CUSTOMER HETEROGENEITY AND TARIFF BIASES IN CLOUD COMPUTING

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Completed Research Paper

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Abstract

In the last two years, mainly practitioners published newspapers and technical reports - outlining the benefits and obstacles of Cloud Computing. Scientific research is limited to technical issues of Cloud Computing so far. Marketing and economic issues have been barely discussed in literature. Especially, customer considerations and pricing are only discussed vaguely in industry reports.

A detailed understanding of the preferences enables providers to design efficient pricing models. Therefore, a survey was conducted to analyze the customer preferences for Cloud services. The results show heterogeneity in preferences and suggest the application of second degree price discrimination. Furthermore, the survey shows existence of flat rate and pay per use tariff bias for Cloud services. Thus, Cloud providers offer their services successfully with a flat rate tariff model, which contradict literature’s prediction of a dominance of flexible pay per use tariffs.

Keywords: Cloud Computing, customer preferences, tariff bias, conjoint analysis
Introduction

Cloud Computing is a paradigm shift towards computing served as a utility and software accessed as a service over the network. This paradigm attracted both the academia and industry to analyze the market potential for Cloud services. IT resources on demand and an increase of datacenter utilization promise flexibility and cost reduction. By migrating software to the Cloud and consuming it as a service, about 60 to 80 percent of the IT costs can be reduced, which are typically spent for IT administration and support (Craig, 2007). This allows companies to invest in core business activities rather than in supporting IT systems, and hence improves business operations. The risk of supporting IT infrastructure operations shifts towards the providers of IT data processing centers (Armbrust et. al., 2009). Technical improvements like virtualization and Web 2.0 technologies foster the development of Cloud Computing.

In the last two years, mainly practitioners published newspapers and technical reports - outlining the benefits and obstacles of Cloud Computing (Meeker et. al., 2008; Rangan et. al., 2008; Staten, 2008). Since the beginning of 2009 there is an increase on scientific publications on Cloud Computing (c.f. Armbrust et al., 2009; Buyya et al., 2009; Vaquero et al., 2009; and Weinhardt et al., 2009). Most of the research work, which has been done so far, focused on various technical issues of Cloud Computing. Marketing and economic issues of Cloud Computing have been barely discussed in literature so far. Especially, customer considerations and pricing are only discussed vaguely in industry reports (e.g. Gens, 2008).

This paper intends to fill this gap. Therefore the usage of Cloud Computing service from a customer perspective is analyzed. So far, it is not clear what customer preferences for Cloud services are and how pricing should be realized based on customer factors. Furthermore, tariff biases could give an explanation why currently Cloud providers offer their services successfully with a flat rate tariff model which contradict literature’s prediction of a dominance of flexible pay per use tariffs. Consequently there are three research questions: What are the preferences of customers for cloud services? Are the preferences different among various groups of customers? How do these preferences influence the pricing of Cloud services?

A survey was conducted focusing on small and medium enterprises in Singapore as (potential) customer of Software as a Service. Using a choice based conjoint analysis this study provides valuable insights into customers’ preferences. In contrast to other existing studies, the relative importance of Cloud service attributes is identified. One of the survey conclusions is that economic reasons such as cost reduction are not among the most important issues as many studies claimed before (e.g. Leipold et al., 2009). Moreover, cluster analysis results show customer preference heterogeneity. Three different customer segments are identified, which should be provided with different Cloud service characteristics. The customer heterogeneity reveals possibilities for second price discrimination based on versioning. Another interesting finding of this work is the existence of flat rate and pay per use tariff biases for Cloud services. Although some Cloud service consumers (28% of the survey respondents) seem to appreciate the flexible adjustment of their bill on the actual usage and hence opt for the pay per use pricing tariff, more consumers (48% of the survey respondents) are significantly influenced by the so-called insurance effects. They appreciate the safety of not having variations in their monthly bill and thus prefer flat rate pricing schemes such as monthly subscription fee. This finding helps to explain the coexistence of these two types of pricing tariffs in the real market. Consequently, the selection of offered tariffs should not only be based on economic considerations, but also take customer preferences into account. To the best of our knowledge, this is the first survey conducted on customer preferences for Cloud services using a well-known methodological research approach.

This paper is structured as follows. The subsequent section provides a basic understanding of the Cloud Computing and discusses the relevant industry studies for this survey. Then the applied methodology is presented and the context of the survey is outlined in the section “Methodology”. The next section discusses the results of the survey. The final section concludes the work.

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1 We use the term Cloud services synonymously with Software as a Service. Infrastructure and Platform as a Service are not considered in this paper.
Related Work

Cloud Computing Definition

The definitions of Cloud Computing are as precise as a cloud itself. A clear definition is especially difficult due to the multiple character of Cloud Computing. Vaquero et al. (2009) see it as a combination of elements of virtualization, utility computing and distributed computing. They offer a good overview of more 20 definitions. As Cloud Computing involves a broad range of computing aspects, the definitions vary as well. There are definitions, which focus on the infrastructure layer and some, which try to reduce the characteristics to a common denominator over all layers and identify the total business model of Cloud Computing. After reviewing several definitions by experts, Vaquero et al. (2009) come up with the following definition, which is said to be a minimum common dominator:

“Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay per use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs.”

Within this definition Vaquero et al. (2009) does not only focus on the infrastructure layer like Armbrust et al. (2009). He considers beside the hardware aspect as well platform and software services. He emphasizes the importance of business models in the Clouds. As claimed by many researchers (see e.g. Youseff et al., 2008) the elements of Cloud Computing are not a technical innovation itself. Sharing computer resources in Grid computing, virtualization and on demand services such as Software-as-a-Service (SaaS) has been there before Cloud Computing. Weiss (2007) concludes that the real revolution of Clouds is the combination of those different IT aspects into a new business model.

Market analysis on pricing models

Though, there is a different belief concerning the pricing models. As, for example, Vaquero et al. (2009) believes in a fix link of Cloud Computing to a pay per use model, this paper outlines the impact of other pricing models by the survey results. Since there is not a study available about the current pricing models in the Cloud service market, a pre-analysis of the providers’ pricing model was necessary to design the actual survey on customer preferences appropriately. Therefore, 50 Cloud service providers were observed with a specific focus on different Cloud layers. Most researchers as Briscoe and Marinos (2009) or Vaquero et al. (2009) believe in the separation into three layers: IaaS, PaaS and SaaS; namely Infrastructure-, Platform-, and Software-as-a-Service. This is in line with the current service offers of Cloud providers.

