Deloitte.

Telecom Advisory Services, LLC

The Economic Impact of Cloud Computing in Israel 2024

This study was funded by Amazon Web Services. All content within the study, including its conclusions, represent the independent findings of the analysis conducted solely by the authors, Telecom Advisory Services, and Deloitte consulting and technologies LTD.

Table of Contents

Authors – Deloitte

Shahar Bracha, Partner, Cloud Transformation leader, Deloitte Israel

Shahar is an experienced leader in the tech industry with a rich history of driving strategic transformations and leveraging technology to enhance services. In Shahar's previous role as the CEO of the Israel Government ICT Authority, he spearheaded the Nimbus project, a government-wide initiative focused on cloud adoption that has had a significant impact on the public sector, enterprises, and small and medium-sized businesses in Israel. This effort has paved the way for the launch of the Cloud Regions in Israel. Shahar's expertise extends beyond the public sector, with significant experience in startups, large enterprises, tailor-made solutions, off-the-shelf products, and consulting services. Shahar is a graduate of the Wexner Senior Leadership Program at Harvard University - Shahar continues to influence the tech landscape in Israel and beyond, championing innovation and digital transformation in his work.

Meirav Hickry, Partner, Cloud Advisory and Strategy Leader, Deloitte Israel

Meirav is a partner in Deloitte Israel, where she leads the cloud advisory and strategy team as part of Deloitte Israel's cloud transformation practice. With a background spanning more than 20 years in technology transformation and consulting, Meirav works with leading enterprises in shaping their cloud transformation journey to align with their business, technology, and strategic goals. Meirav's focus is to build a full operating model for cloud transformation, including process, people, and technology, which will meet all the unique challenges of organizations seeking to achieve value with cloud technologies. Meirav's expertise extends to the financial services industry, particularly in the realm of banking. Having worked with all the leading banks in Israel, she has led a diverse range of projects, including core banking transformation, establishment of digital banking platforms, and fintech solution implementation. Meirav holds a B.Sc. in industrial engineering and management from the Technion – Israel Institute of Technology and an MBA from Tel Aviv University.

Authors – Telecom Advisory Services, LLC

Raul Katz, President, Telecom Advisory Services

Dr. Katz is president of Telecom Advisory Services LLC, director of business strategy research at the Columbia Institute for Tele-Information at Columbia Business School (New York) and visiting professor at the graduate program in the Telecommunications and Technology Management department of the University of San Andres (Argentina). Dr. Katz worked at Booz Allen & Hamilton for twenty years as a lead partner in the Telecommunications Practice in the Americas and was a member of the firm's leadership team. After retiring from Booz Allen, he founded Telecom Advisory Services LLC, in April 2006. He holds a PhD in Political Science and Management and an MS in Communications Technology and Policy from the Massachusetts Institute of Technology (United States), a Maitrise and Licence in Communication Sciences from the University of Paris (France), and a Maitrise in Political Science from the University of Paris-Sorbonne (France).

Juan Jung, Senior Economist, Telecom Advisory Services

Dr. Jung is a senior economist at Telecom Advisory Services, specialized in the telecommunications and digital industries. His experience spans economic impact and regulatory assessment in the telecommunications sector. Before joining Telecom Advisory Services, Dr. Jung was director of the Center of Telecommunication Studies of Latin America (cet.la) and Director of Public Policy at the Inter-American Association of Telecommunications Enterprises (ASIET). Dr. Jung is a professor at the Comillas Pontifical University in Madrid, Spain, where he teaches macroeconomics and courses in the digital economy. He has published articles in several academic journals, including Telecommunications Policy, Information Economics and Policy, the Journal of Regulatory Economics, and the Journal of Regional Science. Dr. Jung holds a PhD and MA in Economics from the University of Barcelona, and a BA in Economics from the University of the Republic (Uruguay).

Impact of Public Cloud Adoption in Israel

During 2023-2033 Cloud adoption could contribute **1.58% to Israel's GDP** resulting in **$105.91B.**

Enterprises that adopt cloud computing exhibit **27.3% higher productivity** compared to those that do not.

50.85% of Israeli firms had purchased cloud services by 2020... However, **only 9.1% of companies** are leveraging cloud for advanced use cases such as core systems modernization andAI/ Gen-AI use cases.

1% increase in Cloud adoption could lead to 0.2% increase in ICT skilled Employment – which predicts **13,700+ new cloud related roles** in upcoming decade.

From 1 cloud data center in Israel in 2020 to 10 by end of 2024.

Global enterprise with high level of cloud adoption reported 88% more efficiency and agility In their business.

01
Executive Summary

In May 2023, Telecom Advisory Services LLC (TAS) published a report titled "The Contribution of Cloud to Economic Growth in the Middle East and North Africa." In this report, Dr Raul Katz presented a macro-economic approach to measure the aggregate productivity gains achieved by economies that adopt cloud computing in the region. In this study, TAS and Deloitte Consulting and Technologies LTD (Deloitte Israel) take a deeper dive into the economic effects specific to Israel, based on the extensive regional research, and the current state of cloud computing in Israel.

In the last decade, **the public cloud has been recognized globally as a force multiplier for organizations that want to stay competitive, realize their strategic plans, and execute organizational-wide transformations while leveraging innovative Solutions such as Gen-AI.** Israeli companies are facing an interesting divide between digital natives and traditional enterprises with regard to their adoption and use of cloud computing. While digital natives are already maximizing the value of cloud by leveraging advanced services and solutions for innovation and acceleration, traditional firms are primarily using cloud for simple use cases such as collaboration tools and niche SaaS (Software-as-a-Service) solutions. This situation is expected to change significantly.

Investments made by the largest cloud service providers, also called Hyperscalers, to establish cloud regions[1], with **10 availability zones opened between 2020 to 2024 in Israel,** are significantly reducing key barriers to adoption, such as data residency and latency. Many of these investments were spurred by the **government-led cloud migration initiative, known as the Nimbus project.** In addition to building local regions, cloud service providers are making large investments in the development of cloud talent, which is another significant barrier for cloud adoption by traditional companies.

Implementing and migrating technology solutions to the cloud not only enables startups, digital natives, and traditional organizations in the private and public sector to drive enhanced productivity, but at an aggregate level, **these solutions may drive economic growth, as measured in terms of gross domestic product (GDP) and job creation.** The total contribution of cloud to GDP is calculated as the sum of cloud spending in the country and the efficiency gains and economic growth enabled by cloud adoption, the so-called "spillover effects."

The economic impact of cloud is also measured in firm productivity. Econometric analysis conducted with microdata of local enterprises compiled by a survey of Israel's Central Bureau of Statistics suggests that organizations that adopt cloud computing **could achieve 27.3% more productivity in comparison to non adopting firms.** However, this elasticity coefficient is expected to differ by company size and the level of sophistication of cloud usage. Small and medium-sized (SMBs) firms that adopt cloud technologies depict higher productivity effects than large firms, which can support the conclusion of the benefits already achieved by digital natives. Moreover, the productivity boost increases with the level of maturity of cloud adoption.

[1]The cloud network infrastructure of Hyperscalers is organized around geography regions and zones established in proximity to clusters of data centers.

Firms that use cloud computing for hosting databases and for gaining computing power to run the company's software and processes (that is, advanced usage levels) may depict higher productivity impact compared to firms with basic cloud usage (for hosting email, for example).

Cloud adoption can also make a significant impact on the public sector and government services. As part of the Nimbus project, the Israeli Government put in place governance policies, processes, and foundations to achieve cloud adoption at scale; however, the actual adoption of cloud computing in the government remains in its very early stages. In 2023, cloud spending was about 3% of the overall government[2] technology spending, but the Nimbus project is expected to drive government cloud adoption significantly, with the consequent impact on public sector efficiency, in terms of the World Bank's Government Cloud Platform Maturity Index.

According to research by Telecom Advisory Services on cloud spillover effects in Israel, it is estimated that, on average, **an increase of 1% in cloud adoption could yield a GDP increase of 0.1%. The combination of cloud spending and spillover effect added 2% to Israel's GDP in 2023,** amounting to $10.13 billion of economic value.

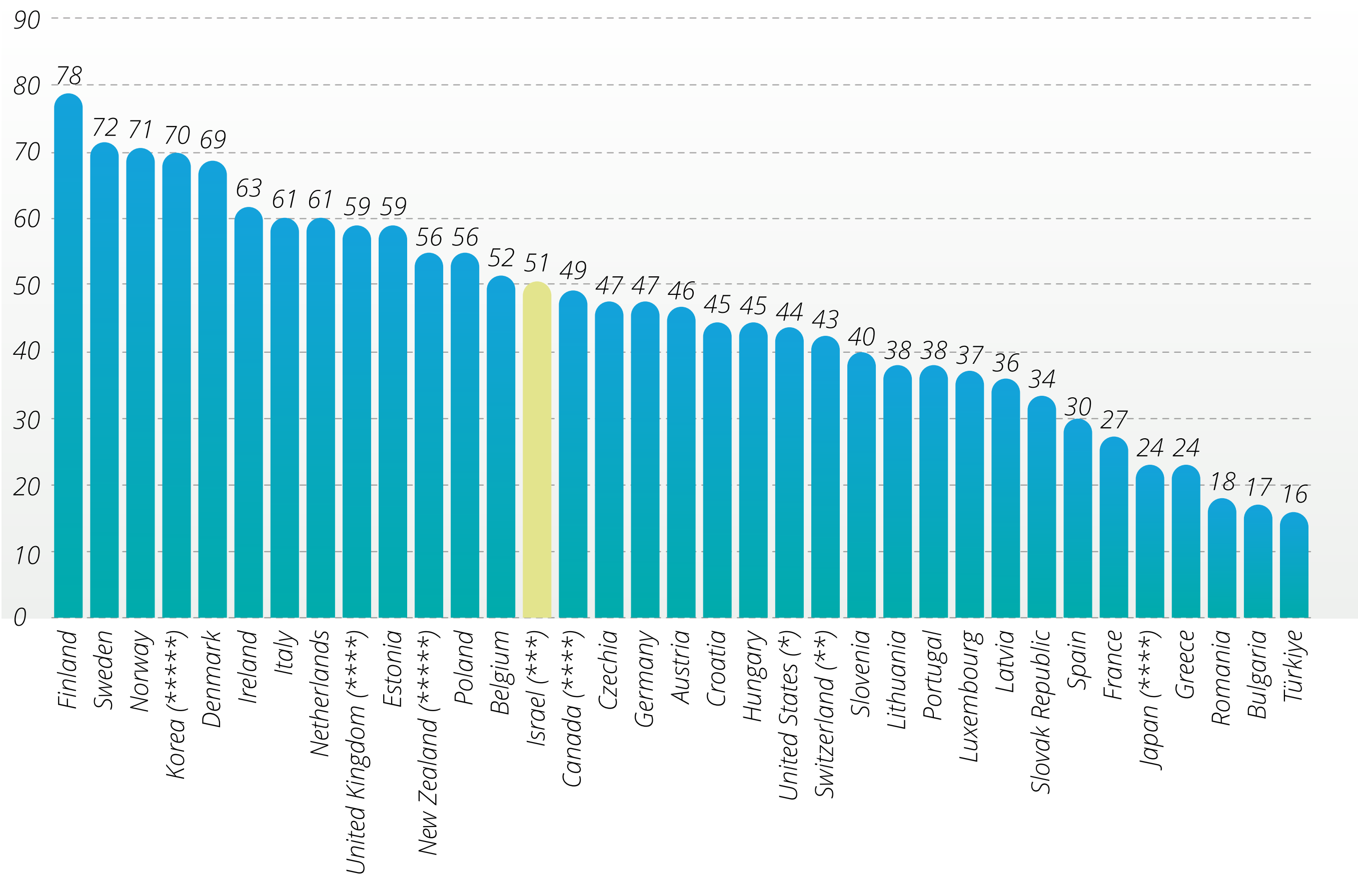
In this report, we detail two scenarios for future projections of cloud computing's economic impact: (i) a moderate scenario that assumes current trends will continue through 2033 and (ii) an aggressive scenario that assumes that recent investments taking place in the country can promote a new expansion phase. The total cumulative economic contribution under the moderate scenario throughout the period 2024–2033 will reach $105.91 billion, or 1.58% of the GDP forecasted for the same period.[3] In addition, this study indicates that a total of over 13,700 new ICT-skilled job positions are expected to be required due to cloud computing spillovers in the whole economy. **Under the aggressive scenario, the total cumulative economic contribution over the same period could reach $142.8 billion, or 2.13% of the projected GDP.** Furthermore, under this scenario, a total of **18,200 ICT-skilled jobs are expected to be needed during the same period from 2024 to 2033** due to similar effects.[4] The difference between the aggressive and moderate scenarios with an inflexion point in 2025 relates primarily to three factors: (i) whether traditional enterprises can gain access to the right talent to implement and support the migration to cloud operations, (ii) whether the public sector can capitalize on the Nimbus project to execute on transitioning government operations and systems to the cloud, and (iii) whether Israeli organizations are able to effectively adopt cloud technologies to support their core technologies and advanced operations, propel innovation, and adapt their operating models and capital allocations to maximize the benefits of the cloud.

[2]Government ICT Report. 2023. https://www.gov.il/he/pages/booklet_on_2023_activities.
[3]GDP over the next decade is calculated considering IMF predicted growth rates.
[4]An important characteristic of the Israeli economy is that it presents very low unemployment rates (3.467% in 2023 according to the IMF). This means that the new skilled positions to be demanded by cloud's spillover might have to be filled from workers that are currently in jobs that require less skills, or by new individuals entering the labor force. From a longer-term perspective, this could result in an important transformation of Israeli workforce, driven by technological progress, and could represent an important challenge for the local economy, as it will need to accelerate the training of workers to prepare them for the expected increase in demand to take place in the forthcoming years. In contrast, if those job positions cannot be filled, it will represent a constraint for the country's future economic growth.

02
Cloud Adoption in Israel

Israel has experienced an important advance in cloud adoption in recent years. However, the country as a whole is still not fully leveraging the power of cloud as a business and technology transformation catalyst. Data available from the Survey of Information and Communication Technologies (ICT) Uses and Cyber Protection in Business,[5] conducted by the Central Bureau of Statistics (CBS) of Israel, suggests that 50.85% of Israeli firms had purchased cloud services by 2020. In comparative terms, Israel adoption level is, according to OECD statistics, close to that of Belgium and Canada, and well above Germany or France, although still at some distance from the top countries, including Sweden and Finland, both showcase more than more than 70% adoption (Graphic 2-1).

Graphic 2-1.
Cloud adoption across OECD countries (2023, or latest year available)
Number of firms using cloud for every 100 enterprises



Note: (*) 2018; (**) 2019; (***) 2020; (****) 2021; (*****) 2022.
Source: Israel Central Bureau of Statistics and OECD statistics.

[5] https://www.cbs.gov.il/en/mediarelease/pages/2021/survey-information-communication-technologies-ict-protection-business.aspx.
As explained in the CBS site, the survey, conducted between July 2020 and March 2021, compiled data on a sample of about 2,500 companies in the private sector with at least 10 employees.

