



# **ABSTRACT**

## **ESSAYS ON INNOVATION ECOSYSTEMS IN THE ENTERPRISE**

### **SOFTWARE INDUSTRY**

by

Peng Huang

Doctor of Philosophy in Management

Georgia Institute of Technology

Fall, 2010

In this dissertation I aim to address the issues that are related to the formation and business value of platform innovation ecosystems in the enterprise software industry. The first study explores the role of three factors – increased payoff from access to platform owner’s installed base, risk of misappropriation due to knowledge transfer, and the extent of competition – in shaping the decisions of third-party complementors to join a platform ecosystem. The second study evaluates the effect of participation in a platform ecosystem on small independent software vendors’ business performances, and how their appropriability strategies, such as ownership of intellectual property rights or downstream complementary capabilities, affect the returns from such partnerships. The third study reveals that users’ co-innovation in enterprise information systems, measured by their participation in online professional community networks, constitute a source of intangible organizational asset that helps to enhance firm level information technology (IT) productivity.

**EXECUTIVE SUMMARY**

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Whether a platform technology can generate significant economic returns often depends on complementary innovations in its related fields, as we have witnessed in the transition from mainframe computing paradigm to the client/server computing model (Bresnahan and Greenstein 1996). In recent years, platform-based competition is becoming increasingly a ubiquitous phenomenon in the information economy. The personal computer, personal digital assistant, and video game console are stylized examples of systems that consist of a core technology platform and interchangeable complementary applications built upon it (Bresnahan and Greenstein 1999). To meet the heterogeneous needs of users and to exploit indirect network effects, owners of platform technology often seek to encourage complementary third-party innovation from resources located outside the firm, ranging from customers, research companies and business partners to universities. This approach of complementary innovation has given rise to the model of an innovation ecosystem, where the collective power of platform users, developers, partners, and consultants is harnessed by the platform owner to achieve the shared success of the community (Adner 2006).

Although we see a growing interest among practitioners and researchers in platform ecosystems (Iansiti and Lakhani 2009), there has been little empirical work in understanding the formation of innovation ecosystems and mechanisms through which they create business value for the various parties. In addition, the few extant studies on platform ecosystems (Eisenmann et al. 2008; Gawer and Henderson 2007; Parker and Van Alstyne 2008; West 2003) almost exclusively focus on the platform owners' decisions to open or close their technology platform or platform governance strategies. In contrast, there is a lack of understanding of the incentives and concerns on the part of third-party complementors who consider joining the platform, and under what conditions platform ecosystems create values for them. Further, in the process of adopting a technology platform, users often create co-innovations by making idiosyncratic adaption, modification and customization of the technology. However, their co-innovation activities in platform ecosystems have largely been left unexamined in prior research.

I aim to bridge the gap in prior literature by modeling and empirically investigating the platform innovation ecosystems in the enterprise software industry. Wide adoption of enterprise software has contributed to the accelerated competition within the US economy and a period of intense innovation in corporate information technology (McAfee and Brynjolfsson 2008). Specifically, I choose SAP AG, the largest enterprise software company as the focal platform owner. This setting represents a good place to begin studying this phenomenon for several reasons. First, the SAP ecosystem is large; it includes over 41,000 customers and more than 7,000 partners, and has been characterized by some as having its own economy (Pang 2007). Second, SAP has taken a series of initiatives to seed complementary innovation and foster its ecosystem, such as promoting technology and solution partnership programs, building a thriving user community of innovation, and opening co-innovation lab facilities to enable co-creation of solutions with its partners, etc (Iansiti and Lakhani 2009). For example, SAP publicly certifies independent software vendors (ISVs) in its

ecosystem, which means that SAP engineers test and endorse that the ISV's software integrates with the SAP platform. In addition, SAP actively promotes the knowledge exchange and co-innovation between its customers, partners, developers and its own employees by sponsoring its online community network, which has drawn participation from more than 1.8 million registered members as of 2010. Using this particular setting, I try to address two broad categories of research questions. The first category relates to the formation of innovation ecosystems, which includes questions like what attracts third party, complementary solution providers to participate in a platform ecosystem; what are the tradeoffs they face when they make such decisions; and under what conditions they can better appropriate the economic returns of their innovation in such relationships so that a successful ecosystem is more likely to emerge? The second category of questions relates to the business values that are enabled by innovation ecosystems for various innovation ecosystem participants, such as independent software vendors that become part of the ecosystem, or the technology platform adopters that invest their efforts to make platform specific co-innovations.

In the first essay of my dissertation, I extend prior research by Gans et al. (2002) to build a payoff model that examines the factors influencing the likelihood an ISV will become certified by SAP as a platform-compatible application provider. I stress three distinct features of this type of partnership. First, the major benefit for ISVs to join the ecosystem is to gain market exposure to the platform owner's installed base instead of accessing the platform owner's technological or marketing resources, and therefore the analysis is different from the context of technology commercialization or markets for technology<sup>1</sup> (Arora and Ceccagnoli 2006). Second, potential risk of entry by the platform owner, together with uncontrollable knowledge transfer during the partnership, brings the

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<sup>1</sup> Research in the markets for technology literature examines transactions for the use, diffusion, and creation of technology. These include transactions involving knowledge that may or may not be protected by intellectual property and may or may not be embodied in a product. For a recent overview of the markets for technology literature see Arora and Gambardella (2010).

