

Understanding Informal Control Modes on Software Platforms – The Mediating Role of Third-Party Developers’ Intrinsic Motivation

Completed Research Paper

Tobias Goldbach

Technische Universität Darmstadt
Hochschulstr. 1
64289 Darmstadt, Germany
goldbach@ise.tu-darmstadt.de

Alexander Benlian

Technische Universität Darmstadt
Hochschulstr. 1
64289 Darmstadt, Germany
benlian@ise.tu-darmstadt.de

Abstract

Software ecosystem platforms such as Google’s Play Store or Apple’s App Store rely heavily on highly motivated third-party developers who are eager to invest their time and effort into developing and updating apps for platforms. Platform owners are challenged to find a balance between developers’ need for autonomy and a platform’s integrity. Despite the widely acknowledged importance of informal control modes in such contexts, limited empirical work exists on how and why clan and self-control affect developers’ behaviors and performance outcomes on software platforms. Drawing on control theory and motivation literature, we conducted an online survey with 230 Android developers to examine how developers’ intrinsic motivation mediates the effects of informal control modes on developer performance. Our findings show that while intrinsic motivation plays an important role in mediating both informal control modes’ effects, clan control exhibits predominantly stronger downstream effects than self-control. Implications for research and practice are discussed.

Keywords: Informal Control Modes, Intrinsic Motivation, Development Effort, Intention to Stay, Software Platforms

Introduction

Software platforms have offered novel ways for third-party developers to develop, manage and distribute software. By providing programming interfaces and developer tools, platform owners deliberately open their organization and enable external developers to extend the core functionality of the platform and to distribute applications via the platform marketplace (Boudreau 2012). In recent years, platform owners were able to build prospering and profitable ecosystems, such as Apple’s App Store, Google’s Play Store or the Facebook App Centre. In Q4 2014, Google’s Play Store offered 1.43 million apps, published by nearly 400,000 developers. A total of \$25 billion have been earned cumulatively by Apple developers from their app sales since 2008 (Apple 2015) and shipments of smartphones worldwide have grown by a 27.7% in 2014 to 1.3 billion (IDC 2015).

Platform owners build on leveraging third-party developers’ ingenuity and skills, and attempt to integrate, motivate and keep developers on their platform (Ceccagnoli et al. 2012). Thereby, software platforms achieve higher output rates, foster innovation and develop new capabilities to react to fast changing markets and customer needs (Boudreau and Lakhani 2009). Consequently, it is rational for platform

owners to create an environment in which developers are continuously motivated to invest their time and effort for developing and improving their apps. From a platform governance view, platform owners are challenged to harmonize their own strategies with the developers' activities and goals (Tiwana et al. 2010). A diverse set of formal and informal control modes are typically exercised on platforms to motivate beneficial developer (i.e., controlee) behaviors (Tiwana et al. 2010). Given the large number of developers and development projects on software platforms, exercising tight control on each project becomes, however, tremendously costly and time-consuming. As a result, informal control modes (i.e., self-control and clan control), which rely on people skills and self-regulation, have been found to gain in importance in decentralized and complex multi-project settings such as software platforms (Goldbach et al. 2014; Kirsch 2004; Tiwana et al. 2013).

Two research gaps in the IS literature regarding control modes are particular noteworthy. First, studies have largely focused on understanding the nature, antecedents and choice of formal and informal control modes (e.g., Choudhury and Sabherwal 2003; Chua et al. 2012; Henderson and Lee 1992; Kirsch 1996; Kirsch 1997; Kirsch et al. 2010; Kirsch et al. 2002) and only a few studies have analyzed the downstream effects of control modes. Studies focused almost exclusively on effects of formal control modes, resulted in mixed findings regarding the effects of clan control, or did not provide an explanatory argument why an effect occurs (Gopal and Gosain 2010; Keil et al. 2013; Tiwana 2010; Tiwana and Keil 2009). Second, most IS control studies have either focused on internal projects (Cardinal 2001; Chua et al. 2012; Kirsch 1996; Kirsch 2004; Kirsch et al. 2010) or outsourced projects (Gregory et al. 2013; Rustagi et al. 2008; Srivastava and Teo 2012; Tiwana and Keil 2009). Studies in more open settings have analyzed the relationship between control and boundary resources on the Apple platform (Ghazawneh and Henfridsson 2013), or the relation between control and autonomy in a business technology ecosystem (Wareham et al. 2014).

Furthermore, motivation is well studied as an important factor influencing behaviors and performance (Locke and Latham 2004). Surprisingly, and to the best of our knowledge, there is limited research and empirical evidence on the relationship between different control modes and controlees' motivation. Intrinsic motivation, based on an individual's inherent interest in an activity, has been found to be superior to other forms of motivation (Carton 1996; Deci and Ryan 2000) and intrinsic motivation plays a predominate role in more open environments (Ke and Zhang 2009). Therefore, we further want to shed light on the link between informal control and developers' intrinsic motivation on software platforms.

In summary, our knowledge regarding the effects of informal control modes on third-party developers' behaviors and outcomes on software platforms is still limited and we lack a deeper understanding of how developers' intrinsic motivation drives these effects. In order to contribute to these research gaps, the purpose of our study is to analyze the effects of self-control and clan control on third-party developers' intrinsic motivation and the role of intrinsic motivation as a possible explanation for why and how informal control modes affect crucial developer outcomes and behaviors. Our study is guided by two research questions:

- (1) *How does self-control and clan control affect third-party developers' intrinsic motivation.*
- (2) *Does developers' intrinsic motivation mediate the relationship between informal control modes and crucial developer behaviors and outcomes?*

For answering these questions, we conducted an only survey with 230 Android developers. Our study provides several theoretical contributions by offering a deeper understanding on how informal control modes operate and positively influence third-party developer behaviors, outcomes and intentions on software platforms. We not only respond to several research calls on analyzing how informal control modes operate on software platforms (Tiwana et al. 2013; Wareham et al. 2014), but also provide empirical evidence for a mediating role of third-party developers' intrinsic motivation in the relationship between informal control modes and developers' effort and intention to stay on the platform. We are thus contributing particularly to IS control literature by providing an explanation of why informal control positively affects developer performance. Third, our study also provides practical insights for platform owners that high-quality performance outcomes can be achieved on software platforms by embracing more soft power instruments rather than exercising tight control.

Our paper is organized as follows: We first present the theoretical background of our study and develop our research model and hypotheses. We then describe our research methodology followed by our results. The paper concludes with a discussion of key findings, implications and directions for further research.

Theoretical Background

Platform Governance and Informal Control Modes

A platform owner usually strives to attain a healthy and viable platform ecosystem, which means durability and growth for the platform (Hartigh et al. 2006). Platform owners build on leveraging third-party developers' ingenuity and skills, and attempt to integrate, motivate and keep developers on their platform (Ceccagnoli et al. 2012). According to Tiwana et al. (2010), platform governance can be defined as who makes what decision on and about a platform, including the allocation of decision rights, the ownership of a platform and its third-party modules, and lastly the control of behaviors and outcomes on a platform. Control refers to the controller's attempts to influence and motivate an individual or a group of individuals (the controlee) to act accordingly to the controller's objectives (Ouchi 1980).

Control mechanisms are typically divided into formal control and informal control modes (e.g., Kirsch 1997; Kirsch et al. 2002): On the one hand, formal control modes are divided into behavior control and outcome control. With output control, controllers pre-specify desirable output requirements and performance targets as objectives in advance, for example by written contracts, which are then monitored, evaluated and accordingly rewarded. By contrast, with behavior control, specific procedures and methodologies are pre-determined, while characteristics of outcomes are free to be chosen by the controlee (Kirsch et al. 2002). On the other hand, informal control modes build on social skills and meanings of self-regulation, based on shared norms and values of groups or individuals. Informal control refers to self-control and clan control. With self-control, individuals set their own goals, monitor themselves and sanction or reward themselves in accordance. Controllers may build an environment suitable for self-regulatory behaviors. By providing tools and trainings for self-regulation as well as information and statistics needed for making decisions, controlees are able to organize and evaluate themselves (Kirsch et al. 2002). Clan control enables controllers to reduce the differences between controlee's activities and their own strategies. By promulgating shared values, beliefs or common goals, controlees as members of a group typically commit themselves to these shared values and beliefs and therefore tend to adopt similar procedures and comparable performance outcomes. Clan control therefore helps to maintain the controlee's integrity without exercising tight control. Clan control is likely to lead to a sense of cohesiveness among clan members, which in turn facilitates self-regulatory mechanisms on a group level (e.g., evaluating and correcting each other) in accordance with shared values and beliefs (Kirsch et al. 2002). Shared values, norms and common goals are not only propagated by a controller but also emerge and are encouraged by members of an effective clan (Kirsch 1997; Turner and Makhija 2006). Self- and clan control are particularly important when outcomes are unclear or difficult to measure and behavior is hard to specify or not observable (Kirsch 1996; Kirsch et al. 2002; Kohli and Kettinger 2004).

