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Investigating e-business models' value retention for start-ups: The moderating role of venture capital investment intensity

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ABSTRACT

Business models help firms to set a right path to create, grow and retain their business value. While previous research shows that business model affects the performance of entrepreneurial firms, there is still limited understanding about how likely different business model selections of Internet of Things (IoT) startup firms retain their value and whether the venture capital investment intensity does play any role in the business model's value retention process. In this study, we suggest that the e-business model selections (i.e. *novelty, efficiency, lock-in and complementarity*) of an IoT mobile Application (App) may affect its value retention. Based on contingency theory, an organization must match its structure and decisions to its external environments. We propose that the venture capitalist's involvement may moderate the strength of the relationship between e-business models and an IoT mobile App's' value retention. We have collected data from 470 start-ups in China. The results show that efficiency-centred and complementarities-centred e-business models increase while lock-in centred e-business model reduces the IoT mobile App's value retention. Furthermore, our findings also indicate that the venture capitalist's involvement does not help all types of e-business model's value retention. The relationship between novelty centred e-business model and value retention is positively only when venture capital investment intensity is high. In contrast, the relationship between efficiency centred e-business model and value retention is positive only when venture capital investment intensity is low. Theoretical and managerial implications are discussed, and some limitations and future research directions are proposed.

1. Introduction

Business model helps firms set a right path to create, grow and retain their business value. Business model research is becoming a focus of attention among both academicians and practitioners. (Zott et al., 2011). However, literature on the conceptual development of business model did not appear until late 1990s and early 2000s. Thereafter it grew in parallel to a rise in exogenous factors like telecommunication technology evolution, the Internet boom (Magretta, 2002; Mahadevan, 2000) and e-business outsourcing services (Teece, 2010). Also, the interdisciplinary nature of business model has led to various ambiguous definitions (Chesbrough and Rosenbloom, 2002; Mahadevan, 2000; Morris et al., 2005; Teece, 2010; Timmers, 1998; Osterwalder and Pigneur, 2002). Within the stream of business models, more attention has been given to the understanding and elicitation of e-business models (for example, Afuah and Tucci, 2001; Amit and Zott, 2001; Eisenmann, 2002; Rappa, 2001; Tapscott et al., 2000; Weill and Vitale, 2001; Zheng, 2006). The definition of Amit and Zott (2001) is arguably the most citied one in the academic literature. They define *business model* as the structure, content, and governance of transactions between the focal firm and its exchange partners. Four different themes in e-business models are classified by Amit and Zott (2001): *novelty-centred business model* referring to novel ways of conducting economic exchanges among various participants; *efficiency-centred business model* referring to means of gaining transaction efficiency among its transaction partners; *lock-in-centred business model* concerning the means to retain engagement with existing transaction partners by creating switching costs or incentives; *complementarity-centred business model* as the method to increase the transactions by creating greater complementarities in

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activities and among different partners in the market. However, very few empirical studies related to these four business models are available in academic literature. Zott and Amit (2007) test the business models' performance implications and find that novelty-centred business model design matters most to the performance of entrepreneurial firms. Further, their study argues that combining both efficiency- and novelty-centred design elements into business models could be counterproductive. Zott and Amit (2008) examine the fit between business model and product market strategy and find that only novelty-centred business models coupled with product market strategies can enhance firm performance. However, both studies have examined only two types of business models: novelty- and efficiency-centred business model, which leave a research gap for future research to study the other two types of business model: *lock-in-centred* and *complementarity-centred*.

Our research aims to contribute to the business model literature in four ways. First, our study is among the few pioneering ones that extend previous research of Zott and Amit, (2007, 2008) by empirically examining the impact of all four types of business model on business value. The term *"value"* refers to the total dollar sum created by the transactions between a firm and its partners (Amit and Zott, 2001; Brandenburger and Stuart, 1996). While previous studies focus on the value creation of business models, this research emphasizes on value retention of business models. We believe that the business model's ability to retain value over time is a meaningful measure of its performance in a fast-changing or fast-growing industry, because many products, especially new and innovative products, usually lose their value very quickly and, as a result, the rate of their value retention is low (Moriarty and Thomas, 1989). Studying value retention may help the firms understand how a business model can increase a customer's purchase intention and satisfaction. Only when the business models can retain their customer base, can the associated product or service offerings be said to retain its value. According to our knowledge, this research is the first in academic literature that provides empirical results on how all four e-business models (including lock-in- and complementarity-centred business models) affect a product's value retention.

Second, we study e-business models in a new, nascent and untested e-business context – the Internet of Things (IoT) and Mobile Applications (Apps) business. IoT is a novel paradigm that facilitates enhanced communication between people and smart objects through Internet-connected devices. The major beneficiary of the IoT innovation resides in consumer Apps that are estimated to grow from 2.9 Billion in 2015 to 13 Billion connected objects in 2020 (Gartner, 2014a, 2014b). Most IoT products are linked to a smart phone via Apps and harness a smart phone's ubiquitous computing capability, facilitate machine-user interaction, and deliver superior user experience (Bouwman et al., 2009). From a refrigerator and home thermostat to car or office whiteboard and medical tablet, IoT mobile technology is successfully engaging the smart-phone to connect the world around us to the Internet (Evothings, 2015). We define *IoT mobile Apps* as the Apps which run on a smart phone, provide machine-to-machine (M2M) connectivity, allow sharing of data services, and facilitate ubiquitous computing across various devices all anchored on the smart phone device (Mobile Future, 2015). So far, there is no research studying the relationship between four e-business models and its potential value retention for the IoT mobile App firms. Statistics show that 95% of mobile Apps are abandoned by users within one month and at an average, an App loses its entire customer base within a few months (Chen, 2015). Therefore, it is important and useful to understand which business model is more likely to help the IoT mobile App firm retain its value. The results of this study may provide important insights and new implications to guide IoT mobile App firms on how to select a winning business model for value retention.

Third, although recent works have addressed the value creation of business model design for entrepreneurial firms, relatively little is known about the specific influence of venture capitalists on the selection of business models. The great "anything, anytime, anywhere" IoT gold rush is on and an unprecedented number of firms are working on how best to monetize the high-value touch points between IoT mobile Apps and their users. Startups are amassing millions of dollars in ventures to make their way out of the conceptual future and into commercialized Apps. According to TechCrunch (2014), American venture capital investments in IoT business soared over ten times from 2010 to 2014, contributing to over $300 million. For the year 2015, the total venture capital funding for the top 100 IoT startups stands at $6.19 Bn (Forbes, 2015). Indeed, the role of venture capitalists should not be ignored, and as prior studies indicate, the venture investors actively coach their investees on how to make business decisions (Croce et al., 2013). We propose that venture capital investment intensity plays an important moderating role in the relationship between an App' business model and its value retention. Ignoring the role of venture capitalist may prevent us from seeing the full and true picture of the e-business model's effect on value retention. Investigating the potential influence of venture capitalists may further develop the understanding for both scholars and managers on the complex value retention process of nascent IoT business.