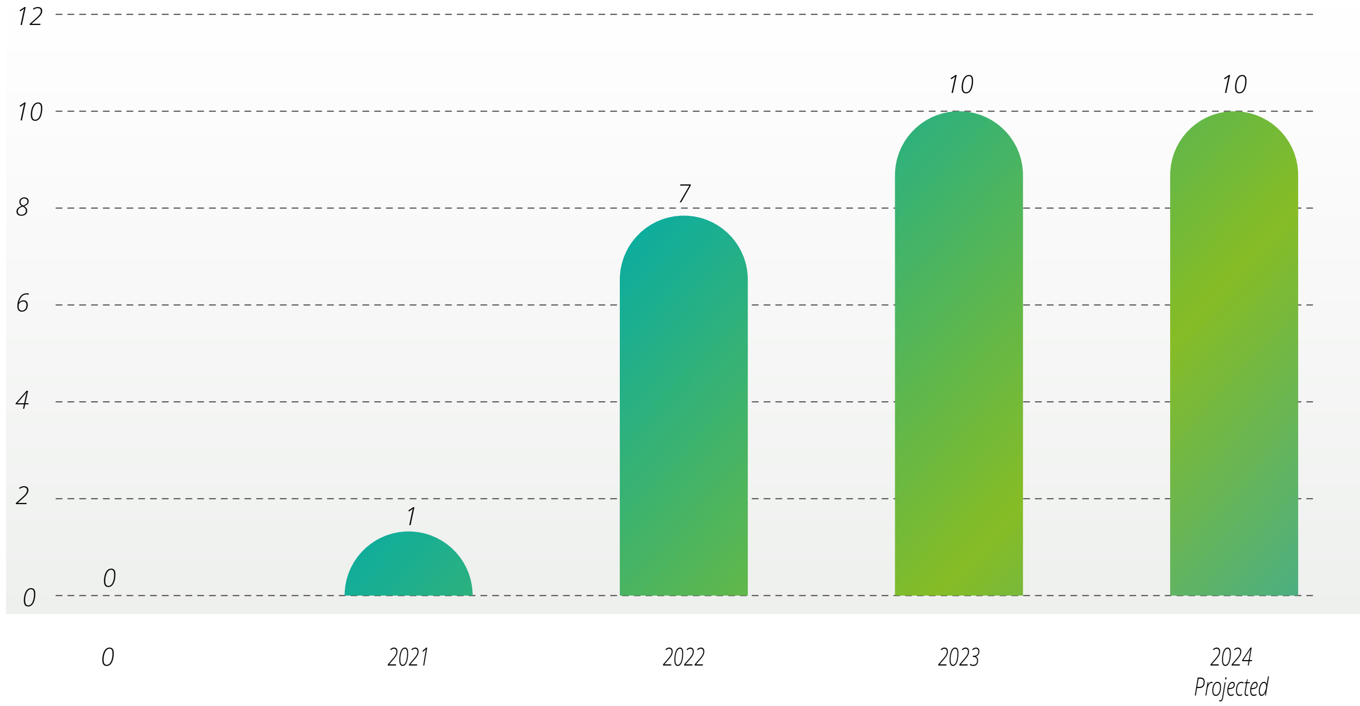
Despite the high adoption of cloud at the national level in Israel, adoption rates are not homogeneous across sectors and enterprises. In fact, at the highest level, the country exhibits very high cloud adoption among "digital natives" combined with low and limited cloud adoption rates in the public sector, and within large enterprises and SMBs traditional businesses (which, hereinafter, will be referred to as traditional companies). This is especially true for core technologies and advanced applications. As reported by the Central Bureau of Statistics,
88.41% of information intensive companies have adopted cloud services, while low technology enterprises exhibit 42.41% adoption.[6] At the sector level, 85.31% of enterprises in the information and communication industry have adopted the cloud, while only 31.35% of companies in the accommodation and food industry, as an example, are cloud users. Furthermore, while most digital native companies have been major adopters of cloud computing and experienced the benefits of cloud technology, traditional companies are primarily only using cloud for basic use cases such as SaaS, CRM solutions, simple data analysis, and collaboration tools. Again, as reported by the Central Bureau of Statistics, while 57.76% of cloud users in the information and communications sectors rely on the cloud to run the company software (which is an indication of advanced adoption), this is the case for only 6.42% of cloud users in the transportation and storage sector.

Why is this the case? Over the past decade, the adoption of cloud computing in the country has faced supply and demand barriers. On the demand side, technology leaders in traditional companies, who primarily have hardware and communications technology backgrounds, viewed the cloud as "just another box" and an "adoption risk" to their organization with limited benefits. Risks originated from a cybersecurity and data protection perspective since cloud regions were located outside Israel.

The lack of any domestic physical cloud data centers deployed by Hyperscalers meant data had to be stored offshore. The perception of risk was coupled with high latency for accessing cloud-based applications. Internally, technology leaders were also concerned about training and attracting skilled talent, impacts on company-wide financials, and the changing regulatory requirements. On the supply side, while local system integrators supported technical cloud migrations, they did not have either the experience or the capacity to drive the real business transformation attached to it. Furthermore, no global system integrators were operating locally around cloud practices to bring global cloud transformation knowledge and best practices to traditional Israeli companies and lead the way.

An initial inflection point was reached five years ago as a result of this confluence of factors. In 2019, the Israeli Government published a tender to drive public sector cloud transformation, which became known as Project Nimbus, which brought bids from all the major Hyperscalers to build local regions and commit to massive talent training programs. As part of the tender, a "cloud first" regulatory framework was also established, allowing the government to procure cloud services more seamlessly. The momentum that has been building in terms of cloud development in Israel has been boosted by massive investments of cloud investment in regional cloud Data Centers in the country. Back in 2020, there was not a single cloud region deployed in the country, according to data provided by TeleGeography. Only four years later, the country has 10 cloud availability zones that have been opened by Amazon Web Services (AWS), Google Cloud platform (GCP), Microsoft Azure, and Oracle, located within Israel (Graphic 2-2).

Graphic 2.2
Israel: Total cloud data centers deployed



Source: TeleGeography; Deloitte Israel internal research.

The massive local infrastructure investment is a response to private enterprise concerns regarding cybersecurity and connectivity. All Hyperscalers have completed the build out of their Israel cloud regions. As cloud regions open in Israel, global system integrators, such as Deloitte, have brought their knowledge of cloud transformation to traditional companies across all sectors. The culmination of these efforts may result in a true potential for a cloud adoption inflection point for core technologies within Israel in the coming years.

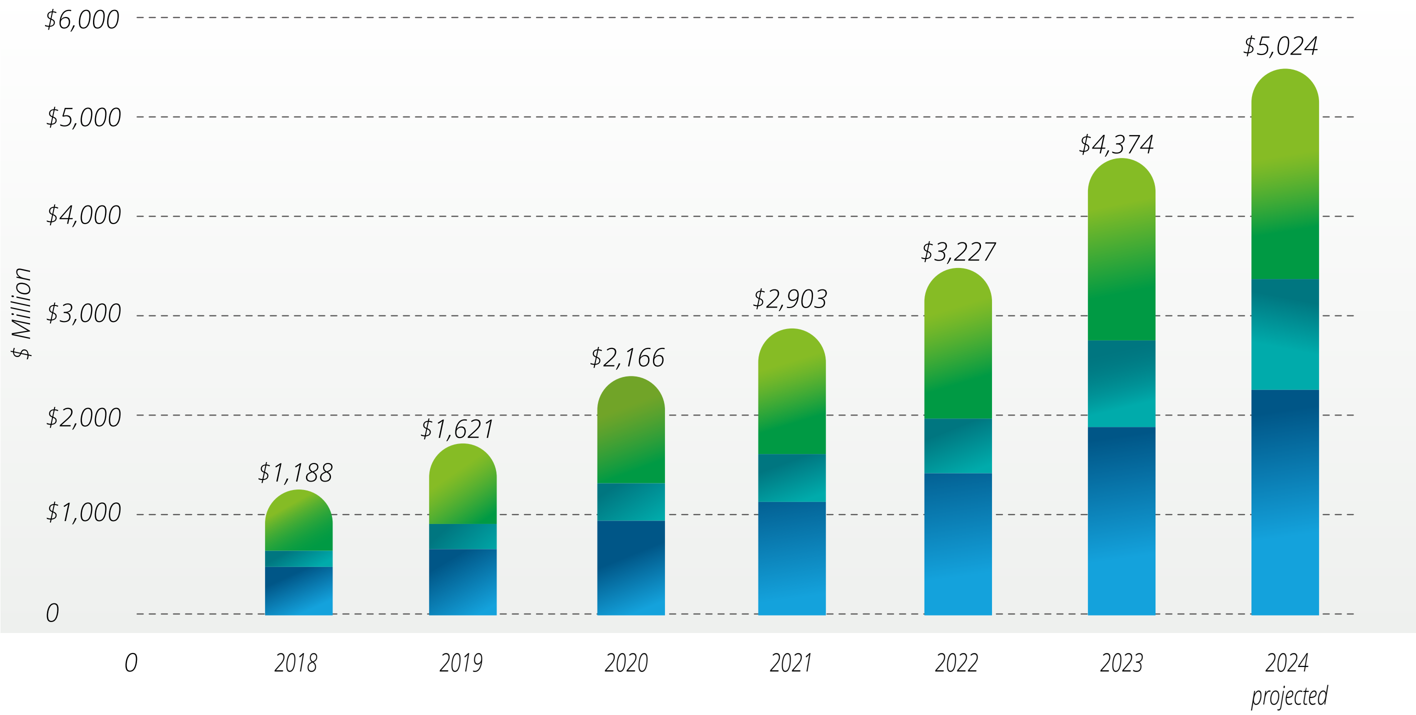
When looking specifically at cloud native development and the usage of cloud for innovation, artificial intelligence (AI) and machine learning (ML) and core solutions among traditional companies, there is still a significant opportunity ahead. Project Nimbus and other related policy initiatives may also have an impact on the private sector transition to the cloud. For example, the project will further bolster the local talent pool by establishing and training around 3,000 new full-time positions to support cloud projects, In the public sector only.

[6]Central Bureau of Statistics (2022). Survey of Information and Communication Technologies (ICT) Uses and Cyber Protection in Business, Table 11.

03
Analyzing the Type and Impact of Cloud Adoption

The Israeli market is already fairly dynamic in the realm of cloud adoption and is poised for further acceleration in the coming years. With a projected annual expenditure of $5.02 billion in 2024, the Israel cloud market has been growing at 27.1% annually, as depicted in Graphic 3-1.

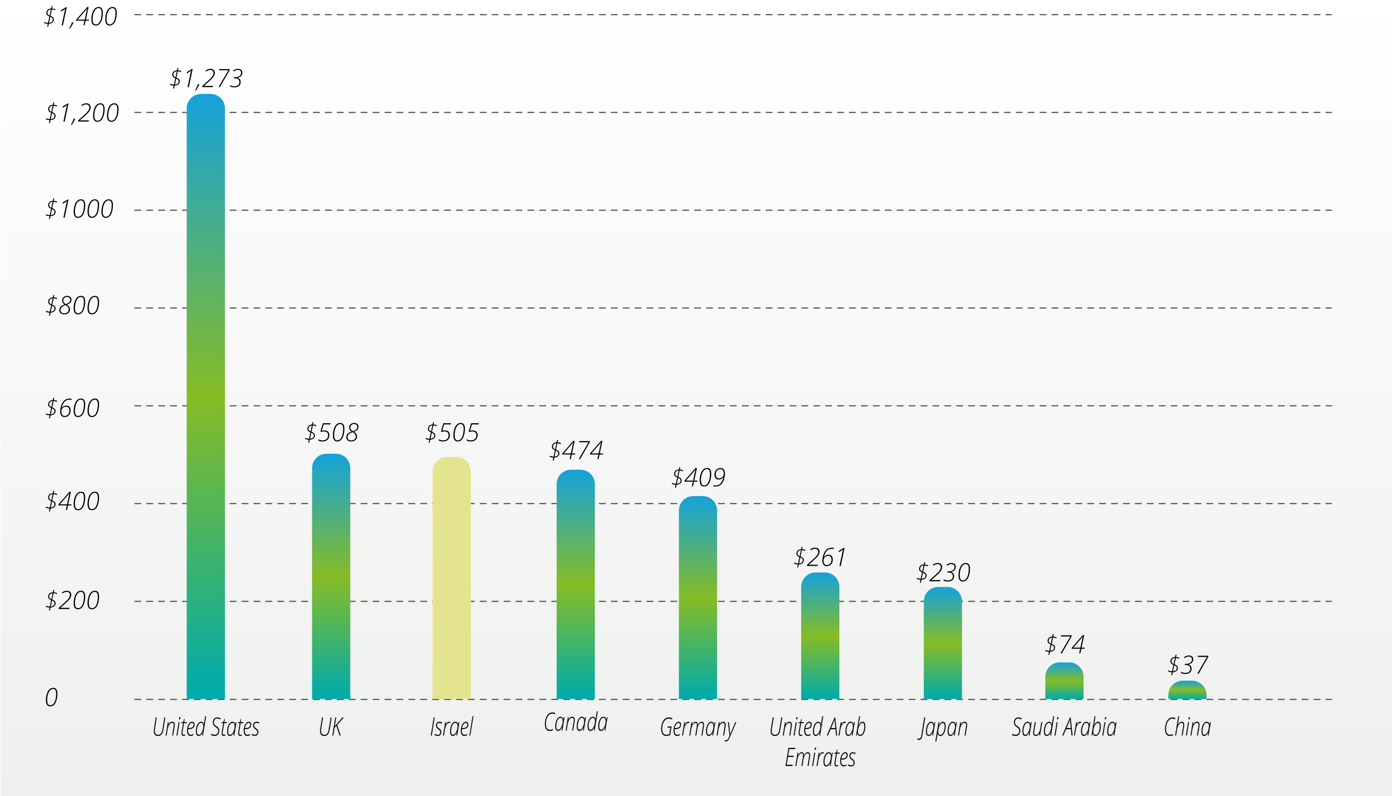
Graphic 3-1.
Israel: Cloud computing market (2018–2024)



Source: TeleGeography; Deloitte Israel internal research.

IaaS represents the largest segment in the cloud landscape, with an estimated spending of $2.1 billion, in 2024, accounting for approximately 41% of the total cloud expenditure. For comparative purposes, the 2024 per capita cloud spending in Israel is normalized to $505. This figure is below the United States and the UK, although higher than other developed economies such as Canada, or Germany. This means that Israel remains an important contender in the global cloud marketplace, as demonstrated in Graphic 3-2.

Graphic 3-2.
Cloud spending per capita in 2024 (USD) Projected



Source: IDC, International Monetary Fund, and Telecom Advisory Services analysis.

However, this high aggregate market figure hides a services maturity shortfall. By taking a closer look at enterprise cloud adoption and type of usage, we can identify three distinct levels of cloud use maturity: 1) Basic – use of cloud for email, office software, and storage files, 2) Intermediate – use of cloud for finance, account software, and CRM, and 3) Advanced – use of cloud for hosting databases, and for gaining computing power to run the company's software and processes. Measuring cloud adoption by maturity level yields a more clarifying perspective than the high level of country-wide cloud adoption initially indicated, as depicted in Table 3-1.

Table 3-1.
Israel: Cloud maturity level by enterprise size (%)

	Basic	*Intermediate*	*Advanced*
Large (greater than 250 employees)	26.4%	5.5%	11.1%
Medium (50 to 249 employees)	24.2%	5.9%	9.6%
Small (fewer than 50 employees)	24.3%	7.6%	6.4%
Average	25.0%	6.3%	9.1%

Note: The following analysis of cloud usage maturity levels is based on the OECD dataset since it reports the CBS data as businesses that purchased cloud services as a share of all establishments with 10 or more employees. The remaining enterprises are non-adopters.
Source: Central Bureau of Statistics, OECD, and Telecom Advisory Services analysis as presented in Appendix A.4.

