

Please quote as: Dellermann, D.; Jud, C. & Popp, K. M. (2016): Why don't they join? Analyzing the Nature and Consequences of Complementors' Costs in Platform Ecosystems. In: International Conference on Information Systems (ICIS). Dublin, Ireland.

Why don't they join? Analyzing the Nature and Consequences of Complementors' Costs in Platform Ecosystems

Research-in-Progress

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Abstract

Platforms enable third-parties to develop new software artefacts like applications and become the locus of digital innovation. Prior studies have mainly focused on the benefits that initially motivate external complementors to join an ecosystem. However, little is known about the costs that are associated with this choice and how such costs actually influence the decision to interrelate with a platform owner. We develop the overarching idea that the complementor's costs are mainly influenced by the interplay of the micro-architecture of single extensions and control modes applied to govern the ecosystem. The purpose of our research is therefore to shed light on the nature of complementors' costs on the micro-level of transactions between the platform owner and the complementor and their effects on the intention to join an ecosystem. Using data from a quantitative survey among complementors of five leading platforms in the Enterprise Application Software industry hypothesized relationships are tested.

Keywords: Transaction Cost Economics, Modularity, Platform Ecosystem, Software Platform, IS Control

Introduction

The emergence of technological platforms like Salesforce's Force.com, SAP's HANA or Apple's iPhone operating system (iOS) substantially changed the logic of value creation in the software industry. While the traditional approach of software engineering was the independent development of a monolithic product by an individual software vendor, modern software strongly relies on innovation from third-party developers called complementors (Ghazawneh & Henfridsson 2013). A digital platform is an expandable base that is provided by a focal platform owner. It enables other actors to develop new artefacts, like applications (i.e. extensions), that extend the basic functionality of this platform and becomes the locus of innovation (Tiwana et al. 2010). The platform and its corresponding modules form an ecosystem, in which numerous participants, including the platform owner (e.g. Salesforce, SAP), suppliers, end users, and complementors transact with each another in complex ways. Such ecosystems are a set of actors functioning as a common unit and bond together with relationships among them. These relationships are underpinned by a common technological core and operate through the exchange of information, resources and artifacts (Jansen et al. 2013).

The main focus of a platform owner is therefore to attract complementors to join the ecosystem that facilitate innovation and the generation of complementary value propositions (Boudreau 2012). However, famous examples, like Blackberry's mobile operating system or SAP's Business ByDesign, show that it remains challenging to gain solid traction among complementors (i.e. third-party developers). Furthermore, platform ecosystems have also been known for its fluctuation and high rates of desertion (Tiwana 2015b).

Prior studies have mainly focused on the motivational factors and the relational rents that initially induce external complementors to join an ecosystem (e.g. Ceccagnoli et al. 2012; Kude et al. 2012). However, little is known about the costs which are associated with this choice and how such costs actually influence the decision to interrelate with a platform owner. Previous studies, that addressed this question, were primarily focusing on a technical perspective and solely on coordination costs related to platform dependencies (e.g. Tiwana 2015b). However, to provide a more holistic analysis of costs which affect a decision to join, also the economic (e.g. contractual, behavioral) dimensions need to be included. In particular, investments in relation-specific assets (e.g. Dyer & Singh 1998) and transaction costs (e.g. Ang & Straub 1998; Williamson 1991) have to be taken into account, when complementors join an ecosystem. If transaction costs are too high they can rapidly outweigh the additional value generated by the ecosystem (Williamson & De Meyer 2012).

Transaction cost theory (TCT) is one of the most prominent theoretical bases to explain and predict relationships and boundary decisions associated with interfirm exchange (e.g. Aubert et al. 2004; Watjatrakul 2005). From TCT's perspective entering partnerships with a platform owner might induce a cost disadvantage for complementors relative to vertically integrated structures. Traditional research in the field of TCT utilizes such costs as exogenous and applied governance modes as an endogenous variable (Rindfleisch & Heide 1997). Contrary to this assumption, we develop the overarching idea that these transaction costs from a complementor's perspective are mainly influenced by the interplay of the micro-architecture of single extensions. This is constraint but not necessarily equal to the platform architecture, as well as the control modes the platform owner applies to govern the surrounding ecosystem.