Fourth, it is common that many research studies reflect the reality of western economies. However, in order to understand whether existing findings from developed countries can be generalized for firms in less-developed economies, there is a need for research studies from other emerging and transitional economies such as China (Wei et al., 2014). China has the largest IoT mobile App market and is the second largest venture capital market in the world. According to a recent report (TechCrunch, 2015), majority of mobile Apps in China do not retain users for more than a week. Thus, it is important and interesting to use the data from China to investigate how a business model's selection may affect value retention and what is the venture capitalist's influence in the business model's value retention process.

The rest of this study is structured as follows: (1) the theoretical background is presented and hypotheses are developed; (2) the research methodology issues are addressed; (3) the empirical results are reported, and the findings of the study are discussed from both academic and managerial perspectives; and (4) the limitations of the study are presented and suggestions for future research are made.

2. Theoretical framework and hypothesis development

2.1. Contingency theory

Contingency theory states that in order to be effective, an organization must match its structure to its contingent factors and, thus, to its environment (e.g., Galbraith, 1973; Lawrence and Lorsch, 1967). Organizations adapt their structure and decisions to both their internal and external environments. Based on this contingency theory approach, we argue that the effect of an IoT mobile App' business model on its value retention may change with the influence of venture capital investments, because venture capitalists may attempt to closely monitor, control and actively manage their investees in order to protect their own vested interests (Kaplan and Schoar, 2005). Some scholars propose that the added value of venture capital investments varies with circumstances (Sapienza, 1992). We believe that venture capitalists may play an important role in the process of how IoT mobile App startups select and implement different business models in order to retain the App's value over time for their consumers. Therefore, beyond the main effect of business models on value retention, this research will also examine the potential moderating role of venture capital investment intensity on the relationship between business models and value retention.

2.2. Hypothesis development

2.2.1. Main effects of e-business models on value retention

Zott and Amit (2008) argue that novelty-centred e-business model increases transactions by allowing linking transaction partners in innovative ways, such as connecting previously unconnected parties, adopting new transaction methods, capturing latent consumer needs, and creating entirely new markets, and so on. There is an abundance of self-aware, predictive, and reactive IoT mobile Apps that meet consumer's potential needs and wants in novel ways. For example, a hydration App connected with a smart cup monitors people's daily water intake. A sensor enabled basketball tracks player's basketball throw statistics, analyses the data and provides virtual coaching to improve skills through the interactions within an App. These ubiquitous computing examples demonstrate that the latest IoT mobile technology helps companies create new products or new functionalities on top of traditional products (Wainewright, 2014), which may create competitive advantage and increase a customer's purchase intentions and enhance his satisfaction. Strong customer purchase intention and satisfaction are positively related to consumer's retention rate (Verhoef, 2003).

Moreover, it is the intelligence-based and data-intensive nature of IoT mobile technology that turns modern mobile phones to "smart phones". Seamless stream of communications and information exchanges between IoT mobile devices gives the power to companies to be always connected with their customers, which can also create new competitive advantages over conventional e-business benefits (Accenture, 2015a). By tapping into various data streams, intelligent Apps can constantly interact with consumers, be aware of their real time location, contexts and needs and can be proactive in providing customized solutions. Such novel and unique product and service offerings may create special customer value and improve customer satisfaction. The improved customer satisfaction may then increase their retention rate (Verhoef, 2003).

Furthermore, combined with the proliferation of IoT mobile devices supported by ubiquitous computing technology, the present age of pervasive web has given way to big data analytics, which generates a thorough knowledge of market trends and consumer lifestyle. By harnessing data from novel sources, the novelty-centred business model transforms an App into vital intellectual property, which creates monopoly rents, helps companies open new value streams for customers, shorten the time to market, improve firm performance, and rapidly respond to novel customer needs. All these competitive advantages discussed above may eventually improve an IoT mobile App's market acceptance and increase the likelihood of retaining the Apps value over time. Thus, we propose:

H1. The more novelty-centred an IoT mobile App's business model is, the higher is its value retention.

2.2.2. Efficiency-centred business model on value retention

An efficiency-centred business model achieves business transaction efficiency by reducing transaction costs (such as customers' searching and bargaining costs), alleviating information asymmetries, and increasing the supply of up-to-date and comprehensive information, and so on (Amit and Zott, 2001). One of the major benefits of IoT technology is real-time information on mission-critical systems (Yu et al., 2014). A wide network of IoTs and associated computational power embedded in smart phones creates vast volumes of real-time information regarding users and IoT device usage. Thus, with the advent of large scale, new data sources arising from the web, social media platforms, sensor-generated content collected through gadgets and mobile phones, an efficiency-centred App may be able to capture data from many customer touch points in a timely manner, which may create competitive advantages for the firm and increase people's purchase intention towards IoT mobile Apps (Fan et al., 2015; Harris et al., 2015), which make the mobile App firms more likely to retain their value.

For example, a vehicle fleet tracking App that connects to a vehicle's On-Board Diagnostic systems can help firms to estimate wear and tear and plan maintenance materials accordingly. A smart App that connects to a water cooler not only reminds users to drink water but also automatically orders new filters. Hence, the increased transaction efficiency and reduced transaction cost may create competitive advantage and improve an App's market acceptance. In short, an efficiency-centred business model can achieve transaction efficiency either vertically or horizontally, or both, which can not only enhance the value of the core IoT products but also increase the customer's retention.

H2. The more efficiency-centred an IoT mobile App's business model is, the higher is its value retention.

2.2.3. Lock-in-centred business model on value retention

Lock-in centred business model increases transaction volume and enhances the retention of stakeholders (such as customers and strategic partners) by preventing the switch-over of these stakeholders to competitors (Amit and Zott, 2001; Zott and Amit, 2007). There are several challenges for IoT mobile App developers when they design a lock-in centred e-business model strategy. Firstly, lock-in effect may come from a dominant design in the product, processes and services (Teece, 1987). However, the booming Application Program Interface (API) economy leads to a fast change in App designs (Weiss and Gangadharan, 2010). The omnipresence open and free access of mobile App development frameworks makes it incredibly easy to build more customer appealing and interactive mobile Apps (Mcpherson, 2016). The current market may have low durability in core Apps. Thus, it is difficult to form a dominant design in IoT mobile App business.

In addition, a lock-in effect in e-business can be also built through customization (initiated by customers) and personalization (initiated by Apps developers) (Amit and Zott, 2001; Zott and Amit, 2007). However, it is very expensive to set up customizable and personalized IoT products and services (Feitzinger and Lee, 1997; Waller et al., 2000). Especially for any small-scale business and also for the early stage of an IoT mobile App developers, the cost of building lock-in centred business model might be higher than the return on financial value.