[7] Refer to Appendix B for data sources from the Central Bureau of Statistics, the OECD, and calculation methodology.

The data presented in Table 3-1 supports three observations:

- When measuring adoption of cloud by maturity level, service adoption is much lower than 50.85% of cloud usage reported above, since most adoption is at the basic level: all enterprise sizes depict basic maturity as their highest level;
- On a percentage basis, firms with the highest level of cloud maturity are significantly less numerous than the other two maturity levels;
- Small enterprises, therefore SMBs, indicate a low level of cloud adoption across all three maturity levels.

This pattern is further illuminated when this data is disaggregated by industry, as depicted in Table 3-2.

Table 3-2.
Israel: Cloud maturity level by sector (%)

	Basic	*Intermediate*	*Advanced*
Manufacturing	22.99%	14.77%	11.60%
Construction	22.3%	9.23%	3.37%
Wholesale trade	30.94%	19.07%	14.59%
Retail trade	22.6%	9.80%	9.33%
Transportation and storage	22.66%	6.03%	6.42%
Accommodation and restaurants	16.23%	2.83%	2.25%
Information and communication	64.41%	47.25%	49.27%
Real estate	38.98%	24.93%	5.57%
Professional, scientific, and technical	41.80%	17.88%	12.89%
Administrative and support	34.75%	19.08%	13.09%

Note: The following analysis of cloud usage maturity levels is based on the OECD dataset since it reports the CBS data as businesses that purchased cloud services as a share of all establishments with 10 or more employees.

The categories are non-exclusive; they are not calculated over different uses; as expected, intermediate and advanced enterprises also include basic applications, such as email. This is why the horizontal estimates should not add up to 100 percent.
Source: Central Bureau of Statistics, OECD, and Telecom Advisory Services analysis as presented in appendix A.2.

As mentioned above, the information and communications industry exhibits significant cloud adoption compared to all other sectors, especially in the advanced category, which confirms the evidence that startups and technology-intensive companies are the primary driver of market growth. In addition, the professional, scientific, and technical sector is exhibiting a high cloud adoption level, although it still has not reached higher levels of maturity. Finally, the transportation and storage industry, a sector critical for logistics productivity, depicts very low cloud maturity level. A similar conclusion can be highlighted in the manufacturing sector.

04
The Benefits and Key Barriers of Cloud Adoption in the Private Sector

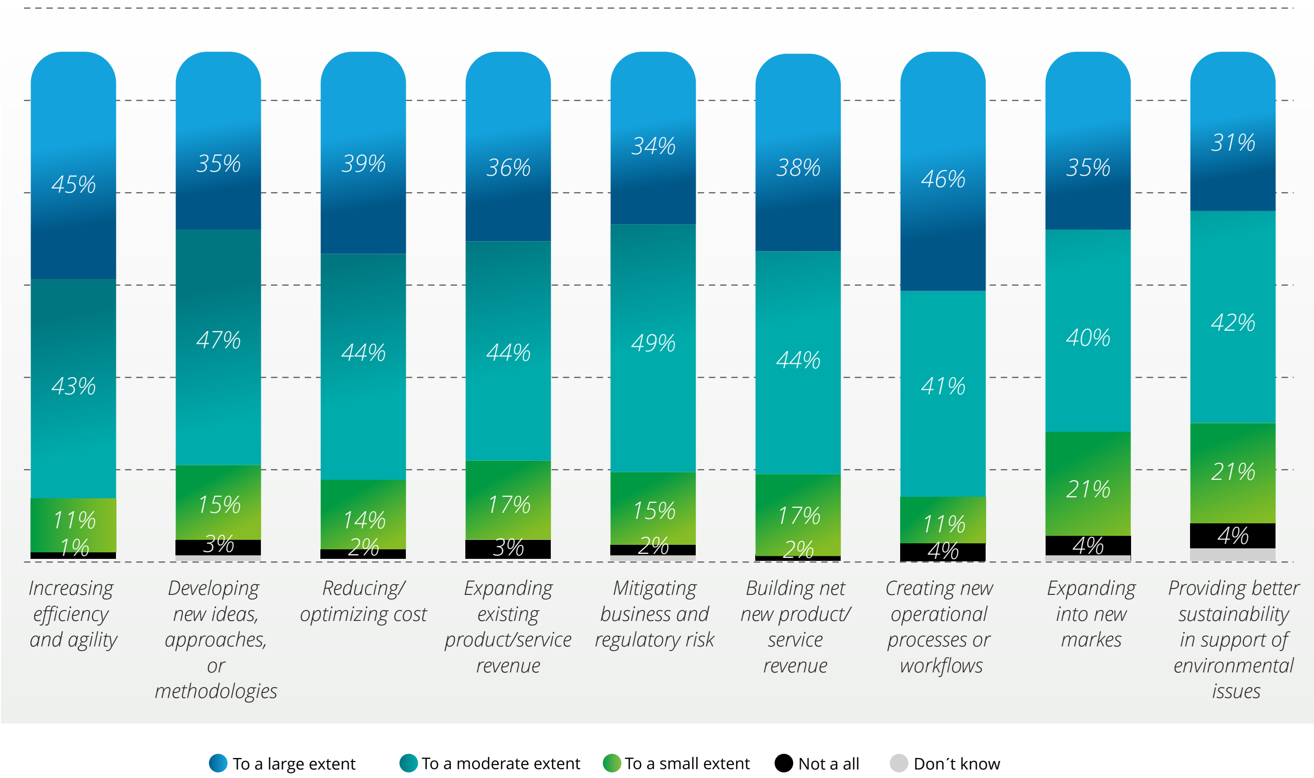
Notwithstanding the uneven market development, the upside for migrating the whole private sector to the cloud is significant. At a microeconomic level, cloud services bring tangible business benefits to an organization. By adopting the advanced technical capabilities of cloud services, organizations gain the ability to quickly scale technical infrastructure, expand market reach into new geographic areas, and develop launch products and services at a faster pace and leveraging the power of Gen-AI solution to improve processes and offerings. Organizations can more rapidly configure their technical infrastructure and applications, enabling them to benefit from increased business agility and to compete in the market more aggressively—ultimately fulfilling the needs of the business in an effective and cost-efficient way. This approach makes the procurement of technical infrastructure, including data storage, application servers, and network capacity, both swift and efficient, eliminating delays in capacity expansion and conserving excess capacity. As a result, risks such as matching hardware procurement with necessary capacity are minimized, leading to optimized operating expenses.

The positive outcomes of these investments in cloud technologies are evident from a survey conducted by Deloitte among U.S. enterprises. The study involved companies in the U.S. that have followed diverse cloud transformation strategies and at varying levels of investment. While they took different approaches, these companies, which are multiple years into their transformation journey, are witnessing significant beneficial results. More than 70% of respondents report a moderate to substantial performance impact across all areas of business, as depicted in Graphic 4-1.

Graphic 4-1.
Cloud investments driving positive outcomes

Extent to which cloud investment is driving positive outcomes in these areas

(Percentage of total respondents; n=500 for each response)



Source : Deloitte. 2022. « Closing the cloud strategy, technology, and innovation gap." Deloitte US Future of Cloud Survey Report, https://www2.deloitte.com/us/en/pages/consulting/articles/cloud-strategy-innovation-survey-report.html.

Another salient advantage of cloud services, as highlighted by the U.S. survey, is the ability to expedite the development and release of new products and services. According to the survey, 80% of respondents observed an enhancement in their ability to generate revenue from new products, and 82% reported improvements in their ability to develop new ideas.
In Israel, while both traditional enterpises and startups are able to leverage this benefit, a Deloitte Israel cloud study revealed significant differences in adoption rates. Of the traditional enterprises and startups surveyed, 94% of startups are utilizing Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS), in contrast to the 64% adoption rate among traditional enterprises. One explanation for this discrepancy is the typically stringent governance processes traditional enterprises must navigate through in comparison to startups, which customarily have greater financial and operational flexiblity.

Furthermore, these cloud services provide startups the ability to reduce the cost of launching their businesses, as affirmed by 82% of startup respondents. Lastly, Israeli respondents also recognize SaaS-based solutions as enhancing the productivity of their workforce. As evidence, 72% of respondents strongly agree that cloud services facilitate remote work and collaboration. Moreover, startups were found to be more inclined to adopt cloud-enabled collaboration tools (88%) compared to traditional enterprises (59%).[8] In the last year, all organizations started recognizing the need to leverage the power of Gen-AI to support business goals - which can not be achived without public cloud services and solutions.

By reviewing the hard-costs of replacing their technical infrastructure (on-premises versus cloud service costs) and evaluating the soft costs of operational efficiencies (such as the costs associated with improving business agility and accelerating product releases), executives can incrementally transform their organizations while adapting to market demands. The breadth of services provided by cloud service providers enables organizations to adopt a modular approach and to develop a comprehensive cloud transformation plan. This plan can stimulate produce and service innovation, while also enhancing internal operations, optimizing financial expenditure, reskilling and refocusing resources, and improving key productivity and time-to-market KPIs. Reflecting on more mature cloud markets, the Deloitte U.S. cloud study provides valuable insights. It posits that the cloud can become a key force multiplier in achieving companies' strategic.

However, in a survey conducted by Deloitte Israel, executives were invited to evaluate a set of concerns and barriers associated with the adoption of cloud services. The results indicate that the most significant barriers[9] are as follows: (i) 59% seek to attain a more comprehensive understanding of the financial reporting implications of cloud usage for their organizations; (ii) 56% report concerns with the ability to find and attract suitable talent to implement and support cloud operations; and (iii) 49% seek a clearer picture of the regulatory requirements to which their respective organizations must adhere when operating with cloud services.

In the Survey, a wide consensus on the first barrier was noted: access to talent. The Israeli Innovation Authority, a branch of the Israeli Government dedicated to fostering the development of industrial research and development (R&D), also recognizes concerns relating to a high-tech industry skills shortage in Israel.[10] In fact, the Deloitte survey found that traditional enterprises consider this issue somewhat more daunting than their startup peers, with 64% of traditional companies stating this as a challenge, in comparison to 47% of startups. This can be attributed to the fact that both large and small organizations are vying for talent from the same pool of candidates to support their cloud operations. The Nimbus project is set to further bolster the local talent pool by establishing an estimation of around 3,000 new full-time positions to support cloud projects.

[8]This is a key element to note, as it relates to the changing lifestyles and work habits due to the COVID19- pandemic, which has led to new labor force behavior with a high focus on hybrid working models.
[9]"Significant Barrier" in the context of this finding is defined by combining blocker, critical barrier, or medium barrier responses.
[10]https://innovationisrael.org.il/en/digital-reports/.

Executives also note concerns with the complex nature of cloud financing, especially understanding the costs of implementing and operating cloud technology compared to the financing of their current physical infrastructure. A second major concern relates to the management of transitioning from fixed-price licensing and infrastructure to a more unpredictable and sometimes inconsistent differentiated pricing model. This concern extends to financial reporting, including how an organization will calculate and forecast its operating expenses as part of its EBITDA calculations. Therefore, chief information officers (CIOs) and chief financial officers (CFOs) are keenly interested to develop a better understanding of the nuances of how cloud services could impact their capital and operational expenditures, as it might have an effect on external shareholders' assessments of the organization's prospects.

Moreover, the study also identifies that regulatory rules and laws, at both regional and global levels, pose significant concern for executives of Israeli organizations. Nearly half of the respondents declared these as significant barriers. Organizations, especially in heavily regulated sectors such as financial services, will require detailed guidance on how to address data sovereignty, data governance, and service restrictions when transitioning their operations to the cloud. In recent years, cloud service providers (CSPs) have significantly invested in obtaining compliance certifications for hardware and software to support various sectors, such as healthcare with HIPAA, financial services with ISO, PCI, and SOC, the public sector with FEDRAMP and FIPS140-2, and the EU general data protection regulation (GDPR), among others. In a significant development, the recent establishment of 10 cloud availability zones in Israel might enable organizations to store content domestically, thereby creating an environment in which numerous public sector organizations and their contractors can leverage the cloud.

It is also noteworthy to mention that this study finds these concerns are shared across all sectors covered by respondents. This finding further supports the notion that organizations, irrespective of size or sector, could benefit from developing a comprehensive cloud strategy and transformation approach to overcome these adoption barriers.

05
Estimating Cloud Computing Economic Spillover for Israeli Enterprises

Data drawn from the Survey of Information and Communication Technologies (ICT) Uses and Cyber Protection in Business, conducted by Israel's Central Bureau of Statistics (CBS), indicates that overall cloud adoption across the country's enterprises was 50.85% in 2020. However, this level of cloud adoption exhibits notable variations across sectors: 85.3% in the information and communication sector, 70.6% in professional, scientific, and technical activities, 57.1% in real estate (administrative and support), 50.7% in manufacturing, and 50.5% in trade activities. All other surveyed sectors reported considerably lower cloud adoption rates.

Furthermore, the CBS survey's detailed microdata offers insights into the economic benefits, or spillover effects, of cloud adoption, differentiated by firm size and degree of intensity in cloud usage. These insights provide a more granular understanding of the cloud's economic impact within local firms. By relying on this microdata, Telecom Advisory Services, with support from CBS, assessed the impact of cloud computing on firm productivity, measured as wages per employee.[12] The selected estimation method was ordinary least squares (with weights), with robust standard errors. This approach enabled estimates for all firms, considering firm size and the degree of maturity of cloud usage, as presented in Section 3.

At the aggregate level, the primary results confirm that firms that adopt cloud computing exhibit higher productivity than firms that do not adopt the technology, with the results being statistically significant at the 1% level. The coefficients indicate that firms that adopt cloud computing are 27.3% more productive than their non-adopting counterparts (as detailed in Table 5-1).

Table 5-1.
Israel: Cloud computing spillover effects on the productivity of Israeli firms

Dependent variable: Log (Labor Productivity)	
Employees	0.0000- [0.0000]
Cloud computing	0.2731*** [0.0330]
Sector fixed effects	YES
Location fixed effects	YES
R-squared	0.3883
Observations	2,002

*Note: *** p<%1 Robust standard errors in brackets.*

Source: Telecom Advisory Services analysis.

In the assessment of the level of impact by firm size, our research indicates that Israeli SMBs benefit from higher spillover effects from cloud computing than larger firms. The coefficients indicate that small and medium firms that adopt cloud computing are 28.5% and 25.8% more productive, respectively, than those that do not use this technology, while for large firms, the coefficient of the level of impact is 12%, as depicted in Table 5-2.[13]

[12]Wages can be considered a suitable proxy for productivity, as according to economic theory, they must represent the marginal productivity of the labor factor.

[13]As a word of caution, it is important to consider that these estimates were conducted through Ordinary Least Squares, not controlling for potential presence of endogeneity. To control for endogeneity, the desired approach would be to conduct an Instrumental Variables (IV) regression. Unfortunately, there were not suitable instruments available in the data sample from the Central Bureau of Statistics for estimating IV regressions.

