Co-creation of Value in a Platform Ecosystem: The Case of Enterprise Software

Marco Ceccagnoli  
College of Management  
Georgia Institute of Technology  
800 West Peachtree St. NW  
Atlanta, GA 30308  
marco.ceccagnoli@mgt.gatech.edu

Peng Huang  
College of Management  
Georgia Institute of Technology  
800 West Peachtree St. NW  
Atlanta, GA 30308  
peng.huang@mgt.gatech.edu

Chris Forman  
College of Management  
Georgia Institute of Technology  
800 West Peachtree St. NW  
Atlanta, GA 30308  
chris.forman@mgt.gatech.edu

D.J. Wu  
College of Management  
Georgia Institute of Technology  
800 West Peachtree St. NW  
Atlanta, GA 30308  
dj.wu@mgt.gatech.edu

ABSTRACT

It has been argued that platform technology owners co-create business value with other firms in their innovation ecosystems to encourage complementary invention and exploit indirect network effects. In this study we examine whether participation in an ecosystem partnership improves the business performance for small independent software vendors (ISVs) in the enterprise software industry and how appropriability mechanisms influence the benefits of partnership. By analyzing the partnering activities and performance indicators of a sample of 1210 small ISVs over the period of 1996-2004, we find that joining a major platform owner’s innovation ecosystem is associated with an increase in sales and a greater likelihood of issuing an IPO. In addition, we show that these impacts are stronger when ISVs have greater intellectual property rights or stronger downstream capabilities. This research highlights the value of interoperability between software products, and stresses that value co-creation and appropriation are not mutually exclusive strategies in inter-firm collaboration.

Keywords: Platform ecosystem, partnership, business value, sales, IPO, intellectual property rights, downstream capabilities
CO-CREATION OF VALUE IN A PLATFORM ECOSYSTEM: THE CASE OF ENTERPRISE SOFTWARE

1. INTRODUCTION

Platform-based technologies such as personal computers, PDAs, and video game consoles are becoming increasingly important in the information economy (Evans et al. 2006). As noted by Boudreau (2007), such platforms are defined as the set of components used in common across a product family whose functionality can be extended by applications. To meet the needs of heterogeneous users and to exploit indirect network effects, owners of a platform often seek to encourage complementary third-party innovation from resources located outside the firm, ranging from customers, research companies and business partners to universities (Linder et al. 2003). This approach of complementary innovation has given rise to the model of an innovation ecosystem. A burgeoning body of research has started to theorize about how such ecosystems are formed and their implications for platform owners, complementary providers, and users (Adomavicius et al. 2007; Adomavicius et al. 2008; Eisenmann et al. 2008; Gawer and Henderson 2007; Lee and Mendelson 2008; Mantena et al. 2007; Parker and Van Alstyne 2008; West 2003).

To encourage complementary innovation, owners of IT hardware and software platforms such as Microsoft, IBM, and SAP often have partnership programs for members of their innovation ecosystems. Members of these partnership programs co-create value with the platform owner by developing applications and solutions to be used on the platform. Such partnerships have also drawn interest as examples of co-opetition (Hamel et al. 1989) that inevitably involve

---

1 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).
competition and conflict of interest. However, despite increasing interest among practitioners and researchers on ecosystems there has been little work in understanding the value of these partnership programs, and under what conditions they are most beneficial to their participants. This is a surprising gap in understanding. For researchers, this means that there is little systematic measurement of the extent to which partnership programs facilitate the co-creation of value. For example, recent theoretical work on how platform owners can encourage the development of ecosystems (Eisenmann et al. 2008; Parker and Van Alstyne 2008; West 2003) would benefit from empirical evidence on the value of these programs. For practitioners, platform owners and their complementors currently have no systematic means to determine how much to invest in them. In addition, efforts of start-up software vendors to use ecosystem participation as a growth strategy will have meaning only if vendors know who is most likely to benefit from such relationship. In short, measurement of the (co-created) value from ecosystem partnership programs has important implications for both researchers and practitioners.

A related question is the issue of value appropriation in IT innovation networks. Recent studies on inter-firm alliances have emphasized the role of partners’ resources and capabilities in value creation (Ahuja 2000; Lane and Lubatkin 1998; Mowery et al. 1996). However, they have generally tended to overlook the effect of appropriation hazards on the co-creation of value by alliance partners. The misappropriation issue is particularly important in the case of platform ecosystem partnerships, as such relationships are often characterized by a conflict between the developers of complemenatary products and the platform owner due to the risks that the latter may eventually compete in the former’s product market space (Gawer and Henderson 2007). The

---

2 For example, over the last decade SAP has resolved a number of disputes with its ecosystem partner ISVs, whose claims include infringement of patents and copyrights as well as misappropriation of confidential information and trade secrets (SAP annual report 1998 – 2008).
question of how these risks of misappropriation affect the returns to partnership has yet to be answered. Acquiring empirical evidence on these issues has important managerial implications, as it will inform when ecosystems are most likely to grow and succeed.

In this paper we take one step toward addressing these gaps in prior research. To do this, we develop a set of hypotheses building upon a rich literature on the commercialization of new technologies and markets for technology (e.g., Arora et al. 2001; Gans et al. 2002; Gans and Stern 2003). Following one stream of this literature (e.g., Gans et al. 2002; Gans and Stern 2003), we explore the decisions of small firms to pursue a cooperative or competitive strategy with incumbents. Focusing in this way allows us to isolate a key tradeoff to potential partners in our setting—the benefits of partnership from accessing a larger installed base versus the potential risks of intellectual property expropriation from the platform owner.

Building on this central tradeoff, we develop a set of hypotheses that predict the relationship between platform ecosystem participation, appropriation strategies and firm performance. We then test these hypotheses in the context of the enterprise software industry. Specifically, using a unique data set on the partnering activities of 1210 independent software vendors (ISVs) over the period of 1996-2004, we evaluate the effects of joining the SAP ecosystem on two critical performance measures for entrepreneurial ISVs: sales and the likelihood of obtaining an initial public offering (IPO). We analyze the former because it is strongly correlated with the profitability and overall financial performance of the firm, due to the high fixed cost/low variable cost structure of software firms. We analyze the latter because it is both a measure of the future sales prospects for the firm and a common measure of small firm performance (Cockburn and MacGarvie 2009; Shane and Stuart 2002). We present robust empirical evidence showing that
the decision to partner is associated with both an increase in sales and a greater likelihood of an IPO.

We next investigate how appropriability strategies, such as ownership of intellectual property rights (IPR) and downstream complementary capabilities by the ISV, moderate the effects of partnership on ISV performance. A rich literature on appropriating the returns to innovation show that both are conducive to appropriating returns through product markets (Teece 1986) or the markets for technology (Arora and Ceccagnoli 2006; Arora et al. 2001; Gans and Stern 2003) and have a significant effect on firm performance (Ceccagnoli 2009), though as yet there is less understanding of how these may condition the value of partnerships in a platform ecosystem. In particular, we find that the impact of partnership on sales and the likelihood of an IPO is greatest for those ISVs who are protected by IPR and who have strong downstream capabilities.

Our study contributes to the extant literature on several fronts. First, although prior research on alliance relationships has examined their impact on firm performance (Bae and Gargiulo 2004; Baum and Oliver 1991; Goerzen and Beamish 2005; Mitchell and Singh 1996; Zaheer and Bell 2005), the focus in much of that literature has been on the value of alliances as a mechanism to facilitate learning and access to specialized resources (Porter and Fuller 1986). Our analysis and theory differs from this extant literature in significant ways: in our setting, partnerships are valuable primarily as a way of signaling compatibility with the platform rather than a mechanism of sharing critical information that will improve the innovative productivity of the partnering organizations (Colombo et al. 2006; Khanna et al. 1998; Mowery et al. 1996). In that way, our study shares similarities with Chellappa and Saraf (forthcoming), who also argue that compatibility signaling is a primary benefit of partnership in enterprise software. However, while Chellappa and Saraf are primarily interested in how a firm’s position in the social network of
large enterprise software firms influences firm performance, we examine the impact of ecosystem partnership on ISV performance.

Our research differs from prior alliance literature (including Chellappa and Saraf) in another significant way. With the exception of Lavie (2007), few authors have simultaneously studied value creation and value appropriation mechanisms in alliance relationships. We bridge this gap by applying theory on innovation commercialization to inter-firm alliance studies. While Lavie (2007) emphasizes the role of bilateral and multilateral competition on value appropriation in alliance relationships, we examine how the benefits of participation in a platform ecosystem vary according to different appropriation strategies. Specifically, our findings imply that appropriability, in particular intellectual property protection, is a critical determinant of the returns to ISVs from the co-creation of value in the software industry, and that successful and sustainable ecosystems will be found in environments where appropriability mechanisms are strong. In such environments, strong ISV participation in the ecosystem will engender a rich supply of innovative solutions to meet heterogeneous customer needs, igniting a virtuous cycle of indirect network effects that will in turn lead to further value co-creation.

More broadly, while a growing body of literature has examined how platform owners can encourage third-party complementors to stimulate indirect network effects, the current literature on platform technology focuses primarily on the management issues and strategies from the perspective of the platform owners (Eisenmann et al. 2008; Gawer and Cusumano 2002). There is at present little work examining the perspective of the platform participants. In this way, our research builds upon (<obscured for review process>) who study the decisions of ISVs to participate in a partnership program.
The rest of the article is organized as follows. In the next section we present an overview of literature in related research areas and propose hypotheses regarding value creation and appropriation in a platform ecosystem. In section 3 we describe the research setting, the data, and methods used in the empirical investigation. We present the results, as well as a set of robustness checks, in section 4. In section 5 we discuss the implications of our findings and conclude.

2. RELEVANT LITERATURE AND HYPOTHESES

In this section we propose hypotheses regarding value creation and appropriation in platform ecosystems. Our hypotheses are grounded in the literature on innovation commercialization, appropriability, and markets for technology (e.g., Arora et al. 2001; Gans et al. 2002; Gans and Stern 2003). This line of work suggests that the decision of start-ups to partner with established firms in order to commercialize their innovations is critically conditioned by ownership of IPR and downstream commercialization capabilities. We apply and extend these ideas to analyze the impact of an ISV decision to join a platform ecosystem on its financial performance. Later, within the section 5, we discuss the generalizability of our findings to other platform environments.

2.1. Appropriating the Returns from Innovation

Technology entrepreneurs such as small enterprise software vendors often face a critical challenge when attempting to translate their innovation into a steady stream of economic returns. When start-ups commercialize their innovations, they often face a choice between (1) embedding the innovation into a product and competing with established firms versus (2) earning returns through cooperation with incumbents (Gans and Stern 2003). A key determinant of this choice is the ownership of costly-to-build downstream manufacturing, marketing, distribution and other complementary capabilities that are essential to a firm’s value chain and required for
successfully launching a product or service (Teece 1986). These complementary capabilities are often a choke point for innovation commercialization, since they cannot be easily contracted for through the market on competitive terms and are therefore rare, path-dependent and difficult to imitate (Teece 1986). Their ownership may constitute a barrier to entry and provide a sustainable competitive advantage (Barney 1991; Rothaermel and Hill 2005; Teece 1992). Indeed, large scale empirical studies suggest that ownership of downstream capabilities required to commercialize an innovation is one of the most effective means of securing returns from innovation across a wide range of industries (Cohen et al. 2000).

While the ownership of downstream complementary assets is typically conducive to an appropriation strategy through vertical integration into the product market, securing returns from innovation by commercialization through the market for technology depends critically on the possession and strength of IPR (Arora et al. 2001; Gans and Stern 2003; Oxley 1999). For example, Gambardella and Giarratana (2008) find a positive relationship between the effectiveness of patent protection and technology licensing in the security software industry, while the ownership of downstream complementary capabilities increases the likelihood that firms will launch new products. Recent research has also extended this literature to examine the role of markets for technology in affecting the survival of entrepreneurial firms in the security software industry (Arora and Nandkumar 2008).

In what follows, we develop a set of hypotheses based on some of the key ideas outlined above.

