

Evolving Cloud Ecosystems: Risk, Competition and Regulation

Anastassios GENTZOGLANIS (*)

University of Sherbrooke, Quebec, Canada

Abstract: Cloud ecosystems are evolving rapidly in the midst of competitive, regulatory and technological uncertainties. The business opportunities cloud computing (CC) is creating are the driving forces behind its acceleration. At present, traditional IT, cloud and hybrid ecosystems vie for market shares and market dominance. The intensity of competition and the absence of regulation in the new markets that cloud computing has created explains the emergence of new platforms and the pre-emptive strategies used by major CC companies. Regulation or the absence of it, security and privacy are the most important factors that hinder the full development of CC industry. The emergence of hybrid ecosystems is viewed as a reply to these problems. The latest research shows that the regulatory differences between the US and the European Union with respect to the CC industry, may explain the current gap that exists in the level of innovation between these countries. Unless the governments and regulatory authorities address the issues of regulation and security at both national and international levels, the orderly growth of this industry is at risk. It is argued that a kind of "producer-consumer protection regulation" is more appropriate for the CC industry.

Key words: competition, cloud capacity, cloud utility, distributed computing, hybrid ecosystems, multi-cloud, regulation, risk, traditional IT platform.

Cloud computing (CC) is growing very fast opening a number of new business opportunities and creating new challenges. Although CC is not entirely new or singular technology, its evolutionary path has accelerated recently essentially because of the widespread deployment of broadband technologies. The Software & Information Industry Association (SIIA, 2011), the principal trade association of the software and digital information content industries, defines CC as an "evolving mechanism for IT consumption and delivery, provisioning a wide variety of computing services from remote locations" (*Ibid*, p. 3). The CC technology has been known for a long time and relied upon by a number of users but the recent developments in online searching and advertising and the release of an

(*) I would like to thank three anonymous referees for helpful comments and suggestions. Any remaining errors are of course mine.

increasing number of new fixed and mobile applications for businesses and individuals made the CC a promising venue for making profits from B2B and B2C markets.

Virtualized access, use and management of the information and communications technology is now possible by means of CC. Users access and utilize the ICT resources via the Internet without using their own proprietary hardware and software. CC allows users to get hardware and software access as a service. Cloud providers may offer these services directly to consumers, to organizations and companies or they may use the infrastructure of other cloud providers who possess storage, computer and data processing capacity. The main elements of cloud computing are Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). CC providers may be vertically integrated firms (Amazon, Google, Microsoft, Orange, etc.) offering the full gamut of services (IaaS, PaaS, SaaS) or specialized entities offering either Pass (Appistry, Flexiscale, gCloud3, etc.), SaaS, (Cloud9 Analytics, Cumulux, NetSuite, etc.), or IaaS, (Enomaly, Eucalyptus, Rackspace, etc.).

CC introduces new business and operational models by enabling companies and organizations to make a more efficient allocation of their scarce resources, particularly computing. The new business framework that is developed around "IT as a service" provides new possibilities for firms and organizations to become tenants instead of owners of hardware and software, freeing thereby funds for use in alternative, high return projects. CC is challenging the business as the usual model by introducing technological and organizational novelties (for some they are viewed as disruptions) that impact on conventional architectures and long-established business designs. CC alters the way businesses are conducted within the organization and its relations with the clients, providers, workers, and the general public. CC changes a firm's production and distribution channels, its processes for buying raw materials or for bidding for new contracts and its policies concerning security, procurement and provisioning. It further affects its funding policies and finance models as well as the traditional agreements with respect to service and service response levels (service level agreements, SLAs).

As with any other novelty - technological, organizational or social - there are risks and opportunities. The risks associated with CC concern all aspects of businesses of a firm or organization but KPMG (2011) identifies primarily three areas of risk, all of them pertaining to data protection and security, like data leakage, data loss of control and data unauthorized

access. These risks are very important for certain firms (for instance, banking and brokerage firms) and for certain lines of businesses, like the sale and purchase of certain financial products on Stock Exchanges. These risks may have either a positive or a negative impact on the pace of innovation in technology and services and on the pace of adoption of/migration to CC. For instance, the risks may impact positively on innovation in technologies and services, particularly when customers are less willing to migrate to CC platforms for security reasons. CC suppliers would then invest more in R&D and innovation (technological and/or service) in order to make their platforms security-proof and convince CC adopters to jump on the CC bandwagon. Nonetheless, the acceleration of R&D and encryption innovations that make safer the use of CC are not enough to incentivize firms to migrate to CC. Recent surveys and academic research (LERNER, 2012) shows that the absence of clear regulation in the CC industry is a disincentive to investment in this industry. In that sense, regulation, if properly designed, may be viewed as a means to achieve an orderly and safer evolution of the CC.

It is thus important that governments and regulatory agencies come to grips with the issues of security that CC raises. Although this is officially recognized by many governments and regulatory agencies, little is done to fill the institutional and regulatory gap that exists in this industry. Regulation is not simply important in dealing with the issues of security and privacy. Regulation can also be appropriate in cases of market power and anti-competitive conduct. The current wave of M&A in the CC industry consolidates the market position of major players and raises their market power. Yet, the CC market is rather young and growing fast alluding to the possibility that this market is contestable. Should the CC industry be regulated on the ground that the actual and potential customers would face a CC industry structure similar to the credit card industry with the potential of abuse of monopoly power on the part of CC providers? Are the contestability arguments strong enough to warrant no regulation? If not, what type of regulation should be designed and applied to this industry.