Although control literature has a long tradition in IS research, recent studies have noted our limited knowledge about how different control modes operate and affect individuals, especially regarding third-party developers on highly dynamic and multi-project based software platform contexts (Ghazawneh and Henfridsson 2013; Goldbach et al. 2014; Tiwana et al. 2013; Wareham et al. 2014). In particular Tiwana et al. (2010) pointed out that control on software platforms requires a delicate balance between third-party developers' need for autonomy and a platform's integrity. They further noted that exercising strict formal control on every development project may become tremendously costly and time-consuming or even be redundant, given that interests among these two parties are not principally divergent. Against this backdrop, we believe that exercising informal control modes presents an opportunity to grant developers a certain amount of autonomy while simultaneously bringing developers onto a common path of shared values, beliefs and goals, without the need for tight supervision and regulation. This is in line with previous studies which stated that informal control and soft-power instruments are particular important in such decentralized and complex multi-project contexts (Kirsch 2004; Tiwana et al. 2010; Yoffie and Kwak 2006). However, there is still limited understanding on how and why informal control modes affect third-party developers' behaviors, outcomes and intentions on software-platforms. Previous research on the downstream effects of control modes have primarily focused on formal control modes in outsourcing

contexts and the few studies that looked at the consequences of clan control showed only limited or inconclusive findings (Gopal and Gosain 2010; Keil et al. 2013; Tiwana 2010; Tiwana and Keil 2009).

A variety of formal and informal control mechanisms can be observed on software platforms (Tiwana 2014). Self-control manifests itself in different parts on the platform. While Apple, for example, tightly approves every app that is published on the platform in order to secure quality and the adherence of development guidelines, such an approval process is largely absent on Google's Android platform and therefore the responsibility lies within self-control of third-party developers. Moreover, ensuring that development projects finish within budget and schedule is typically overseen by third-party developers themselves (Bergvall-Kåreborn and Howcroft 2011). To interact with each other, third-party developers usually participate in platform-dedicated online communities (e.g., developer.apple.com or developer.android.com). Additional channels for sharing information, knowledge, expertise and best practice solutions are forums, wikis, blogs, chats and developer conferences. Platform owners typically establish and interact with developers in such communities and social media channels in order to create clan control on software platforms. As an example, Apple products are promoted as being well designed and innovative as well as implying a trendy lifestyle, which in turn is shown in the design, usability and user experience of the products, reflecting the Apple brand. Android, on the other side, is a more open and less regulated platform and Android developers aim at a wide variety of devices, diversity in offered apps and customizability for customers (Bergvall-Kåreborn and Howcroft 2011). App developers mainly share such norms and values, which in turn is manifested in their development approaches, functionalities and design of third-party apps. Common norms and goals in a development context may also be the adherence to coding and design standards, naming conventions, testing processes and framework usage. The exercise of control mechanisms may vary across different platforms (mobile, social media, open source). However, this study focuses on mobile platforms.

Third-Party Developers Intrinsic Motivation

As mentioned earlier, control is defined as controller's attempts to influence and motivate an individual or a group to act in accordance with the objectives of the controller (Ouchi 1980). Therefore, control modes are largely exercised to motivate individuals' behavior. Motivation is well studied as an important factor influencing human behavior (Locke and Latham 2004) and particularly intrinsic motivation has been recognized as a critical antecedent for high quality performance (Utman 1997). This indicates the importance of understanding work-environment characteristics that positively affect individuals' intrinsic motivation. Surprisingly, and to the best of our knowledge, there is limited research and empirical evidence on the relationship between different control modes—as understood in the research stream of Kirsch (1997)—and controlees' motivation.

Motivation generally refers to “*internal factors that impel action and to external factors that can act as inducements to action*” (Locke and Latham 2004, p. 388). According to self-determination theory, motivation is generally classified as extrinsic or intrinsic motivation (Deci and Ryan 1985). Extrinsic motivation refers to a motivation to complete a task or engage in an activity because of its consequences, such as gaining a reward or evading punishment. In contrast, intrinsic motivation is related to individuals' motivation to complete a task or perform an action out of own interest, enjoyment and for the sake of the activity itself (Deci and Ryan 2000). Intrinsic motivation has been found to be superior to other forms of motivation (Carton 1996; Deci and Ryan 2000) and intrinsic motivation plays a predominant role in more open environments (Ke and Zhang 2009). Given that software platforms rely on highly motivated third-party developers who are eager to invest their time and effort into developing and updating apps for the platform, we focus on the role of third-party developers' intrinsic motivation in order to analyze the effects between informal control modes and crucial developer outcomes.

Self-determination theory proposes that it is more likely to perform intrinsically motivated activities when basic psychological needs are satisfied, which make individuals' activities more interesting and more likely to be performed for their own sake. These basic needs refer to individuals' autonomy, competence and relatedness (Deci and Ryan 2000). Autonomy refers to a perceived degree to which an individual performs a task or persuades a goal which is based on own decisions and own desires. Competence is the degree to which an individual can interact effectively with the work environment and the perception of their competence to accomplish desired outcomes. Relatedness is the degree to which individuals feel connected to others and are involved with their social surroundings (Deci and Ryan 2000; Gagne and

Deci 2005). On the contrary, situations that undermine individuals' autonomy and make them feel incompetent or rather isolated from their work-environment will weaken their intrinsically motivated behavior. Intrinsic motivation is generally associated with a sense of well-being, higher self-esteem and integrity as well as a higher overall job satisfaction (e.g., Carton 1996; Deci and Ryan 1985; Deci and Ryan 2000; Vallerand and Bissonnette 1992). Indeed, having fun and enjoying an activity is seen as the core of intrinsic motivation (Deci and Ryan 1985).

Previous studies have found that software development is an inherently motivating task, given that it is creative and complicated, but challenging for superiors to observe (Hilkert et al. 2010; Kirsch 1996; Weinberg 1998). In literature on open source software, developers' intrinsic motivation has been examined as a crucial engagement factor for many open source contexts. However, while for example Shah (2006) found evidence that intrinsic motivation is positively related to developers' engagement in a project, Roberts et al. (2006) found no significant effect on developers' contribution level. Nevertheless, open source software contexts are different from our study's context, due to the typically absence of a central platform owner who provides a software core and who steers and controls activities and decisions on and around a software platform. In addition, Amabile et al. (1994) pointed out that individuals' motivation regarding specific activities may vary regarding their surrounding context. Thus, the purpose of our study is to examine third-party developers' intrinsic motivation regarding app development on software platforms. This activity typically includes being exposed to the platforms' principal market and governance strategies, interacting with the platform and its community, and employing available development resources.

Research Model and Hypotheses

In the following, we develop our research model (Figure 1). We propose that (1) informal control modes will positively affect third-party developers' intrinsic motivation to develop apps for the platform and (2) their intrinsic motivation mediates the effects of informal control modes on crucial developer outcomes.

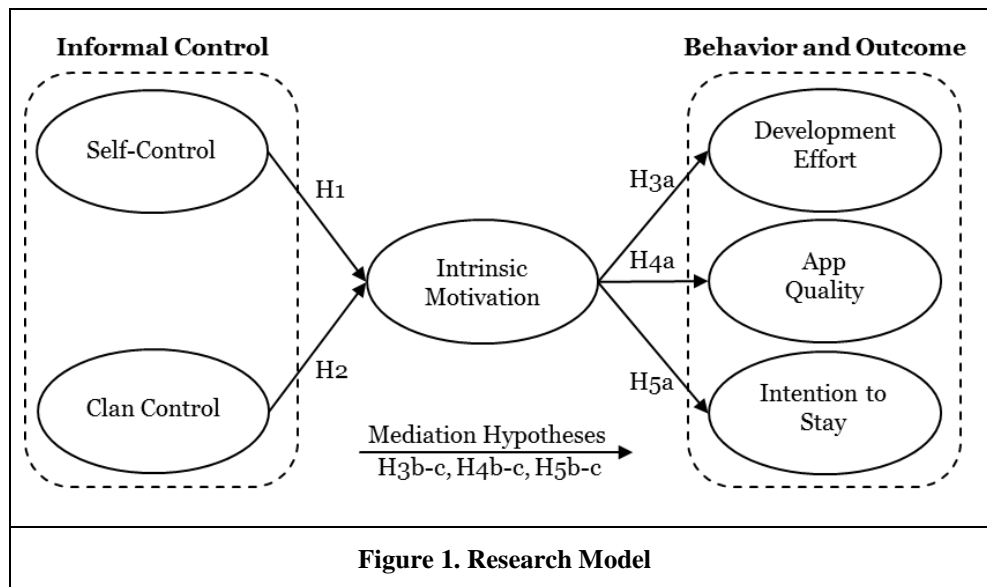


Figure 1. Research Model

Informal Control Modes and Intrinsic Motivation

Self-control is based on self-management and self-regulation by the controlee (Kirsch 1997). Controllers implement self-control in their work-environment by giving controlees freedom to decide on their own activities and to choose their own goals in specific areas. Other forms of regulations or monitoring which may result in infringements on individuals' activities are mainly absent and individuals are not urged to comply with pre-specified behaviors or outcomes. Thus, self-control creates a work environment in which individuals have the opportunity to pursue their self-interests and to satisfy their desire to work autonomously. If individuals perceive a certain amount of autonomy, their activities are likely to be

intrinsically motivated and associated with enjoyment and satisfaction (Deci and Ryan 1985). Also, if individuals gain control over their own work, they are likely to perceive their work as meaningful and interesting (Slocum and Sims 1980). Taken to the software platform context, if platform owners grant third-party developers a certain amount of freedom to decide on their own development goals and activities as well as encourage and train developers in exercising self-control, developers are likely to perceive and appreciate a higher degree of autonomy. This in turn may lead to higher intrinsic motivation during app development on the platform. In summary, these arguments suggest that:

H1: The exercise of self-control is positively related to third-party developers' intrinsic motivation.