Although modular platform architecture is commonly believed to reduce the need for control (Sanchez & Mahoney 1996), platform owners utilize different formal (e.g. screening of authorized extensions) and informal (e.g. common values) control mechanisms to ensure that the interaction between the extensions and the platform meet the platform owner's interests. This approach underlines the inseparability of control from extension architecture (e.g. Tiwana 2015a & b). The governance mode therefore is a predefined and exogenous factor for complementors and influencing their amount of transaction costs. Previous literature on modularity assumes that modularity reduces transaction costs, however this premise is yet empirically untested (Baldwin 2008).

The purpose of our research is therefore to shed light on the nature of complementors' transaction costs on the micro-level of transactions between the platform owner and the complementor, and their effects on the decision to join a platform ecosystem. We therefore combine two theoretical streams: TCT and modular systems theory as well as its interaction with different modes of platform control. Hypothesized relationships are tested by using data from a quantitative survey among complementors on five leading cloud platforms in the Enterprise Application Software (EAS) industry (i.e. Microsoft Azure, Oracle Cloud Platform, Amazon Web Services, SAP HANA, and Salesforce Force.com). Our study is guided by the following research questions:

- (1) *How do complementors evaluate transaction costs to make a decision to join in platform ecosystems?*
- (2) *How do different control mechanisms accomplished by the platform owner as well as their interplay with the extension architecture facilitate the transaction costs of complementors?*

Our study potentially contributes to a deeper understanding of factors that influence complementor's join decision (e.g. Ceccagnoli et al. 2012; Kude et al. 2012) by analyzing the nature and consequences of a complementor's transaction costs in the context of software platforms, applying the theoretical lens of TCT. Furthermore, we intend to empirically prove the role of modular architecture on transaction costs (Baldwin 2008). We attempt to extend IS control literature by analyzing the consequences of specific control choices (e.g. Gopal & Gosain 2010; Tiwana & Konsynski 2010). Finally, we aim at contributing to

intra-platform research and particularly the interplay between control and extension architecture (e.g. Tiwana 2015a).

Theoretical Background

Transaction Costs in Platform Ecosystems

Transaction cost theory (TCT) is one of the most prominent approaches for boundary decisions that are associated with interfirm exchange (Williamson 1991). In IS research for instance, this theoretical framework is frequently applied in analyzing the degree of outsourcing (e.g. Aubert et al. 2004; Watjatrakul 2005). From TCT's perspective, entering ecosystem partnerships to create third-party applications might induce a cost disadvantage relative to vertically integrated structures (Williamson & De Meyer 2012). In general, TCT defines the costs of economic exchange (i.e. search and information costs; costs of decisions; investments in social relations; opportunity costs) within the boundaries of a specific system (i.e. market or hierarchies) and therefore explains the costs of interorganizational collaboration and the most suitable governance mode for reducing this costs (e.g. Ngwenyama & Bryson 1999).

Taken to the platform context, transactions, which are located in modular task networks (Baldwin 2008), always create costs. From the perspective of TCT, such costs of exchange relationships can arise from three dimensions: behavioral and environmental uncertainty as well as asset specificity (Rindfleisch & Heide 1997). First, asset specificity refers to the transferability of a certain asset that is needed for a transaction. Specific assets are significantly more valuable in a particular exchange relationship than within alternative partner relations and lead to a 'lock-in' effect resulting in hold-up problems and high switching costs (Watjatrakul 2005). Second, behavioral uncertainty arises from the complexity of performance evaluation and creates cost for monitoring and enforcement as well as the failure to identify suitable partners (Rindfleisch & Heide 1997). Third, environmental uncertainty refers to the unpredictability of the firm's environment that surrounds an exchange. This type of uncertainty consists of two sub-dimensions: technological as well as market uncertainty (Rindfleisch & Heide 1997). Complementors therefore face difficulties in managing such exchange relations, which may cause progressive costs related to coordination and adaption (Williamson 1991).