Because of space limitations, this paper focuses on the current and future industry structure of CC and the implications it would have on the level of competition and the strategies that firms adopt to strengthen their (anti)competitive position. Traditional theoretical arguments associated with the advantages for being first- or second-mover may be used to explain the race among CC providers to get important market shares at the expense of their competitors. The technological and market characteristics, economies of scale, scope and density, may be used to explain the sources of market

power among CC providers and the consideration for introducing regulation. Given the nature of CC industry, if regulation is applied at the national level only, its efficacy may be reduced. By contrast, if it is accompanied by cooperative agreements at both national and international levels, its efficacy is strengthened. It is argued in this paper that a type of "producer-consumer protection regulation" is essential for the orderly development of this new market. To the best of our knowledge, no other research deals with these issues in the CC industry.

The following section defines and presents the CC industry. It examines and analyzes the traditional and cloud ecosystems and compares their main characteristics. By using recent statistical data, it gives a picture of the global CC industry and its main characteristics. Its organizational structure, its level of competition and the characteristics of demand and supply of CC services are essential statistical data that allow a researcher to surmise on the concentration of this industry and its degree of competition. The conduct of individual firms depends on the main structural characteristics of the industry and this determines ultimate performance. The technical characteristics of new technologies, particularly the CC, may be attractive in terms of convenience, cost, and other characteristics but users may not be able to reap the benefits of these technologies if there is not enough competition among CC providers. The 3rd section analyzes the sources of market power and the potential abuse of it. It examines the strategies of CC firms to consolidate their market position and presents summary statistics on their merger activity. The 4th section analyzes and critically examines the arguments for introducing regulation in the industry. The last section concludes and offers policy recommendations.

■ Market characteristics of the global cloud computing industry

Before presenting the main market characteristics of the CC industry, it is important to define it. The definition helps to delineate its size and to get a better picture of its importance. CC is defined as the use of remote software and applications rather than the use of a proprietary in-house infrastructure and software. These services are offered via the web by highly specialized firms and allow users to have more free space over their own computers and to manage better their IT budgets. Given that CC services are priced on a pay as needed basis, users of CC could achieve lower costs and increase

their competitiveness. Investment in in-house infrastructure or software is thus avoided and the firms can use the funds they save for other core projects.

DUBEY & WAGLE (2007) and ARMBRUST *et al.* (2009) argue that firms using the CC can save important sums of money by avoiding investing upfront on hardware and software equipment. ETRO's (2009) macroeconomic model estimates the benefits arising from the use of CC in a number of EU countries and finds that CC has a large impact on the cost structure of all sizes of firms and particularly on small and medium size enterprises (SMEs). Additionally, CC has a positive impact on the creation of new firms, new products and the creation of jobs. For the whole EU-27, CC's contribution is about 0.2% and this implies the creation of a million new jobs and few hundred thousand new SMEs (ETRO, 2009, p. 3). LIEBENAU *et al.* (2012) argue that CC stimulates economic growth through the creation of jobs and increase in productivity. They examine the impact of CC on the aerospace and mobile services industries in the US, UK, Germany and Italy from 2010-2014. Their results show that, among the four countries, CC has greater effect in terms of employment in the US and UK (an increase from 19,500 in 2010 to 54,500 in 2014 for the US and from 900 to 4,040 for the UK for the same period). Briefly, CC contributes to the wealth creation by stimulating growth through the creation of a dynamic industry structure.

The World Economic Forum (WEF, 2010) has identified a number of industries which could benefit from CC (table 1).

Table 1 - Potential users of CC technologies

<i>Major sectors for potential use of cloud computing</i>	<i>Potential applications of cloud computing</i>
Education /Research	<ul style="list-style-type: none"> - Interactive / Collaborating learning - Access to global resources - Low cost simulations
Manufacturing	<ul style="list-style-type: none"> - Improved manufacturing processes - Supply chain coordination and increased speed for delivery - Integration of design and development of prototypes among subsidiaries and global collaborators
Healthcare	<ul style="list-style-type: none"> - Intensive and flexible use of computing power for medical research and drug discovery - Intensive use for health and insurance services - Telemedicine and real-time health monitoring

Source: WEF (2010, p. 3)

Recent studies (LERNER, 2012; T-Systems International, 2011) have identified a number of factors that may impede the full development of the

CC industry. For instance, privacy, security, lock-in effects, compliance and governance have been identified as the main impediments to the development of the CC industry. The potential for growth of CC is very high but if nothing is done either by the industry (self-regulation) or the government (light or heavy-handed regulation), this potential may be lost.

The CC industry is dominated by a few well-known international firms with headquarters mainly in the USA but some important players are in Europe and Asia. Amazon with its web services (AWS) competes with Microsoft and Google and the three of them compete with the traditional infrastructure makers such as AT&T, EMC, Hewlett-Packard, IBM, Oracle and Verizon. Other companies such as RightScale, GoGrid, Salesforce, NetSuite, RackSpace, and Enomaly from Canada, dominate the North America market. These companies face competition from other national companies with strong CC industry such as Germany, England, France, Israel (KPMG, 2011).

New emerging cloud ecosystems and trends

Three main market segments exist for this industry: software-as-a-service (SaaS), infrastructure-as-a-service (IaaS) and platform-as-a-service (PaaS).

In the SaaS model, applications are built specifically for network delivery. Users have access to them via the Internet. These applications may be provided to a specific company or a group of companies and can be deployed privately or publicly. Amazon Web Services is a good example of publicly available cloud services.

In the IaaS model, services such as CPU, storage and networking are made available over the Internet and this creates opportunities for cost savings in infrastructure.

