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Impact of cloud computing technologies on pricing models of software firms – Insights from Finland

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Abstract. In this paper we study the changes in the pricing models of software firms that use cloud computing technologies as part of their products and services. This paper presents findings from 324 responses to a questionnaire survey on how pricing model elements of software firms have changed as a result of adopting hardware virtualization, multi-tenancy, online delivery and configurability. The findings suggest that Software-as-a-Service firms – making use of the cloud computing technologies – are generally simplifying their pricing model, increasing the use of usage-based pricing, reducing the customers' influence and unifying their pricing across customers. These changes occur together with standardization of their products or services. The findings provide a view to the transformation of the software industry, characterized by both technological and business model redesigns.

Keywords: cloud, SaaS, pricing, software firms, business models.

1. Introduction

Software-as-a-Service (SaaS) is both a delivery and a business model for software firms defined by technological and business characteristics. Recent literature describes SaaS as the delivery of multi-tenant, virtual, web-based and configurable application that is accessible through browser [1]–[4]. Applying these technological characteristics to its application enables a software firm to offer a cloud computing service with the essential cloud characteristics to its customers. Viewing SaaS from the business perspective, the model is understood as offered through a different revenue logic compared to the traditional licensed software, such as subscription-based and/or usage based pricing [2], [5]–[7].

Introducing cloud technologies therefore implies changes not only to software architecture but also to business model design. Among the business model elements, a well-designed revenue logic is a key condition for commercial success. Pricing models influence not only the demand, but have an effect also on the way how users use the product or service, and have a long-term influence on customer relationships [8]. The revenue logic can also differentiate a product from the competitors and this way increase the company's revenues [9]. However, even though pricing is a powerful strategic tool in manager's hands, it also causes challenges to software firms that develop SaaS to the market. Information is often difficult to price and the currently observed constantly changing labyrinth around software pricing makes pricing even more complex [3], [10]–[13].

With the emergence of cloud technologies, the software market evolves rapidly and the firms' needs for strategic changes increase. Different studies in current literature focus on software firms' revenue logic and their products and services. However, despite of its importance, there is a shortage of empirical evidence on how the software firms *changed* their pricing models due to adopting cloud computing technologies. This study fills the gap by analyzing 324 Finnish software firms to find out (1) what are the changes in pricing model that are caused by cloud computing technologies, such as virtualization, multi-tenancy, online delivery and configurability; and (2) whether changes in pricing model elements are caused directly by cloud computing technologies or through changes in the firms' products or services offered to their customers.

The contribution of this paper is two-fold. First, researchers gain a better understanding on how the cloud technologies transform the software industry and how firms change their value proposition and pricing model after adopting cloud technologies. Secondly, the managerial implications provide insights into how particular cloud technologies affect different aspects of pricing.

The structure of this article is as follows. In the next section, we give an overview on recent work related to value proposition and revenue logic as key business model elements in the context of cloud technologies and describe the hypotheses of this research. In Section 3, we describe the research methodology used in this article. In Section 4 we present the findings of our analysis. We conclude our paper with discussion and summary in sections 5 and 6, respectively.

2. Theoretical background

2.1 Business models

Business model is a conceptual model of a business: a description of how a company organizes itself, operates and creates value [10], [14]–[17]. The static view on business models sees them as a blueprint for the coherence between core business model components [18]. Besides others, the core business parameters include value proposition incorporating the product/service portfolio [14], [15], [18], [19] and revenue logic referring to the structure of income [14], [15], [19].

On the other hand, the dynamic view uses the business model concept as a tool to address change and innovation in the firm or in the model itself [18]. Changes in the model itself can be related to the different phases of the lifecycle of business models, such as creation, extension, revision and termination [20]. The reason for these changes might be a response to external and/or internal influences. In the literature, the advances in contemporary technology are argued to be a key external factor that leads to changes in business strategies and processes [17], [19], [21]–[24]. Moreover, Chesbrough and Rosenbloom [19] argue that the financial performance of a given firm is associated with developments in firm's environment, but *only* through changes in the firm's business model. Besides the external influences, the need for business model changes might also come internally. Business models are designed, implemented and changed by employees of the company who make decisions based on their perception of the firm's environment [18]–[20]. As a consequence, the elements of business models are interrelated and changes in one of the components might cause changes also in others [18].