An interesting result is that most Cloud providers, in this case about 20%, do not advertise their prices at all. It is mainly based on a negotiation process. On an infrastructure layer often even the pricing tariffs are not provided before contacting the provider. In total only 36% of the observed Cloud service providers advertised concrete prices. A possible explanation could be that they try to avoid margin cutting price wars. The frequency of different pricing tariffs changes with each layer. This reflects the different requirements each Cloud layer sets on their pricing tariffs. Table 1 gives an overview of the results.

<table>
<thead>
<tr>
<th></th>
<th>Free</th>
<th>Pay per use</th>
<th>Fixed Fee</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IaaS</td>
<td>0%</td>
<td>20%</td>
<td>4%</td>
<td>14%</td>
<td>37%</td>
</tr>
<tr>
<td>PaaS</td>
<td>8%</td>
<td>15%</td>
<td>10%</td>
<td>4%</td>
<td>37%</td>
</tr>
<tr>
<td>SaaS</td>
<td>10%</td>
<td>0%</td>
<td>13%</td>
<td>2%</td>
<td>26%</td>
</tr>
<tr>
<td>Total</td>
<td>18%</td>
<td>35%</td>
<td>27%</td>
<td>20%</td>
<td>100%</td>
</tr>
</tbody>
</table>
In general a differentiation between private customer and business customers has to be done. Most Cloud services, which are focusing for private users, are often for free as Microsoft’s Live Mesh\(^2\). In contrast business Cloud services are charged most often on a pay per use or fixed fee tariff. Only some add on services on IaaS or SaaS are for free as well. Still 18% of the observed Cloud providers offered their service for free.

On an infrastructure layer pay per use is the common pricing tariffs. This seems to be consistent with the concern about congestion in an infrastructure environment (MacKie-Mason and Varian, 1995). Providers as Amazon\(^3\) base their prices on usage of requested server performance in hours. Storage is based on transferred data and time of storage. As differentiation through added value services is less likely on an IaaS layer, price competition is more common.

PaaS providers offer their development tools often for free. The deployment of the customer hosted web services is then priced either on a pay per use or fixed fee tariff. The prices are based on a combination of uptime and requested resources in order to run it. PaaS provider can use a lock-in effect this way. As soon as web services are customized to a specific platform, switching costs are high due to necessary changes in programming language. This is consistent with the idea of strong ex ante competition with an ex post monopoly situation (Varian, 2003).

Fixed fee tariffs are dominant on a SaaS layer. As mentioned earlier fixed fees are easy to implement and convenient to handle. Furthermore, as these services offer a high level of complexity the measurement of usage is more difficult than on an IaaS layer. This may be an explanation why pay per use is unpopular. However, SaaS offer great possibilities to use versioning. By combining different services or adding new features to services, different offers can be created. These can be priced differently according to the users’ willingness to pay. A well known example is Google Apps\(^4\). They offer a free version in competition to a yearly fixed fee. The price is justified by additional features which allows customer to run Google Apps even in a professional environment. Furthermore, group discount are common on a SaaS layer as well.

MacKie-Mason & Varian (1995) results on congestible network resources can be transferred in order to explain the current variety of pricing tariffs in the Cloud industry. They showed that on a market with heterogeneous customer preferences there may exist a restaurant equilibrium. A restaurant equilibrium is defined as “various providers offering different service quality at different prices, with single consumer using more than one provider for different purposes”. One goal of this paper is to analyze whether SaaS customers differ in their preferences and are thus heterogeneous. A provider can then apply versioning strategies and different pricing tariffs to increase his revenue.

However, the preferences from a consumer perspective remains blurry. Although providers aim to design services according to the demand of the market, it is not clear how the provider decided to add or remove features of their services.

**Previous studies**

Consulting and industry companies are regularly publishing studies about consumer behavior. However, studies from an academic point of view are still missing. Thus, the related work presented below focus on the consulting and industry studies.

**Avanade study**

Avanade\(^5\), a business technology service provider, identified security issues as the top concern (Leipold et al., 2009). 5 out of 6 respondents put more trust into existing internal systems than in Cloud based systems. The respondents also fear the loss of control of data and systems. Though, they think that their current internal system is too expensive. Therefore, 50% of the surveyed companies use new technologies in order to cut costs. Moreover 71% of the respondents agree that Cloud Computing is a real technology option and 65% believe furthermore that it reduces up-front costs. These reduced up-front costs and the improved agility to respond quickly to market conditions are the

\(^2\) [http://www.mesh.com](http://www.mesh.com)  
\(^3\) [http://aws.amazon.com](http://aws.amazon.com)  
\(^4\) [http://www.google.com/apps](http://www.google.com/apps)  
\(^5\) [http://www.avanade.com](http://www.avanade.com)
top reasons for early adopters to invest into this new technology. Although, the majority of companies report no plans to integrate Cloud Computing within the following twelve months, they are willing to benefit from the cost savings and flexibility of Cloud Computing.

Avanade finds increasing acceptance of SaaS applications. Already more than half of their respondents are already using these services and 93% of them consider the introduction of SaaS as a success, whereas most of them are using these services for less than a year. Even more, two third of the respondents intend to increase their use of SaaS. However, 2 out of 3 respondents prefer SaaS delivered internally than by a third-party service provider and if they use an external solution, they most often do not only use one provider.

**NTT Study**

In the NTT (2009) survey, 46% of the respondents consider the definition of Cloud Computing as unclear. This may be one more reason why only 17% of the interviewed respondents said that their companies are already using Cloud Computing. Furthermore 35% of CIOs and CFOs are not planning to invest in Cloud Computing and another 32% are unsure whether they will within the next two years. An exception from these statistics is the technology and communication sector, where already 60% of the companies are using Cloud services and 75% are intending to expand their usage. However as the main barrier for entering Cloud Computing, the respondents name security issues followed by reliability issues. Interestingly, the cost savings have to be higher for technology decision makers than for finance decision makers, but should be at least between 10-20%. SaaS solutions are a possible part of companies strategic IT plans, as about 60% of the respondents are looking to invest within this field. The NTT survey showed moreover that there are possibilities for online storage, backup services, customer relationship management, office tools and email tools to be valuable for organizations. In contrast, their survey showed that most of the respondents refuse to move financial and accounting systems and business critical systems into the Cloud. Even if CIOs and CFOs clearly see the benefits of Cloud Computing, so the conclusion of the survey, it seems that Cloud Computing model will not be considered in short term.