Table 5-2.
Israel: Cloud computing spillovers by firm size

Group	Segment	Cloud adoption	Fixed Broadband adoption	Coefficient for Cloud computing
By Size	Large enterprises – 250 or more employees	78.8%	98.4%	0.1199**
	Medium enterprises – 50–249 employees	67.7%	94.3%	0.2578***
	Small enterprises – 10–49 employees	46.6%	82.8%	0.2850***

*Note: *** p<1%, ** p<5%. Robust standard errors in brackets.*

Source: Central Bureau of Statistics and Telecom Advisory Services analysis.

This result is consistent with the research conducted by Chen et al. (2022), which revealed small firms were found to accomplish a higher increase in profitability from cloud usage than larger firms.[14] The authors attribute this to the fact that smaller firms typically have less structural inertia than large companies. This flexibility proves more beneficial for the efficient use of cloud computing services, as it enables small businesses to derive substantial operational benefits from cloud implementation, thereby yielding higher profitability. In addition, small firms, even those with limited ICT capacities, can access sophisticated computational resources through the cloud. This access helps reduce operational costs and enables them to focus more intently on their core businesses, which can, in turn, result in higher competitive advantage and firm profitability.

The influence of company size on productivity also becomes evident when disaggregating enterprises by the maturity level of their cloud usage (defined as basic, intermediate, and advanced in Section 3). As cloud usage intensifies, so too does the resulting boost in the productivity effect, as demonstrated in Table 5-3.

Table 5-3.
Israel: Cloud computing spillovers by cloud maturity level

Segment	Coefficient for Cloud Computing Spillovers
Basic cloud computing use	0.071
Intermediate cloud computing use	0.110*
Advanced cloud computing use	0.131*

*Note: * p<10%. Robust standard errors in brackets.*

Source: Central Bureau of Statistics and Telecom Advisory Services analysis.

In summary:

- Enterprises that adopt cloud computing exhibit 27.3% higher productivity compared to those that do not. This finding supports there are overarching benefits of this technology, particularly in terms of IT efficiency and revenue generation.
- Small firms that adopt cloud technology exhibit higher productivity effects than larger firms. This finding indicates two potential dynamics at work: (i) smaller cloud-adopting firms tend to include a larger concentration of digital natives, who are generally more adept at incorporating technology as a primary IT platform than traditional enterprises and (ii) small firms have fewer organizational barriers to assimilate cloud technology as compared to large firms (as explained in Section 2), thereby accounting for its economic benefits. However, it is important to note that this effect emerges only in those small firms that are actively using cloud technology.
- The productivity boost incerase correspond directly with the level of maturity of cloud adoption. Firms that use cloud computing for hosting Data and obtaining computational power for running company software and processes (that is to say, to reach advanced usage levels) depict a higher productivity impact compared to firms with basic cloud usage (such has hosting email, for example). Employees at firms with advanced cloud computing usage earn 13% more than their counterparts at firms that have not adopted cloud technology.

[14]Chen, X., Guo, M., and Shangguan, W. 2022. "Estimating the impact of cloud computing on firm performance: An empirical investigation of listed firms." Information & Management, 103603 ,(3)59.

06
Overall Contribution of Cloud Computing Services to the Israel Economy

In the preceding section, the economic contribution was measured at the firm level, focusing on productivity. The aggregate economic impact, however, can be estimated by calculating the cloud's contribution to the Israeli GDP. The economic contribution of the public cloud to the GDP of a country encompasses two effects: (i) the cloud spending, commonly known as the "direct effect," and (ii) the spillover effects of the service throughout the entire economy, termed as the "indirect effect." The cloud spending, that is, the direct effect, is a measure of local market demand that can be fulfilled through cloud service providers based either within the country or beyond the nation's borders. The spillover effect measures the impact of cloud procurement on the overall economy through the increase of business performance within the country. For example, when cloud services enable the adoption of IT services in the SMB sector, which benefits from the scalability of state-of-the-art IT, it is considered as a spillover effect.

The methodology applied in this analysis relies on public secondary data and econometric modeling, factoring in cloud spending and economic spillover effects, as depicted in Table 6-1.

Table 6-1.
Revenue and spillover effect contribution of cloud services to GDP

Item	*Indicator*	*Source*
(1)	Cloud spending	Public secondary sources
(2)	Spillover effect of cloud services	Estimated from the econometric analysis
(3)	Total impact of cloud services relative to the GDP	(2) + (1)

Source: Telecom Advisory Services.

6.1 Assessing the impact of cloud computing services on GDP

As noted in Section 3, expenditure on cloud services in Israel in 2024 is projected to be $5.02 billion. Conversely, the indirect effect relies on the elasticity of cloud adoption growth. It is understood that the evolution of GDP is contingent upon specific unobserved local characteristics, physical capital stock, labor, broadband adoption and, most importantly, public cloud adoption. For this purpose, it is necessary to forecast cloud adoption from the value provided by the Central Bureau of Statistics: 50.85% for 2020. The only data available is the growth in cloud spending (source: IDC), that increased from $1.19 billion in 2018 to $3.23 billion in 2022, culminating in $5.02 billion in 2024.

The starting assumption establishes a link between the evolution of spending and adoption. While it is recognized that spending growth is a good predictor of cloud adoption increases, it must be considered that not all spending increases can be attributable to new users (expansion in adoption). Existing users upgrading to new services and plans offered by cloud providers, thus increasing their spending, should also be considered. To understand the complex relationship between spending increase and adoption growth, we analyzed the correlation between both variables using a sample of developed countries for which data is available, including Canada, Germany, Japan, and the United Kingdom. In those countries, cloud adoption data is reported by the OECD, while spending data is provided by IDC. For all these countries, we have certain data points exhibiting spending and adoption growth rates from 2016 through 2021 (Table 6-2).

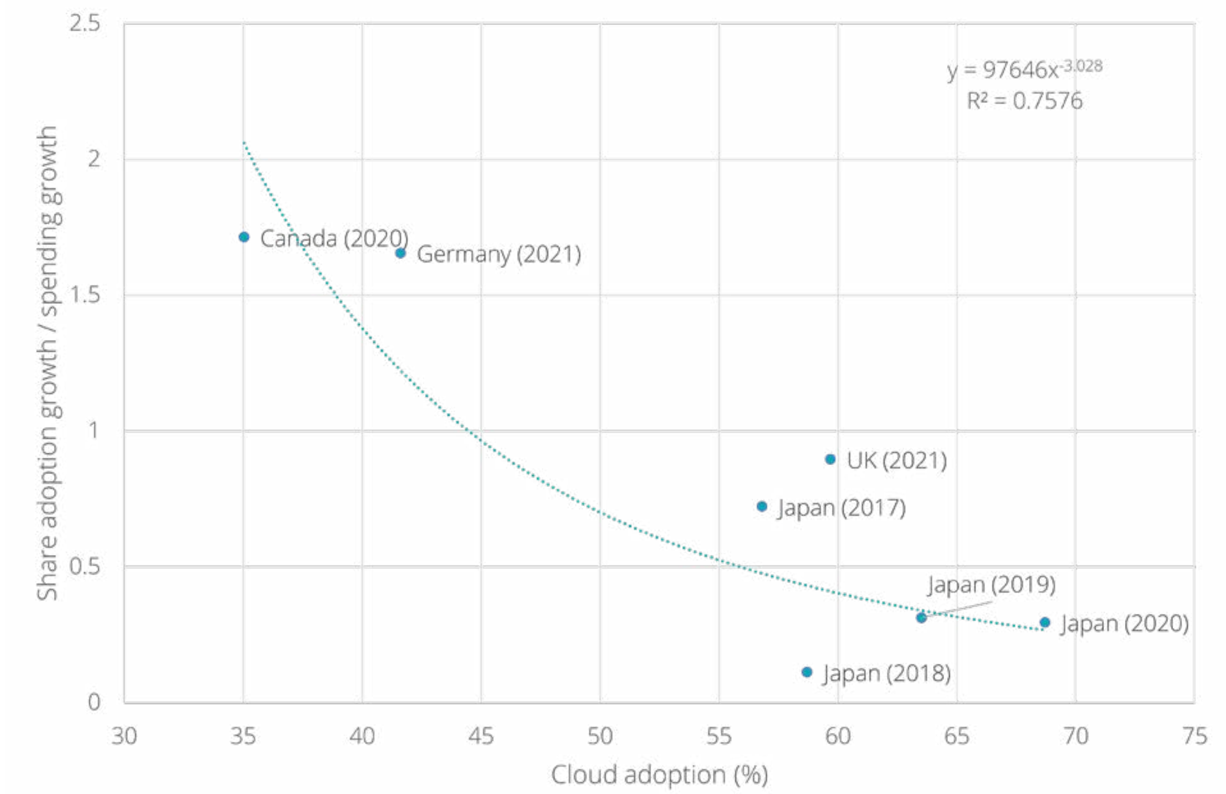
Table 6-2.
Scenarios for future evolution of cloud spending in Israel

Country	Cloud adoption growth (%)	Spending growth (%)	Share (adoption growth/ spending growth)
Germany (2021)	24.8%	15.0%	165.6%
Japan (2020)	8.2%	27.6%	29.7%
Japan (2019)	8.2%	26.1%	31.3%
Japan (2018)	3.3%	29.6%	11.3%
Japan (2017)	21.2%	29.3%	72.3%
UK (2021)	12.6%	14.0%	89.7%
Canada (2020)	39.9%	23.3%	171.4%
Average	**16.9%**	**23.5%**	**71.9%**

Source: IDC, OECD, Telecom Advisory Services analysis.

The average annual adoption growth stands at 16.9%, while average spending growth is 23.5%. This reveals that, effectively, we cannot directly extrapolate spending growth to adoption, as this latter figure is, on average, 71.9% of the former. Moreover, based on this information we find that the higher the adoption level, the lower the share of spending growth that can be attributable to adoption expansion. As the percentage of firms adopting cloud technology increases, there are fewer opportunities for cloud adoption, while existing adopters also increase their cloud spending on new applications. By applying a potential function, we can extrapolate for each cloud spending growth data point to determine the associated growth rate in cloud adoption (refer to Graphic 6-1).[15]

Graphic 6-1.
Cloud adoption and ratio adoption relative to spending growth



Source: IDC, OECD, and Telecom Advisory Services analysis.

[15]In order to estimate cloud adoption for forthcoming periods, we forecast the future values based on the expected evolution of cloud spending, as this latest information is available from reliable sources (e.g., Gartner, IDC, Statista). Based on the real data points for specific countries presented Graphic 6-1, we can associate the evolution of cloud adoption to the ratio between adoption growth and spending growth. The downward slope represented in Graphic 6-1 suggests that when cloud adoption is low, all spending increases can be directly associated with adoption increases. However, for higher cloud adoption values, only a diminishing share of cloud spending increases translates into adoption increases. This can be explained as in more mature markets, an important portion of spending increases appears to be used to upgrade plans or to subscribe to additional cloud services or functionalities for existing users, rather than to add new users to the subscriber base.

This indicates that the relationship between expenditure growth and adoption increase is likely to vary over time in Israel, as a rising number of firms adopt the technology. According to this relationship, we estimate that general cloud adoption has reached approximately 72.2% by 2023. At this stage, we can calculate the overall economic contribution of the cloud for the year 2023.

Once the overall cloud adoption in Israel has been estimated, we can calculate its economic impact through a system of simultaneous equations described in Appendix A.3. Considering the interrelationship between fixed broadband and the economic impact of the cloud, having a high broadband adoption, as observed in Israel, contributes to maximizing the economic effect of the cloud. In addition to fixed broadband adoption, the spillover effect of cloud contribution also is related to differences in cloud adoption. Accordingly, the elasticity will depend on the estimated coefficient (0.0003), as well as the actual adoption levels of broadband and the cloud. We employed the estimated coefficient of 0.0003 to calculate the GDP contribution in 2023 (refer to Table 6-3).

Table 6-3.
Israel: Overall contribution of the cloud to GDP (2023)

	Estimate	*Source*
1. Cloud spending ($B) 2022	$ 3.23	IDC
2. Cloud spending ($B) 2023	$ 4.37	IDC
3. Growth rate (%)	35.6%	((2)-(1))/(1)
4. Broadband adoption (%)	100%	ITU
5. Cloud adoption 2022 (%)	64.9%	Estimation from spending evolution
6. Cloud adoption 2023 (%)	72.2%	Estimation from spending evolution
7. Elasticity (%)	0.10%	Calculation applying equation (1): log (4) * (6) * 0.0003
8. Spillover (%)	1.13%	(((6)-(5)) / (5)) * (7)
9. GDP ($B)	$ 509	IMF
10. Spillover ($B)	$ 5.75	(8) * (9)
11. Total contribution ($B)	$ 10.13	(2) + (10)

Source: Telecom Advisory Services analysis

In summary, when combining spending and spillover effects on GDP, public cloud services generated a significant contribution to the Israeli economy in 2023, specifically $10.13 billion, or 2% of the GDP.

6.2. The impact of cloud computing on job creation of ICT specialists

To estimate the impact of cloud services on ICT-specialists employment, we built a model covering OECD countries (Table 6-4). We employed as dependent variable the proportion of the ICT-skilled labor force over total employment.[16] As explanatory variables beyond cloud adoption, we introduced GDP per capita, to control for economic development, and inflation, to account for the effects usually represented through the Phillips curve.[17]

Table 6-4.
Cloud computing spillover effects on employment

Dependent variable:	*Log(Employment ICT specialist rate over overall employment)*
Log (Cloud adoption)	0.205***
	[0.024]
Log (GDP per capita)	0.369**
	[0.172]
Inflation	-0.269**
	[0.864]
Country fixed effects	YES
R-squared	0.596
Observations	195

Note: *** p<1%, ** p<5%, * p<10%. Robust standard errors in brackets.

Source: Telecom Advisory Services analysis.

The results point to a significant effect of cloud adoption on increasing demand for high skilled job positions. Notably, we can state that

1% increase in cloud adoption could yield 0.205% increase in the share of ICT skilled jobs over the total employment.[18]

We employed the coefficients in Table 6-4 to simulate the expected increase in the demand for skilled job positions in the Israeli economy during 2023. The increase in cloud adoption of 11.3% yielded a rise of 2.23% in the ICT-specialists employment ratio (refer to Table 6-5).[19]

[16]It is worth to recall that this variable refers specifically to ICT specialists, which may diverge for the overall figures of employment in the technological sector. For example, according to the recent report of the Israel Innovation Authority (2024), employment in high-tech accounted for 11.6% of total employment in 2023, a higher figure that estimated by the OECD for ICT specialists in Israel (7.76%). Considering that we needed a cross-country dataset, we relied on OECD data to conduct the empirical analysis.
[17]The data was compiled from statistics provided by the OECD.
[18]This elasticity is based on the coefficient estimated for a cross-country sample. Unfortunately, data availability was not enough to perform a country-specific regression for the case of Israel. It is worth commenting that the particularities of Israel, with very low unemployment rates in skilled positions, can mean that these effects may also end up increasing wages in the case of difficulties to fill the vacancies.
[19]These are estimates based on cross-country coefficients from regression analysis. It is worth commenting that in the case of Israel, with high demand for skilled job positions, these jobs may well end up in alternative positions rather than unemployed in the absence of the simulated effect.

