Digital Economy / Digital Regulation

# Understanding Cloud Computing Market Dynamics in Europe

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## Key Messages

1. Using cloud computing services foster productivity (i.e. cost reduction) and innovation. Cloud computing provides flexibility and scalability, and converts fixed costs into variable costs. It can be a facilitator of innovation in software services, storage and management. It is a change of paradigm, from owning ICT assets to purchasing ICT services.
2. The evolution of cloud computing adoption in the EU-15 is similar to that of other countries in the EU. Moreover, its growth path has increased since 2016. Nearly 30% of the firms in our sample used cloud computing services in 2018.
3. The speed of cloud computing adoption depends on the firm size. SMEs are adopting cloud computing services on a smaller scale than large firms. However, this could be a misperception since not all cloud services are perceived as such.
4. High-dependence on cloud computing services (i.e. the usage of services such as financial software applications, Customer Relationship Management apps and computing power for firms' own software, which can be used together with others) is increasing among European firms. Large firms show greater growth in the consumption of high-dependent services (82%) than SMEs (75%). There is no indication that this gap will be reduced in the short term, which means that high dependency on cloud will be a main trend. The use of low-dependence on cloud computing services in large firms grew by 50% between 2014 and 2018, whereas for SMEs this rate remained constant.
5. Supply conditions depict a concentrated market, both geographically and by number of providers, with prices falling and service quality improving.
6. European countries are too dependent on foreign-owned digital infrastructure as the major cloud providers are from the US and China. Consequently, policymakers and governments are interested in developing a European cloud infrastructure that allows firms and governments to store sensitive data with homegrown providers. They claim that Europe needs a data infrastructure that ensures data sovereignty and enables data sharing on a broader and secure basis.

## Introduction

The rise of the New Digital Economy, defined as the combination of mobile access to the Internet and cloud computing, is certainly altering the dynamics of economic growth. Most economic activity involves, to some extent, the developments brought about by this revolution. Cloud computing means the shift toward storage, analysis and development of new applications in the cloud. It is a computing architecture revolution, transforming not only where computing is done, but also the manner in which software is produced and the tools available for business process automation (Kushida et al., 2015). In this scenario, understanding the main factors of cloud computing adoption

and its implications is key to figuring out the new dynamics of economic growth under such conditions. In addition, from the supply side, it is important to understand the market structure to explore potential impacts on cloud computing adoption by firms. This report focuses on European countries to illustrate these issues.

## Cloud Computing Service Use and Market Structure: From the Perspective of Supply and Demand

The world's transition from an era in which computing resources were both scarce and expensive to a time where the same resources are cheap and abundant generates a new wave of commoditization. Technical improvements in computer power and communication networks together with lower prices of computing resources fostered the emergence of cloud computing. Firms' investment in ICT as a percentage of nominal GDP has been falling substantially and much of the observed decline in the ICT investment rate is a reflection of slower growth in computers and communication equipment investment compared to GDP (Van Ark, B., 2016). In contrast to the slowdown in such investment, there has been a major rise in spending on ICT services such as data storage and information processing services (i.e. cloud computing), computer system design, and other information services (including Internet publishing). This shift from owning ICT assets to purchasing ICT services is having a large impact as firms move to external service providers for their ICT infrastructure.[1] It changes the paradigm of industrial organization that affects all industries.

Benefits derived from the usage of cloud computing are twofold. First, there are productivity gains due to the cost reduction associated with a leaner and more efficient IT-based organization, greater business flexibility, scalability and improved data capabilities. Firms can benefit from elastically managed architectures that reduce the uncertainty surrounding computation requirements in the future, preventing inaccurate investment decisions in the form of fixed costs of entry in ICT capital. These savings might improve companies' resource allocation and efficiency, and can ultimately contribute to the economy's overall productivity performance. Second, cloud computing fosters innovation and competition. Firms can access the most innovative software and hardware solutions faster and cheaper since cloud computing providers are, in most cases, the developers of such solutions. In addition, Wauters et al., (2014) estimates that between 2015 and 2020 the development and deployment of cloud computing could lead to the creation of 303,000 new businesses, in particular SMEs. If IT capital investment requirements decrease, the minimum efficient scale is reduced and smaller firms can enter the market more easily.