In the context of platform ecosystems, the term transaction refers to any exchange between a platform owner and a complementor that is required to develop and provide a complementary product. Hence, high transaction costs for complementors result from multilateral relationships with the platform owner as well as the platform's environment, which are governed by different forms of control. In past research in TCT, firms typically attempt to minimize transaction costs by selecting a certain governance mode (e.g. Aubert et al. 2004). However, the mechanisms introduced by the platform owner on a large scale are not necessarily appropriate for reducing the transaction costs of every single complementor. Especially, governance mechanisms that are applied at a large scale might not optimize each single complementor's costs. On the other hand, modularity literature claims that a modular architecture reduces transaction costs across module boundaries (Baldwin 2008; Baldwin & Woodard 2008). Consequently, the level of modularization of the complementor's app should influence the amount of transaction costs. We therefore argue that the interplay of platform control and extension architecture is a crucial prerequisite for the amount of transaction cost, which a complementor faces after joining an ecosystem.

Extension Architecture and Platform Control

For analyzing platform ecosystems and exchange within them, two inseparable parts of platform management are crucial: the architecture of single extensions as well as platform control mechanisms (Tiwana et al 2010).

First, modularity refers to the concept of any complex system with intentionally minimized interdependences between the single subsystems it consists of (Sanchez & Mahoney 1996). A platform, i.e. an extendable codebase, allows the development of complementary subsystems (i.e. extensions or applications) that augments a platform's functionality (Tiwana et al. 2010). Hence, the modularity of a system can be theoretically described along two dimensions: decoupling of an extension from the platform, which allows the widely independent development of a complementary product, and the use of

standardized interfaces as connections that ensure interoperability between the extension and the platform (Sanchez & Mahoney 1996). We therefore separate extension's microarchitecture from the ecosystem's macro architecture (Baldwin & Clark 2008). On the level of the microarchitecture of an application, extension modularization is focusing on the linkages between the platform and the extension at the extension's interface rather than the modularity of the internal architecture of an app. Following Tiwana (2015a: 268), we define extension modularization as the "degree to which an extension is loosely coupled and interacts through standardized interfaces with the platform." Hence, the more modularized an extension is, the more independently it can be developed yet interoperate with the platform.

Control is the second major component when trying to understand transaction cost of complementors joining an ecosystem. In this context, control refers to the mechanisms that govern actions of the partners and are established by a central platform owner (Choudhury & Sabherwal 2003). Although, the interests of the platform owner and complementors are not necessarily misaligned in platform ecosystems, the applied control mechanisms are an exogenous variable for complementors. Control theory (Kirsch 1996; Ouchi 1979), typically segments such mechanisms into two main approaches: formal control and informal control modes. Two suitable and most common control mechanisms in the context of software platforms are input control as well as clan control. First, clan control, describes a contolees attempt to foster a set of shared values and common norms (Kirsch 1997). This approach aims at reducing deviant behavior as in such case other members of the clan might react with social sanctioning. Clan control therefore results in behaviors of both the platform owner and the complementor that would not violate such values (Goldbach & Benlian 2015; Ouchi 1979). Second, input control, i.e. the degree to which platform owners governs the extensions of the complementor, involves formal application and selection processes that control which apps the complementor is allowed to introduce to the ecosystem (Tiwana 2015a). Hence, not all extensions are admitted into the platform ecosystem. Although, both control mechanisms are widespread in practice, little is known about their effect on transaction costs and their consequences for the complementor in general (e.g. Gopal & Gosain 2010; Keil et al. 2013).

Research Model and Hypotheses

Within this section, we develop our research model. Therefore, we propose that the dimensions of transaction costs (H1a, H1b, H1c, and H1d) influence a complementors decision to join an ecosystem and that different control mechanisms as well as their interplay with the extension architecture are prerequisites for the amount of transaction cost (H2a, H2b, H2c, and H2d). Our research model is shown in Figure 1.