Exercising clan control is based on promulgating shared values, norms and beliefs and on reducing different views across individuals, which could be achieved either by the controller or by individuals of the clan (Choudhury and Sabherwal 2003; Kirsch 1997; Rowe and Wright 1997). Exercising clan control builds on regular interactions and information sharing among members of a collective in order to spread these shared values, norms and common goals. Clan control is realized when individuals have internalized common goals and strategies through shared norms and values and therefore have become part of the clan (Kirsch et al. 2002). According to self-determination theory, individuals are more likely to be intrinsically motivated and to enjoy their activities if their basic need for autonomy, competence and/or relatedness is satisfied (Deci and Ryan 2000). Commitment to a group along with a homelike feeling is likely reached by individuals who are working for and with people with similar mindsets and common goals (Das and Teng 2001; Ouchi 1980). Therefore, clan control facilitates a sense of belonging and relatedness with other members of the clan. Members of a clan typically discuss issues and questions openly and share information and knowledge among members (Gopal and Gosain 2010). Thus, clan members have possibilities to share their expertise, express their competence in discussions and shape their working environment. Lastly, individuals exposed to clan control still perceive a fair amount of autonomy and opportunity to pursue their self-interests. The constraint to comply with pre-specified behaviors or outcomes is largely absent. Applied to the platform context, if clan control is successfully exercised and individuals have become part of the platforms' community, third-party developers are likely to satisfy their needs for relatedness, competence and autonomy. This in turn is likely to facilitate their intrinsic motivation to develop apps for the platform. Therefore, we suggest:

H2: The exercise of clan control is positively related to third-party developers' intrinsic motivation.

Intrinsic Motivation and Developers' Behaviors and Outcomes

Platform owners commonly strive to leverage third-party developers' ingenuity and skills, and attempt to integrate, motivate and keep developers on their platform (Ceccagnoli et al. 2012). In order to analyze effects on third-party developers' performance outcomes, we adapt a classification from previous literature (Fernandez and Moldogaziev 2012): First, work-related outcomes refer to individuals' effort (i.e., how hard they work) and their willingness to find better ways to work, resulting in higher-quality outcomes (i.e., how smart they work). Second, job-related outcomes refer to a general job satisfaction and loyalty towards their employer. Thus, we are focusing on work-related (i.e., development effort and app quality) and platform-related outcomes (i.e., developers' intention to stay on the platform).

Development Effort

Effort can be defined as the intensity and amount of resources expended on a given task and reflects how hard an individual works (Kanfer 1990). High development effort is likely to enhance third-party developers' outcomes and may manifest itself in how often apps are released and updated.

Individuals with a high intrinsic motivation perform activities for the enjoyment, satisfaction and interest mainly derived from the activity itself, for which they experience also a sense of well-being, higher self-esteem and increased initiatives (Deci and Ryan 1985). Because of such enjoyment and interest in an activity, individuals are willing to devote effort (Deci and Ryan 2000). These positive effects are likely to enhance individuals' expectation that their efforts will lead to positive outcomes (Locke and Latham 2004). Also, their self-interest and autonomy may let them perceive their outcomes depending on their own efforts (Wang and Netemeyer 2002). This is in turn likely to motivate individuals to invest even more time and effort into their activities. Taken to the software platform context, if third-party developers are intrinsically motivated and enjoy developing apps for a platform, they are more likely to try harder and invest more effort into their development activities. Thus, we postulate that:

H3a: Third-party developers' intrinsic motivation is positively related to their app development effort.

We further argue that the relationship between self-control and development effort as well as between clan control and development effort is mediated by third-party developers' intrinsic motivation. As discussed above, encouraging and supporting developers in exercising self-control as well as building a clan and exercising clan control on a software platform may stimulate third-party developers' intrinsic motivation. This higher intrinsic motivation may then empower third-party developers to invest more effort into their activities. We therefore suggest that intrinsic motivation carries the positive effects of self-control and clan control over to developers' effort during app development. Therefore, we postulate:

H3b: Intrinsic motivation mediates the effect of self-control on development effort.

H3c: Intrinsic motivation mediates the effect of clan control on development effort.

App Quality

High quality apps are a particular important performance indicator for software platforms, given that such apps are typically rewarded by the platform's customer base with strong sales and low-quality apps with rather poor sales (Tiwana 2014). On software platforms, such quality is typically reflected by app ratings in the platform store and high ratings are a typical goal for developers and platform owners alike.

Intrinsically motivated behaviors are generally associated with a sense of well-being, higher self-esteem and increased initiatives (e.g., Deci and Ryan 1985) which is likely to lead to a greater attention and focus on a task (Osterloh and Frey 2000). Such intrinsically motivated attention has been found to stimulate individuals to engage in creative processes and to explore new pathways for performing a task, which in turn may lead to better problem solving as well as more creative and higher quality outcomes (Amabile et al. 1990; Reiter-Palmon et al. 1998). Additionally, intrinsically motivated behavior has been found to result in faster learning (Ryan and Deci 2000). In a software platform context, third-party developers who are intrinsically motivated and enjoy developing apps for a platform will have a higher possibility to pay great attention to their development activity and arising problems. This stronger focus and higher creativity is likely to enable newer and better ways to solve problems and produce more reliable and higher-quality apps for the platform. Thus, we hypothesize that:

H4a: Third-party developers' intrinsic motivation is positively related to their app quality.

Accordingly to the above arguments, we believe that when third-party developers perceive higher levels of self-control and clan control, they are more likely to perform app development on a platform out of intrinsic motivation and enjoyment. This in turn may also lead to higher creativity and more attention on their app development processes, which is likely to lead to higher quality apps. Thus, we suggest:

H4b: Intrinsic motivation mediates the effect of self-control on app quality.

H4c: Intrinsic motivation mediates the effect of clan control on quality.

Intention to Stay

A crucial platform-related outcome is third-party developers' intention to stay and constantly participate on a platform in the long run (Boudreau 2012; Ceccagnoli et al. 2012). Developers typically contribute to the platform's productivity, robustness and innovative capacity when they continue to develop and update apps for the platform and engage themselves in the platforms' community (Iansiti and Levien 2004).

As mentioned before, individuals who are intrinsically motivated perform a task out of interest, enjoyment and satisfaction (Deci and Ryan 1985). Such motivation is likely to be energized and sustainable over time and is typically reflected in an individual's intention to act (Deci and Ryan 2000). Previous studies have empirically demonstrated the relationship between intrinsic motivation and behavioral intentions regarding system and technology usage. When individuals enjoy using a system, they are likely to accept the system and therefore develop a behavioral intention to further use the system (Davis et al. 1992; Venkatesh and Speier 1999). Adapted to the software platform context, if developers enjoy developing apps for a platform and if they feel more satisfied and comfortable, they are more likely to feel an urge to keep performing this activity. These arguments suggest that third-party developers will have a higher intention to keep contributing to and participating in a software platform, when they feel a higher intrinsic motivation and enjoyment while developing apps for the platform. Thus, we postulate:

H5a: Third-party developers' intrinsic motivation is positively related to their intention to stay on the platform.

Given that third-party developers exposed to self- and clan control are more likely to be intrinsically motivated and to enjoy developing apps for a platform, we again argue that this higher intrinsic motivation will carry the positive effects over to developers' intention to stay on the platform. Therefore:

H5b: Intrinsic motivation mediates the effect of self-control on intention to stay.

H5c: Intrinsic motivation mediates the effect of clan control on intention to stay.

Research Methodology

Data collection and Sample Description

We created an online survey and collected data with app developers of the Android platform in order to test our hypotheses. Google Inc. introduced the Android platform in 2008. The mobile app platform is a typical two-sided software platform with an operating system, middleware and external and internal applications. With a Software Development Kit, third-party developers are able to develop apps for Android devices and to offer these apps via the Play Store, or the Amazon App-Shop. While Android is mostly free, it is not open source. Google is controlling the Android system, device manufactures and app developers have to rely on or cooperate with Google. The Google Play Store offers several proprietary and non-open software (Bergvall-Kåreborn and Howcroft 2011). In Q4 2014, Android offered 1.43 million apps in the Google Play Store, published by nearly 400,000 app developers, and the Amazon App-Shop about 300,000 apps from nearly 50,000 app developers. 60% more Android apps were download in Q4 2014 compared to Apple apps and Android holds 76.6% of the mobile market (AppFigures 2015; IDC 2015). Thus, we believe that Android developers are a suitable representation for the mobile app market and for data collection in our study.