---

3 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).
2.2. Participation in the Ecosystem and Sales

In technology industries where network effects are important and a dominant standard has yet to be established, small technology firms may initiate an alliance or join a platform ecosystem to achieve technology compatibility with a platform. The literature on standards competition suggests that technology compatibility is often a prerequisite to gaining access to the user base of the platform owner (Brynjolfsson and Kemerer 1996; Katz and Shapiro 1994; Kauffman et al. 2000; Matutes and Regibeau 1988; Tassey 2000).

Since the key objective of partnerships in this industry is to achieve compatibility between innovative software solutions of the complementors and the platform, cooperation is a way to access a key complementary asset, certification of software compatibility, that increases a startup’s ability to appropriate the returns from its innovation (Arora et al. 2001; Gans et al. 2002; Gans and Stern 2003; Teece 1986). This kind of alliance therefore *co-creates value* by avoiding investments in hard-to-duplicate complementary assets (e.g., investments needed to integrate complementary products with the platform and gain a reputation for quality and reliability). They also increase the *value captured* by the complementors, by allowing the ISV to achieve a more reliable integration with the platform, as well as reach the installed base faster and more effectively.

Indeed, since platform owners are usually established incumbents with a large installed base, partnership exposes an ISV to a greater potential market that is not served or is underserved by the platform owner. Successful exploitation of the platform owner’s user base is therefore expected to boost the sales of a partnering ISV. In addition, in order to become a certified complementary solution provider to a platform, an ISV may have to conform to a series of quality specifications in product design and pass a rigorous certification process conducted by
the platform owner. As a result, obtaining certification from an industry leader may be perceived by users as a quality signal (Rao and Ruekert 1994), which may enhance the willingness-to-pay of the ISV’s potential customers, and in turn have a positive impact on sales revenue. Indeed, prior research has shown that obtaining quality certification such as ISO 9001 enhances software companies’ revenue and is associated with higher price per unit of output (Arora and Asundi 1999).

Therefore, we propose

Hypothesis 1 (H1). An ISV’s participation in an enterprise software platform’s innovation ecosystem is associated with an increase in sales.

A few words are in order about the statement of our hypothesis. As we discuss in section 2.4, while platform participation may be associated with an increase in sales on average, the relationship between participation and sales may vary significantly with ISV characteristics (in particular the appropriation strategies of the ISV) and the market conditions under which the ISV operates. In other words, there may exist considerable heterogeneity in value co-creation—and for the ISV, value appropriation—across partnerships. Further, ISVs may choose to partner with incomplete knowledge about the future values of these variables that will moderate the effects of partnership. We discuss these variables in detail in section 2.4.

2.3. Participation in the Ecosystem and IPO

For young entrepreneurial software companies, a crucial dimension of long term performance is the speed at which the company issues an initial sale of securities in the financial market (Hsu 2006; Stuart et al. 1999). An initial public offering (IPO) is a critical milestone which marks the transition of a privately held venture into a publicly owned company. From the perspective of a
new venture, selling securities to the public is a less expensive way to raise working capital that is required for future growth and expansion, and it presents an opportunity to the equity holders to exchange their stake in the company for cash.

However, the IPO market is a context in which investors need to assess the quality of relatively new companies with a short track-record and about which investors will have limited information (Pollock and Rindova 2003). We argue that given the significant uncertainty surrounding a new venture’s viability and future profit generating capabilities, an ISV’s decision to join a platform ecosystem will be an effective way of mitigating uncertainties in the eyes of third party investors. First, the market’s evaluation of the firm is based on its expected future cash flow (Kaplan and Ruback 1995), which will be correlated with its current market penetration and sales. Since joining the platform ecosystem facilitates a faster and more effective penetration of the installed base by the ISV, as argued above, such partnerships should be interpreted favorably by the financial markets and boost investors’ confidence in the future profitability of the new venture, resulting in a greater likelihood of IPO.

Second, institutional theory (DiMaggio and Powell 1983) suggests that organizations are under the pressure of institutional environments to conform to prevailing social norms and demonstrate legitimacy. Third parties such as investors will be more willing to engage in exchange relationships with firms that have proven social legitimacy (Sine et al. 2007). To the extent that small ventures have limited history of demonstrating their conformance to prevailing rules, practices and social norms, partnering with large, well-established companies can significantly increase their visibility, reputation, image and prestige. Indeed, studies have examined how endorsements from venture capitalists (Gulati and Higgins 2003; Shane and Stuart 2002), investment banks (Gulati and Higgins 2003; Stuart et al. 1999), alliance partners (Stuart et al.
1999) and media coverage (Pollock and Rindova 2003) can affect impression formation and impart legitimacy to entrepreneurial ventures, and increase the likelihood of raising capital through an IPO. Therefore, we propose

Hypothesis 2 (H2). An ISV’s participation in an enterprise software platform’s innovation ecosystem is associated with an increase in the likelihood of issuing an IPO.

2.4. Participation in the Innovation Ecosystem and Appropriation Strategies

As is widely noted in the markets for technology literature, cooperative strategies like ecosystem partnerships often occur in the shadow of competition (Arora and Ceccagnoli 2006; Arora et al. 2001; Gans et al. 2002; Gans and Stern 2003). The above literature has highlighted the paradox of disclosure that occurs when start-ups explore potential licensing strategies with established firms: when trading in ideas, the willingness to pay for potential buyers depends upon their knowledge of the idea, however disclosure of the idea implies that the potential buyer need not pay for it (Gans and Stern 2003).

Similar appropriability risks arise for small ISVs who consider joining a platform ecosystem. Although joining a platform ecosystem may improve an ISV’s sales and likelihood of IPO on average, there may be considerable risks associated with such relationships that may lead to variance in the returns to partnership. One particular risk is that the platform owner may replicate the technology of the ISV and begin to offer a competing product, a risk that is likely to increase with partnership. Inter-firm collaborative relationships often lead to unintended knowledge transfer (Khanna et al. 1998; Mowery et al. 1996). Knowledge that is not protected by any appropriation mechanism can therefore be profitably used by collaborators (Bresser 1988; Heiman and Nickerson 2004). As noted above, the potential risk that platform owners may enter
a complementor’s product space has been acknowledged by theoretical and case study work on software platforms (Gawer and Cusumano 2002; Gawer and Henderson 2007; Iansiti and Levien 2004), but has not been empirically tested.

The partnership between an ISV and a software platform owner is likely to facilitate such knowledge spillovers. Software certification may require the ISV to disclose proprietary knowledge, the codification of business processes or its best practices that the platform owner could imitate. In this way, the costs of entry for the platform owner into the ISV’s product market are reduced. In other words, by joining a platform ecosystem an ISV is exposed to a greater expropriation risk.

Prior research has noted that the disclosure problem can be ameliorated if IPR are available (Arora and Ceccagnoli 2006; Gans and Stern 2003; Oxley 1999). Both patents and copyrights have been shown as common methods of IPR protection in the software industry (Bessen and Hunt 2007; Graham et al. 2009). In particular, in the presence of patents and copyrights, a start-up may be able to deter imitation or exercise its IPR and prevent entry once imitation has occurred (Gans et al. 2002). We expect that stronger IP protection from patents and copyrights will increase the payoff to partnering by decreasing the risks of imitation. As a result, the effect of partnership on sales and the likelihood of issuing an IPO will be higher in the presence of IP-based appropriability strategies.

Appropriability risks will also be affected by the ownership and strength of specialized downstream capabilities (Arora and Ceccagnoli 2006; Ceccagnoli and Rothaermel 2008; Gans and Stern 2003; Rothaermel and Hill 2005; Teece 1986). These are specialized downstream assets necessary to manufacture, market, and distribute products, e.g., assets that lose value when
redeployed to other classes of products. For example, sales forces that specialize in a particular product may have accumulated specialized skills that are not easily transferred and would require time and costly retraining to be exploited in selling different classes of products. Specialized complementary assets are difficult to imitate since they are built over long periods of time, are not easily codified, and often result from the interaction of people from different parts of a firm’s organization (Teece 1992).

The effect of partnering on the ISVs’ returns will be higher in the presence of specialized downstream capabilities for two reasons. First, the returns to accessing the platform owner’s installed base will be greater if the ISV has an established brand image or strong marketing, distribution and service capabilities, as it is able to convert platform adopters into its own customers more effectively. Second, an ISV with strong downstream capabilities will be better able to defend its “territory” in the presence of platform owner entry than firms without such capabilities. Knowledge embedded in business practices or downstream service and consulting activities is difficult to codify and therefore will be more difficult for the platform owner to imitate (Barney 1991; Dierickx and Cool 1989). For example, implementation of enterprise software often requires extensive effort to configure it to meet the user’s idiosyncratic needs (Hitt et al. 2002; Ko et al. 2005). Knowledge of how to conduct such configurations will typically reside in the consulting and service activities of the ISV. Such downstream knowledge and capabilities are difficult to transfer across firm boundaries (Brown and Duguid 2001; Von Hippel 1994) and may also act as a barrier to entry.

In summary, we argue that the extent to which an ISV may benefit from joining a platform ecosystem is likely to vary according to the ISV’s ownership of IPR and downstream capabilities. Particularly, we propose
Hypothesis 3 (H3). The positive effect of an ISV’s participation in an ecosystem on sales is greater when a) the ISV is better protected by intellectual property rights such as patents and copyrights, and b) the ISV has stronger downstream capabilities.

Hypothesis 4 (H4). The positive effect of an ISV’s participation in an ecosystem on the likelihood of issuing an IPO is greater when a) the ISV is better protected by intellectual property rights such as patents and copyrights, and b) the ISV has stronger downstream capabilities.

Figure 1 schematically represents the research model and the hypotheses.

[Insert Figure 1 about here]

3. METHODS AND MEASURES

3.1. Research Context

Enterprise software is often considered to be the organizational operating system (Chellappa and Saraf forthcoming; Cotteleer and Bendoly 2006), which consolidates the diverse information needs of an enterprise’s departments together into a single, integrated software that operates on a shared database. In this study we are interested in the partnership between an enterprise software platform owner and the ISVs that develop complementary applications that are integrated with the owner’s platform. As noted above, we adopt the definition of Boudreau (2007) and define a platform as the components used in common across a product family whose functionality can be extended by applications and is subject to network effects. ISV applications extend the functionality of the platform and co-create value for customers who adopt the platform. SAP AG, the business software company, is chosen as the focal enterprise software platform owner for several reasons. First, SAP’s enterprise computing platform is economically significant.
Partnerships are core to SAP’s platform strategy and its network of software solution providers, value-added resellers, distributors, technology and services partners (numbering over 7,000 as of 2009) is among the industry's largest (SAP 2009). Second, many core features of SAP’s platform are common to other settings where platform owners co-create value with their partners. For example, partnership with SAP signals compatibility with SAP’s platform (Chellappa and Saraf forthcoming), enabling ISVs to more easily sell to SAP’s installed base. Similar motivations are behind the decisions of firms to join platforms such as Cisco’s Internetwork Operating System (IOS) platform for computer networking (Gawer and Cusumano 2002). Further, platform participants in other industries face similar expropriation risks, as platform owners have entered complementary markets for efficiency gains or strategic advantage (Casadesus-Masanell and Yoffie 2007; Eisenmann et al. 2007; Gawer and Cusumano 2002; Gawer and Henderson 2007).

To join SAP’s partner program, ISVs develop a product and then obtain a certification from SAP which endorses the interoperability between the product and the SAP platform. In particular, ISVs that plan to achieve software integration with the SAP solutions work with one of the local SAP integration and certification centers (ICCs) to have their product certified. The process typically involves a feasibility study, service offer processing, and extensive testing by SAP. If successful, SAP issues a formal SAP ICC contract for the ISV to sign and applicable fees are paid by the ISV and the now-certified integration is publicly listed online in the SAP partner information center.

By making its product SAP-certified, the ISV effectively signals its compatibility with the SAP platform. This will strengthen the ISV’s ability to sell to SAP’s large customer base. In addition, by teaming up with a prestigious industry leader, ISVs gain endorsements, enhance their social legitimacy, and signal their technological excellence (Stuart et al. 1999). The reputation
consequences of strategic partnership are particularly important in high-technology industries, which are noted for pervasive uncertainty (Tushman and Rosenkopf 1992).