There is currently little in the literature that empirically examines just how exactly software providers do convert to supplying SaaS. A couple of exceptions to this are the studies by Stuckenberg et al. [6], Ojala and Tyrväinen [25] and Novelli [26]. While their findings are based on rare cases, they both seem indicate a trend towards offering more standardized products and services, increasing customer-facing activities and changes in revenue logic towards subscription-based pricing.

2.2 Value proposition and cloud technologies

As a core item of business model, value proposition communicates the value that the companies' product/service portfolio creates for the target customers using technology [19]. In software industry, the product/service portfolio incorporates the set of functionalities of the software, the needed infrastructure and the deployment, delivery and maintenance of the software [27], [28]. Specifically, software firms that develop SaaS to the market companies employ cloud technologies in their value proposition, such as hardware virtualization, multi-tenancy, and web service [1]. Besides, a cloud mature application should also be configurable [2]. These four technologies give the software firms the means to introduce SaaS service to the market, a service which has the essential cloud computing characteristics of on-demand self-service (through configurability), network access (web service), resource pooling (virtualization and multitenancy) and elasticity (virtualization), as they're described in the reference definition of cloud services [29].

Hardware virtualization offers an abstract computing platform to the users instead of the physical characteristics, such as raw computing, storage, network resources [1]. Virtualization also enables encapsulation for the applications, so that they can be installed, configured and maintained [30].

In a multitenant architecture, a single instance of common code and data is shared between multiple tenants [31]. Besides the requirements of shared hardware resources, shared application and shared database instance, Bezemer et al. [32] requires also high degree of configurability in look-and-feel and workflow from multitenant software. Some researchers consider also multi-instancy as a form of multi-tenancy [33], where a vendor hosts separate instances for each customer within shared hardware [33], [34].

Web service represents communication over the HTTP protocol, where the customers use a browser to use the application [1]. SaaS is therefore also a delivery model, software that is available through the network.

Configurable software offers the possibility for users to modify the application's appearance and behavior through metadata services to meet their needs. These configuration changes might refer to user interface and branding (graphics, colors, fonts, logos, etc.), workflow and business processes, extensions to the data model and access control [2].

2.3 Revenue logic and software pricing models

The revenue logic describes the structure of revenues, how the company makes money by serving its customers [14], [18]. In software industry, the most common revenue streams are: i) monthly or annual subscription fees, ii) advertising based revenue, iii) transaction based revenue (customers are charged based on the number of transactions they perform), iv) premium based revenue (revenue is generated from charging for premium versions besides the free versions), v) revenue from implementation and maintenance services and vi) software licensing [28], [35]–[37].

Software pricing in these above introduced revenue models may base on different aspects. The software pricing model parameters of Lehmann and Buxmann [38] and the SBIFT model of Iveroth et al. [39] are taken into account in the classification of cloud pricing models that describes these models along 7 dimensions [40]:

1. **Scope** represents the granularity of the offer, whether it is priced as a package or different prices are given for different functionalities.
2. **Base** represents the information base the price is set on. The price might be decided based on cost considerations, the competitors' prices, based on performance or customer value.
3. **Influence** represents the ability of buyers and sellers to influence the price, and it contains the options Pricelist, Negotiation, Result-based price, Pay-what-you-want, Auction and Exogenous pricing.
4. **Formula** represents the connection between price and volume, and it contains different variations of fix and variable price components.
5. **Temporal rights** represent the length of service's usage period, and it can be Perpetual, Subscription-based or Pay-per-use.
6. **Degree of discrimination** represents the level of price variety depending on the buyer. The software may be offered to the customers with a different price in different regions or with a price dependent on the time of buying. The price can depend on the acquired volume, software's quality, or it might be even customer-specific.
7. **Dynamic pricing strategy** represents the strategy of dynamic price change over time. Penetration, skimming or hybrid pricing strategies belong to this dimension.

It can be noted, that these 7 dimensions of cloud pricing framework are different by nature: the dimensions Base and Dynamic pricing strategy represents long-term, strategic decisions made usually by the upper management; while the other five dimensions describe the elements of pricing models that can be modified more easily.

We chose to use this framework as a starting point for the present study, since it provides the most state-of-the-art and the most integrative work in the current pricing literature in cloud context. The framework adopts general pricing model elements to software business and cloud context, allowing researchers and practitioners to study different pricing model aspects in a systematic, holistic way.