## Factors for Cloud Computing Adoption: Evidence from European Firms

According to Eurostat, most firms in European countries use the Internet (97%). Moreover, nearly 30% and 27% of the firms in the EU-15 and EU-28, respectively, were using cloud computing services in 2018. However, the impact of cloud services on the economy depends on the type of service implemented and consumed. With regard to technological abstraction level, the traditional classification distinguishes three types of service: Infrastructure as a Service (IaaS), which includes computing power; Platform as a Service (PaaS), the most common example of which is database storage; and Software as a Service (SaaS), which includes email services and customer management programs, among others.

Eurostat classifies cloud usage according to the level of dependency of a firm on cloud services in low, medium and high cloud computing services. Low-dependence cloud computing services include email (SaaS), office software[2] (SaaS) and file storage (PaaS) offered in a "closed package" which includes a limited number of fully

1: This can range from moving data into a "private cloud" (i.e. a company's internal cloud) to accessing public cloud services to store, access and process data.
2: Office software is the terminology that Eurostat uses for referring to productivity tools.

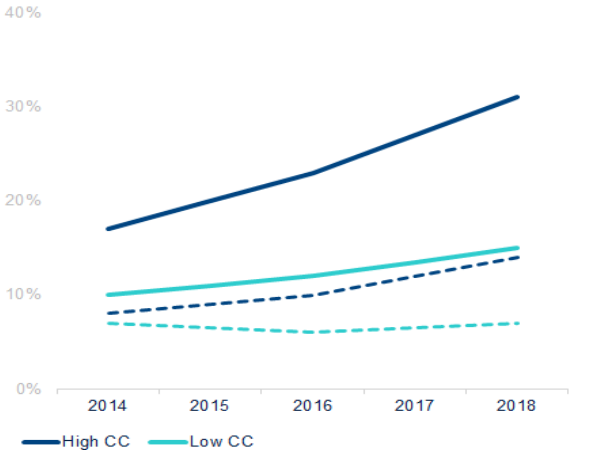
developed functionalities and where users' parameterization effort is low. Medium-dependence cloud computing services are less standardized and generate a greater engagement of the firm with cloud services. They are services that require higher involvement by the user to be set or operated, such as database hosting (PaaS that enables you to run database-supported applications). Finally, high-dependence cloud computing services include financial software applications (SaaS used to automate, assist and store business or personal financial information such as traditional ERP—Enterprise Resource Planning—software), Customer Relationship Management (SaaS that helps firms manage business processes, customer data or customer interaction) and computing power (IaaS offers computing power to run enterprises' own software). Figure 1 summarizes this service classification. In order to belong a given category (i.e. low, medium or high), firms must report having at least one of the service with the *Yes/No* category but none of the services under the *No* category. We observe differences in the adoption of cloud computing for each type of service, which generates different degrees of dependence. Use of low-dependence cloud computing services alone remains constant, while the use of cloud services associated with a high-dependence have increased dramatically in the last five years. Moreover, there is greater growth in the consumption of cloud services that generate high dependence (i.e. financial software applications, Customer Relationship Management apps and computing power for firms' own software) in large firms than SMEs. Adoption growth rates are 82% and 75%, respectively. Consumption of low-dependence cloud services in large firms grew by 50% between 2014 and 2018, whereas rates for SMEs remained constant (Figure 2). This increases the cloud service adoption gap between SMEs and large firms, which is not expected to close in the short term.[3] The use of high-dependence services incorporate a larger number of functionalities that the low-dependence and hence, productivity gains derived from the former might be bigger as well. Cloud computing adoption is crucial for SMEs since they have limited capacity to hire and retain human capital with the skills to address specific IT needs and new challenges related to data driven business management (i.e. big data analytics). Moreover, cloud service providers offer comprehensive solutions as a service that allows SMEs to compete with new entrants whose business models are usually based on cloud solutions.

Figure 1. **CLOUD COMPUTING SERVICES CLASSIFICATION BY DEPENDENCE LEVEL**

| Use of cloud computing services | Low | Medium | High | Service |
|---|---|---|---|---|
| a) e-mail | Yes/No | Yes/No | Yes/No | SaaS |
| b) Office software | Yes/No | Yes/No | Yes/No | SaaS |
| c) Storage of files | Yes/No | Yes/No | Yes/No | PaaS |
| d) Hosting firms' database | No | Yes | Yes/No | PaaS |
| e) Financial software applications | No | No | Yes/No | SaaS |
| f) Customer Relationship Management app | No | No | Yes/No | SaaS |
| g) Computing power for firms own software | No | No | Yes/No | IaaS |

Source: BBVA Research

Figure 2. **USE OF CLOUD COMPUTING SERVICE-DEPENDENCE BY FIRM SIZE**




Source: BBVA Research, based on data from Eurostat. Solid line: large firms, dotted line: SMEs