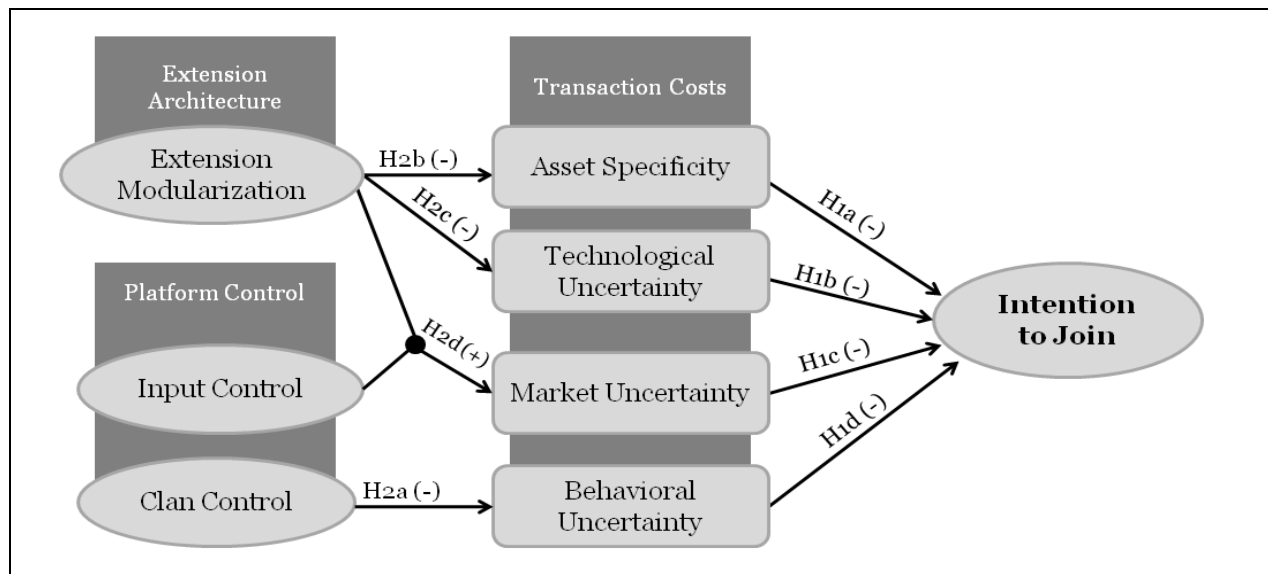


Figure 1. Research Model

Transaction Cost Dimensions in Decisions to Join

Asset Specificity

Asset specificity refers to the transferability of a certain asset that is needed for transactions in a relationship (Rindfleisch & Heide 1997). In the case of relationships between the platform owner and the complementor, these relation-specific assets (Dyer & Singh 1998) require investments in relation-specific knowledge to participate in the platform ecosystem and capitalize from the access to complementary resources (Aubert et al. 2004). Specific assets for ecosystem participation can be for instance, human assets, technological assets or knowledge about platform architecture, interface specifications and market characteristics. High levels of asset specificity and the related investment requirements create dependences between partners and lead to lock-in effects and increased switching costs. This makes it difficult for the complementors to leave the actual ecosystem and port the extension to a different software platform (Kude & Dibbern 2009). A high specificity of assets, which is needed to build complementary applications therefore results for instance in high multi-homing costs, i.e. the sum of costs for adopting, operating, and opportunity costs for maintaining affiliation with a certain platform (Armstrong & Wright 2007). Hence, greater asset specificity will negatively influence the complementor's decision to join an ecosystem.

Hypothesis 1a: Greater asset specificity decreases a complementor's intention to join an ecosystem

Environmental Uncertainty

The concept of environmental uncertainty explains the unpredictability of the firm's environment that surrounds an exchange (Walker & Weber 1984). Therefore, not just the direct exchange with the platform owner, but also the indirect environment of the ecosystem influences the costs of complementors. Environmental uncertainty as a larger concept can be divided into two sub-dimensions: the volatility of market conditions (e.g. market, demand, and competitive environment) and technology (e.g. technological complexity) (Rindfleisch & Heide 1997). The unpredictability of technological changes, the customer demand, or the competitive environment therefore increases the costs for managing such relationships during the development of complementary.

First, technological uncertainty covers the complexity and inability to accurately forecast the technical requirements within a relationship, for instance for interface specifications. As a result, partners may act opportunistically, when environmental factors change (Ang & Cummings 1997). Thus, complementors face more difficulties in managing the relationship, which may cause progressive costs related to coordination and adaption to meet the new requirements (Heide & John 1990). Following this logic, higher technological uncertainty will negatively influence a complementor's decision to join.

