines of Ouchi's control theory [65], rather than an unrelated systems dynamics and engineering notion of control within complex systems (see [79]).

References

1. Anderson, S., and Dekker, H. Management control for market transactions. *Management Science, 51,* 12 (2005), 1734–1752.

2. Armstrong, J., and Overton, T. Estimating non-response bias in mail surveys. *Journal of Marketing Research, 14,* 3 (1977), 396–402.

3. Aron, R.; Clemons, E.; and Reddi, S. Just right outsourcing: Understanding and managing risk. *Journal of Management Information Systems, 22,* 2 (Fall 2005), 37–55.

4. Arora, A., and Gambardella, A. Complementarity and external linkages: The strategies of large firms in biotechnology. *Journal of Industrial Economics, 38,* 4 (1990), 361–379.

5. Aulakh, P.; Kotabe, M.; and Sahay, A. Trust and performance in cross border marketing partnerships: A behavioral approach. In P. Beamish and P. Killing (eds.), *Cooperative Strategies: North American Perspectives.* San Francisco: New Lexington Press, 1997, pp. 163–196.

6. Bagozzi, R.P.; Yi, Y.; and Phillips, L.W. Assessing construct validity in organizational research. *Administrative Science Quarterly, 36,* 3 (1991), 421–458.

7. Baiman, S. Agency research in managerial accounting: A second look. *Accounting, Organizations and Society, 15,* 4 (1990), 341–371.

8. Barki, H.; Rivard, S.; and Talbot, J. An integrative contingency model of software project risk management. *Journal of Management Information Systems, 17,* 4 (Spring 2001), 37–69.

9. Barua, A.; Lee, S.C.H.; and Whinston, A. The calculus of reengineering. *Information Systems Research, 7,* 4 (1996), 409–428.

10. Belsley, D.; Kuh, E.; and Welsch, R. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity.* New York: John Wiley & Sons, 1980.

11. Bernheim, B., and Whinston, M. Incomplete contracts and strategic ambiguity. *American Economic Review, 88,* 4 (1998), 902–932.

12. Bradach, J., and Eccles, R. Price, authority, and trust: From ideal types to plural forms. *Annual Review of Sociology, 15,* 1 (1989), 97–118.

13. Browne, G.J., and Rogich, M.B. An empirical investigation of user requirements elicitation: Comparing the effectiveness of prompting techniques. *Journal of Management Information Systems, 17,* 4 (Spring 2001), 223–250.

14. Carson, S.; Madhok, A.; and Wu, T. Uncertainty, opportunism and governance: The effects of volatility and ambiguity on formal and relational contracting. *Academy of Management Journal, 49,* 5 (2006), 1058–1077.

15. Carte, T., and Russell, C. In pursuit of moderation: Nine common errors and their solutions. *MIS Quarterly, 27,* 3 (2003), 479–502.

16. Choudhury, V., and Sabherwal, R. Portfolios of control in outsourced software development projects. *Information Systems Research, 14,* 3 (2003), 291–314.

17. Das, T., and Teng, B.S. Between trust and control: Developing confidence in partner cooperation in alliances. *Academy of Management Review, 23,* 3 (1998), 491–512.

18. David, R., and Han, S. An assessment of the empirical support for transaction cost economics. *Strategic Management Journal, 25,* 1 (2004), 39–58.

19. Domberger, S. *The Contracting Organization.* New York: Cambridge University Press, 1998.

20. Dutta, A., and Roy, R. Offshore outsourcing: A dynamic causal model of counteracting forces. *Journal of Management Information Systems, 22,* 2 (Fall 2005), 15–36.

21. Dyer, J. Effective interfirm collaboration: How firms minimize transaction costs and maximize transaction value. *Strategic Management Journal, 18,* 7 (1997), 535–556.

22. Edwards, J., and Lambert, L. Methods for integrating moderation and mediation: A general analytical framework using moderated path analysis. *Psychological Methods, 12,* 1 (2007), 1–22.

23. Eisenhardt, K. Control: Organizational and economic approaches. *Management Science, 31,* 2 (1985), 134–149.

24. Ethiraj, S.; Kale, P.; Krishnan, M.; and Singh, J. Where do capabilities come from and how do they matter? A study in the software services industry. *Strategic Management Journal, 26,* 1 (2005), 25–45.

25. Faraj, S., and Sproull, L. Coordinating expertise in software development teams. *Management Science, 46,* 12 (2000), 1554–1568.

26. Finken, S. Discursive conditions of knowledge production within cooperative design. *Scandinavian Journal of Information Systems, 15,* 1 (2003), 1–9.

27. Fox, J. *Regression Diagnostics.* Newbury Park, CA: Sage, 1991.

28. Gerwin, D., and Ferris, J. Organizing new product development projects in strategic alliances. *Organization Science, 15,* 1 (2004), 22–37.

