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Marc Daumas

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# Effect of R&D Tax Credit on the cost-metrics of cloud computing

## A case study from France

Marc Daumas  
PROMES (UPR CNRS 8521 in Perpignan) & ASR (GDR CNRS 725), France  
[marc.daumas@promes.cnrs.fr](mailto:marc.daumas@promes.cnrs.fr)

### Abstract

*Cloud computing probably carries disruptive innovations that will change our future in many ways. We explore in this article how R&D Tax Credit changes the cost metrics of cloud computing with short- and long-term effects of its future developments and acceptance as a new key technology. Some of the situations described here may be in effect or arise in some other countries but in-depth analysis of legal texts and practices is necessary to identify them. The comparisons in this article are limited to bare costs. I do not propose adjustments or my opinion to policy makers in order to remain on a scientific level. Yet we go as far as possible as long as we remain in the intents of present laws and regulations.*

### 1. Introduction

Cloud computing and its declinations such as XaaS (for *X as a Service* where X might be an S for Software, an I for Infrastructure, a P for Platform or more recently a D for Database, an N for Network, B and P for Business Process and without any acronym for services such as Security, Storage or finally Information) have introduced many changes in technological as well as economical development of information technology companies. It has been a main thrive for both new and more settled ones and it will probably be a disruptive technology as opposed to incremental innovations.

Yet, it is still difficult to predict what services will be commonly adopted in the future and what fees users or sponsors will be willing to pay for them. As these questions relate both to technological developments in hardware/software/networks and to sociological

evolutions, we could expect a good dose of trials and failures to gather new significant insights and answers.

Cloud computing is also perceived as strategic for its implication to defense, as well as economic intelligence and law enforcement, making local alternatives preferable to global clouds for a variety of applications. This point was certainly a part of the decision of the French government to invest 150 million € (\$196 million) in a national cloud [3].

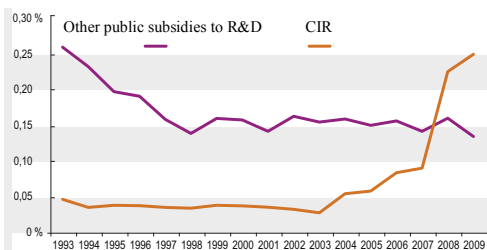
In the meantime, France grants 4.7 billion € (\$6.2 billion) annually on an R&D Tax Credit (also known as CIR) to boost local spending by the industry on Research and Development [8,9,10]. This figure represents 0.25% of France GDP and it is higher than all other local cumulated direct government subsidies for R&D in France. For 2009, cumulated subsidies and exemptions for R&D spending in France rose to 0.38% of its GDP, an amount substantially higher than in the U.S. or Canada for example (0.22% in 2008 according to the OECD), two countries which also strongly support R&D in the industry.

We will see that CIR laws and regulations make buying hardware and software licenses, with all their maintenance costs, preferable to public cloud computing for companies that use such commodities for R&D. Section 2 describes CIR peculiarities in the French legal systems and provides a few numbers on CIR. Section 3 presents a few key points on cloud computing in order to make this presentation more self-contained. Section 4 presents cost-comparisons between the ownership of computing commodities and the use of public cloud computing. We end this presentation with a few concluding remarks.

## 2. French R&D Tax Credit

### 2.1. Main CIR incentive

An R&D Tax Credit (Crédit d'Impôt Recherche – CIR) was established in France in 1983 with some major changes in 2004 and a significant increase of its amount in 2008 following the election of former President Nicolas Sarkozy. Figure 1 below, adapted from [15,16 – folio 25] presents a sharp change around 2008 due both to the new regulations, that provide higher government refunds for each euro spent by the industry on R&D, and to a larger number of companies spending money for R&D and filing CIR applications.