Gender	N	%	Experience software development	N	%
Male	214	95.1%	< 1 year	21	9.1%
Female	11	4.8%	1 to 3 years	39	17.0%
Age	N	%	3 to 5 years	30	13.0%
15-24	41	17.8%	5 to 7 years	26	11.3%
25-34	89	38.7%	> 7 years	114	49.6%
35-44	62	27%	Experience app development	N	%
44-64	37	16.1%	< 1 year	24	9.1%
65+	1	0.4%	1 to 3 years	100	43.5%
Employment	N	%	3 to 5 years	66	28.7%
Employed (company)	43	18.7%	5 to 7 years	24	10.4%
Independent/freelancer	17	7.4%	> 7 years	19	8.3%
Hobbyist or private	94	40.9%	Number of developed apps for ...	Mean	SD
Self-employed	67	33.0%	... Android	7,29	9.83
Multiple Platforms	N	%	... Apple	2.47	6.13
Yes	113	49.1%	... Windows Phone	0.65	3.55
No	117	50.9%	... Blackberry	0.21	1.67

With a self-developed web-crawler, and similar to previous app developers studies (Benlian et al. 2015), we collected contact data from random Android developers on the Google Play Store and additional data from their published apps. We sent a link to our survey via mail to about 8,000 app developers. The invitation to the survey and the survey's start page explained the purpose of the study and ensured anonymity and confidentiality of the response data. We also asked to forward the survey invitation to a lead developer in order to obtain survey answers from key informants (Kumar et al. 1993). Developers could win a tablet, an e-book reader or amazon gift-cards as a reward for participation.

Our survey was started by 526 developers, which represents a common response rate in such settings of 6.58%. In total, 236 developers finished our survey, from which we removed 6 cases due to implausible short handling time, resulting in a final sample size of $N=230$. We tested for a possible non-response bias by comparing Chi-squares of the responses from the first quartile and those of the last quartile and found no significant difference between these groups on our main constructs (Armstrong and Overton 1977). This suggests that non-response bias is unlikely to be an issue in our study. Most participants are hobbyist and private app developers (40.9%) or self-employed (33%). The majority has more than 5 years of experience in software development and between 1 and 5 years in app development. Developers in our sample have developed mostly for Android with an average of 7.29 developed apps, while 49.1% have developed as least one app for another platform. Sample demographics are shown in Table 1.

Measurement of Constructs

All measures in our survey (see Table 2) were based on established scales from previous studies and were slightly revised to make them more fitting and understandable for the study context. Measures for self-control and clan control were adapted from Tiwana and Keil (2009), which are based on the original control measures of prior studies from Kirsch et al. (2002). We added one more item for self-control in order to capture if developers’ self-regulation is not caused by an act of ignoring platform rules. We similarly added one more item for clan control in order to capture if shared norms, values and common goals influence developers’ procedures and outcomes.

<i>Self-Control</i> (Kirsch et al. 2002; Tiwana and Keil 2009)	I self-manage my app development process on the platform.
	I set specific goals for my app project without the platform owner’s involvement.
	I define specific procedures for my app project’s activities without the platform owner’s involvement.
	The platform owner grants autonomy to set goals independently.
<i>Clan Control</i> (Kirsch et al. 2002; Tiwana and Keil 2009)	I attempt to interact regularly with other developers on the Android platform (e.g., in forums, chats, blogs).
	I attempt to understand the platforms’ goals, values and norms.
	I place a significant weight on understanding the platforms’ goals, values, and norms.
	I actively participate in developer forums, channels or conferences to understand the platform’s goals, values and norms.
	Shared norms, values and goals of the platform influence my app development (procedures, outcomes, etc.).
<i>Intrinsic Motivation</i> (Deci and Ryan 2002)	I enjoy developing apps for the Android platform.
	I would describe developing apps for the Android platform as very interesting.
	Developing apps for the Android platform is fun to do.
<i>Development Effort</i> (Deci and Ryan 2002)	I put a lot of effort into developing apps for the Android platform.
	It is important to me to do well at developing apps for the Android platform.
	I try very hard on developing good apps for the Android platform.
<i>Intention to Stay</i> (Agarwal and Karahanna 2000)	I plan to use the Android platform for app development in the future.
	I intend to continue using the Android platform for app development in the future.
	I expect my use of the Android platform for app development in the future.

Note: All items measured with a 7-point Likert scale, anchored at (1) = strongly disagree and (7) = strongly agree.

Measures for intrinsic motivation and development effort were adapted from the Intrinsic Motivation Inventory (www.selfdeterminationtheory.org), initially developed by Deci and Ryan, and which has been used and shown to be stable in several previous studies (e.g., Deci et al. 1994; Ryan 1982). Previous studies have found, that some items within these subscales overlap considerably and therefore may be reduced to less items (Ryan 1982; Wilde et al. 2009). For intrinsic motivation, we adapted three items from the interest/enjoyment subscale, which is seen as the self-reported measure of intrinsic motivation (Deci and Ryan 2002), and for development effort, we adapted three items from the effort subscale. Both

measures were revised to capture app development on a specific platform (i.e., activity and context). Measures for intention to stay were based on the behavioral intention construct of Agarwal and Karahanna (2000) and were adjusted to the general platform context. For app quality, we draw on objective data from our web crawler, averaging the rating scores of developers’ app portfolio in the Google Play Store. In addition, we included control variables to account for alternative explanations. We included participants’ age and gender, years of experience in app-development and size of their app portfolio in the platform store, i.e. the number of published apps.

Data Analysis and Results

We used structural equation model (SEM) with partial least squares (PLS) to test our research hypotheses. PLS allows for simultaneous testing of the measurement model (i.e., the psychometric properties of the measurement scales) and the estimation of the structural model (i.e., the strength and direction of the relationship between the variables) (Chin 1998). PLS has an added advantage over covariance-based methods (e.g., LISREL) in that it (1) maximizes the explained variance of endogenous variables in the structural model, which enables to understand the amount of variance explained in the constructs and (2) PLS does not make distributional assumptions for the data (Chin 1998). We used the software SmartPLS 2.0.M3 (Ringle et al. 2005). For robust PLS calculation, a minimum sample size of ten times the maximum number of any paths in the model is suggested (Hair et al. 2012), which our data exceeded with $N=230$. For assessing the significance levels of the paths, we used a bootstrapping procedure with no sign changes and 1,000 resamples following recommendations by Hair et al. (2012). In a two-step approach, we first assessed our measurement model and then analyzed our hypotheses.

Assessment of Measurement Model

We assessed content validity, convergent validity and discriminant validity for all our latent reflective constructs, according to guidelines by Gefen and Straub (2005). For content validity, we performed a qualitative pre-test with developers in order to detect ambiguities, which resulted in some minor wording changes. For convergent validity we used three criteria recommended by Fornell and Larcker (1981): First, all measurement factor loadings must be significant and above the threshold value of 0.70; second, composite reliabilities should exceed 0.80; and third, the average variance extracted (AVE) by each construct must exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). All factor loadings of the measurement items were significant (all $p < .001$) and above the recommended threshold value, with one exception. One item of clan control loaded slightly below the recommended threshold (0.671), which is, however, still in an acceptable range (Chin 1998). Furthermore, every item loaded highest on its construct and cross-loadings differences were much higher than the recommended threshold value of 0.1 (Gefen and Straub 2005). The constructs composite reliabilities were all above 0.885 and the values for AVE were all higher than 0.692. Thus, all constructs met the norms of convergent validity (see Table 3).