SaaS business model has an altered licensing scheme compared to the traditional software business, where acquiring a perpetual use license represents the common method of transaction [5]. Instead, in SaaS the customer organization and the software firm agree on a subscription and the software firm develops, deploys and operates the software application in its datacenter of choice. This can been interpreted as separating the ownership of software from its use [41], [42], hence software is provided and consumed as a service rather than as a product. Contemporary SaaS pricing models have been studied notably by Lehmann and Buxmann [38], [43]. However, their studies focus on the current pricing models of SaaS vendors, rather than how pricing models have changed together with changes in technologies and value propositions.

2.4 Research gap and hypothesis development for the current study

In our review of the extant literature, we searched for prior work related to cloud technologies, SaaS and pricing models but also the business model concept with a special focus on changes in business models that occurred as a response to technological changes. We found that different aspects of cloud computing have been received moderate attention from the researchers; however, despite of its importance, prior literature lacks empirical studies on how software firms *changed* their pricing models due to adopting cloud computing technologies. In current study therefore we focus on the role of cloud computing technologies in the pricing models of software firms.

In software business, as a result of technological changes and competitive forces, there is a gradual shift in business models towards increasing service revenues [28]. With the emergence of cloud computing, software firms not only implement technological changes by introducing multi-tenancy, hardware virtualization, configurability and internet-based delivery, but these technological characteristics imply also changes to the revenue logic. SaaS software is often offered through the subscription model billed monthly or even in shorter periods [38]. SaaS vendors may often provide their prices through pricelists on their websites [43], indicating more transparent and unified pricing across customers, where the influence of the customers on prices decreases [40]. A cloud solution is a result of co-operation of different value chain partners, where the SaaS provider might pass the usage-based pricing metrics derived from the PaaS provider to the end customers. Both customers and providers might prefer simple pricing models where different functionalities are bundled into one package with one price. [38], [40], [43]

Based on the claimed characteristics of software firms, we assess pricing model changes caused by introducing cloud computing technologies through changes in the pricing model elements and we hypothesize that:

H1. Adopting cloud computing technologies, i.e. introducing hardware virtualization, multi-tenancy, internet-based usage of the software and configuration through internet is associated with change towards 1) simpler pricing 2) less negotiation 3) usage-based pricing 4) shorter contracts and 5) more unified pricing across customers.

SaaS software is argued to be more standardized than the traditional software: only a limited set of functionalities is provided to a larger market segment instead of customer-specific solutions [4]. Changes in value proposition imply changes also in other business model elements, such as the pricing model [10], [46]. Therefore, we assess whether pricing model changes are caused by changes in value proposition and we hypothesize that:

H2. Standardizing the value proposition, implementing a limited set of new functionalities is associated with change towards 1) simpler pricing 2) less negotiation 3) usage-based pricing 4) shorter contracts and 5) more unified pricing across customers.

3. Research method

3.1 Data collection

The goal of our empirical study was to capture changes in software firms' pricing models due to adoption of cloud technologies. The data used in this study was collected as part of the annual Finnish software industry survey whose primary aim is to gather the information about the current state of software industry. The definition of software firm followed the tradition of the Software Industry Survey[1], focusing on all Finnish companies whose main activity is to provide software as products or services to the customers. The details of the survey can be found online, so in this study we describe the sample and the data collection procedure only shortly.

The survey follows a modified version of the tailored design [44] and collects data using letters and web-based form with email invitations. The mailing list of the survey contained key informants of 4878 software firms. The data collection started in April and ended in June 2013. The respondents were contacted five times and the data gathering resulted in receiving 379 complete and 121 partial responses.

After collecting the data, we used a filter to select the companies appropriate for the goal of this study. As our focus was on firms providing Software-as-a-Service, which originate from either software product firms or software services firms, we excluded producers of embedded software and software resellers from the analysis. Further, since the objective of this study was to examine the factors causing changes in the firms' pricing models, we excluded software firms younger than two years from the analysis. In total, 324 usable responses from software companies matched our inclusion criteria and were used for the analysis.

3.2 Concepts and their operationalization

We conceptualized the pricing model of software firms through its dimensions in the cloud pricing framework [40]. The pricing model incorporates the granularity of the offer, the customers' negotiation level, the pricing formula consisting of fix and variable price components, the temporal rights and price discrimination [38]–[40]. Cloud technology includes hardware virtualization, multi-tenancy, web-based software and configurability [1], [2]. Value proposition was conceptualized through the firms' product/service portfolio that is offered to the customers [19], [45].

