

## Research Report

# Pricing the Cloud – A User Perspective

CLOUD COMPUTING PROMISES ENHANCED FLEXIBILITY AND SUBSTANTIAL ECONOMIC BENEFITS THROUGH THE ON-DEMAND LEASE OF IT RESOURCES. THESE TWO ASPECTS ARE STRONGLY INFLUENCED BY THE PRICING OF CLOUD RESOURCES. BASED ON A SAMPLE OF 48 INFRASTRUCTURE PROVIDERS, WE EXAMINE CURRENT PRICING SCHEMES IN THE CLOUD MARKET FROM A USER PERSPECTIVE.

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### Introduction

Information collection, processing, and dissemination – in various forms – constitute the foundation of most business activities in the financial services industry (Berger, 2003). Hence, this sector has been among the most intensive users of information technology for many decades. Nowadays, information technology is among the top cost factors in the financial services domain, and has been estimated to account for about 15 to 20% of a bank's overall administrative expenses (Moormann and Schmidt, 2007). A major driver of IT costs is the need of a continual overprovision of capacities, such that peaks in resource demand can be met by corresponding supply. In a competitive environment, such as the financial services domain, the reduction of such costs is a constant aim.

Cloud computing promises to alleviate the problem of resource overprovisioning; it allows users to flexibly lease resources – such as virtual machines (VMs) or storage – whenever the need arises. Hence, capital expenditures can be transformed into operational expenditures, rendering the use of information technology more flexible and economically efficient. Naturally, a main feature that determines flexibility and the resulting economic benefits of cloud computing is pricing. Traditionally, cloud computing has been associated with a pay-per-use (or pay-as-you-go) pricing scheme, which permits the short-term lease of resources whenever they are required (Mell and Grance, 2011). In recent years, however, different schemes, such as subscriptions and auctions, have also been introduced. They promise additional cost savings, but also

require a more precise forecasting of future demands. Furthermore, commitment periods constitute an implicit minimum on prices, since resources will always be billed for a certain discrete period (for example, one hour), regardless whether they have been used during that period or not. Hence, they are also referred to as minimum billing periods. In our work, we aimed to empirically examine these two aspects – pricing schemes and commitment periods – from a user stand-point, based on a comprehensive study in the cloud computing market.

### Methodology

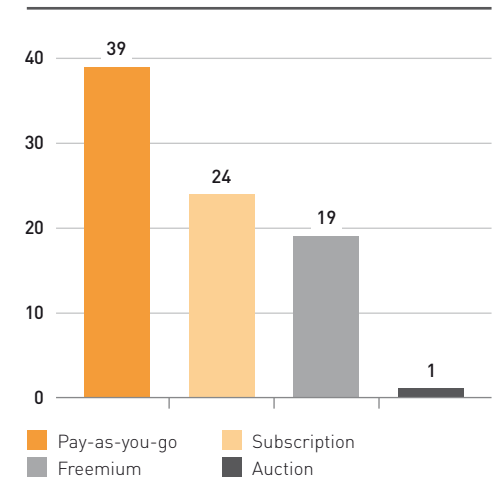
In our study, we focused on the *Infrastructure as a Service* (IaaS) market, since it exhibits a relatively high degree of homogeneity with respect to the available types of resources and comparatively little lock-in effects. Our focus was not on the actual prices for specific resource types, but on the pricing schemes and commitment periods that are applied. For the study, we initially determined a set of 48 different IaaS providers using Google, based on common search terms such as “cloud”, “cloud computing”, “IaaS”, and “provider”. For each provider, we identified and stored any artifacts that contained statements on pricing, such as Web pages or terms of service.

It should be noted that our study focused on publicly available pricing information; hence, providers may offer different pricing schemes as part of bilateral negotiations with (major) customers. Since our sample includes a large number of providers – both major players and small- and medium-sized companies – we believe that it constitutes a representative picture of the IaaS

market. Nevertheless, limitations may arise from our previously described search procedure: First, Google's index may be incomplete, i.e., certain providers may not be (prominently) listed. Second, our search terms may be inadequate to identify all providers of interest.

### Summary of Findings

Figure 1 shows the *pricing mechanisms* that were found among the considered providers. As can be seen, pay-as-you-go pricing is the dominant scheme and used by essentially all providers in our sample. However, subscription and freemium models are also widely applied, usually as a complement to pay-as-you-go pricing. The first commonly requires the payment of a certain up-front fee, which subsequently permits to lease resources at a reduced rate – compared to a pay-as-you-go price – over



**Figure 1: Applied pricing mechanisms among the considered IaaS providers (sample size n = 48; multiple options may apply for a single provider)**

a certain period of time. With the second pricing scheme, providers usually offer a free version with limited functionality and charge for an enhanced version. A prominent example for the combination of multiple pricing schemes is Amazon Web Services' Elastic Compute Cloud, which offers a freemium-style *Free Tier*, pay-as-you-go *On-Demand Instances*, subscription-based *Reserved Instances*, and auction-based *Spot Instances*. Interestingly, Amazon is also the only provider in our sample to apply an interactive pricing scheme, i.e., auctioning.