Finally, previous literature suggests that switching costs from "lock-in" generally harms consumer welfares (Farrell and Klemperer, 2006). Most IoT devices are "locked-in" with their accompanying mobile Apps, only with which these devices work. This reduces the interoperatability between different IoT devices, which leads to extra costs for consumers. A low level of interoperatability between devices and Apps also causes vast volumes of data to be under-utilized, limiting the possibility to leverage big data analytics. Users usually have to purchase and install various Apps and IoT hardware to achieve different functionalities (Forbes, 2013). As a result, consumers may be reluctant or more careful to make an adoption decision towards IoT mobile Apps due to potential lock-in effect. Whether lock-in-centred business model can really increase returns continues to be debated and doubted in academic literature (Perkins, 2003). Some researchers argue that given more intense competition, lock-in strategy is too costly for consumers compared to open strategy (Zhu and Zhou, 2012). In addition, policy makers also raise red flags and discourage "lock-in" business model due to the social inefficiency. Thus, we propose that lock-in-centred business model is more likely to reduce customer's purchase intention and customer satisfaction. Under such circumstances, it may be difficult to retain the App's value even after downloading the Apps:

H3. The more lock-in-centred an IoT mobile App's business model is, the lower is its value retention.

2.2.4. Complementarity-centred business model on value retention

Complementarity-centred business model intends to provide a bundle of complementary goods/services that are more valuable than the total value of having each of goods/service separately (Amit and Zott, 2001). The last few years have witnessed the growth of platform economy based on open API technology, thus allowing complementarities in value co-creation through innovation democratization (Von Hippel, 2005) and by promoting coopetition in competitive markets (Cusumano, 2010). By integrating APIs from a third-party data provider, App developers are able to provide a bundle of various services, which can create more value than if they provide each service separately. An App can also release its own APIs to other Apps so that the transaction costs will be reduced for consumers. For example, the APIs of a sports tracker App allows health insurers to make these decisions based on aggregate insightful customer profiles that include heart rate, stress levels, activity levels as well as gender and age. The App, in turn, can include insurance as a part of its value-added service.

Previous literature found that complementary product strategy may offer a significant competitive advantage through its multiplier effect on sale of the primary product (Sengupta, 1998). As more and more data sources are integrated, the content of a IoT mobile platform gets richer. So, complementarity-centred Apps offer technological and business innovation to co-create business value. We argue that the added value creation through complementary design may attract customer intention over time, which makes it more likely to retain an App's value.

H4. The more complementarity-centred an IoT mobile App's business model is, the higher is its value retention.

2.2.5. Moderating effects of venture capital investment intensity

Capital is the lifeblood for young and growing ventures in order to enable them grow and meet their milestones (Stulz, 2001). Besides the App's business model selection, the choice of venture capitalists and extent of venture capitalist control also affects an entrepreneurial firm's performance (Carpenter and Petersen, 2002; Caselli et al., 2009; Colombo and Grilli, 2007; Gompers and Lerner, 1999; Gorman and Sahlman, 1989; Kunze, 1990; Sahlman, 1990). The literature argues that venture capitalists tend to actively involve themselves in the ventures they fund through closely monitoring and controlling to exercise risk mitigation (De Clercq and Manigart, 2007; Kaplan and Schoar, 2005). In addition, because venture capitalists seek both short and long term return on investments (Bergemann and Hege, 1998), they may emphasize on how their investees can create and retain business value by satisfying customers' needs over time.

Novelty-centred IoT mobile Apps create and retain value for consumers by providing novel and unique new product and service offerings. However, this underlying entrepreneurial value creation and retention process may face high risk and financial constraints in day-to-day operations and research and development (R & D) process (Engel and Keilbach, 2007; Jiang, 2010; Peneder, 2010; Ueda and Hirukawa, 2003). Venture capital investments usually play a central role in the funding of innovative projects (Brander et al., 2002; Bygrave, 1988; Dimov and Milanov, 2010; Hopp and Rieder, 2011; Kaplan and Stromberg, 2004; Lerner, 1994; Sahlman, 1990). Apart from that the venture capitalists bring the valuable financial capital to IoT startups. They also have extensive experiences in R & D and business operations particularly in high-tech segments. The innovative projects are more likely to succeed with both financial support and non-financial service guidance from venture capitalists than those without it (Large and Muegge, 2008). The support include business and management consulting, strategic planning and coaching (Gompers and Lerner, 1999; Gorman and Sahlman, 1989; Sahlman, 1990), corporate strategy formation (Venckuviene, 2014a), faster access to markets (Hellmann and Puri, 2000, 2002), greater internationalization of firms (Fernhaber and McDougall-Covino, 2009; Lockett et al., 2008; Peneder, 2010), which may enhance competitive advantage in the novelty-centred business model's value retention process over time.

Based on agency theory (Eisenhardt, 1989), Sapienza and Gupta (1994) find that higher level of innovation and uncertainty requires more interaction between venture capitalists and CEOs of the investees in order to facilitate joint decision making. As a result, high innovation ventures benefit most from venture capitalist's involvement by gaining additional value in the interaction process (Jääskeläinen et al., 2006; Sapienza, 1992). Therefore, we suggest that high venture capital investment intensity fosters the relationship between novelty-centred business and value retention.

H5. The higher the venture capital investment intensity is, the stronger is the association between novelty-centred business model and value retention.

Intensive venture capital investments hamper the value retention process of an efficiency-centred IoT mobile App. Venture capitalists tend to closely monitor their investees (Bottazzi et al., 2008). Research argues that monitoring of venture capital firms can add value only when the venture lacks resources or faces perceived business risks, or when the task environment is highly uncertain, and when venture capitalists make heavy investments and finally when the venture capitalists command high operating experience in the venture's industry (MacMillan et al., 1989; Robbie et al., 1997; Sapienza et al., 1996). Compared to a novelty-centred counterpart, an efficiency-centred App requires relatively less financial support and venture capitalists' industry-specific experience as the R & D costs and market uncertainty are relatively low. The key success factor for an efficiency-centred business model is fast adaptability (Reeves and Deimler, 2011), because the low innovative nature of this business model makes it easily imitable. A close monitoring of venture capitalists usually creates disagreements between the venture investors and investees (Sapienza and Gupta, 1994). Such organizational friction may slow down the decision process, miss the best timing to enter a fast changing market, and eventually damage its value creation and retention. Therefore,

H6. The higher the venture capital investment intensity is, the weaker is the association between efficiency-centred business model and value retention.

If venture capitalists select projects with a lock-in centred business model, they may closely monitor the projects in order to balance the pros and cons of lock-in. The pro of lock-in business model is that once customers and strategic partners choose a lock-in-centred business model, it is less likely for them to move away and switch to competitors due to a high switching cost. The con of lock-in business model is that it is less likely for customers and strategic partners to make the adoption decision if there are any alternative non-lock-in options available in the market. Literature suggests that venture capitalists value the market acceptance and customer satisfaction of their funded projects (Nunes et al., 2014). They may guide and coach those firms that follow a lock-in business model on how to communicate with consumers, ease their concerns, and educate consumers about the product benefits that are valuable for the consumer adoption decision. Thus, we predict that the negative effect of lock-in-centred business model on an App's value retention might be reduced or neutralised by the presence of a venture capitalist.

