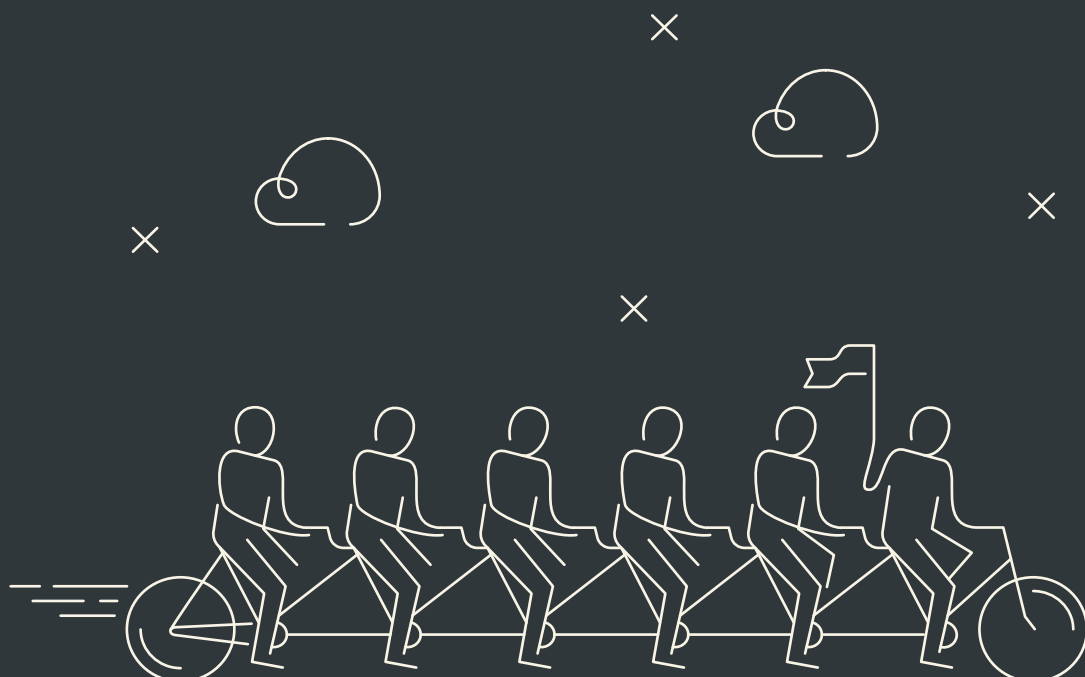


DIGITAL FRANCE

Economic Impacts of Google's Cloud Investment

An Implement Consulting Group study commissioned by Google | June 2022





ABOUT IMPLEMENT CONSULTING GROUP

Implement Economics is the economics expert unit of Implement Consulting Group.

The team is an adviser to corporate and government decision-makers. The team advises on digitalisation, regulation and international trade and has provided a series of impact assessments for the European Commission and governments in Europe, Asia and the Americas.

The team applies economic modelling, data analytics and econometrics to help solve worthwhile problems.

Headquartered in Copenhagen with offices in Aarhus, Stockholm, Malmo, Gothenburg, Oslo, Zurich, Munich, Hamburg and Raleigh (NC), Implement Consulting Group employs 1,000 consultants working for multinational clients on projects worldwide.

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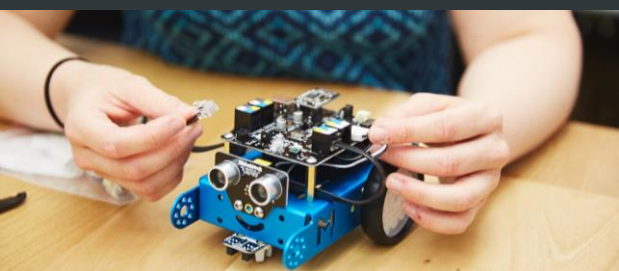
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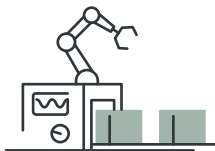
AI	Artificial intelligence
CAGR	Compound annual growth rate
CRM	Customer relationship management
DESI	Digital Economy and Society Index
ECB	European Central Bank
ERP	Enterprise resource planning systems
GDP	Gross domestic product
HDI	Human Development Index
IMF	International Monetary Fund
ICT	Information and communications technology
MFP	Multi-factor productivity
ML	Machine learning
OECD	Organisation for Economic Co-operation and Development
PUE	Power usage effectiveness
Tbps	Terabits per second
SME	Small and medium-sized enterprises

Disclaimer

This report (the "Report") has been prepared by Implement Consulting Group (Implement). The purpose of this Report is to assess the economic impacts of Google LLC's ("the Company") cloud infrastructure investment in France. All information in this report is derived from or estimated by Implement's analysis using proprietary and publicly available information. The Company has not supplied any additional data, nor does it endorse any estimates made in the report. Where information has been obtained from third-party sources and proprietary research, this is clearly referenced in the footnotes. The Report is based on work conducted from August 2021 to May 2022. Implement's analysis is, in addition to the primary market research and publicly available data, based on data provided by the Company. In preparing the Report, Implement has, without independent verification, relied on the accuracy of information made available by the Company. Implement will not make any representation or warranty as to the correctness, accuracy or completeness of the contents of the Report or as to the sufficiency and/or suitability thereof for the Company's or the reader's purposes, nor does Implement assume any liability to the Company, the reader or any other legal entities for any losses or damages resulting from the use of any part of the information in the Report. The information contained herein is subject to change, completion or amendment without notice. In furnishing the Report, Implement undertakes no obligation to provide the Company with access to any additional information. The Company does not endorse any estimates made in the report. Where information has been obtained from third-party sources and proprietary research, this is clearly referenced in the footnotes.

KEY FINDINGS

Google Cloud in France can strengthen the French government’s digitalisation agenda, increase productivity, generate high-salary jobs and enhance the IT skills of the French workforce. Google delivers cloud services through carbon-neutral data centres and is committed to knowledge sharing and developing tools that can help French companies innovate and reduce their carbon footprint.



PRODUCTIVITY

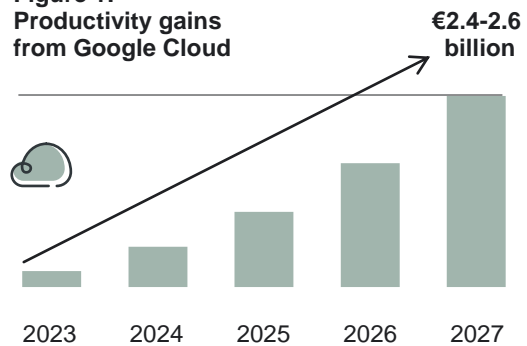
Cloud computing can increase economic growth in France ...

By 2027, Google Cloud can contribute:



Helping French companies digitalise and improve productivity supports long-term growth in France.

Figure 1: Productivity gains from Google Cloud

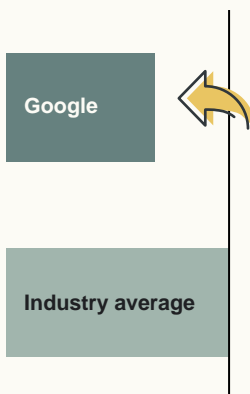


PLANET



... and contribute to the carbon-free transition

France targets a net-zero carbon goal by 2050. Google has highly efficient data centres and innovative AI solutions that help French companies reduce their carbon footprint.



Google data centres are **33%** more efficient than the industry average.

... generate jobs and develop people ...



PEOPLE

By 2027, Google can generate and sustain:



To gain the full potential of digitalisation, IT skill development is needed.



Google has helped 650,000 French citizens improve their IT skills – 49% of them are women.

ACCELERATING GROWTH VIA CLOUD

Google is already serving cloud customers in France. In 2022, Google will expand their cloud region in France to further support French companies in their digital transformation journey. Google's investments in new infrastructure and employment of highly skilled labour such as engineers and sales professionals will have a positive impact on the cloud ecosystem in France.

Cloud is essential for digitalisation and competitiveness in France

Digitalisation and competitiveness are key elements of the 2020 France Relance economic recovery and resilience plan.¹ Digitalisation is key to boosting local economic development, increasing resilience, improving productivity and raising the standard of living.²

Cloud services are a key part of the ongoing digital transition, and global cloud market revenue approached €300 billion in 2022.³ More than half of enterprise IT spending in key market segments will shift to the cloud by 2025.⁴ Cloud makes scalable computing resources available on-demand, fundamentally changing the economics of IT use from an ownership model with high upfront fixed costs to an outsourced model with highly variable costs.