A couple of examples will help to place our research context in perspective. LogicTools Inc. is a software company that provides an integrated suite of strategic supply chain planning solutions that optimize the supply chain by simultaneously optimizing account production, warehousing, transportation and inventory costs, as well as service level requirements. It became an SAP software partner in January 2004 (Simchi-Levi et al. 2006). Since then, LogicTools’ customer base has been growing rapidly, adding 30 new clients in 2005 alone, with its sales growing by over 50% in 2005 (Business Wire Inc. 2006). According to the press release, “LogicTools' software partnership with SAP and certified integrations make LogicTools' solutions an easy choice for many companies”. As yet another example, TIBCO Software Inc. (www.tibco.com), an ISV that provides enterprise application integration solutions, certified its interface for SAP R/3 solutions and became a member of the SAP Complementary Software Partner program in 1998 (Business Wire Inc. 1998). Since then it became the de facto standard for event-driven computing and enterprise application integration in finance, manufacturing, construction, electronic commerce and other industries, and obtained an initial public offering at NASDAQ one year later (Business Wire Inc. 1999). This IPO was highly successful with a strong first day of trading, when its stock price increased from $15 to $32.375.

On the other hand, joining SAP’s platform ecosystem is not costless for ISVs. Besides the fixed cost of developing a platform-compliant version of the software solution, certification application fees and yearly membership fees, there are considerable misappropriation risks for ISVs due to the extensive knowledge sharing involved in the relationship. For example, AMC Technology, a leading provider of multi-channel integration solutions that allows contact centers
to more efficiently manage all types of customer interactions, has been a certified SAP software partner since 1998. With its introduction of the product suite mySAP CRM 5.0 in 2005, SAP folded the multi-channel integration functionality into its platform and entered into AMC’s product territory with a “CRM Interaction Center” module, which allegedly contained copyrighted AMC code from AMC’s “Multi-Channel Management Suite” product. AMC soon filed a lawsuit that claimed vicarious copyright infringement, breach of contract, and misappropriation of trade secrets by SAP (Shapiro 2005).

### 3.2. Data

We test our theoretical predictions using a longitudinal data set of 1210 small independent software vendors over the period of 1996 - 2004. We collect information on both the ISVs’ decisions to join SAP’s innovation ecosystem and information on their business performance. The sampling period starts from 1996 as we find no such partnership activities between SAP and small ISVs in the sample before then (more details will be provided later in the section on variable definitions).

Our primary data source is the CorpTech database, which has detailed information on over 100,000 public and private firms, including information on sales, employees, product offerings, source of funding and company executives. It is well known that studies related to firm performance solely based on public firms may suffer from severe sample selection bias (Cockburn and MacGarvie 2006; Shan 1990), and will be particularly problematic for our study given our focus on small firms.

---

4 These data have been used frequently to study firm behavior in technology industries. For examples of recent studies using the CorpTech database to study the software industry, see Lerner and Zhu (2007) and Cockburn and MacGarvie (2009).
To construct a representative sample of entrepreneurial ISVs that could potentially form partnerships with SAP, we first identify within CorpTech the set of firms operating in the United States and who list computer software as their primary industry. To further identify firms in the enterprise software industry we examine the product portfolios of current SAP software partners, and then find all software firms in CorpTech that produce similar products. The first step involves retrieving a complete list of SAP’s current software partners. SAP publishes the directory of all its certified partners as well as their solution offerings on its Internet portal, and a search using the terms “Country: United States” and “Partner Category: Independent Software Vendor” yields a list of 411 software firms that are current SAP partners. Comparing this list with software firms within CorpTech generates 206 matching records.

We use these matching records to identify the set of potential partners. One of the key advantages of the CorpTech database is that it records the product portfolio of each company and assigns each product to a 3-digit product class. We retrieve the distinct 2-digit product classification codes of the 206 current SAP software partners, and find that SOF-MA (manufacturing software, 61 firms) and SOF-WD (warehousing/distribution software, 44 firms), are the most frequent software product codes in the product portfolios of the matched partnering firms. To verify that the unmatched partners are not systematically different from those matched to CorpTech, we collect information on the unmatched ISVs from Company Insight Center (CIC), a database launched by BusinessWeek and Capital IQ. A short business profile is obtained from CIC for each of the remaining ISVs, which is complemented by a description of their business and products we collect from the ISVs’ websites. Then we manually examine the

---

6 CorpTech uses a proprietary, 3-digit product classification system. For example, a product coded as “AUT-AT-DA” means “factory automation”-“automatic test equipment”-“analog/digital component”.
product portfolio of these ISVs by reading their business profiles and product descriptions. We find that manufacturing software and warehouse/distribution software are also the two most frequently produced by the unmatched ISVs, similar to the ISVs that are matched in the CorpTech database. We subsequently define our sample as firms that have produced SOF-MA or SOF-WD products during the sample period. The final query retrieves 2175 ISVs from the CorpTech database.

We further exclude established incumbents and restrict our sample to startup ISVs. Consistent with prior literature (Petersen and Rajan 1994; Puranam et al. 2006) that has focused on small, entrepreneurial businesses, we restrict our sample to firms with less than 500 million in sales and 1000 employees, and those established after 1980. We exclude established incumbents because of our research focus on small ISV behavior and because the partnering incentives and payoffs of large firms are likely to be quite different from those of small firms. For example, to the extent that large firms sponsor platforms of their own, partnership may increase the value of a large firm’s own platform. Also the misappropriation risks that large firms face after partnering may be quite different than those of small firms due to the latter’s strong IPRs and/or downstream capabilities. Our final sample consists of 1210 ISVs with 6578 observations over the 1996 - 2004 time period. The typical ISV in the final sample is about 12 years old, with 56 employees and average sales of $7 million.

It should be noted that in our setting ISVs produce software products that can be sold both as a stand-alone product and as platform compliant software. Once the product is developed, the cost

---

7 As an additional check, we manually go through the business description field in the CorpTech data set for each company, and visit the website of each firm (if the company no longer exists, we visit the archival web site from www.archive.org instead) to confirm that the ISVs produce enterprise software applications, and delete those that do not fit the profile.
of making it compatible with a platform (technical cost, to be specific) is considerably lower than product development cost. As a result, ISVs rarely make products that are dedicated to one specific platform from the beginning; in most cases a stand-alone product is first developed, then is made compatible with the platforms of incumbents. In addition, many ISVs certify their product for multiple platforms to gain access to as many customers as possible.8

3.3. Dependent Variables

Sales. Sales data for each company-year are retrieved directly from the CorpTech database, and are measured in millions of US dollars. We take the log form of the sales variable (that is, log (1+x) to avoid taking log of zeroes) as the dependent variable in the regressions because this variable is highly skewed to the right. When the distribution of dependent variable is skewed, models using logged dependent variable often satisfy the classical linear model assumptions more closely than models using the level of the dependent variable (Verbeek 2008; Wooldridge 2008).

IPO. We search the Securities Data Company (SDC) platinum database to retrieve the list of ISVs in our sample that issued an initial public offering in the US market during the sample period. We also obtain the date of IPO. The variable is set to 1 if an IPO is issued for a firm during a year, 0 otherwise.

---
8 As an additional check, we examined the history of SAP partners in our sample to check whether their certified products were new, exclusive add-ons for only one platform. If this is true, it may suggest alternative explanations for the proposed hypotheses, especially H1. We found that all our partners fell into one of three cases: (1) they had already produced multiple versions of the software prior to partnering with SAP; (2) they had already used trademarks related to the product in commerce at least two years prior to partnering (and so were not new); or (3) the product has been certified by multiple other enterprise software platforms such as Oracle, Siebel, J.D. Edwards, Infor, PeopleSoft, etc. We further note that ISVs in our sample had been around for several years prior to partnering; The average age of the ISVs in the year prior to patenting is 9.4 (with the youngest being 1 in the year prior to partnering (that is, 2 in the year when a partnership was formed) and oldest being 23), and the average sales of these firms at one year prior to partnering is $20.7 million (with the lowest being $.33 million).
3.4. Independent Variables

**Partnership.** The independent variable of interest is whether an ISV is an SAP-certified software solution provider in a particular year. As our study is longitudinal in nature, using the list of partnering ISVs retrieved from SAP’s web portal as the dependent variable is problematic for several reasons. First, the list of partnering ISVs reflects only the current snapshot but fails to capture historical partnering events. Second, the enterprise software industry experiences considerable entry and exit during the sampling period; many partnering firms are eventually acquired by or merged with other companies. Third, information about the exact partnering date is missing from SAP’s web portal, which makes determination of the year of partnership formation difficult.

As an alternative to overcome the aforementioned difficulties, we identify the partnership formation events through press releases. To test the viability of this approach, we examined the existing partner list retrieved from the SAP web portal to see whether a matching press release could be found in the Lexis/Nexis database for each firm. For a random sample (60 firms) of the 411 existing SAP partners, we are able to find a matching news release for over 98% of the firms, which confirms the validity of using press releases to determine the formation of partnerships. We subsequently apply the same algorithm to our sample universe and retrieve 148 alliance events between sample ISVs and SAP. It is notable that there has been no such alliance activity prior to 1996. We further exclude pure joint development, marketing or distribution alliances and alliances after 2004 from the list. In addition, for ISVs that have multiple SAP alliance press releases (due to certification for multiple products, new versions of same product, or different interface certifications), we use the first instance of such events to indicate the time that the ISV joins SAP’s platform ecosystem.
The *partnership* variable is set equal to 1 in the first year that a partnership is formed and remains 1 for the rest of the years, and is 0 otherwise. We treat partnering with SAP as an absorbing state, as there are no obvious reasons for a partnering ISV to make its certified product incompatible with SAP’s platform. In order to verify that partnering with SAP is indeed an absorbing state, we collect information on the ISVs’ status after the partnering events. We find that partnering ISVs fall into the following three categories. (1) 31% of the ISVs are partners with SAP as of April 2010 (they are listed on SAP’s current ecosystem website) and their products remain certified. (2) 46% of the ISVs were acquired or merged with other companies since they partnered with SAP. By reading the press releases of these merger and acquisition events, we find that the certified product existed at the acquisition/merger event in all cases, and note that such firms are dropped from our sample subsequently. (3) 23% of the ISVs are no longer listed on SAP’s website as certified partners, but their most recent SAP certification occurs after 2004, the end of our sample period. To summarize, these efforts reassure us that partnering is an absorbing state for all the ISVs during our sample period (1996 - 2004).

*Patents.* We measure the patent stock of ISVs by using the USPTO CASSIS patent BIB database. Although diversified software vendors may have patented innovations in related areas (e.g., manufacturing control or data acquisition equipment), we are primarily interested in their software patents. We follow Hall and MacGarvie (2006) by defining the universe of software patents as the intersection of the two sets of criteria: the patents in the software-related U.S. Patent Office technology classes defined by Graham and Mowery (2005), and those that are found in the results of a Boolean queries that searches for key words in the text of issued patents.
(as defined by Bessen and Hunt (2007)). For a survey of different ways to identify software-related inventive activities see Arora et al. (2008). We also weight the resulting stock of software patents using each patent’s forward citations, to account for the heterogeneity in the value of an innovation protected by the patent (Hall et al. 2001).

**Copyrights.** The cumulative number of registered software copyrights for each firm-year is obtained from the United States Copyright Office. To indicate copyright type, the US Copyright Office assigns a prefix to each copyright it issues. As we are interested in software copyrights, we retrieve only those copyrights that are described as “computer file” within the TX (monograph including books, maps and software) class.

**Downstream capabilities.** Following prior literature, we use the stock of software trademarks registered in the U.S. as a proxy of the ISV’s effort to build brand, reputation, and distribution channels (Gao and Hitt 2004). According to the USPTO definition, a trademark is “a word, phrase, symbol or design, or combination of words, phrases, symbols or designs, that identifies and distinguishes the source of the goods or services of one party from those of others.” While trademarks may not directly protect a firm against the imitation of its products by its rivals per se, they enhance a firm’s appropriability by legally protecting its investments in marketing and other intangibles such as brand and reputation (Fosfuri et al. 2008). It is important to note that trademarks not only protect the brand and logo of a firm’s products, but also the broader marketing and promotional investments. For example, “The Best-Run Businesses Run SAP” is a

---

9 As a robustness check, we also use the union of the two software patent sets and derive alternative measures, and find that all the empirical results are robust to this alternative measure.