Table 6-5.
Israel: Overall contribution to employment by cloud (2023)

Category	Estimate	Source
1. Employment in 2022	4,186,992	CBS
2. ICT-specialists employment in 2022 (as a % of overall employment)	7.76%	Extrapolated from OECD estimation for 2021 (7.7%)
3. Job positions for ICT specialists in 2022	325,046	(1) * (2)
4. Cloud adoption in 2022	64.9%	Table 6-3
5. Cloud adoption in 2023	72.2%	Table 6-3
6. ICT-specialists employment ratio increase attributable to 1% increase in cloud adoption	0.205%	Table 6-4
7. Projected increase in cloud adoption for 2023	11.32%	(5)-(4)/(4)
8. Anticipated increase in ICT-specialists employment ratio in 2023 due to cloud adoption	2.23%	(7) * (6)* 100
9. ICT-specialists employment in 2023 (as a % of overall employment) due to cloud computing	7.94%	(2) * (1+(8))
10. Number of ICT-specialists jobs required in 2023 attributable to cloud computing adoption	7,546	(9)-(2) * (1)

Source: Telecom Advisory Services analysis

As highlighted in Table 6-5, the ICT-specialists employment ratio for 2023, including the new jobs required as a result of spillover effects related to the increase in cloud computing adoption, is estimated to be 7.94%. Therefore, the growth in cloud computing adoption in 2023 represents a demand of approximately 7,546 job positions for ICT-skilled workers.

6.3. Overall contribution of cloud computing in the next decade

While the contribution of the cloud to the GDP in 2023 is significant, it is also relevant to estimate its impact for the period from 2024 to 2033. In this chapter we will use the latest GDP and cloud spending predictions being done by the IMF and IDC.

For this purpose, we need to extrapolate the forecast into the future. We developed two alternative scenarios to estimate the remaining period up to 2033—a moderate and an aggressive one—with an inflection point in 2025 (refer to Table 6-6). We view 2025 as the next critical inflection point due to a confluence of three factors: (i) we estimate it will take approximately two years following the completion of local cloud regions for business enterprises and public sector ministries to establish cloud transformation strategies and begin implementation, (ii) successful adoption and operation of the cloud by an initial set of leaders in the next two years will be crucial before the wider market is willing to undergo change, and (iii) the talent base will expand dramatically in the next two years as the level of demand for cloud skills grows.

Table 6-6.
Scenarios for future evolution of cloud spending in Israel

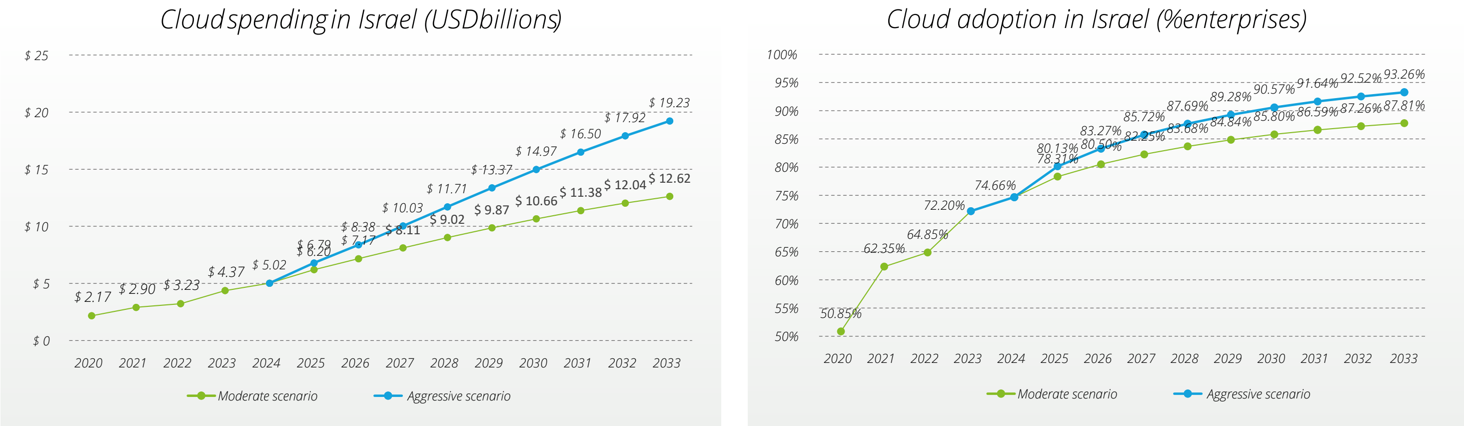
Scenario	Assumption for 2026-2033	Rationale	Driving Factors
Moderate	Growth rate will progressively decline, from 14.2% in 2026 to 4.9% in 2033	Yearly growth in cloud spending will decline according to IDC. We assume it will continue to decline, following that decreasing trend, until reaching 4.9% in 2033	• Lack of cloud skilled talent • Low adoption of advanced and moderate cloud services • Low adoption of cloud uses by non-information intensive industries
Aggressive	Annual growth rates for 2026–2033 will be 50% higher than those projected in the moderate scenario	Assumes that the country may not yet be in a steady state phase, with big investments still planned, which will expand current momentum for the next 10 years	• Growth in availability of cloud skilled talent • Adoption of advanced and moderate cloud uses driven by the launch of cloud regions in Israel

Source: Telecom Advisory Services analysis.

As denoted in Table 6-6, the moderate scenario assumes that the current spending trend will continue until 2033. This predicts annual growth in cloud spending will progressively decline until reaching a saturation point, reflecting a mature technology. Conversely, the aggressive scenario assumes that recent investments occurring within the country (as highlighted in Graphic 2-2 with the recent development of cloud regions) can potentially stimulate a new growth phase, extending the recent momentum for additional years. In this alternative scenario, we assume that the annual growth rates for 2026–2033 will be 50% higher than those projected in the moderate scenario.

On this basis, we can extrapolate cloud adoption in the future. For this purpose, we relied on the estimated link between cloud adoption and cloud spending presented above. Under these assumptions, we plot in Graphic 6-2 the estimated evolution of both cloud spending (left graphic) and adoption (right graphic) for each scenario. In the moderate scenario, spending will evolve from $6.20 billion in 2025 to $12.62 billion in 2033, with adoption reaching 87.8% of firms in 2033. However, with the aggressive scenario, both spending and adoption could respectively reach $19.23 billion and 93.3%.

Graphic 6-2.
Israel: predicted evolution of cloud spending and adoption (With an inflection point in 2025)



Source: IDC, OECD, Telecom Advisory Services analysis.

Table 6-7 presents the detailed results of the spillover effects generated by public cloud adoption growth for the period 2023–2033 and the spending generated in the same period, for the moderate scenario. The moderate scenario predicts a diminishing rate of growth in both spending and adoption figures.

Overall, the total cumulated economic contribution over the period 2024–2033 is estimated to reach $105.91 billion, amounting to 1.58% of the GDP forecasted for the same period.[20] Furthermore, under the moderate scenario, a total of over 13,700 new ICT-specialists job positions might be required during the period 2024–2033, attributable to cloud computing spillover effects within the economy.

[20]GDP over the next decade is calculated considering IMF predicted growth rates.

Table 6-7.
Israel: total economic contribution of the cloud in 2023–2033—moderate scenario

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Cloud spending ($B)	$4.37	$5.02	$6.20	$7.17	$8.11	$9.02	$9.87	$10.66	$11.38	$12.04	$12.62
Growth rate (%)	35.6%	14.8%	23.5%	15.5%	13.2%	11.2%	9.5%	8.0%	6.8%	5.7%	4.9%
Broadband adoption (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Share adoption growth / spending growth	31.9%	23.0%	20.8%	18.0%	16.6%	15.5%	14.7%	14.1%	13.6%	13.3%	13.0%
Cloud adoption (%)	72.2%	74.7%	78.3%	80.5%	82.3%	83.7%	84.8%	85.8%	86.6%	87.3%	87.8%
Elasticity (%)	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12
Spillover (%)	1.13%	0.35%	0.53%	0.31%	0.25%	0.20%	0.16%	0.13%	0.11%	0.09%	0.08%
GDP ($B)	$509	$531	$570	$595	$622	$651	$682	$715	$749	$785	$822
Spillover ($B)	$5.75	$1.87	$3.01	$1.85	$1.54	$1.30	$1.11	$0.96	$0.83	$0.72	$0.63
Total contribution ($B)	$10.13	$6.89	$9.21	$9.02	$9.65	$10.32	$10.98	$11.62	$12.21	$12.76	$13.25
Increase in ICT skilled employment ratio due to %1 increase in cloud adoption	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%
Increase in ICT skilled employment ratio due to cloud adoption	2.32%	0.70%	1.00%	0.57%	0.45%	0.35%	0.29%	0.23%	0.19%	0.16%	0.13%
ICT skilled employment (as a % of employment)	7.94%	8.0%	8.1%	8.1%	8.2%	8.2%	8.2%	8.2%	8.2%	8.3%	8.27%
ICT skilled jobs	332,592	334,922	338,276	340,214	341,734	342,946	343,924	344,721	345,375	345,916	346,364
New demand for ICT skilled jobs due to cloud computing	7,546	2,330	3,354	1,938	1,520	1,212	978	797	654	540	448

Source: Telecom Advisory Services analysis.

In Table 6-8, we present the detailed results of the spillover effects induced by the growth of public cloud adoption and the corresponding spending generated in the period from 2023 to 2033, as per the aggressive scenario.

Table 6-8.
Israel: total economic contribution of the cloud in 2023–2033—aggressive scenario

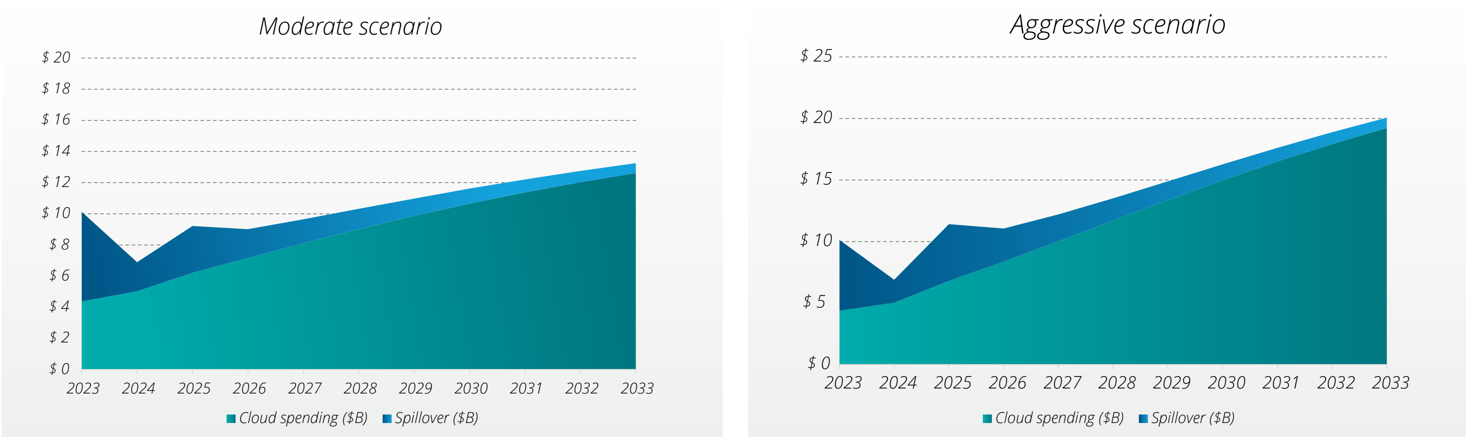
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Cloud spending ($B)	$4.37	$5.02	$6.79	$8.38	$10.03	$11.71	$13.37	$14.97	$16.50	$17.92	$19.23
Growth rate (%)	35.6%	14.8%	35.2%	23.3%	19.7%	16.7%	14.2%	12.0%	10.2%	8.6%	7.3%
Broadband adoption (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Share adoption growth / spending growth	31.9%	23.0%	20.8%	16.8%	14.9%	13.7%	12.8%	12.1%	11.6%	11.2%	10.9%
Cloud adoption (%)	72.2%	74.7%	80.1%	83.3%	85.7%	87.7%	89.3%	90.6%	91.6%	92.5%	93.3%
Elasticity (%)	0.10	0.10	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13
Spillover (%)	1.13%	0.35%	0.81%	0.45%	0.35%	0.28%	0.22%	0.18%	0.15%	0.12%	0.10%
GDP ($B)	$509	$531	$570	$595	$622	$651	$682	$715	$749	$785	$822
Spillover ($B)	$5.75	$1.87	$4.62	$2.68	$2.17	$1.81	$1.52	$1.30	$1.12	$0.97	$0.84
Total contribution ($B)	$10.13	$6.89	$11.41	$11.05	$12.20	$13.52	$14.89	$16.27	$17.62	$18.89	$20.07
Increase in ICT skilled employment ratio due to 1% increase in cloud adoption	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%	0.205%
Increase in ICT skilled employment ratio due to cloud adoption	2.32%	0.70%	1.50%	0.80%	0.60%	0.47%	0.37%	0.30%	0.24%	0.20%	0.16%
ICT skilled employment (as a % of employment)	7.9%	8.0%	8.1%	8.2%	8.2%	8.3%	8.3%	8.3%	8.3%	8.4%	8.38%
ICT skilled jobs	332,592	334,922	339,953	342,678	344,751	346,369	347,655	3486,91	349,533	350,224	350,794
New demand for ICT skilled jobs due to cloud computing	7,546	2,330	5,031	2,725	2,073	1,618	1,286	1,036	843	691	570

Source: Telecom Advisory Services analysis.

In the aggressive scenario, the total cumulated economic contribution during the period from 2024 to 2033 is expected to reach $142.8 billion, representing 2.13% of the forecasted GDP for the same period. Furthermore, this scenario projects the demand of 18,200 new jobs during the period from 2024 to 2033 due to the spillover effects of cloud computing on the economy.

By comparing the economic value under both scenarios, we observe that the contribution is significantly larger under the aggressive scenario (Graphic 6-3).

Graphic 6-3.
Israel: predicted evolution of cloud-generated economic value (B$)



Source: Telecom Advisory Services analysis.

Similarly, the gap between moderate and aggressive scenarios for the cumulated values with respect to the contribution from 2026 to 2033 is considerable (Graphic 6-4).

Graphic 6-4.
Israel: Predicted total contribution ($B)

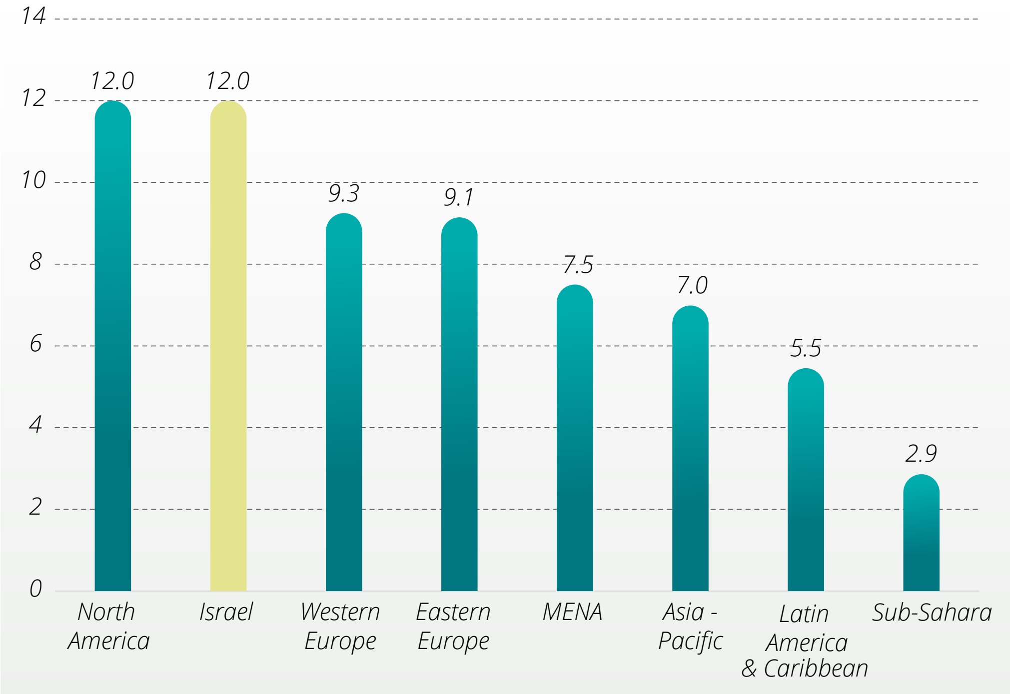
Source: Telecom Advisory Services analysis.