**Hosting Study**

The focus of the study from Hosting (2009) was on the small and medium enterprises. Two third of the respondents believe that Cloud Computing brings fundamental change in how technology services are provided or at least provide instant value to their companies. The study further reveals that most companies have already had some experience with external hosting providers, as 90% of the respondents use web hosting, email hosting, database hosting or any other hosting services already. Although typical Cloud services, such as application hosting (30%) and online storage (21%) play a minor role so far.

Moreover, the survey asked the respondents to name the three most important factors, which drive them to invest in Cloud Computing. 34% of the respondents ranked cost savings as the number 1 factor for investing. High availability (17%), performance (12%) and consumption based pricing are seen as important drivers as well. It is no surprise to the researcher of Hosting, because those factors have prompted companies to outsource their IT services for years. Not surprisingly, security was 64% of the time named as one of the top three obstacles. But also support (58%) and lock-in effects (40%) are concerns which should be taken seriously by providers in order to provide suitable solutions to their customers. Also the provider reputation (27%) seems to be an important issue for respondents in their decision for a Cloud provider. Being asked for the preferred pricing for Cloud services, 32% of respondents preferred a month-to-month payment, with no contracts and the charges based on the actual usage. Another 16% wanted the same pricing model, but instead of charging on usage, they preferred a flat rate. Hosting assumes that especially for unpredictable business usage based pricing is new and may get increasing attention in the future.

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7. [http://www.hosting.com](http://www.hosting.com)
IDC Studies

In October 2008 IDC\(^8\), published their study on Cloud Computing interviewing 244 IT executives and CIOs (IDC, 2008). They figured out the top benefits for investing into Cloud Computing. About 64% of the respondents evaluated the speed and ease of deployment as the most important benefit of Cloud Computing. The following three benefits all deal with improving the economics. 62% of respondents appreciate the alignment of costs with the utilization through pay per use tariffs. 57% see the benefit of reducing internal IT staff and 53% appreciate the advantage of replacing large up-front costs with streaming payments. IDC explains the high number of economic issues by the fact that cost competitiveness is most relevant aspect for CIOs. However, respondents still see a lot of challenges remaining for Cloud services. More than 74% name security as their top concern with Cloud Computing.

Users fear critical IT resources to be outside of their firewalls and worry attacks on external servers. Performance and availability of the service is dependent on a lot of factors such as network availability, performance of the provider’s systems as well as on the underlying supply chain of the services (61%). Therefore IDC predicts that Cloud providers with clear transparency of interdependencies and credible service level agreements should be more successful on the market.

In December 2009 IDC (2009) published their follow up study on Cloud Computing. The respondent population was similar to the previous study and allows comparisons of the results. Economic issues remain the top drivers for Cloud adoption, as most important pay per use (78%), monthly payments (78%) and less internal IT stuff/costs (67%) are under the top five benefits of Cloud Computing. Speed and simplicity of deployment still remains the second most named benefit of Cloud Computing with 78% of respondents rating it as very important. The increase of importance of standardization with 69% is a sign of the increasing understanding of customers for the Cloud service model. IDC stresses the fact that standardization can help to respond quickly and efficient on businesses’ changing needs and therefore predicts that standardization will be an additional justification for moving applications into the Cloud. Security, availability and performance remain the most rated challenges of Cloud Computing by respondents. Cost concerns got increase attention from the respondents, of whom 81% named it. The report explains this behavior by Cloud customers being unable to predict their demand for services and therefore may calculate wrong. Standardization and lock-in effect have been considered for the first time within this study. About 80% are afraid to stuck with software as decades before and wonder whether standards would give them more freedom. Lock-in effects are even more highlighted as a lot of respondents are afraid of being unable to reintegrate services to their in-house IT after unsuccessfully migrating to the Cloud. Standards are furthermore considered as challenges in terms of integrating Cloud services with already existing in-house IT. Therefore, the report suggests providers to focus more on user friendly Cloud standards in order to gain greater market share. As Cloud Computing is in its evolving status, this market share might be an important early majority.

In general, customers are quite open for the new and innovative services. Cost reduction is the most important motivation to move to the Cloud. Security issues are the biggest concern for the customers. However, a detailed analysis on the preferred pricing models and a methodological sound approach for analyzing the customer preferences is missing in all the above mentioned surveys.

Methodology

This section summarizes the research methods, which have been used within this study. At first, the methodology of choice based conjoint analysis, which has been used to reveal customer preferences, is presented. Moreover, cluster analyses have been used in order to identify customer segments and are discussed in more detail as well. Although regression and variance analysis were included in the research methodology, they are not further explained here due to their common understanding. The section concludes by outlining the context of the used survey. All methods are discussed only briefly to comprehend the research approach in this paper. Interested readers in conjoint analysis may refer to Hauser and Rao (2003) or Green (2001) for further explanation. Cluster, regression and variance analysis are discussed in detail in Hair et al. (2009).

Conjoint Analysis

Conjoint analyses were first used in psychology during the 1960s, before Green and Rao (1971) introduced them to marketing literature. In a more recent publication, Green et al. (2001) stresses the fact that conjoint analysis have

\(^8\) [http://www.idc.com](http://www.idc.com)
become the most used marketing research method for analyzing consumer trade-offs, by identifying customers’ part
worth utilities for attribute levels. The popularity can be explained by the central contribution of conjoint analysis:
provide an answer why customer choose the products or services they choose. Green sums it up: “Conjoint analysis
is a technique for measuring trade-offs for analyzing survey responses concerning preferences and intentions to
buy…”.