Figure 2 depicts the results of our study with respect to *commitment periods*. As can be seen, in conjunction with a pay-as-you-go pricing scheme, most IaaS providers seem to follow the example of Amazon Web Services, arguably one of the pioneers in the cloud mar-

ket, which uses a one-hour commitment period for its On-Demand Instances. However, a small number of providers also offer more fine-granular commitment periods in the order of magnitude of minutes or even seconds. Such shorter periods may be advantageous to users when resources are only leased for very brief time periods, e.g., in order to handle burst loads. In contrast, many providers also use longer commitment periods in the order of magnitude of months or years, mostly in conjunction with subscription models. As the previously mentioned example of Amazon Web Services' Reserved Instances demonstrates, such models may be advantageous to a user if he/she continuously requires and actually exploits resources. However, it also contradicts the initially stated notion of high elasticity that is commonly associated with cloud computing

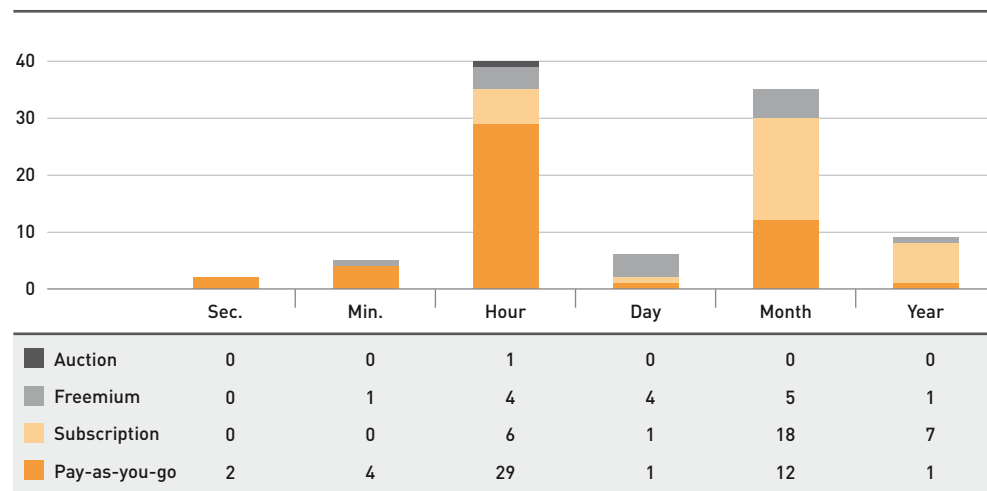


Figure 2: Minimum commitment periods by order of magnitude across all pricing mechanisms among the considered IaaS providers (sample size n = 48; multiple options may apply for a single provider)

(Mell and Grance, 2011), because costs will accrue even if instances are *not* actively used by the consumer.

**Discussion and Conclusion**

In summary, our study shows that pay-as-you-go and subscription models are the pre-dominant pricing scheme in the IaaS market today. Thus, the empirical evidence largely supports the literature view, which commonly associates cloud computing with pay-as-you-go pricing. In contrast, market-oriented pricing schemes – such as auctions –, which have been a prominent field of research in recent years, play a negligible role. This indicates that users prefer the guaranteed resource availability of pay-as-you-go or subscription pricing models over the potential cost savings of interactive pricing models – a notion which is also supported by past research (Agmon Ben-Yehuda et al., 2011).

In any case, due to the prevalence of commitment periods – most commonly in the order of magnitude of hours with pay-as-you-go models and months for subscription-based models –, pricing does not scale perfectly linear with the actual resource usage. This limits the flexibility of cloud computing in situations where resources are required only for very brief periods of time, e.g., to handle load bursts. Nevertheless, cloud computing may offer substantial economic benefits compared to on-premise IT and traditional outsourcing. Both models usually require a long-term commitment in the order of magnitude of years – either in the form of capital expenditures for hard- and software or constant operational

fees –, which is commonly not required in the cloud computing market.

It should be acknowledged, however, that factors other than pricing also play a crucial role, specifically for users in the financial services sector. These factors include, most notably, non-functional requirements such as availability and security of IT resources. Hence, despite its potential economic benefits, cloud computing will likely remain a complement, rather than substitute for traditional IT in years to come.

**References**

**Agmon Ben-Yehuda, O.; Ben-Yehuda, M.; Schuster, A.; Tsafirir, D.:** Deconstructing Amazon EC2 Spot Instance Pricing. In: Proceedings of the 3<sup>rd</sup> IEEE International Conference on Cloud Computing Technology and Science, Athens, Greece, 2011.

**Berger, A.:** The Economic Effects of Technological Progress: Evidence from the Banking Industry. In: Journal of Money, Credit, and Banking, 35 (2003) 2, pp. 141-176.

**Mell, P.; Grance, T.:** The NIST Definition of Cloud Computing. Available online at <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>, 2011.

**Moormann, J.; Schmidt, G.:** IT in der Finanzbranche. Springer-Verlag, Berlin/Heidelberg, 2007.