



DIGITAL SPAIN

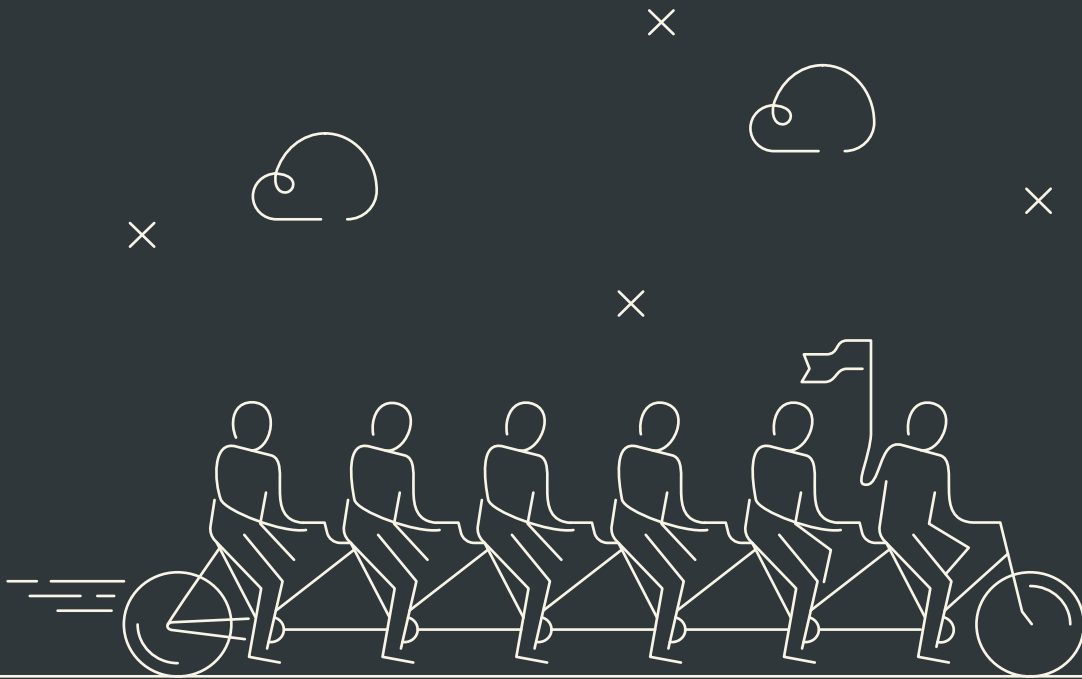
Economic impacts of Google's cloud
infrastructure investment



An Implement Consulting Group
study commissioned by Google



May 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.

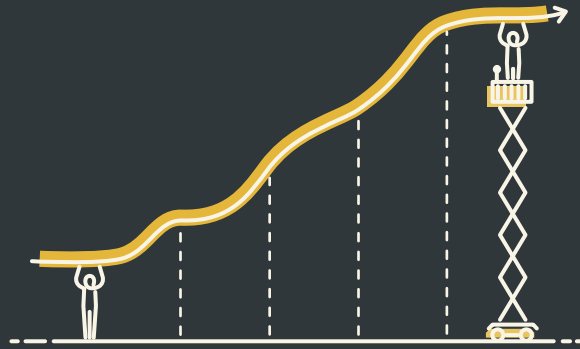
The team applies economic modelling, data analytics and econometrics to help solve worthwhile problems.

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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ACRONYMS

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

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 Spain. All information in this report is derived or estimated by Implement's analysis using both 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.

ACCELERATING GROWTH VIA CLOUD

In 2022, Google will launch a new cloud region in Madrid in partnership with Telefónica. A cloud region requires significant investment in new infrastructure and employment of highly skilled labour such as engineers and sales professionals. Over five years, Google will invest more than \$650 million in accelerating the digital transition of Spain.¹

Digital transformation is key to growth, innovation and new job creation in Spain

Cloud computing is an innovative and powerful technology. It is a key component of the digital transformation of Spain and the Digital Spain 2025 programme.² The Spanish government, the Organisation for Economic Co-operation and Development (OECD) and the European Union (EU) prioritise digitalisation to boost local economic development, increase resilience, improve productivity and raise the standard of living.^{3&4}

The COVID-19 pandemic revealed that economies and firms need to be resilient and adapt to new ways of working. Cloud computing is a critical enabler of this adaptation in Spain and will accelerate the shift to digitalisation.⁵

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

Cloud adoption enables Spanish firms to standardise and automate processes. This will allow firms to:

- Reduce IT overhead costs by 30 to 40 percent⁶
- 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
- Free up human and financial resources to innovate and sustainably grow their business

Implement Economics applied the results from a recent OECD study⁷ to estimate the economic impacts of accelerated cloud adoption in Spain.

The research finds that adoption of Google Cloud in Spain can support around 10,000 jobs annually and contribute about €1.2-1.3 billion to Spanish 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 3,700 jobs and contribute about €0.24 billion to Spanish GDP by 2027.

The research also finds that cloud impacts are especially pronounced for SMEs and manufacturing. To illustrate the potential for Spain, Implement Economics estimates that productivity gains in manufacturing in Spain can amount to around €3-4 billion annually if the Spanish manufacturing sector reaches the EU average cloud adoption rate. 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 Spain's digitalisation, boost productivity and growth and create more highly skilled jobs in Spain.

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. (OECD)⁸

GOOGLE CLOUD WILL HELP SPAIN BECOME FIT FOR THE DIGITAL FUTURE

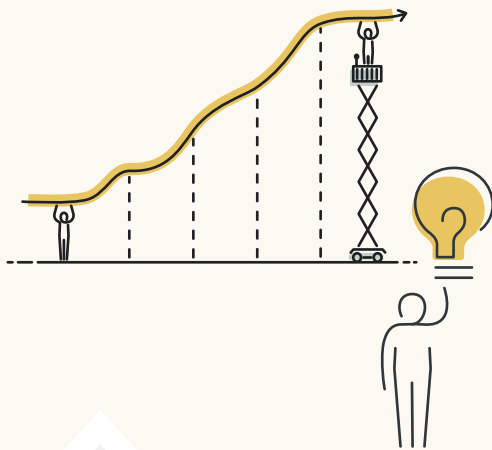
Implement Economics finds that Google's cloud services in Spain can help increase long-term productivity, which in turn will contribute about €1.2-1.3 billion to Spanish GDP by 2027. Increased cloud adoption will also improve the competitiveness of Spanish enterprises and support around 10,000 new job openings for highly skilled jobs in Spain.

The main impact estimated in this report is the productivity gains that Spanish firms can achieve from increased cloud adoption (channel 1). There are also impacts from the infrastructure investments. Google's cloud infrastructure investment also supports jobs and skill development in terms of engineers, salespeople and local suppliers (channel 2).

CHANNEL 1

9,000-10,000 JOBS

€1.2-1.3 BILLION IN GDP



Productivity impacts of cloud adoption (channel 1)

Helping Spanish firms digitise and improve productivity is key to long-term growth in Spain. As more Spanish firms digitise 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 €1.2-1.3 billion to Spain's GDP by 2027.

A Spanish job market fit for the future

When firms become more productive, some jobs become redundant, while new and higher paid jobs emerge. These labour market dynamics make estimates of the job impact of productivity gains uncertain. Implement Economics projects that the productivity gains achieved by Spanish firms from adopting Google's cloud services will open 9,000-10,000 jobs by 2027. This job creation can help absorb job closures elsewhere in the Spanish economy.

CHANNEL 2

3,700 JOBS

€0.24 BILLION IN GDP



Impacts of cloud infrastructure investments (channel 2)

Implement Economics projects that Google's technical cloud infrastructure investments will support 3,700 jobs per year and contribute €0.24 billion to Spanish GDP by 2027.