The COVID-19 pandemic revealed that economies and firms need to be resilient and adapt to new ways of working.⁵ Cloud computing is a critical enabler of this adaptation in France and will accelerate the shift to digitalisation. Google is already in partnership with companies such as Sanofi, Carrefour and Airbus to provide them with the digital tools to fast-track innovation and respond to challenges such as COVID-19.⁶

In this report, Implement Economics assesses the economic impacts of Google Cloud in France. The impact assessment focuses on productivity gains and job creation from the accelerated adoption of cloud services such as Google Cloud by French firms.

Cloud adoption enables French firms to standardise and automate processes. This allows firms to:

- Scale up or down their information technology (IT) based on the business need.
- Access artificial intelligence and machine learning technologies to develop market and customer insights.
- Provide digital solutions that improve supply chain strategies.
- Improve customer service and quickly deploy customer-facing solutions.
- Reduce IT overhead costs by 30 to 40 percent.⁷
- Free up human and financial resources to innovate and sustainably grow their business.

Implement Economics applied the results from a recent OECD study⁸ to estimate the economic impacts of accelerated cloud adoption in France. The research finds that adoption of Google Cloud in France can generate and sustain around 13,000-14,000 jobs annually and contribute about €2.4-2.6 billion to French GDP by 2027. This includes productivity impacts across manufacturing, services and government. Separately, the direct, indirect and induced impacts of Google's investment in cloud technical infrastructure support around 4,600 jobs and contribute about €0.49 billion to French GDP by 2027. The analysis also reveals that positive cloud impacts are especially pronounced for SMEs and manufacturing.

To illustrate the potential for France, Implement Economics estimates that productivity gains in manufacturing in France can amount to around €5-6 billion annually if the French manufacturing sector reaches the EU average cloud adoption rate.⁹ This in turn can catalyse an array of positive economic effects in the rest of the economy.

All in all, accelerated cloud adoption will enable France's digitalisation, boost productivity and growth and create more highly skilled jobs in France.



"Improving the conditions for the creation and growth of new technology-based firms increases their direct job-creating potential while indirectly contributing to economy-wide growth and job creation through higher productivity, lower prices and greater product variety." – OECD¹⁰

FRANCE IS PUSHING FOR FASTER CLOUD ADOPTION

The France Relance plan for 2030 has three objectives: 1) carbon neutrality by 2050, 2) competitiveness by investing in future technologies and 3) cohesion and reducing inequality through workforce development, training and education in digital technology and innovation.

Following the France Relance plan, the French government declared their support for cloud adoption. In November 2021, the then French Secretary of State for Digital Transition and Electronic Communications, Cédric O, announced that a cloud acceleration strategy is underway as a key pillar of growth and to address socioeconomic challenges.¹¹ Cloud computing is also a key part of France's future investment programme.¹²

Implement Economics finds that Google's cloud services in France can help increase long-term productivity, improve the competitiveness of French enterprises and support new highly skilled jobs in France.

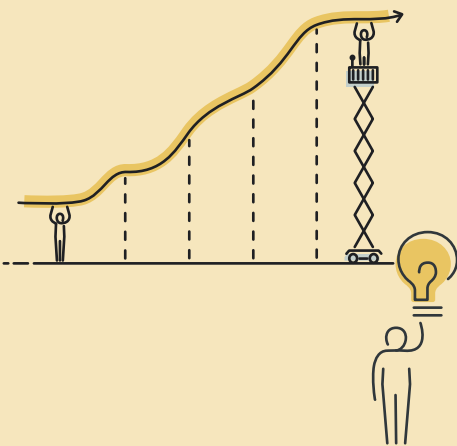
Furthermore, we find that Google's French cloud investment is aligned with the French government's overall priorities, i.e. to 1) reduce the carbon footprint through tech, 2) improve competitiveness through cloud adoption to enable innovation and 3) upskill the workforce.

This report evaluates the economic impacts of higher cloud adoption in France on productivity, people and planet based on two channels: productivity gains and jobs. In the first channel, we estimate productivity gains that French firms can undergo by migrating to the cloud. In the second channel, we estimate the impacts of Google's cloud infrastructure investment on GDP, jobs, incomes and strengthening of skills in segments such as engineering, sales and services.

CHANNEL 1

13,000-14,000 JOBS

€2.4-2.6 BILLION IN GDP



Productivity impacts of cloud adoption (channel 1)

Helping French firms digitalise and improve productivity is key to long-term growth in France. As more French firms digitalise and adopt cloud services, including Google Cloud, their productivity and operational efficiency increase. Implement Economics estimates that productivity gains from the adoption of Google's cloud services will contribute €2.4-2.6 billion to France's GDP by 2027. These productivity gains will improve competitiveness in terms of supporting research, innovation and entrepreneurship.

Supporting jobs that are fit for the future

Growth in digitisation is creating new occupations that require high-skilled workers and reshaping the future of work in France. These labour market dynamics make estimates of the job impact of productivity gains uncertain. Implement Economics projects that the productivity gains achieved by French firms from adopting Google's cloud services can generate and sustain 13,000-14,000 high-salary jobs by 2027. The new jobs can help mitigate the undergoing shifts in the French labour market.

CHANNEL 2

4,600 JOBS

€0.49 BILLION IN GDP



Impacts of cloud infrastructure investments (channel 2)

Separately, Implement Economics projects that Google's technical cloud infrastructure investments can support 4,600 jobs by 2027 and contribute €0.49 billion to French GDP by 2027.

APPLIED METHODOLOGIES

This report evaluates the impacts of Google's French cloud investment across three dimensions:

- **Productivity** – the economic impacts
- **People** – the social impacts
- **Planet** – the environmental impacts

Implement Economics uses a two-channel model to capture the economic impacts of Google Cloud in the French economy in the productivity and people dimensions:



1

PRODUCTIVITY IMPACT FROM CLOUD ADOPTION (CHANNEL 1)



Channel 1 measures the impacts of cloud adoption on productivity, which we refer to as catalytic impact. Firms that migrate from legacy on-premise data centres to the cloud will achieve productivity gains from more innovative work processes and higher operational efficiency. Implement Economics has applied results from a recent OECD study¹³ which finds that firms experience higher productivity growth after having adopted cloud services. Our extensive literature review of academic studies shows that cloud adoption also has positive impacts on overall firm performance, including firm survival, employment growth and increased sales.^{14&15}

2

IMPACTS OF CLOUD INFRASTRUCTURE INVESTMENTS (CHANNEL 2)



Channel 2 measures the direct, indirect and induced impacts of Google Cloud in terms of jobs and GDP contribution from Google's infrastructure investment.¹⁶ This methodology is based on input-output tables from the OECD, tailored to the French economy.¹⁷

Data input

This report relies on quantitative and qualitative data from multiple sources, including the OECD¹⁸, Eurostat, the International Monetary Fund, academic journals and corporate reports.

CLOUD IS KEY TO DIGITALISATION

The digital strategy, France Num, highlights digital transformation as: *“a major challenge for the competitiveness of French enterprises, the maintenance of activity in the territories and for employment.”*¹⁹

France improved its position among its European peers and ranked 15th in the 2021 Digital Economy and Society Index (DESI). The index, which tracks the EU Member States’ progress in digital competitiveness, identified opportunities to fast-track France’s digitalisation such as higher cloud adoption, electronic invoicing and AI.²⁰

Cloud computing is considered a key digital technology for enhancing productivity and innovation and delivering better services.²¹ Migration to the cloud allows organisations in sectors such as manufacturing to drive the digital transformation of their entire business by making core processes more efficient, deriving critical insights from data and improving how they reach and better serve their customers.²²⁻²⁵ For example, Groupe Renault has teamed up with Google Cloud to accelerate the digitisation of their production facilities and supply chain.^{26&27}

Groupe Renault and Google Cloud partner to accelerate Industry 4.0

Google Cloud’s solutions and experience in smart analytics, machine learning (ML) and artificial intelligence (AI) will enable Groupe Renault to improve their supply chain and manufacturing efficiency, production quality and the reduction in their environmental impact through energy savings.

These improvements will ultimately foster the development of new vertical solutions for the automotive industry.

“This collaboration is a perfect illustration of Groupe Renault’s digital strategy, applied here to the industrial field. This agreement and the commitment of our IT, manufacturing and supply chain management teams will allow us to accelerate the deployment of our Industry 4.0 plan designed to transform and connect our production sites and logistics processes around the world to improve our standards of excellence and performance. This partnership is also an asset for Groupe Renault employees who will benefit from high-level training in digital data management,” underlines José Vicente de los Mozos, Director of Manufacturing and Logistics, member of Groupe Renault’s Executive Committee.²⁸

23%

annual growth rate in global data creation between 2020-2025³¹



The creation and consumption of data is growing at an incredible speed. According to IDC forecasts²⁹, the amount of digital data created over the next five years will be greater than twice the amount of data created since the advent of digital storage. This means that global data creation and replication will experience a compound annual growth rate (CAGR) of 23 percent over the 2020-2025 forecast period. The amount of data created and replicated experienced unusually high growth during the pandemic due to the dramatic increase in the number of people working, learning and entertaining themselves from home.³⁰

CLOUD REQUIRES TECHNICAL INFRASTRUCTURE

Cloud services need data centres to store, process and send data all over the world. There are more than 7 million data centres around the world filled with racks and servers for high-performance computing.³² They function as the “beating heart” of the digital economy.