10 Use of patent data is becoming increasingly common in IS research. For one example, see Kleis et al. (2009).

11 A copyright protects the original expression of an idea fixed in a medium and does not need to be registered to be obtained. However, registration of a copyright in the US Copyright Office provides evidence of validity of the claim and enables the right holder to file an infringement suit in court and to file for statutory damages as well as recover attorneys’ fees if claims are litigated (http://www.copyright.gov/circs/circ01.pdf).
registered trademark of SAP AG, as well as Microsoft’s slogan “Global Access to Local Knowledge”. We follow prior research where trademarks have been used as a proxy for the stock of marketing-specific downstream assets and a firm’s brand capital (Fosfuri et al. 2008; Gambardella and Giarratana 2006). Brand capital represents a hard to imitate capability since it is not easily contracted for through the market on competitive terms and is hard to be redeployed to alternative uses and alternative users (Williamson 1991). The data have been obtained from the USPTO CASSIS Trademarks BIB database. We use only software trademarks that are active for the firm-year.

3.5. Control Variables

We control for a number of firm characteristics that could potentially influence operational performance. In particular, we control for an ISV’s basic R&D capabilities by including its yearly stock of publications in academic journals or conferences in both the sales and IPO regressions. We obtain this variable from the ISI Web of Knowledge database, by searching for the ISV’s name as organization and (“article” or “proceedings paper”) as document type. We weight the number of publications by the number of forward citations obtained by each article, to account for heterogeneity in their importance.

Software firms’ funding sources are likely to impact their operations. We therefore control for the effect of firms’ source of funding. We create three dummy variables, cinvest, pinvest and vinvest following the CorpTech database classification of funding sources into corporate investment, private investment or venture capital investment.

We also control for firm age in both performance equations based on the year in which an ISV was established, as well as its quadratic term, to account for nonlinear effects. As typically done
for IPO equations, we control for firm size by incorporating the number of employees, which is obtained directly from the CorpTech database. Due to the high correlation (> 0.9) between sales and employees we exclude sales in IPO equation to avoid multicollinearity (Hsu 2006). The variable employees is not included in the sales equation due to endogeneity concerns. To control for performance differences between public and privately held companies we instead add an ownership indicator variable in the sales equation.

Investments in product and process innovations are driven in part by expectations about the potential size of the market and its growth potential (Acemoglu and Linn 2004; Cohen 1995; Schmookler 1966). In other words, ecosystem partnership may be associated with unobserved industry-level features such as expected industry growth that may influence a firm’s success. To control for these industry-level features, we obtain the target industries that each ISV serves from the CorpTech database and classify them into 40 categories (such as banking, chemical, oil and gas). Next, we calculate the industry growth rate by averaging the sales growth rates of all the ISVs that serve the industry. We then map the industry growth to individual ISVs and derive the variable industryGrowth as a control. Table 1 presents the summary statistics of all of our variables, as well as the correlation among them.

[Insert Table 1 about here]

3.6. Methods

Main effect of partnering. Cross-sectional analysis of the effect of partnering on an ISV’s performance is likely to suffer from unobserved firm heterogeneity which may be correlated with

---

12 Notice that the correlations need to be interpreted with caution due to the panel structure of the data. For example, the correlation coefficient between partner and IPO is 0.06. If the data are collapsed at the firm level the correlation increases to 0.24, which reflect variation between firms. Similarly, the correlation between trademarks and IPO is 0.005 overall, but jumps to 0.11 in the between sample. It is difficult to describe the correlation between variables within firms.
partnering decisions, resulting in inconsistent estimates. We choose panel data methods with fixed effects as a starting point for the empirical analysis. Specifically, for firm sales we estimate the following equation:

\[
\begin{align*}
\log(\text{sales}_{it}) = & \alpha + \beta_1 \text{partner}_{it} + \beta_2 \text{patent}_{it} + \beta_3 \text{copyright}_{it} \\
& + \beta_4 \text{trademark}_{it} + \beta_5 \text{age}_{it} + \beta_6 \text{age}^2_{it} + \beta_7 \text{public}_{it} \\
& + \beta_8 \text{cinvest}_{it} + \beta_9 \text{pinvest}_{it} + \beta_{10} \text{vinvest}_{it} \\
& + \beta_{11} \text{publication}_{it} + \beta_{12} \text{industryGrowth}_{it} + \text{year}_t + c_i \\
& + u_{it}
\end{align*}
\]

(1)

where \(\text{year}_t\) is a set of year dummies, and \(c_i\) denotes firm fixed effects. The variables patent, copyright, trademark and publication are entered in log form (that is, log \((1+x)\) to avoid taking log of zeroes) because their distributions are highly skewed.

Following prior studies (Forman et al. 2009; Gowrisankaran and Stavins 2004; Tucker 2008) with binary dependent variables, we estimate the IPO regression using a linear probability model with firm fixed effects, due to the known difficulty of controlling for time-invariant unobserved heterogeneity using panel data probit or logit models.\(^{13}\) In particular, we estimate:

\[
\begin{align*}
1(\text{IPO}_{it+1} = 1) = & \alpha + \beta_1 \text{partner}_{it} + \beta_2 \text{patent}_{it} + \beta_3 \text{copyright}_{it} \\
& + \beta_4 \text{trademark}_{it} + \beta_5 \text{age}_{it} + \beta_6 \text{age}^2_{it} + \beta_7 \text{cinvest}_{it} \\
& + \beta_8 \text{pinvest}_{it} + \beta_9 \text{vinvest}_{it} + \beta_{10} \text{publication}_{it} \\
& + \beta_{11} \text{industryGrowth}_{it} + \beta_{12} \text{employee}_{it} + \text{year}_{t+1} + c_i \\
& + u_{it+1}
\end{align*}
\]

(2)

\(^{13}\) For a full discussion of these issues, see Wooldridge (2001). Unconditional fixed effects provide inconsistent estimates using probit or logit models because of the well-known incidental parameters problem. Further, conditional fixed effects models drop panels where there is no variation in the dependent variable — in our setting, this would include any ISV that does not eventually issue an IPO.
where \(1(IPO_{t+1} = 1)\) represents a binary variable indicating whether an IPO has been issued in year \(t+1\). Note that only private firms are included in the IPO regression. The observations after a firm goes public are dropped from the sample as the firm is no longer exposed to the hazard of issuing an IPO. We lag all the independent variables by one year to further mitigate for potential endogeneity of the right-hand-side variables. Number of employees is entered into the regression equation in log form.

*Moderating effects of appropriation mechanisms.* In order to evaluate Hypotheses 3 and 4, we add interactions between an ISVs’ partnering statuses and its IPR and downstream capabilities. To enable a more intuitive interpretation of our regression results, we create discrete measures of IPR and downstream capabilities. Particularly, the variables \(highCopyright\) and \(highTrademark\) are set to 1 if an ISV’s cumulative number of copyrights and trademarks are in the top quartile of the distribution\(^{14}\). Because less than 15% of the observations have patents, the variable \(highPatent\) is set to 1 if an ISV has at least one patent during the year, 0 otherwise.

To summarize, we estimate the following two equations to test if the effects of partnering on an ISV’s sales and likelihood of issuing an IPO are moderated by appropriation mechanisms.

\(^{14}\) As a robustness check, we test the models using an alternative threshold, the 50th percentile, to define the variables \(highPatent\), \(highCopyright\) and \(highTrademark\). We conduct further robustness checks using continuous values for patents, copyrights and trademarks. All our findings reported in the main text are robust to these alternative specifications.
\[ \log(sales_{it}) = \alpha + \beta_1 partner_{it} + \beta_2 highPatent_{it} + \beta_3 highCopyright_{it} \\
+ \beta_4 highTrademark_{it} + \beta_5 age_{it} + \beta_6 age^2_{it} \\
+ \beta_7 public_{it} + \beta_8 cinvest_{it} + \beta_9 pinvest_{it} + \beta_{10} vinest_{it} \\
+ \beta_{11} publication_{it} + \beta_{12} industryGrowth_{it} \\
+ \beta_{13} partner_{it} \times highPatent_{it} + \beta_{14} partner_{it} \\
\times highCopyright_{it} + \beta_{15} partner_{it} \times highTrademark_{it} \\
+ year_t \times c_i + u_{it} \] (3)

\[ 1(IPO_{it+1} = 1) = \alpha + \beta_1 partner_{it} + \beta_2 highPatent_{it} \\
+ \beta_3 highCopyright_{it} + \beta_4 highTrademark_{it} + \beta_5 age_{it} \\
+ \beta_6 age^2_{it} + \beta_7 cinvest_{it} + \beta_8 pinvest_{it} + \beta_{10} vinest_{it} \\
+ \beta_{11} publication_{it} + \beta_{12} industryGrowth_{it} \\
+ \beta_{13} employee_{it} + \beta_{13} partner_{it} \times highPatent_{it} \\
+ \beta_{14} partner_{it} \times highCopyright_{it} + \beta_{15} partner_{it} \\
\times highTrademark_{it} + year_{t+1} \times c_i + u_{it+1} \] (4)

4. RESULTS

4.1. Effect of Joining Platform Ecosystem on Sales

The results of fixed effects models that use \( \log(sales) \) as the dependent variable are presented in Table 2. Variables are entered into the regressions sequentially. In column 1 we present the baseline model in which only the variables partnering status, IPR and downstream capabilities are included. In column 2 we add the other control variables. In column 3 we include year dummies.

[Insert Table 2 about here]

Examining the results from the final model, we find support for Hypothesis 1, suggesting that joining a platform ecosystem is associated with greater sales. The variable \( partner \) is significant.
at the 5% level in all of the models. On average, ISVs enjoy a 26% ($=e^{.23}-1$) increase in sales after they become SAP certified. Interestingly, we also find that ISVs’ annual sales are strongly correlated with their appropriability mechanisms, as the coefficients of patent, copyright and trademark are positive and highly significant.\textsuperscript{15}

4.2. Effect of Joining Platform Ecosystem on IPO

Hypothesis 2 suggests that joining a platform innovation ecosystem is associated with a greater likelihood of issuing an IPO. The hypothesis is supported by the results in Table 3. As we did for the sales models, we present the baseline model in column 1, the one with the full set of control variables in column 2, and include year dummies in column 3. The variable partner is significant at the 5% or 10% level in all of the models. Using the results of the full model in column 3, we find that joining SAP’s platform ecosystem is associated with a 5.9 percentage point increase in the likelihood of obtaining an IPO, supporting Hypothesis 2.

[Insert Table 3 about here]

4.3. Robustness Checks

We test a number of alternative models and use different variable definitions to demonstrate the robustness of our findings. The results are presented in Table 4 (sales results) and Table 5 (IPO results).

[Insert Table 4 about here]

\textsuperscript{15} Note that we present two sets of R-squared values in all of our tables. First, we present “within” R-squares that do not include the explanatory power of the fixed effects on the explained sum of squares, and are computed based on the fraction of variance explained within firms. These within R-square values are lower than our R-squared with fixed effects, which are based on the total (within and between) sum of squares and incorporate the explanatory power of our fixed effects. Note that in our IPO regressions, our dependent variable is binary, not continuous, and regressions with binary dependent variables typically have lower R-squared values than continuous variables. For further examples, see Forman et al. (2009).
First, in the benchmark models we use forward-citation-weighted patents and publications as independent variables. In column 1 of Table 4 and Table 5 we present a similar specification using a fixed effects model and raw counts of patent stocks and scientific publications that are unweighted by forward citations. Second, although fixed effects models are robust to unobserved heterogeneity and require weaker model assumptions, they are more susceptible to attenuation bias arising from measurement error (Griliches and Hausman 1986). In column 2 of Tables 4 and 5 we present the results from a random effects model. We observe that the estimates of the marginal effects of partnering are very similar to that of the fixed effects model.