Since the primary goal of the survey was different from the aims of this study, we had to choose between investigating specific changes in the pricing models with

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[1] See http://softwareindustrysurvey.org for details about the survey.

single-item measures or studying only one pricing aspect in detail. The aspects of SaaS pricing are diverse, therefore we could not follow the suggestion of the configuration approach [46] to measure one aspect and infer changes to the whole pricing model. Thus, we used single-item measurements for measuring and interpreting various pricing model changes.

The dependent variables of this study measure changes in software firm's pricing model during the last three years. We designed the variables based on the characteristics of assumed SaaS pricing models: capturing change toward having simpler pricing model (labelled "Scope"), toward less negotiation ("Influence"), toward usage-based pricing ("Formula"), toward committing to shorter contracts than before ("Temporal rights") and toward more unified pricing across the customers ("Discrimination"). We excluded the dimensions "Base" and "Dynamic pricing strategy" from our research setting due to their long-term, strategic nature and rather concentrated on different operative aspects on pricing models.

Measuring change in the value proposition was based on the assumption that SaaS firms standardize their products and services and implement fewer new functionalities to their products/services than before. The five dependent variables and the independent variable "Standardization" and "Fewer functionalities" were measured with the question "How well these statements describe the change of your company's business model during the last three years?", where response options were anchored ranging from "1=strongly disagree" to "5=strongly agree".

The independent variables measuring technology adoption are dummy (binary) variables that describe whether or not the companies use hardware virtualization (labelled "Virtualization") multi-tenancy (labelled "Multi-tenancy"), web-based software (labeled "Online delivery") and configurability (labelled "Configurability") in their products and services. These were measured by the question "Which cloud computing features were used in your company's products or services in 2012?", and had the options "Hardware virtualization", "Multi-tenancy", "Internet-based usage of product or service" and "Configuration through internet (Customer self-service)".

The control variables are the size and age of the company ("ln(Size)" and "ln(Age)", respectively). The proxy for the size of the company is the firm's revenue in 2012 and the company's age is determined based on the age of the firm in 2012. Using these control variables is justified. A larger company may have better resources to initiate and execute changes compared to smaller firms with limited resources. On the other hand, the more mature companies are likely to suffer from inertial forces within the organization that obstructs changes [47].

3.3 Data analysis

In this study we used non-parametric correlations and multivariate ordinal regression analyses to investigate the hypotheses. In particular, non-parametric correlations are used to reveal associations between cloud technologies, changes in value proposition and elements of pricing models. The ordinal regression analyses were employed to assess the pricing model changes attributable to adoption of cloud technologies and changes in value proposition. Ordinal regressions treat each ordinal value as an independent variable; thus it is possible to examine parameter estimates for a certain range of values within an independent variable [48].

Before running the data analyses, exploratory tests were carried out to choose the most appropriate statistical methods. Specifically, after realizing that the dependent variables were negatively skewed, we run the Shapiro-Wilk's test of normality and the test was significant. Thus, the sample did not come from normally distributed population; therefore we chose to use non-parametric statistics. We also investigated the potential presence of outliers. After exploring the data, we detected four influential responses visually using box plots and removed them from the analysis. Next, we applied Harman's single-factor test to check the common method variance problem, that is typical in case of survey research [49]. The unrotated factor solution did not reveal a single factor, which would account for the majority of the variance in the model, suggesting that the method variance would not be a problem in the data. Different concerns are related to the ordinal regression analyses, such as the multicollinearity of the independent variables, the choice of link function, and the proportional odds assumption. From the correlation statistics presented in the Table 1, we did not detect high correlations between the independent variables; thus, multicollinearity would not impede the results. Our choice of link function was driven by the distribution of the ordinal outcome as suggested by the literature [50], and we employed Cauchit for the model "DV=Scope" (outcome with many extreme values), Probit for the model "DV=Influence" (the underlying latent trait of the ordinal outcome is normally distributed) and Logit for the models "DV=Formula" and "DV=Discrimination" (evenly distributed categories). Finally, to test the proportional odds assumption the authors ran tests of parallel lines in SPSS. With all the models, the Chi-Square statistics were insignificant, indicating that the assumption was not violated.

