EVA^{TM} and the Cloud: An Integrated Approach to Modeling of Cloud Computing

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Abstract—**Cloud Computing (CC) has been on the rise. Its pervasiveness has tremendous effects on both CC users and CC providers as well as on governments. The latter purports to regulate the industry to increase its security and users' confidence. *Shannon's channel* and "rational inattention" may explain the remarkable rise of this industry. But the switch from a CAPEX to an OPEX model that CC entails has significant impacts on firm valuation and wealth creation. This shift in management strategy may increase risks and the latter have negative effects on firms' performance. The existing financial models cannot capture entirely these characteristics of the CC industry. New models are needed which take into account the CC business practices, particularly the SLA (service level agreements) and evaluate the impact of CC deployment on firms' performance. This paper presents the EVA financial model and applies it to the CC industry. It divides risks in various subcomponents and proposes new methods for their quantification. It is argued that the EVA model is better suited to analyze the CC industry than other competing financial models.**

Index Terms—**cloud computing, EVA financial analysis, new business models, pay-as-you-go principle, rational inattention.**

I. Introduction

Lately, cloud computing (CC) has been on the hype for a number of reasons. For the users, particularly business firms and other organizations, it is a new convenient platform to make business at lower costs. For the developers and vendors of these technologies, CC is a new strategy to increase market shares, strengthen financial might and develop strategies that make them less vulnerable to other innovations and emerging business models. For consumers, the benefits of CC are not clear-cut. The issues of security are looming large and may make them more reluctant to go shopping on-line but if the cost savings of the firms implementing CC are passed on to consumers (or at least part of them) the lower prices may incentivize them to buy more. For governments and regulatory agencies, CC raises a number of important policy questions as they are summarized by the European Union's (EU) vice president for the Digital Agenda, Neelie Kroes. To quote, "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"[1]. 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." [1]

Although 'codes of conduct' are not enough to provide answers to security and other policy concerns, the industry is growing quite fast without waiting the government to intervene and regulate it. Because of space limitations, this paper does not deal with all the above mentioned policy issues. Rather it focuses on the financial aspects of CC and the implications it has on firms' costs and strategies that may be adopted to strengthen their competitive position. Traditional theoretical arguments associated with the advantages for being first- or second-movers may be used to explain the race for CC but recent theoretical advances – "rational inattention"- arguments are more convincing than the traditional ones. But the fundamental question remains: does CC really bring the financial benefits that it promises? This paper addresses these issues.

The following section defines and presents the CC industry. 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 rip the benefits of these technologies if there is not enough competition among CC providers. Section 2.2 analyses the effects of CC on firms' investment costs and their financial position. Users, firms and other organizations use various financial models to evaluate the costs and benefits of their investments in physical infrastructure. CC frees investment funds that can be used by the users of CC in best alternative projects with higher returns. If the cost of building an in-house computing reserve or storing capacity is higher than the savings realized by avoiding investment in such capacity, from a financial point of view, CC is a good financial strategy. The paper concludes that CC adoption implies a shift in management strategy from CAPEX to OPEX and this may increase firms' risks rather than reducing. Other pricing mechanisms such as decupling may be used to break this relation.

II. Market Characteristics of the Global Cloud Computing Industry

A. Market Structure and Industry Perspectives

Before presenting the main market characteristics of the

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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.

Research from Dubey and Wagle [2] and Armbrust et al.[3] indicates that firms using the CC can save important sums of money by avoiding investing in up-front on hardware and software equipment. Simply spending on ICT according to their production necessities makes them more competitive. Etro [4] uses a macroeconomic model to estimate the benefits arising from the use of CC in a number of EU countries. His findings corroborate the theoretical assertions that CC has a large impact on the cost structure of all sizes of firms and particularly on small and medium size enterprises (SMEs). Furthermore, CC has a positive impact on the creation of new firms, new products and the creation of jobs. For the whole EU-27, Etro [4] estimates the contribution of CC to be in the order of 0.2% and this implies the creation of a million new jobs and few hundred thousand of new SMEs. Briefly, CC contributes to the wealth creation by stimulating growth through the creation of a dynamic industry structure.

The World Economic Forum [5] has identified a number of industries which could benefit from CC (Table 1).