It is possible that there exist time-varying omitted variables that affect both the ISV’s decision to join SAP’s platform ecosystem and its performance, which are not fully accounted for in our fixed effects models in Tables 2 and 3. For example, it is possible that ISVs with superior performance choose to join the SAP’s platform ecosystem. We address these endogeneity concerns in several ways. First, as a falsification test we verify that the measured positive impacts of partnering on ISV performances do not occur before the partnering year (Agrawal and Goldfarb 2008). If we expect firms with better financial status will join SAP’s ecosystem, it is likely that we will observe an increase in sales or the likelihood of an IPO in the years preceding their partnership with SAP. To investigate this possibility, we add as additional controls two dummy variables that are equal to one in the two years prior to the first partnering event. We present the results in column 3 of Tables 4 and 5. The results show no significant preexisting trend on sales or the likelihood of an IPO for partnering ISVs. The effect only takes place after partnering with SAP.
Second, we use instrumental variables (IV) methods to address potential endogeneity concerns. In particular, we use two candidate variables that should be correlated with the partnering decision but not with financial performance. The first variable describes how many executives of an ISV have personal connections with SAP. From the CorpTech database we retrieve the complete list of executives for every firm-year. We then look up the working experience of each executive on the business-oriented social network website, LinkedIn, to find if he/she has ever worked for SAP as an employee. We then aggregate the number of executive links to SAP at the firm-year level. The rationale for using this variable as an instrument is that an executive’s past working experience at SAP is likely to establish personal connections that would increase the propensity to partner with SAP. However, it is unlikely to be correlated with unobserved firm-level factors that would increase the performance of the firm where he/she serves as an executive. The second variable describes the propensity to partner with SAP among ISVs that serve markets similar to those of the focal ISV. The CorpTech database has data on the target industries within which each company sells its products and services, which we broadly classify into 40 categories. We calculate the fraction of ISVs that partner with SAP in each industry-year, and use this to approximate the partnering propensity at the industry level. We then calculate the partnering propensity for each ISV, by weighting these data by the set of industries served by the ISV. If an ISV serves multiple industries, the industry level propensities are averaged to derive the ISV’s propensity. The logic for this variable is that it will capture cross-industry differences in the value of partnership. However, conditional on our controls for industry growth, it should be uncorrelated with factors influencing ISV performance. Following prior literature on instrumental variables under binary endogenous variables, we use these instruments to run a probit model of the propensity of a firm-year to be an SAP partner.\footnote{That is, we run the probit model of partnership on our two instruments: social connections and industry propensity} We then use the predicted
probability of partnership from this probit model, and the square of this predicted probability, as our instruments. Using nonlinear fitted values of instruments in this way has been shown under some cases to have superior efficiency properties than a traditional linear first stage but still provides consistent estimates (Angrist 2001; Newey 1990).

We present the results from the instrumental variable model in column 4 of Tables 4 and 5. Our results are robust to the use of these models.¹⁷

Since acquisition by another firm is often considered a successful exit strategy for small start-up firms, an alternative measure of forward-looking performance in the literature is whether the firm issues an IPO or has been acquired (Cockburn and MacGarvie 2009). We also examine how partnership influenced the likelihood of obtaining an IPO or acquisition,¹⁸ and the results were qualitatively similar to our IPO models.¹⁹

### 4.4. Moderating Effect of Appropriability Mechanisms for Sales

Hypothesis 3 suggests that the positive effect of joining a platform ecosystem on an ISV’s sales is greater when the ISV enjoys greater IPR protection or stronger downstream capabilities. In other words, the effect of partnering on ISV sales is moderated by their appropriability mechanisms. We present the results for the moderating effects in Table 6. As usual, fixed effects panel data models are used. Column 1 presents the baseline model where only partnering status, to partner.

¹⁷ All the instrumental variable results presented in the paper are supported by tests of instruments validity (available from the authors upon request). Indeed, the p-value related to the tests of the joint null hypothesis of no effect of the instruments on partnership is always lower than 0.001. In addition, the tests of the overidentifying restrictions (Hansen J tests) always suggest that the instruments used are exogenous in all the IV specifications presented in the paper.

¹⁸ We define acquisitions as majority share acquisitions, and we exclude bankrupt acquisitions and liquidation acquisitions. Data are collected from the SDC Platinum database.

¹⁹ Due to space constraints, the results of these models are not reported, but are available from the authors upon request.
appropriability mechanisms and their interactions are included. In column 2 we add the control variables, while in column 3 we include year dummies. The results in column 3 suggest that ISVs who partner with SAP on average experience a 43.6% sales increase provided they have high patent stocks, a 32% increase provided they have high copyright stocks, or a 26.9% increase provided they have high trademark stocks. The upper panel of Figure 2, which is based on column 3 of Table 6, visually illustrates the moderating effect of IPR and downstream capabilities on the relationship between partnership and ISV sales. Surprisingly, our results indicate that ISVs whose innovations are not protected by any means of appropriation do not experience any significant improvement in sales. If anything, their sales performance is poorer (though not significantly so) than if they did not partner.

While a firm’s stock of trademarks is a good measure of its marketing and distribution capabilities, we acknowledge that the downstream capabilities of an ISV may encompass other equally important dimensions that may not be entirely captured by the firm’s stock of trademarks, such as its consulting and other professional service capabilities. As a robustness check of our measure of downstream capabilities, we construct a variable that measures the extent of software services that are offered by an ISV. The CorpTech database provides information on our sample firms’ portfolio of software service offerings, which are classified into categories such as software consulting services, business intelligence services, custom software programming services and artificial intelligence R&D services. From this information we derive the variable \( \text{anyService} \), which indicates that the ISV offers services to its clients (about 22% of the sample has \( \text{anyService} \) equal to 1). After sales service and support is an

---

20 The complete list of service categories is as follows: artificial intelligence (AI) services, AI software programming, AI R&D services, other R&D services not elsewhere classified, software consulting services, custom software programming services, applications software services, systems software services, other custom programming services, and other software services.
important part of the service offerings of many ISVs, and in many cases will be required by potential buyers to purchase the software. Thus, it is an alternative measure of downstream capabilities.

We present the results with this new measure in columns 4 and 5 of Table 6. When \textit{anyService} is substituted for \textit{highTrademark} it behaves very similar to the latter variable; the interaction term of Partner and \textit{anyService} is positive and significant in column 4. However, when both \textit{highTrademark} and \textit{anyService} are included in the same regression (in column 5) we find that the latter variable is statistically insignificant. We take this as evidence that while both \textit{highTrademark} and \textit{anyService} capture downstream capabilities, \textit{highTrademark} is more important than \textit{anyService} in appropriating the returns from partnership. There may be several reasons for this result: trademarks may be a stronger appropriability mechanism because they are more difficult to imitate; further, in the case of a sales increase the stock of trademarks can be scaled up at a much lower cost than services. Regardless of the measure used, we find that the interactions between \textit{partner} and \textit{highPatent} and \textit{highCopyright} are all positive and significant at conventional levels. The results lend support to Hypothesis 3a and 3b.

4.5. Moderating Effect of Appropriability Mechanisms for IPO

We find that the positive effect of joining a platform ecosystem on the ISVs’ likelihood of issuing an IPO is also moderated by their appropriability mechanisms. Table 7 presents the results of this model. Confirming Hypothesis 4a (column 3 of Table 7), we find that the increase in the likelihood of obtaining an IPO will be 19.0 percentage points higher provided the ISV
also has high patent stocks and 15.8 percentage points higher provided it also has high copyright stocks. These results are statistically significant at conventional levels. We do not find evidence that ISVs with high trademarks experience greater benefits from partnering. The moderating effects of IPR are illustrated in the lower panel of Figure 2. In addition, we find that if the innovations of an ISV are not protected by any appropriability mechanism, there is no evidence that partnering will increase the likelihood of obtaining an IPO. This can be seen from the insignificant (and negative) coefficient of the partner variable.

We believe that the lack of result for the interaction of partner and highTrademark may be due to a feature of our data: the number of IPOs decline dramatically throughout our sample because of the deterioration of financial market conditions in the wake of the dot-com bust. At the same time, the fraction of firms with highTrademark increases from 22.0% (in 1996) to 38.0% (in 2004). Thus, it is difficult for us to separate the effects of increasing trademarks from deteriorating financial market conditions on the likelihood of an IPO. In a separate set of regressions, we interacted our partner variable with a post-2001 dummy and found that the marginal effect of partner on IPO declines substantially post-2001 because of this change in external environment. Thus, we believe our coefficients for the partner × highTrademark variable are biased downward because of this change in economic and financial conditions. As a robustness check, we also used the alternative measure anyService (column 4 and column 5) but again found no evidence that this measure of downstream capabilities was complementary with partnership. ²¹

²¹ Note that because we measure no significant moderating effects of trademarks on IPO likelihood, we do not include a graph of these results in Figure 2.
While we do use firm fixed effects in all of our models in Tables 6 and 7, one potential concern is that there may exist time-varying omitted variables that may be correlated with partner and its interaction with $highPatent$, $highCopyright$ and $highTrademark$. If that is the case, then our estimates of these parameters may be biased. However, use of instrumental variables for the complete set of endogenous variables is difficult in our setting: This would require a set of four separate instruments, which would compound the usual problems that fixed effects remove all of the useful cross-sectional variation in the data and in the presence of measurement error give rise to attenuation bias (Angrist and Pischke 2009; Greene 2002). To reduce the number of endogenous variables that we must instrument for, we create a new variable called $highIPR$ which equals to one if either $highPatent$ or $highCopyright$ is one. Since patents and copyrights are used as substitute forms of IPR protection in the software industry (Lerner and Zhu 2007), this variable is a combined measure of IPR protection for the ISV.

Thus, we have three endogenous variables: partner, partner X $highIPR$, and partner X $highTrademark$. Following prior literature on the use of instrumental variables in nonlinear (in variables) settings (Gallant 1987, p. 440), we instrument for these variables using the predicted values of partner using the method above, and the interaction of this variable with $highIPR$, $highTrademark$, and other exogenous variables such as age, age-squared, and sales growth. In total, we have eight instruments for three endogenous variables.

Instrumental variables estimates for our sales regressions are included in column 6 of Table 6. Our results are qualitatively robust to the use of instrumental variables and fixed effects. The coefficient estimates show that partnership will only be associated with an increase in sales in the presence of $highIPR$ and $highTrademark$. The coefficient for the interaction of partner with $highIPR$ remains significant at the 10% level. The interaction of partner with $highTrademark$,
while not significantly different than zero at conventional levels, remains statistically significant at the 12.5% level.

Instrumental variable results related to the IPO equation with interactions are not shown due to the poor fit of the model (negative R-squared) and the inability to identify the effects under study. We believe that this is due partly to the difficult data environment: In the IPO regressions our dependent variable is binary, a particularly challenging setting to estimate via nonlinear IV (instrumenting for partnership and its interactions) using only the within firm variation (because of our use of firm fixed effects). Further, as noted above, the effect of highTrademark is inherently more difficult to identify in this setting because of the aggregate time series trend in highTrademark and partner.

5. CONCLUSIONS

To summarize, we report participating in a platform ecosystem as a new and viable innovation commercialization strategy employed by small ISVs. Our results demonstrate that, on average, ISVs can achieve significant benefits through participation in a platform ecosystem—benefits that can translate into significant increases in sales and an increased likelihood of eventually attaining an IPO, a widely recognized measure of success for start-up firms. However, there exists considerable heterogeneity in the extent to which ISVs can capture the value co-created by these partnerships. In particular, ISVs without downstream marketing or service capabilities or without IPR such as patents and copyrights will appropriate less of the co-created value generated from compatibility with the platform. These results are robust to a battery of robustness checks, including instrumental variables analysis and a falsification exercise.
Limitations. We believe that our study represents a careful analysis of the impact of platform participation on small firm performance. However, like any empirical study, it does have several limitations. One potential issue arises from sample definition, in particular how to determine the “at-risk” set of potential participants in the ecosystem. As noted above, in this study we identify the set of at-risk firms as those software firms producing manufacturing and warehousing/distribution software. We chose not to extend our sample to firms producing other product types for two reasons. First, many of the software firms in our sample produce other types of products beyond manufacturing and warehousing/distribution. Thus, our sample includes a much broader cross-section of software products than might appear at first glance. For example, among our sample of 1210 ISVs, 474 also produce accounting software, 323 provide utility systems software, and 256 also provide sales/marketing software. Second, selecting on other software product types would introduce significant unobserved heterogeneity into our sample by adding many firms whose products are unrelated to SAP’s software and for whom the benefits of partnership are likely to be extremely low. For example, if we add producers of accounting software to our list (SOF-AC; the group with the next highest hazard rate of partnership), it would increase our sample size by over 2000 firms, but would add only 14 partners.