29. Ghoshal, S., and Moran, P. Bad for practice: A critique of the transaction cost theory. *Academy of Management Review, 21,* 1 (1996), 13–47.

30. Gibson, C., and Birkinshaw, J. The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of Management Journal, 47,* 2 (2004), 209–226.

31. Goold, M., and Quinn, J. The paradox of strategic controls. *Strategic Management Journal, 11,* 1 (1990), 43–57.

32. Gopal, A.; Sivaramakrishnan, K.; Krishnan, M.; and Mukhopadhyay, T. Contracts in offshore software development: An empirical analysis. *Management Science, 49,* 12 (2003), 1671–1683.

33. Granovetter, M. Economic action and social structure: The problem of embeddedness. *American Journal of Sociology, 91,* 3 (1985), 481–510.

34. Grossman, S., and Hart, O. An analysis of the principal–agent problem. *Econometrica, 51,* 1 (1983), 7–46.

35. Grudnitski, G. Eliciting decision-makers' information requirements. *Journal of Management Information Systems, 1,* 1 (Summer 1984), 11–32.

36. Gulati, R. Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. *Academy of Management Journal, 38,* 1 (1995), 85–112.

37. Hair, J.; Black, W.; Babin, B.; Anderson, R.; and Tatham, R. *Multivariate Data Analysis with Readings,* 6th ed. Englewood Cliffs, NJ: Prentice Hall, 2006.

38. Hansen, M. Knowledge networks: Explaining effective knowledge sharing in multiunit companies. *Organization Science, 13,* 3 (2002), 232–248.

39. He, Z., and Wong, P. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science, 14,* 4 (2004), 481–494.

40. Henderson, J., and Lee, S. Managing I/S design teams: A control theories perspective. *Management Science, 38,* 6 (1992), 757–777.

41. Hickey, A.M., and Davis, A.M. A unified model of requirements elicitation. *Journal of Management Information Systems, 20,* 4 (Spring 2004), 65–84.

42. Highsmith, J., and Cockburn, A. Agile software development: The business of innovation. *IEEE Computer, 34,* 9 (2001), 120–122.

43. Inkpen, A.C., and Currall, S.C. International joint venture trust: An empirical examination. In P.W. Beamish and J.P. Killing (eds.), *Cooperative Strategies: North American Perspectives,* San Francisco: New Lexington Press, 1997, pp. 308–334.

44. Inkpen, A., and Currall, S. The coevolution of trust, control, and learning in joint ventures. *Organization Science, 15,* 5 (2004), 586–599.

45. Jaccard, J., and Turrisi, R. *Interaction Effects in Multiple Regression,* 2d ed. Thousand Oaks, CA: Sage, 2003.

46. Kirsch, L.J. The management of complex tasks in organizations: Controlling the systems development process. *Organization Science, 7,* 1 (1996), 1–21.

47. Kirsch, L.J. Portfolios of control modes and IS project management. *Information Systems Research, 8,* 3 (1997), 215–239.

48. Kirsch, L.J.; Sambamurthy, V.; Ko, D.-G.; and Purvis, R.L. Controlling information systems development projects: The view from the client. *Management Science, 48,* 4 (2002), 484–498.

49. Koh, C.; Ang, S.; and Straub, D. IT outsourcing success: A psychological contract perspective. *Information Systems Research, 15,* 4 (2004), 356–373.

50. Kumar, S., and Seth, A. The design of coordination and control mechanisms for managing joint venture–parent relationships. *Strategic Management Journal, 19,* 6 (1998), 579–599.

51. Lamb, R., and Kling, R. Reconceptualizing users as social actors in information systems research. *MIS Quarterly, 27,* 2 (2003), 197–235.

52. Larson, A. Network dyads in entrepreneurial settings: A study of governance of exchange relationships. *Administrative Science Quarterly, 37,* 1 (1992), 76–104.

53. Lee, J., and Kim, Y. Effect of partnership quality on IS outsourcing success. *Journal of Management Information Systems, 15,* 4 (Spring 1999), 29–61.

54. Levi, M.; Kleindorfer, P.R.; and Wu, D.J. Codifiability, relationship-specific information technology investment, and optimal contracting. *Journal of Management Information Systems, 20,* 2 (Fall 2003), 77–98.

55. Lindell, M., and Whitney, D. Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology, 86,* 1 (2001), 114–121.

56. Luo, Y.D. Contract, cooperation, and performance in international joint ventures. *Strategic Management Journal, 23,* 10 (2002), 903–919.

57. Malhotra, N.; Kim, S.; and Patil, A. Common method variance in IS research: A comparison of alternative approaches and a reanalysis of past research. *Management Science, 52,* 12 (2006), 1865–1883.