TABLE I: EXAMPLES OF BENEFITS OF CLOUD COMPUTING

Short-term benefits	**Medium-term benefits**	**Long-term benefits**
Costs	Government efficiency	Innovation
IT flexibility	collaboration	Δ in R&D and S&T
Business efficiency	Productivity	GDP growth
new services and products	Quality in service	Competitiveness and new jobs
just-in time and better organizational structure	Business flexibility	Opportunities in education and e-learning

TABLE II: POTENTIAL USERS OF CLOUD COMPUTING

Major sectors for potential use of cloud computing	**Potential applications of cloud computing**
Education /Research	• Interactive / Collaborating learning • Access to global resources • Low cost simulations
Manufacturing	• Improved manufacturing processes • Supply chain coordination and increased speed for delivery • Integration of design and development of prototypes among subsidiaries and global collaborators
Healthcare	• 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

The number of potential users is usually used to make an estimation of the market potential. Table 2 indicates the industries and organizations that can potentially use CC. As it can be seen from this figure, CC is potentially quite pervasive.

Fig. 1 identifies the main impediments for the development of the CC industry. Although the potential for growth of CC is very high, if nothing is done either by the industry (self-regulation) or the government (light or heavy-handed regulation), this potential may be chocked by one or many impediments as they are identified by the WEF (2010) [6].

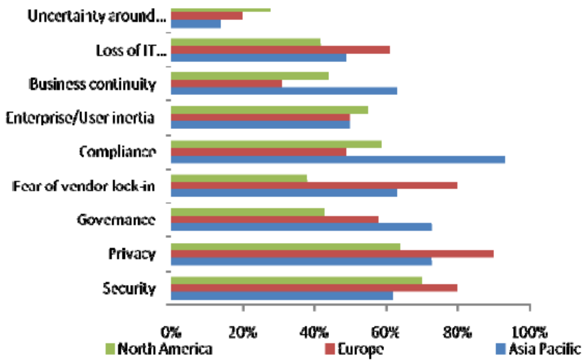

Fig. 1. Major Impediments for the Adoption of Cloud Computing by Region – Percentage (%) of Respondents who Rated "Very Serious"

The CC industry is dominated by few well-known international firms with headquarters in the USA. 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 [7], England, France, and Israel [8]. There are also a growing number of new start-ups around the world [9].

B. Financial Modeling of Cloud Computing

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 grows quite fast. It is expected to grow by 43% in 2011 but this growth rate would not be sustained in the foreseeable future. Estimates 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 3 shows the size of the industry by 2015 and the share in revenues by category of users.

TABLE III: THE SIZE OF THE CLOUD COMPUTING INDUSTRY MEASURED BY TOTAL REVENUE (YEAR 2015)

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

It is clear from table 3 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.

From a theoretical point of view, the CC industry developed as a consequence of the rapid increase in information and its importance for strategic decision-making processes in both large and SMEs. The new theory of "rational inattention" is quite powerful and it can be used to explain the growth of CC industry. In its simplest form, it states that humans have limited cognitive capacities which limit the ability to process all information available, the so-called Shannon's channel. This makes people more selective and forces them to make choices with respect to subjects to which they pay more or less attention. These limits known as "rational inattention" may force decision makers to use external services (cloud services) for some of their basic functionalities. Rational inattention theory has been used increasingly lately to explain many micro and macro-economic phenomena such as price and wage rigidity, unemployment and even interest rates and monetary policy [10]. 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 in software and the cost savings can be used to increase investment in core business. CAPEX expenses are converted into OPEX and this has an important impact on fixed and variable costs of the firm1. 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 is 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 firms by moving from a CAPEX to an OPEX model has to switch its strategy and focus most on the management of operational expenses rather than its balance sheet. This is a great shift in management and firm's strategies.

Further, a business cycle affects unequally 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 they 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 Variable2.

III. FINANCIAL MODELING OF CLOUD COMPUTING

A. The use of financial models and the cloud

CC is a new field and economists and financial analysts have not yet developed models specific to this field. The current shift from client/server to CC has ignited lively debates and speculation concerning the future role of CC in the IT industry and the emergence of an appropriate business model to this nascent industry. The IT specialists need to have a clear view of the long term trends of this industry but they lack the economic and financial tools to make such projections.