Citizens, governments and businesses use large amounts of information that data centres store, process and communicate.

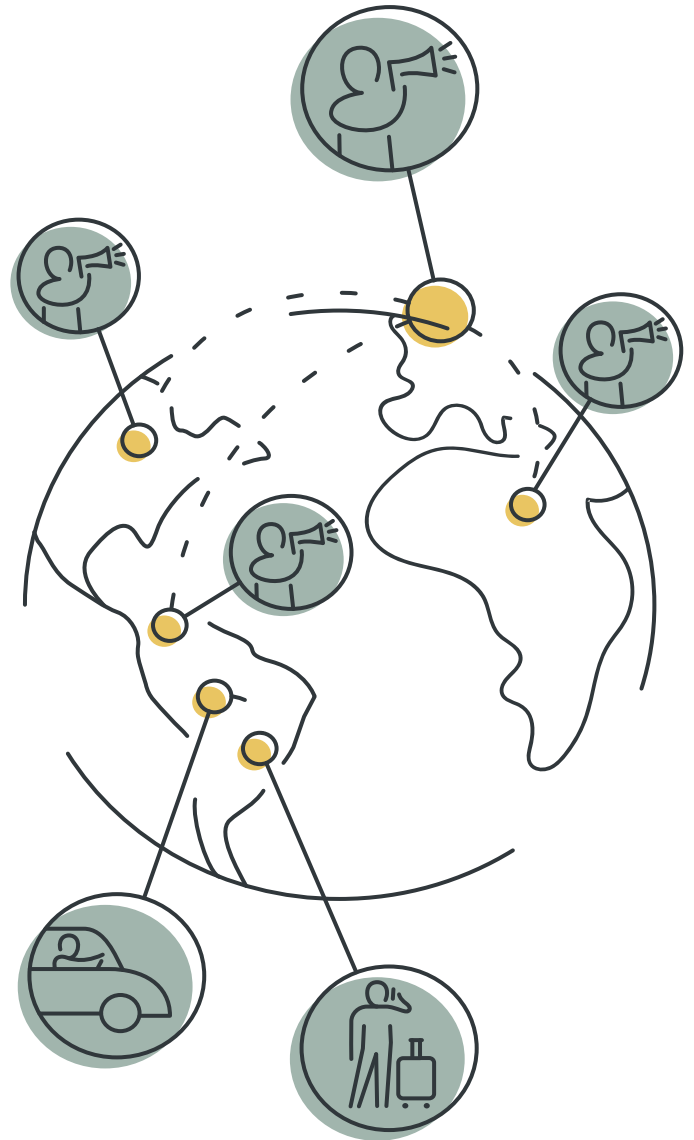
Data centres and cloud technology allow users to stream millions of videos, send emails and access social media on a daily basis. The technology enables businesses to operate global and local supply chains, optimise factories and conduct financial transactions and much more.

Operating cloud solutions at scale requires technical infrastructure investments as well as service and technical support. It requires setting up servers and racks, installing networking equipment and connecting to undersea fibre-optic cables. These investments and ongoing operations are needed to make the cloud work. It allows for data to traverse oceans and transmit rapidly from one point to another.³³

The Dunant subsea cable

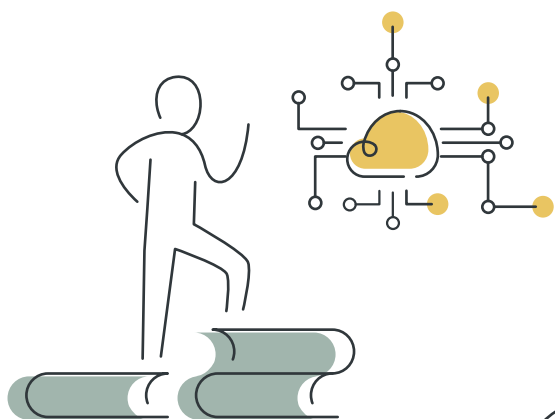
98 percent of international internet traffic is ferried around the world by subsea cables. A vast underwater network of cables crisscrossing the ocean makes it possible to share, search, send and receive information around the world at the speed of light. These cables help bring information to and from Google’s cloud data centres, providing reliable, low-latency connectivity at a time when it is more important than ever.³⁴

In 2021, the Dunant subsea cable connecting Virginia Beach in the US with Saint-Hilaire-de-Riez on the French Atlantic coast became operational. The Dunant cable delivers record-breaking capacity of 250 terabits per second (Tbps) across the Atlantic and will tightly integrate Google’s cloud region in Paris into Google’s global infrastructure.³⁵



If data is the lifeblood of the digital economy, data centres are the heart of digital infrastructure, and cloud services are the brains of the entire ecosystem.

CLOUD MIGRATION BENEFITS USERS



Lower ICT costs from economies of scale

Cloud services will replace large and expensive on-premise solutions. With cloud solutions, firms can access the computing power and memory storage of hyperscale providers like Google on a monthly basis.³⁶

Cloud services are available to users in a flexible and low-cost way, typically in pay-as-you-go rental packages, allowing firms to benefit from economies of scale irrespective of their size. A recent study found that adopting cloud services reduced IT overhead costs by 30 to 40 percent.³⁷



High-speed remote collaboration

The COVID-19 pandemic accelerated the adoption of remote work and service delivery. Firms and public sector organisations now rely on effective, cloud-based technologies that facilitate teamwork and customer interactions globally and locally.³⁸ Cloud services are distributed at scale, which allows for high-speed data transfers with low-latency connections from anywhere in the world.³⁹



Greater security at lower costs

With advanced security tools, cloud service providers protect sensitive data against cyber attacks. Moving to the cloud allows firms to outsource their ICT security to a large-scale operator such as Google Cloud. With the use of cloud services, data can be stored across multiple secure locations, allowing for disaster recovery and resiliency planning.⁴⁰



Catalyse innovation through data analytics

Cloud services allow for firms of any size to leverage the benefits of AI solutions.⁴¹ This can give critical insights from data – such as consumer spending patterns, client behavioural activity and financial data. Using advanced data analytics can generate higher revenues for businesses.^{42&43}