APPLIED METHODOLOGIES



In 2022, Google will launch a new *cloud region* in Madrid in partnership with Telefónica. The new cloud region is one of Google's first in Southern Europe.⁹ Over five years, Google will invest more than \$650 million in accelerating the digital transition of Spain with the aim to “*help Spanish businesses, big and small, find new ways to innovate and contribute to the country's economic recovery.*”¹⁰

Implement Economics assesses the impacts of Google's cloud region investment on the Spanish economy via two distinct channels:

1

PRODUCTIVITY IMPACT FROM CLOUD ADOPTION (CHANNEL 1)



Channel 1 measures the impacts of cloud adoption on productivity. Spanish 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 study¹¹ 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 in terms of for example firm survival, employment and sales.^{12&13}

2

IMPACTS OF CLOUD INFRASTRUCTURE INVESTMENTS (CHANNEL 2)



Channel 2 measures the direct, indirect and induced impacts of *Google Cloud* in Spain in terms of jobs and GDP contribution from Google's infrastructure investment in Spain.¹⁴ This methodology is based on input-output tables from the OECD, tailored to the Spanish economy.¹⁵

Data input

This report assesses the impact of Google's infrastructure investment in Spain from 2023-2027. The impact assessment draws upon data from Google, the OECD Structural Analysis Database and a recent OECD study on the productivity impacts of cloud adoption.¹⁶

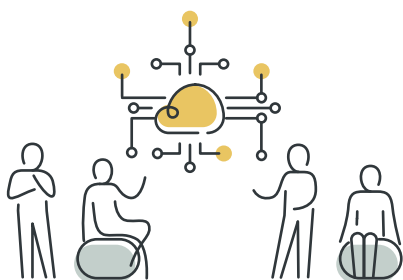
CLOUD IS KEY TO DIGITALISATION

As announced in Spain's Digital 2025 agenda, digital transformation is *"one of the fundamental levers for relaunching economic growth, reducing inequality, increasing productivity and making the most of all of the opportunities offered by ... new [digital] technologies."*¹⁷

The Digital Economy and Society Index (DESI), which tracks the EU Member States' progress in digital competitiveness, shows that Spain was ranked 9th in 2021. While this is a two-position improvement from the previous year, there is opportunity for further improvement, particularly in terms of integration of digital technologies.¹⁸ According to a recent report by Telefónica, digitisation could increase Spain's GDP by 1.5-2.5 percentage points each year until 2025 and improve the productivity of SMEs by 15-25 percent.¹⁹

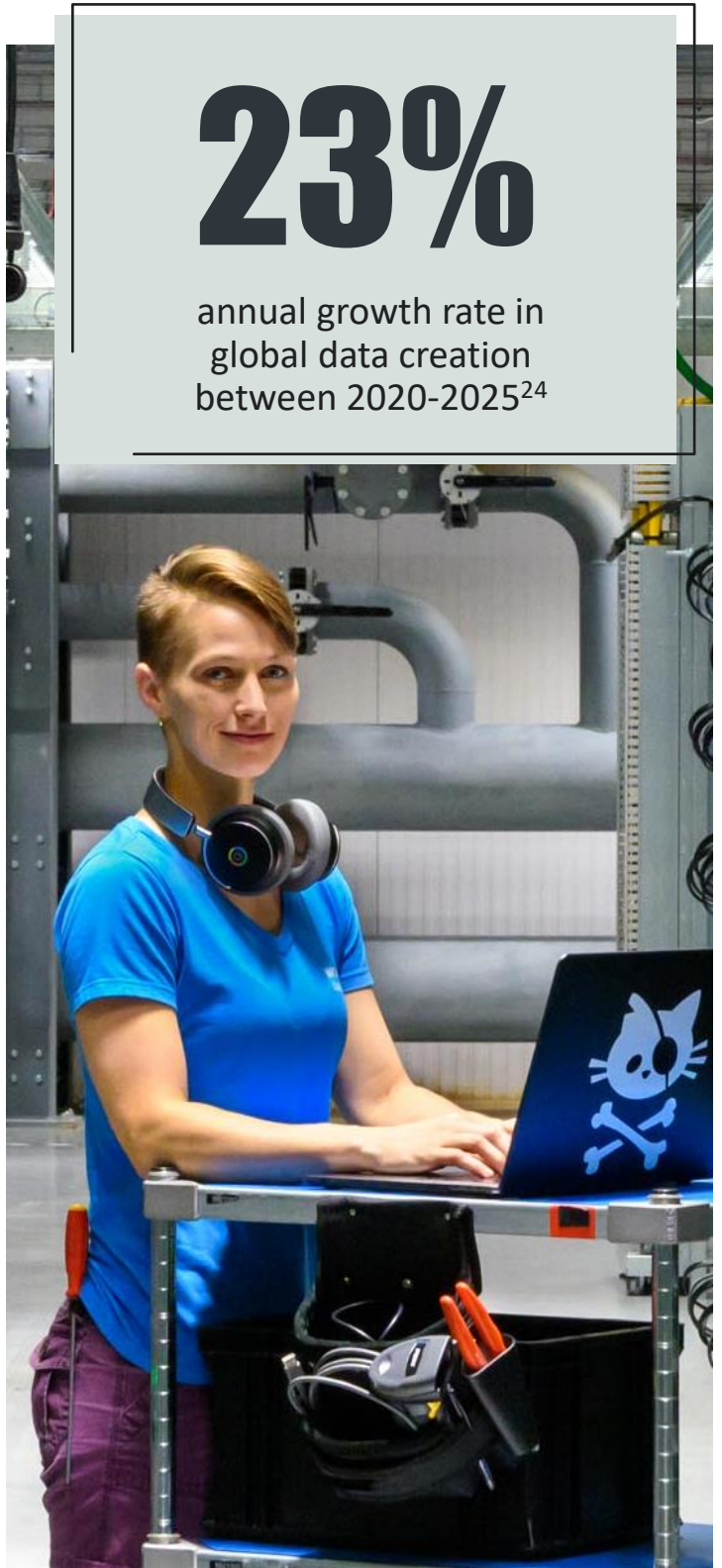
Cloud computing is considered one of the key digital technologies for enhancing productivity and delivering better services.²⁰ Migration to the cloud allows organisations to drive the digital transformation of their entire business by making core processes more efficient, deriving critical insights from data and improving how they reach and better serve their customers.²¹

The creation and consumption of data is growing at an incredible speed. According to IDC forecasts²², 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.²³