In the absence of better tools and/or because of time constraints to develop new ones, industry analysts increasingly rely on the current financial models to evaluate the prospects of this industry. The best method to evaluate the performance of firms in the CC industry is to use the economic and financial models that respect the characteristics and market conditions of this industry. Not all existing models are suitable though for this industry. Some specialists [7] have proposed the CAPM (Capital Asset Pricing Model) as the best one to use to calculate the cost of equity capital. Admittedly, this model has its own merits but it cannot evaluate whether the adoption of a strategy or of a project by the firms in the CC industry contributes to the creation of value for their shareholders. It is urgent therefore for financial analysts to study in more detail the main

[1] It is argued that the competition for cost reduction brings users of CC to a situation similar to prisoner's dilemma by which the non cooperative game leads to an inferior overall performance. As a result, the quality of service (QoS) offered to customers may be inferior under CC as compared to the service using proprietary software and infrastructure. If this is the case customer dissatisfaction would reduce cash flows and the wealth to stockholders (The Opengroup, 2011).

[2] It is beyond the scope of this paper to deal with this issue here. For more details on this approach see RRI, 2011.

characteristics of this industry and develop financial models which are more appropriate for this type of analysis. It is argued in this paper that, in the absence of a better model, the EVA financial model is much broader than the CAPM and it is better suited to analyze the CC industry.

Indeed, in finance a number of models are used to make an evaluation of various investment projects, their cash-flows and the performance of the industry. Thus, Monte Carlo models, ARIMA, Black and Scholes, the Gordon model, EVA (Economic Valued Added) [11]. CAPM and the WACC are frequently used. Depending on the focus of the analysis, one model may be judged more appropriate than the other. For instance, in the case of the determination of the risk and return of an investment project, the CAPM is considered to be the most suitable one. By the same token, in the case of the regulated utilities, the CAPM is also used to determine the cost of equity. Once the latter is determined using objective criteria, the regulatory authorities determine the allowed rate of return (the maximum level of return that companies could realize on new investments without fearing of penalties or other sanctions). In few jurisdictions, particularly in the US, the regulatory authorities may use the Gordon model or the constant dividend growth model to make such estimations.

As far as the CC industry is concerned, the ARIMA, MCM (Monte Carlo Methods) and/or BSM (Black and Scholes Models) are less suitable than the CAPM (Capital Asset Pricing Model) [12]. This is so because the CC industry is relatively more stable than the finance industry. The latter is quite volatile and subject to heavy speculation. More complex models are thus required to evaluate the soundness of the business strategies of firms in the financial industry. By contrast, the CC industry is a nascent one and as such, there are many start-ups, although well-established companies are increasingly entering this industry. Organizational sustainability [13] is an important matter of concern for these companies and the existing models are mainly qualitative and unable to make the quantitative estimations that these companies need for their projects. The CAPM provides the quantitative basis for a thorough analysis of all aspects of organizational sustainability by focusing on two key concepts; the risk and return.

Risk is a major component of return and one of the most important variables in the determination of the return of an investment. The use of accurate financial models capable of estimating and predicting, with as much precision as possible, the relevant risk of an investment and/or of another business decision is of paramount importance for the CC industry. Business sustainability may be threatened by wrong or inaccurate estimates of risk.

In the finance literature, risk is divided into two components. One part is called systematic risk and it cannot be reduced or eliminated by diversification or another risk-management method. It is the part of risk for which investors required a prime commensurate with risk. This part of risk is measured by the beta which is defined as the sensitivity of the return of an asset with respect to the variability of an economy-wide index like the Dow Jones Industrial average for the United States or the CAC for France). The other component of risk is the unsystematic one and it is specific to each asset. Given its specificity, it is possible to eliminate it via diversification and other risk-management techniques. Since managers are able to diversify away this part of risk, investors do not expect a compensation (prime) for it. Primes are viewed as deviations from the returns on riskless assets. It is essential therefore to define which assets are riskless and to calculate the average expected return of the market. By subtracting from the average market return the return of a riskless asset and multiplying it by the beta of the asset, it is possible to get the prime which is commensurable with the systematic risk of the asset.

In mathematical symbols, the CAPM formula is quite simple, although its detailed calculations are quite laborious and demanding, in terms of data requirements and other resources.

$$E(R_i) = R_f + [\beta * (E(R_M) - R_f))] \quad (1)$$

where $E(R_i)$ is the expected return of an asset or of an investment

R_f is the return of the risk-free asset

R_M is the average expected return on the stock market and

β is the beta of the asset or the sensitivity of returns of an asset with respect to the variability of returns of the market.