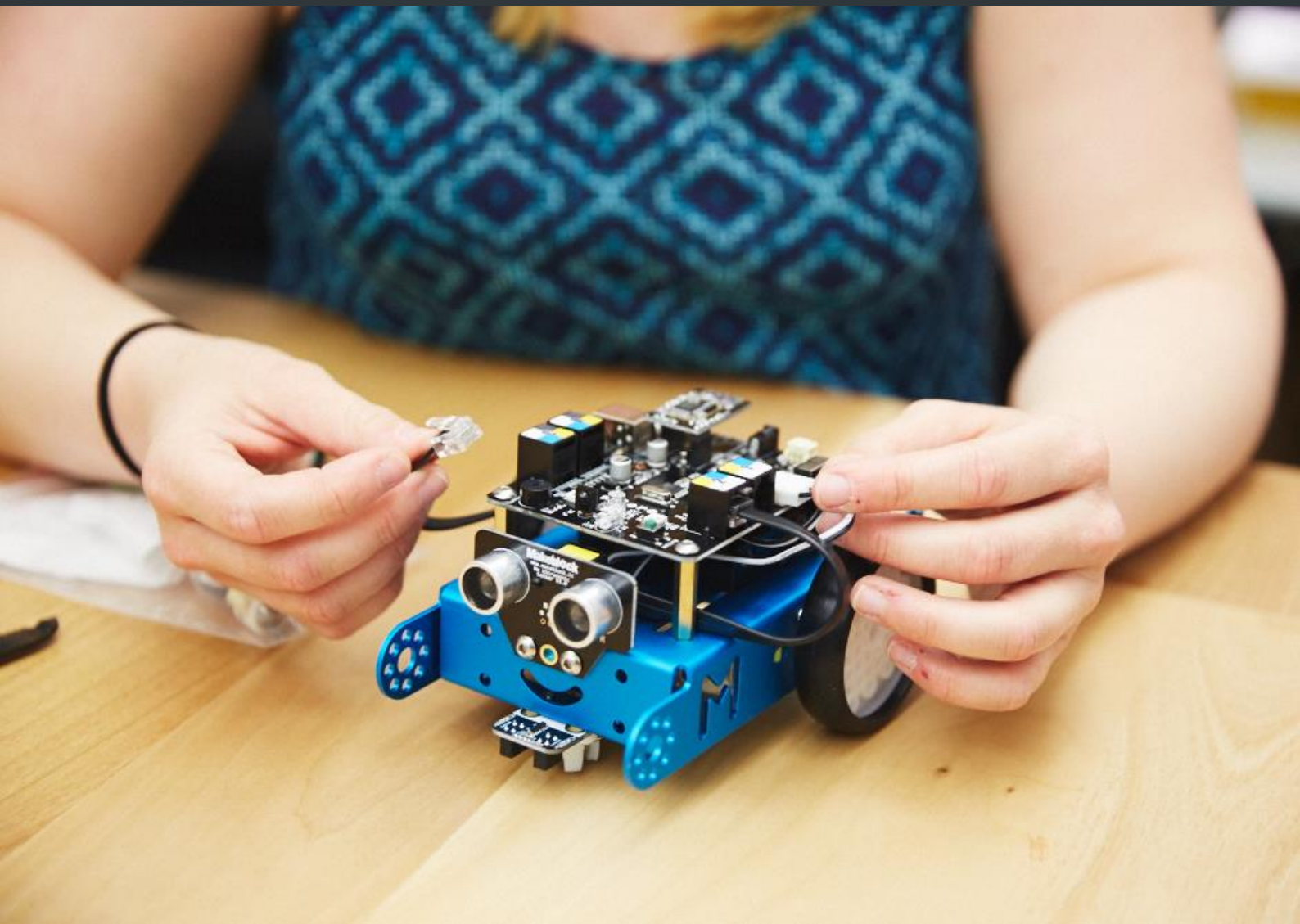
Promote sustainability

Multi-tenancy cloud storage systems allow firms to reduce overall power and energy. Large-scale data centres are much more energy-efficient than on-premise data centres.

Lawrence Berkeley National Laboratory estimates that if 80 percent of the servers in private clouds move to hyperscale cloud facilities, energy use would decrease by 25 percent.⁴⁴

PRODUCTIVITY

THE ECONOMIC IMPACTS



CLOUD ADOPTION ENHANCES PRODUCTIVITY

In 2022, Google is launching a new cloud region in France. Increased cloud adoption will improve the competitiveness of French enterprises. This will help French businesses find new ways to innovate and contribute to the country’s economic recovery.

OECD research shows that the adoption of cloud services increases firm productivity and that even small increases in adoption rates can increase industry-wide productivity growth.⁴⁵ Productivity growth is a long-run source of economic welfare, and even small changes to productivity growth can generate significant contributions to economic welfare. Google’s cloud services are part of the ongoing migration of French firms to the cloud.

1

CHANNEL 1: PRODUCTIVITY IMPACTS OF CLOUD ADOPTION

When Google establishes a new cloud region, it will contribute to accelerating growth in cloud solutions in France.

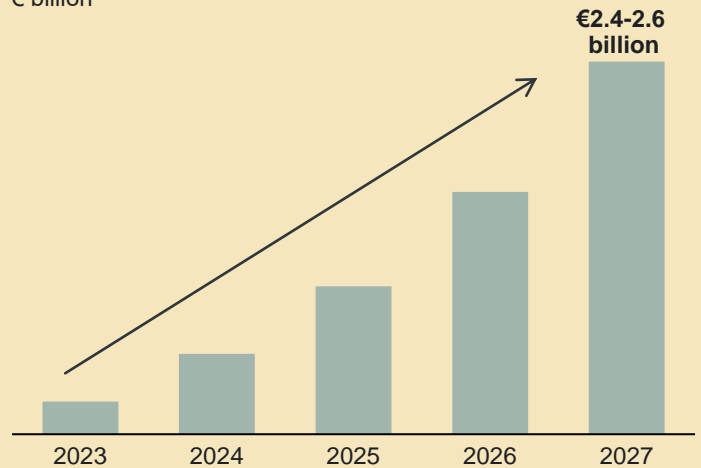
€2.4-2.6 billion in GDP⁴⁶ contribution through productivity gains related to Google Cloud

French firms that adopt cloud services experience higher productivity due to the cost-effective scaling of IT operations that cloud services offer to users.⁴⁷ Cloud services catalyse technology-enabled business innovation, reduce ICT overhead costs and lead to higher productivity growth.⁴⁸

The projection of Google Cloud’s contribution to productivity growth towards 2027 is based on OECD estimates of the impacts on firm productivity.

Google’s projected share of these gains⁴⁹ assumes that Google’s cloud services have the same average productivity impact as other cloud solutions in the OECD study.⁵⁰ The projection includes a conservative estimate of the productivity impact for cloud clients in financial services and in the public sector, which is not covered in the original OECD research.⁵¹ Note that there are additional productivity impacts not measured here relating to firms with less than ten employees (see appendix for details).

Figure 1: Productivity gains from Google Cloud
€ billion



2

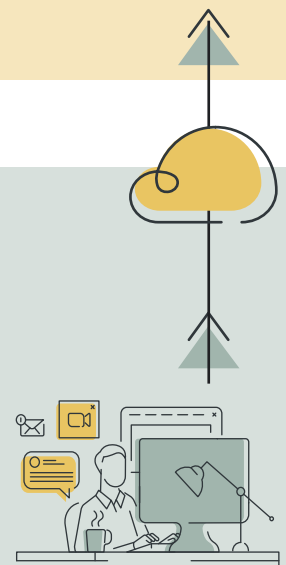
CHANNEL 2: IMPACTS OF CLOUD INFRASTRUCTURE INVESTMENTS

€0.49 billion in GDP contribution from the technical operations of Google Cloud in France and the provision of cloud services. Google’s cloud region requires investment in technical equipment and skilled people on the ground. This gives another perspective on the impacts of Google’s investment in France.⁵²

Table 1: Channel 2 GDP impact in 2027 across the value chain in France

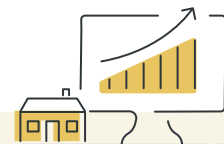
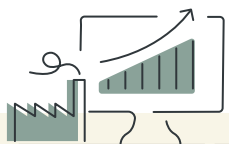
	Direct	Indirect	Induced	Total
GDP	€240m	€100m	€150m	€490m

Source: Implement Economics analysis using input-output model



LARGER PRODUCTIVITY GAINS FOR INDUSTRY AND SMES

Cloud adoption increases economy-wide productivity. Furthermore, the OECD study shows that cloud benefits are more pronounced in the manufacturing industry and for small and medium-sized enterprises (SMEs) – especially for small firms with 10-20 employees.⁵³



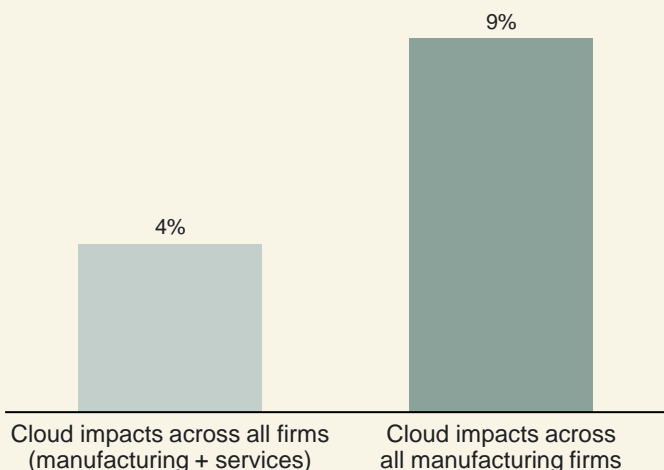
Manufacturing firms

The OECD study finds that cloud adoption increases overall productivity across all firms – not just those adopting cloud but also non-adopters through spillovers. Productivity gains from cloud adoption in the manufacturing industry are more than double the average effect across all sectors.

Assuming a 1 percentage point increase in the cloud adoption rate every year for the next ten years, the average productivity gain across manufacturing and service firms will be 4 percent. In comparison, the average productivity impact across manufacturing firms is 9 percent, compared to a scenario with no increase in adoption rates.