23%

annual growth rate in
global data creation
between 2020-2025²⁴



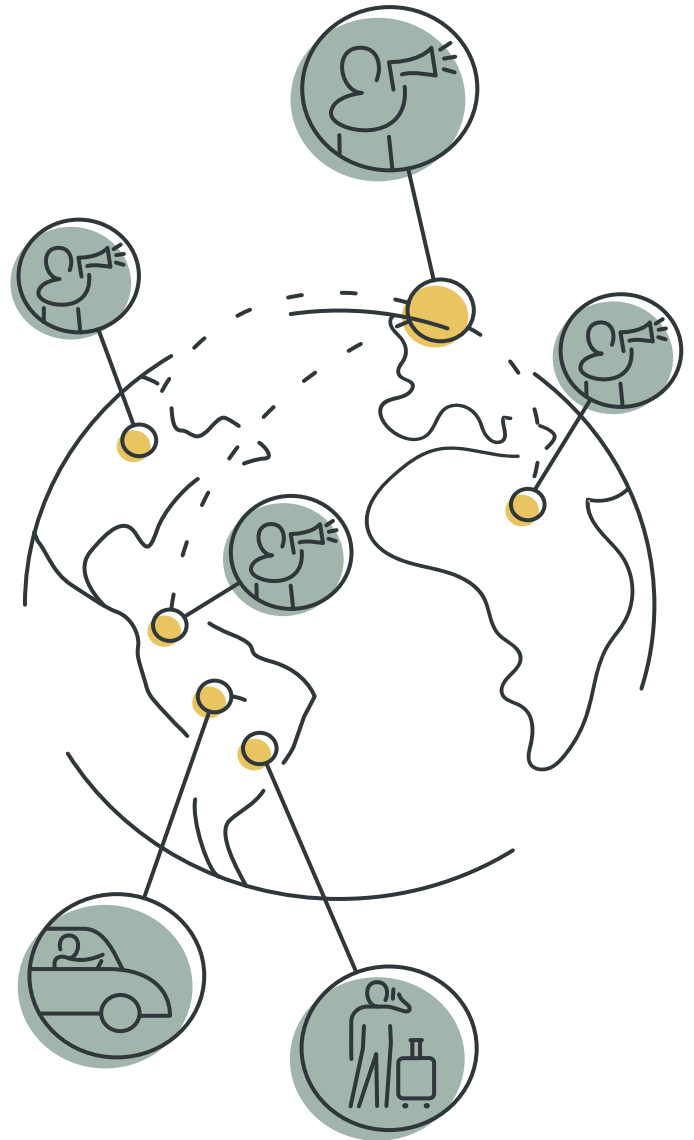
CLOUD REQUIRES TECHNICAL INFRASTRUCTURE

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. They can be thought of as the “heart” of the digital economy.²⁵

These data centres store, process and communicate large amounts of data used by citizens, governments and businesses.

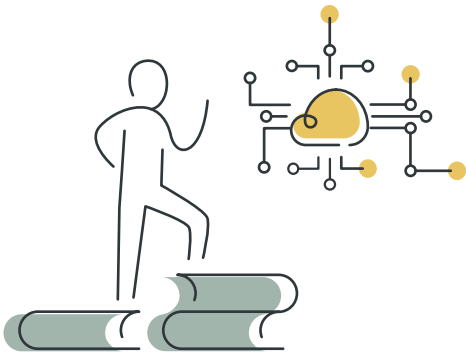
Data centres and cloud technology allow users to stream videos, send emails and access social media. It also allows businesses to operate supply chains, optimise factories and conduct financial transactions and much more.

Operating cloud solutions at scale in Spain requires technical infrastructure investments. 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.²⁶



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 hyper-scale providers like Google on a monthly basis.²⁷

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.²⁸

High-speed remote collaboration



The COVID-19 pandemic accelerated the adoption of remote work, and firms increasingly rely on effective cloud-based technology solutions that facilitate strong connections for collaborative work.²⁹ Cloud services are an essential catalyst that provides the key tools required for firms to communicate across oceans, time zones and continents. Cloud services are distributed at scale, which allows for high-speed data transfers with low-latency connections from anywhere in the world.³⁰

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.³¹

Catalyse innovation through data analytics



Cloud services allow for firms of any size to leverage the benefits of AI solutions. 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.³²

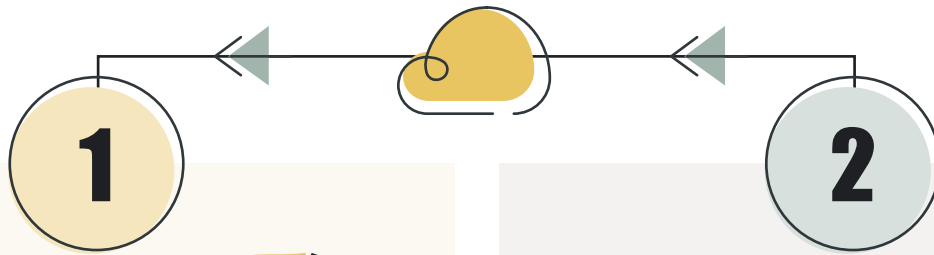
Promote sustainability



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 were moved to hyperscale cloud facilities, it would result in a 25 percent drop in energy use.³³

CLOUD IMPACTS THE ECONOMY VIA TWO CHANNELS



PRODUCTIVITY IMPACTS OF CLOUD ADOPTION

Google Cloud services increase operational efficiency and accelerate innovation for their users, which in turn enhances their productivity.

Annual impacts by 2027

€1.2-1.3 billion

in GDP³⁴ contribution through productivity gains related to Google Cloud

As Spanish firms become more productive and competitive, they will, all things being equal, secure new and more future-proof jobs in the region of

9,000-10,000 jobs

Spanish firms that adopt cloud services experience higher productivity due to the cost-effective scaling of IT operations that cloud services offer to users.³⁵ Cloud services catalyse technology-enabled business innovation, reduce ICT overhead costs and lead to higher productivity growth.³⁶ Note that the reported impacts include companies with more than ten employees. This means that there is an additional impact for companies with less than ten employees not quantified here.

IMPACTS OF CLOUD INFRASTRUCTURE INVESTMENTS

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 Spain.

Annual impacts by 2027

€0.24 billion

in GDP contribution from the technical operations of Google Cloud in Spain and the provision of cloud services

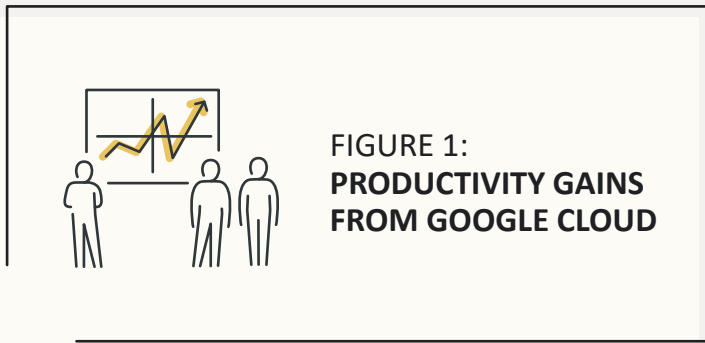
Operating, selling and installing cloud services require people at Google, resellers and suppliers as well as local shops and restaurants in the region of

3,700 jobs

Providing cloud services requires highly skilled sales and engineering jobs at Google Cloud in Spain. It also requires activity at the resellers of Google's cloud services.³⁷ Furthermore, Google Cloud will indirectly support jobs throughout the Spanish economy via local supplier purchases. Finally, wage spending by these employees supports local jobs throughout the local economy.³⁸

CLOUD ADOPTION ENHANCES PRODUCTIVITY

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.³⁹ 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 Spanish firms to the cloud.