The use of CAPM allows the determination of the expected return of an asset but also the cost of this asset. Start-ups and established CC firms use both sources of funds to finance their investment projects; equity and debt. The use of CAPM allows the calculation of the cost of equity capital. If the average cost of debt capital is calculated (using various valuation methods), CC firms are able to calculate the WACC (Weighted Average Cost of Capital) which is the average marginal cost of the funds used to finance their investment projects.

To make data collection and quantification more tractable, particularly for CC firms, risks and returns are divided in various categories; technical, financial and business/commercial. This makes their identification and calculation easier both before and after the deployment of cloud solutions and/or services.

- **Technical**: returns on investment could be higher and risks lower because of technical improvements and better performance. Improvements in technologies and accumulated experience through learning by doing and/or laboratory or collaborative work lead to better performance. Using EVA™ (Economic Value Added) techniques, it is possible to quantify the data needed to make a thorough analysis of the CC firms' performance. EVA analysis utilizes financial data which are used to verify whether the investment decisions of the firms and/or any other strategy contributes to shareholders' wealth. Managers set targets either technical and/or financial and adopt strategies that contribute to the attainment of these targets within specific time limits. Deviations from the targets present an opportunity to revise the strategies and/or to develop new ones. EVA analysis in conjunction with the CAPM model are useful tools to evaluate the rewards CC stakeholders get from their investment in either SaaS, IaaS or PaaS segments of the market.
- **Financial**: risks and returns are financial/economic by nature. In any market transaction there are various risks

which may be high or low depending on a number of factors such as the creditworthiness of counterparties and economy-wide variables such as interest rates, inflation and general economic activity. In many cases, risks may arise from industry practices with respect to pricing of its products and services. In the CC industry SLA (Service Level Agreements) are traditionally used to sell its services/solutions to the clients. These are binding contracts between the vendor of CC solutions and its clients and they normally accompanied with clauses of minimum service, speed and security specifications and other similar clauses. Failure to abide to these clauses, severe penalties, either pecuniary or non pecuniary (loss of reputation), may be imposed. This affects negatively the cash-flows of the firm and its profitability. These results are reflected in the analysis when using EVA techniques and the financial performance of the firms. Projects that reduce the capacity of the firm to increase or at least maintain a steady flow of revenues over time contribute to making the EVA negative. Financial risk is increased the further a firm is with respect to its promises to deliver a certain quality of service. In the CC industry, *uptime* is a common metric, particularly for data services such as shared hosting, dedicated servers and virtual private servers. Common clauses are encountered in the SLAs such as percentage of network uptime, power uptime and the number of scheduled maintenance windows. If there is a 100% uptime guarantee with a CC firm's customers, the latter are assured that the service is available 24x7x365. Of course, there are costs associated with this type of service and these costs should be weighed against the potential benefits arising from this quality service. Both cost and benefits could be quantified to evaluate the cost of capital of the firm and ultimately the EVA.

- **Business/Commercial**: a CC firm may incur gains or losses when security and reliability are heavily weighted by its clients. In CC both issues are extremely important and firms that are able to increase in client/user confidence, through better or different technologies and hosted applications, particularly software programs such as SaaS and other scalable Managed Services options (such as Network Monitoring, Disaster Recovery and Remote Data Back-Up services) are getting ahead of competition with superior customer service and market shares. This better financial performance is also reflected in the EVA metrics and the cost of capital of the firm. The advantages of moving first in the competition race (*first-mover advantage*) [14] are well documented in the Industrial Organization (IO) literature. CC firms may get these advantages either in the technology or service race (SaaS, IaaS and PaaS). Quantitatively, these advantages are measured in terms of increased market shares and various models have been developed that deal with these issues. The end result depends on the type of competition and the game entrants and incumbents play. In the case of CC, the best model that can be used to describe the current and future structure of the industry and quantify the results of the competition race is the Stackelberg model. According to this model, the leader is not necessarily the largest firm in the industry. It may be either a start-up or an incumbent. As long as the firm is able to sense as closely as possible the current and growth path of the industry and introduce new and/or superior services and technologies, it is able to get higher market shares and higher profitability. In that case, NOPAT (Net Operating Profit After Taxes) in the EVA analysis increases and the latter has a positive effect on stakeholders' wealth. Because there is always the possibility that other firms may challenge the leader at any time, the leader is always on alert, forcing it to improve continuously its technologies and services. Although the business risks are high, the strategies developed by the CC companies may reduce such risks and achieve better performance.