Hypothesis 1b: Greater technological uncertainty decreases a complementor's intention to join an ecosystem

Second, market uncertainty is crucial for the costs of complementors, as for instance the sustainability of the specific niche is required to succeed and changes in the market environment can significantly affect complementors (Pierce 2009). This sub-dimension of environmental uncertainty furthermore covers uncertainty regarding the competition among different complementors' extensions in satisfying end user needs (Tiwana 2015a). Higher market uncertainty therefore creates significant costs and will also negatively influence a complementor's decision to join a platform ecosystem.

Hypothesis 1c: Greater market uncertainty decreases a complementor's intention to join an ecosystem

Behavioral Uncertainty

In contrast to environmental uncertainty, which is not directly related to the exchange partner, behavioral uncertainty arises from the complexity of performance evaluation. Taken to the platform context, the platform owner might follow its individual interests and cause hidden costs by performing inefficiently

and ineffectively (Williamson 1985). Although platform owners encourage the development of complementary products to nurture the overall value of the ecosystem, there is often a tension between them and complementors (Rochet & Tirole 2003). This tension arises from the complementor's threat of opportunistic behavior of the platform owner, by for instance exploiting resources or poaching in the partner's niche (Kude & Dibbern 2009). The complementors in an ecosystem therefore face the threat of opportunistic behavior, after they have already committed resources to the relationship. Behavioral uncertainty and the risk of opportunism are especially high in small numbers bargaining situations, i.e. distribution of power to a small number of dominant firms, which creates market inefficiencies (Doz & Hamel 1998). For instance, the platform owner might utilize the complementor's lock-in situation and take advantage at its cost, or use a dominant position to refuse sharing resources that are crucial for mutual value creation. Hence, the costs for measuring and evaluating the performance of the partner, which are caused by the platform owner performing inefficiently, have a negative impact on the complementor's join decision.

Hypothesis 1d: Greater behavioral uncertainty decreases a complementor's intention to join an ecosystem

The Nature of Transaction Costs in Platform Ecosystems

After conceptualizing the consequences of transaction costs in platform ecosystems, our research zooms on the interplay of different control mechanisms and extension architectures to explore the nature of such transaction costs. We therefore develop the overarching idea that the dimensions of transaction costs are shaped by the interplay of the micro-architecture of single extensions, which is constraint, but not necessarily equal, to the platform architecture, as well as the control modes centrally applied to govern the surrounding ecosystem.

Clan Control and its Effect on Behavioral Uncertainty

The most common informal mechanism to govern partners and the interaction within an ecosystem is clan control. This form of control is accomplished by mutual values and shared goals between actors in the ecosystem. Common values are introduced by a central controller, i.e. the platform owner but also emerge among members of an effective ecosystem. Such control is a crucial soft power instrument for platform owners to bring actors around their platform on a common path (Tiwana et al. 2013). For instance, platform owners may release norms, mutual values and goals that are beneficial for the strategic aims of the platform like behaviors covering app updates and bug fixing (Goldbach & Benlian 2015). Such informal control is used to align the behavior of actors with the overall ecosystem goals. When, for instance, collective norms are violated by one member of the clan (e.g. the platform owner), other members (e.g. other complementors) will react with social sanctioning. Clan control therefore describes a suitable control mechanism when behavior of the platform owner is hard to specify (Kirsch 1996). Hence, the common values and norms, introduced by the mechanism of clan control and shared between the platform owner and the complementor, reduce the complementor's uncertainty that the platform owner might for instance act opportunistically.

Hypothesis 2a: Greater use of clan control decreases behavioral uncertainty

Extension Modularization and its Effect on Asset Specificity

To analyze the role of architecture in creating transaction costs, we zoom on the level of the micro-architecture of a single extension. In particular, extension modularization is focusing on linkages between the platform and the extension on a micro-level (Tiwana 2015b). This deliberate design choice of the complementor minimizes the extension-platform dependencies on the degree to which an extension is required to be conforming to the interface. Such specifications, however, are determined by the platform owner. Standardization of interfaces describes the degree to which the linkage between the platform and the extensions is stable and well-documented by applying boundary resources like application programming interfaces (APIs) (Tiwana et al. 2010). A high level of standardization decreases the need for the complementor to make huge investments in knowledge regarding the internal implementation of a certain platform, which is highly bound to a specific platform and will have less value if the complementor switches to another platform. Standardized interfaces reduce the asset specificity of third-party