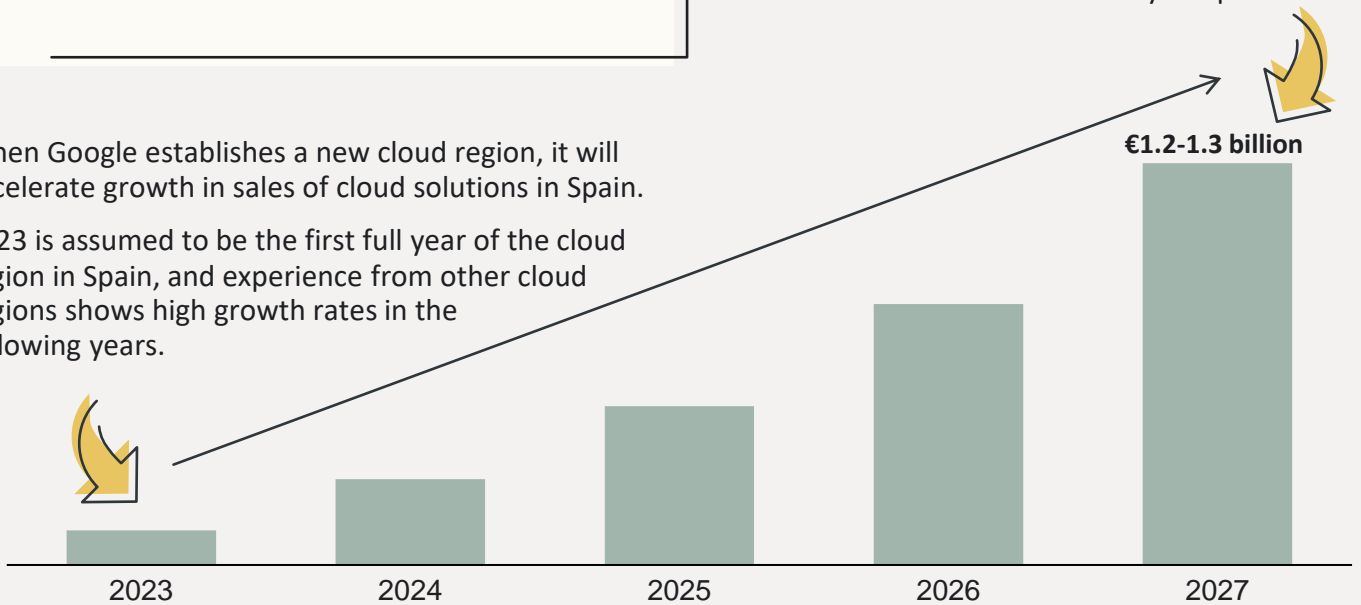


IMPACT

By 2027, the productivity gains from the increased adoption of Google's cloud services by Spanish firms are expected to contribute **€1.2-1.3 billion** annually to Spanish GDP.⁴⁰

When Google establishes a new cloud region, it will accelerate growth in sales of cloud solutions in Spain.

2023 is assumed to be the first full year of the cloud region in Spain, and experience from other cloud regions shows high growth rates in the following years.



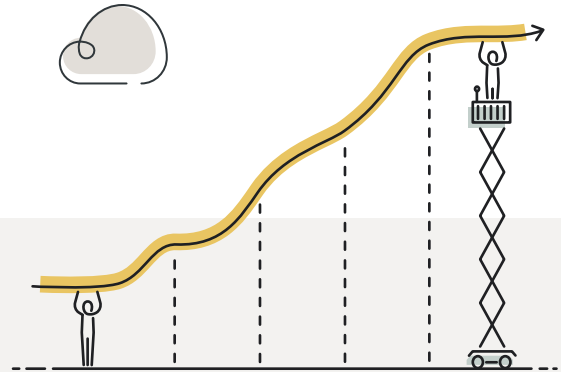
The projection of Google Cloud's contribution to productivity growth towards 2027 is based on estimates from a recent OECD study, which estimates the impacts of higher cloud adoption rates on firm productivity and Google's share of these gains.⁴¹ It is assumed that Google's cloud services have the same average productivity impact as other cloud solutions in the OECD study.⁴²

The estimate includes a conservative estimate of the productivity impact for cloud clients in financial services and the public sector, which is not covered in the original OECD research because there is no cloud adoption data in these sectors.

Note that there are additional productivity impacts not measured here relating to firms with less than ten employees. See appendix for further details.



HIGHER PRODUCTIVITY GENERATES WEALTH AND WELFARE



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



The adoption of new technologies is usually measured in terms of adoption rates, i.e. what share of firms in a given industry or economy applies the new technology, e.g. cloud services. In Spain, for example, 31 percent of manufacturing and service firms are using cloud services in one form or another.⁴³

The OECD study finds that productivity increases as a whole (i.e. across adopters and non-adopters) when more firms adopt cloud services.⁴⁴

Specifically, the OECD study finds a significant impact on firm-level productivity growth.⁴⁵

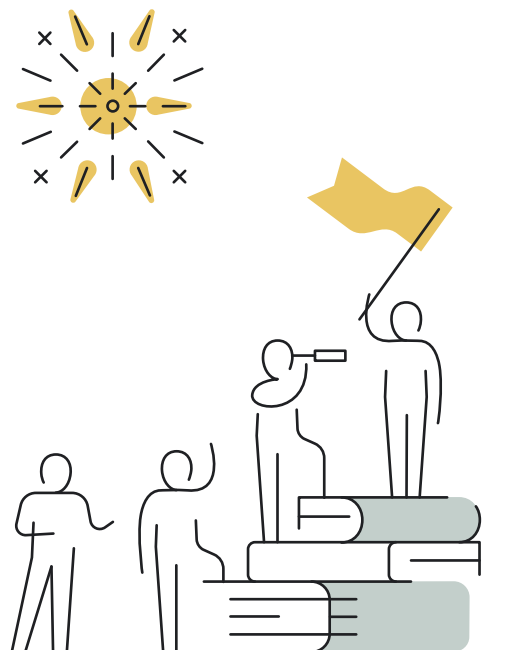
Over time, productivity growth will increase the overall productivity level. Higher productivity benefits firms as well as their consumers through cheaper or better products and services and benefits works through real wage increases.⁴⁶ All in all, it is associated with higher quality of life.

A foundation for improvements to quality of life

Productivity generates wealth and welfare through real wage increases for the average Spanish worker.⁴⁷ Multi-factor productivity (MFP) measures the amount of output (goods and services) produced per unit of input (labour, capital, energy, materials and purchased services).⁴⁸

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 to workers.^{49&50}

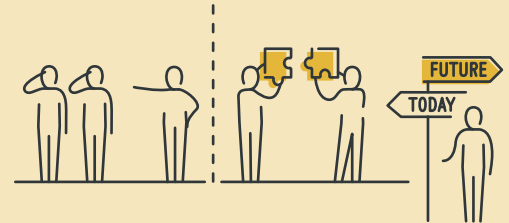
Income per capita is an important measure of quality of life. For example, it is one of three main components of the Human Development Index (HDI) along with health and knowledge. Higher income also increases tax revenue and thereby gives the Spanish government more financial room in Spain's public budgets.⁵¹



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.” (OECD)⁵²



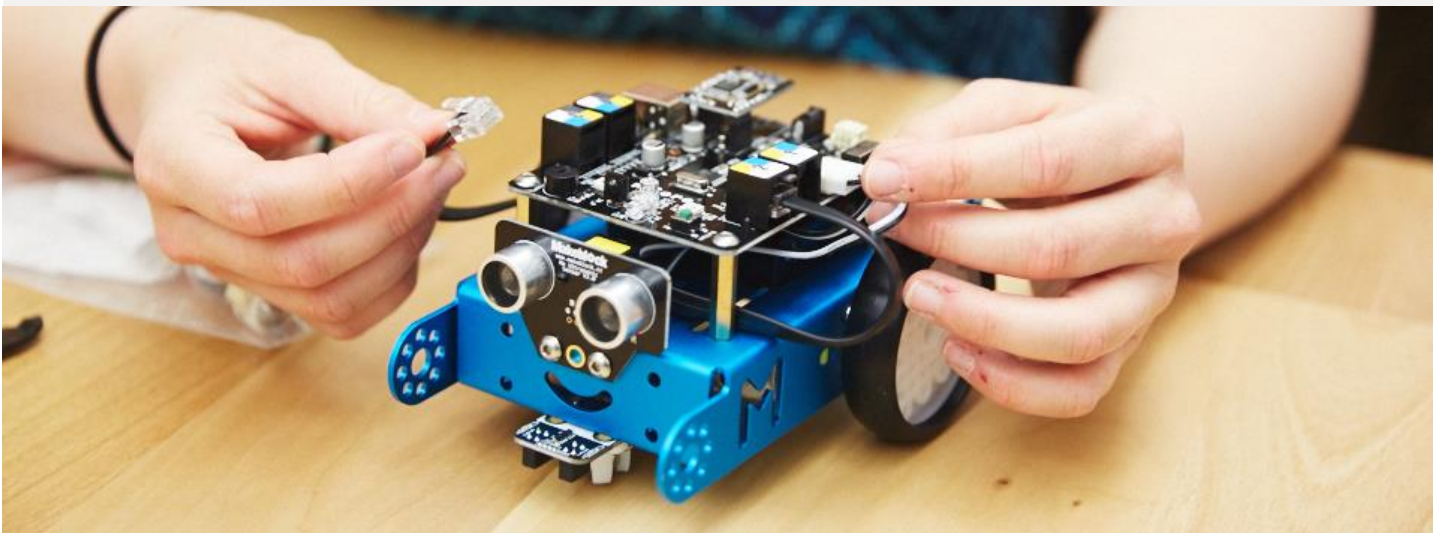
A Spanish job market fit for the future

When firms become more productive, some types of 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”*.⁵³