B. *Integrated approach to financial modeling of the cloud*

EVA is a performance evaluation metric and as such is a much broader concept than the CAPM. Indeed, the CAPM is only a component of the EVA but its calculation is essential for the determination of the impact of a project or a strategy on firms' profitability and long term sustainability. According to the Stern Stewart Company, EVA is calculated as net operating income after taxes less the cost of invested capital, i.e., both debt and equity employed to produce the net income. EVA's formula is as follows:

EVA = Net Operating Profit After Taxes – Capital Charges

EVA = NOPAT – WACC * EA (economic asset or invested capital)

EVA = (ROA – WACC * EA) (2)

where

NOPAT = Net Operating Profit After Taxes

WACC = Weighted Average Cost of Capital

EA = economic asset or Invested Capital

ROA = Return on Assets [ROA = NOPAT/EA and NOPAT = EBIT - T]

EBIT = Earnings Before Interests and Taxes

T = Taxes

EVA is a measure that informs quickly the CC firms' stakeholders (managers, shareholders, employees, etc.) whether the value of the firm has been destroyed or created through clear and successful strategies. Thus,

If EVA > 0 firm's stakeholders would be better off with the project than without it, and

If EVA < 0, firm's stakeholders would have been better off if the money invested in the deployment of CC technologies and services had been distributed to shareholders as dividends. In that sense EVA is able to predict the impact on firm's value before and after the deployment of CC technologies and services.

EVA calculations can be illustrated by a simple example. Using formula (2), one needs to estimate four components to calculate EVA:

1. Net Operating Profits after Taxes
2. Economic Asset or invested capital or capital charged
3. Cost of capital (equity and debt) and
4. Weighted Average Cost of Capital

For calculating EVA, we are assuming that:

- k_d =7%, the average interest rate for corporate bonds
- t = 25%, the average tax rate
- β= 1.75
- R_M = 11%, the expected return of a broad index of

stock market, DJ or S&P 500

- R_F = 4%, the return of the riskless asset

Taking into account the above data and using the CAPM formula (1) above, the cost of equity capital is Ke = 16.25%. The after tax average cost of bonds is: Kd = i*(1-t) = 7* (1-0.25) = 5.25% and the WACC is:

WACC = (E/E+D)*Ke + (D/E+D)*Kd = 60%*16.25% + 40%*5.25% = 11.85%

If NOPAT is equal to 125 948 and the Economic Asset is equal to 420 243, EVA is calculated in the table below.

TABLE IV: EVA CALCULATIONS FOR A CC HYPOTHETICAL FIRM

The calculation of EVA	
NOPAT	125 948
Economic Asset	420 243
WACC	11.85%
Capital charges	49798.80
EVA	**76 149. 20**

A positive EVA implies value creation. If a CC firm could deploy cloud services effectively, its strategy creates value for its shareholders. The return on the investment is commensurable with its risk as indicated by the beta of the project. The investment earns its opportunity cost and adds value to its shareholders by the amount indicated by EVA. The bigger the EVA figure is, the bigger the market value of the firm. The growth in EVA implies higher returns on investment in terms of higher profits and stock prices

IV. CONCLUSION

CC is a growing industry but, as yet, there are not financial models specifically developed for this industry to evaluate its performance. Organizational sustainability requires models capable of providing a detailed analysis of the impact of deployment of SaaS, IaaS and PaaS products and services. Recently a number of authors [7] suggest that the CAPM is the most appropriate model for analyzing, from a financial point of view, the CC industry. Indeed, the CAPM model is well established in the finance literature and it is better than other competing financial models for the CC industry. Nonetheless, the CAPM is only one component of a broader model, EVA. The latter provides better means to evaluate the business strategies of firms in the CC industry. Although this paper contributes to the literature by adapting the EVA model to the CC industry, further work is needed to make this model more suitable for the CC industry. Industry practices, particularly the use of SLA contracts introduces rigidities which may either increase or reduce the risks the CC companies are facing as this industry evolves towards uncertain trajectories. This paper stressed the importance of the quantification of these risks and proposed some financial tools to evaluate a fair return on CC investments. Future research should focus on the development of better metrics of these risks and the determination of their premiums by taking into account the business practices of the CC industry.

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