In contrast to the traditional conjoint analysis, where constructed stimuli are rated or arranged, in choice based
conjoints analyses respondents take actual decisions. Louviere and Woodworth (1983) were the first to introduce the
discrete choice theory into conjoint analysis. The choice based conjoint analysis is based on the belief that customers
choose in order to maximize their utility. Furthermore, it is assumed that consumer choices are correlated to
attributes’ part worth utility – and thus directly connected to customers’ preferences. Therefore, Himme (2009)
explains, a function explaining the total utility of a stimulus based on each attribute’s part worth value has to be
defined. Additionally, another function is needed to express the probability of choice based on the stimulus’s total
utility. Using then the respondents’ choices in combination with theory of chance and models of discrete choice the
part worth utilities of the different attributes level can be estimated. Green et al. (2001) sum up the procedure of the
choice based conjoint analysis as they say that “… respondents typically see profile descriptions of two or more
explicit competitors, which vary on one or more attributes. In this case, the task is […] to pick one’s most preferred
profile from the set …”. The greatest advantage is that the extern validity of choice based conjoint analyses is
typically higher as Gensler (2006a) points out. Balderjahn et al. (2009) mention that the possibility to include a non-
choice option with choice based conjoint analyses increases the realism further more. On the other side, until some
years ago, the smaller information output and the involved constraint of not being able to estimate individual part
worth utilities was a disadvantage of the choice based conjoint analysis. However, recent developments in
Hierarchal Bayes approaches in conjoint analysis have made it possible to estimate as well individual part worth
values (Rossi et al., 2005). Besides the definition of the utility and choice functions, the design of a choice based
conjoint analysis includes three more steps, which are explained here in more detail.

Creating the Stimuli

Fundamental for the quality of a conjoint analysis is the selection of attributes, as even the most efficient analyse
method will not be able to create valuable results, if the input data was of low quality. As Weiber and Mühlhaus
(2009) mention, the selection of attributes and their levels have an essential influence on the outcome of the
following processes of the creation of choice sets and the specification of the utility and the choice functions. Auty
(1995) highlights: “No decision is more critical to the usefulness of the conjoint exercise than the one that must be
made about which attributes to include”.

Weiber and Mühlhaus (2009) mention several possibilities for identifying preference relevant attributes. The
cheapest and fastest approach is a document review which can include among other things technical literature, test
reports and literature. However these resources often do not provide profound information, so that interviews can be
conducted with either consumer or experts. An alternative to these direct methods is the group of projective
methods, which are characterized by their indirect identification of relevant attributes by presenting pictures,
questioning and using services. These methods, such as association tests or group interviews, have the advantage of
being able to identify preferences, which are not easily phrased.

Huber et al. (2007) outline several criteria for the selection of suitable criteria. After selecting suitable attributes, the
attributes’ levels have to be defined. Weiber and Mühlhaus (2009) mention especially two considerations: First of all
the decision of whether to use concrete or abstract levels. Secondly, each attribute levels can be either described by
binary features or continuous dimension. Operators are seeking for detailed information and a high number of
attributes and levels. However from a respondent perspective, a low number is more practicable. The number of
choices a respondent can take without the influence of over information is limited to five or six attributes with up to
four levels (cf. Green and Srinivasan, 1978).

Creating the Choice Sets

In most cases not all stimuli can be presented the respondent at the same time, as it would overstrain him. Addelman
(1962) offers methods in order to reduce the number of presented stimuli. For the remaining stimuli subgroups have
to be built, so called choice sets, which include a specific number of stimuli and might include a non-choice option
as well. As a consequence the optimal number of choice sets as well as the allocation of stimuli to specific choice
sets has to be defined. As Gensler (2006a) mentions a total number of 20 choice sets should not be exceeded as signs
of fatigue might decrease the quality of answers. Backhaus et al. (2008) limit the number of choice sets to even less than 17, which should at a maximum contain 7 stimuli. Gensler states that creating an efficient design is characterized by low variance and covariance of the estimated part worth utilities. Achieving these low values is fulfilled by a low level of attributes’ interference and a balance of each stimuli’s utility.

**Specification of the Utility Function and Choice Function**

There are three common utility functions for individual attributes as mentioned by Green et al. (2001). The part-worth model is the most common used method. The model assumes that each level can create any part worth utility and is therefore very flexible and furthermore includes the other both methods as special cases. However, as the utility differences between the different stimuli cannot be observed, customers’ choice can only be predicted.

There are four common choice functions (Backhaus et al., 2008), which describe customers’ choice behavior. Besides the Max-Utility-Model, the Random-Choice-Model and the Attraction-Model, the Multinomial Logit-Choice-Model (MNL-Model) is the most common model for estimating the choice decision. The MNL model involves all previous models by parameter variation. Moreover, the probability of an alternative choice is dependent on its utility in relation to the overall utility of all alternatives. Thereby the probability is only influenced by the utility differences between the alternatives rather than by their absolute utility amount. However, all models have in common that they simplify the complex choice process of human beings. Therefore all models, except of the Max-Utility-Model, provide probabilities of selecting a specific alternative instead of concrete choice.

**Estimation of Part Worth Utilities**

With choice based conjoint analysis the only data available is the discrete choice decision respondents took. Instead of metric or ordinal data, as with the traditional conjoint analysis, the choice based conjoint provides only nominal data. Therefore trade-off utilities cannot be estimated by regression methods or least square methods. Therefore there are two different approaches in order to estimate the part worth utilities: The Maximum Likelihood approach (ML-method) and the Hierarchical Bayes approach (HB-method).

Bunch and Batsell (1989) showed that for the estimation of part worth utilities within the MNL-modell, the maximum likelihood method (ML-method) provides very good results. Backhaus et al. (2008) explain that the ML-method tries to estimate the unknown parameters, so that the likelihood of the realized data is maximized. In the case of the MNL problem this means that the part worth utilities have to be estimated that the actual discrete choice decisions are explained the best. This is true, if the probability for the chosen alternative k in a specific choice situation r is as high as possible and true for all 1, … , r ∈ R situations. However, Gensler (2006a) stresses the fact, that a downside of the MNL approach is the fact, that in order to gain undistorted part worth utility parameters a large number of choice decisions per respondent have to be present, as they determine the degree of freedom. In literature a number of 60-120 degrees of freedom are proposed. This will be too much for a single respondent to answer. That’s why utility parameters are only estimated on an aggregated level using maximum likelihood functions.