Productivity gains are even larger for complex cloud services such as accounting applications and CRM software.⁵⁴

FIGURE 2: Increase in multi-factor productivity after 10 years with +1 percentage point adoption per year (Percent)



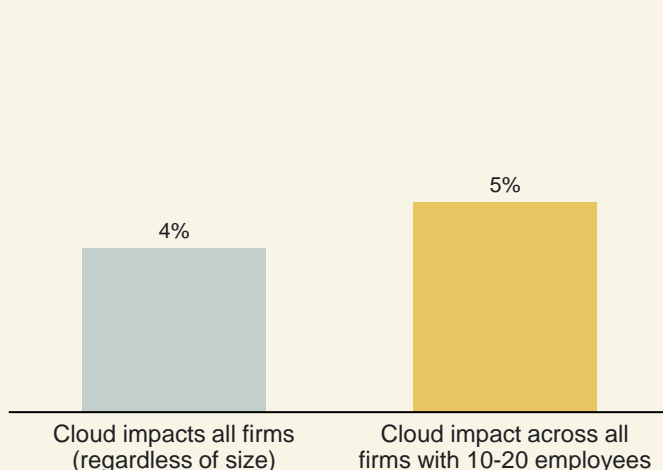
Small firms

Small firms in the EU are less digitalised than larger ones, and the gap has persisted despite an overall increase in digitalisation.⁵⁵ Accelerating the digitalisation of SMEs and start-ups is a priority for the French government.⁵⁶

The OECD study finds that cloud services generate larger productivity gains for smaller firms. In addition, the study finds that implementing cloud services is less demanding than other digital technologies. Cloud services do not require large upfront investment and require fewer in-house IT skills and expertise. This makes cloud especially attractive for smaller firms, which can support the French government in helping small firms become more digitalised.⁵⁷

Assuming a 1 percentage point increase in the cloud adoption rate every year for the next ten years, small firms (10-20 employees) will have 5 percent higher productivity than otherwise, while the average impact across all firm sizes is 4 percent. These results suggest that cloud adoption can be particularly helpful for SMEs.

FIGURE 3: Increase in multi-factor productivity after 10 years with +1 percentage point adoption per year (Percent)



CLOUD INFRASTRUCTURE INVESTMENTS UNLEASH POTENTIAL

Catching up with EU adoption rates

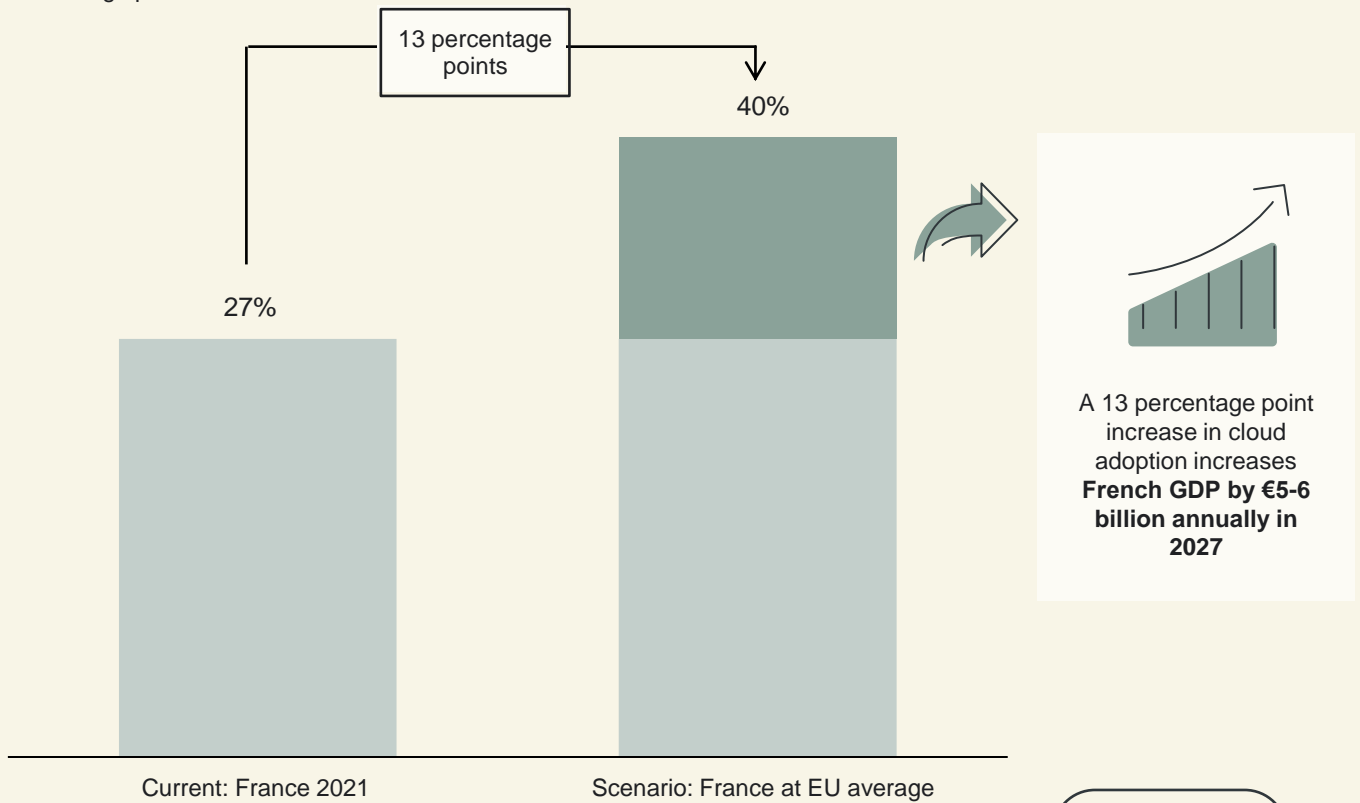
France is the home of many world-leading manufacturers with complex value chains and advanced manufacturing.

From 2020 to 2021, the adoption rate for French manufacturing firms increased from 25 percent to 27 percent. However, France can potentially reap large economic benefits if French cloud adoption in the manufacturing sector reaches the EU average (40 percent).⁵⁸ The French Google investment is expected to contribute to the acceleration of cloud adoption and help unleash productivity gains in French global firms.

If the French manufacturing sector’s cloud adoption reaches the EU average, it is estimated to generate productivity gains worth €5-6 billion annually for the French economy in 2027.

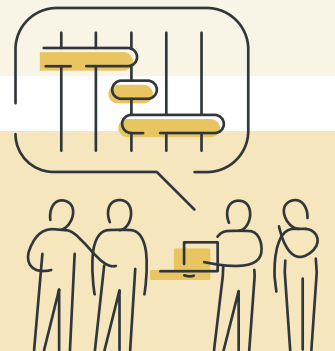
FIGURE 4: ADOPTION OF CLOUD FOR FRENCH MANUFACTURING FIRMS

Percentage points



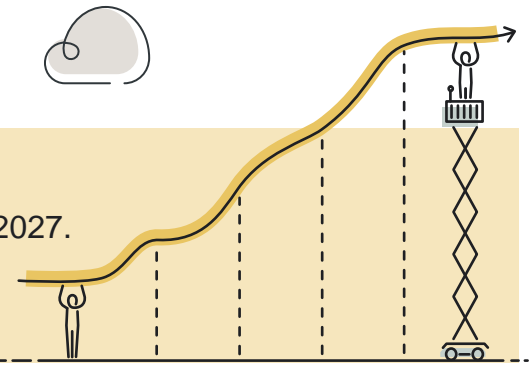
The estimate relies on a recent OECD study which uses firm-level time series data for 20 European countries.⁵⁹ The above estimate assumes that this average impact will apply going forward.

The OECD study finds that cloud adoption accelerates growth for the less productive firms, which suggests that returns are not diminishing.



HIGHER PRODUCTIVITY GENERATES WEALTH AND WELFARE

Migration to Google Cloud improves operational efficiency. These impacts are lasting and expected to increase towards 2027.



Increase in cloud adoption ...

increases productivity for all firms in the industry...

which benefits the French economy broadly

The adoption of new technologies is usually measured in terms of adoption rates, i.e. the share of firms in a given industry or economy that adopts the new technology such as cloud services. In France, for example, 31 percent of manufacturing and service firms use cloud services in one form or another.⁶⁰

The OECD study finds that productivity increases in the entire industry (i.e. across adopters and non-adopters) when more firms adopt cloud services.⁶¹

Specifically, the OECD study finds a significant impact on firm-level productivity growth.⁶²

Over time, productivity growth can lead to higher innovation and optimisation. Higher productivity provides French consumers and workers with better and cheaper products, improved services and higher wages, which can enhance the quality of life.⁶³

A foundation for improvements to quality of life

Productivity generates wealth and welfare through real wage increases for the average French worker.⁶⁴ Multi-factor productivity (MFP) measures the amount of output (goods and services) produced per unit of input (labour, capital, energy, materials and purchased services).⁶⁵

When MFP increases, each hour of work produces a larger unit of employee output, so each labour hour generates more revenue – which in general is associated with higher wages for workers.^{66&67}

Income per capita is an important measure of quality of life. For example, it is one of three main components of the Human Development Index (HDI) along with health and knowledge.⁶⁸