In the PaaS model, a cloud-hosted environment is offered to develop, deploy and test cloud-SaaS applications. This service may be offered free of charge but the other two services have a fee according to the needs of the users.

Measured in terms of revenues, software-as-a-service (SaaS) segment is much larger than infrastructure-as-a-service (IaaS). In 2010, the SaaS accounted for 70% of the industry revenue and IaaS for 30%. Globally, the CC industry attained the \$12.1 billion cap in 2010 and it is growing quite fast.

It is expected to grow by 43% in 2011 but this growth rate would not be sustained in the foreseeable future. Estimates (FORBES, 2010) indicate that the year-on-year growth rate will be around 13% over the next five years. It is expected though that the share of IaaS will increase to 40% from its actual 30% share. Table 2 shows the size of the industry by 2015 and the share in revenues by category of users.

Table 2 - The size of the cloud computing industry measured by total revenue (year 2015)

<i>Users of CC</i>	<i>Percentage</i>	<i>Dollars (billion)</i>
Registered IT Partners	39%	\$14.0
Vendor-driven	36%	\$12.9
Communications service providers	23%	\$8.2
Managed service providers	2%	\$0.5
Total	100%	\$35.6

Source: author's compilations from various sources

It is clear from the table above that the size of the CC industry and its future growth are indeed quite significant. Given the potential for growth of CC industry, it is anticipated that it will attract new entrants in the future. Competition would be fierce and many M&A would follow before the industry settles down.

Recent studies (TUTINO, 2011) advance the argument according to which information management is a strategic variable. In the current context of increased competition information management becomes a strategic variable. Both large and SMEs may use external services such as the ones offered by the CC industry to manage some of their routine operations. By freeing time, managers can focus more on their core businesses. By choosing how much attention to devote to different subjects, firms' managers choose to maximize their productivity.

Not only is productivity increasing but also CC reduces risk. By deciding to use CC, firms avoid investing in infrastructure and software and the cost savings can be used to increase investment in the core business. CAPEX expenses are converted into OPEX and this has an important impact on fixed and variable costs of the firm. By reducing its operating leverage, the proportion of fixed costs relative to variable costs, the firm is able to reduce its risk too. This affects the firm's cost of capital (WACC) but also the way to calculate the return on investment and the appropriateness of the project by calculating its Net Present Value (NPV). However, cash flows are affected by the methods of pricing that are used in CC. The pay-as-you-go model used by the CC industry makes cash flows more volatile. Cash flows,

particularly after tax cash flows, are important determinants of a firm's future value and a measure of a firm's financial ability to stay afloat and pay its credit holders. The firm, by moving from a CAPEX to an OPEX model, has to switch its strategy and focus chiefly on the management of operational expenses rather than its balance sheet. This is a large shift in management and firm's strategies.

Further, a business cycle affects in an uneven fashion the users and the providers of CC. When the economy is in expansion the pay-as-you-go model would increase operating expenses for the users of CC and the revenues for the providers of CC. This boosts profits for the CC providers but the opposite is true when the economy is in contraction (coupling effect). The pay-as-you-go model penalizes them particularly when competition creates rigidities in prices. This creates a need to change the pay-as-you-go model and adopt a pricing strategy reminiscent to the one used by other industries which were using pricing mechanisms that made them vulnerable during the recent financial crisis. The new pricing model suggested by many that makes decoupling possible is the Straight Fixed Variable.

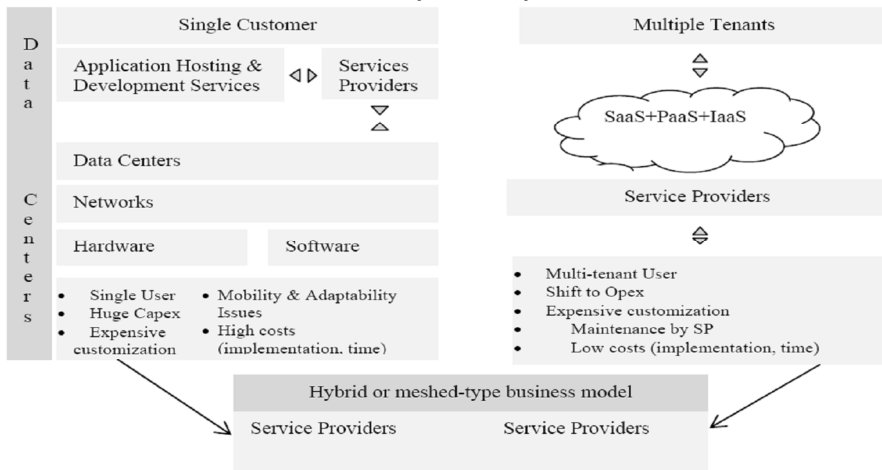
Comparisons of cloud ecosystems and their importance

The cloud ecosystem is characterized by its cost and strategic advantages and its simple industry structure. Indeed, the demand and supply aspects of the cloud seem *a priori* less complicated than in the traditional IT ecosystem for a number of reasons. First, in the cloud, suppliers or service providers interact with multi tenants or users of cloud services. The latter are offered on demand, thereby freeing users, be it consumers or business, from the need to invest in proprietary hardware and software to carry-on their businesses. In contrast, the traditional IT ecosystem is more appropriate for a single user and requires huge Capex and high implementation and maintenance costs. Customization, although possible, is highly expensive and once realized, limits adaptability and mobility. These lock-in effects raise important competition issues related to portability and mobility and the capacity of IT users to be flexible in the market place and stay competitive domestically and internationally.