Individual preferences couldn’t be calculated for a long time and seen as the major disadvantage of choice based conjoint analysis. The gained data from choice based conjoint analyses just included not enough information, as Himme (2009) states. The aggregated data though, assumes homogeneous preferences of the customers. This might not always be a realistic assumption and result in distortion of the estimation. In order to take account of customers’ heterogeneity Hierarchical Bayes approaches have been introduced to conjoint analysis by DeSarbo et al. (1992). This approach, as mentioned by Green et al. (2001), “…permit(s) the measurement of individual differences as well.”

The fundamental assumption is that preferences are characterized by a specific distribution, commonly the normal distribution. The individual preferences can be estimated due to the fact that two different models are combined. In the first model, the distribution of the individual utilities is defined. Commonly a multivariate normal distribution is used. Superior to this model is the choice model of the respondents for which most often a multinomial logit model is used. Therefore the approach is called hierarchical. Based in an iterative process, the individual utility parameters are estimated and a distribution on an aggregated level is conducted. In the following step this aggregated distribution is used in order to improve the estimates for the individual utilities. The process is kept on until no essential improvements can be realized. As a result, acceptable estimations of the individual part worth utilities can be realized.
Finally, in order to interpret, compare and aggregate individual preferences, it is necessary to standardize the part worth utilities as Gensler (2006b) points out. The estimated raw part utilities provide no possibilities for direct analysis due to their model specification. Therefore a calculation of the relative importance of different attributes is necessary. If one attribute has high part worth utilities for all of its levels, it can be considered to be important for the customers, however the variation of the attribute’s level has only a small impact on the total utility. Therefore this attribute may not be considered as relevant for the decision process. Consequently, the attribute’s range of part worth utilities in each level has to be considered - which is the difference between the smallest and greatest attribute’s part worth utility.

Cluster Analysis

Cluster analysis helps to understand whether there are similarities between the different respondents. The method aims for summing up respondents to groups (clusters) with most homogeneous characteristics or attributes, or in our case preferences. At the same time the method tries to increase the heterogeneity between the different clusters.

Defining the Distance Measure

At the beginning there is only a raw matrix consistent of respondents and variables, which describe them. In order to quantify the similarity between the different respondents, this raw matrix has to be transferred into a similarity matrix. The appropriate measure for this transformation depends on whether the raw data is nominal, binary or metric. As within this survey the cluster analysis is based on metric preference data, only metric measures are presented here. There are measures which are based on distances and others which are based on similarities. A common used distance measure is the Minkowski metric, which is often used in combination with the Euclidian distance. In this case the differences between variables of respondents are squared and summed up. The Euclidian distance is then calculated by square rooting this sum. The advantage of this measure is that small differences between variables are less taken into account than bigger ones. An alternative to distance measures are direct similarity measures. The Pearson’s correlation coefficient, for instance, measures the similarity between two objects by taking all objects’ variables into account. However the results, using each of the two measures, are different. Direct similarity measures are based on correlation values and therefore take only into account the development of the variables instead of their absolute value. In contrast distance measures only take into account the absolute difference between the variables.

Algorithm of Merger

The next step in the cluster analysis involves the selection of the merger algorithm. There is a wide variety of different approaches, so that explaining all of them would go beyond the scope of this paper. As hierarchical methods starts with either one cluster combining all respondents or by clustering each respondent individually, these methods suit well the data at hand. New clusters are created by splitting, respectively combining, the previous clusters. The single-linkage, complete-linkage and the ward approach are the most often used hierarchical methods. All approaches use the initial distance matrix transformed out of the raw data in step one of the cluster analysis. However, the single-linkage approach tends to build one big cluster whereas the complete-linkage tends to build a lot of small clusters. Therefore they are less suitable for this research problem. The ward approach does not suffer from the mentioned disadvantages. This results from the fact, that the ward approach has the advantage that it uses a measure for heterogeneity for selecting which clusters should be combined. It selects the clusters which increase the heterogeneity the least. As a measure for the heterogeneity the ward approach uses the sum of squared Euclidean distance. Bergs (1981) showed that the ward approach delivers very good clustering results compared to other approaches.

Number of Clusters

So far the presented hierarchical methods all end with only one last cluster, including all initial respondents. However selecting the number of optimal clusters is a difficult task, as it is always a trade-off between the homogeneity of the different groups and the manageability of the number of clusters. Therefore statistical criteria should be used to decide how many clusters should be used.

The elbow criterion is an optical method. When the heterogeneity measure is plotted over the number of clusters, the so called screen plot, a sudden increase in heterogeneity with a decrease in clusters can be observed by a break in the
screen plot. This occurrence can be used in order to decide for the optimal number of clusters. Another possibility to identify the best number of clusters was introduced by Mojena (1977). He uses a standardization of a merger coefficient $\alpha_i$. In the case of a ward approach the merger coefficient $\alpha_i$ is the sum of squared Euclidean distance as a measure for the heterogeneity of the current selection of clusters. When the standardised merger coefficient $\alpha_i$ hits a predefined boundary the first time, it can be considered as an indicator for a reasonable number of clusters.

**Results**

A web-based survey was used to collect empirical data. The survey focused on small and medium enterprises (SME) in Singapore. Following a definition of the European Commission (2003) it includes all small companies with fewer than 50 employees and all medium enterprises with 51 up to 250 employees. The survey was conducted in a four-week period in November 2009. Potential respondents were recruited from a customer list of a major Singaporean telecommunication company. They were contacted with an invitation letter which was sent via email. Per link they were forwarded to the online questionnaire. The processing time of the survey was kept short to about 15 minutes to fill out, in order to prevent consumers from dropping out, as pointed out by Seehan (2001). A total of 144 SMEs participated in the survey and 60 completed data sets.

The sample of 60 respondents fulfills the screening requirements, as 67% of the participating respondents are working in a small company with less than 50 employees in total, 27% are working in a medium sized company with 51 up to 250 employees, and 6% are working in bigger companies. Furthermore, a wide range of different industry sectors have been included as shown in Figure 1, assuring that there is no industry bias within the study. All respondents’ industries with less than 5% share were grouped within “other”.

![Figure 1. Participating Industries](image_url)

About 24% of the respondents are working on a chief executive level. Still the most respondents (57%) consider themselves as employees. The remaining proportion of 19% includes other position - mainly on a medium management level.