Implications for Other Industry Environments. Our study follows prior work that has used case studies of individual industries to examine the implications of platforms for producer and user behavior (Adomavicius et al. 2008; Nair et al. 2004). We believe this approach is appropriate for the study of platform industries insofar as it reduces unobserved heterogeneity across observations and improves internal validity. However, our focus on platform ecosystems is valid across a wide variety of settings. Large ecosystems have been fundamental to the success
(in terms of platform sales, and ultimate business survival) of IT platforms such as Ethernet (13 vendors supported Ethernet in 1982 compared to the three vendors supporting Token Ring; Von Burg 2001); Microsoft Windows (38,338 vendors, including 3,817 ISVs; Iansiti and Levien 2004); Palm Handhelds (who claimed over 140,000 developers for its standard in 2001; Nair et al. 2004); and iPhone (50,000 applications as of June 2009),\(^\text{22}\) as well as Real estate platforms like Multiple Listing Service (12,322 listings in the Madison, WI area according to Hendel et al. 2009).

Moreover, the key platform issues that we study—the benefits to joining a platform from signaling technological compatibility and the risks of entry from the platform owner—also have widespread validity. For example, complementors benefit from compatibility with platforms such as Microsoft Windows, the Cisco Internetwork Operating System (IOS), and Intel microprocessors, however the threat of incursion from the platform owner into the complementor’s market has been a focus of theoretical work and case studies in all three industries (Eisenmann et al. 2007; Gawer and Cusumano 2002; Gawer and Henderson 2007).

While our setting shares many features with other IT platforms, one key difference is that complementors in our setting have the option to choose between joining a platform and selling platform-independent, stand-alone applications. In particular, in our setting, the platform plays the role of reducing compatibility costs among heterogeneous components, rather than providing an infrastructure that includes components required for complementary applications to run. In that way, our setting shares similarity with environments like Cisco’s Internetwork Operating System (IOS) platform (which reduces the costs of communication among heterogeneous routers and switches) rather than the Microsoft Windows or Xbox platforms (which includes key

infrastructure required for complementors’ applications to run). More empirical research is needed in this latter, important area.

It is important to state how ecosystem partnerships are distinct from other forms of IT value co-creation (Kohli and Grover 2008). Like other settings of IT value co-creation, in our setting IT is “instrumental in creating a product to co-create business value” (Kohli and Grover 2008). However, in other settings IT is used to co-create value by facilitating standardization of business processes or improving information flows between heterogeneous systems of individual firms (Markus et al. 2006). In this way, IT facilitates value co-creation by reducing transaction costs through inter-organizational systems that, among other things, strengthen supply chain relationships (Bharadwaj et al. 2007; Clemons et al. 1993; Gerbauer and Buxmann 2000; Melville et al. 2004). In our setting, partnership aids in the standardization of interfaces between software products that are used to co-create business value. In so doing, we add to the evolving work in IS that seeks to understand how firms co-create value through IT platforms (Dhar and Sundararajan 2007).

**Theoretical Implications.** Platform-based innovation ecosystems present an interesting setting for studies on the dynamics of inter-organizational collaboration and competition. An increasing body of theoretical work has examined firm strategies in platform markets, including decisions on the extent to which a platform should be opened (Eisenmann et al. 2008; Parker and Van Alstyne 2008; West 2003) and vendor reactions to open and closed platforms (Lee and Mendelson 2008; Mantena et al. 2007). However, there has been little research that measures the value co-created through participation in such a platform. Our study takes initial steps to investigate these issues from the perspective of small, complementary solution providers in the enterprise software industry.
Perhaps most significantly, we establish a set of boundary conditions on the extent to which this value is captured by small ISVs. These findings extend and complement (<obscured for review process>), who show that highly innovative ISVs are more likely to join a platform ecosystem. Interestingly, while this focus on establishing the conditions for appropriating value from IT investment has long been a focus on other ecosystems studied in the information systems literature such as supply chain relationships (Grover and Saeed 2007; Subramani 2004), it has drawn relatively little attention in empirical work on software platforms. We feel this is a fruitful area for future research.

Finally, our contributions to the markets for technology literature stems naturally from our focus on the enterprise software industry. In this setting technology commercialization by entrepreneurial companies may be facilitated by joining the platform ecosystem. Such partnerships represent a natural setting for the identification of the effect of IPR on technology commercialization and firm performance, a key objective of this paper and the markets for technology literature (Arora and Ceccagnoli 2006; Arora et al. 2001; Cockburn and MacGarvie 2006; Cockburn and MacGarvie 2009; Gans et al. 2002). Indeed, unintended knowledge spillovers are particularly salient during SAP software certification, which requires partnering firms to closely integrate their product interface designs. This highlights a clear tradeoff for technology commercialization by ISVs. Our results imply that strong IPR directly influence this tradeoff by affecting the likelihood of expropriation of IP rights and platform owner entry. Further, strong IPR will indirectly benefit the platform owner by nurturing the platform ecosystem with innovative software solutions. In other words, IPR appear to favor both value appropriation and value co-creation in the enterprise software industry.
Managerial Implications. Our findings have important implications for both platform sponsors as well as those who participate in the platform ecosystem. First, our results suggest that under certain conditions ISVs who join a platform ecosystem will see gains in operational performance. However, ISVs whose innovations are not protected by IPR or downstream complementary capabilities should be cautious about initiating partnerships. To prevent the threat of invasion from the platform owner, they should actively seek IPR protection, or secure complementary downstream capabilities first. Finally, we believe that it is critical for the platform owners to understand the incentives of complementary product providers. In particular, the appropriate management of the expropriation concerns of its smaller yet most innovative entrepreneurial partners represents a potential strategy to sustain their innovation ecosystems.

More generally, our results suggest some conditions under which a “virtuous cycle” may be realized in a software platform ecosystem. As is well known, there is significant variation in the extent to which formal appropriability mechanisms like patents and copyrights are effective at protecting firms’ IP rights (Cohen et al. 2000). Our results suggest that ISVs who participate in markets for which appropriability mechanisms like patents are strong will see greater returns from partnership. These greater returns will in turn encourage new partners to join the ecosystem, and will also draw in additional customers (and in turn, more partners). Our results similarly suggest conditions under which this virtuous cycle is unlikely to occur, however. In environments where appropriability mechanisms are weak, our results suggest that the expected gains from partnership are relatively low, and under such conditions the platform ecosystems are most likely to be unsuccessful in attracting complementary innovation.
Figure 1. Research Framework
Figure 2a: Marginal Effect of Partnership on Growth in Sales by Patent Stock

Figure 2b: Marginal Effect of Partnership on Growth in Sales by Copyright Stock

Figure 2c: Marginal Effect of Partnership on Growth in Sales by Trademark Stock

Figure 2d: Marginal Effect of Partnership on IPO Likelihood by Patent Stock

Figure 2e: Marginal Effect of Partnership on IPO Likelihood by Copyright Stock

Notes:
1. Marginal effects on sales are measured by percent increase
2. Marginal effects on IPO are measured by increase in percentage point

Figure 2. Moderating effects of patents, copyrights and trademarks
Table 1. Summary Statistics and Correlation Matrix

| Variable            | Mean   | Std. Dev. | Min   | Max    | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      | 11      | 12      | 13      | 14      |
|---------------------|--------|-----------|-------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1 Sales<sub>i,t</sub> | 7.539  | 16.219    | 0.000 | 206.400| 1.000   |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 2 IPO<sub>i,t+1</sub> | 0.004  | 0.064     | 0.000 | 1.000 | 0.035   | 1.000   |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 3 Partner<sub>i,t</sub> | 0.017  | 0.129     | 0.000 | 1.000 | 0.295   | 0.063   | 1.000   |         |         |         |         |         |         |         |         |         |         |         |         |
| 4 Copyright<sub>i,t</sub> | 1.988  | 12.841    | 0.000 | 498.000| 0.253   | 0.029   | 0.044   | 1.000   |         |         |         |         |         |         |         |         |         |         |         |
| 5 Patent<sub>i,t</sub> | 0.145  | 0.722     | 0.000 | 13.000| 0.253   | 0.029   | 0.044   | 1.000   |         |         |         |         |         |         |         |         |         |         |         |
| 6 Trademark<sub>i,t</sub> | 0.835  | 2.011     | 0.000 | 23.000| 0.035   | 0.129   | 0.016   | 1.000   |         |         |         |         |         |         |         |         |         |         |         |
| 7 Age<sub>i,t</sub> | 12.566 | 5.830     | 0.000 | 24.000| -0.052  | -0.059  | -0.058  | 0.069   | -0.114  | 0.004   | 1.000   |         |         |         |         |         |         |         |         |         |
| 8 Publication<sub>i,t</sub> | 0.600  | 5.259     | 0.000 | 137.000| 0.000   | -0.005  | 0.003   | 0.016   | -0.005  | 0.030   | 0.045   | 1.000   |         |         |         |         |         |         |         |         |
| 9 Corporate invest<sub>i,t</sub> | 0.046  | 0.210     | 0.000 | 1.000 | 0.102   | 0.010   | 0.101   | -0.019  | 0.031   | 0.062   | -0.118  | -0.016 | 1.000   |         |         |         |         |         |         |         |
| 10 Private invest<sub>i,t</sub> | 0.501  | 0.500     | 0.000 | 1.000 | 0.087   | -0.029  | -0.039  | 0.007   | -0.048  | 0.053   | -0.144  | -0.017  | -0.068  | 1.000   |         |         |         |         |         |         |         |
| 11 VC invest<sub>i,t</sub> | 0.122  | 0.327     | 0.000 | 1.000 | 0.176   | 0.108   | 0.171   | -0.008  | 0.155   | 0.106   | -0.339  | 0.039   | 0.071   | -0.073  | -0.000  | 1.000   |         |         |         |         |
| 12 Employee<sub>i,t</sub> | 56.248 | 104.904   | 1.000 | 997.000| 0.901   | 0.071   | 0.283   | 0.240   | 0.286   | 0.385   | -0.075  | 0.049   | 0.108   | -0.100  | 0.199   | 1.000   |         |         |         |         |
| 13 Industry growth<sub>i,t</sub> | 1.261  | 0.342     | 0.873 | 6.322 | 0.007   | 0.006   | 0.012   | -0.001  | -0.012  | -0.023  | -0.051  | 0.013   | -0.019  | -0.015  | -0.019  | 0.011   | 1.000   |         |         |         |         |
| 14 Public<sub>i,t</sub> | 0.061  | 0.239     | 0.000 | 1.000 | 0.447   | -0.017  | 0.230   | 0.059   | 0.248   | 0.243   | -0.058  | 0.072   | 0.075   | -0.040  | 0.157   | 0.477   | 0.013   | 1.000   |         |         |

Notes.
Number of firms: 1210; Number of observations: 6578.
Table 2. Effect of Partnering on Sales