Second, in the cloud ecosystem customization is much easier. Further, pecuniary costs, and also the costs in terms of time, are lower than the traditional IT ecosystem. Since customers are not the owners of the cloud ecosystem their Capex is reduced. This shift from Capex to Opex frees

investment funds and the latter can be invested in other business opportunities. The multiplicity of tenants makes cloud computing services a commodity for which competition among cloud providers is possible. There are business interactions among cloud providers and cloud tenants and since CC services are priced on a pay as needed basis, users of CC could achieve lower costs and strengthen their competitiveness. Investment in software or in-house infrastructure is reduced and in some cases entirely forgone. This provides extra funds for investment in other core projects. The figure below illustrates the main characteristics and compares the traditional IT, cloud and hybrid ecosystems.

Figure 1 - Main characteristics and comparisons of the traditional IT, cloud and hybrid ecosystems



Hybrid or meshed-type models become increasingly popular. They offer more advantages by combining traditional and CC ecosystems. Also, they provide more flexibility and offer a greater proximity to users' needs. Because of these characteristics, hybrid cloud has been adopted by 54% of the 171 respondents in a survey realized by FROST & SULLIVAN (2011, p. 11). The corresponding figures for public and private cloud are 12% and 34% respectively.

Hybrid cloud computing

Traditional dedicated hosting and cloud hosting ecosystems are the two extremes of the continuum. Hybrid ecosystems, i.e., platforms that combine both the traditional and the cloud ecosystems have also been developed to

satisfy the needs of some categories of clients. The hybrid ecosystem allows a seamless switch between platforms, the traditional and cloud, or the simultaneous use of both of them. If neither the traditional nor the cloud ecosystems are able to provide the full benefits they promise, the hybrid cloud ecosystem is considered as the best alternative particularly when special conditions apply.

For instance, BARKER (2010) notes that hybrid ecosystems are more suitable for clients who have specific requirements particularly the ones related to security and reliability of the system. Different computing needs and specific demands for different applications make hybrid models more appropriate. Dedicating (private) hosting has thus its appeal to firms with sensitive security and reliability policies. Some firms may consider their line of businesses too critical or sensitive and prefer proprietary (private) applications rather than cloud hosting (public). By contrast, firms that aim at promoting their products and services and using applications with variability in traffic and usage patterns may prefer scalable cloud platform. Thus, firms have the option to choose among various platforms. Hybrid platforms allow them to pass from one to the other seamlessly without extra cost and/or additional complexities.

Investment in traditional ecosystems allows firms to use in-house hardware, software and applications but these systems are usually designed to satisfy peak demand. If the latter occurs infrequently, their use implies high costs for the firm and relative cost inefficiencies. Thus the non-virtualization of in-house server implies extra, i.e., unnecessary costs. For firms that use their server only ten percent of the time according to recent statistics by vmware, (VMware, 2006, p. 6), the cost savings may be important. The use of a virtualized or cloud hosting server brings efficiencies by reducing costs and making the operations faster and more capable. Nonetheless, there are some costs associated with migration. Buying IT as a service and the use of web based environments and applications require the withdrawal or abandonment of legacy systems. Such a strategy is costly and may not be appropriate for some firms. A hybrid system may be cheaper and more suitable for some operations and applications.

All in all, CC providers promise to be the ultimate outsourcing solution to large and small corporations, organizations and governments. Not all of them have embraced CC migration equally though. For instance, a small percentage of small and medium sized enterprises (SMEs) uses CC, although most of them recognize the importance of migrating to the CC platform (table 3). The reasons evoked are chiefly their concern with respect

to data security (although their own in-house security standards are perhaps inferior to the ones currently used in the cloud).

Table 3 - Cloud adoption by size of business in the USA

Size	2010 (%)	2011(%)
Small	7	13
Medium	17	36
Large	22	45

Source: Rethinking the Outsourced Cloud, Part II: 2011 Benefits of Cloud Adoption, 2011

Large multinational corporations and government organizations have also a low CC utilization rate but their migration to the cloud is actually increasing quite fast. The expected revenues from such an explosion of the cloud make CC providers more innovative in terms of services offerings, "public education", and strategies to dominate the market. Many large corporations are investing heavily in cloud computing hoping to take advantage of being the first mover (technological leadership, pre-emption of assets, and buyer switching costs). These strategies give them the possibility to acquire more market power which would have an impact on competition and eventually this will call for regulation.

■ Economies of scale and natural monopoly in the cloud

Large CC companies acquire cloud-based technology solutions and buy out promising start-ups specialized in the development of virtualization and security technologies. There is a wave of mergers and acquisitions (M&A) in this industry and this trend is expected to continue as the industry becomes more mature via consolidation. Large corporations do not limit their buying activity to the acquisition of small start-ups but they buy other important and long-established technology firms. These deals aim at consolidating further their market position in emerging CC technologies. M&A are pre-emptive strategies that would allow the realization of the advantages of being the first in technological leadership and market position. A recent report by PwC (2010) summarizes the global top technology M&A among technological giants (table 4).

The present trend in M&A and the sheer potential of the CC market let us surmise that the current wave of M&A would continue and even intensify in the future. The "verticalization" of nascent industries or well-established

ones experiencing important technological and institutional changes is not a new phenomenon (for instance, telecommunications, electricity, railway industries).