The total employment in Spain is determined by labour supply and the functioning of the labour market. The wage levels of workers in Spain will be positively influenced by increasing productivity. Productivity has positive as well as negative impacts on labour demand. On the one hand, higher productivity means that firms can produce more with less labour. On the other hand, higher productivity effectively makes households richer and thereby increases the demand for all goods and services. This means more demand for labour.⁵⁴

These dynamics make the total job impact uncertain. Our estimate indicates that the productivity gains achieved by Spanish firms from adopting Google’s cloud services in 2027 are associated with 9,000-10,000 new job openings.⁵⁵

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



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.⁵⁶

Manufacturing firms

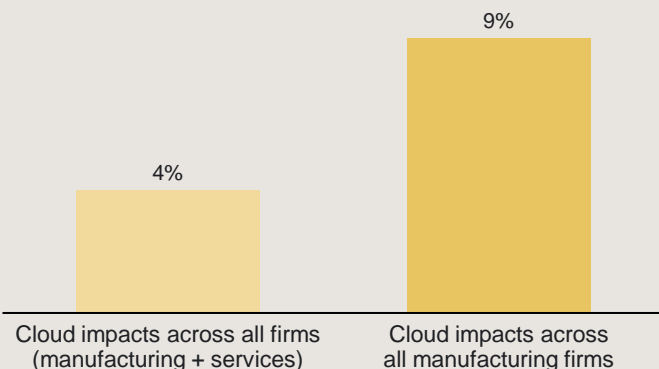


The OECD study finds that cloud adoption increases overall productivity across all firms – not just those adopting cloud but also non-adopters through spillovers. Productivity gains from cloud adoption in the manufacturing industry are more than double the average effect.

Assuming a 1 percentage point increase in cloud adoption 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.⁵⁷

FIGURE 2: INCREASE IN MULTI-FACTOR PRODUCTIVITY AFTER 10 YEARS WITH +1 PERCENTAGE POINT ADOPTION PER YEAR
Percent



Small firms

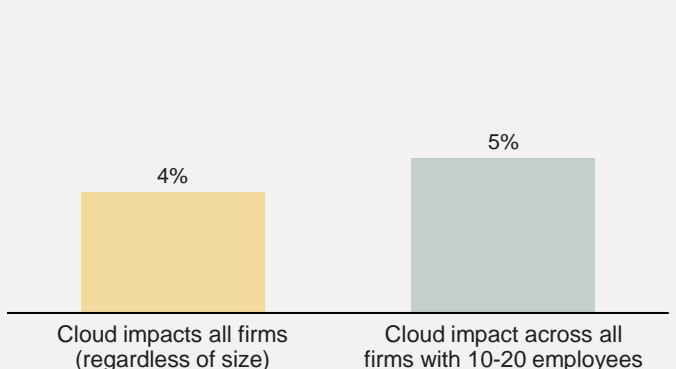


Small firms in the EU are less digitalised than larger ones, and the gap has persisted despite an overall increase in digitalisation.⁵⁸ Accelerating the digitalisation of SMEs and start-ups is also a priority for the Spanish government.⁵⁹

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 Spanish government in helping small firms become more digitised.⁶⁰

Assuming a 1 percentage point increase in cloud adoption 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 in terms of ensuring digital catching up by SMEs.

FIGURE 3: INCREASE IN MULTI-FACTOR PRODUCTIVITY AFTER 10 YEARS WITH +1 PERCENTAGE POINT ADOPTION PER YEAR
Percent



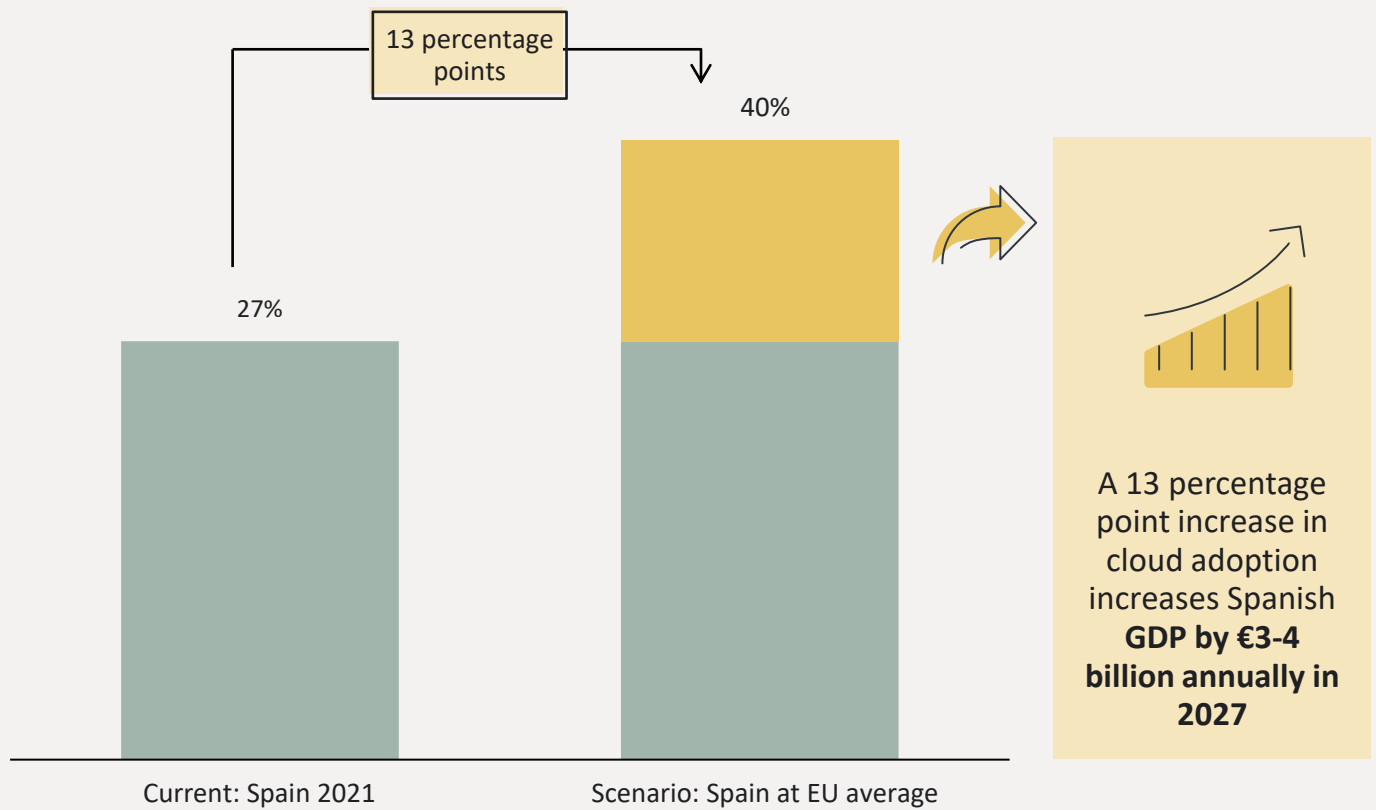
CLOUD INFRASTRUCTURE INVESTMENTS UNLEASH POTENTIAL

Catching up with EU adoption rates

From 2020 to 2021, the adoption rate for Spanish manufacturing firms increased from 24 percent to 27 percent. However, Spain can potentially reap large economic benefits if Spanish cloud adoption in the manufacturing sector reaches the EU average (40 percent).⁶¹ Google’s investment into Spain is expected to contribute to the acceleration of cloud adoption.