**Figure 1:** Fraction of French GDP spent on CIR and other public subsidies to R&D in the industry

Observers may conclude that lawmakers were pursuing the following goals with CIR:

- Increase the amount of R&D spending in France, by French companies and locally operated subsidiaries of international companies.
- Prevent transfer of existing French R&D centers and teams to some other countries by significantly lowering costs of R&D in France.
- Help French industry attain or maintain technical leadership with trained high-tech teams established in France.
- Increase the potential for license royalties from European and international patents.
- Nurture cooperations between the industry and academic research.

Articles 244 quater B, 199 ter B, 44 sexies and 49 septies F to N of the General Tax Code (law) define CIR. Articles L45 B, L13 CA, L80 B and R45 B-1 (where L identifies law articles and R identifies

regulations) of the Code of Tax Procedure define procedures applicable to CIR.

Article 244 quarter B states that amortized investments in goods and buildings purchased as new and used for R&D are eligible to CIR. That includes hardware and some software licenses.

The same article states that labor cost of research scientists, engineers and technicians are also eligible to CIR for the part of their work time effectively dedicated to R&D operations. Other expanses are only estimated at a flat rate based on the amortized investments and the labor cost of research scientists, engineers and technicians.

The definition of R&D operations used to rely heavily on Frascati Manual [18] and on a French tax instruction published in February 2000. Yet the yearly guidebook on CIR compiled by the French Ministry of Higher Education and Research has strongly contributed to establish a consensus. It led to the edition of a new tax instruction that defines precisely R&D and that was published in 2012 [13].

We will not go into the details of the latest tax instruction. Yet it states that operations that are strictly necessary to R&D operations are also eligible to CIR for amortized investments and salaries of research scientists, engineers and technicians. When a given task is necessary both to R&D operations and to some other operations such a producing sold or leased goods and services, the part of the task eligible to CIR should be restricted to the expenditures strictly necessary to the R&D operations.

### 2.2. Exemptions granted to JEI/JEU

Startup innovative companies are also eligible to exemptions from taxes (corporate and local ones) and social contributions to the welfare system for up to 8 years after their incorporation. JEI companies (Jeune Entreprise Innovante) must perform a sufficient amount of R&D (yearly, 15% of their gross expenditure) and meet some criteria of independence. JEU companies (Jeune Entreprise Universitaire) must transfer academic research and have a strong link with initiating universities.

JEI/JEU exemptions do not scale with R&D expenditure though they reduce the price of workforce by about 20% (factor 115/145).

## 2.3. Rescript from the fiscal administration

Rescript is a procedure first used by the Roman Empire and later by the Catholic Pope where someone asks a written question. The recipient provides an authoritative answer, initially limited to “awarded” or “rejected”.

This procedure has been enacted by the French fiscal administration in many ways. One of them is to check that a given R&D project described by a company is also rightfully viewed as R&D by the administration. Another one is to explore beforehand a question that has never been asked to the administration because practices are evolving or will evolve. We will see some evolutions of CIR that might be acted by the administration without the need for any amendment to the laws.

## 3. A few words on cloud computing

This section presents definitions and key issues on cloud computing and a small panorama of government supported cloud initiatives in France, in the UK and in the US.

### 3.1. Public, private and hybrid clouds

Public clouds were probably the first initiatives to be coined as cloud computing. A **public cloud** offer is created when a company C provides a service on some computers to anyone willing to pay a fee or find a sponsor for this service. The main advantages of public cloud are that (1) customers no longer need to invest on computing commodities and (2) computing expenditures are adapted to the customers’ needs on a yearly, monthly, daily or hourly basis. The main condition for cloud computing to develop is that customers trust their cloud service provider with their data. That possibly includes their algorithms and their codes.

Availability of data and services, backup mechanisms, ease of use, hotlines and user friendliness are adjustable variables that allow various companies to propose different offers fulfilling a wide range of needs from customers. It may happen that the cloud service involves third party customers as when a customer of a cloud provider sets up a merchant website to sell goods or services to other customers. In this article, we focus only on the relation between the cloud provider and the primary customer.