Table 1. Non-parametric correlations between the variables

	Spearman rho		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Scope	Coefficient	1.000												
		Significance													
2	Influence	Coefficient	.222	1.000											
		Significance	.001	.											
3	Formula	Coefficient	.218	.106	1.000										
		Significance	.001	.104	.										
4	Temporal rights	Coefficient	.044	.045	.140	1.000									
		Significance	.501	.488	.032	.									
5	Discrimination	Coefficient	.489	.256	.185	.030	1.000								
		Significance	.000	.000	.005	.644	.								
6	Virtualization	Coefficient	.089	.042	.174	-.007	.141	1.000							
		Significance	.170	.519	.007	.911	.029	.							
7	Multi-tenancy	Coefficient	.171	.197	.230	-.093	.159		1.000						
		Significance	.008	.002	.000	.150	.014		.						
8	Online delivery	Coefficient	.131	.040	.182	-.025	.130			1.000					
		Significance	.043	.534	.005	.697	.045			.					
9	Configurability	Coefficient	.234	.146	.180	.020	.125				1.000				
		Significance	.000	.024	.005	.762	.053				.				
10	Standardization	Coefficient	.189	.144	.276	-.020	.261	.230	.200	.106	.070	1.000			
		Significance	.003	.026	.000	.764	.000	.000	.002	.100	.278	.			
11	Fewer	Coefficient	.080	.165	.135	.186	.141	-.060	-.008	-.068	.031	.143	1.000		
	functionalities	Significance	.222	.012	.040	.004	.032	.354	.901	.297	.634	.028	.		
12	ln(Age)	Coefficient	-.056	-.076	.047	.063	.025	-.064	-.045	-.059	-.107	.010	.050	1.000	
		Significance	.387	.242	.475	.334	.697	.309	.469	.343	.085	.876	.444	.	
13	ln(Size)	Coefficient	-.127	-.033	.005	.043	.017	.154	.169	.040	.049	.114	-.102	.159	1.000
		Significance	.056	.621	.941	.519	.802	.016	.008	.539	.443	.086	.124	.009	.

4. Results

The variables and their non-parametric correlations are visible in Table 1. The results show that some variables capturing the changes in software firms' pricing models are positively correlated with the adoption of cloud technologies. Specifically, the change towards having simpler pricing model (Scope) is associated with multi-tenancy, online delivery, configurability; change towards less negotiation (Influence) is positively correlated with multi-tenancy and configurability; change towards usage-based pricing (Formula) is associated with virtualization, multi-tenancy, online delivery and configurability; and change towards more unified pricing across the customers (Discrimination) is associated with virtualization, multi-tenancy and online delivery. However, change towards shorter subscription periods (Temporal rights) is not correlated with the use of the technologies; thus, we exclude the ordinal regression model explaining this change by introducing cloud technologies from this study.

Change in value proposition toward more standardized product/service or towards fewer functionalities is associated with change in different pricing model elements. Table 1 also shows correlations between dependent variables.

Results from the ordinal regressions of the four models are shown in Table 2, which reports the regression parameter estimates for the levels of dependent variables ("DV"), for the independent variables and controls. The table also reports two pseudo r-squares of Nagelkerke – for the full model and for controls only – which assess the overall goodness of fit of the ordinal regression models. While the values give some indication of the strength of the associations between the dependent and the predictor variables, the authors note that these r-squares should not be interpreted similarly to the OLS regressions. However, comparing the r-squares between a model including only controls and the full model, the higher r-square on each full model indicates better prediction on the outcome. Lastly, the tables include model fitting information for the final models; −2 log-likelihood, Chi-square and significance. The values are statistically acceptable for all models. This means that the models yield predictions more fitting than the marginal probabilities for the dependent variable categories.