58. Mathiassen, L.; Saarinen, T.; Tuunanen, T.; and Rossi, M. A contingency model for requirements development. *Journal of the Association for Information Systems, 8,* 11 (2007), 570–598.

59. McEvily, B.; Perrone, V.; and Zaheer, A. Trust as an organizing principle. *Organization Science, 14,* 1 (2003), 91–103.

60. Milgrom, P., and Roberts, J. Complementarities and fit: Strategy, structure, and organizational change in manufacturing. *Journal of Accounting and Economics, 19,* 2–3 (1995), 179–208.

61. Mjoen, H., and Tallman, S. Control and performance in international joint ventures. *Organization Science, 8,* 3 (1997), 257–274.

62. Nidumolu, S., and Subramani, M. The matrix of control: Combining process and structure approaches to managing software development. *Journal of Management Information Systems, 20,* 3 (Winter 2003–4), 159–196.

63. Nunnally, J.C. *Psychometric Theory.* New York: McGraw-Hill, 1978.
64. Ouchi, W. The relationship between organizational structure and organizational control. *Administrative Science Quarterly, 22,* 1 (1977), 95–113.
65. Ouchi, W. A conceptual framework for the design of organizational control mechanisms. *Management Science, 25,* 9 (1979), 833–848.
66. Ouchi, W. Markets bureaucracies and clans. *Administrative Science Quarterly, 25,* 1 (1980), 129–141.
67. Ouchi, W., and Maguire, M. Organizational control: Two functions. *Administrative Science Quarterly, 20,* 4 (1975), 559–569.
68. Ovaska, P.; Rossi, M.; and Smolander, K. Filtering, negotiating and shifting in the understanding of information system requirements. *Scandinavian Journal of Information Systems, 17,* 1 (2005), 31–66.
69. Oxley, J., and Sampson, R. The scope and governance of international R&D alliances. *Strategic Management Journal, 25,* 11 (2004), 723–729.
70. Peffers, K.; Gengler, C.E.; and Tuunanen, T. Extending critical success factors methodology to facilitate broadly participative information systems planning. *Journal of Management Information Systems, 20,* 1 (Summer 2003), 51–85.
71. Ping, R. A parsimonious estimating technique for interaction and quadratic latent variables. *Journal of Marketing Research, 32,* 3 (1995), 336–347.
72. Pitts, M.G., and Browne, G.J. Stopping behavior of systems analysts during information requirements elicitation. *Journal of Management Information Systems, 21,* 1 (Summer 2004), 203–226.
73. Podsakoff, P.M.; MacKenzie, S.B.; Lee, J.Y.; and Podsakoff, N.P. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88,* 5 (2003), 879–903.
74. Poppo, L., and Zenger, T. Do formal contracts and relational governance function as substitutes or complements? *Strategic Management Journal, 23,* 8 (2002), 707–725.
75. Ramaswami, S. Marketing controls and dysfunctional behaviors: A test of traditional and contingency theory postulates. *Journal of Marketing, 60,* 2 (April 1996), 105–120.
76. Reuer, J., and Ragozzino, R. Agency hazards and alliance portfolios. *Strategic Management Journal, 27,* 1 (2006), 27–43.
77. Ring, P., and Van de Ven, A. Developmental processes of cooperative interorganizational relationships. *Academy of Management Review, 19,* 1 (1994), 90–118.
78. Roberts, T.L.; Cheney, P.H.; Sweeney, P.D.; and Hightower, R.T. The effects of information technology project complexity on group interaction. *Journal of Management Information Systems, 21,* 3 (Winter 2004–5), 223–248.
79. Rodrigues, A., and Williams, T. System dynamics in software project management: Towards the development of a formal integrated network. *European Journal of Information Systems, 6,* 1 (1996), 51–56.
80. Rustagi, S.; King, W.; and Kirsch, L. Predictors of formal control usage in IT outsourcing partnerships. *Information Systems Research, 19,* 2 (2008), 126–143.
81. Shrout, P., and Fleiss, J. Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86,* 2 (1979), 420–428.
82. Siggelkow, N. Misperceiving interactions among complements and substitutes: Organizational consequences. *Management Science, 48,* 7 (2002), 900–916.
83. Simonin, B. The importance of collaborative know-how: An empirical test of the learning organization. *Academy of Management Journal, 40,* 5 (1997), 1150–1174.
84. Smith, M.A.; Mitra, S.; and Narasimhan, S. Information systems outsourcing: A study of pre-event firm characteristics. *Journal of Management Information Systems, 15,* 2 (Fall 1998), 61–93.
85. Sundaramurthy, C., and Lewis, M. Control and collaboration: Paradoxes of governance. *Academy of Management Review, 28,* 3 (2003), 397–415.
86. Tanriverdi, H. Information technology relatedness, knowledge management capability, and performance of multibusiness firms. *MIS Quarterly, 29,* 2 (2005), 311–325.
87. Tellioglu, H., and Wagner, I. Cooperative work across cultural boundaries in systems design. *Scandinavian Journal of Information Systems, 11,* 1 (1999), 1–16.