H7. The higher the venture capital investment intensity is, the weaker is the negative association between lock-in-centred business model and value retention.

Although complementarity-centred business model may not be the best choice for venture capitalists similar to a novelty-centred business model, it is a popular selection in their portfolio because complementarity-centred projects may easily boost consumer adoption at the early-stage of innovation. Prior studies argue that venture capitalists help their investees in formulating better strategic alliances (Lindsey, 2008) and thus reap network benefits from contacts with suppliers,

customers, and potential managers (Hellmann and Puri, 2002; Hochberg et al., 2007). Under the guidance of venture capitalists, it may be more effective for IoT startups and developers to implement good complementarities with other products in the market, which is more likely to improve long term satisfaction of customers. Therefore, the venture capital investment intensity may strengthen the positive relationship between complementarity-centred business model and value retention:

H8. The higher the venture capital investment intensity is, the stronger is the association between complemantarity-centred business model and value retention.

3. Method

3.1. Setting, sample and procedure

For this study, we chose China as our research setting for two reasons. Firstly, with the largest Internet population, highest percentage of total world Internet users, and fastest growth rate of digital audience (Wei et al., 2011), China provides a great opportunity for IoT mobile app development. China is by far world's largest IoT market with 74 million connections as of 2014, representing almost a third of the global base with a compound annual growth rate of approximately 29% (GSMA, 2015). Secondly, China is also the world's second largest venture capital market, representing 33.05% of the total venture capital investments over 2006–2013 (World Economic Forum, 2015). Bloomberg (2016) reports that in the year 2015, value of venture capital investment in China reached $37 billion, which is more than double compared to 2014. China's government-backed venture capital funds also have funded world's biggest tech start-up pool (Fortune, 2016). Both venture firms and corporations are investing huge sums of money into Chinese IoT mobile business companies to leverage China's manufacturing capacity for quick and low-cost device conceptualization and development (Caixin, 2016; PC World, 2014). Therefore, China is the most suitable setting for us to empirically test our theoretical model related to the e-business model and venture capital's role in IoT start-ups.

We conducted a two-stage large-scale survey in China to test our hypotheses. The first stage survey was carried out by the end of 2013. It is usually very challenging to collect data from small businesses in China (Ang and Schmidt, 1999; Siu et al., 2004). We worked with one of the largest computer vocational training institutes in China for data collection. This institute organized a four-day App development training workshop. Our sample may not be completely random. However, we believe that working with trainee developers was the most effective way to identify a large group of e-business start-ups and increase the response rate in a large-scale survey from IT entrepreneurs in China. 1266 Apps trainee developers attended this workshop. We obtained permission to gain access to these developers and asked them whether they have developed any IoT mobile Apps that were launched online during the last four months. If so, their project managers were invited to participate in our survey.

Out of 1266 dispatched emails, 203 were returned by the mail server as undeliverable. Therefore, the effective mail-out was 1063. The number of responses received was 554. We sent a reminder email one week later to the remaining respondents (excluding the email addresses classified as undeliverable) and received 327 responses. Eventually 470 application project managers agreed to take part in our study and answered our questionnaire on their IoT mobile App business under strict confidentiality. The distribution of our sample by functionality categories is shown in Table 1.

To gauge the non-response bias, we divided the sample into early and late respondents. We assumed that the characteristics of the latter group would provide good indications of those of the non-respondents (see Armstrong and Overton, 1977; Johnson, 1990). Accordingly, we compared the characteristics (geographic base and months after launch) of the two groups. We noticed that early respondents were mainly from China's capital city Beijing and late respondents were from rest of China. A dummy variable was then included in our econometric model to capture this difference. We observed no overall significant difference in other characteristics. The follow-up responses are included in the data set.

Table 1
The distribution of sample by functionality.

Category	Number
Maps and Navigation	142
Health and Fitness	115
Outdoor & Indoor Communication	41
Aviation & Marine Search and Rescue	63
Retailing & Logistic Management	109
Total	470

We conducted the second stage study in the summer of 2015 in order to enhance the causality inference between e-business models and their value retention. We contacted 470 project managers again to verify whether, 18 months after the first-stage study, their IoT mobile Apps are still being actively used and how much value they believed that the apps were worth of. A continuous variable represents an App's value retention in our regression analyses. The lag of 18 months enables us to satisfy the temporal precedence condition of causality (Cook and Campbell, 1979) and as a result, makes our findings more robust.

3.2. Measures

3.2.1. Business model (Data collected in Stage 1)

We have followed the approaches of Dess and Robinson (1984), MacCormack et al. (2001) and Zott and Amit (2002) to use the perceptual measures of a panel of university professors specializing in technology management and e-business, senior IoT engineers and IT business builders with a sound understanding of business model generation and App development. We adopted the four scales of business model of Zott and Amit ((2002), see Appendix A), which has been applied to several studies (Zott and Amit, 2007, 2008). We started with a pilot study with four senior App project managers. Based on their feedback on the initial questionnaire of Amit and Zott (2002), we removed a item namely "inventory costs for participants in the business model are reduced" from the initial efficiency scale and one item "number of patents awarded" from the initial novelty scale, because we were not able to obtain such information. We also merged the three ambiguous items from "bundling of complementary resources and capabilities (i.e. online–offline, supply chain integration, and technologies)" into one variable and the two variables of vertical and horizontal complementarities respectively as a single variable as "bundling of various complementarities". We have retained all the other variables of the original scale for the lock-in variable.

The panel of two e-business angel investors, four professional IT consultants, and 16 developers who have had at least five-year's experience, used the sample Apps for two months. The business model of every App was evaluated by two panel members based on their discussions, professional knowledge and usage experience. A university business professor (one of authors) supervised the whole evaluation process and made sure evaluation consensus was reached. The Cronbach alpha coefficients of these four constructs were all higher than 0.7 and all items significantly loaded onto the corresponding latent factors. The results of CFA model show that the unconstrained four-factor model fits the data better (X^2=1732.878, df=813 $p < 0.01$, CMIN/DF=2.131; CFI=0.940, IFI=0.940, RMR=0.066 RMSEA=0.049) than the single-factor model (X^2=8075, df=819 $p < 0.01$, CMIN/DF=9.861; CFI=0.528, IFI=0.529, RMR=0.252 RMSEA=0.137) and

Table 2
Descriptive Statistics.