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Baseline model</th>
<th>(2) With firm level controls</th>
<th>(3) With year dummies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Partner</strong></td>
<td>0.484*** (0.115)</td>
<td>0.254** (0.105)</td>
<td>0.231** (0.105)</td>
</tr>
<tr>
<td><strong>Patent</strong></td>
<td>0.179*** (0.032)</td>
<td>0.121*** (0.026)</td>
<td>0.111*** (0.027)</td>
</tr>
<tr>
<td><strong>Copyright</strong></td>
<td>0.233*** (0.034)</td>
<td>0.167*** (0.031)</td>
<td>0.156*** (0.031)</td>
</tr>
<tr>
<td><strong>Trademark</strong></td>
<td>0.204*** (0.025)</td>
<td>0.102*** (0.024)</td>
<td>0.085*** (0.024)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td>0.079*** (0.009)</td>
<td>0.037*** (0.011)</td>
</tr>
<tr>
<td><strong>Age^2</strong></td>
<td></td>
<td>-0.002*** (0.000)</td>
<td>-0.002*** (0.000)</td>
</tr>
<tr>
<td><strong>Publication</strong></td>
<td></td>
<td>0.062 (0.065)</td>
<td>0.048 (0.065)</td>
</tr>
<tr>
<td><strong>Cinvest</strong></td>
<td>0.339*** (0.119)</td>
<td>0.327*** (0.117)</td>
<td></td>
</tr>
<tr>
<td><strong>Pinvest</strong></td>
<td>0.040 (0.045)</td>
<td>0.027 (0.045)</td>
<td></td>
</tr>
<tr>
<td><strong>Vinvest</strong></td>
<td>0.172** (0.085)</td>
<td>0.171** (0.085)</td>
<td></td>
</tr>
<tr>
<td><strong>IndustryGrowth</strong></td>
<td></td>
<td>0.048*** (0.015)</td>
<td>0.055*** (0.016)</td>
</tr>
<tr>
<td><strong>Public</strong></td>
<td>0.715*** (0.136)</td>
<td>0.704*** (0.136)</td>
<td></td>
</tr>
<tr>
<td><strong>Year dummies</strong></td>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>1.232*** (0.019)</td>
<td>0.476*** (0.071)</td>
<td>0.848*** (0.090)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td></td>
<td>6578</td>
<td>6578</td>
</tr>
<tr>
<td><strong>Number of firms</strong></td>
<td></td>
<td>1210</td>
<td>1210</td>
</tr>
<tr>
<td><strong>R-squared (within)</strong></td>
<td></td>
<td>0.103</td>
<td>0.183</td>
</tr>
<tr>
<td><strong>R-squared (with fixed effects)</strong></td>
<td></td>
<td>0.906</td>
<td>0.914</td>
</tr>
</tbody>
</table>

**Notes.**
Fixed effects panel data models with robust standard errors in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.1.
<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Baseline model</th>
<th>(2) With firm level controls</th>
<th>(3) With year dummies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner</td>
<td>0.066** (0.033)</td>
<td>0.060* (0.034)</td>
<td>0.059* (0.034)</td>
</tr>
<tr>
<td>Patent</td>
<td>0.004 (0.004)</td>
<td>0.005 (0.004)</td>
<td>0.004 (0.004)</td>
</tr>
<tr>
<td>Copyright</td>
<td>0.019** (0.008)</td>
<td>0.016** (0.008)</td>
<td>0.016* (0.008)</td>
</tr>
<tr>
<td>Trademark</td>
<td>0.002 (0.003)</td>
<td>-0.000 (0.003)</td>
<td>-0.000 (0.003)</td>
</tr>
<tr>
<td>Age</td>
<td>0.000 (0.001)</td>
<td>-0.001 (0.001)</td>
<td></td>
</tr>
<tr>
<td>Age²</td>
<td>-0.000 (0.000)</td>
<td>-0.000 (0.000)</td>
<td></td>
</tr>
<tr>
<td>Publication</td>
<td>-0.006* (0.003)</td>
<td>-0.006* (0.003)</td>
<td></td>
</tr>
<tr>
<td>Employee</td>
<td>0.004*** (0.002)</td>
<td>0.004** (0.002)</td>
<td></td>
</tr>
<tr>
<td>Cinvest</td>
<td>0.043 (0.028)</td>
<td>0.044 (0.028)</td>
<td></td>
</tr>
<tr>
<td>Pinvest</td>
<td>0.004 (0.005)</td>
<td>0.004 (0.005)</td>
<td></td>
</tr>
<tr>
<td>Vinvest</td>
<td>0.027 (0.021)</td>
<td>0.028 (0.021)</td>
<td></td>
</tr>
<tr>
<td>IndustryGrowth</td>
<td>0.002 (0.002)</td>
<td>-0.001 (0.002)</td>
<td></td>
</tr>
<tr>
<td>Year dummies</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.005 (0.003)</td>
<td>-0.025*** (0.009)</td>
<td>-0.003 (0.022)</td>
</tr>
<tr>
<td>Observations</td>
<td>6266¹</td>
<td>6266¹</td>
<td>6266¹</td>
</tr>
<tr>
<td>Number of firms</td>
<td>1175¹</td>
<td>1175¹</td>
<td>1175¹</td>
</tr>
<tr>
<td>R-squared (within)</td>
<td>0.020</td>
<td>0.032</td>
<td>0.037</td>
</tr>
<tr>
<td>R-squared (with fixed effects)</td>
<td>0.654</td>
<td>0.662</td>
<td>0.664</td>
</tr>
</tbody>
</table>

Notes. Fixed effects panel data models with robust standard errors in parentheses.
*** p < 0.01; ** p < 0.05; * p < 0.1.
¹: only private companies are included. Post IPO observations are dropped.
### Table 4. Robustness Check, Sales

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unweighted patent and publication</td>
<td>Random effects</td>
<td>Years before partner</td>
<td>Instrumental variables</td>
</tr>
<tr>
<td>Partner</td>
<td>0.230**</td>
<td>0.232**</td>
<td>0.298***</td>
<td>1.995**</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.096)</td>
<td>(0.115)</td>
<td>(0.822)</td>
</tr>
<tr>
<td>Patent</td>
<td>0.443***</td>
<td>0.097***</td>
<td>0.110***</td>
<td>0.100***</td>
</tr>
<tr>
<td></td>
<td>(0.091)</td>
<td>(0.022)</td>
<td>(0.027)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Copyright</td>
<td>0.128***</td>
<td>0.173***</td>
<td>0.156***</td>
<td>0.136***</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.022)</td>
<td>(0.031)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Trademark</td>
<td>0.080***</td>
<td>0.136***</td>
<td>0.084***</td>
<td>0.057**</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.021)</td>
<td>(0.023)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Age</td>
<td>0.035***</td>
<td>0.032***</td>
<td>0.036***</td>
<td>0.037***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.008)</td>
<td>(0.011)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Age²</td>
<td>-0.002***</td>
<td>-0.002***</td>
<td>-0.002***</td>
<td>-0.002***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Publication</td>
<td>0.062</td>
<td>0.014</td>
<td>0.049</td>
<td>0.089</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
<td>(0.044)</td>
<td>(0.065)</td>
<td>(0.068)</td>
</tr>
<tr>
<td>Cinvest</td>
<td>0.321***</td>
<td>0.301***</td>
<td>0.328***</td>
<td>0.347***</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.082)</td>
<td>(0.117)</td>
<td>(0.125)</td>
</tr>
<tr>
<td>Pinvest</td>
<td>0.024</td>
<td>-0.058*</td>
<td>0.028</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.033)</td>
<td>(0.045)</td>
<td>(0.048)</td>
</tr>
<tr>
<td>Vinvest</td>
<td>0.166*</td>
<td>0.290***</td>
<td>0.168**</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>(0.086)</td>
<td>(0.059)</td>
<td>(0.086)</td>
<td>(0.108)</td>
</tr>
<tr>
<td>IndustryGrowth</td>
<td>0.054***</td>
<td>0.059***</td>
<td>0.055***</td>
<td>0.057***</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Public</td>
<td>0.626***</td>
<td>0.791***</td>
<td>0.705***</td>
<td>0.426**</td>
</tr>
<tr>
<td></td>
<td>(0.137)</td>
<td>(0.105)</td>
<td>(0.136)</td>
<td>(0.217)</td>
</tr>
<tr>
<td>One year before partnering</td>
<td></td>
<td></td>
<td></td>
<td>0.070</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.102)</td>
</tr>
<tr>
<td>Two years before partnering</td>
<td></td>
<td></td>
<td></td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.123)</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>0.868***</td>
<td>0.941***</td>
<td>0.850***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.090)</td>
<td>(0.067)</td>
<td>(0.090)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>6578</td>
<td>6578</td>
<td>6578</td>
<td>6578</td>
</tr>
<tr>
<td>Number of firms</td>
<td>1210</td>
<td>1210</td>
<td>1210</td>
<td>1210</td>
</tr>
<tr>
<td>R-squared (within)</td>
<td>0.197</td>
<td></td>
<td>0.193</td>
<td>0.069</td>
</tr>
<tr>
<td>R-squared (with fixed effects)</td>
<td>0.915</td>
<td></td>
<td>0.915</td>
<td></td>
</tr>
</tbody>
</table>

**Notes.**
Robust standard errors in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.1.
Table 5. Robustness Check, IPO

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Unweighted patent and publication</th>
<th>(2) Random effects</th>
<th>(3) Years before partner</th>
<th>(4) Instrumental variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner</td>
<td>0.059* (0.034)</td>
<td>0.058* (0.035)</td>
<td>0.063* (0.035)</td>
<td>0.242* (0.132)</td>
</tr>
<tr>
<td>Patent</td>
<td>0.018 (0.016)</td>
<td>0.006 (0.004)</td>
<td>0.004 (0.004)</td>
<td>0.002</td>
</tr>
<tr>
<td>Copyright</td>
<td>0.015* (0.008)</td>
<td>0.014** (0.006)</td>
<td>0.016** (0.008)</td>
<td>0.014* (0.008)</td>
</tr>
<tr>
<td>Trademark</td>
<td>-0.000 (0.003)</td>
<td>-0.001 (0.003)</td>
<td>-0.000 (0.003)</td>
<td>-0.003 (0.004)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001 (0.001)</td>
<td>0.000 (0.001)</td>
<td>-0.001 (0.001)</td>
<td>-0.001 (0.001)</td>
</tr>
<tr>
<td>Age²</td>
<td>-0.000 (0.000)</td>
<td>0.000 (0.000)</td>
<td>-0.000 (0.000)</td>
<td>0.000 (0.000)</td>
</tr>
<tr>
<td>Publication</td>
<td>-0.010** (0.004)</td>
<td>-0.005 (0.003)</td>
<td>-0.005* (0.003)</td>
<td>-0.002 (0.002)</td>
</tr>
<tr>
<td>Employee</td>
<td>0.004** (0.002)</td>
<td>0.006*** (0.002)</td>
<td>0.004** (0.002)</td>
<td>0.001 (0.002)</td>
</tr>
<tr>
<td>Cinvest</td>
<td>0.044 (0.028)</td>
<td>0.028 (0.021)</td>
<td>0.044 (0.028)</td>
<td>0.041 (0.028)</td>
</tr>
<tr>
<td>Pinvest</td>
<td>0.004 (0.005)</td>
<td>-0.002 (0.004)</td>
<td>0.004 (0.005)</td>
<td>0.006 (0.005)</td>
</tr>
<tr>
<td>Vinvest</td>
<td>0.029 (0.021)</td>
<td>0.035** (0.015)</td>
<td>0.028 (0.021)</td>
<td>0.014 (0.018)</td>
</tr>
<tr>
<td>IndustryGrowth</td>
<td>-0.001 (0.002)</td>
<td>-0.001 (0.002)</td>
<td>-0.001 (0.002)</td>
<td>-0.001 (0.002)</td>
</tr>
<tr>
<td>One year before partnering</td>
<td></td>
<td></td>
<td></td>
<td>-0.009 (0.030)</td>
</tr>
<tr>
<td>Two years before partnering</td>
<td></td>
<td>0.032 (0.050)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.002 (0.022)</td>
<td>-0.021* (0.011)</td>
<td>-0.003 (0.022)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>6266¹</td>
<td>6266¹</td>
<td>6266¹</td>
<td>6266¹</td>
</tr>
<tr>
<td>Number of firms</td>
<td>1175¹</td>
<td>1175¹</td>
<td>1175¹</td>
<td>1175¹</td>
</tr>
<tr>
<td>R-squared (within)</td>
<td>0.038</td>
<td></td>
<td>0.040</td>
<td>0.041</td>
</tr>
<tr>
<td>R-squared (with fixed effects)</td>
<td>0.664</td>
<td></td>
<td>0.665</td>
<td></td>
</tr>
</tbody>
</table>