**Localization of data** is a multifaceted subject. It may prevent law enforcement or government agencies to seize data. For example, business accounting can be performed in a write-only manner where customers cannot access the details of their books but only reports that are compiled on demand in a foreign country. Data can be scattered in a few countries to make international collaborations of law enforcement agencies less efficient. Fake orders can be generated automatically to make very challenging any attempt to recreate the actual books from eavesdropping in the originating country of postmortem analysis of seized computers. And of course, strong encryption and signing mechanisms can be applied to all the steps in this process.

Law abiding companies may use this ability to fight some corrupted administrations and to continue updating their books after they have provided an accurate image fulfilling a request from a law enforcement agency. Other companies and individuals may take large advantages of this situation.

The work around to the need for customers to trust their service provider is to have all of them be part of the same company or a selected group of companies. This situation has been coined as **private cloud** when only one company is involved or when the group is strongly integrated. We may also refer to a **community cloud** to indicate a less connected group of users. All the other points can remain similar between a private/community cloud and a public one. Services can be billed from provider to customers inside the company or the group, and multinational companies or groups can localize their data in foreign countries. The key issue in a private cloud is to keep the servers busy 24 hours a day, 7 days a week all year long. That might require a large group unless some part of the computing commodities may be wasted.

The alternative is to sell the unused resources to outsiders meaning that the cloud will serve two classes of customers: insiders – from the same company or group, and outsiders – anyone willing to pay the fee or find a sponsor for the service. This is called **hybrid cloud**. For the provider, a hybrid cloud gives all the advantages of public and private/community clouds with the only drawbacks that (1) the cloud security needs to be strengthened and (2) the provider needs to recruit and handle customers.

### 3.2. US federal cloud

Following the previous definitions, the US Federal Cloud [11] is a private cloud. Its main objective is to reduce operating costs through scale economies across the 30 or so federal agencies concerned while providing strengthened security. The goal presented in the 2011 reference is to reduce annual federal IT expenditure from \$80 billion to \$20 billion. FedRAMP [5] is a connected government initiative that provides “a standardized approach to security assessment, authorization, and continuous monitoring for cloud products and services”.

US Federal Cloud follows the well-established scheme of interactions between US government and the industry that was started after the end of the Great Depression [2]. Federal actions in private industry are very limited but subcontracts, mostly based on defense and security needs, help establish large US based companies. Most majors aeronautics firms in the US are very good examples of this scheme.

A debate is going on right now about a shift on this scheme induced by the IT and the economy of knowledge as visible in the “New Age of Discovery: Government’s Role in Transformative Innovation” panel that was held by the Information Technology and Innovation Foundation on August 2nd in Washington DC. Participants were Hon. Barton J. Gordon (Partner, K&L Gates), Kathleen Kingscott (Senior Director, Strategic Partnerships, IBM Research), Arun Majumdar (Former Director, Advanced Research Projects Agency-Energy) and Eric Toone (Principal Deputy Director, ARPA-E).<sup>1</sup>



### 3.3. UK government cloud

The main government supported cloud initiative in the UK is G-Cloud. It is very similar to the US federal cloud.

### 3.4. French public supported cloud

The French government supported cloud is based on two industry consortia gathered in the “Cloud Andromède” project. Orange and Thales corporations drive one consortium. SFR and Bull corporations drive

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<sup>1</sup> Audio and video recordings of the panel are available through [goo.gl/bKqxb](http://goo.gl/bKqxb) link or with the QR code next to the paragraph.

the second one. They will set up public clouds that should be used both by the administration and the industry for their own needs on sensitive data. Each consortium associates a telecom retail company used to handle a large number of individual customers (Orange and SFR) and a high-end computer company used to build large systems (Thales and Bull). Each project of Cloud Andromède will receive an investment of 75 million € (\$98 million) from CDC (Caisse des Dépôts et Consignations) a government controlled investment bank. April-May 2012 press releases state that each consortium will reach a total investment of 225 million € (\$280 million).