Variable	Mean (S. D.)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Value	3.365 (0.752)																		
2. Beijing	0.63 (0.39)	−0.063																	
3. Age	10.45 (8.66)	−0.137**	−0.045**																
4. Team Size	8.12 (2.15)	0.259**	−0.008	−0.106**															
5. Experience	3.88 (6.19)	−0.027	−0.005	−0.023*	0.107**														
6. R & D	84,876 (17,128)	0.332**	−0.044**	−0.093**	0.287**	−0.028**													
7. Ad.	19,659 (1,161)	0.289**	−0.143**	−0.304**	0.159**	−0.042**	0.462**												
8. OEM	0.29 (0.492)	0.129**	0.022*	−0.006	−0.123**	−0.070**	0.443**	0.454**											
9. Platform	0.68 (0.338)	−0.228**	0.041**	0.215**	−0.114**	−0.016	−0.103**	−0.106**	0.054**										
10. VC	0.120 (0.117)	0.212**	−0.162**	−0.453**	0.071	0.051	0.454**	0.441**	0.355**	−0.006									
11. Novelty	0(1)	0.001	−0.011	0.006	0.080**	0.492**	−0.041**	−0.069**	−0.081**	−0.011	0.046								
12. Efficiency	0(1)	−0.077	−0.118**	0.143**	0.132**	0.056**	−0.009	−0.030**	−0.248**	−0.033**	−0.251**	0.112**							
13. Lock-in	0(1)	0.134**	−0.067**	−0.223**	0.148**	0.030**	0.422**	0.513**	0.444**	−0.051**	0.498**	−0.01	0.003						
14. Complementarity	0(1)	0.122**	−0.037**	0.028**	0.111**	0.048**	−0.056**	−0.063**	−0.213**	−0.012	−0.202**	0.082**	0.127**	−0.042**					
15. Novelty-Category-IV	0(1)	−0.051	−0.064	−0.066	−0.008	0.567**	−0.138**	−0.187**	−0.122**	−0.026	0.093*	0.694**	0.225**	−0.018	0.034				
16. Eff-Category-IV	0(1)	−0.016	−0.139**	0.159**	−0.014	0.121**	−0.218**	−0.295**	−0.385**	−0.061	−0.211**	0.215**	0.609**	−0.248**	0.174**	0.273**			
17. Lock-Category-IV	0(1)	0.112*	0.017	−0.058	0.068	−0.02	0.676**	0.666**	0.621**	0.045	0.463**	−0.027	−0.223**	0.644**	−0.250**	−0.028	−0.276**		
18. Comp-Category-IV	0(1)	0.128**	−0.067	−0.044	−0.08	0.068	−0.265**	−0.319**	−0.370**	−0.167**	−0.212**	0.04	0.166**	−0.270**	0.670**	0.053	0.210**	−0.333**	
19. Competition-IV	0(1)	−0.001	0.113*	0.091*	0.047	−0.162**	0.456**	0.495**	0.630**	0.219**	0.144**	−0.116*	−0.271**	0.388**	−0.376**	−0.150**	−0.331**	0.454**	−0.493**

another CFA model with the four latent factors in which the correlations were constrained to be zero (X^2=6265.620, df=819 $p < 0.01$, CMIN/DF=7.650; CFI=0.646, IFI=0.647, RMR=0.270, RMSEA=0.119). These tests confirm the reliability and validity found in Zott and Amit (2002). We then, followed their approach to standardize and aggregate four business model scores from items.

3.2.2. Control variables (Data collected in Stage 1)

We included a series of factors that could confound an App's value retention as control variables: age of the App (i.e. number of months since the first version was launched), team size of the App project (i.e. number of developers working on the App), average programming experience of developers in terms of years, a dummy variable for the geographic location (1 for Beijing-based project teams, 0 for otherwise), a dummy variable for the App's platform (1 for multiple platform including Android, iOS, Windows Phone; 0 for otherwise), a dummy variable for OEM-specific App (1 if the App was developed for cellphone manufacturers, telecom carriers, IoT hardware manufactures or App Stores for the purpose of bundling with Cellphones or IoT device; 0 if the App was a stand-alone application), and the firm's expenditure on R & D and advertising.

3.2.3. Venture capital investment (Data collected in Stage 2)

We used the ratio of the total amount of venture capital equity investment since the creation of the firm till June 2015 divided by the total shareholder equity of the firm in June 2015.

3.2.4. Value retention of an App (Data collected in Stage 2)

We measured the value retention of an App 18 months after the first round of data collection. The retained value of an App was coded as 1 if the App had no value left in the market, and firm withdrew the App from major App Stores; 2 if the App had very little value in the market, and still remains in the market to be sold without any updates; 3 if the App has some value, and the firm may update it but does not produce any corresponding IoT devices; 4 if the App has good value in the market, but there is a high possibility to slow down the App's updates and production in near future; 5 if the App has great value in the market, and it is still in full development mode.

It is difficult to use objective financial performance measures for young IoT mobile business startups because they are often make negative earnings, less tangible assets and low book value (iiMedia, 2014). We cannot use the number of downloads from App Stores as a performance indicator since the number of download fails to fully capture the total value created and appropriated by an App. This measure is especially not trustworthy in China. In China, Android devices and jail-broken iPhones cannot connect to Google Play and iOS App Store respectively. Chinese smartphone users usually download Apps from third-party App Stores, with a hundred or so such stores in the Chinese online market. These third party stores do not scrutinize the accuracy of user reviews, and thus many developers can manipulate the number of downloads and publish fake or solicited reviews.

4. Analyses and results

Table 2 shows the means and correlation matrix of the variables used in the regressions. In general, the average value retention score is 3.365. The dependent variable is significantly correlated to lock-in (0.134, $p < 0.01$) and complementarities (0.122, $p < 0.01$), but not with novelty and efficiency. The average percentage of venture capital investments to total shareholder equity is 12%.

Endogeneity might be an issue that threatens the viability of models making causal claims regarding business model and value retention. There are two possible sources of endogeneity in our study. On the one hand, even though we have included certain control variables, we may have missed certain other confounding variables. On the other hand, since we have relied on experts' perception to measure, a degree of measurement error is inevitable. The Hausmen homoscedasticity tests confirmed that novelty- (χ^2=2.99, $p < 0.10$), efficiency- (χ^2=5.90 $p < 0.05$), lock-incentred (χ^2=12.06, $p < 0.01$) and complementarity-centred (χ^2=2.79, $p < 0.10$) business model variables suffer from the problem of endogeneity. Venture capital investments, however, do not encounter the endogeneity issue (χ^2=0.06, $p > 0.10$). To alleviate the endogeneity problems, we adopted an 18-month lagged design as a treatment. In addition, we employed the instrumental variable (IV) approach for the four business models that have long been used in econometrics to draw unbiased inferences in non-laboratory study settings (Imbens and Angrist, 1994; Wintoki et al., 2012). We first identified instrumental variables from the literature. Strategic management literature of structure-conduct-performance argues that the competitive environment can have an important imprinting effect on how an organization designs its set of boundary-spanning transactions (Aldrich, 1979; Dess and Beard, 1984; Langlois, 1992, 2005; Langlois and Robertson, 1995; McArthur and Nystrom, 1991; Pfeffer and Salancik, 1978; Randolph and Dess, 1984). In the highly competitive IoT mobile App market, every firm that wants to enjoy a share of the pie must try to find ways to release untapped potential and differentiate its product offerings. It is reasonable to believe that while App project managers design their business model, they usually scan market structure for similar offerings in order to thoroughly ascertain the level of competition that their Apps may face in the market.