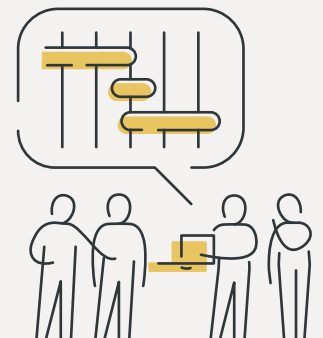
If the Spanish manufacturing sector’s cloud adoption reaches the EU average, it is estimated to generate productivity gains worth **€3-4 billion annually** for the Spanish economy in 2027.

FIGURE 4: ADOPTION OF CLOUD FOR SPANISH MANUFACTURING FIRMS
Percentage points



The estimation relies on a recent OECD study which uses firm-level time series data for 20 European countries.⁶² The above estimate assumes that this average impact will apply going forward.

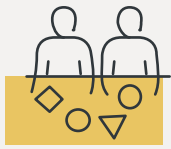
The OECD study finds that cloud adoption accelerates growth for the less productive firms, which suggests that returns are not diminishing.



IT SKILLS ARE NEEDED TO EASE GROWTH CONSTRAINTS

Google contributes to IT skill development in Spain through courses designed to prepare the Spanish 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*”.⁶³ Google has trained over 1 million Spanish citizens in digital and IT skills.⁶⁴



TRAINED 1 MILLION PEOPLE IN SPAIN

Google has trained more than 1 million people with the *Grow with Google* programmes in Spain.⁶⁵



48% WOMEN

Google has trained more than 709,000 people, 48 percent of them being women, with *Google Activate*, Google’s digital skills programme (free of charge).⁶⁶



82,000 FOUND NEW OPPORTUNITIES

More than 82,000 people in Spain have found a job or grew in their career with *Google Activate*.⁶⁷



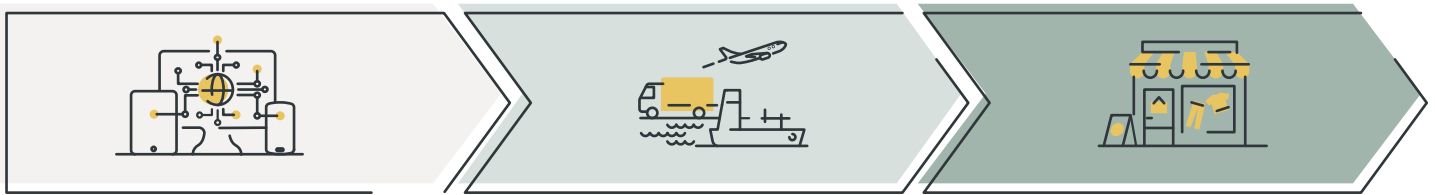
Google has helped enhance IT skills for over

1 MILLION

Spanish citizens.⁶⁸

CLOUD TECHNICAL INFRASTRUCTURE INVESTMENTS SUPPORT JOBS

In addition to the productivity impacts (channel 1), Google’s cloud region in Spain will also generate additional economic activity (channel 2). The jobs supported by Google in Spain 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 Spain (**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 Spanish government’s national accounts. The methodology is explained in the appendix.



DIRECT

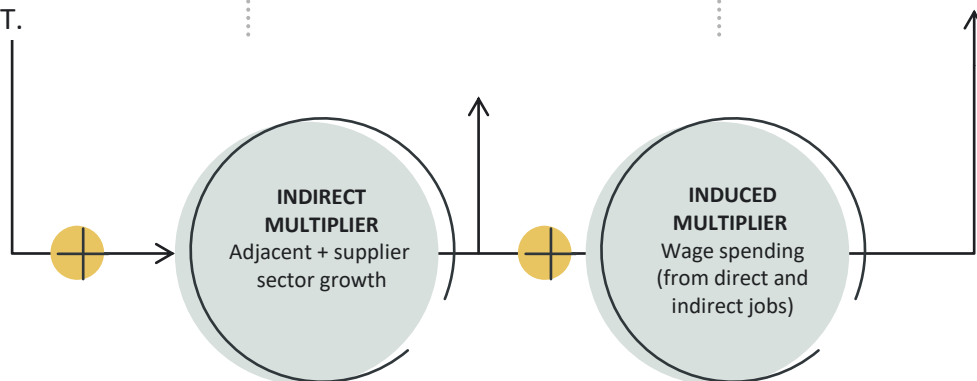
Direct impacts arise mainly from the sales of cloud services (like storage, computing power, data security and operations management software), installation associated with the migration to cloud and maintenance of IT.

INDIRECT

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

INDUCED

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



EXPECTED 2027 IMPACT OF GOOGLE CLOUD INFRASTRUCTURE INVESTMENTS

Table: Channel 2 impacts in 2027 across the value chain in Spain

Metrics	Direct	Indirect	Induced	Total
Jobs (FTEs)	1,200	1,000	1,500	3,700
Labour income	€50m	€30m	€40m	€120m
GDP	€100m	€50m	€90m	€240m

Source: Implement Economics analysis using input-output model

IMPACTS OF INFRASTRUCTURE INVESTMENTS INCREASE OVER TIME

Google’s cloud infrastructure investment and the provision of cloud services will support jobs and contribute to Spain’s GDP. Impacts are expected to increase over time as the infrastructure investment is rolled out.

Implement Economics’ estimates of channel 2 impacts across the value chain in Spain:



Economic impacts of cloud infrastructure investments



Supporting 800 jobs in 2023, growing to 3,700 jobs in 2027



GDP contribution of €50 million in 2023, growing to €240 million in 2027



Labour income of €20 million in 2023, growing to €110 million in 2027

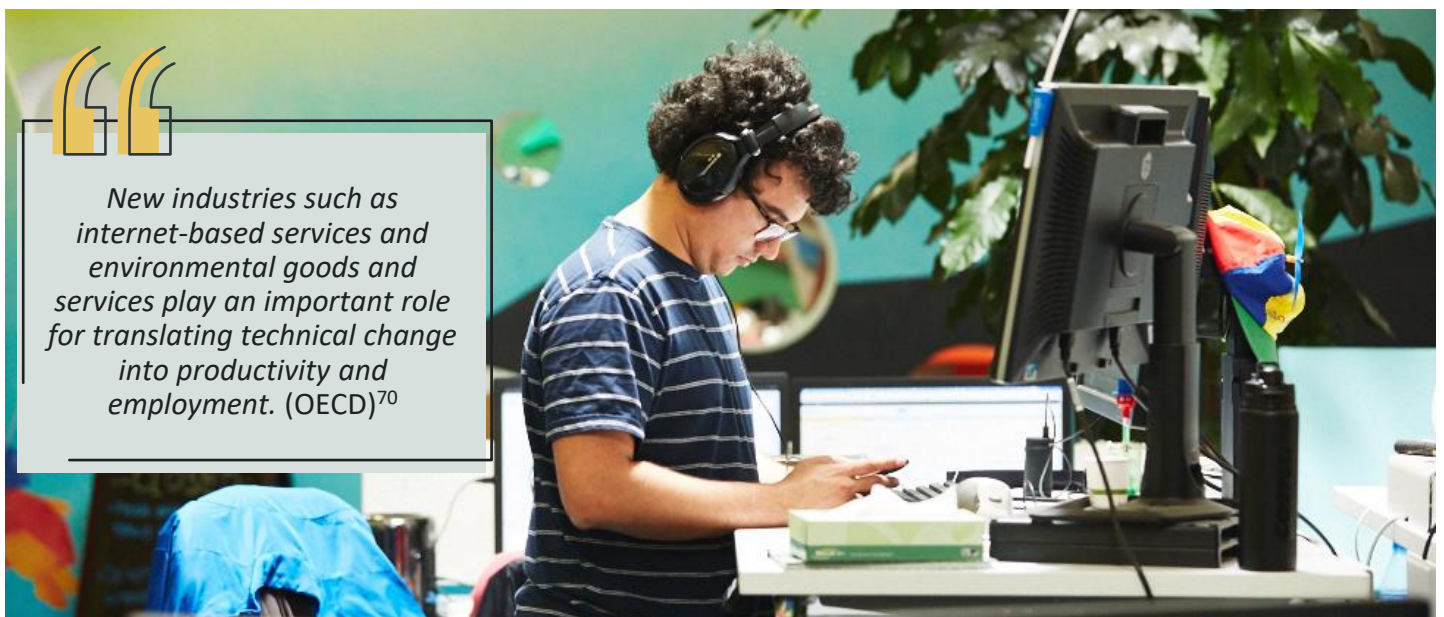
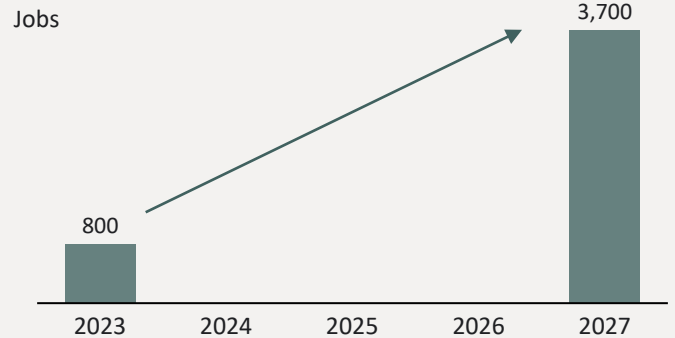
Google’s cloud infrastructure investment in Spain (channel 2) can support about 3,700 jobs throughout the value chain in Spain and add €240 million to Spanish GDP in 2027.⁶⁹ They include the direct, indirect and induced impacts of the activity in Spain and are gross impacts (i.e. before diversion of resources from other parts of the economy). The jobs supported directly by Google and their resellers are computer sales and programming jobs which are high-income jobs compared to other industries.