**Customer Preferences**

In order to estimate the preferences of the total sample, a choice based conjoint analysis, which was first introduced by Louviere and Woodworth (1983), was included in the survey. The first step of the analysis was the selection of suitable attributes and attribute levels for describing Cloud services best. Following Weiber and Mühlhaus (2009), a document review has been done and a list of 18 attributes with 49 attributes’ levels in total was created. This list was then reduced by validating it through expert interviews$^9$. Their experience based on previous focus group and one on one interviews with key customer groups. The resulting selection of attributes is shown in Table 2.

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$^9$ Expert interviews include one on one interviews with marketing and IT experts from a major telecommunication company in Singapore.
This selection has some similarities to previous studies. Five of the listed attributes are named as top benefits or obstacles for Cloud Computing by Hosting (2009). Security and reliability was not included in the list for the following reasons. First of all, although security and reliability in general remain important issues for consumers, a lack of security or reliability are considered as a knock-out criterion in this research scenario. In this case, these attributes should not be included in the conjoint analysis, as Weiber and Mühlhaus (2009) point out. Second, it is assumed that from a consumer’s perspective it is impossible to differentiate Cloud services based on security and reliability.

<table>
<thead>
<tr>
<th>Table 2. Conjoint Attributes</th>
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<tr>
<td>Provider Reputation</td>
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<td>Required Skills</td>
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<tr>
<td>Migration Process</td>
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<tr>
<td>Pricing Tariff</td>
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<td>Cost compared to intern</td>
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<td>solution</td>
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</table>

For the creation of efficient choice sets, an implementation of Kuhfeld (2009) by the statistic application SAS was used. Street (2005) approved the efficiency of these SAS algorithms compared to alternative approaches. In total, 13 choice sets have been included in the survey, and each consists of three stimuli alternatives and one non-choice option. In order to ensure the external validity, the 13th choice set has been used as a holdout set. Choices in holdout sets are not used for the estimation of part worth utilities and can therefore be used to proof external validity. The number of choice sets and alternatives was set in order to balance between the required information and the respondents’ exhaustion, as proposed by Gensler (2006a).

To estimate the part worth utilities for the total sample, an implementation of Kuhfeld (2009) was adopted. This implementation includes a part-worth model for all attributes, except cost reduction. For cost reduction a vector model was assumed. The choice decision behavior was predicted using a multinomial logit choice model (MNL). Afterwards, the part worth utilities were estimated with a maximum likelihood approach (ML) and finally were standardized to relative importance, which are shown in Figure 2. The null hypothesis that “there are no strictly preferred attributes and all part worth utilities equal zero” is rejected based on a significance level of $\alpha=0.01$ and a likelihood ratio of 161.34. In other words, the research finds that potential consumers of Cloud services do have a strong preference with regards to the different service attributes. The holdout rate, the ratio of estimated and actual choice in the holdout sets, of 58% is a proof of the external validity.
Provider reputation is the attribute with the highest relative importance. It can be concluded that the cloud service offered by a new market entrant with no reputation, all else equal, will be evaluated with 26% less utility compared to the service from a well-established provider. Hence, the new entrant has to offer other additional incentives, such as higher cost reductions, in order to compete against the existing well-established cloud companies. This finding suggests that established IT companies can benefit from their “historical” good reputation and take over market leadership positions in the Cloud industry. But also telecommunications companies have high potential to enter the cloud computing field successfully. The fact that reputation is ranked high can possibly be explained by its correlation with trust. As mentioned earlier, security issues are hard to differentiate. Therefore, trust in the providers’ security arrangements is of importance.

The use of standard data formats is ranked the second most important attribute with 21% relative importance. It indicates that consumers are afraid of being locked in by one specific service provider. This result is consistent with the IDC (2009) study which highlighted the increased importance and consumer understanding of provider lock-in situations. Therefore, it is suggested that in general cases providers should offer their services with standard data formats, as otherwise consumers will react with high loss of utility. For those providers who are considering using their specific data formats should evaluate carefully whether the additional benefits from consumer lock-in outweigh the decrease of consumer utility and possible loss of market share. New market entrants can use standard data formats to initially increase the market share, but they should be aware of facing stronger competition since switching to other providers is facilitated.

The results show that in contrast to all previous industry studies (see Section ‘Previous studies’) economic aspects are less important. The different research approach of using relative rather than absolute importance of the attribute could be an explanation for the lower rank of economic aspects. Companies may take the cloud solution into consideration because of their economic benefits. However, when they are choosing a specific cloud provider, other service attributes play a more crucial role in the decision process. Surprisingly, the pricing method (with 16% relative importance) is as important as the cost reduction (17%). This suggests the importance of adopting a smart pricing strategy (for providers).

Using the same choice design and answers, a Hierarchical Bayes approach has been used in order to estimate individual part worth utilities. For the estimation an implementation of Rossi et al. (2005) was used within the statistical program R. In contrast to the ML approach, a prior distribution of the part worth utilities had to be formulated. Rossi’s normal distribution was used, as it makes the least assumptions about the distribution’s

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**Figure 2. Preferences of the Total Sample in Relative Importance**

![Figure 2. Preferences of the Total Sample in Relative Importance](image-url)
parameter. The resulting Monte Carlo Simulation has been executed 10,000 times. In order to exclude fluctuating calculation from the burn in phase at the beginning, the mean of the last 5,000 calculations has been used as the individual part worth utility. By using standardization, relative importance for each respondent could be calculated from individual part worth utilities. As this paper concentrates on the preference heterogeneity between different groups of Cloud customers, the following results are all related to cluster specific preferences.

**Influencing Factors**

Of interest within this study was the question whether any demographic factors have a predominant influence on customers’ preferences. An analysis of variance was used with SPSS in order to identify any relationship between demographic factors and individual preferences. If a significant influence was found, an a-posteriori clustering was conducted in order to group the respondents based on the demographic factor. Then a ML conjoint analysis was used in order to illustrate the different cluster preferences.