Constructs	Mean (SD)	Loading Range	Composite Reliability	Average Variance Extracted
Self-Control	6.17 (1.06)	0.777 - 0.891	0.901	0.692
Clan Control	4.73 (1.46)	0.671 - 0.901	0.922	0.711
Intrinsic Motivation	5.62 (1.15)	0.919 - 0.937	0.944	0.858
Development Effort	5.73 (1.09)	0.796 - 0.870	0.885	0.715
Intention to Stay	6.25 (1.11)	0.925 - 0.981	0.970	0.916
App Quality	4.01 (0.94)		Single-item	

For discriminant validity, the square root correlation between a pair of constructs should be less than the AVE of each construct (Fornell and Larcker 1981). All correlations among constructs are less than the square root of AVE (see Table 4), indicating evidence for discriminant validity. Given that our data was collected in the same time period, we also checked for possible common method bias (Podsakoff et al. 2003). Harman’s one factor test revealed that a single factor could not explain most of the variance among the model variables; the first factor explained only 29.07%. We also compared construct correlations

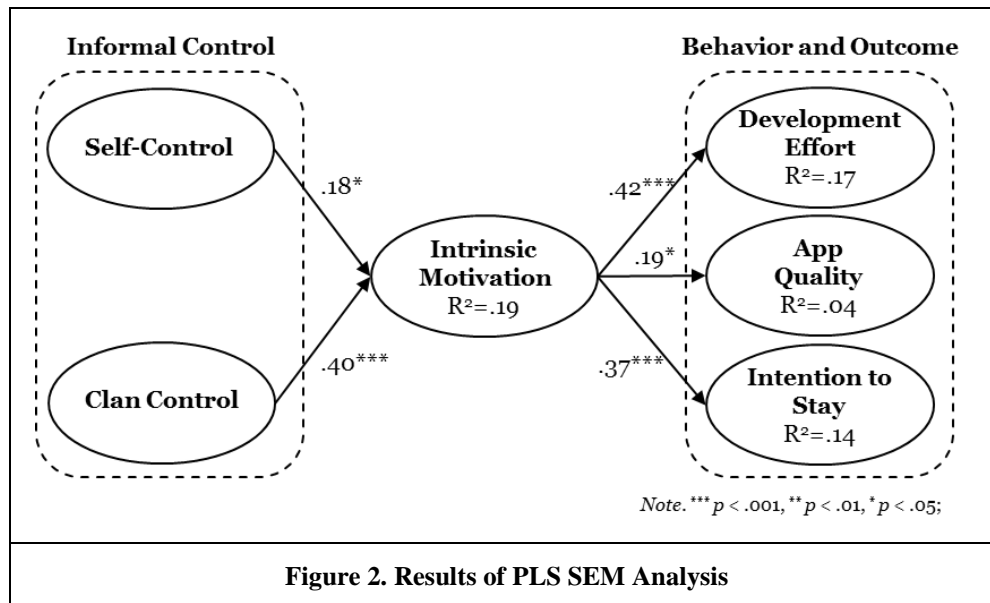
(Pavlou et al. 2007), revealing that no constructs related over 0.9. Both indicate that common method bias is unlikely to exist. All results suggest that the constructs are theoretical and empirical distinguishable concepts with good measurement properties.

	Constructs	1	2	3	4	5	6
1	Self-Control	0.83					
2	Clan Control	0.04	0.84				
3	Intrinsic Motivation	0.19	0.40	0.93			
4	Development Effort	0.26	0.39	0.42	0.85		
5	Intention to Stay	0.27	0.23	0.37	0.22	0.96	
6	App Quality	0.11	0.09	0.19	0.09	-0.06	-

Hypotheses Testing

We first tested for alternative explanations by analyzing the effects of our control variables on the model’s dependent variables. We did not find any significant effects of age, gender, experience in app development or portfolio size on development effort, app quality or intention to stay (all $p > .05$), with one exception. Experience in app development had a positive and significant impact on development effort ($\beta = .15$; $p < .05$) which, however, explained only a low amount of variance. The results of the structural model analysis are shown in Figure 2.

The model explained 19% of the variance in intrinsic motivation, 17% of the variance in development effort, 14% of the variance in intention to stay and only 4% of variance in app quality. Regarding the effects of informal control modes on intrinsic motivation, we found that self-control had a positive significant effect on intrinsic motivation ($\beta = .18$; $p < .05$), which supported H1. Furthermore, clan control had a strong positive significant effect on intrinsic motivation ($\beta = .40$; $p < .001$), in support of H2. Regarding the effects of intrinsic motivation on developers’ behaviors and outcomes, we found that intrinsic motivation had a positive and significant effect on development effort ($\beta = .42$; $p < .001$), supporting H3a. We also found a positive significant effect of intrinsic motivation on app quality ($\beta = .19$; $p < .05$), which supported H4a. Finally, and as expected, we found that intrinsic motivation had a positive significant effect on developers’ intention to stay ($\beta = .37$; $p < .001$), supporting H5a.



Given that clan control exhibited a remarkably stronger effect on intrinsic motivation than self-control, we further investigated the differential effects of both informal control modes on third-party developers’ intrinsic motivation. Following procedures by Sarstedt and Wilczynski (2009), we compared

bootstrapping results for the path coefficients based on paired t-tests. The results showed that the effect of clan-control on third-party developers intrinsic motivation ($\beta = .40$; $p < .001$) is consistently and significantly stronger (t -value = 77.67; $p < .001$) than the effect of self-control on intrinsic motivation ($\beta = .18$; $p < .05$).

Mediation Analysis

In order to test for a mediating effect of third-party developers’ intrinsic motivation, we performed a two-step approach, following recommendations by Preacher and Hayes (2008). In step 1, we analyzed the direct effects of self-control and clan control on development effort, app quality and intention to stay without the mediator intrinsic motivation. In step 2, we introduced intrinsic motivation into the model and analyzed the full path model. In step 1, the model explained 22% of the variance in development effort, 12% of the variance in intention to stay and only 2% of the variance in app quality. We found a positive significant effect of self-control on development effort ($\beta = .25$; $p < .001$) and of self-control on intention to stay ($\beta = .26$; $p < .01$). However, the effect of self-control on app quality was not significant ($\beta = .11$; $p > .05$). Regarding clan control, we found a positive significant effect of clan control on development effort ($\beta = .39$; $p < .001$) and of clan control on intention to stay ($\beta = .22$; $p < .01$). Then again, we could not find a significant effect of clan control on app quality ($\beta = .08$; $p > .05$).

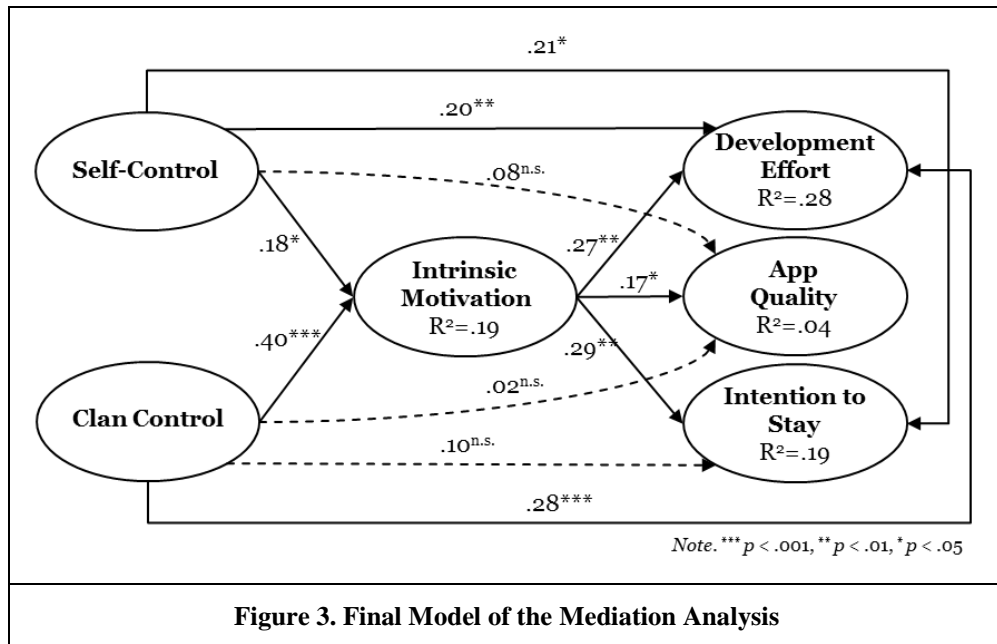


Figure 3. Final Model of the Mediation Analysis

In step 2 (see Figure 3), we introduced our mediator intrinsic motivation into the model. Due to the significant effects of intrinsic motivation, the explained variance increased in development effort ($R^2 = .28$), intention to stay ($R^2 = .19$) and app quality ($R^2 = .04$) compared to the analysis in step 1. First, we found a positive significant effect of intrinsic motivation on development effort ($\beta = .27$; $p < .01$). The effect of self-control on development effort decreased but remained significant ($\beta = .20$; $p < .01$) and also the effect of clan control on development effort decreased but remained significant ($\beta = .28$; $p < .001$). Therefore, intrinsic motivation partially mediated the effect of both self-control and clan control on development effort in support of H3b and H3c. Second, we also found a significant positive effect of intrinsic motivation on intention to stay ($\beta = .29$; $p < .01$). The effect of self-control on intention to stay decreased slightly but remained significant ($\beta = .21$; $p < .05$), while the effect of clan control on intention to stay decreased and became non-significant ($\beta = .10$; $p > .05$). This suggests that intrinsic motivation partially mediated the effect of self-control on intention to stay and fully mediated the effect of clan control. This supports H5b and H5c. Finally, because there were no significant effects of self-control and clan control on app quality, intrinsic motivation did not mediate the effects from self-control and clan control on app quality. Therefore, H4b and H4c had to be rejected. Table 5 summarizes the results of our hypotheses testing.