Table 4 - Top M&A in the technology sector in 2010

<i>Acquirer</i>	<i>Acquired</i>	<i>Billions (in euros)</i>
Oracle Corp	Sun Microsystems	5.481
SAP AG	Sybase	5.595
Xerox Corp	Affiliated Computer Services	5.536
NEC Electronics Corp	Renesas Technology Corp	2.798
NTT	Dimension Data Holdings plc	2.457
Hewlett-Packard	3Com Corp	2.127
Hewlett-Packard	3PAR Inc	1.837
Hexagon AB	Intergraph Corp	1.687
Berkshire Partners, Advent and Bain Capital	Skillssoft plc	1.516
IBM	Netezza Corp	1.466

Source: PwC (2010).

<http://www.pwc.co.uk/eng/publications/technology-mergers-acquisitions-2011-video.html>

M&A (table 5) become inevitable as competition threatens the viability of some of them. For acquiring firms, vertical M&A is a rapid means to acquire technologies that would take years to develop internally. Also, M&A provide them the means to offer a full gamut of cloud services realizing important economies of scope. Further, horizontal M&A offer the possibility to acquiring firms to realize more economies of scale and economies of density.

Table 5 - M&A in the technology sector by region, 2010

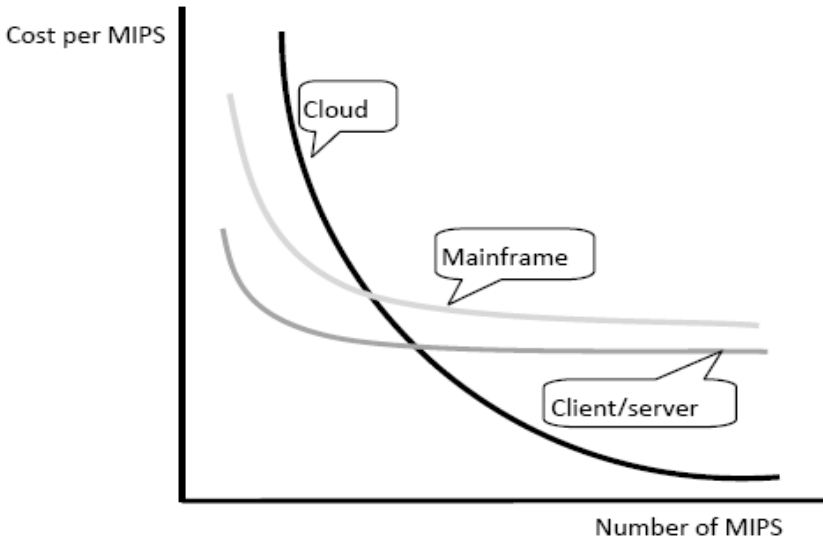
<i>Geographical Region</i>	<i>% of Global Deals</i>	<i>Value of the deals (billions of euros)</i>
North America	39%	n/a
Asia Pacific	28%	n/a
Europe	25%	n/a
Total		75.5 in 2010 (36.8 in 2009)

Source: author's compilations

As CC becomes more widespread and better understood and security issues are eased, more and more companies would migrate to CC to host their data and applications and use the virtual capacity of the cloud. M&A would increase as a strategy to increase profits in a lucrative and fast growing CC market. In the US, some CC firms are ready to pay multiples of EBITDA to acquire competitive firms and consolidate their positions. For

instance, Cincinnati Bell and Montagu Private Equity paid double digit EBITDA multiples for CyrusOne and Host Europe Group. The table above shows the percentage of global deals in CC for 2010. Again, North America dominates with 39% of the world total while the EU is lagging behind by 25%.

Figure 2 - Economies of scale in cloud computing industry



Source: Microsoft (2011)

Technological advances may either have a marginal or a significant impact on the shape of a firm's cost functions. In a recent study, Microsoft (2011) conceptualized the effect of each technology (cloud, mainframe, client/server) on a firm's average cost. Observing the graph above, it is obvious that the CC is a more pervasive technology than mainframe or client/server. Although the previous two technologies could attain the minimum efficient scale (MES) at a relative similar number of MIPS, the CC attains its MES at a much higher level. Size it does matter to achieve these economies of scale and density. Convincingly, the M&A strategy pays itself and offers the possibility to minimize the costs of merged CC firms.

Competition develops where profit opportunities exist and there are no barriers to entry. In CC industry the potential for profit is huge and current players are building preemptive strategies to keep actual and potential competition at bay. Such strategies may reduce the potential savings CC is supposed to bring to both business and retail customers. CC may exhibit

important economies of scale, density and scope and the latter confer natural monopoly advantages to CC providers. Economies of scale and scope are found at every layer of the CC industry, the SaaS, PaaS and IaaS.

Natural monopoly characteristics at the provider level bring about monopoly power. The latter may be used to discriminate against customers particularly the ones who lack important purchasing power, like SMEs. If the buyers are SMEs and large corporations alike, the monopoly may exercise its power and deprive SMEs the opportunity to get the same prices as their large counterparts. Thus, the economies of scale, density and scope at the upstream level may have a negative impact on the retail or downstream market. This makes competition among large and small firms more uneven and puts SMEs at a clear disadvantage. Only few start-ups may temporarily survive and the market for some services, particularly the on-line advertising and on-line gaming would be dominated first and foremost by large corporations. Price discrimination at the wholesale level would impact the level of competition at the retail level and this has a negative impact on social welfare.

In the CC industry the monopoly power stems from three distinct sources: a) bandwidth availability or resource scarcity; b) barriers to entry because of economies of scale, density and scope and; c) preemptive strategies used to control the CC platform.