innovation (Schilling 2000) and hence minimize the costs of coordination and transaction for complementors during their transactions with the platform owner (Baldwin 2008). Therefore, the modularization of extensions shapes the transaction cost of complementors in platform ecosystems. In particular, modularity reduces the complementor's specific investments in knowledge and technologies that are bound to a certain platform and thus the asset specificity of such transactions.

Hypothesis 2b: Greater modularization of an extension decreases asset specificity

The Dual Role of Extension Modularization's Effect on Environmental Uncertainty

Generally, extension modularization decreases platform dependencies and aims at reducing complexity (Simon 1962). In particular, decoupling reduces the need for adaptations in the complementor's extension after changes in the platform (Nambisan 2002). Modification of the platform therefore does not affect the single extension of third-party developers. Furthermore, standardization also pays on the argument of decoupling to keep transaction costs low. The use of standardized interfaces enables stability without risking the functionality of an application (Tiwana et al. 2010). The technological requirements of the relationship are hence less complex and volatile (Schilling 2000). Extension modularization therefore decreases the uncertainty of the technological environment and consequently reduces the need and costs for adaption. However, if an adaption of the extension is required, modularization enables rapid changes and reintegration of a revised extension (Tiwana & Konsynski 2010; Tiwana 2015a). Extension modularization therefore reduces the complexity of evaluating technological changes and the related technological uncertainty.

Hypothesis 2c: Greater modularization of an extension decreases its technological uncertainty

On the level of intra-platform competition, however, extension modularization influences the volatility of the market environment and competitors. The assumption that modularization creates the potential for enabling an extension's evolution due to decoupling, reducing interdependencies and the use of standardized interfaces which eases interoperability with the platform is widespread in modularity literature (e.g. Sanchez & Mahoney 1996, Simon 1962). Nevertheless, extension modularization by itself is not sufficient to accelerate evolution, as every change of the extension requires guaranteeing interoperability and quality standards of the ecosystem (Baldwin & Clark 2006). Input control involves formal application and selection processes that are required to get admission to the ecosystem and allow the platform owner to guarantee interoperability, quality or a fit with the platform's interests, values, and positioning (Tiwana 2015a). Following Tiwana (2015a), the evolutionary capabilities of a platform are therefore catalyzed by the level of input control, as this control mechanism becomes a bottleneck in accelerating evolution. Consequently, the evolution of one extension alters the competitive environment of other third-party innovations in the ecosystem. Apart from the positive effect of an extension's evolution on its individual performance, the interplay of input control accomplished by the platform owner and the level of possible extension modularization therefore enhances the unpredictability of competitors and the market. Especially, if extension modularization and input control are both high, their interaction effect accelerates market uncertainty.

Hypothesis 2d: The interplay of input control and extension modularization increases market uncertainty

Methodology

To test the proposed research model, we will conduct a quantitative online survey to collect primary data. For the context of our research we choose the partner ecosystems of five leading cloud platforms in the EAS domain (i.e. Microsoft Azure, Oracle Cloud Platform, Amazon Web Services, SAP HANA, and Salesforce Force.com). The platforms were chosen for two reasons. First, they are all established players and have a solid traction among complementors. This means that all examined platforms have a large partner ecosystem. Second, due to their size and high level of power imbalance, they perfectly meet our requirements for analyzing especially the role of the interplay of platform governance and extension architecture on the cost of complementors. The sampling frame is a random sample of partners on all of the platforms. We eliminated those partners that are suppliers or system integrators solely focusing on

complementors, which are developing and offering complementary value propositions in form of software artefacts (i.e. extensions).

Measures

We followed the principles of Babbie (1990) to ensure rigorous scale development and validation procedures. To ensure validity, measures that have already been validated in prior studies were used wherever possible and scales were adapted slightly when necessary to create a closer fit for the purpose of our study. We recognize that a survey methodology measures the respondent's perception of a specific phenomenon and utilizes human proxy respondent's assessment of aspects about organizational properties. Furthermore, we used a pretest and a pilot study to develop our measurement instruments and ensure validity, reliability as well as rigor of the constructs for our main study (Lewis et al. 2005). Table 1 provides a summary of our measures.