88. Tiwana, A., and Bush, A. A comparison of transaction cost, agency, and knowledge-based predictors of IT outsourcing decisions. *Journal of Management Information Systems, 24,* 1 (Summer 2007), 263–305.

89. Tiwana, A., and Keil, M. Does peripheral knowledge complement control? An empirical test in technology outsourcing alliances. *Strategic Management Journal, 28,* 6 (2007), 623–634.

90. Tiwana, A., and Keil, M. Control in internal and outsourced systems development projects. *Journal of Management Information Systems, 26,* 3 (Winter 2009–10), 9–44.

91. Turner, K., and Makhija, M. The role of organizational controls in managing knowledge. *Academy of Management Review, 31,* 1 (2006), 197–217.

92. Uzzi, B. Social structure and competition in interfirm networks. *Administrative Science Quarterly, 42,* 1 (1997), 35–67.

93. Walker, G., and Weber, D. A transaction cost approach to make or buy decision. *Administrative Science Quarterly, 29,* 3 (1984), 373–379.

94. Whittington, R.; Pettigrew, A.; Peck, S.; Fenton, E.; and Conyon, M. Change and complementarities in the new competitive landscape: A European panel study, 1992–1996. *Organization Science, 10,* 5 (1999), 583–600.

95. Williamson, O.E. Comparative economic organization: The analysis of discrete structural alternatives. *Administrative Science Quarterly, 36,* 2 (1991), 269–296.

96. Xia, W., and Lee, G. Complexity of information systems development projects: Conceptualization and measurement development. *Journal of Management Information Systems, 22,* 1 (Summer 2005), 45–84.

97. Yourdon, E. *Modern Structured Analysis.* Englewood Cliffs, NJ: Prentice Hall, 1989.

98. Zand, D.E. Trust and managerial problem solving. *Administrative Science Quarterly, 17,* 2 (1972), 229–239.

Appendix: Measures for All Independent and Dependent Variables and Their Factor Structure

	1	2	3	4	5
Systems development ambidexterity was measured following Gibson and Birkinshaw [30] as the product of alignment and adaptiveness. *Systems development alignment* used four items (anchors: "strongly disagree" and "strongly agree") that tapped into the extent to which the project development process was effective in successfully fulfilling the client's project . . .					
. . . needs	**0.891**	0.125	0.164	0.024	0.051
. . . objectives	**0.872**	0.048	0.179	0.118	0.089
. . . quality expectations	**0.834**	0.171	0.041	–0.020	0.147
. . . functional requirements	**0.745**	0.087	0.270	0.054	0.103
The *adaptiveness* dimension used four items (anchors: "not at all" and "to a great extent") that assessed the extent to which it was possible to incorporate new requirements and design changes in response to changing client needs during each of the following successive project stages:					
1. requirements analysis	0.098	**0.735**	–0.025	0.074	0.365
2. high-level design	0.135	**0.904**	–0.062	0.010	0.151
3. detailed design	0.103	**0.912**	0.110	–0.042	–0.070
4. development and coding	0.066	**0.710**	0.185	–0.070	–0.172
All three control mechanisms were adapted from Kirsch et al. [48] and used "strongly disagree" and "strongly agree" as anchors. *Outcome control* was measured using three items that assessed the extent to which the client placed significant weight on . . .					
. . . timely project completion	–0.020	0.148	0.148	0.110	**0.781**
. . . completion within budget	0.303	–0.055	0.110	0.083	**0.708**
. . . accomplishing project goals	0.516	0.014	0.083	0.156	**0.533**

(continues)

Appendix: Continued

	1	2	3	4	5
Behavior control was measured using three items that assessed the extent to which the client expected the vendor to follow an understandable, written sequence of steps . . .					
. . . toward accomplishing project goals	0.172	–0.017	**0.808**	0.076	0.352
. . . to ensure the system met the client's requirements	0.189	0.093	**0.887**	0.140	–0.002
. . . to ensure the success of the project	0.257	0.134	**0.826**	0.186	0.078
Clan control was measured using three items that assessed the extent to which members from the client firm . . .					
. . . attempted to be "regular" members of the project team	0.019	0.063	0.104	**0.866**	0.047
. . . placed a significant weight on understanding the project team's goals, values, and norms	0.116	–0.045	0.023	**0.887**	0.089
. . . actively participated in project meetings to understand the project team's goals, values, and norms	0.041	–0.072	0.245	**0.833**	0.149
Eigenvalue	5.2	2.7	2.0	1.5	1.2
Percent variance explained by factor	19.7	16.5	14.2	13.9	10.5

Note: The dominant factor loading is shown in boldface.