Bandwidth availability or resource scarcity is a serious concern in the CC. Huge investments are required to ease the bottlenecks that the last mile has created. CC that has access to bandwidth may be in an advantageous position compared to the ones without it. Various regulatory models have been applied to overcome the difficulties and encourage investment in broadband (BB) in the telecommunications industry with some success (GENTZOGLANIS & ARAVANTINOS, 2010). Major telecommunication companies offer CC services and compete with new entrants, small and large, who may not possess or may not have full access to the competitors' network. Incumbents who control the last mile may get a monopoly power and appropriate regulatory policies may be needed to attenuate this problem. Bandwidth scarcity can, for example, limit the potential for full competition in the CC industry.

The second source of barriers to entry (economies of scale, density and scope) arises from the use of pre-emptive strategies by the incumbent CC firms. By investing in infrastructure major CC firms pre-empt the market and exclude from it the arrival of new entrants. It is thus important to monitor the

behavior of the incumbents, despite the beneficial effects (allocative efficiencies) that these strategies may provide.

The platform used to deliver the CC services is quite important and its control creates barriers to entry and market power. This is the third source of monopoly in CC industry. The incumbents in this industry may use the M&A strategies to get the control over the platform (including standards). Vertical and horizontal integration create a monopoly whose market power may be used at the expense of its clients. If portability is costly or inexistent, CC users become captive and an abuse of monopoly power may result.

In sum, CC industry is evolving quite fast. The emergence of various platforms to deliver digital content may impinge negatively on the choice customers have to get this content. CC providers may use a unique platform to host Apps/content and require Apps to be downloaded to users' devices using exclusively their platform. Such conduct distorts competition and reduces social welfare. As the CC industry evolves and consolidation via M&A intensifies, it would be possible for some incumbents to employ anticompetitive behavior and abuse their monopoly or quasi-monopoly position. In these circumstances, regulation plays its role (LAISE & WALDEN, 2012). But is it sufficient to introduce regulation based solely on this argument? If regulation is defined in a broader sense to include *ex-ante* and *ex-post* regulation, then the answer may be positive. The next section presents these arguments.

■ Regulating the cloud and its impact on innovation: EU vs. USA

It was argued above that technological and institutional aspects of the CC industry may call for regulation. In this paper, regulation is defined in a broader sense to include both *ex-ante*, i.e., competition law and *ex-post* regulation, i.e., cost-of-service and/or incentive regulation. Security and privacy issues can be dealt with a specific regulation that aims at offering what the market needs, credibility and safety. Credibility is an important ingredient for further development of CC industry. Migration to the cloud could only be realized if such regulation is put in place (figure 3 below).

It is thus important that governments and regulatory agencies come to grips with the issues of credibility and security that CC raises. Although this issue is recognized by many governments and regulatory agencies, little is

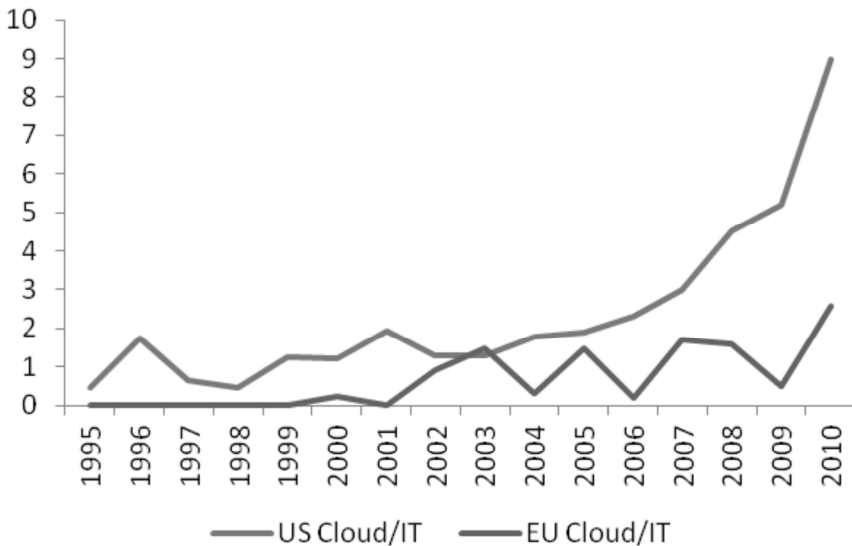
done to fill the institutional and regulatory gap that exists. For instance, the European Union's (EU) vice president for the Digital Agenda, KROES (2011) stated that:

"Freedom of expression, the protection of privacy and personal data, net neutrality and the preservation of an open internet - these and other issues are fundamentally public policy issues".

Self-regulation is not appropriate and heavy-handed regulation is viewed as a more compelling alternative. To quote Kroes again:

"Who will be liable if something goes wrong in the cloud and data is lost or compromised? Which rules and which jurisdiction will apply? These are not questions that 'codes of conduct' on their own can answer in a satisfactory way." (KROES, 2011).