Table 1. Construct Measures	
Construct	Source of Measurement
Join Decision	
<i>Intention to Join the Ecosystem</i>	Newly Developed Scale
Transaction Costs Dimensions	
<i>Asset Specificity</i>	Adapted from Heide & John (1990)
<i>Technological Uncertainty</i>	Adapted from Walker & Weber (1984); Stump & Heide (1996)
<i>Market Uncertainty</i>	Adapted from Walker & Weber (1984); Stump & Heide (1996)
<i>Behavioral Uncertainty</i>	Adapted from Stump & Heide (1996)
Extension Architecture	
<i>Extension Modularization</i>	Adapted from Tiwana (2015a)
Platform Control	
<i>Clan Control</i>	Adapted from Kirsch et al. (2002)
<i>Input Control</i>	Adapted from Tiwana (2015a)

Data Collection and Analysis

A pilot test was conducted with a small group of complementors to further refine our survey items. Following previous approaches in surveys of app developers (e.g. Goldbach & Benlian 2015), we will use a self-developed web-crawler to gather a random sample of contact data from the platforms' app stores. The online questionnaire will then be sent via e-mail to complementors to be forwarded to key informants (Kumar et al. 1993). Furthermore, we attempt to use a second data source to reduce the threat of common method bias.

Next to that, we are aware of the bias that might occur due to focusing on complementors, which have already successfully joined a specific platform ecosystem. To increase the quality of unbiased results, we attempt to also understand complementors which rejected the possibility to participate in an ecosystem or which did not make this decision yet. Therefore, we will integrate this group of complementors into our research by contacting developer communities and particularly complementors that are already part of the partner community of a certain platform but have not developed any applications on this platform yet. Applying this approach will probably enhance the comprehensiveness of decisions to join.

Once primary data are collected, we will use the structural equation model (SEM) (Gefen et al. 2000) with partial least squares (PLS). We choose the PLS approach for analyzing our data, as this allows testing the measurement model (i.e., the psychometric properties of measurement scales) and the estimation of the structural model (i.e., the strength and direction of relationships between the variables) simultaneously. PLS provides an advantage over covariance-based methods (e.g., LISREL) by (1) maximizing the explained variance of endogenous variables in the structural model that enables understanding the level of variance explained in the constructs and by (2) not making any a priori distributional assumptions for the data (Chin 1998).

Conclusion

Our primary objective in this research project is to analyze the nature and consequences of transaction costs in platform ecosystems from the perspective of complementors. In particular, we attempt to shed light on how the architecture of a single extension and especially its interplay with different control mechanisms accomplished by a platform owner facilitates transaction costs and how such costs influence the decision of joining an ecosystem. Therefore, we apply an analysis on the micro-level of single relationships between complementors and platform owners rather than on the macro-level of a whole ecosystem. Our intended theoretical contribution is three-fold. First, we believe that this study contributes to previous work on factors that influence complementor's choice of ecosystems (e.g. Ceccagnoli et al. 2012; Kude et al. 2012) by introducing a cost perspective. Therefore, we propose TCT, which IS research traditionally uses in research on outsourcing (e.g. Aubert et al. 2004; Watjatrakul 2005), as a valuable theoretical lens for platform management. Second, we intend to provide empirical evidence for the influence of modular architecture on transaction costs (Baldwin 2008) by particularly examining its interplay with different modes of platform governance. We therefore contribute to IS control literature by investigating the consequences of certain control choices (e.g. Gopal & Gosain 2010). Third, our research contributes to current studies on intra-platform research and the interplay between control and extension architecture (e.g. Tiwana 2015a). In particular, we extend our current understanding of complementor's costs in platform ecosystems (e.g. Tiwana 2015b) by providing a more holistic examination. We therefore go beyond the technical focus, arising from platform dependencies, and include an economic exchange perspective, which also investigates environmental factors of an ecosystem that exceed the sole dyadic focus of transactions.

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