Table 5. Summary of Hypotheses Testing

H1	Self-Control → Intrinsic Motivation	supported
H2	Clan Control → Intrinsic Motivation	supported
H3a	Intrinsic Motivation → Development Effort	supported
H3b	Self-Control → Intrinsic Motivation → Development Effort	supported
H3c	Clan Control → Intrinsic Motivation → Development Effort	supported
H4a	Intrinsic Motivation → App Quality	supported
H4b	Self-Control → Intrinsic Motivation → App Quality	not supported
H4c	Clan Control → Intrinsic Motivation → App Quality	not supported
H5a	Intrinsic Motivation → Intention to Stay	supported
H5b	Self-Control → Intrinsic Motivation → Intention to Stay	supported
H5c	Clan Control → Intrinsic Motivation → Intention to Stay	supported

Similar to above, we additionally examined the differential effects of self- and clan control on third-party developers effort and intention to stay, following again procedures by Sarstedt and Wilczynski (2009). The results showed that the effect of clan control on development effort is consistently and significantly stronger than the effect of self-control (t-value = 26.51; p < .001). Furthermore, the effect of self-control is consistently and significantly stronger on developers’ intention to stay compared to the effect of clan control (t-value = 31.95; p < .001).

Given the rather low variances explained in our dependent variables, we further analyzed different effect sizes (f^2 , q^2) and the predictive relevance (based on Stone-Geisser- Q^2) in our final model, following guidelines by Cohen (1988). The f^2 effect size reports the change in the R^2 when a specific exogenous construct is omitted from the model. Table 6 shows that f^2 effect sizes in our model are mostly small (> 0.02) or medium (> 0.15), with minor exceptions where we have to assume negligible influence (< 0.02). Further, we analyzed the predictive relevance (Q^2) of our model with respect to the endogenous variables. Table 6 shows, all Q^2 values are above zero, thus providing support for the predictive relevance for the model’s endogenous constructs. The q^2 effect sizes for the predictive relevance are mostly small (> 0.02) or medium (> 0.15), with minor exceptions where we have to assume no predictive relevance (< 0.02).

Table 6. Variance Explained (R^2), Predictive Relevance (Q^2) and Effect Size (f^2 and q^2)

	Intrinsic Motivation		Developer Effort		App Quality		Intention to Stay	
	R^2	Q^2	R^2	Q^2	R^2	Q^2	R^2	Q^2
	f^2	q^2	f^2	q^2	f^2	q^2	f^2	q^2
Self-Control	.038	.024	.052	.029	.006	0.036	0.053	0.047
Clan Control	.194	.156	.091	.052	.000	0.005	0.010	0.021
Intrinsic Motivation	-	-	.072	.047	.023	0.044	0.084	0.072

Discussion and Conclusion

The objective of this paper was to better understand the effects of self-control and clan control in a software platform context. We focused on the mediating role of third-party developers’ intrinsic motivation in the relationship between informal control modes and developers’ effort, app quality and intention to stay on a platform. First, our study results demonstrate that both self-control and clan control positively influence third-party developers’ intrinsic motivation to develop apps on the platform. Conversely, developers are likely to have a lower intrinsic motivation if they perceive decisions and activities on a platform less originated by themselves and refuse to regularly interact and share common norms, values and goals with the platform and its community. In addition, our findings indicate that clan control is more conducive in shaping third-party developers’ intrinsic motivation compared to self-control. Second, our study revealed that third-party developers’ intrinsic motivation enhances crucial developer outcomes, behaviors and intentions on software platforms. Particular, developers with a higher

intrinsic motivation to develop apps for the platform invest more time and effort in their app development procedures, are more likely to have higher quality apps in the platform store and are more willing to stay on the platform and keep developing apps for the platform. Finally, and most important, our mediation analysis revealed an explanatory mechanism for why self-control and clan control operate beneficially on software platforms. Third-party developers' intrinsic motivation serves as a mediator, carrying the positive effects of self-control and clan control over to developers' effort and intention to stay on the platform. In other words, third-party developers exposed to self-control and clan control are likely to foster a higher intrinsic motivation to develop apps for the platform, which ultimately leads to higher development effort and a higher intention to stay on the platform. However, the explained variances and effect sizes in our structural model are rather small, revealing a tension between our theoretical development and the study's results. Other factors we did not account for may have overridden the effects of intrinsic motivation. For example, third-party developers' extrinsic motivation (i.e. selling apps and earning money) may have stronger effects on third-party developers' behaviors and outcomes. In order to gain a deeper understanding of control modes in software platform contexts and for maximizing the model's explanatory power, future studies are advised to reproduce our findings and include additional constructs (i.e. in particular app developers' extrinsic motivation).

In addition to the study's key findings, other results of our mediation analysis are worth discussing. Given that we could not find a direct effect from self-control and clan control on app quality in the mediation analysis, we could not identify a mediating effect of intrinsic motivation in this relation. However, due to positive significant effects from intrinsic motivation on app quality, intrinsic motivation still plays a role between informal control modes and developers' app quality. Furthermore, the direct effects from self-control and clan control on development effort and self-control on intention to stay remained significant, thus intrinsic motivation only partially mediated these effects. On the one hand, this again demonstrates the importance and positive effects of self-control and clan control on software platforms, even without the underlying explanatory mechanism of third-party developers' intrinsic motivation. On the other hand, these results call for further research in order to detect other mediators and explanatory arguments besides intrinsic motivation regarding the relationship between informal control modes and crucial developer behaviors and outcomes.

Theoretical and Practical Implications

Our study suggests a number of interesting implications. From a theoretical point of view, the study findings provide a deeper understanding of the effects of informal control modes on software platforms. First, our study addresses an important gap in IS control literature by analyzing the relationship between control modes and an individual's motivation, which, to the best of our knowledge, has not yet been empirically tested and established in IS research. More specifically, our study demonstrates that both self-control and clan control on software platforms are positively related to third-party developers' intrinsic motivation. Moreover, we could show that clan control is more conducive for third-party developers' intrinsic motivation compared to self-control. Assumed that an overemphasis of self-control could also lead to coordination and performance problems (Slocum and Sims 1980), our study suggests that clan control is the superior choice of informal control on software platforms. This is because clan control grants a certain amount of autonomy while simultaneously bringing developers onto a common path of shared values, beliefs and goals, without the need for tight supervision and regulation.

Second, our study provides evidence that third-party developers' intrinsic motivation serves as a mediator, carrying the positive effects of self-control and clan control over to developers' effort and their intention to stay on the platform. Thus, our study addresses another important gap, given that only a few studies have investigated important downstream effects of control modes, which, in addition, have largely focused on formal control without providing insights into underlying explanatory processes. By identifying third-party developers' intrinsic motivation as an underlying explanatory argument of why informal control modes positively affect developers' behaviors and outcomes, our study contributes to advancing control literature (Kirsch 1997; Ouchi 1979). Moreover, our study demonstrates that even without exercising conventional formal control modes, high performance outcomes are possible. Therefore, our study not only contributes to the ongoing discussion about "more control is better" (Tiwana 2010), but also responds to calls for research on analyzing governance mechanisms in dynamic and fast-growing platform ecosystems, especially with a focus on hitherto underexplored informal control modes (Tiwana et al. 2013; Wareham et al. 2014). Third, we also contribute to motivation literature.

While motivation literature and self-determination theory has a long tradition in organizational contexts, only a few studies have analyzed motivational factors in software platform contexts. Given the limited studies in this area and mixed results regarding developers' intrinsic motivation in open source software development contexts (e.g., Roberts et al. 2006; Shah 2006), our study further advances the body of knowledge regarding antecedents of platform developers' intrinsic motivation and how this motivation affects their behaviors and outcomes. Finally, our study reveals a tension between the theoretical development and the rather moderate strength of the study results. We therefore provide new research opportunities for future studies to investigate alternative explanations for developers' performance outcomes, i.e. developers' extrinsic motivation, in order to maximize the model's explanatory power.

Beyond these theoretical implications, our study provides practical implications for platform owners as well. First, our study results demonstrate that self-control and especially clan control is positively related to third-party developers' intrinsic motivation, which leads to higher development effort and a higher intention to stay on the platform. Therefore, in order to leverage third-party developers' ingenuity and skills and to integrate, motivate and keep developers on the platform, platform owners are advised to increasingly exercise and choose areas for self-control and clan control. Our study shows that even without exercising conventional tight formal control modes, high performance outcomes are possible. Platform owners are therefore advised to exercise more soft-power instruments, i.e. self- and clan control, instead of hard-power instruments (Yoffie and Kwak 2006). Platform owners may encourage and support third-party developers in exercising self-control by structuring the platform environment appropriately, providing crucial informational cues and statistics necessary for making self-directed decisions, offering trainings for self-management and examples for possible best-practice behaviors and decisions. For clan control, platform owners are advised to promulgate shared norms, values and common goals which are beneficial for the platform and to set an example of best practice and desired work-related behaviors and outcomes. They may participate in developer communities and spread desired platform goals, beliefs and market strategies with newsletters, publications for developers or dedicated conferences. Moreover, in order to build a strong platform community (or clan), platform owners could provide an ecosystem which simplifies collaboration and communication between third-party developers in order to spread such shared norms, values and goals. Developer forums, chats and conferences as well as solution-oriented wikis and blogs may help developers to interact with each other and to build social relations in the community. Moreover, third-party developers are advised to choose platforms with a more open and self-regulating governance structure in order to maximize their freedom and intrinsic motivation. App developers may try to understand the norms, values and common goals of a platform and incorporate these into their development activities. Interacting with the platforms' community and following shared values and common goals may help them to become part of a platform clan, positively affect their intrinsic motivation and lead to higher development effort and a higher intention to stay on the platform.