The main goal of Cloud Andromède is to create a sovereign cloud for France and Europe. No formal definition of a sovereign cloud is publicly available but this notion appears in some official documents from the Senate of the French Republic for example [4]. The key issue is localization of sensitive data in France.

## 4. Cost comparison

We will compare a company A that buys and operates its computing commodities for numerical simulation to a company B that runs such commodities in a third party C company using external cloud computing. We will detail 3 scenarios based on the use of 100 CPUs. Reference [6] proposes a cost of ownership of \$4,000 (about 3,000 €) per CPU and per year. This cost breaks down to 62.5% for amortized hardware and software, 12.5% for supplies and utilities (that includes office space that could also be amortized yet we will assume that this is marginal for the sake of simplicity) and 25% for workforce. The author of [6] also proposes to allocate all the scale economies associated with cloud computing (he suggests 50%) to generate profit for cloud providers.

### 4.1. Stable day-round year-round needs

In this situation, company A is able to match its needs with off-the-shelf resources in order to allocate 100% of its amortized resources to its projects and to invest timely as its needs evolve. Company A might most probably not be able to do so on a project-by-project basis, but it may set up a private cloud.

Each thousand euros spent by company A on amortizing its hardware/software generates between 525 € and 700 € of CIR. Conditions apply for the

workforce associated to installation and maintenance to be eligible to CIR:

1. Only the research scientists, engineers and technicians that are also notably involved in the R&D projects may perform these tasks.
2. These tasks must be strictly necessary to the R&D projects of the company, and to no other projects.
3. The costs associated with these tasks must be marginal compared to the cost of the rest of the R&D project.

As soon as company A meets the above conditions, each thousand euros spent on workforce generates between 450 € and 600 € in CIR with a possible JEI/JEU exemption of 200 € on social contribution. In this case, CIR generation is reduced between 360 € and 480 € leading to a cumulated cost reduction between 560 € and 680€.

If we use the figures presented earlier in this section, cost of ownership falls from 3,000 € between 1,678 € (56%) and 1,175 € (39%) cumulating the benefits of JEI/JEU and first application to CIR.

In a more general form, the fraction of the cost paid by company A can be written as follows where

- x is the fraction of the initial cost of the hardware/network/software and buildings listed as amortization,
- y is the fraction of the initial operation and maintenance costs spent on research scientists, engineers and technicians,
- t is CIR refund rate – usually 30%, but possibly 35% (second year) or 40% (first application), and
- j is equal to 1 (non JEI/JEU) or 115/145 (for JEI/JEU).

$$1-1.75xt + (j-1.5tj-1)y$$

If we define a characteristic point at x=62.5% and y=25% from reference [6], we obtain the characteristic value of

$$0.75-1.09375t+0.25j-0.375tj,$$

leading to the results of Table 1.

**Table 1:** Fraction of initial cost finally paid by Company A to set up a private/community cloud

|                      |       |                       |
|----------------------|-------|-----------------------|
| x = 62.5%<br>y = 25% | j = 1 | j = $\frac{115}{145}$ |
| t=30%                | 56%   | 53%                   |
| t=35%                | 49%   | 46%                   |
| t=40%                | 41%   | 39%                   |

## 4.2. Constantly and quickly changing needs

The main advantage of cloud computing is that company B pays only for the part of infrastructure it actually uses. If we assume that R&D programs run 10 months a year, 5 days a week, and 8 hours a day, the use of R&D servers by company B falls down to 19%. So does the cost of leasing its computing commodities. If we use the figures presented early in this section, cost of leasing falls from 3,000 € (ownership) to anything as low as 570 € (19%) depending on the actual use of the servers by R&D teams.

This figure is optimistic in the sense that R&D teams use night and weekend for long batch runs. Yet R&D teams also spend some working hours to meetings. The highest saving rates may only apply to SME with a few small R&D teams. As R&D teams and their numbers grow, it becomes easier to use a higher percentage of the computing facilities for R&D.