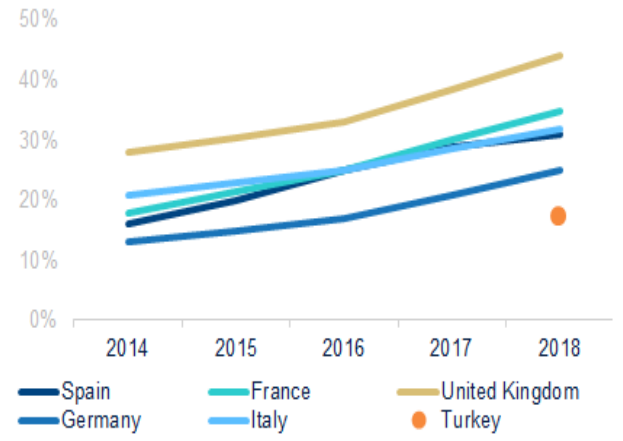
Our focus is on the evolution of high-dependence cloud services since they show rapid growth and might have a greater impact on economic activity. Figures 3 and 4 illustrate the levels of cloud computing adoption in selected countries for large firms and SMEs respectively. While we observe a homogeneous pattern for large firms, adoption

3: In 2016, we observe a change in the slope that generates larger growth rates.

by SMEs is more heterogeneous. In all the cases except Italy, high cloud computing service use increases over time with much higher levels for large firms than for SMEs (more than double in certain countries). The UK shows the highest adoption of high cloud computing services. This could be linked to the fact that it is one of the European countries where processing centers of major American CSPs are located. In addition, its authorities are pioneers in issuing guidance on cloud adoption and are among the most supportive in this regard.

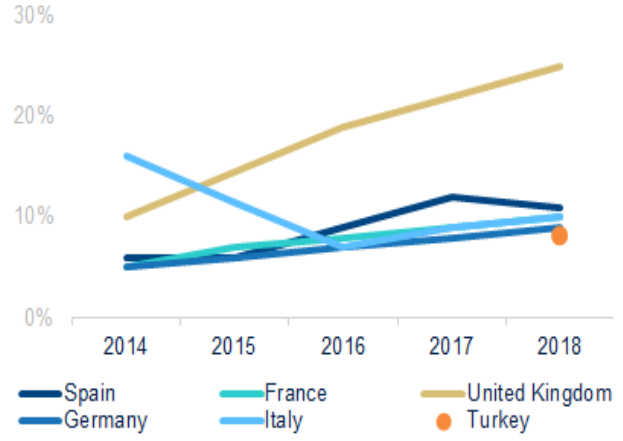
Conversely, having a prominent homegrown cloud provider or a clear view on how the European cloud scene should be does not seem to generate a big impact on cloud adoption. Despite the fact that Germany, France, Italy and Spain hold different positions on the cloud and that German and French CSPs seem to be better positioned in the European cloud market than the ones in Italy and Spain, their cloud adoption rates do not differ widely. In addition, German authorities have been quite vocal on the impact that high reliance on American CSPs could have. On the other hand, Spanish and French authorities have not yet taken a clear stance on cloud usage. Finally, even in Turkey, where there are regulatory limitations for using cloud services provided abroad, cloud adoption among SMEs is at a similar level to that of the EU's big four.