Table 2. Ordinal regression models with parameter estimates

	DV=Scope			DV=Influence			DV=Formula			DV=Discrimination		
	Estimate	StdErr	Sig.	Estimate	StdErr	Sig.	Estimate	StdErr	Sig.	Estimate	StdErr	Sig.
DV ordinal level =1	-40.651	31.242	.193	-1.477	.527	.005	-.339	.919	.712	-.958	.990	.333
DV ordinal level =2	-.996	.945	.292	.073	.510	.887	.924	.895	.302	1.154	.913	.206
DV ordinal level =3	.749	.947	.429	1.060	.513	.039	2.684	.910	.003	2.760	.926	.003
DV ordinal level =4	4.911	1.306	.000	2.580	.544	.000	5.419	.965	.000	6.186	1.015	.000
virtualization	-.132	.285	.644	-.029	.164	.861	.218	.293	.456	.133	.294	.650
multi-tenancy	.943	.318	.003	.368	.171	.031	.557	.308	.071	.294	.309	.342
online delivery	.069	.304	.821	-.034	.182	.850	.425	.320	.184	.196	.323	.544
configurability	1.043	.311	.001	.155	.166	.351	.351	.297	.236	.226	.301	.453
standardization	.329	.140	.019	.101	.079	.199	.518	.140	.000	.394	.141	.005
fewer functionalities	.041	.143	.776	.252	.083	.002	.214	.145	.139	.264	.151	.080
ln(Age)	-.065	.186	.725	-.199	.104	.056	.180	.183	.325	.118	.187	.527
ln(Size)	-.081	.057	.153	-.009	.028	.753	-.037	.050	.457	.027	.051	.588
Pseudo R^2 (Nagelkerke)	.160			.115			.172			.098		
Pseudo R^2 (controls only)	.003			.016			.004			.004		
Model fitting information	536.509	35.630	.000	548.369	24.924	.002	543.388	38.424	.000	509.455	20.534	.008

Focusing on the ordinal regression parameter estimates for this study, the adoption of multi-tenancy is significant in predicting the change towards having simpler pricing model (in model “DV=Scope”, Est.=943, Sig.=.003), towards less negotiation (“DV=Influence”, Est. =.368, Sig. =.031) and to some extent notable in predicting the change towards usage-based pricing (“DV=Formula, Est. =.557, Sig. =.071). Besides, software firms with highly configurable applications are more likely to change their pricing model towards having simpler pricing model (“DV=Scope, Est. =1.043, Sig. =.001). The change towards simpler pricing model is also predicted by the standardization of the products and services (“DV=Scope”, Est. =.329 Sig. =.019). Besides, change in value proposition towards more standardized product/service is a better predictor of changes towards usage-based pricing (“DV=Formula”, Est. = .518, Sig.=.000) and toward more unified pricing across the customers (DV=”Discrimination”, Est.= .394, Sig.= .005) than the cloud technologies. Furthermore, change towards fewer new functionalities is the best predictor for change towards less negotiation (DV=”Influence”, Est.=.252, Sig.=.002).

5. Discussion

The current study supports most of our hypotheses deriving from the literature regarding the pricing model changes due to adoption of cloud computing technologies. The use of virtualization, multi-tenancy, online delivery and configurability are associated with the increased use of usage-based pricing. Besides, the use of multi-tenancy and configurability is associated with less negotiation with the customers. This can be explained by the fact that multi-tenancy constraints the customers' options for customization [51] that results in the customers' lower influence on both the product/service and its pricing. In addition to the above mentioned associations, the use of multi-tenancy, online delivery and configurability is significantly correlated with change towards simpler pricing with less pricing components. Also, the use of hardware virtualization, multi-tenancy and online delivery correlates with change towards more unified pricing across customers.

Based on the results, multi-tenancy is the most influential factor among cloud computing technologies that affects 4 out of 5 pricing model dimensions. Since multi-tenancy is the indicator of a cloud-mature, standardized application, it is not surprising that the use of it implies fundamental changes in the pricing as well. Prior research accentuates the role of multi-tenancy in the success of SaaS vendors [33]. However, based on this finding we claim that besides implementing multi-tenancy, changes most likely occur also in business model elements, such as the revenue logic, and these changes contribute *together* to the success. On the other hand, keeping our research method in mind, we cannot rule out the possibility that online delivery, configurability and virtualization might be introduced earlier than 3 years, leaving some dimensions of pricing models untouched during these last years.

It has to be noted that based on the empirical findings, the use of cloud computing technologies does not imply change towards shorter subscription contracts. Even though the use of these technologies enables shorter subscription contracts with the customers, the results show that the aim of software companies is to develop longer customer relationships. A possible explanation for this could be the possibly heavy competition in the market and the firms' high initial investments whose return need to be secured.