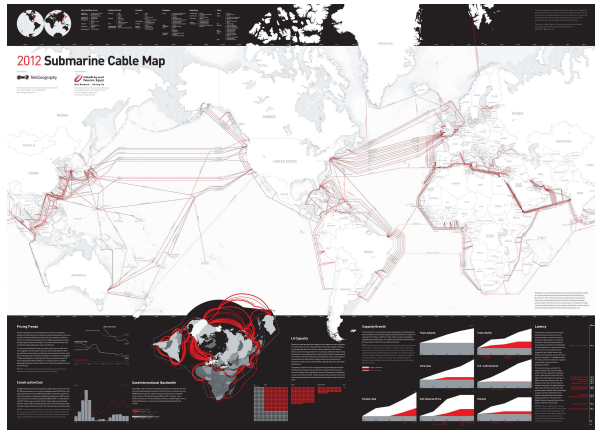
Company B may use a community cloud owned by a GIE (Groupement d'Interêt Economique). In that case, the members of the GIE could share ownership of the commodities and each member would receive CIR according to the part of the commodities that it amortizes and the amount of R&D operations performed on the commodities. Yet, a consensus on this point should be validated through the rescript procedure described in Section 2.3.

The above figures also assume that some other companies use the computers rented by company B during nighttime and weekends to keep leasing costs significantly low. One way to do so for cloud providers is to have customers in various countries to take advantage of the time difference.

The first figure on next page shows the submarines cables available to computer networks for customers in one

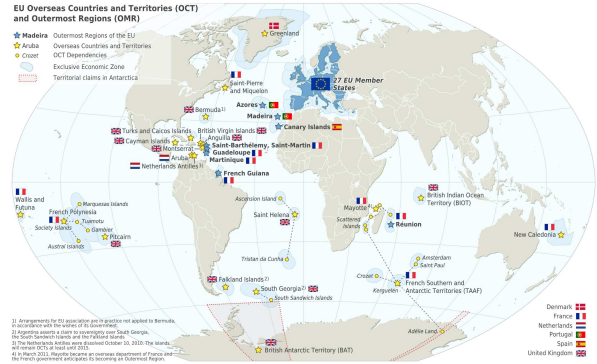


time zone to use cloud commodities in another time zone.<sup>2</sup>



Company A may also become an hybrid cloud provider to lease the part of its computing commodities not used for R&D. Cloud income would exactly balance the cost of the part of the computing commodities not used for R&D. In the meantime, company A will obtain all the benefits of CIR and JEI/JEU for the part of the commodities used for R&D. Assuming that company A uses only 20% of its computing commodities, that would imply amortizing a server that is 5 times larger than its initial needs.

Company A may also use its computing commodities to perform R&D for some other companies worldwide. Most outsourced R&D projects cannot be handled without at least some limited workforce close to the customers. This workforce must be located in the European Union (and one of its special member state territories) presented in the map on the next column, to be eligible for CIR<sup>3</sup>. Yet if the workforce is located outside the EU, its overseas countries and territories and its outermost regions, amortized hardware and software might still be eligible. A consensus on this point should be validated through the rescript procedure described in Section 2.3.



### 4.3. Transitional R&D on cloud

Cloud computing is still an area where R&D is active as visible from the 64 publications citing reference [1] in the ACM Digital Library on May 2012. It means that many cloud providers use some of their projects to perform full-scale R&D tests. CIR can be applied to this part of the activity of providers operating in France to reduce their costs of operation. From a random drawing of 93 files presenting R&D activities of French large and small companies in IT as a part of the 15,746 companies known in the CIR database,

- 22 companies used the word “cloud” to refer to cloud computing;
- 14 companies from the same set used acronym “SaaS”;
- 6 companies used both word and acronym and
- 30 companies used “cloud”, “SaaS” or both terms.

Acronyms “IaaS” and “PaaS” appeared only in one file. XaaS and other related acronyms were never used.