Figure 3. **USE OF HIGH CLOUD COMPUTING SERVICES: LARGE FIRMS**




Source: BBVA Research, based on data from Eurostat

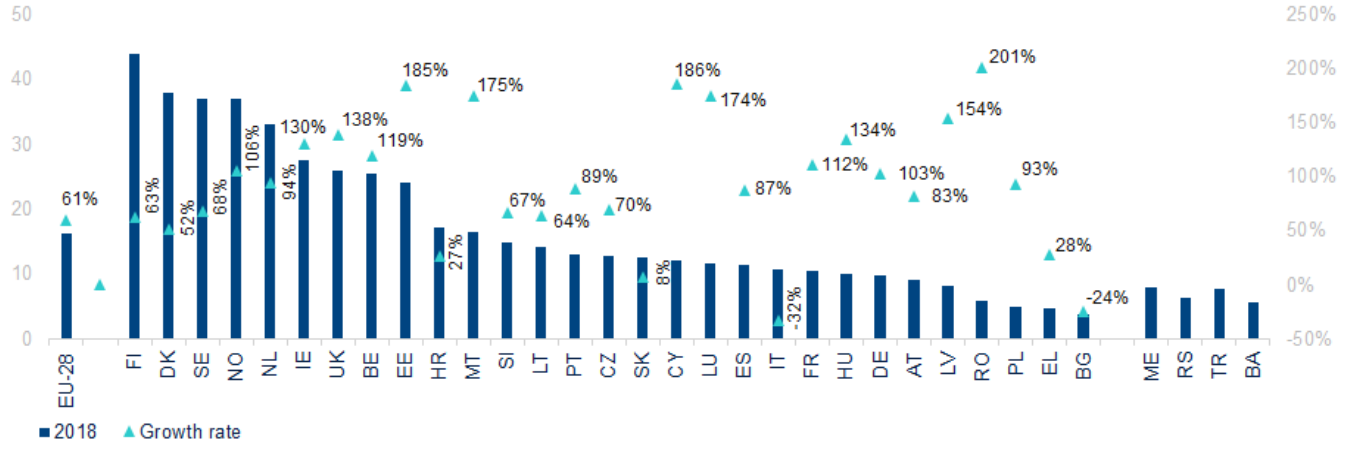
Figure 4. **USE OF HIGH CLOUD COMPUTING SERVICES: SMEs**




Source: BBVA Research, based on data from Eurostat

Figure 5 shows the growth rates of cloud computing service usage by country. It shows dramatic growth in adoption in most countries, which indicates that the cloud computing services market is expansive and the shift toward full usage of digital services is far from being complete. Finland and Denmark were the leading countries in high cloud computing services in 2018 (latest data available). The countries with highest growth rates are Romania and Cyprus, whereas Italy and Bulgaria show the lowest rates. Despite not having big European players in this field, some European countries show strong cloud adoption.

Figure 5. **HIGH-DEPENDENCE CLOUD COMPUTING SERVICES (2014–2018) (% OF FIRMS)**




Source: BBVA Research, based on data from Eurostat. Note: Data for Montenegro, Turkey, Serbia and Bosnia and Herzegovina are not available for 2014

With regard to the different types of services, the growth rates disaggregated by service among medium and high cloud computing services show similar growth paths of approximately 14% for EU-28. Company database hosting is the service with the most dynamic growth (13%), followed by financial software applications (10%).

Nevertheless, it is possible that figures related to the cloud service use are higher than the ones shown by Eurostat. There are two potential downward biases, one due to the statistics design and other because respondents are not aware of all the cloud services they are using. The first downward bias could be generated by the lack of identification of the websites as a cloud-based service in the Eurostat questionnaires. The downward second bias, associated with the lack of awareness, affects SMEs in a greater extent, where respondents generally have less technical knowledge. Statistics regarding website ownership show that nearly 80% and 95% of SMEs and large firms, respectively, have a website. It is highly unlikely that such a large proportion of SMEs have their own servers. The difference between firms that buy cloud computing services and those with a website is higher in SMEs (three times on average). In addition, there is a wide range of website service providers in the market whose core service is cloud-based. Further evidence that supports the idea that cloud adoption is underrepresented in the statistics, especially for SMEs, is that a considerably higher percentage of large firms than SMEs claim that they buy email as a cloud computing service, which is unlikely given the smaller capacity of SMEs to own a server and the rare supply of this service outside the cloud. This fact was pointed out by McAfee in its Cloud Adoption and Risk Report (2019), where it noted that the firms using their services reported an average usage of 30 cloud services while in fact McAfee (2019) registers that the average firm uses almost 2,000 cloud services.

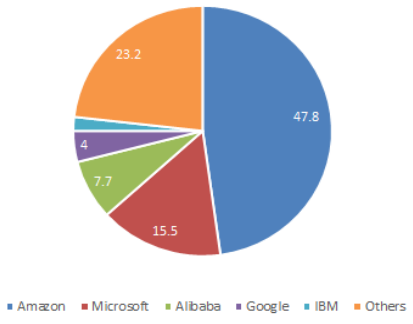
## Market Structure and Cloud Computing Prices from the supply-side: A European Perspective

Cloud services are global by nature. Regardless of where they are produced, they can be consumed anywhere in the world. However, most of the main CSPs (Cloud Service Providers) are originally from the US or China and their data processing centers are concentrated in a few countries. For instance, the major IaaS providers have the majority of their processing centers in G20 countries. This service regionalization is aimed at reducing the impact of technical issues such as broadband availability or communication latency as well as regulatory restrictions imposed on certain economic activities.