Considering the use of services on different Cloud layers, using SaaS services has a significant influence on a 5% significance level on the individual preference of the sample. Interestingly SaaS users differ significantly in their preference for tariff choice. As the non SaaS users in average prefer a flat rate tariff, SaaS users go for the pay per use model. Furthermore, these respondents are slightly more cost sensitive and have a higher preference for standard electronic customer support. However, it is important to consider that current users of SaaS are early adopters within the emerging field of Cloud Computing. This circumstance may explain why current users are looking for flexible payment methods and cost advantages, as these are the most discussed promises within Cloud Computing. The results state that using PaaS has a significant influence on a 5% level on data formats, which is however not surprising as developing and deploying services are highly linked to programming languages. Therefore PaaS users prefer standard languages and data formats. Moreover a significant influence of job position to customer service preferences was found. C-level managers prefer individual personal support whereas employees and middle manager tend to prefer standard electronic support. A possible explanation is the additional expertise employees have within their work related field and therefore ask for less personal support.

Similar to the Hosting (2009) study, company size has no influence in this study and further demographic factors, such as IT application expenditures and industry type have no significant influence as well.

**Customer Segments**

Based on the estimated individual relative importance, a cluster analysis was conducted with SPSS in order to identify specific customer cluster. A Ward approach was used in combination with an Euclidean distance measure. The relative importance utilities are already standardized in a way which allows comparisons of different customers on the same scale, as requested by Backhaus et al. (2008). The distance measure was more suitable than direct similarity measures, as the absolute distance between the preferences are of interest instead of their development. In order to estimate the best number of clusters the test of Mojena was conducted, after the elbow criterion delivered no clear result. Using three clusters resulted in a Mojena value of 2.4, which was considered as a good result. Respondents were grouped based on their cluster membership and a ML conjoint analysis was conducted for each cluster. The reason is Backhaus et al. (2008) recommendation of conducting a new conjoint analysis based on all respondents per cluster instead of aggregating individual analysis. This leads to more differentiation of part worth utilities and a better interpretation of the resulting values.

23% of the respondents are considered to belong to cluster 1, 42% of respondents to cluster 2 and 35% to cluster 3. The quality of the clustering was approved by conducting an analysis of variance which revealed a highly significant relationship between cluster membership and individual preferences on a 0.1% significance level. Table 3 shows the resulting cluster specific relative importance and Figure 3 illustrates them. Interestingly, there are no differences in the relative importance of provider’s reputation for all three clusters. However, the remaining attribute preferences reveal the heterogeneity of the respondents.

Within *cluster 1*, all attributes are pretty balanced, however the economic factors are slightly considered as more important. The customers within this cluster are focusing on their costs (20% relative importance) and prefer the flexible pricing tariff pay per use (20%). This is the typical kind of flexible, cost cutting customer most researcher as Vaquero et al. (2009) have in mind, if they think of potential customers for Cloud Computing.
Cluster 2 includes a more traditional customer. Cost cutting is the second most important issue with 23% relative importance and may be the reason for considering Cloud services at all. Because in contrast to other respondents, these potential customers would prefer a one-time purchase and are therefore less afraid of provider lock-in. As a consequence they are the least sensitive for data formats with only 4% relative importance. However, they are afraid of the complexity of the new technology, as they ask for no required training skills. This attribute is ranked higher compared to the two other clusters. If customers then need assistance, they prefer an individual service support.
a person they can directly talk to. They evaluate this service support in the case of an emergency as most important (24%).

Cluster 3 includes respondents who do not care about cost savings (2%), but ask for a service which just runs and is priced with predictable costs. Therefore the flat rate tariff is preferred the most with 38% relative importance followed by a one-time purchase approach with 26%. Besides standard electronic support, these respondents do not appreciate further assistance and do not care about training requirements. However they do mind the lock-in effect, as the use of standard data format was ranked as the second most important attribute (28%). A possible explanation is their dependency on a running IT service and the willingness to change service providers quickly, in the case of any system complications.

Tariff Bias

Customer clusters especially differ in their preference for different pricing tariffs. In order to further understand these preferences, tariff bias research has been considered. The approach is based in most parts on Lambrecht and Skiera (2006), who observed respondent’s tariff choice in a survey. In order to provide an explanation for the cause of occurring tariff biases, a multi item scale was used. Respondents rated their agreement on effect specific statements on a Likert scale of 1 (strongly disagree) to 5 (strongly agree). The effects included the insurance, taximeter, convenience and flexibility effect.

The existence of tariff bias within this study is modeled on the basis of the conjoint analysis. The choice sets included a clear statement of cost reduction, independent on usage or price. Three alternatives have been included in the attribute of pricing tariff: pay per use, flat rate and a one-time purchase. As the cost situation is already predefined, respondents should be indifferent between the different tariff options. If the conjoint analysis provides clear preferences on an individual level, they can only be explained by an existing bias. The importance of the bias is then calculated on the ratio between respondents with bias to the total population. There are no measures of dimension or value within this analysis, as the conjoint analysis hasn’t included any specific prices and respondents’ surpluses are unknown as well.

Our results show an existence of tariff bias within the Cloud Computing industry. Considering the importance, 48% of respondents have a bias for flat rates and 28% of respondents a bias for pay per use. Therefore, these results are very similar to Schulze and Gedenk (2005), who observed similar web services of online newspaper. However, the results differ from earlier studies within telecommunications (e.g. Kridel et al., 1993) which found predominantly flat rate tariffs. The pay per use bias can be explained by the flexibility effect. The conducted regression analysis shows a significant relationship between the evaluation of flexibility and the preference for pay per use. This relationship was verified with a t-test on a 10% significance level. This result is consistent with the conclusion of Schulze and Gedenk (2005). Some Cloud customers seem to appreciate the flexible adjustment of their bill on their actual usage – even if they have to pay more this way. Moreover the insurance effect has a significant influence on a 10% level on the flat rate bias, which is consistent with previous studies within telecommunications. Cloud customers as customers of telecommunications services enjoy the safety of not having variations in their monthly bill. Taximeter and convenience effects have no influence on tariff biases within this study. For the convenience effect, this result is not surprising, as there is only little evidence of an influence of this effect in previous studies. However, taximeter effects have often been mentioned in relationship with flat rate tariffs. It could either be that customers are not as sensitive for rising costs during usage of Cloud services, or customers just have no experience in that kind of pricing of IT services.