07
Impact of Cloud Computing on Government Efficiency in Israel

So far, our analysis has focused on the contribution of cloud computing to Israel's economy, analyzing service adoption from the perspective of private sector adoption. However, considering the nascent adoption of cloud technology in the Israeli public sector, it is relevant to estimate the future impact of some key initiatives in the public sector including the Nimbus Project.

In August 2021, the government passed a resolution[21] stating the Nimbus project is of strategic importance and a cloud-first approach should be implemented for all government projects from that point forward. In April 2024 the government passed a follow up resolution accelerating the government's transition to the cloud and setting goals and KPIs for this transition.[22]
According to the Government Cloud Platform Maturity Index developed by the World Bank,[23] which measures the development level of cloud-related policies, Israel's index parallels North America's, and is well above other advanced economies such as Western Europe (Graphic 7-1).

Graphic 7-1.
Government cloud platform maturity index (2022)



Source: Telecom Advisory Services analysis.

Although this index indicates that the underlined policies and regulation for cloud adoption in the public sector has created an environment that supports the efforts of the government to achieve economic gains from cloud transformation, we observe from the ICT yearly report[24] that during 2023 only 3% of total IT spending is currently allocated towards public cloud consumption.

[21]Government resolution 231, 1 Aug 2021. Promoting the government transition to a public cloud. https://www.gov.il/he/departments/policies/dec231_2021.
[22]Government resolution 1700, 17 April 2024, Adoption of the government cloud strategy and the acceleration of the government-managed migration to the public cloud and the amendment of the government resolution. https://www.gov.il/he/pages/dec1700-2024.
[23]The Government Cloud Platform Index is a composite index based on five indicators: (i) type of cloud platform, (ii) cloud data hosting policy, (iii) cloud services provided, (iv) one or several government cloud, (v) monitoring and publishing cloud usage.
[24]Government ICT Report. 2023. https://www.gov.il/he/pages/booklet_on_2023_activities.

To estimate the future potential impact of cloud computing on government efficiency indicators, we rely on a cross-country database, for which the variables reported in Table 7-1 were collected. In most cases, the variables cover the period 2009 through 2021, although there are years or countries that have missing data. For the Government Cloud Platform Index, data is available beginning from 2020, as this is a new index developed by the World Bank.

To measure government efficiency, we collected a selection of metrics for this purpose. Primarily, we have relied on the Government Effectiveness index[25] developed by the World Bank for the World Governance Indicators database.

This index measures perceptions of the quality of public services, civil service, policy formulation and implementation, the independence of the government, and the credibility of the government´s commitment to such policies. We acknowledge, however, that this indicator might not provide a fully accurate view, as it may cover a wider scope; thus, we have compiled additional variables that can be considered as proxies for government efficiency. These variables include the time required to register a property, which can be assumed to reflect a measure of the degree of bureaucracy, and hence, levels of efficiency. Similarly, we have accounted for the time required to start a business, the time to export goods, and the time to prepare and pay taxes. In all these cases, we have based our analysis on the assumption that higher values correspond to lower efficiency levels.

Table 7-1.
Variables to estimate the effects of cloud computing on government efficiency

Variable	*Description*	*Source*
Cloud adoption	Cloud adoption (% firms)	OECD
Government cloud platform	Government cloud platform index, built from the following indicators: i) type of cloud platform established, ii) Government cloud data hosting policy, iii) cloud services provided, iv) number of shared Government cloud, and v) monitoring and publishing of cloud usage	World Bank
GDP per capita	GDP per capita in current dollars	World Bank
Time to register property	Time required to register property (days)	World Bank
Time to start a business	Time required to start a business (days)	World Bank
Time to export	Time required to export, border compliance (hours)	World Bank
Time to prepare and pay taxes	Time required to prepare and pay taxes (hours)	World Bank
Government Effectiveness	Measures perceptions of the quality of public services, of the civil service, of policy formulation and implementation, the degree of its independence, and the credibility of the government's commitment to such policies	World Bank

Source: Telecom Advisory Services analysis.

[25]The Government Effectiveness Index is an index developed by the World Bank, which measures the quality of public services, civil service, policy formulation, and policy implementation and the credibility of a government´s commitment to maintain these qualities. See https://databank.worldbank.org/databases/governance-effectiveness.

To conduct our analysis, we relied on two cloud-related variables to measure the effects of policy on government adoption of cloud computing, and ultimately, on government efficiency. First, we introduced the Government Cloud Platform Maturity Index developed by the World Bank. We posit this to be the most accurate variable for this analysis, as it effectively measures the degree of cloud policy development. This data is available for a worldwide sample of countries; however, as the data was collected only during a limited period, there are insufficient observations to estimate its effect on all government efficiency metrics aforementioned. To expand the breadth of our analysis, we also considered cloud adoption at firms (source: OECD) as an alternative cloud indicator, as it is expected to be largely correlated with cloud adoption in the government sector. This specific analysis, however, will only encompass OECD countries. Furthermore, we will control the economic development through the introduction of GDP per capita.[26] Finally, all estimations will include country fixed effects to control for local-level unobserved variables, and year fixed effects to account for shared economic cycles across countries.

The regression for the first model, utilizing the Government Cloud Platform Index developed by the World Bank, is presented in Table 7-2. We employed ordinary least squares (OLS) for the estimation, and, as expected, there is a positive and statistically significant correlation between the Government Cloud Platform Index and the Government Effectiveness Index.

Table7-2.
Regression to estimate the effects of the Government Cloud Platform Index on Government Efficiency - worldwide sample

Variables	Dependent variable: Government Efficiency
Government cloud platform	0.047*
	[0.028]
Log (GDP per capita)	0.317***
	[0.092]
Country fixed effects	Yes
Year fixed effects	Yes
Observations	374

*Note: *** p<1%, ** p<5%, *p<10%. Standard errors in brackets.*

Source: Telecom Advisory Services analysis.

[26] We also tested a control for government size, by relying on the variable of government spending as a share of GDP. However, we removed this variable as it was found not to be statistically significant.

Subsequently, we present the results for the OECD sample using cloud adoption in Table 7-3. We first estimate, in column (i), the model for the broader dependent variable, the Government Effectiveness Index.

We found the coefficient for cloud adoption to be positive and statistically significant at a 5% level, suggesting a correlation between higher levels of cloud adoption and the effectiveness of the government of the country.

Table 7-3. Regression estimates of the effects of cloud adoption on government efficiency in OECD countries

Variables	Government Efficiency	Time to register property	Time to start a business	Time to export	Time to prepare and pay taxes
Cloud adoption	0.003**	-0.022	-0.214**	-0.030***	-1.037
	[0.002]	[0.100]	[0.099]	[0.006]	[1.344]
Log (GDPpc)	0.004	6.079	19.968**	-0.328	88.164
	[0.106]	[9.034]	[8.991]	[0.582]	[121.858]
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	215	150	150	143	150

*Note: *** p<1%, ** p<5%, *p<10%. Standard errors in brackets.*

Source: Telecom Advisory Services analysis.

In column (ii)[27], we introduce as a dependent variable the time required to register a property. In this case, we anticipate a negative sign for cloud adoption, as higher adoption should theoretically reduce the time required for such public procedures, hence improving efficiency. Although the sign of the coefficient is negative, it is not statistically significant. In column (iii), the time required to start a business is the dependent variable. In this case, the coefficient for cloud computing is negative and statistically significant, at the 5% level, suggesting that cloud adoption contributes to efficiency gains in this area. We observe a similar result in column (iv) when the dependent variable is the time required to export. Here, cloud usage is negative and highly significant at the 1% level, once again suggesting an important contribution for efficiency gains. Finally, in column (v), we use the time required to prepare and pay taxes as the dependent variable. In this case, the coefficient for cloud computing presents the expected sign, albeit not statistically significant.

In conclusion, our findings across the six separate regressions carried out using different samples and variables, show that, at least in four cases, cloud computing plays a significant role in increasing government efficiency. Therefore, it is reasonable to assume that cloud technology is a relevant infrastructure that can deliver economic gains at the government level.

Given the economic importance of information technology for government decision making and public sector operations, states search for all types of technology inputs that can provide a cost/efficient answer to the growing complexity challenge. This explains why cloud computing has become so important in the policies and initiatives of governments of developed economies.[28] Reflecting the multiple benefits derived from government adoption of cloud computing, analysts estimate that worldwide public sector spending on public cloud services in 2024 amounts to USD 64.20 billion (or 10% of the total spending), projected to reach USD 120.70 billion by 2027.[29] As an example of progress, approximately 60% of Singapore's eligible government systems have already been migrated had already been migrated to the government commercial cloud.[30]

[27]The following are business indicators that can be affected by government IT infrastructure; for example, speed up the processing of export documentation-these indicators are part of the World Bank e-government index.
[28]See, in particular, for the United States Kent, S. (2019). Federal Cloud computing strategy. Washington, DC: Executive Office of the President, in the United Kingdom Cabinet Office and Paymaster General Government Transformation Strategy: Role of GDS, World Bank (2022). Government migration to cloud ecosystems, Washington, DC: World Bank, Abell, T., Husar, A., and May-Ann, L. (2021). Cloud computing as a key enabler for digital government across Asia and the Pacific, Asia Development Bank Technical Paper No. 77: Manila.
[29]Source: IDC. Public Cloud Services Spending.
[30]Marzouk, Z. (2022). "Singapore's government cloud save country 50% in hosting costs." ITPro (November 16).

Considering Israel's progress in developing policies for governmental use of cloud computing, its future impact on government efficiency can be estimated as presented in Table 7-4.

Table 7-4.
Cloud-induced improvement in government effectiveness in 2023

Segment	*Value*	*Source*
1. Israel Government Effectiveness Index (last data) available	1.292	World Bank
2. Cloud adoption 2022	64.9%	Table 6-3
3. Cloud adoption 2023	72.2%	Table 6-3
4. Increase in cloud adoption	7.3%	(3)-(2)
5. Coefficient linking Δ cloud with Δ (Government Effectiveness)	0.003	Table 7-3
5. Impact on government effectiveness	0.022	(4) *(5) *100
6. New Government Effectiveness index	1.314	(1) + (5)

Source: Telecom Advisory Services.

As represented in Table 7-4, we calculated a 5.1 percentage point increase in cloud adoption between 2022 and 2023 in Israel. In particular, the World Bank's last reported index value of 1.292 would have become 1.314 because of the level of growth in cloud adoption, marking an improvement of 1.7%. That said, considering that the level of government efficiency in Israel is comparatively low and that the estimation of impact is based on an average number of nations, the effect of cloud on efficiency in the country could be higher than estimated.

In conclusion, while it is true globally that there is a direct correlation between cloud adoption and government efficiency, this correlation is yet to be fully realized within Israel. The Nimbus project has established the regulatory environment and procurement framework for accelerating cloud adoption, and major cloud service providers opened data centers within Israel (thereby eliminating the data residency compliance requirements). Thus, government cloud adoption is estimated to rise quickly over the next decade, with noticeable impact on Israel's ranking in the Government Efficiency Index.

Bibliography

Armbrust, Michael, Armando Fox, Rean Griffith, Anthony Joseph D., Randy Katz, Andy Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, Ion Stoica, and Matei Zaharia. 2010. "A view of cloud computing." Communications of the ACM, 53(4), 50–58.

Avram, Abel. 2016). "FaaS, PaaS, and the Benefits of the Serverless Architecture," InfoQ, June 25, 2016, https://www.infoq.com/news/2016/06/faas-serverless-architecture

Amazon Web Services. 2021. AWS Economic Impact Study: AWS Investment in Indonesia.

Berman, Saul, J., Lynn Kesterson Townes, Anthony Marshall, and Rohini Srivathsa. 2012. "How cloud computing enables process and business model innovation." Strategy and Leadership, 40(4): 27–35.

Bolwin, Lennart, Johannes Ewald, Hanno Kempermann, Hilmar Klink, Sebastian van Baal,, and Benita Zink. 2022. The importance of AWS for the German economy. Cologne: Institut der deutschen Wirtschaft Köln Consult GmbH.

Carcary, Marian, Eileen Doherty, and Gerard Conway. 2014. "The Adoption of Cloud Computing by Irish SMEs—an Exploratory Study." Electronic Journal of Information Systems Evaluation, 17(1), 3 –14.

Chen, Xi, Ming Guo, and Wuyue Shangguan. 2022. "Estimating the impact of cloud computing on firm performance: An empirical investigation of listed firms." Information & Management, 59(3), 103603.

Chen, Pei-yu, and Shin-yi Wu. 2013. "The Impact and Implications of On-Demand Services on Market Structure." Information Systems Research, 24(3), 750–767.

Cohen, Robert B. 2017. "Understanding the Next Production Revolution and its Relationship to Software Innovations." Mimeo, Economic Strategy Institute (January 22).

Dalenogare, Lucas Santos, Guilherme Brittes Benitez, Néstor Fabián Ayala, and Alejandro Germán Frank. 2018. "The expected contribution of Industry 4.0 technologies for industrial performance." International Journal of production economics, 204, 383–394.

Domes, Cathleen, David Linthicum, Diana Kearns-Manolatos, Jay Parekh, and Chris Thomas. 2022. "Closing the cloud strategy, technology, and innovation gap." Deloitte Center for Integrated Research. us-future-of-cloud-survey-report.pdf (deloitte.com)

Ebadi, Yalda and Nima Jafari Navimipour. 2019. "An energy aware method for data replication in the cloud environments using a Tabu search and particle swarm optimization algorithm." Concurrency and Computation: Practice and Experience, 31(1).

Frontier Economics. 2022. "The sky is the limit: How cloud computing is the key to better public services in Ireland." Technology Ireland.

Gal, Peter, Giuseppe Nicoletti, Theodore Renault, Stéphane Sorbe, and Christina Timiliotis. 2019. Digitalisation and productivity: In search of the holy grail–Firm-level empirical evidence from EU countries. Organisation for Economic Co-operation and Development (OECD) Economics Department Working Papers No. 1533.

Garrison, Gary, Robin L. Wakefield, and Sanghyun Kim. 2015. "The effects of IT capabilities and delivery model on cloud computing success and firm performance for cloud supported processes and operations." International Journal of Information Management, 35(4), 377–393.