Limitations and Future Work

While our study offers several important contributions, it is important to evaluate the results and implications in the light of its limitations. First, our study was focused on app developers of the Android platform and our survey was completed by mostly hobbyist, private or self-employed developers. While we believe that Android developers are a good representative of the mobile app industry, external validity of the study results is limited and may be not applicable to other platforms or employed app developers. Future studies are advised to analyze informal control modes and developers' intrinsic motivation across different platforms, such as Apple's App Store or Facebook's App Center, including a broader mix of employed and private third-party developers. Given that control mechanisms vary across different platform types, future studies may also include open source platform contexts. A result comparison of different platforms could also provide relevant insights for platform governance literature. Second, and as mentioned above, we are aware that the study's structural model explained only a low amount of variance. As an explanation, other factors we did not account for may have overridden some effects, and regarding app quality, the used measurement may not reflect the true quality of developers' apps. While our study is, to the best of our knowledge, the first to establish the link between control modes and intrinsic motivation, future studies may extend the study's model by including and comparing different types of control and motivation. Future studies may analyze and compare the differential effects of formal and informal control modes as well as their interaction effects in a portfolio of control modes (Kirsch 1997). Regarding third-party developers' motivation, future studies are advised to analyze intrinsic motivation in

more detail by separately measuring developers' perceived autonomy, competence and relatedness as well as different forms of extrinsic motivation into their analysis. Future studies may also include additional endogenous variables and alternative measurements in order to improve the models' explanatory power.

Conclusion

Software platforms rely heavily on highly motivated third-party developers who are eager to invest their time and effort into developing and updating apps for the platform. The myriad of third-party developers, apps and development projects on software platforms have increased the importance of exercising informal control as part of platform governance. However, our knowledge regarding the effects of such control modes in platform settings is still limited and underlying explanations are largely missing. By integrating control and motivational theory, our study provides a deeper understanding of the positive effects of self-control and clan control in software platform settings and reveals a mediating role of third-party developers' intrinsic motivation on developers' effort and intention to stay on a platform. Clan control was found to be particularly beneficial in shaping developers' intrinsic motivation and developer performance on software platforms. Despite our comprehensive findings, we believe that our study took only initial steps and that analyzing the effects of informal control on software platforms and third-party developers' motivations as an underlying explanatory mechanism is still a rich avenue for future research. We hope that our study was able to provide new insights and ideas in order to further advance IS research on software platform governance and control.

Acknowledgements

The authors would like to thank the House of IT e.V. and Software AG, Darmstadt for supporting this research.

References

- Agarwal, R., and Karahanna, E. 2000. "Time Flies When You're Having Fun: Cognitive Absorption and Beliefs About Information Technology Usage," *MIS Quarterly* (24:4), pp. 665-694.
- Amabile, T.M., Goldfarb, P., and Brackfield, S.C. 1990. "Social Influences on Creativity: Evaluation, Coaction, and Surveillance," *Creativity Research Journal* (3), pp. 6-21.
- Amabile, T.M., Hill, K.G., Hennessey, B.A., and Tight, E.M. 1994. "The Work Preference Inventory: Assessing Intrinsic and Extrinsic Motivational Orientations.," *Journal of Personality and social Psychology* (66:5), pp. 950-967.
- AppFigures. 2015. "App Stores Growth Accelerates in 2014." Retrieved March 31, 2015, from <http://blog.appfigures.com/app-stores-growth-accelerates-in-2014/>
- Apple. 2015. "App Store Rings in 2015 with New Records." Retrieved February 2, 2015, from <http://www.apple.com/pr/library/2015/01/08App-Store-Rings-in-2015-with-New-Records.html>
- Armstrong, J.S., and Overton, T.S. 1977. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research* (14), pp. 396-402.
- Benlian, A., Hilkert, D., and Hess, T. 2015. "How Open Is This Platform? The Meaning and Measurement of Platform Openness from the Complementors' Perspective," *Journal of Information Technology* (30:3), pp. 209-228.
- Bergvall-Kåreborn, B., and Howcroft, D. 2011. "Mobile Applications Development on Apple and Google Platforms," *Communications of the Association for Information Systems* (29).
- Boudreau, K.J. 2012. "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation," *Organization Science* (23:5), pp. 1409-1427.
- Boudreau, K.J., and Lakhani, K.R. 2009. "How to Manage Outside Innovation," *MIT Sloan Management Review* (50:4), pp. 69-76.
- Cardinal, L.B. 2001. "Technological Innovation in the Pharmaceutical Industry: The Use of Organizational Control in Managing Research and Development," *Organization Science* (12:1), pp. 19-36.
- Carton, J.S. 1996. "The Differential Effects of Tangible Rewards and Praise on Intrinsic Motivation: A Comparison of Cognitive Evaluation Theory and Operant Theory," *The Behavior Analyst* (19), pp. 237-255.
- Ceccagnoli, M., Forman, C., Huang, P., and Wu, D.J. 2012. "Cocreation of Value in a Platform Ecosystem: The Case of Enterprise Software," *Management Information Systems Quarterly* (36:1), pp. 263-290.

- Chin, W.W. 1998. *The Partial Least Squares Approach for Structural Equation Modelling*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Choudhury, V., and Sabherwal, R. 2003. "Portfolios of Control in Outsourced Software Development Projects," *Information Systems Research* (14:3), pp. 291-314.
- Chua, C.E.H., Lim, W.K., Soh, C., and Sia, S.K. 2012. "Enacting Clan Control in Complex It Projects: A Social Capital Perspective," *Management Information Systems Quarterly* (36:2), pp. 577-600.
- Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, New Jersey: Lawrence Erlbaum Associates Inc.
- Das, T.K., and Teng, B.-S. 2001. "Trust, Control, and Risk in Strategic Alliances: An Integrated Framework," *Organization Studies* (22:2), pp. 251-283.
- Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. 1992. "Extrinsic and Intrinsic Motivatoion to Use Computers in the Workplace," *Journal of Applied Psychology* (34:437-461).
- Deci, E.L., Eghrari, H., Patrick, B.D., and Leone, D.R. 1994. "Facilitating Internalization: The Self-Determinaton Theory Perspective," *Journal of Personality* (62), pp. 119-142.
- Deci, E.L., and Ryan, R.M. 1985. *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum Press.
- Deci, E.L., and Ryan, R.M. 2000. "The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior," *Psychological Inquiry* (11:4), pp. 227-268.
- Deci, E.L., and Ryan, R.M. 2002. *Handbook of Self-Determination Research*. Rochester, NY: University of Rochester Press.
- Fernandez, S., and Moldogaziev, T. 2012. "Using Employee Empowerment to Encourage Innovative Behavior in the Public Sector," *Journal of Public Administration Research and Theory* (23:1), pp. 155-187.
- Fornell, C., and Larcker, D.F. 1981. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research* (18:1), pp. 39-50.
- Gagne, M., and Deci, E.L. 2005. "Self-Determination Theory and Work Motivation," *Journal of Organizational Behavior* (26:4), pp. 331-361.
- Gefen, D., and Straub, D.W. 2005. "A Practical Guide to Factorial Validity Using Pls-Graph: Tutorial and Annotated Example," *Communications of the Association for Information Systems* (16:1), pp. 91-109.
- Ghazawneh, A., and Henfridsson, O. 2013. "Balancing Platform Control and External Contribution in Third-Party Development: The Boundary Resources Model," *Information Systems Journal* (23:2), pp. 173-192.
- Goldbach, T., Kemper, V., and Benlian, A. 2014. "Mobile Application Quality and Platform Stickiness under Formal Vs. Self-Control – Evidence from an Experimental Study," in: *Thirty Fifth International Conference on Information Systems (ICIS)*. Auckland, New Zealand.
- Gopal, A., and Gosain, S. 2010. "The Role of Organizational Controls and Boundary Spanning in Software Development Outsourcing," *Information Systems Research* (21:4), pp. 960-982.
- Gregory, R.W., Beck, R., and Keil, M. 2013. "Control Balancing in Information Systems Development Offshoring Projects," *Management Information Systems Quarterly* (37:4), pp. 1211-A1214.
- Hair, J., Sarstedt, M., Ringle, C., and Mena, J. 2012. "An Assessment of the Use of Partial Least Squares Structural Equation Modeling in Marketing Research," *Journal of the Academy of Marketing Science* (40:3), pp. 414-433.
- Hartigh, E., Tol, M., and Visscher, W. 2006. "The Health Measurement of a Business Ecosystem," in: *European Chaos/Complexity in Organisations Network (ECCON) annual meeting 2006*. Bergen aan Zee, Netherlands.
- Henderson, J.C., and Lee, S. 1992. "Managing I/S Design Teams: A Control Theories Perspective. (Information System)," *Management Science* (38:6), pp. 757-777.
- Hilkert, D., Benlian, A., and Hess, T. 2010. "Motivational Drivers to Develop Apps for Social Software-Platforms: The Example of Facebook," *AMCIS 2010 Proceedings, Paper 86*, Lima, Peru.
- Iansiti, M., and Levien, R. 2004. *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*. Boston, MA, USA: Harvard Business Press.
- IDC. 2015. "Smartphone Os Market Share, Q4 2014." Retrieved March 31, 2015, from <http://www.idc.com/prodserv/smartphone-os-market-share.jsp>