Thus, our first IV is the perceived level of competitive threat for each sample App, which is measured by our panel of experts using a five-point Likert scale based on their professional experience as well as based on the reports of App Annie (2014), CNNIC (2014), iResearch, (2012, 2013a, 2013b, 2014) and an in-depth analyses of similar applications available on the Top 3 App Stores in China (i.e. MyApp.com, 91.com and Zhushou.360.cn). Moreover, Zirger (1990) identifies that competitiveness related to similar products is one of the key determinants in the success of a new product. Gatignon and Xuereb (1997) also find that it is important to have a competitive orientation in high-growth markets with uncertain demand. Therefore, it is reasonable to believe that when selecting an App's business model, App developers usually refer to the selections of competitors in the market. An App's business model may be influenced by those of similar Apps. To capture the contextual effect on business model selection caused by similar Apps, we borrowed the approach used to measure the community-level social capital effect on individual-level behaviour in the health economics literature (Berkman and Kawachi, 2000; Lochner et al., 1999). That is, we first calculated the average scores of the four business model variables of the Apps within the same functional categories. Then, we measured how different a sample App's business model is to its direct competitors by subtracting its four business model variables from the average ones of its direct competitors within the same functional category. The correlation coefficients between these five IVs and the dependent variable are shown in Table 2. Only the category-level lock-in (γ=0.112, $p < 0.10$) and complementarity (γ=0.128, $p < 0.05$) business model difference IVs are weakly correlated to the dependent variable.

The results of IV estimation regression are summarized in Table 3. We tested the validity of these five IVs in the first-stage regression of Model 1, controlling the possible confounding effects of control variables (Ahmed et al., 2014; Chou et al., 2014). The competition IV is significantly associated to the four endogenous business model variables. The four category-level business model difference IVs are significantly associated to their corresponding individual-level business model variables. The results of the Hansen over-identification test supports the exogeneity and validity of instrument variables (0.013, $p > 0.10$). The values of the partial R^2 are greater than 0.10 (Guilkey, 2014; Shea, 1997). The F-statistics of the first-stage regressions are significant and the Cragg–Donald minimum eigenvalue statistic were significantly greater than 10 (Stock and Yogo, 2005). Hence, we can safely conclude that the IVs are not weak, indicating that our IVs are

Table 3
The first stage regression results of instrumental variables and control variables in model 1.

DV=	Novelty	Efficiency	Lock-in	Complementarity
Constant	0.024(0.07)	0.358(0.08)***	−0.212(0.068)***	−0.752(0.093)***
IV-Competition	0.091(0.034)***	0.123(0.041)***	−0.085(0.034)**	0.101(0.046)**
IV-Novelty-Category-Diff.	0.434(0.032)***	0.031(0.038)	−0.01(0.034)	−0.045(0.045)
IV-Efficiency-Category-Diff.	0.048(0.024)**	0.743(0.029)***	0.034(0.026)	−0.019(0.035)
IV-Lock-in Category-Diff.	0.004(0.02)	0.069(0.021)***	0.314(0.022)***	0.045(0.022)**
IV-Complementarity-Category-Diff.	−0.007(0.02)	−0.014(0.021)	0.019(0.017)	0.604(0.026)***
Beijing	0.028(0.048)	0.04(0.059)	0.001(0.047)	−0.078(0.071)
Team	0.845(1.06)	−0.063(1.567)	0.469(1.945)	−0.731(1.059)
R & D	−0.072(0.045)*	−0.005(0.05)	0.025(0.041)	−0.06(0.061)
Age	0.003(0.029)	0.077(0.036)**	−0.041(0.027)	0.048(0.035)
Advertising	0.043(0.054)	0.021(0.056)	0.198(0.052)***	0.12(0.067)*
Experience	1.058(0.073)***	−0.045(0.077)	0.123(0.066)*	0.137(0.093)
OEM	−0.049(0.088)	−0.624(0.119)***	0.356(0.089)***	−0.501(0.119)***
VC	−0.002(0.034)	−0.037(0.034)	0.055(0.037)	−0.016(0.045)
Platform	−0.045(0.026)*	−0.077(0.032)**	−0.045(0.023)**	0.009(0.039)
Partial R2	0.346	0.603	0.550	0.436
Shea's Adj. Partial R2	0.276	0.501	0.527	0.417
Robust F-Statistics	43.304***	150.151***	115.777***	42.216***
The First Stage Regression Hansen's J-Statistics	0.013 (p=0.910)			
The First Stage Regression Minimum Eigenvalue Statistic	35.316			

Note: the first stage regression of Model 2 is as the same as the one of Model 1.

validly linked to the endogenous business model variables but not to the error term in the explanatory equation, conditional to the other covariates.

Now we can test our hypotheses 1–4 in the second stage regressions of Model 1, which estimates the main effects of venture capital investment intensity and the four business model variables. Model 2 estimates the corresponding main and the interaction effects (i.e. Hypothesis 5–8). The standardized coefficients are shown in Table 4. The significant Wald-test statistics indicate that both models are valid and explain significant proportions of variance (R^2=32.6% in Model 1% and 34.4% in Model 2). The main effect of novelty on the dependent variable is negative (−0.012, $p > 0.10$) but not statistically significant at the 5% level. H1 is not supported. The main effect of efficiency-centred business model on the dependent variable is positively significant (0.024, $p < 0.05$) which supports H2. As predicted in H3, lock-in-centred business model is negatively (−0.058, $p < 0.01$) associated with value retention. The positive main effect of complementary-centred business model on value (0.04, $p < 0.01$) also provides support to H4.

Table 4
The second stage regression results.