Israel Innovation Authority (2024). 2024 Annual Report – The State of High-Tech.

Kathuria, Abhishek, Arti Mann, Jiban Khuntia, Terence J.V. Saldanha, and Robert Kauffman. 2018. "A Strategic Value Appropriation Path for Cloud Computing." Journal of Management Information Systems, 35(3), 740–775.

Katz, Raúl and Fernando Callorda. 2018. "The economic contribution of broadband, digitization, and ICT regulation." Geneva: International Telecommunication Union.

Katz, Raúl and Fernando Callorda. 2020. "The economic contribution of broadband, digitization, and ICT regulation: Econometric modelling for the Arab States region." Geneva: International Telecommunication Union.

Katz, Raúl and Fernando Callorda. 2020. "The economic contribution of broadband, digitization, and ICT regulation: Econometric modelling for the Arab States region." Geneva: International Telecommunication Union.

Katz, Raúl and Juan Jung. 2021. "The impact of policies, regulation, and institutions on ICT sector performance." Geneva: International Telecommunication Union.

Khayer, Abul, Yukun Bao, and Bang Nguyen. 2020. "Understanding cloud computing success and its impact on firm performance: an integrated approach." Industrial Management & Data Systems, 120(5), 963–985.

Loukis, Euripidis, Marijn Janssen, and Ianislav Mintchev. 2019. "Determinants of software-as-a-service benefits and impact on firm performance." Decision Support Systems, 117, 38–47.
Low, Chinyao, Yahsueh Chen, and Mingchang Wu. 2011. "Understanding the determinants of cloud computing adoption." Industrial Management & Data Systems.

Luo, Xin (Robert), Wei Zhang, Ranjit Bose, Han Li, and Q. B. Chung. 2018. "Producing competitive advantage from an infrastructure technology: The case of cloud computing." Information Systems Management, 35(2), 147–160.

Malladi, Suresh and Mayuram Krishnan. 2012. "Does Software-as-a-Service (SaaS) Have a Role in IT-Enabled Innovation? - An Empirical Analysis." Proceedings of American Conference on Information Systems.

Marston, Sean, Zhi Li, Subhajyoti Bandyopadhyay, Juheng Zhang, and Anand Ghalsasi 2011. "Cloud computing-The business perspective." Decision support systems, 51(1), 176–189.

McAfee, Andrew. 2011. "What Every CEO Needs to Know About the Cloud." Harvard business review, 89(11), 124–132.

Mell, Peter and Timothy Grance 2011. The NIST Definition of Cloud Computing. National Institute of Standards and Technology (NIST) Special Publication 800-145. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf

Nagpal, Pankaj, and Kalle Lyytinen. 2010. Modularity, Information Technology Outsourcing Success, and Business Performance. Conference: Proceedings of the International Conference on Information Systems, Saint Louis, Missouri, U.S.

Naseri, Afshin, and Nima Jafari Navimipour. 2019. "A new agent-based method for QoS-aware cloud service composition using particle swarm optimization algorithm." Journal of Ambient Intelligence and Humanized Computing, 10(5), 1851–1864.

Park, Sang Cheol, and Sung Yul Ryoo. 2013. "An empirical investigation of end-users' switching toward cloud computing: A two factor theory perspective." Computers in Human Behavior, 29(1), 160 –170.

PricewaterhouseCoopers. 2021. The Impact of Cloud Computing on the Indonesian Economy. The Impact of Cloud Computing on the Indonesian Economy (pwc.com)

Schniederjans, Dara G., and Douglas N. Hales. 2016. "Cloud computing and its impact on economic and environmental performance: A transaction cost economics perspective." Decision Support Systems, 86, 73–82.

Sheikholeslami, Fereshteh and Nima Jafari Navimipour. 2017. "Service allocation in the cloud environments using multi-objective particle swarm optimization algorithm based on crowding distance." Swarm and Evolutionary Computation, 35, 53–64.

Sorbe, Stéphane, Peter Gal, Giuseppe Nicoletti, and Christina Timiliotis. 2019. Digital dividend: Policies to harness the productivity potential of digital technologies. OECD Economic Policy Paper No. 26.

Violante, G. L. (2008). Skill-biased technical change. The new Palgrave dictionary of economics, 2, 1-6.

Wang, Nianxin, Huigang Liang, Yu Jia, Shilun Ge, Yajiong Xue, and Zhining Wang. 2016. "Cloud computing research in the IS discipline: A citation/co-citation analysis." Decision Support Systems, 86, 35–47.

Yunhsin Chou, Cindy, Ja-Shen Chen, and Yu-Ping Liu. 2017. "Inter-firm relational resources in cloud service adoption and their effect on service innovation." The Service Industries Journal, 37(3-4), 256–276.

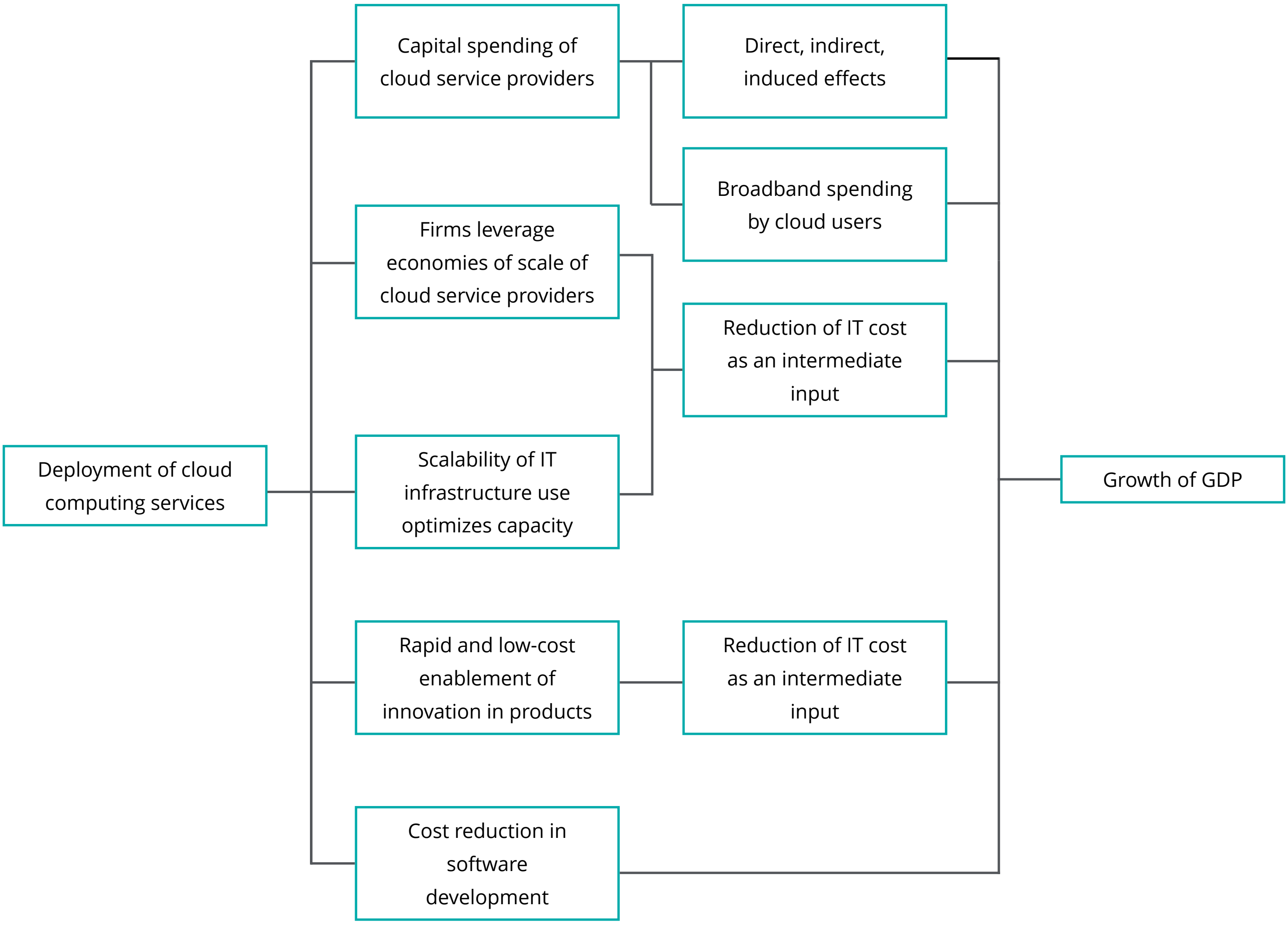
Yusuf, Arief Anshory. 2020. «The Effect of New Technologies on the Indonesian Economy: An Economy-Wide Assessment.» Centre for Strategic and International Studies (CSIS) Working Paper Series.

Appendices

A.1. Theoretical framework and empirical strategy

Before attempting to estimate the impact of cloud computing on GDP, it is important to synthesize existing findings from the research reviewed above and formalize a set of hypotheses. These hypotheses will form a foundational understanding of the causal relationship between cloud computing and GDP growth. Figure A-1 presents the set of factors that explain why the adoption of cloud computing can be linked to GDP growth.

Figure A-1.
Casual links between cloud computing and economic growth



Source: Telecom Advisory Services analysis.

The first effect, consisting of the impact of capital expenditure by cloud providers, pertains to the investment customarily associated with infrastructure deployment. The investment linked to the construction of data centers in an economy drives direct, indirect, and induced effects, as calculated through input-output models. In the first place, data center construction drives investment to build and operate the facility. In addition, data center construction and operation have an impact on indirect spending through business-to-business transactions. Finally, the household consumption based on the income generated from direct and indirect jobs drives induced economic effects. This is precisely the analysis of impact of AWS's investment on the Indonesian economy (AWS, 2021).

The second effect of cloud computing on GDP relates to firms harnessing the economies of scale and scalability of IT use as a result of cloud adoption. This is derived from the microeconomic benefits that organizations, including private enterprises and government agencies, experience when they acquire cloud services. Cloud computing provides these customers with advantages in cost reduction, flexibility, and scalability. Customers are then able to automatically adjust their storage and software use to quickly scale in response to load, saving resources (Armbrust, et al, 2010). This reduction in resource expenditure has a beneficial impact on firms' margins and overall monetary value, thereby contributing to GDP.

The third effect centers on rapid and low-cost innovation generated because of cloud adoption. The study of survey data has found that SaaS has an impact on ICT-enabled innovation within firms (Chou et al., 2017; Kathuria et al., 2018; Chen et al., 2022), although the effect appears to be moderate, according to Loukis, et al. (2019), and PricewaterhouseCoopers (2021).

Finally, cloud services have made an important economic contribution to the field of software development. As stipulated by Byrne et al. (2017), when cloud vendors adopt technologies that enable them to develop products and offer services with greater abstractions, it simplifies the work of software development for organizations using cloud services. As a result, they can focus only on code programming and its deployment, lowering development costs. Consequently, this results in higher margins and, potentially, an increase in sales.

In summary, the combination of these four effects has an impact on GDP growth. This contribution should be added to the actual spending on cloud service providers within the national economy.

A.2. Empirical strategy

The empirical strategy selected for this research is supported by a theoretical model that differentiates direct (sales) and spillover effects on the GDP attributable to public cloud adoption. These should not be conflated with the direct, indirect, and induced effects derived from initial cloud investment, commonly known as the construction effect. Our purpose is to examine the different economic effects that occur once cloud providers have deployed infrastructure within a country. Under this scenario, direct effects include all spending of users purchasing from cloud companies offering services in an economy, while the spillover effects of cloud services capture the impact on the rest of the economy.

The direct effects are relatively straightforward to quantify as they pertain to the spending of cloud users, or alternatively, the expenditure on cloud services across all sectors of the economy. However, spillover effects are more complex to calculate as they represent the cloud's contribution to the broader economy. To estimate the spillover effects of cloud computing, we start with an empirical model based on an augmented Solow framework, in which economies produce according to a Cobb–Douglas production function:

$$GDP_{it} = A_{it}K_{it}^{\alpha}L_{it}^{\beta} \qquad (1)$$

where GDP represents gross domestic product, K is the physical capital stock, and L is labor. Subscripts i and t denote, respectively, countries and time periods. The term A represents total factor productivity (TFP), which reflects differences in production efficiency across countries over time.

Naturally, TFP is expected to depend on digital technologies. However, if we were to replace this variable with only a cloud-related variable, it would result in the problem of omitted variable bias. In other words, the contribution of cloud computing would capture the effects of other digital technologies, such as broadband, which needs to be isolated. Alternatively, if we were to introduce separately a cloud and a broadband variable, it could lead to multicollinearity, as both are expected to be largely correlated. Therefore, we propose a different approach, modeling broadband as an enabler of the economic impact of cloud adoption. This is reasonable as both technologies are largely complementary; in fact, without broadband, the cloud is not expected to yield any economic impact.

Therefore, we expect TFP to depend on broadband adoption (denoted by BB), and beyond it, we can assume that a higher cloud adoption (CLOUD), as a variable measuring adoption, will enhance that impact. As a result, TFP is proposed as:

$$A_{it} = \Omega_i BB_{it}^{\Phi+\delta CLOUD_{it}} \qquad (2)$$

Accordingly, TFP depends on country-specific characteristics represented by fixed effect Ω_i, a term reflecting time invariant idiosyncratic productivity effects, which may make some economies more productive per se because of unobserved characteristics. As it is assumed that broadband connectivity contributes to increased productivity, A is considered to depend positively on the level of broadband adoption, denoted by BB. Thus, we expect a positive value for Φ indicating the economic gains derived from broadband. Another important aspect that could shape the impact of broadband on country-level productivity is cloud adoption. Therefore, the empirical exercise will consist in identifying the sign and significance level of the parameter δ. If, as anticipated, we verify that δ > 0, this means that CLOUD enhances the positive impact of broadband. Essentially, for two countries with the same broadband adoption, we expect to observe a larger economic impact for those with higher adoption of cloud services. Inserting Equation (2) into (1), we obtain:

$$GDP_{it} = \Omega_i BB_{it}^{\Phi + \delta CLOUD_{it}} K_{it}^{\alpha} L_{it}^{\beta} \qquad (3)$$

Applying logarithms for linearization, and after some rearrangements, we derive:

$$\log(GDP_{it}) = \mu_i + \alpha \, log(K_{ist}) + \beta log\,(L_{ist}) + \Phi log\,(BB_{ist}) + \delta CLOUD_{ist} log\,(BB_{ist})$$

where $\mu_i = \log(\Omega_i)$ represents a country-level fixed effect. Thus, we understand that the evolution of GDP depends on specific, unobserved local characteristics, physical capital stock, labor, broadband adoption, and, most importantly, public cloud adoption.

From the last equation, we can calculate the economic impact of broadband, which is expected to depend on the adoption of cloud services:

$$\frac{\partial \log(GDP_{it})}{\partial \log(BB_{it})} = \Phi + \delta CLOUD_{it}$$

Similarly, we can directly calculate the economic contribution of CLOUD because of the spillover effects on the economy's productivity:

$$\frac{\partial \log(GDP_{it})}{\partial \mathrm{CLOUD}_{it}} = \delta \log(BB_{it})$$

This signifies that the impact of CLOUD GDP is expected to depend on the advancement of broadband infrastructure. Thus, if there is no broadband connectivity, the impact of cloud is zero. More importantly, if broadband adoption is constrained by high telecommunications prices, the positive impact of the cloud is diminished.