In the current study, besides technological characteristics and changes in pricing model elements, our model incorporated also changes towards more standardized products/services and fewer functionalities. The results show that change in value proposition explains most of the changes in different pricing model elements. This underscores the interrelation of different business model elements suggested by the literature (e.g. [10], [47]); namely, decisions to individual business model elements may affect several aspects of the firm.

Firms that standardize their products and services change also their pricing model; thus, revenue logic is highly important in a firm's strategy that needs attention from the managers. Besides standardizing the software, unifying the pricing across customers and using more volume dependent pricing components is justified. Standardized, less customer-specific software can be sold for the same price for different customers since the minimal customization work offsets the differences in the development costs. Standard software may generate more revenues with employing usage-based pricing in case there are big differences in the users' demand. With incorporating usage-dependent pricing components into the revenue logic, the infrastructure costs are passed directly from the provider to the customers. This way the company is able to catch also the long-tail of the market.

The analysis shows also that companies that implement fewer new functionalities give less negotiation power to their customers. Concentrating on the core functionalities leaves no or minimal room for user-specific customization work, thus, it makes negotiation unnecessary. Hence, SaaS firms offering standard software with a limited set of core functionalities usually employ pricelists in their pricing to attract customers.

The strength of associations between variables in this study indicates that implementing technological and business models changes is complex. The software firm's managers' cognitive processes may play an important role in adjusting different business model elements, in some cases even greater than the technological opportunities. We consider also the possibility that the software firm had already executed the changes before, thus, there had not been changes in the last three-year period.

During the study, we paid special attention to the common possible bias in survey research, such as measurement errors, problems related to sampling, coverage, and non-response [44]. To reduce the risk of measurement error we attained guidance on the survey questions from both researchers and practitioners in the field. Whenever available, we applied scales that have been tested in previous studies. One of the concerns with the measurements is the use of single-item measures, which are argued to insufficiently capture the conceptual domain. However, this claim has been challenged by DeVellis [52] by arguing that each item of a scale is precisely as good measure as any other of the scale items and that the items' relationship and errors to the variable are presumed identical. Understanding of this perplexity guided the authors not to make claims about the changes in pricing model dimensions (e.g. scope of the pricing model), but rather about the parameters (e.g. the number of pricing model components).

The software industry survey practically covers and contacts all the Finnish software companies; therefore we consider coverage and sampling errors irrelevant. The overall sampling rate for the software industry survey nonetheless is roughly 10 percent, which suggests a potential risk of non-response bias. However, the effective sample contained software firms of all types, ages and sizes, and the concern is principally if there are theoretically relevant differences between respondents and non-respondents. In this case, the effective sample contained sufficient variety in dependent variables to support the analysis of the hypotheses.

6. Conclusions

Using cloud computing technologies in software applications implies changes also to the business aspects of software firms; among which pricing is extremely important in achieving success in the competitive SaaS market. The current study fills a research gap in the current literature by focusing on the impact of deploying cloud computing technologies on different pricing model elements. In this paper the results of the research are presented related to the impact of hardware virtualization, multi-tenancy, online delivery and configurability on different dimensions of pricing models, such as the scope of it, the influence of the customers on pricing, the use of usage-based pricing, the temporal rights and price discrimination across customers.

After analyzing an effective sample of 324 software firms, we conclude that the use of cloud computing technologies implies changes in different dimensions of the pricing models. The results show that multi-tenancy is the most influential factor, affecting 4 out of 5 dimensions, while hardware virtualization, online delivery and configurability are associated with changes in some of the aspects of the pricing model. Software firms that use cloud computing technologies in their products and services seem to make their pricing model simpler, use usage-based pricing, reduce the customers' influence and unify their pricing across customers. They do not, however, shorten the length of the contracts with their customers. The current study also revealed that changes in pricing models happens together with changes in the value proposition; this underlines the interrelation of different business model elements suggested also by the literature (e.g. [10], [47]).

This study is the first to examine the changes in pricing models of SaaS firms empirically and therefore the authors suggest these findings to serve as a starting point for future studies. The practical implication of this study is an increased understanding about how the SaaS vendors are changing their business models and consequently how the market of software products and services is evolving as a result of recent technological advances. As the market is transforming to embrace the promises of cloud computing technologies, studies on business models offer predictions about what are the viable configurations of business models and how deployment of technologies changes the configurations. Since the survey is limited to Finland, the study does not necessarily provide a representative illustration on SaaS firms in a global context; therefore similar studies in other countries are welcome to complement the results.

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