Figure 3 - Ratio of investment in CC companies to investment in all IT companies: US vs. EU

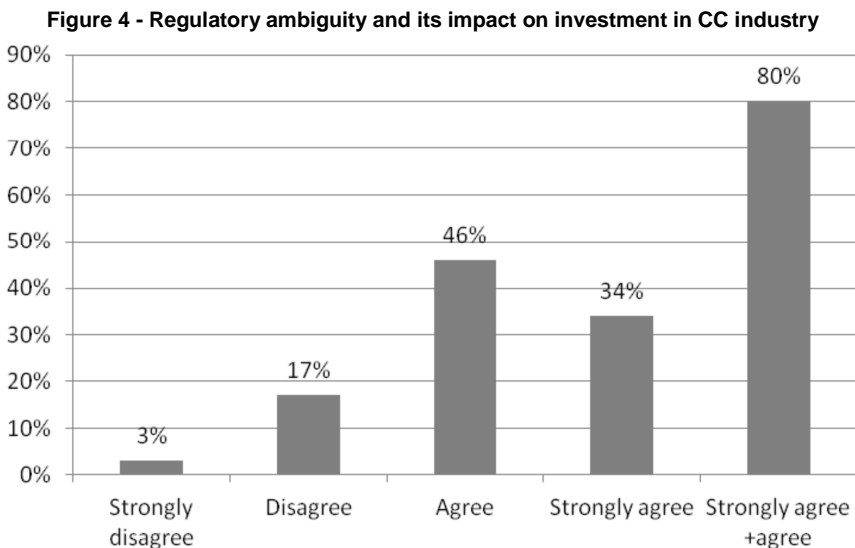


Source: LERNER (2012, p. 8)

Regulation seems to have an impact on investment in CC industry. For instance, LERNER (2012) in an empirical study examined the effects of changes in copyright policies on venture capital (VC) in CC industry in the USA and Europe. He demonstrates that regulatory differences between the two constituencies have had an impact on the level of innovation and development of this industry. More transparency and clearer legislation in the US, as it was streamlined by the "Second Circuit Court of Appeals'

August 2008 decision in *The Cartoon Network, et al. v. Cablevision*", compared to the EU, has led to an increase in investment in innovation in the US CC firms. Such incremental VC investment, ranged from \$728 million to approximately \$1.3 billion over the two-and-a-half years after the Cablevision decision. This is equivalent to \$2 to \$5 billion in traditional R&D investment. Such increases in R&D investment gave an advance of the US CC industry compared to the EU CC industry (figure 3). Thus, Lerner's empirical findings suggest that clear and more transparent regulation concerning the scope of copyright law as in the case of Cablevision can provide important incentives to venture capitalists. Under clear and stable regulatory environment investment in CC industry is stimulated and this further increases its level of innovation.

Figure 4 illustrates the effects of regulatory ambiguity on investment in innovations in CC industry.



Source: LERNER (2012).

A very small percentage of investors (3%) strongly disagree with the statement "I am uncomfortable investing in business models in which the framework is ambiguous". By contrast, 80% of them either agree or strongly agree with the statement. Investors are clear; they do not want to invest when the regulatory climate is uncertain or ambiguous. Although many agree that in most of the cases, *ex-post* regulation, i.e., competition law suffices to deal with market power issues in the CC industry, nonetheless,

there is a disagreement with respect to the introduction of *ex-ante* regulation in this industry. It is true that, *a priori*, *ex-ante* regulation is not a prerequisite for the CC industry. Prior to considering introducing it, serious studies, theoretical and empirical, should first verify whether there are natural monopoly characteristics in some segments of the CC industry. Natural monopoly confers undue market power to certain CC suppliers and possibly an abuse of their monopoly and/or their dominant position. In this case *ex-ante* regulation is a valid option and can be used to address these problems.

In the previous section, it was argued that there are good reasons to believe that there may be some economies of scale, density and scope in the CC industry. But even if they exist, it does not necessarily mean that there is market power. CC industry has good reasons to claim that this industry is a nascent one and there are still many challenges before it is considered as a grid, like electricity or water. At its current level of development, the CC industry cannot be viewed as a "utility" and thus *ex-ante* regulation is not required. The "computing as a utility" argument is not a reality yet. That is, the CC industry is not a grid. Therefore, regulation may not be necessary to contain the potential for abuse of market power or of dominance position of some large CC firms.

Currently the size of the CC market is small but its growth potential is quite high and this creates a lot of room for competition. Since the market growth is as high as the current statistics indicate, the potential for market dominance and/or abuse of market power are limited indeed. As the reliability, efficiency and security of the CC industry is getting better and potential customers perceive the benefits of virtualization of their ICT needs, then migration will continue but it will take some years before the market could become more mature and/or saturated. Abuse of monopoly power is usually observed in saturated markets and currently the CC industry is far from being saturated. Economic arguments do not justify *ex-ante* regulation of the CC industry like the one applied to telecommunications, electricity and water. Nonetheless, regulation for data security and privacy is more appropriate and urgent. Its design and application would contribute to an orderly development of this industry.

In cases of market dominance, incumbents use their position to reduce the choice of consumers by raising barriers to entry or making their products unique. Portability and switching are either technically impossible or economically costly and social welfare is reduced. Dynamic and static efficiencies may be sacrificed by this type of behavior and the allocative efficiencies arising from the sheer size of the dominant firm are not shared

with the customers. Prices are higher than marginal cost of production and consumers are worse off by this market structure. To take an example from the mobile telecom industry, Apple's conduct could be considered as abusive, in some respects, as it used to reduce the choice of consumers, albeit the choice offered by Apple itself was quite impressive.

It is too early to introduce an *ex-ante* regulation in the CC industry. Even later when the industry will be more mature, it may not need it either. It is better to adopt a "wait-and-see" approach rather than introducing such regulation too fast. Nonetheless, the CC industry urgently needs a producer-protection regulation which guarantees the security and reliability of the industry and provides incentives to users to migrate to the cloud. International agreements and the establishment of a supra-national regulator who will monitor and coordinate international (cross-border CC trade) and facilitate cooperation in case of fraud are essential to the creation of an environment that will provide incentives to virtualization of IT needs. This regulation protects the industry as well as its clients. This "producer-consumer protection regulation" i.e., the one that protects producers and users alike would stimulate investment and innovation.