Possibilities for Price Discrimination

These cluster specific preferences show a strong heterogeneity of customer preferences for Cloud services. Therefore the premises for price discrimination are given. As mentioned by Varian (2003), versioning is one possibility of second degree price discrimination. This approach seems to suit well the results, as customers’ preferences cannot be observed directly, but the resulting customer cluster types give a good idea how preferences are distributed within the market. Similar to information goods (Chen and Seshadri, 2007), provider can relatively

10 For further definition of different effects please refer Lambrecht and Skiera (2006) or Schulze and Gedenk (2005).
11 See Lambrecht and Skiera (2006) for a more detailed overview.
easy and inexpensive differ Cloud service attributes and quality by changing attribute characteristics and offer several versions of their service. As a consequence, discrimination based on self selection should work quite well within the Cloud industry. Based on the defined clusters, there are three ideal services shown in Table 4 which can be offered within the market:

<table>
<thead>
<tr>
<th>Table 4. Ideal Cloud Services</th>
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<tbody>
<tr>
<td><strong>Cluster 1</strong></td>
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<tr>
<td>Reputation</td>
</tr>
<tr>
<td>Required Skills</td>
</tr>
<tr>
<td>Migration Process</td>
</tr>
<tr>
<td>Pricing Tariff</td>
</tr>
<tr>
<td>Costs Comparison</td>
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<tr>
<td>Customer Support</td>
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</tbody>
</table>

Although the preferences are quite heterogeneous, the resulting ideal services are quite similar for some attributes. All clusters prefer a high reputation of the provider and as cluster 3 customers are as good as indifferent towards previous training requirements, an easy usable service would fit all clusters. Besides, all clusters would prefer standard data formats and the most possible cost reduction. However, there are differences concerning the pricing tariff and the level of customer support. Each cluster prefers different pricing tariffs and only cluster 3 prefers individual personal customer support the most. Therefore, offering a core service with the previous mentioned similar attributes and adding the possibility to modularize the most preferred pricing tariff on top is a promising service portfolio strategy in order to face the heterogeneous market. Moreover, a basic customer support can be included with standard electronic sources like frequently asked questions, documentation or forums. For a more personal support, like on telephone or personal visit, an extra fee can be charged. This way, support sensitive customers can be charged additionally, while still satisfying the basic demand for customer support for the remaining customers. This idea suits well Varian et al.’s (2004) approach of mass customization, where customers build up their individual service according to their preferences and pay respectively. Especially IT services offer possibilities to individualize services with less complexity than with traditional products. The results of this study conclude that customers should have the possibility to shape their own Cloud service with a core service and additionally choose pricing tariffs and customer support based on their individual preference and be priced accordingly.

**Conclusion**

Cloud Computing is getting more and more attention from practitioners and researchers. Current research work focuses more on definitions and technical challenges (Armbrust et al., 2009; Vaquero et al., 2009; or Youseff et al., 2008). Customer preferences have hardly been analyzed. The goal of this paper is to identify customers’ preferences for cloud services, in particular Software as a Service (SaaS) in Singapore and to show heterogeneity between different groups of customers. Furthermore, the paper intends to show the influence of preferences on pricing of Cloud services, specifically on preferred pricing models and the existence of tariff biases within Cloud Computing. Examining the results, versioning as a method of second degree price discrimination seems to be most suitable for Cloud services from a provider’s perspective.

Based on a choice based conjoint analysis, respondents’ preferences for Cloud service attributes are estimated. This approach allows in contrast to previous industry studies the consideration of relative instead of absolute importance levels and draws a more diverse picture. The results show that on average reputation of the Cloud provider and the use of standard data formats are more important than economic considerations such as costs reduction or tariff
choice. After conducting a cluster analysis, the preference heterogeneity of customers is revealed. The study finds three different kinds of customers with specific needs - differing especially in their preference for different pricing tariffs. This circumstance offers opportunities of second degree price discrimination as several Cloud service versions can be offered and customers self select themselves based on their willingness to pay. The results suggest offering a core service which uses standard data formats, is easy to use and provides standard customer service. Customers should be able to choose a tariff and a higher level of customer service based on their individual preferences. This approach follows the idea of mass customization in information technology, which was discussed by Varian et al. (2004).

Besides, the influence of demographic factors on customers’ preferences has been observed within this study. Differences occur between users and non users of Software as a Service. While current users appreciate flexible tariff models and cost reduction, it is possible that the differences occur because of the fact that current users are early innovators and are focusing on proposed benefits of Cloud Computing. Other influences from demographic factors, such as company size or industry type, are not observed. Hence, third degree price discrimination on the observed factors within this study seems to be unreasonable. However, the study included a small selection of demographic factors and further research may identify more possibilities.

The study further shows existence of tariff bias for Cloud services. About half of the respondents showed a flat rate bias, whereas still about one out of four has a pay per use tariff bias. The insurance effect has significant influence on the flat rate bias and flexibility effects on the pay per use bias. Therefore, the results show similarities to previous studies in telecommunications (cf. Lambrecht and Skiera, 2006).

Practitioners can gain an insight from this study into Cloud Computing from a customer perspective and get an idea of customer preferences for Cloud services (e.g. reputation and standard data formats more important than cost reduction). They can learn how customer preferences interact with their pricing model and how the services have to be designed in order to attract more customers. Whether service providers use pricing only for increasing their revenue or controlling congestion, they should always take customer preferences and biases into account.

The past development was mainly technology-driven. Providers built their economic models based on the technical feasibility. Due to an increasing competition on the Cloud Computing market, in future, providers have to shape their services according to customer preferences in order to strengthen their competitive advantage. Providers with a sufficient amount of customers can use the methodology described in this paper to compare their customers’ preferences and the customer segments they are serving. Based on this information they can adapt their service portfolio, if required.

There are several new fields for promising future research. First of all, this study showed customer heterogeneity and possibilities of price discrimination. However, the study does not provide any insight on how these different preferences result in different willingness to pay. Future research may therefore estimate individual willingness to pay. Breidert (2006) provides an overview of possible approaches. The results would allow a further cost benefit analysis of introducing versioning into Cloud Computing. Besides versioning, price discrimination based on time and quantity seem to be promising in Cloud Computing and are already applied in practice. However, the customer preferences concerning these factors are blurry. A thorough analysis on, e.g. advance reservation, may help providers to precisely design their pricing models.

References


12 E.g. RenderRocket (http://www.renderrocket.com/)
Track I: Gateway to the Future