Notes.
Robust standard errors in parentheses.
*** p < 0.01; ** p < 0.05; * p < 0.1.
¹: only private companies are included. Post IPO observations are dropped.
Table 6. Moderating Effect of IPR and Downstream Capabilities, Sales

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Baseline model</th>
<th>(2) With firm level controls</th>
<th>(3) With year dummies</th>
<th>(4) With service only</th>
<th>(5) With service and trademarks</th>
<th>(6) Instrumental Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner</td>
<td>0.057 (0.136)</td>
<td>-0.084 (0.129)</td>
<td>-0.149 (0.129)</td>
<td>-0.043 (0.107)</td>
<td>-0.185 (0.132)</td>
<td>-0.543 (1.398)</td>
</tr>
<tr>
<td>HighPatent</td>
<td>0.616*** (0.058)</td>
<td>0.383*** (0.057)</td>
<td>0.346*** (0.056)</td>
<td>0.356*** (0.056)</td>
<td>0.344*** (0.056)</td>
<td></td>
</tr>
<tr>
<td>HighCopyright</td>
<td>0.456*** (0.045)</td>
<td>0.339*** (0.043)</td>
<td>0.310*** (0.043)</td>
<td>0.315*** (0.043)</td>
<td>0.310*** (0.043)</td>
<td></td>
</tr>
<tr>
<td>HighTrademark</td>
<td>0.199*** (0.021)</td>
<td>0.104*** (0.021)</td>
<td>0.088*** (0.021)</td>
<td>0.089*** (0.021)</td>
<td>0.070* (0.031)</td>
<td></td>
</tr>
<tr>
<td>AnyService</td>
<td></td>
<td>0.009 (0.043)</td>
<td>0.017 (0.043)</td>
<td>0.017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HighIPR</td>
<td></td>
<td>0.285*** (0.063)</td>
<td>0.285*** (0.063)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner × HighPatent</td>
<td>0.392*** (0.149)</td>
<td>0.323** (0.143)</td>
<td>0.362** (0.142)</td>
<td>0.466*** (0.148)</td>
<td>0.426*** (0.149)</td>
<td></td>
</tr>
<tr>
<td>Partner × HighCopyright</td>
<td>0.251** (0.127)</td>
<td>0.262** (0.121)</td>
<td>0.278** (0.121)</td>
<td>0.265** (0.121)</td>
<td>0.295** (0.121)</td>
<td></td>
</tr>
<tr>
<td>Partner × HighTrademark</td>
<td>0.385*** (0.112)</td>
<td>0.214* (0.107)</td>
<td>0.238** (0.106)</td>
<td>0.199* (0.110)</td>
<td>1.175 (0.765)</td>
<td></td>
</tr>
<tr>
<td>Partner × AnyService</td>
<td></td>
<td>0.230* (0.121)</td>
<td>0.161 (0.124)</td>
<td>0.161</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner X HighIPR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.498* (1.323)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.081*** (0.007)</td>
<td>0.035*** (0.009)</td>
<td>0.038*** (0.009)</td>
<td>0.035*** (0.009)</td>
<td>0.029*** (0.011)</td>
<td></td>
</tr>
<tr>
<td>Age²</td>
<td>-0.002*** (0.000)</td>
<td>-0.002*** (0.000)</td>
<td>-0.002*** (0.000)</td>
<td>-0.002*** (0.000)</td>
<td>-0.002*** (0.000)</td>
<td></td>
</tr>
<tr>
<td>Publication</td>
<td>0.083* (0.050)</td>
<td>0.066 (0.050)</td>
<td>0.064 (0.050)</td>
<td>0.062 (0.050)</td>
<td>0.120* (0.068)</td>
<td></td>
</tr>
<tr>
<td>Cinvest</td>
<td>0.357*** (0.069)</td>
<td>0.339*** (0.068)</td>
<td>0.354*** (0.068)</td>
<td>0.342*** (0.068)</td>
<td>0.329** (0.136)</td>
<td></td>
</tr>
<tr>
<td>Pinvest</td>
<td>0.049 (0.034)</td>
<td>0.035 (0.034)</td>
<td>0.042 (0.034)</td>
<td>0.036 (0.034)</td>
<td>0.059 (0.050)</td>
<td></td>
</tr>
<tr>
<td>Vinvest</td>
<td>0.165*** (0.051)</td>
<td>0.164*** (0.051)</td>
<td>0.158*** (0.051)</td>
<td>0.159*** (0.051)</td>
<td>-0.035 (0.125)</td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>0.749*** (0.061)</td>
<td>0.730*** (0.061)</td>
<td>0.754*** (0.061)</td>
<td>0.732*** (0.061)</td>
<td>0.484* (0.225)</td>
<td></td>
</tr>
<tr>
<td>IndustryGrowth</td>
<td>0.048*** (0.013)</td>
<td>0.055*** (0.015)</td>
<td>0.055*** (0.015)</td>
<td>0.056*** (0.015)</td>
<td>0.058*** (0.018)</td>
<td></td>
</tr>
<tr>
<td>Year dummies</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.220*** (0.014)</td>
<td>0.430*** (0.053)</td>
<td>0.839*** (0.076)</td>
<td>0.838*** (0.077)</td>
<td>0.835*** (0.077)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>6578</td>
<td>6578</td>
<td>6578</td>
<td>6578</td>
<td>6578</td>
<td>6477</td>
</tr>
<tr>
<td>Number of firms</td>
<td>1210</td>
<td>1210</td>
<td>1210</td>
<td>1210</td>
<td>1210</td>
<td>1109</td>
</tr>
<tr>
<td>R-squared (within)</td>
<td>0.091</td>
<td>0.182</td>
<td>0.192</td>
<td>0.189</td>
<td>0.193</td>
<td>0.012</td>
</tr>
<tr>
<td>R-squared (with fixed effects)</td>
<td>0.904</td>
<td>0.913</td>
<td>0.915</td>
<td>0.914</td>
<td>0.915</td>
<td></td>
</tr>
</tbody>
</table>

Notes. Fixed effects panel data models with robust standard errors in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.1.
## Table 7. Moderating Effect of IPR and Downstream Capabilities, IPO

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline model</td>
<td>With firm level controls</td>
<td>With year dummies</td>
<td>With service only</td>
<td>With service and trademarks</td>
</tr>
<tr>
<td>Partner</td>
<td>-0.077 (0.071)</td>
<td>-0.081 (0.072)</td>
<td>-0.083 (0.071)</td>
<td>-0.068 (0.042)</td>
<td>-0.080 (0.071)</td>
</tr>
<tr>
<td>HighPatent</td>
<td>0.002 (0.008)</td>
<td>0.002 (0.010)</td>
<td>-0.000 (0.009)</td>
<td>-0.001 (0.009)</td>
<td>-0.001 (0.009)</td>
</tr>
<tr>
<td>HighCopyright</td>
<td>0.016* (0.010)</td>
<td>0.016 (0.010)</td>
<td>0.016 (0.010)</td>
<td>0.015 (0.010)</td>
<td>0.015 (0.010)</td>
</tr>
<tr>
<td>HighTrademark</td>
<td>0.004 (0.004)</td>
<td>0.000 (0.004)</td>
<td>-0.000 (0.004)</td>
<td>-0.000 (0.004)</td>
<td>-0.000 (0.004)</td>
</tr>
<tr>
<td>AnyService</td>
<td>0.006 (0.004)</td>
<td>0.006* (0.004)</td>
<td>0.006* (0.004)</td>
<td>0.006* (0.004)</td>
<td>0.006* (0.004)</td>
</tr>
<tr>
<td>Partner × HighPatent</td>
<td>0.194*** (0.098)</td>
<td>0.189* (0.102)</td>
<td>0.190* (0.101)</td>
<td>0.180* (0.103)</td>
<td>0.179* (0.100)</td>
</tr>
<tr>
<td>Partner × HighCopyright</td>
<td>0.162** (0.068)</td>
<td>0.160** (0.068)</td>
<td>0.158** (0.067)</td>
<td>0.160** (0.068)</td>
<td>0.163** (0.069)</td>
</tr>
<tr>
<td>Partner × HighTrademark</td>
<td>0.005 (0.054)</td>
<td>0.005 (0.054)</td>
<td>0.007 (0.054)</td>
<td>0.016 (0.053)</td>
<td>0.016 (0.053)</td>
</tr>
<tr>
<td>Partner × AnyService</td>
<td>-0.041 (0.031)</td>
<td>-0.045 (0.028)</td>
<td>-0.041 (0.031)</td>
<td>-0.045 (0.028)</td>
<td>-0.045 (0.028)</td>
</tr>
<tr>
<td>Age</td>
<td>0.001 (0.000)</td>
<td>-0.001 (0.001)</td>
<td>-0.001 (0.001)</td>
<td>-0.001 (0.001)</td>
<td>-0.001 (0.001)</td>
</tr>
<tr>
<td>Age²</td>
<td>-0.000 (0.000)</td>
<td>-0.000 (0.000)</td>
<td>-0.000* (0.000)</td>
<td>-0.000* (0.000)</td>
<td>-0.000* (0.000)</td>
</tr>
<tr>
<td>Publication</td>
<td>-0.004* (0.002)</td>
<td>-0.004* (0.002)</td>
<td>-0.005* (0.003)</td>
<td>-0.005* (0.003)</td>
<td>-0.005* (0.003)</td>
</tr>
<tr>
<td>Employee</td>
<td>0.004*** (0.002)</td>
<td>0.004** (0.002)</td>
<td>0.004** (0.002)</td>
<td>0.004** (0.002)</td>
<td>0.004** (0.002)</td>
</tr>
<tr>
<td>Cinvest</td>
<td>0.041 (0.028)</td>
<td>0.041 (0.028)</td>
<td>0.041 (0.028)</td>
<td>0.041 (0.028)</td>
<td>0.041 (0.028)</td>
</tr>
<tr>
<td>Pinvest</td>
<td>0.004 (0.005)</td>
<td>0.004 (0.005)</td>
<td>0.004 (0.005)</td>
<td>0.004 (0.005)</td>
<td>0.004 (0.005)</td>
</tr>
<tr>
<td>Vinvest</td>
<td>0.024 (0.021)</td>
<td>0.026 (0.021)</td>
<td>0.027 (0.021)</td>
<td>0.027 (0.021)</td>
<td>0.027 (0.021)</td>
</tr>
<tr>
<td>IndustryGrowth</td>
<td>0.002 (0.002)</td>
<td>-0.001 (0.002)</td>
<td>-0.001 (0.002)</td>
<td>-0.001 (0.002)</td>
<td>-0.001 (0.002)</td>
</tr>
<tr>
<td>Year dummies</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.001 (0.003)</td>
<td>-0.026*** (0.009)</td>
<td>0.003 (0.021)</td>
<td>-0.001 (0.020)</td>
<td>-0.000 (0.020)</td>
</tr>
<tr>
<td>Observations</td>
<td>6266¹</td>
<td>6266¹</td>
<td>6266¹</td>
<td>6266¹</td>
<td>6266¹</td>
</tr>
<tr>
<td>Number of firms</td>
<td>1175¹</td>
<td>1175¹</td>
<td>1175¹</td>
<td>1175¹</td>
<td>1175¹</td>
</tr>
<tr>
<td>R-squared (within)</td>
<td>0.038</td>
<td>0.053</td>
<td>0.058</td>
<td>0.060</td>
<td>0.060</td>
</tr>
<tr>
<td>R-squared (with fixed effects)</td>
<td>0.660</td>
<td>0.669</td>
<td>0.671</td>
<td>0.672</td>
<td>0.672</td>
</tr>
</tbody>
</table>

Notes. Fixed effects panel data models with robust standard errors in parentheses.  
*** p < 0.01; ** p < 0.05; * p < 0.1.  
¹: only private companies are included. Post IPO observations are dropped.
References


Business Wire Inc. 1998. "TIBCO Receives SAP Interface Certification for Its TIB/Adapter for SAP R/3; Company Becomes a Member of the SAP Complementary Software Partner Program," PALO ALTO, Calif.


55