	Model 1	Model 2
Constant	0.565(0.02)***	0.553(0.022)***
Beijing	0.006(0.015)	0.001(0.015)
Project Age	−0.052(0.009)***	−0.046(0.009)***
Team Size	0.307(0.332)	0.428(0.332)
Experience	0.028(0.038)	0.004(0.039)
R & D	0.069(0.013)***	0.065(0.013)***
Ad.	0.041(0.015)***	0.036(0.015)**
OEM	0.037(0.03)	0.056(0.031)*
Platform	−0.022(0.008)***	−0.019(0.008)**
VC	0.006(0.009)	−0.004(0.014)
Novelty	−0.012(0.022)	−0.002(0.022)
Efficiency	0.024(0.011)**	0.039(0.016)**
Lock-in	−0.058(0.017)***	−0.058(0.022)***
Compl.	0.048(0.01)***	0.043(0.016)***
Novelty*VC		0.021(0.008)***
Efficiency*VC		−0.194(0.089)**
Lock-in*VC		0.006(0.038)
Compl.*VC		−0.009(0.063)
F-Test/Wald	238.000***	287.880***
R-squared	0.326	0.344

In Model 2, the main effects of the four business model variables remain qualitatively unchanged. The interactive effect between novelty and venture capital investment intensity is significantly positive (0.021, $p < 0.01$), supporting H5. The negative interactive effect between efficiency and venture capital investment intensity (−0.194, $p < 0.01$) strongly support H6. Neither the interactive effect between VC investments and lock-in (0.006, $p > 0.10$) nor that between venture capital investments and complementarity (−0.009, $p > 0.10$) is statistically significant.

To illustrate the patterns of the significant interaction effects between business models and venture capital investment intensity on venture retention, we plotted two significant interaction effects using one standard deviation above and below the mean to represent high and low levels of the moderating variable (Aiken and West, 1991). Fig. 1 presents these plots. As shown in Panel A, the relationship between novelty-centred business model and value retention is positive when there is high level of venture capital investment, while it is negative when there is low level of venture capital investment. But the opposite is observed for the efficiency-centred business model. According to panel B, there is a positive relationship between efficiency-centred business model and value retention when the level of venture capital investment intensity is low and there is a negative relationship when the level of venture capital investment intensity is high.

Finally, the control variable age of the App project is negatively associated with value retention, suggesting that the age of the App may negatively impact the value retention in the IoT mobile business. Cross-platform development is also negatively associated with the dependent variable, probably because high costs incurred in developing an application across multiple platforms may hamper an App's value retention. As expected, the expenditure on R & D and that on Advertising are positively associated with value retention.

5. Discussions

The central goal of our study is to test the main effects of four different e-business models (such as *novelty, efficiency, lock-in and complementarities*) on an IoT mobile App's value retention, and also to examine whether venture capital investment intensity moderates the relationship between four different e-business models and its value retention. Based on contingency theory, an organization must match its

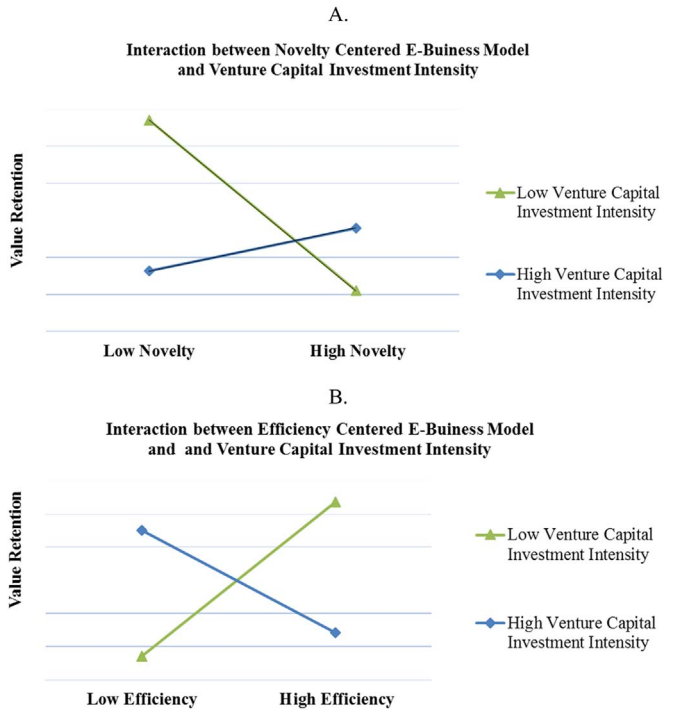

Fig. 1. The interaction effects between business models and venture capital investment intensity on value retention.

structure and decisions to both their internal and external environments. This research proposes that the strength of the relationship between e-business models and Apps' value retention outcome may be moderated by the influence of venture capital investment intensity.

Our findings provide new empirical evidences on how different e-business model selections affect IoT mobile Apps' value retention. We find that efficiency-centred and complementarities-centred e-business models improve while lock-in centred e-business model reduces an App's value retention. However, novelty-centred e-business model does not have a significant main effect, maybe because it is difficult to create successful novel and radical innovation (McDermott and O'Connor, 2002), which leads to low value retention rate. In addition, other possible explanation is that novelty-centred IoT devices, like some disruptive technologies, are too complex for most consumers, and it takes time for consumers to adopt it despite obvious benefits (Fisher and Price, 1992; Hirunyawipada and Paswan, 2006). From the consumer IT technology acceptance theory perspectives (Bruner and Kumar, 2005; Childers et al., 2001; Dabholkar and Bagozzi, 2002; Davis, 1986), the value retention of a novelty-centred App depends on whether consumers perceive usefulness, risk, ease of use and fun from usage. Reports show that lack of perceived value, high price, concerns with privacy and security are the major barriers hampering consumer adoption of IoT products (Endeavour Partners, 2014; Accenture, 2015b). That may be the case for most novelty-centred IoT Apps, which usually focus on one or a few unique functionalities/measures (e.g. heart rate BPM, room air humidity, and hit angles in tennis). These figures are hard to understand by non tech savvy consumers or amateur health enthusiasts, and fail to provide any valuable insights.

Finally, we find that the effect of two types of e-business models on value retention is dependent on the venture capitalist's involvement: venture capital investment intensity positively moderates the relationship between novelty-centred e-business model and value retention, but negatively moderates the relationship between efficiency-centred e-business model and value retention. Venture capital investment intensity does not play a moderating role in the value retention process of both lock-in and complementarities-centred e-business models. This may mean that venture capitalists do not involve very much in the development of these two business model selections. As a result, the strength of relationship between lock-in centred e-business model and value retention and complementarities centred e-business model and value retention will stay the same regardless of the venture capital investments.

5.1. Theoretical contributions and managerial implications

This research seeks to contribute to the existing academic literature by theorizing and empirically testing how different e-business models retain value for start-ups in the IoT mobile Apps industry and how venture capital investment intensity plays a moderating role in the value retention process of four e-business models. We make five important theoretical contributions to the body of knowledge of e-business models and entrepreneurship practices.

Firstly, the efficiency-centred e-business model is positively related to an App's value retention. If an IoT mobile App can reduce consumer's transaction costs and improve transaction efficiency, then the App is more likely to have higher customer satisfaction and market acceptance, which in turn leads to good value retention over time. Thus, this finding suggests that IoT start-ups should consider and select efficiency-centred e-business model for value retention.