With regard to the market composition of cloud computing providers, there is no single cloud computing market but many. Depending on the type of service, we identify three broad markets: IaaS, PaaS and SaaS. Each of them could be subdivided according to the specific functionalities they offer. This is especially true of SaaS, where there is a wide range of available services that range from data analytics to video editing, including the services covered by Eurostat (email, office software, financial services and customer relationship management). The higher the level of abstraction of the service, the less standardized it is. However, even within the lowest levels of abstraction (IaaS), cloud providers offer a mix of standardized and proprietary technologies. This enables users to find a fair balance between portability, functionality and simplicity, since the more standardized the technology, the easier it is to change CSPs but the less personalized the services, as proprietary solutions tend to offer a wider range of functionalities or, at least, more seamlessly integrated ones.

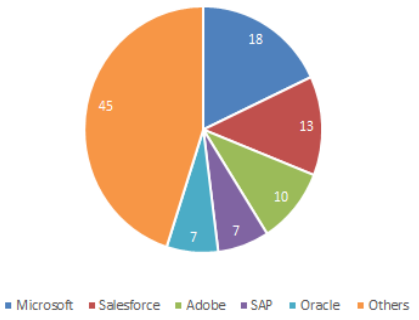
The global market for cloud computing providers is highly concentrated. Figure 6 shows the worldwide IaaS public cloud services market share. The major public cloud IaaS providers (Amazon 48%, Microsoft 16%, Alibaba 8% and Google 4%) account for almost 77% of the market share. For the SaaS public cloud services market share, we find a similar market structure although less concentrated than for IaaS. The main players (Microsoft 18%, Salesforce 13%, Adobe 10%, SAP 7% and Oracle 7%) account for 55% of the worldwide market share (Figure 7). Moreover, the cloud computing market is also experiencing rapid growth with revenues expected to almost double in the period 2018–2022 (Synergy Research Group, 2019). The forecast for the worldwide public cloud service revenue is USD 250 billion in 2020 and will be 30% higher in 2022 (Gartner, 2019).

Figure 6. **WORLDWIDE IAAS PUBLIC CLOUD SERVICES MARKET SHARE (%) 2018**




Source: BBVA Research, based on data from Gartner

Figure 7. **WORLDWIDE SAAS PUBLIC CLOUD SERVICES MARKET SHARE (%) Q1-2019**




Source: BBVA Research, based on data from Synergy Research Group

Finally, in relation to the cost of the services, in the last decades, ICT prices have been declining at the same time as digital capital asset quality has improved. Computing, storage and bandwidth costs have been falling very rapidly in constant-quality terms. According to Mussomeli et al. (2016), computing prices fell from USD 222 per million transistors to less than USD 0.06 between 1992 and 2016; storage cost decreased from USD 569 per GB to less than USD 0.01; and bandwidth prices dropped from USD 1,245 per Gbps to less than USD 10. Moreover, cloud computing prices dropped by over 30% per year during the 2000s.[4] This sharp decline in cost, coupled with more recent computing power improvements and better technological capabilities, has enabled companies to adopt cloud computing services on a large scale.

4: For instance, in March 2014, Google announced 30% price cuts for its cloud computing services and storage and one year later, announced further cuts of between 20% and 30% (Lardinois, 2014 and Yegulalp, 2015).

## Geopolitical Concerns

Data sovereignty is an important issue in European policy makers' agenda.[5] Businesses relinquishing control of their data to foreign companies is considered a systemic risk to an economy's competitiveness and sovereignty. Moreover, recent geopolitical tensions and trade wars have fed this ongoing debate, pointing out that European firms are too dependent on foreign-owned digital infrastructure, mainly those provided by the US and Chinese cloud computing suppliers. The main concern is caution about domestic champions and governments ceding control of their data to foreign cloud providers such as Amazon, Google or Alibaba, fearing European companies could lose control of their data.

Only a few European providers have relevance, albeit low, on the global cloud computing market. This lack of European or national 'cloud champions' is a strategic vulnerability and authorities are adopting measures in order to reduce the perceived risks and create the conditions for a surge in European cloud service providers. Among these measures, we can identify four main trends:

- Standardization of basic elements. DG Connect (European Commission) has facilitated a collaborative approach on this topic with the creation of Code of Conduct for data portability between different service providers in accordance with Article 6 of the FFNPD Regulation. In addition, recommendations have been issued for the development of a cloud certification scheme by ENISA, as foreseen in the Cybersecurity Act and the forthcoming works on Model Contractual Clauses for Cloud Services. These workflows are intended to reduce the likelihood of a cloud user being locked in a given CSP, ensure the highest level of security when using cloud services and speed up contractual negotiations between cloud users and providers, while ensuring control.