relevance of appropriability mechanisms such as intellectual property rights (Graham and Mowery 2003) and downstream complementary capabilities (Teece 1986). Third, the relationship often involves collaboration between competitors, characterized as co-opetition<sup>2</sup> (Nalebuff and Brandenburger 1997). In many cases both the platform owner and the ISV provide similar functional modules and compete in multiple product markets, and the formation of partnerships may depend critically on the intensity of competition. These three factors – increased payoffs from access to the platform owner’s installed base, risk of misappropriation due to knowledge transfer, and extent of competition – form the main trade-offs to the partnering decision that I study in this essay. The model predicts that appropriability strategies based on intellectual property rights and the possession of downstream complementary capabilities by ISVs are positively related to partnership formation, and ISVs use these two mechanisms as substitutes to prevent expropriation by the platform owner. In addition, the model shows that greater competition in downstream product markets between the ISV and the platform owner is associated with a lower likelihood of partnership formation, while the platform’s penetration into the ISV’s target industries is positively associated with the propensity to partner. I then assemble a unique data set on the partnership decisions of 1201 ISVs over 1996 to 2004 to test these model-based predictions, and find support for the theoretical predictions.

In the second essay of my dissertation, I extend the previous payoff model to investigate the business value associated with joining a platform ecosystem and how start-up ISVs’ appropriation strategies lead to differences in the returns to the partnership. I argue that such partnerships emerge as a new type of inter-organizational relationship (IOR) that is different from a number of other types of IORs that have been examined in prior research such as joint ventures, alliances, networks,

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<sup>2</sup> Co-opetition is a term used to describe collaboration between competitors. It was coined by Raymond Noorda, the founder of the networking software company Novell, to characterize Novell's business strategy. For details, see Nalebuff and Brandenburger (1997).

trade associations, and supply chain relationship. More importantly, the value creation processes associated with such a relationship are likely to be different from those of other types of IORs. For example, the primary reason for start-up ISVs to join a platform ecosystem is to signal compatibility of software applications and to thereby gain access to the platform owner's installed base, in contrast to other inter-organizational relationships where organizational learning, risk sharing, resource pooling or strategic factors are important. I predict that the formation of such a partnership is associated with greater market access (Chellappa and Saraf forthcoming), positive product quality signal (Rao and Ruekert 1994), and social legitimate endorsement (Stuart et al. 1999), which leads to improved ISV performance after joining the platform ecosystem. In addition, I propose that due to the risk of expropriation by platform owner, the extent to which ISVs benefit from this relationship is moderated by their appropriability mechanisms. I test empirically how the business value of the ecosystem is reflected in sales, the likelihood of issuing an initial public offering (IPO) and the chances of being acquired of the ecosystem participants, and show that the positive performance impacts are greater when an ISV's innovation is protected by IP rights and downstream complementary capabilities. These results, combined with those from the first study, reveal some conditions under which a "virtuous cycle" may be realized in a software platform ecosystem. Particularly, ISVs who participate in markets for which appropriability mechanisms like patents are strong will see greater returns from partnership. These greater returns will encourage new partners to join the ecosystem and enhance the value of the platform, and will also draw in additional customers. A larger customer base will, in turn, attract more partners to participate in the platform ecosystem.

In the third essay of my dissertation, I conduct a study to evaluate the value of a platform technology owner sponsored online co-innovation community to technology adopting firms, linking research on innovation ecosystems to information technology (IT) business value studies. Literature

on IT business value has documented that there is considerable variation in the distribution of IT productivity among individual firms (Brynjolfsson and Hitt 2000). Recent studies have attributed this variation to complementarities between IT investment and firm workforce practice, investment in human capital, IT governance or business process reengineering. However, this research has largely ignored the role of user co-innovation in information systems in explaining this variation. Drawing upon theories of resource based view of IT and firm dynamic capabilities, I argue that IT using firms' co-innovation in enterprise information systems complements their adoption of IT infrastructure and it improves the firms' IT productivity. Organizations' accumulation of co-innovation over time is likely to be heterogeneously distributed among firms due to their different strategic pursuits, and it is not easily transferred across firm boundaries due to time diseconomies, causal ambiguity and social complexities, and therefore it constitutes an important source of intangible assets that complements firms' IT investment (Barney 1991; Mata et al. 1995). Enterprise software, being the backbone of enterprise information systems, presents an exemplary context where user firms engage in extensive co-innovation. Enterprise software products are highly process-oriented and usually need to be tailored to fit business practices, where idiosyncratic local needs usually drive innovations in work practices (Hitt et al. 2002). To empirically identify the complementarities between user co-innovation in corporate information systems and IT investment, I construct a sample from fortune 1000 firms and collect data on their implementation of SAP enterprise software, their IT infrastructure, their stock of co-innovation in SAP's software platform, and their business performance. To resolve the challenge of measuring enterprise software adopters' co-innovation in the underlying software platform, I collect data on SAP user firms' participation and contribution to an SAP-sponsored online community network. Incorporating IT co-innovation into production function framework, I find that firms with mean level stock of IT co-innovation extract as much as 54.5% greater productivity from their IT investment than those without IT co-



innovation. The results suggest that the strategy of innovation ecosystem by technology vendors may work to the benefits of technology adopters as well as technology owners. For platform technology owners, fostering a co-innovation ecosystem can facilitate knowledge exchange, reduce the cost of co-innovation, and encourage innovation activities which will enhance the value of the platform for its users. The availability of a large reservoir of co-innovation will further help the diffusion of the technology due to indirect network effects.

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