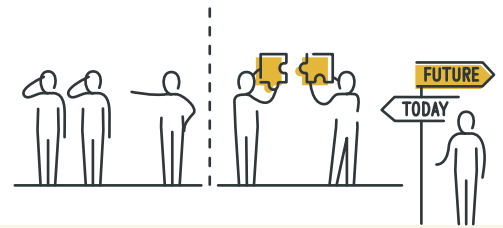


PEOPLE

THE SOCIAL IMPACTS



CLOUD ADOPTION SUPPORTS JOBS FOR THE FUTURE



“Improving the conditions for the creation and growth of new technology-based firms increases their direct job-creating potential while indirectly contributing to economy-wide growth and job creation through higher productivity, lower prices and greater product variety.” – OECD⁶⁹

Supporting jobs that are fit for the future

When firms become more productive, some jobs become redundant, while new and usually more productive jobs emerge. OECD research shows that *“historically, this process has led to net job creation, as new industries replace old ones and workers adapt their skills to changing and expanding demand.”*⁷⁰

The total employment in France is determined by labour supply and the functioning of the labour market. The wage levels of workers in France will be positively influenced by increasing

productivity. This relates to the ongoing skilling and up-skilling of the labour force which is needed to ensure a match between the requirements of the new technology and the skills available.⁷¹ This underlines the importance of creating the labour force of the future and building the technology skills of the workforce alongside the increase in the adoption of cloud. Between 2011 and 2017, four in ten additional jobs created in the EU were in ICT task-intensive occupations.⁷²



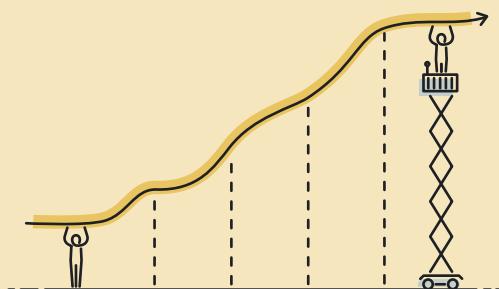
Channel 1 impacts on jobs

Channel 1 impacts refer to the productivity gains for users, i.e. French firms and public institutions using cloud solutions related to Google Cloud in France.

As French firms become more productive and competitive, they will, all things being equal, require new and more future-proof jobs in the region of 13,000-14,000 jobs.⁷³ The corresponding labour income impact is projected to be €0.9-1.0 billion in 2027.⁷⁴

These new jobs are expected to be created in productive and digitalised firms that will contribute to an economically sustainable development of the French economy in the long run.

“New industries such as internet-based services and environmental goods and services play an important role for translating technical change into productivity and employment.” – OECD⁷⁵



Channel 2 impacts on jobs and labour income

Separately, the investment in new cloud infrastructure in France also supports highly skilled jobs.

Providing cloud services requires highly skilled sales and engineering professionals at Google Cloud in France. It will also require activity at the resellers of Google’s cloud services.⁷⁶ The 1,700 direct jobs are not strictly Google headcount but also include resellers and subcontractors.

Furthermore, Google Cloud will indirectly support jobs throughout the French economy via local supplier purchases. Finally, wage spending by these employees supports local jobs throughout the local economy.⁷⁷

Almost 4,600 jobs are projected to be supported throughout the value chain in relation to the new French Google cloud region. The corresponding labour income impact is projected to be around €250 million in 2027.

Table 2: Channel 2 jobs and labour income impacts in 2027 across the value chain in France

	Direct	Indirect	Induced	Total
Labour income	€120m	€60m	€70m	€250m
Jobs	1,700	1,100	1,800	4,600

Source: Implement Economics analysis using input-output model

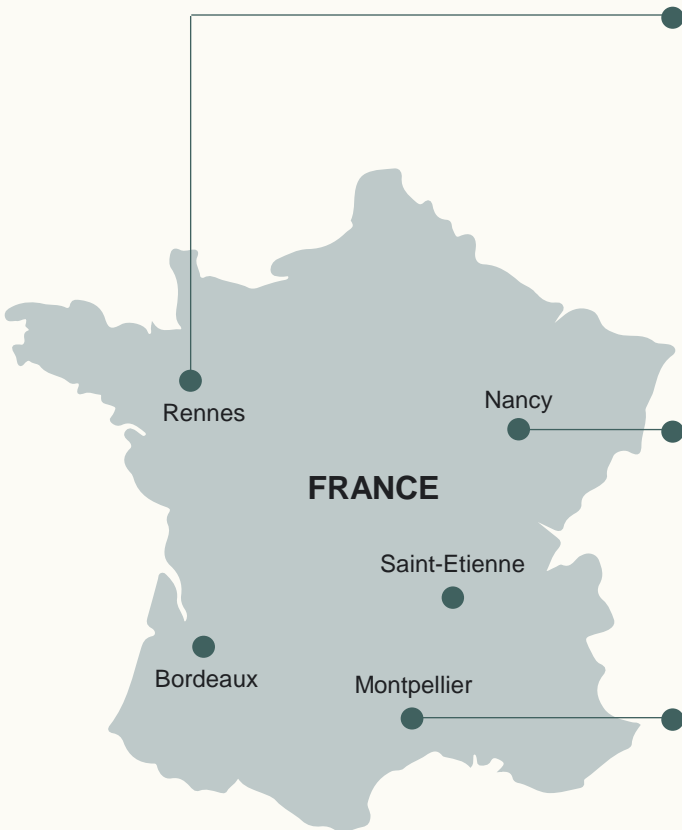
IT SKILLS ARE NEEDED TO EASE GROWTH CONSTRAINTS

Google contributes to IT skill development in France through courses designed to prepare the French society for embracing the opportunities offered by the technology.

Cloud adoption can be thwarted by skill and occupational shortages. There are synergies between digitalisation and skill development, and the OECD concludes that “*broad-based policies that support the diffusion of digital technology, such as the roll-out of high-speed broadband and the upgrade of the skill pool, can bring important aggregate productivity benefits.*”⁷⁸ Google supports local skills through programmes such as Google Ateliers Numériques, a French training programme that provides small businesses, students and job seekers with relevant skills and digital tool training for free.⁷⁹ Since the Google Ateliers Numériques programme was launched in 2012, Google has trained more than 650,000 French citizens – 49% of the participants were women.^{80&81} With five physical Grow with Google hubs in France (Nancy, Rennes, Montpellier, Bordeaux, and Saint-Etienne) and partnerships with French universities,^{82&83} Google contributes to increasing digital skills and creating opportunities for French citizens.



Google is helping women grow professionally across France



● Anne-Cécile, a middle-aged woman from Rennes, France, has always been the creative type with a passion for handcrafting bracelets made of miyuki pearls. When she found herself unemployed at 52, she wanted to try something completely different: selling her products online. But she did not know where to start to get her business off the ground. So she visited the Grow with Google hub in her hometown and signed up for ten free digital skills courses through the Ateliers Numériques (French for “digital workshop”) programme. After learning the basics of search engine optimisation and online communication, Anne-Cécile not only launched her online jewellery business but also landed a job in marketing a few months later.⁸⁴

● 23-year-old Océane, who was unemployed in Nancy, wanted to work in digital marketing but felt that she lacked the hard skills she would need to secure a role. To upskill and increase her knowledge, she completed every training on digital marketing at Google Atelier Numérique in Nancy and took private sessions with coaches. During her time at the hub, she met with a recruiter and, after making that connection, is now employed full time as a web marketing manager.⁸⁵

● Karine is an ethnologist, reporter, speaker and founder of the company Terres Indigènes. Karine was planning a trip and cultural exchange with indigenous people in Southeast Asia. She had a hunch that she needed a digital crowdfunding campaign but did not know where to start. She took advantage of the resources available at the Grow with Google hub in Montpellier, attending ten one-on-one coaching and training sessions on using YouTube and social networks. She then successfully ran a €20,000 crowdfunding campaign funded by hundreds of contributors.⁸⁶

PLANET

THE ENVIRONMENTAL IMPACTS

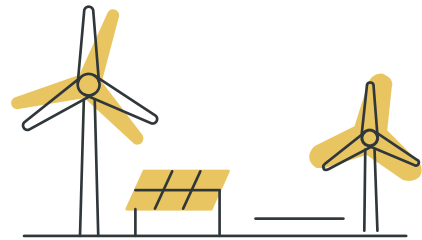


GOOGLE CLOUD IS HIGHLY ENERGY-EFFICIENT

Cloud services will grow strongly in the coming years. This means that the infrastructure and equipment to deliver this must follow suit; however, growth should not be at the expense of climate commitments. Therefore, it is essential to focus on the energy efficiency of cloud technology and on reducing the carbon footprint.⁸⁷

Google has been transitioning to clean energy for more than a decade – and is a front-runner in the industry.