- Developing the current regulatory framework to ensure that cloud service providers are supervised by competent authorities. For instance, in the financial market, the European Supervisory Authorities have recommended that the European Commission consider the convenience of directly regulating and supervising cloud service providers as they are becoming critical providers for the financial industry.

- Increasing control over existing public cloud services. The German self-sovereign cloud was an initial attempt that involved Microsoft and various German firms, which received government support.

- Promoting the surge of European providers through public funding, the federation of existing cloud infrastructure [6] or the promotion of other distributed IT paradigms such as edge computing.[7] The European strategy focuses on the development of at least one European cloud infrastructure that allow firms and governments to store sensitive data with homegrown providers. In October 2019, Germany announced its "Gaia-X" project that intends to develop a federated cloud infrastructure.[8]

5: Under the Trump Administration's Cloud Act signed last year, US storage providers can be ordered to provide local authorities information held on their servers no matter where that data is physically located. A similar concept has been enshrined in Chinese law since 2017, in which citizen information must be stored in-country and accessible to authorities on demand.
6: This is already part of the European Open Science Cloud https://ec.europa.eu/info/news/eu-ministers-endorse-commissions-plans-research-cloud-2018-may-29_en
7: For instance, edge computing is one of the areas in which the European Commission recommends investing in the recent Policy and investment recommendations for trustworthy Artificial Intelligence
8: See https://www.bloomberg.com/news/articles/2019-10-28/germany-to-unveil-european-cloud-to-rival-amazon-alibaba

## Conclusion

The rise of the New Digital Economy is altering the dynamics of economic growth. Using cloud computing services fosters productivity (i.e. cost reduction) and innovation by providing flexibility, scalability and converting fixed costs into variable costs. It can be considered as a facilitator of innovation in software services, storage and management. It is a shift from owning ICT assets to purchasing ICT services. The evolution of cloud computing usage in the EU-15 countries is similar to that outside EU-15. Nearly 30% of the firms in our sample used cloud computing services in 2018. If we look at the type of service, high-dependence on cloud computing services (i.e. the usage of services such as financial software applications, Customer Relationship Management apps and computing power for firms' own software, which can be used together with others) is increasing among European firms. Large firms show greater growth in the consumption of high-dependent services (82%) than SMEs (75%). The use of low-dependence on cloud computing services in large firms grew by 50% between 2014 and 2018, whereas for SMEs this rate remained constant. This may increase the productivity gap between large firms and SMEs, however, the speed of cloud computing adoption does not depend solely on the size of the firm. The sector in which firms operate is an important feature that will be addressed in further research.

In terms of supply conditions, the cloud computing market is highly concentrated, with a small number of large providers supplying European and even global demand. Revenues are high and prices are falling while adoption figures are rising significantly. However, the most important providers' CSPs are originally from the US or China and this concentration is causing concern. Not having a European or national host is perceived as a geostrategic vulnerability, which has generated an ongoing debate on European countries' dependence on foreign-owned digital infrastructure. The European strategy focuses on the development of at least one European cloud infrastructure that allow firms and governments to store sensitive data with homegrown providers. In order to achieve this objective, high-quality and fast communication networks are a necessary condition to move to the cloud.

Further research is needed to understand important factors for cloud computing adoption by firms of different sectors and sizes. The implications of the adoption of cloud computing goes beyond economic growth; it is a strategic activity for an economy that also plays a key role in the global race for AI and enhances cybersecurity.

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## Appendix: List of Countries

| GEO\TIME | |
|---|---|
| EU-28 | EU-28 |
| | |
| Finland | FI |
| Denmark | DK |
| Sweden | SE |
| Norway | NO |
| Netherlands | NL |
| Ireland | IE |
| United Kingdom | UK |
| Belgium | BE |
| Estonia | EE |
| Croatia | HR |
| Malta | MT |
| Slovenia | SI |
| Lithuania | LT |
| Portugal | PT |
| Czechia | CZ |
| Slovakia | SK |
| Cyprus | CY |
| Luxembourg | LU |
| Spain | ES |
| Italy | IT |
| France | FR |
| Hungary | HU |
| Germany | DE |
| Austria | AT |
| Latvia | LV |
| Romania | RO |
| Poland | PL |
| Greece | EL |
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