Impacts of cloud infrastructure investments over time

Impacts are expected to increase as the investment is rolled out and Spanish firms migrate to the cloud. In 2027, Google’s cloud services are expected to support around 3,700 jobs across the value chain if growth expectations come through.

FIGURE 5: EMPLOYMENT IMPACTS



New industries such as internet-based services and environmental goods and services play an important role for translating technical change into productivity and employment. (OECD)⁷⁰

GREEN INVESTMENTS MAKE THE CLOUD CLEANER

Google is decarbonising their energy consumption so that by 2030, they expect to operate on carbon-free energy.⁷¹ Google’s carbon-free objective is well aligned with Spain’s ambition to reach net zero emissions by 2050.⁷² The Spanish government relies on digitisation of the economy to reach their goal: *“Accelerate the digitisation of the production model through digital transformation driving projects in strategic economic sectors such as Agri-food, Mobility, Health, Tourism, Commerce or Energy, among others. These projects aim to reduce CO₂ emissions by 10 percent due to the digitisation of the economy in 2025.”*⁷³



Technologies reduce energy consumption

Google is committed to creating tools, sharing expertise and investing in advanced technologies that help others in the transition to a carbon-free world. Business leaders in Spain share the ambition of using technology to meet climate goals. In a recent survey, 70 percent of executives in Spain said that technology enables the development of new products and services that leverage more sustainable methods.⁷⁴

Google has recently made a cloud solution available for commercial buildings and industrial facilities such as airports, shopping malls and other data centres, helping them reduce their carbon impact.⁷⁵ For example, by using Google AI to analyse large data sets and forecast demand, the French retailer Carrefour managed to drastically reduce food waste.⁷⁶



Hyperscale data centres reduce energy use

Google has reduced the energy needed to cool their data centres by 30 percent by using machine learning.⁷⁷ In addition, hyperscale data centres such as Google’s are highly energy-efficient:

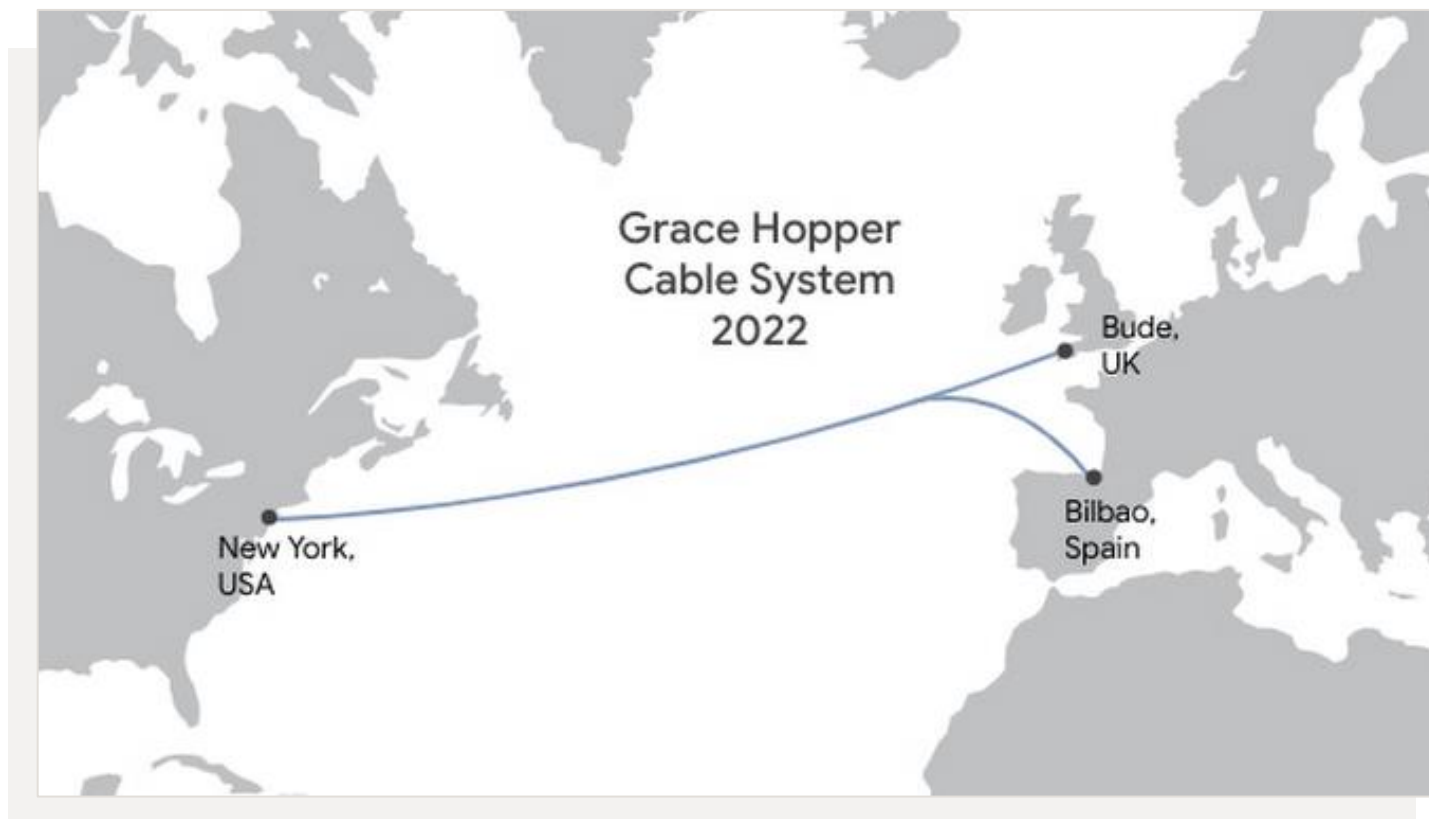
- Multi-tenancy cloud storage is much more efficient than local company servers.⁷⁸
- Lawrence Berkeley National Laboratory estimates that if 80 percent of servers in small private data centres moved over to hyperscale data centres, it would result in a 25 percent drop in energy use.⁷⁹



25% REDUCTION

in energy use if 80 percent of servers in small private data centres moved to hyperscale cloud facilities.⁸⁰

INVESTMENTS IN SUBSEA CABLES CONNECT SPAIN TO THE WORLD



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.⁸¹

In July 2020, Google announced a new subsea cable – Grace Hopper – connecting Spain with the United Kingdom and United States. This is Google’s first-ever subsea route to Spain. The Spanish landing point will more tightly integrate **Google’s cloud region in Madrid** into Google’s global infrastructure. The Grace Hopper cable will be equipped with 16 fibre pairs (32 fibres), a significant upgrade to the internet infrastructure connecting the United States with Europe. The project is expected to be completed in 2022.⁸² In June 2019, Google announced Equiano, a subsea cable connecting Africa with Europe. Equiano runs along the west coast of Africa, between Portugal and South Africa, with branches along the way that will connect numerous African countries, including Togo and Nigeria.⁸³

With these cable investments, Google Cloud is significantly expanding the connectivity of the Iberian Peninsula, including Spain.