- Kanfer, R. 1990. "Motivatoin Theory and Industrial and Organizational Psychology," in *Handbook of Industrial and Organizational Psychology*, M.D. Dunnette and L.M. Hough (eds.). Palo Alto: Consulting Psychologists Press, pp. 75-170.
- Ke, W.L., and Zhang, P. 2009. "Motivations in Open Source Software Communities: The Mediating Role of Effort Intensity and Goal Commitment," *International Journal of Electronic Commerce* (13:4), pp. 39-66.
- Keil, M., Rai, A., and Liu, S. 2013. "How User Risk and Requirements Risk Moderate the Effects of Formal and Informal Control on the Process Performance of It Projects," *European Journal of Information Systems* (22:6), 11//, pp. 650-672.
- Kirsch, L.J. 1996. "The Management of Complex Tasks in Organizations: Controlling the Systems Development Process," *Organization Science* (7:1), pp. 1-21.
- Kirsch, L.J. 1997. "Portfolios of Control Modes and Is Project Management," *Information Systems Research* (8:3), pp. 215-239.
- Kirsch, L.J. 2004. "Deploying Common Systems Globally: The Dynamics of Control," *Information Systems Research* (15:4), pp. 374-395.
- Kirsch, L.J., Ko, D.-G., and Haney, M.H. 2010. "Investigating the Antecedents of Team-Based Clan Control: Adding Social Capital as a Predictor," *Organization Science* (21:2), pp. 469-489.
- Kirsch, L.J., Sambamurthy, V., Dong-Gil, K., and Purvis, R.L. 2002. "Controlling Information Systems Development Projects: The View from the Client," *Management Science* (48:4), pp. 484-498.
- Kohli, R., and Kettinger, W.J. 2004. "Informating the Clan: Controllingphysicians Costs and Outcomes," *MIS Quarterly* (28:3), pp. 363-394.
- Kumar, N., Stern, L.W., and J.C., A. 1993. "Conducting Interorganizational Research Using Key Informations," *The Academy of Management Journal* (36:6), pp. 1633-1651.
- Locke, E.A., and Latham, G.P. 2004. "What Should We Do About Motivatoin Theory? Six Recommendations for the Twenty-First Century," *Academic Management Review* (29:3), pp. 288-403.
- Osterloh, M.B., and Frey, B. 2000. "Motivatoin, Knowledge Transfer, and Organizational Forms," *Organization Science* (11:5), pp. 538-550.
- Ouchi, W.G. 1979. "A Conceptual Framework for the Design of Organizational Control Mechanisms," *Management Science* (25:9), pp. 833-848.
- Ouchi, W.G. 1980. "Markets, Bureaucracies, and Clans," *Administrative Science Quarterly* (25:1), pp. 129-141.
- Pavlou, P.A., Liang, H., and Xue, Y. 2007. "Understanding and Mitigating Uncertainty in Online Exchange Relationships: A Principal-Agent Perspective," *MIS Quarterly* (31:1), pp. 105-136.
- Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y., and Podsakoff, N.P. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies.," *Journal of Applied Psychology* (88:5), pp. 879-903.
- Preacher, K.J., and Hayes, A.F. 2008. "Asymptotic and Resampling Strategies for Assessing and Comparing Indirect Effects in Multiple Mediator Models," *Behavior Research Methods* (40:3), pp. 879-891.
- Reiter-Palmon, R., Mumford, M.D., and Threlfall, K.V. 1998. "Solving Everyday Problems Creatively: The Role of Problem Construction and Personality Type," *Creativity Research Journal* (11:187-197).
- Ringle, C.M., Wende, S., and Will, A. 2005. "Smartpls 2.0 (M3) Beta." Hamburg Hamburg
- Roberts, J.A., Hann, I.-H., and Slaughter, S.A. 2006. "Understanding the Motivations, Participation, and Performance of Open Source Software Developers: A Longitudinal Study of the Apache Projects," *Management Science* (52:7), pp. 984-999.
- Rowe, W.G., and Wright, P.M. 1997. "Related and Untrelated Diversification and Their Effect on Human Resource Management Controls," *Strategic Management Journal* (18:4), pp. 329-338.
- Rustagi, S., King, W.R., and Kirsch, L.J. 2008. "Predictors of Formal Control Usage in It Outsourcing Partnerships," *Information Systems Research* (19:2), pp. 126-143.
- Ryan, R.M. 1982. "Control and Information in the Intranpersonal Sphere: An Extension of Cognitive Evaluation Theory.," *Journal of Personality and Social Psychology* (43), pp. 245-254.
- Ryan, R.M., and Deci, E.L. 2000. "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions," *Contemporary Educational Psychology* (25:1), pp. 54-67.
- Sarstedt, M., and Wilczynski, P. 2009. "More for Less? A Comparison of Single-Item and Multi-Item Measures," *Die Betriebswirtschaft* (69:2), pp. 211-227.

- Shah, S.K. 2006. "Motivation, Governance, and the Viability of Hybrid Forms in Open Source Software Development," *Management Science* (52:7), pp. 1000-1014.
- Slocum, J.W., and Sims, H.P. 1980. "A Typology for Integrating Technology, Organization, and Job Design," *Human Relations* (33:3), pp. 193-212.
- Srivastava, S., and Teo, T. 2012. "Contract Performance in Offshore Systems Development: Role of Control Mechanisms," *Journal of Management Information Systems* (29:1), pp. 115-158.
- Tiwana, A. 2010. "Systems Development Ambidexterity: Explaining the Complementary and Substitutive Roles of Formal and Informal Controls," *Journal of Management Information Systems* (27:2), pp. 87-126.
- Tiwana, A. 2014. *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*. Burlington, Massachusetts: Morgan Kaufmann.
- Tiwana, A., and Keil, M. 2009. "Control in Internal and Outsourced Software Projects," *Journal of Management Information Systems* (26:3), pp. 9-44.
- Tiwana, A., Konsynski, B., and Bush, A.A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics (Research Commentary)," *Information Systems Research* (21:4), pp. 675-687.
- Tiwana, A., Konsynski, B., and Venkatraman, N. 2013. "Special Issue: Information Technology and Organizational Governance: The IT Governance Cube," *Journal of Management Information Systems* (30:3), pp. 7-12.
- Turner, K.L., and Makhija, M.V. 2006. "The Role of Organizational Controls in Managing Knowledge," *Academic Management Review* (31:1), pp. 197-217.
- Utman, C.H. 1997. "Performance Effects of Motivational State: A Meta-Analysis," *Personality and Social Psychology Review* (1), pp. 170-182.
- Vallerand, R.J., and Bissonnette, R. 1992. "Intrinsic, Extrinsic, and Amotivational Styles as Predictors of Behavior: A Prospective Study," *Journal of Personality* (60:3), pp. 599-620.
- Venkatesh, V., and Speier, C. 1999. "Computer Technology Training in the Work-Place: A Longitudinal Investigation of the Effect of Mood," *Organizational Behavior and Human Decision Processes* (79:1-28).
- Wang, G., and Netemeyer, R.G. 2002. "The Effects of Job Autonomy, Customer Demandingness, and Trait Competitiveness on Salesperson Learning, Self-Efficacy, and Performance," *Journal of the Academy of Marketing Science* (30:3), pp. 217-228.
- Wareham, J., Fox, P.B., and Cano Giner, J.L. 2014. "Technology Ecosystem Governance," *Organization Science* (Published online in Articles in Advance 13 Mar 2014).
- Weinberg, G. 1998. *The Psychology of Computer Programming. Silver Anniversary Edition*. New York: Van Nostrand Reinhold.
- Wilde, M., Bätz, K., Kovaleva, A., and Urhahne, D. 2009. "Überprüfung einer Kurzsкала Intrinsic Motivation (Kim)," *Zeitschrift für Didaktik der Naturwissenschaften* (15), pp. 31-45.
- Yoffie, D.B., and Kwak, M. 2006. "With Friends Like These: The Art of Managing Complementors," *Harvard Business Review* (84:9), pp. 88-98.