Secondly, lock-in-centred business model is negatively related to the value retention of IoT mobile Apps. Perceived low level of interoperability or poor compatibility in the lock-in centred e-business model may make the consumers reluctant to take an adoption decision toward IoT mobile Apps following the lock-in strategy. The implication of this result suggests that IoT start-ups should not defy the open spirit of the Internet. It is better for developers not to select the lock-in centred e-business model as low consumer preference and acceptance makes it difficult for the firm to retain its value over time.

Thirdly, complementarity-centred e-business model is positively related to the IoT mobile App's value retention. This result is in line with Adner and Kapoor's (2010) finding. A complementarity-centred App serves as focal product to integrate suppliers and complementary components seamlessly. The promising opportunities offered by effective bundling of connected or complementary IoT hardware and services can not only generate benefits of improved customer experience and network externalities on the supply side, but also increase demand exponentially if network externalities are integrated in the most optimal fashion to match users' needs with a number of value providers offering an optimal cost-benefit equation of complementary transactions. The managerial implication of this finding is that IoT start-ups should use more complementary designs to retain value over time.

Fourthly, although we do not find the direct effect of novelty-centred e-business model on value retention, the moderating effect indicates that novelty-centred e-business model is positively related to an App's value retention when venture capital investment intensity is high. Novelty-centred e-business model, however, is negatively related to value retention when venture capital investment intensity is low. This finding is not surprising given that radically innovative products usually require significant time and capital investments on R & D before the firm can reap the monopoly rents from that innovation. The venture capitalists' experiences in strategy planning, formation, and risk-management may significantly improve the effect of novelty centred e-business model on value retention. Based on the implications of our results, we suggest that IoT start-ups should value and invite the involvement of venture capitalists in their novel App development process so that they will be able to benefit needed financial resources and non-financial service supports to sustain long-term radical innovation.

Finally, venture capital investment intensity inhibits the positive relationship between efficiency-centred e-business model and value retention. Our finding shows that efficiency-centred e-business model is positively related to value retention when venture capital investment

intensity is low and is negatively related to value retention when venture capital investment intensity is high. The results indicate that too much involvement of venture capitalists does not benefit the IoT start-ups with efficiency-centred business model, as monitoring and controlling of venture capitalists most likely creates barriers to effective communication and increases transaction time, which then reduces the efficiency-centred business model's competitive advantage, and eventually jeopardizes the value retention process. Therefore, efficiency-centred IoT start-ups should be cautious in determining the extent of venture capital investments.

5.2. Limitations and directions for future research

We acknowledge several limitations of this study, which may provide opportunities for future research. Firstly, our sample size, although is the largest to the best of our knowledge, focuses only on very early-stage IoT mobile start-ups in China. Our findings may not be generalizable with large corporations in the same sector and firms in other sectors. Secondly, value retention is measured from the supply-side perspective: IoT mobile Apps developers or firms. Future studies may complement our study by asking the demand-side customer to answer their perceived value retention (Woodruff, 1997). Thirdly, given that the IoT sector is still largely in its infancy stage, most IoT Apps may need a few years to unfold their future business value. Future works should conduct longitudinal studies to examine the business model evolution of an App and its impact on long-term performance. Fourthly, in this research, we did not consider the overlaps among different e-business models. Business models are not mutually exclusive and can occur simultaneously or in combination with each other (Zott and Amit, 2007). For example, some App projects may be viewed as both efficiency- and complementary-centred business model. It is also possible that some e-businesses provide efficiency, complementarities, lock-in and even novelty features at the same time (Bucherer et al., 2012). Future research should study the potential interactions among four different e-business models in order to deepen our knowledge about how different e-business models work collectively to create and retain value.

In short, since the global IoT mobile market continues to grow, business model experimentation will also continue. An unprecedented number of firms and venture capitalists rush into the gold App business to monetize the high-value touch points. We hope that the ideas presented in this study will inspire and enable future researchers to overcome our limitations and improve the understanding of business models and value retention in the nascent IoT business.

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Appendix A. The standardized regression weights of the four business model scales

Novelty	α=0.775
1. Does the App successfully bring together new market participants?	0.516
2. Does the App link market participants to transactions in novel ways?	0.527
3. Does the App offer new assortment of services and information to users?	0.51
4. Does the App foster novel transactions?	0.504
5. Does the App allow users to access unprecedented variety of services?	0.512
6. Does the App offer richness (quality and depth) in the links between participants?	0.55
7. Does the App follow upgrades based on innovations?	0.507
8. Are there few or no competing service providers with the potential to leapfrog the App?	0.506
9. Is the App mainly based on a patent/trade secrets/copyrights?	0.494
10. Is the App a pioneer in the business?	0.476
Efficiency	α=0.808
1. Does the discussed App enable fast transactions?	0.506
2. Does the discussed App enable simple transactions?	0.532
3. Do the transactions using the discussed App display any errors?	0.521
4. Is the business model of the App scalable?	0.556
5. Are costs other than those already mentioned in the App minimized?	0.576
6. Does the output from the App help the user to take informed decisions?	0.538
7. Does the App's business model reduce information asymmetry by providing users with knowledge about the quality and nature of information exchange?	0.53
8. Does the App's business model foster transparency in transactions?	0.532
9. Does the App's business model foster access to a large number of potential users?	0.538
10. Does the App's business model foster access to an increased product assortment?	0.541
11. Does the App's business model enhance overall transaction efficiency?	0.482
Lock-In	α=0.970
1. Does the App provide incentives to users for repeat transactions?	0.858
2. Does the App allow users to customize the features to suit their needs?	0.857
3. Does the App apply some methods to personalize the services?	0.841
4. Is the personalization feature of the App useful in customer retention?	0.876
5. Does the App promote transaction safety?	0.886

6. Does the App promote transaction reliability?	0.557
7. Does the App promote trust by giving user control over the use of personal information?	0.788
8. Does the App promote trust by not misusing, asking for or sharing user profile information with other participants?	0.656
9. Does the App have a dominant social network design?	0.921
10. Does the App foster a strong "virtual community" base?	0.617
11. Does the App encourage "affiliate programs" originating from vendor's partners?	0.912
12. Does the App exhibit direct network externalities with users being able to benefit from other similar users?	0.701
13. Does the App exhibit indirect network externalities with one group of participants (other Apps or customers) being able to benefit from other groups?	0.899
14. Does the App require the users to make considerable app-specific investments in time and effort to familiarize themselves with the App	0.823
15. Does the App require the users to have specialized assets (hardware and software) to use the App?	0.931
16. In general, does the Application succeed in creating effective lock-in?	0.939
Complementarity	α=0.743
1. Is the App compatible with different mobile technologies?	0.51
2. The business model of the App provides the user with a wide variety of complementary services unique to its business model	0.498
3. Does the App's business model support complementary services as offered by other App providers sharing the same business model?	0.533
4. Does the App's business model support cross selling of services?	0.524
5. Does the App's business model foster effective bundling of complementary services?	0.563

(1=most unlikely, 2= unlikely, 3=neutral, 4=likely, 5=most likely)

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