Google has been decarbonising their operations and offsetting their own emissions since 2007. As of 2020, Google has eliminated their entire carbon legacy (covering all operational emissions before the company became carbon neutral in 2007) through the purchase of carbon offsets. This means that Google’s lifetime net carbon footprint until then is zero.⁸⁸ In 2020, Google set their most ambitious sustainability goal to date: by 2030, Google aims to run on carbon-free energy (CFE) – around the clock – at the company’s data centres and offices worldwide.⁸⁹ The carbon-free commitment is part of a broader sustainability commitment, which includes advancing the circular economy and water sustainability.^{90&91}



Google cloud is highly energy-efficient

Hyperscale data centres reduce energy use

Multi-tenancy cloud storage is much more efficient than private company servers.⁹² Lawrence Berkeley National Laboratory estimates that if 80 percent of servers in small, private data centres moved over to hyperscale data centres, it would result in a 25 percent drop in energy use.⁹³

Google is more efficient than the industry average

Efficiency improvements applying AI have contributed to the overall power usage effectiveness (PUE) of Google’s data centres. Google’s average PUE is 1.11 – which is 33% more efficient than the industry average.⁹⁴

Figure 5: Power usage effectiveness (PUE)⁹⁵



Google continues to achieve high energy efficiency by using advanced technological solutions and by making data centres work harder when the sun is shining and the wind is blowing.⁹⁶ Compared to five years ago, Google delivers six times as much computing power with the same amount of electrical power.⁹⁷ For example, Google has reduced the energy needed to cool their data centres by 30 percent by using machine learning.⁹⁸

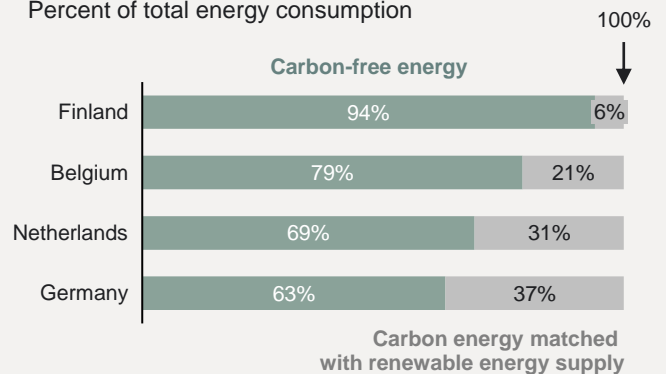
Google cloud mainly relies on carbon-free energy

The energy consumption of Google’s current data centres in the EU is 63 to 94 percent carbon free.⁹⁹

Wind and solar power do not work in all places at all times. This means that Google data centres sometimes produce more renewable energy than they need to consume, which is then fed into the local grid and is available to other local energy consumers. Overall, Google matches 100 percent of their electricity consumption with renewable energy.¹⁰⁰

In 2017, Google became the first company of its size to 100% match their annual electric consumption with renewables.¹⁰¹

Figure 6: Google energy consumption¹⁰²
Percent of total energy consumption



GOOGLE CLOUD HELPS CUSTOMERS BUILD A MORE SUSTAINABLE FUTURE

Technologies reduce energy consumption

France has the ambition to reach net-zero emissions by 2050. The French government relies on technological and innovative solutions to reach their goals: *“This ambition must translate into public and private investments, and [...], channelling resources towards meaningful initiatives and making the call between swiftly rolling out mature technologies or awaiting new solutions enabled by the innovations in progress.”*¹⁰³

Business leaders in France share the ambition of using technology to meet climate goals. In a recent survey, 76 percent of the surveyed executives in France said that technology enables the development of new products and services that leverage more sustainable methods.¹⁰⁴

Google Cloud delivers advanced technologies that can help French companies and public institutions reach this goal¹⁰⁵

Google is committed to creating tools, sharing expertise and investing in advanced technologies that help others in the transition to a carbon-free world. Google has recently made a cloud solution available to commercial buildings and industrial facilities such as airports, shopping malls and other data centres, helping them reduce their carbon impact. For example, by using Google AI to analyse large data sets and forecast demand, the French retailer Carrefour managed to drastically reduce food waste.¹⁰⁶ “Google Cloud has given us the flexibility to adapt our infrastructure and the agility to make changes very quickly. We’ve been able to adopt and standardise industry best practices across the whole company and provide the highest possible service to our customers” (Carrefour).¹⁰⁷

Google enables individual citizens to reduce their carbon footprint

New features on Google Search and Google Maps help individuals make the sustainable choice.¹⁰⁸



Eco-friendly routing

A new feature on Google Maps directs drivers to the most fuel-efficient route when it has roughly the same estimated time of arrival as the fastest route. The eco-friendly routing model optimises lower fuel consumption by looking at key factors like road incline and congestion. In addition to optimising individual routes, Google is helping cities reduce carbon emissions by using AI to optimise traffic lights.^{109&110}



Sustainable houses

Nest Renew is a new programme that allows households to become more energy-efficient by automatically shifting their energy consumption to times when the energy is cleaner. This flexibility is key in making better use of clean energy on the local grid.¹¹¹



Sustainable shopping

New search tools allow consumers to make more sustainable choices for their homes. Choosing the right home appliances can have an impact on the environment. Google is adding new suggestions to the shopping tap when consumers search for energy-intensive products like furnaces, dishwashers or water heaters. These suggestions will help consumers narrow their search to a more sustainable and cost-effective option.¹¹²



Sustainable travel

Google adds information on carbon emissions directly to Google Flights. This gives travellers transparency on CO2 emissions associated with every flight and flight seat. Google is also making the sustainability practices of hotels more transparent. When searching for a hotel on Google, travellers can easily see which hotels have meaningful sustainability practices.¹¹³



APPENDIX



LINKS BETWEEN CLOUD ADOPTION AND PRODUCTIVITY

Challenges of solving the Productivity Paradox

Firms use cloud computing services to improve their operations and business models, and the migration to cloud should be expected to enhance their productivity.

While several studies have found a positive impact of the adoption of cloud computing on firm performance (employment or turnover growth) and survival rate, only few studies have found an impact on productivity. This missing link has been named the “Productivity Paradox”.

A recent OECD¹¹⁴ study applies solid econometric methods to capture the productivity impact of cloud computing.

Findings of a recent OECD study

Relying on adoption rates at an industry level, the OECD study finds a positive and statistically significant impact of cloud adoption on firm-level multi-factor productivity (MFP).¹¹⁵ To measure the impact of cloud adoption on firm-level MFP as accurately as possible, the econometric model controls for:

- **Innovation spillovers** | MFP growth of the productivity frontier (average MFP among the five percent most productive firms in the industry) is included to control for industry differences in frontier productivity.
- **Convergence** | Lagged distance to the frontier is included to control for industry differences in how firms below the frontier benefit from catching up.
- **Firm characteristics** | Firm size and age are included to account for differences in firm-level productivity.
- **Fixed effects** | Industry and country-year fixed effects are included to account for unobserved common productivity drivers.

Main findings of the OECD study

The OECD study is based on cloud adoption during the period 2010-2016 for 20 European countries. The study provides robust evidence that cloud adoption in an industry is associated with productivity gains at a firm level. The study distinguishes between:

- **Basic cloud computing** | Refers to ICT services used over the internet as a set of computing resources.
- **Complex cloud computing** | Refers to a subset of relatively more complex uses of cloud computing (e.g. accounting applications, CRM software or computing power).

Eurostat does not collect data on cloud adoption for the public and financial sectors and only for enterprises with more than ten employees.¹¹⁶ It has therefore not been possible for the OECD study to estimate productivity impacts for this part of the economy.¹¹⁷

Increased productivity translates into higher GDP

Higher productivity from cloud adoption helps firms produce more output with their available resources. When the firm’s capital stock and employment are held constant, higher productivity will enhance GDP contribution one-to-one.¹¹⁸

To estimate Google’s contribution to productivity growth, the study takes the following approach

1) Estimating the overall productivity contribution of cloud adoption

- Assuming an annual growth rate in cloud adoption based on the historic (pre-pandemic) growth rate.
- Calculating the MFP productivity growth impact in manufacturing and services from the increase in adoption rate using a non-cumulative interpretation of the parameter estimate from the OECD study.¹¹⁹
- Using country-level data on productivity and value added in manufacturing and services for firms with more than ten employees.

2) Estimating Google’s share of the total productivity contribution

- Assuming Google’s share of total productivity contribution in manufacturing and services is equal to the current global market share of Google Cloud.
- Assuming a moderate MFP productivity growth impact (half of OECD impact) for the Google Cloud customers in public and financial services.