■ Conclusions and policy recommendations

Cloud ecosystems are evolving rapidly in the midst of competitive, regulatory and technological uncertainties. The business opportunities cloud computing (CC) is creating are the driving forces behind its acceleration. At present, traditional IT, cloud and hybrid ecosystems vie for market shares and market dominance. The intensity of competition and the absence of regulation in the new markets that cloud computing has created explains the emergence of new platforms and the pre-emptive strategies used by major CC companies. Regulation or the absence of it, security and privacy are the most important factors that hinder the full development of CC industry.

The emergence of hybrid ecosystems is viewed as a reply to these problems. The latest research shows that the regulatory differences between the US and the European Union with respect to the CC industry, may explain the current gap that exists in the level of innovation between these countries. Unless the governments and regulatory authorities address the issues of regulation and security at both national and international levels, the orderly growth of this industry is at risk. It is thus more appropriate for the CC

industry to introduce a kind of "producer-consumer protection regulation" i.e., one that protects the producer while protecting the users. This regulation would stimulate investment and innovation.

References

- ARMBRUST, M.A., R. GRIFFITH, A. JOSEPH, R. KATZ, A. KONWINSKI, G. LEE, D. PATTERSON, A. RABKIN, I. STOICA & M. ZAHARIA (2009): "Above the Clouds: A Berkeley View of Cloud Computing", mimeo, UC Berkeley RAD Laboratory. <http://berkeleyclouds.blogspot.com/>
- BARKER, R. G. (2010): "Cloud Computing Online Search, and Advertising: Market Overview", Centre for Law and Economics, Working Paper No. 1, 29 July.
- Deloitte Development (2009): "Cloud computing", A collection of working papers (Unpublished).
- DUBEY, A. & WAGLE, D. (2007): "Delivering Software as a Service", *The McKinsey Quarterly*, May.
- ETRO, F. (2009): "The Economic Impact of Cloud Computing on Business Creation, Employment and Output in Europe", *Review of Business and Economic*, 1-24.
- FORBES (2010): *Analysys Mason, Cloud Computing Forecasts*, July. <http://newinnovationsguide.com/Cloud.html>
- FROST & SULLIVAN (2011): "Hybrid Clouds: Is it the future of Cloud Computing?" http://www.citictel-cpc.com/english/pdt/pdt_cloud/files/fns_hybrid_cloud.pdf
- GENTZOGLANIS, A. & E. ARAVANTINOS (2010): "Investment in Broadband Technologies and the Role of Regulation", in GENTZOGLANIS, A. & A. HENTEN (Eds), *Regulation and the Evolution of the Global Telecommunications Industry*, E. Elgar Publishing.
- KPMG (2011): "The Cloud Changing the Business Ecosystem". http://www.kpmg.com/IN/en/IssuesAndInsights/ThoughtLeadership/The_Cloud_Changing_the_Business_Ecosystem.pdf
- KROES, N. (2011): "Cloud Market Share: 2 Percent, But Growing". <http://www.datacentermanagement.com>
- LAÍSE DA CORREGGIO, L. & I. WALDEN (2012): "Competition in the Clouds: The role of competition law?" <http://ssrn.com/abstract=1840547>

LERNER, J. (2012): "The Impact of Copyright Policy Changes on Venture Capital Investment in Cloud Computing Companies".

[http://www.ccianet.org/CCIA/files/ccLibraryFiles/Filename/000000000559/Cablevision%20white%20paper%20\(11.01.11\).pdf](http://www.ccianet.org/CCIA/files/ccLibraryFiles/Filename/000000000559/Cablevision%20white%20paper%20(11.01.11).pdf)

LIEBENAU, J., P. KARRBERG, A. GROUS & D. CASTRO (2012): "Modelling the Cloud Employment effects in two exemplary sectors in The United States, the United Kingdom, Germany and Italy", *LSE-Enterprise*, January.

Microsoft (2011): Submission to the Australian Government Information Management Office In response to the *Cloud Computing Strategic Direction Paper*, Opportunities and applicability for use by the Australian Government, January.

PwC (2010): <http://www.pwc.co.uk/eng/publications/technology-mergers-acquisitions-2011-video.html>

Software and Information Industry Association (SIIA, 2011): "Defining Cloud Computing: attributes".

http://www.sia.com/index.php?option=com_content&view=article&id=794:defining-cloud-computing-attributes-and-benefits&catid=163:public-policy-articles

T-Systems International GmbH (2011): "White Paper Security in the cloud: Securely harnessing the benefits of cloud computing".

http://www.t-systems.de/tsip/servlet/contentblob/t-systems.de/en/143682_1/blobBinary/WhitePaper_Security-in-the-cloud-ps.pdf;jsessionid=C7EE014B957795C938986B64A68F9EBE?ts_layoutId=586836

TUTINO, A. (2011): "Rational Inattention Guides Overloaded Brains Helps Economists Understand Market Behavior", Federal Reserve Bank of Dallas, Vol. 6, No. 3. March.

Vmware (2006): *VMware White Paper, Reducing Server Total Cost of Ownership with VMware Virtualization Software*. <http://www.vmware.com/pdf/TCO.pdf>

WEF - World Economic Forum (2010): *Exploring the Future of Cloud Computing: Riding the Next Wave of Technology-Driven Transformation*.

<https://members.weforum.org/pdf/ip/itcc/Exploring-the-future-of-cloud-computing.pdf>