Yet this effect will not last as this area will mature and less R&D will be necessary on industrialized platforms.

<sup>2</sup> Figure is included in this publication thanks to a “Creative Commons” license. Full size picture is available through [goo.gl/X5B0U](http://goo.gl/X5B0U) link or with the QR code next to the paragraph.

<sup>3</sup> Figure is included in this publication thanks to a “Creative Commons Attribution-ShareAlike 3.0 Unported” license. Its author is [Alexrk2](http://Alexrk2). Full size picture is available through [goo.gl/3Ayy8](http://goo.gl/3Ayy8) link or with the QR code next to the paragraph.



## 5. Concluding remarks

Historically, the situation of France is rare amongst the industrialized nations on some key features that share some influence on this comparison. First, France has been a large centralized state impersonated by its head for a long time. Most French person could quote “I am the State” (in French) though it was too hastily attributed to King Louis XIV visiting the parliament of Paris back in 1655 [14, p 126].

Second, French governments (even the conservative and the liberal ones) interfere frequently with the industry on strategic as well as economic issues. This mix is visible on the “Plan calcul” started in 1966 under Presidency of General Charles de Gaulle [17].

Third, French knowledge-bearing elites graduating from Ecole Polytechnique and ENA top education institutions are usually first recruited in the administration though many of them end-up working for the industry sooner or later. This leads to the feeling that administration and industry managements are part of the same “state created” group that is better positioned to initiate and implement large technology projects [20].

The three points just mentioned amongst many less significant ones are good reasons for this detailed analysis of the cost of cloud computing in France. We have seen that R&D Tax Credit may reduce the price of ownership of a private cloud used for R&D down to 39% of its original costs. We have also seen that the combined benefits of CIR and JEI/JEU can also be obtained for a few years for public cloud as soon as providers use their services for full-scale R&D testing strictly necessary, based on existing scientific knowledge.

A change in article 244 quarter B by the French parliament could extend the benefit of CIR and JEI/JEU to the lease of community, hybrid and public clouds for R&D. In this case, the new article may require that the hardware, software, network and workforce are solely located in France or in the EU including OCTs and OMRs. Such a law would make a difference in a time where big existing cloud providers consider developing offshore servers.

Such servers would definitively be out of reach from most law enforcement agencies. Yet they would be able to reach a safe harbor of their choice in a few

countries in minutes in case of unrest if they sail close to the EU for example. Place of choices would be the English channel (in the North Sea) where a ship could sail to France, UK, Belgium, Nederland, Germany, Denmark, Norway and Sweden. Other places of choice can be located around the world, including for example the northern Gulf of Mexico

In the meantime, we have explored two situations that could benefit to the development of cloud. Changes to French law are not required, but as these situations are new, two rescripts could guarantee a consensus with the administration on these situations.

## 6. Acknowledgment

This report is a part of ASR initiative to set up a club of industry partners in France. ASR is a nationwide federation of about 100 French research teams sponsored by French National Center for Scientific Research (CNRS). ASR represents about 600 graduate students, research scientists and university professors. Prospective industry partners may contact the author preferably to one of the following affiliation-free addresses.

[marc.daumas@ens-lyon.org](mailto:marc.daumas@ens-lyon.org)  
[daumas@alumni.smu.edu](mailto:daumas@alumni.smu.edu)

The author may have had access to privileged information concerning the French R&D Tax Credit as a part of his ending 2-year assignment to C1 department at DGRI in the French Ministry of Higher Education and Research. Yet, this report is based on documents publicly available and knowledge available to the 200 or so experts hired on a case-by-case basis. The views in this paper are solely the responsibility of the author and should not be interpreted as reflecting the views of the French Ministry of Higher Education and Research (Direction Générale de la Recherche et de l’Innovation – DGRI) or the French Ministry of Economy, Finances and Industry (neither Direction de la Législation Fiscale – DLF, nor Direction Générale des Finances Publiques – DGFIP).

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