Although this report does not examine the economic impact of the Grace Hopper cable, there are significant ecosystem benefits of subsea cable landings such as this. For example, a recent study of the landing into Portugal of Google’s Equiano cable and the Ellalink cable finds that *“the two 2021/2022 forthcoming cables are expected to lower the latency and increase the internet bandwidth for internet users in **Portugal, which increases the internet usage and subsequently increases Portuguese GDP by up to €500 million per year.**”*⁸⁴ Similar impacts should also be anticipated for the Grace Hopper cable landing in Spain and would add to the economic impacts of Google’s investment in the Madrid cloud region.





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 OECD⁸⁵ 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).⁸⁶ 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.⁸⁷ It has therefore not been possible for the OECD study to estimate productivity impacts for this part of the economy.⁸⁸

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.⁸⁹



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

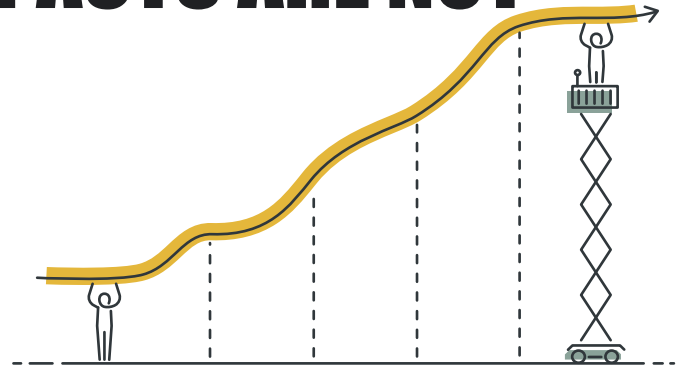
1) Estimating the overall productivity contribution of cloud adoption

- 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.⁹⁰
- 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 study⁹¹ 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.

OECD findings are likely to underestimate positive impacts

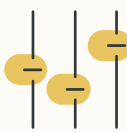
The OECD study addresses some of the main challenges of assessing the causal link between cloud adoption and productivity. However, the study will tend to underestimate the positive impacts of cloud adoption on productivity due to:



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.

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.⁹²

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 Spanish economy.

Data sources applied in the study

This study relies on two complementary sources:

1. OECD Structural Analysis Database (STAN) 2021 ed.⁹³

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.



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- 4) European Commission (2019)
- 5) Anderton et al. (2020). *ECB Occasional paper*
- 6) Bommadevara et al. (2018)
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- 8) OECD (1998)
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- 10) Ministerio De Asuntos Económicos Y Transformación Digital. *Digital Spain 2025*
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- 12) Jin & McElheran (2017)
- 13) DeStefano et al. (2020)
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- 16) Gal et al. (2019)
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- 26) Google Cloud (2021). *Infrastructure*
- 27) European Commission (2017)
- 28) Bommadevara et al. (2018)
- 29) Anderton et al. (2020). *ECB Occasional paper*
- 30) Singh et al. (2021)
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- 32) The Economist (2021). OpenAI, an AI research and deployment company, assesses that computing power used in AI projects doubles every 3.4 months. Thus, there is a high demand for business insights utilizing the vast amount of data available in the digital economy.
- 33) Jones (2018). Based on projection for US data centers.
- 34) Throughout the paper, we labelled value-added GDP for brevity. Impacts throughout the report are in 2021 prices.
- 35) Gal et al. (2019)
- 36) European Commission (2017)
- 37) Employment at Google's resellers is included in the direct impacts. This is based on conservative assumptions about reseller expenditures and using average ICT service wages and cost structure from OECD data.
- 38) Projected impacts from the technical infrastructure investment are based on the customised IO model for Spain (OECD STAN Database).
- 39) Gal et al. (2019)
- 40) Impacts throughout the report are in 2021 prices.
- 41) Synergy Research Group estimates that Google Cloud has a share of 10% of global cloud infrastructure service revenues (including IaaS, PaaS and hosted private cloud services).
- 42) Gal et al. (2019). The OECD researchers interpret the productivity gains as being cumulative over five years with a 10-percentage-point increase in adoption, giving rise to 3.5 percent higher productivity. As stated in the 2019 OECD economic outlook, these estimates probably represent an upper bound of actual gains. For this reason – and to ensure conservative estimates – we have assumed smaller cumulative effects than in the original research paper.
- 43) Eurostat. *Cloud computing services.* Growth in the Spanish adoption rate is based on the pre-pandemic trend in cloud adoption in Spain and is more conservative (smaller) than projected growth rates of the cloud market by e.g. Gartner.
- 44) Gal et al. (2019), table 2. The estimates only include manufacturing and service enterprises, excl. financial sector of +10 employees.
- 45) Mankiw (2020). Relying on a traditional Cobb-Douglas function $Y=A \cdot K^\alpha \cdot L^{1-\alpha}$ we see that productivity growth (A) translates directly into growth in production.
- 46) Acemoglu & Restrepo (2018)
- 47) According to standard economic theory, real wages are determined by the marginal product of labour (the amount of output one additional worker can produce when holding the capital stock constant). Thereby, real wages are determined by labour productivity. Mankiw (2020).

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- 54) Acemoglu & Restrepo (2018)
- 55) This projection is based on the assumption that the jobs supported will have a broad impact within most industries within manufacturing and services.
- 56) Gal et al. (2019), table 3 & table B.8
- 57) Gal et al. (2019), table 3
- 58) Gal et al. (2019), table B.8
- 59) Ministerio De Asuntos Económicos Y Transformación Digital. *Digital Spain 2025*
- 60) Thelle et al. (2021). *Digital future unlocked*
- 61) Eurostat, Cloud computing services
- 62) Gal et al. (2019). OECD researchers interpret the productivity gains as being cumulative over five years with a 10 percentage point increase in adoption, giving rise to 3.5 percent higher productivity. As stated in the 2019 OECD economic outlook, these estimates probably represent an upper bound of actual gains. For this reason – and to ensure conservative estimates – we have assumed smaller cumulative effects than in the original research paper.
- 63) Gal et al. (2019)
- 64) Statistic provided by Google
- 65) Statistic provided by Google
- 66) Statistic provided by Google
- 67) Statistic provided by Google
- 68) Statistic provided by Google
- 69) The 3,700 jobs are estimated by Implement and not job numbers supplied by Google. These are the total number of jobs throughout the value chain, including jobs generated by Google, their resellers, their suppliers and more broadly in the local economy through the induced effects (local spending). The estimate is based on expected expenditures by Google, and their resellers and impacts at suppliers and local shops and businesses are estimated by Implement using OECD input-output tables for Spain.
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- 88) Gal et al. (2019)
- 89) Mankiw (2020). Relying on a traditional cobb-Douglas function $Y=A \cdot K^\alpha \cdot L^{1-\alpha}$ we see that productivity growth (A) translates directly into growth in production
- 90) 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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