SEVERAL POSITIVE IMPACTS ARE NOT CAPTURED

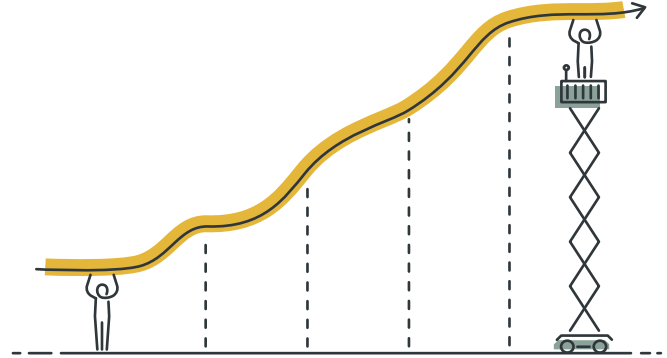
Robustness of the OECD study

The OECD study¹²⁰ runs several tests for robustness that enhance the credibility and applicability of the study.

In particular:

Catching up | The study confirms that the productivity increase of lagging firms is achieved via digital adoption rather than a catch-up to more advanced firms.

Spillovers | The study confirms that firms benefit from their own digital adoption and positive productivity spillovers when other firms in the industry adopt new digital tools.



The OECD findings are likely to underestimate positive impacts

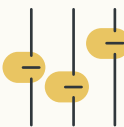
The OECD study addresses some of the main challenges of assessing the causal link between cloud adoption and productivity. However, the study will tend to underestimate the positive impacts of cloud adoption on productivity due to:



Exclusion of high performers | The study excludes the cloud impact for firms at the productivity frontier (the top five percent in each industry), which may lead to an underestimation of the impacts since frontier firms are also likely to be early adopters of cloud and in particular complex cloud.



No reallocation impacts | Focusing on firm-level impacts, the study leaves aside reallocation impacts within industries as well as cross-industry spillovers (economy-wide productivity gains when highly productive firms and industries grow at the expense of their less productive parts of the economy). This will tend to underestimate productivity and socioeconomic gains from cloud adoption.



Intensity of use not considered | The measure of digital adoption used in the study is binary at a firm level (surveyed firms report using the technology or not), and it does not explore differences in adoption intensity (e.g. in the number of different cloud services adopted). If there are synergies between the adoption of multiple services, the study will tend to underestimate the total impacts.



Impacts reflect short-term gains | The study measures the instantaneous impacts on a firm's productivity after cloud adoption. If it takes time for the firm to fully integrate and benefit from cloud adoption, the study will tend to underestimate the long-term impacts of cloud adoption.



Impacts for micro-firms and the public and financial sectors are not included | The OECD study covers only the service and manufacturing sectors. Likewise, firms with less than ten employees and the most productive firms are excluded in the study. Because some industries and firms are excluded, we assess that the impacts presented in this report are lower bound estimates.

DATA AND MODELLING ASSUMPTIONS FOR THE INFRASTRUCTURE INVESTMENT ASSESSMENT

The analysis is based on quantitative economic modelling using national accounts data

To quantify the impact of cloud operations, we have applied an input-output model that is based on data from the national accounts describing the flow of final and intermediate goods and services between industries. Results are reported in 2021 price levels using the average exchange rate for 2021 (€0.85 per \$).¹²¹

The relationship between an industry's inputs and outputs is assumed to be constant in input-output models, which implies that industries operate under constant returns to scale.¹²²

Based on the input-output tables, we have calculated a set of multipliers reflecting the expenditures that Google has from operating the cloud. This allows us to assess the economic impacts of Google's cloud operations on the rest of the economy. We use the tables to compute the GDP (value-added), employment and labour income multipliers.

The impacts assessed in an input-output model are gross impacts, meaning that they do not consider any potential diversion of resources from other activities in the French economy.

Data sources applied in the study

This study relies on two complementary sources:

- 1. OECD Structural Analysis Database (STAN) 2021 ed.** ¹²³
This data provided harmonised national input-output tables for 45 industries. The STAN database provides employment data (total employment) and labour compensation data by industry.
- 2. Google's estimate of operational expenditure and employment**
Google has shared their expectations in terms of the anticipated operational expenditure divided into wages, maintenance, space and power and other costs. Google has also shared the current and expected employment numbers of sales and engineer personnel.

Key assumptions about the impacts of increased expenditures

The impacts of selling and operating cloud services are based on the operating expenditures of Google's existing cloud activities and the expected increase in their capacity.

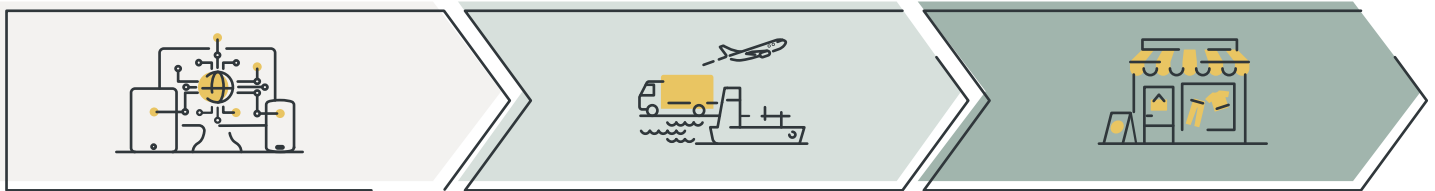
All IT equipment is conservatively assumed to be 100 percent imported and thus has no impact domestically. However, installation costs and maintenance of ICT hardware are – by nature – performed domestically and are therefore included in the impact assessment.

In addition, sales personnel, engineers, resellers, maintenance, finance, canteen and other office activities also generate direct employment impacts related to cloud services. These additional employment impacts were found using operational expenditures and the employment coefficient from the information and other communication industry.



CLOUD TECHNICAL INFRASTRUCTURE INVESTMENTS SUPPORT JOBS

Separately from the productivity impacts (channel 1), Google’s cloud region infrastructure investment in France will generate economic activity (channel 2). The jobs supported by Google in France through the delivery of cloud technical infrastructure investments (direct impacts) require upstream purchases from local suppliers (indirect impacts) and spur downstream spending from employees and suppliers’ wages into other industry sectors in France (induced impacts). The local economic impacts of these infrastructure investments are quantified using an input-out model which contains industry sector-specific multipliers based on OECD data and the French government’s national accounts.



DIRECT

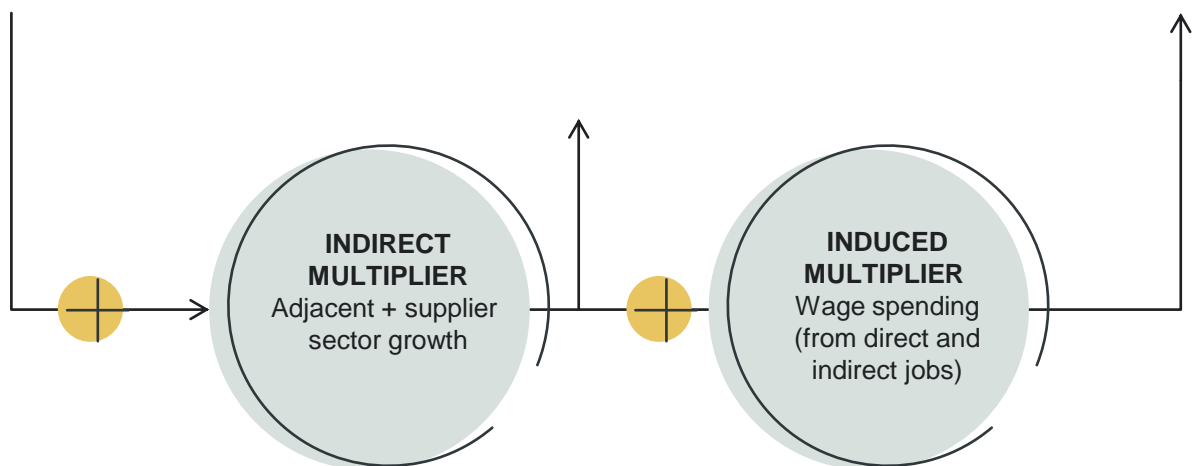
Direct impacts arise mainly from the sales of cloud services (like storage, computing power, data security and operations management software), installation associated with the migration to cloud and maintenance of IT.

INDIRECT

Indirect impacts of cloud services arise from Google France’s purchases from local suppliers to support the sales, installation and maintenance of cloud services in France.

INDUCED

Induced impacts arise when wages, paid out to employees and suppliers, are spent in France (e.g. shopping, restaurant visits and entertainment).



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- 119) Implement Economics is assuming that the estimated impact of an increase in adoption only increases the productivity growth rate once (i.e. the impact of an increase in a given year only has a one-year effect). In the original paper, Gal et al. assumes a permanent growth impact and thus a cumulation of growth impacts over time. Implement's assumption is in line with the interpretation of the 2019 Economic Outlook, which expresses reservation about the size of the impact. Implement's assumption reduces the impact to 25 percent of the original cumulative interpretation.
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