A prevalent critique of such estimation models presented above is that the results for the ICT effects could signify correlation rather than causality, as adoption of digital technologies may be considered both as a driver and a consequence of productivity and economic growth.[31] As such, both broadband adoption and cloud computing could be potentially endogenous. This likely reverse causality may arise due to three factors: (i) individuals and firms in high-income countries may have higher resources to pay for ICT (and therefore, cloud services), (ii) policy interventions are aimed to stimulate deployment, and (iii) ICT usage may depend on each country's level of development because digital adoption can run in parallel with other technological advancements (Czernich, 2011[32]).

To address these concerns, we propose to estimate the effect of cloud adoption utilizing a structural multi-equation model, as has been previously done by other authors (Roller and Waverman, 2001[33]; Koutroumpis, 2009[34]; and Katz and Callorda, 2018[35]). This system of equations effectively endogenizes broadband infrastructure and cloud adoption because it involves the supply and demand of these infrastructures (see Table A.2-1).

Table A.2-1.
System of simultaneous equations

Aggregate production equation		$Y_{ist} = f(K_{it}, L_{it}, BB_{it}, CLOUD_{it})$
Broadband equations	Demand equation	$BB_{it} = g(INCOME_{it}, P_{it}, HK_{it}, URBAN_{it})$
	Supply equation	$BB\ INV_{it} = h(P_{it}, COMP_{it})$
	BB infrastructure production	$\Delta BB_{it} = j(BB\ INV_{it})$
Cloud equations	Demand equation	$CLOUD_{it} = k(INCOME_{it}, P_{it}, HK_{it}, URBAN_{it})$
	Supply equation	$CLOUD\ INV_{it} = v(P_{it}, COMP_{it})$
	Cloud infrastructure production	$\Delta CLOUD_{it} = z(CLOUD\ INV_{it})$

Note: In this context, i and t denote respectively country and year.
Source: Telecom Advisory Services.

The system is based on a principal equation (that is, aggregate production equation) that is essentially an augmented Cobb–Douglas production function, where economic growth is driven by capital (K), labor (L), broadband adoption (BB), and cloud adoption (CLOUD).

[31]Cardona, Mélisande, Tobias Kretschmer, and Thomas Strobel. 2013. "ICT and productivity: conclusions from the empirical literature." Information Economics and Policy, 125–109 ,(3)25.
[32]Czernich, Nina, Oliver Falck, Tobias Kretschmer, and Ludger Woessman. 2011. "Broadband infrastructure and Economic Growth." The Economic Journal, Vol. 121, No. 532–505 ,552.
[33]Röller, Lars-Hendrik. and Leonard Waverman. 2001. "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach." The American Economic Review, 923–909 ,4 ,91.
[34]Koutroumpis, Pantelis. 2009. "The economic impact of broadband on growth: a simultaneous approach." Telecommunications Policy, 485–471 ,9 ,33.
[35]Katz, Raul and Fernando Callorda, F. 2018. "The economic contribution of broadband, digitization and ICT regulation." Geneva: International Telecommunications Union.

The broadband demand equation states that broadband adoption is a function of the average income per country, the price of a standard service for the connection to the network, the degree of human capital endowment, and the percentage of the population that lives in densely populated areas. The supply equation links the aggregate broadband investment to broadband price levels and competition intensity in the telecom market. These variables affect the dynamic of the supply side of the broadband market. Furthermore, the infrastructure equation models the annual change in broadband as a function of broadband investment.

From now on, we apply the approach followed for the case of broadband, to endogenize cloud adoption, as well. This means that we introduce specific equations related to cloud demand, cloud supply, and cloud infrastructure production. In this sense, cloud demand is expected to depend on the average income, cloud prices, the degree of human capital, and the degree of urbanization. The cloud supply equation links cloud investment as a function of cloud prices and the competitive intensity in the local cloud sector. Additionally, the variation in cloud adoption is modelized to be dependent on cloud investment.

A.3. Econometric model of cloud impact on GDP

Upon applying the model for a sample of worldwide countries during period 2017-2021, we obtained the following results, as depicted in Table A.3-1.

Table A. 3-1. Econometric model results

Aggregate production equation	**Dependent variable: Log (GDP)**	
	Log(K)	0.6026** (0.1048)
	Log(L)	0.3297*** (0.0866)
	Log (BB)	0.2714*** (0.0968)
	Log (BB)*Cloud	0.0003*** (0.0001)
Broadband demand equation	**Dependent variable: Log (BB)**	
	Log (P_{BB})	-0.0655*** (0.0218)
	Log (HK)	0.8097*** (0.2498)
	Log (GDP per capita)	0.6205*** (0.0804)
	Urban	-0.0000 (0.0000)
Broadband supply equation production	**Dependent variable: Log (BB inv.)**	
	Log (P_{BB})	-0.0659*** (0.0246)
	Log (HHI)	-0.0107 (0.4962)
Broadband infrastructure	**Dependent variable: ΔBB**	
	Log (BB inv.)	0.0673 (0.0977)
Cloud demand equation	**Dependent variable: Log (Cloud)**	
	Log (P_{CLOUD})	-0.0350** (0.0143)
	Log (HK)	0.3080 (0.2959)
	Log (GDP per capita)	0.3536*** (0.0881)
	Urban	0.0000*** (0.0000)
Cloud supply equation	**Dependent variable: Log (Cloud revenue)**	
	Log (P_{CLOUD})	-0.0857*** (0.0324)
	Cloud companies	0.0072*** (0.0017)
	Cloud zones	0.6516*** (0.1775)
Cloud infrastructure production	**Dependent variable: Δ Cloud**	
	Log (Cloud revenue)	5.2015*** (0.4823)
	Country Fixed Effects	YES
	Year Fixed Effects†	YES
	R-squared†	0.9985
	Observations	349

*Note: * p<%10, ** p<%5, *** p<%1. †refers to the first equation of the structural model.*

Source: Telecom Advisory Services analysis.

The model, represented in Table A.3-1, performed as expected, displaying positive and significant coefficients for capital, labor, broadband, and cloud in the first equation. In the secondary equations, the results also conformed to our expectations. The findings reflect a negative effect on price (elasticity effect) and a positive one from income in the demand equation; competitive intensity drives investment in the supply equation, while cloud adoption depends positively on income. Subsequently, the critical factors influencing cloud investment include the number of operating cloud companies and the development of local cloud regions. Returning to the coefficients of interest in the main equation, these results point to a broadband adoption coefficient of 0.271, while the interacted cloud coefficient stands at 0.0003. These results represent significant evidence of the relevant macroeconomic effect of cloud technology.

However, the coefficients presented above cannot be interpreted directly as elasticities, as further algebra is needed. For this purpose, we calculate the derivative of GDP with respect to cloud computing in the first equation of the model, and replace δ=0.0003 as estimated in Table A.3.1:

$$\frac{\partial \log (GDP_{it})}{\partial \text{CLOUD}_{it}} = 0.0003 * \log (BB_{it}) \qquad (1)$$

From this, we can easily obtain the elasticity between GDP and cloud adoption:

$$\frac{\partial GDP_{it}}{GDP_{it}} \frac{\text{CLOUD}_{it}}{\partial \text{CLOUD}_{it}} = 0.0003 * \log(BB_{it}) * \text{CLOUD}_{it} \qquad (1)$$

Considering the interrelationship between fixed broadband and the cloud's economic impact, having a high broadband adoption, as observed in Israel, contributes to maximizing the economic impact of the cloud. In addition to fixed broadband adoption, spillover cloud contributions are also related to differences in cloud adoption.

Accordingly, the elasticity presented in equation (1) will depend on the estimated coefficient (0.0003), and on the actual adoption levels of broadband and the cloud. This implies that each economy will have its own elasticity level to determine the magnitude of the spillovers. Noting Israel as an example, with a cloud adoption of 50.85% among enterprises and broadband adoption exceeding 100% of households, an increase of 1% in cloud adoption will yield GDP growth of 0.10%.

Finally, if we add the spillover effects generated from cloud services (the spillover effect) derived from the econometric analysis to the expenditure in cloud services (the direct effect), we obtain a measure of the overall economic contribution (refer to Table A.3-2).

Table A. 3-2.
Revenue and spillover contribution of cloud services to GDP

Item	***Indicator***	***Source***
(1)	Revenue created: Spending in cloud service	Public secondary sources
(2)	Spillover effect: Spillover effect of cloud services	Estimated from the econometric analysis
(3)	Total impact of cloud services to the GDP	(1) + (2)

Source: Telecom Advisory Services

Having formalized the models for use, we will now describe the data to be utilized in the analyses. The data required to run the models presented above was compiled from the sources listed in Table A.3-3.

Table A. 3-3.
Data sources

Code	Description	Source
GDP	Gross domestic product, current prices (USD)	IMF
K	Capital stock at current prices (USD). When not available, calculated using previous stock, depreciation rate, and investment or gross capital formation	Penn World Tables / IMF / World Bank
L	Number of persons engaged. When not available, calculated using the data on labor force and unemployment rate	Penn World Tables / IMF / World Bank
BB	Fixed broadband adoption (% households)	ITU / TAS
Price BB	BB price - fixed broadband basket	ITU
COMP BB	Herfindahl Hirschman Index of fixed broadband	OVUM/Regulators
Price Cloud	Average based on the price of the mean broadband commercial plan and the price of Local Access all metro area cost of a Fast Ethernet (100 Mbps circuit) for 0-5km range. When not available, values are estimated based on extrapolation of previous trends.	TeleGeography
BB investment	Telecommunications investment per capita 5-year average (USD)	ITU / TAS
Cloud revenue	Cloud companies' revenue per capita (USD)	Statista
HK	Mean years of schooling, population 25+ years	UNESCO / TAS
Urban	Urban population (% of total population)	World Bank / TAS
Cloud companies	Number of cloud companies	Crunchbase / TAS
Cloud zones	Number of cloud regions (every 1 million inhabitants)	Telegeography / IMF

Source: Telecom Advisory Services.

A.4. Assessment of cloud usage by Israeli enterprises
A.4.1. Raw data

The original data concerning cloud usage by enterprises in Israel was generated from a survey conducted by the Israel Central Bureau of Statistics (CBS) between July 2020 and March 2021[36]. The survey encompassed a sample of approximately 2,500 businesses (with a response rate of 2,020), representing a population of 29,825 establishments employing 10 or more employees. The population excludes establishments in agriculture, finance, diamonds, public and local administration, education, health, and non-governmental organizations.[37] The survey results present the total adoption of cloud services across enterprise size and sector, as well as the percentage of businesses utilizing cloud services.

The OECD Going Digital database reports the CBS data but converts the type of cloud service use from (i) the percentage of businesses purchasing cloud services to (ii) businesses that purchased cloud services as a share of all businesses with 10 or more employees.[38] As a result, the adoption of cloud type naturally diminishes. In addition, the OECD conversion modifies slightly the sector decomposition: (i) the trade sector is disaggregated across wholesale and retail, and (ii) the administrative and support services sector is reported separately.
Finally, one category reported by the CBS (cloud use for ERP hosting) is not included in the OECD dataset. Table A.4-1 presents the comparison of the CBS and the OECD datasets.

[36] https://www.cbs.gov.il/en/mediarelease/pages/2021/survey-information-communication-technologies-ict-protection-business.aspx.
[37] Central Bureau of Statistics. Methodological appendix to the survey of uses in information technology and communication and cyber protection in businesses 2020.
[38] Refer to https://goingdigital.oecd.org/en/indicator/25.

Table A. 4-1.
CBS versus OECD data: Cloud usage by Israeli enterprises

	Total		Email		Office software		Finance & Accounting.		CRM		Hosting databases		Storage files		Run own software		ERP	
	CBS	OCDE	CBS	OCDE	CBS	OCDE	CBS	OCDE	CBS	OCDE	CBS	OCDE	CBS	OCDE	CBS	OCDE	CBS	OCDE
Total		50.85	81.78	41.58	56.78	28.87	49.96	25.41	29.83	15.17	50.91	25.89	75.28	38.28	23.69	12.04	24.41	
Large	78.75	78.75	81.74	64.64	57.89	49.51	52.20	34.25	27.54	33.14	48.75	53.17	74.26	62.64	20.01	30.89	23.06	
Medium	67.67	67.67	81.86	55.39	51.41	34.79	43.34	29.33	35.37	23.93	54.93	37.17	78.01	52.79	33.44	22.63	27.32	
Small	46.61	46.61	82.08	38.10	62.87	26.98	43.49	24.33	42.08	12.83	67.51	22.72	79.54	34.61	39.22	9.33	33.11	
Manufacturing[39]	49.64	49.64	82.89	40.73	46.84	22.99	45.54	22.68	28.81	14.77	47.10	24.32	70.18	35.47	24.70	11.60	34.46	
Construction	40.74	40.74	77.83	31.71	54.74	22.30	68.52	27.91	22.64	9.23	38.69	15.76	64.20	26.15	8.27	3.37	28.68	
Trade	60.72		71.45		50.42		52.95		26.75		50.71		77.10		23.91		26.26	
Wholesale trade		60.72		44.98		30.94		30.13		19.07		30.43		47.91		14.59		
Retail trade		40.69		31.62		22.60		24.06		9.80		24.09		30.62		9.33		
Transportation and storage	40.69	31.35	80.25	25.16	72.27	22.66	46.71	14.64	19.22	6.03	37.14	11.65	76.55	24.00	20.48	6.42	19.39	
Accommodation and food	31.33	31.45	76.12	23.94	51.60	16.23	29.22	9.19	9.00	2.83	39.72	12.49	68.49	21.54	7.14	2.25	2.14	
Information and communications	31.45	85.31	91.82	78.33	75.50	64.41	55.39	47.25	63.48	54.15	89.33	76.21	91.62	78.16	57.76	49.27	38.01	
Real estate; Administrative and support	85.31	72.90	80.68	72.90	62.26	38.98	63.28	51.18	35.34	24.93	46.91	36.83	80.58	68.39	20.46	5.57	23.18	
Professional, scientific, and technical activities	72.90	70.64	96.07	67.86	59.17	41.80	37.66	26.60	25.31	17.88	44.65	31.54	72.20	51.00	18.24	12.89	13.65	
Administrative and support service activities		53.46		39.89		34.75		32.67		19.08		24.47		40.86		13.09		

The following analysis of cloud usage maturity levels is based on the OECD dataset, as it reflects the proportion of businesses that have purchased cloud services relative to all establishments with a workforce of 10 or more employees.

A.4.2. Assessment of maturity levels

On the basis of expert assessment on levels of cloud usage maturity, we defined three levels of cloud maturity based on the type of cloud adoption by industry sector:

- **Level 1:** usage of cloud for email, office software, and storage files
- **Level 2:** usage of cloud for finance and accounting software, and CRM
- **Level 3:** usage of cloud for hosting databases, and for gaining computing power to run the company's software and processes

For each sector, we assigned the lowest adoption value of type category, according to the OECD dataset. In other words, the lowest percent of cloud usage indicates the highest percentage of enterprises at the corresponding maturity level. For example, the values for large Israeli enterprises were calculated as follows:

- Large businesses (employing greater than 250 employees): 26.4% of enterprises exhibit a basic maturity level, 5.5% of enterprises exhibit an intermediate maturity level, and 11.1% exhibit an advanced level of maturity.

- Medium businesses (employing between 10 and 249 employees): 24.2% of enterprises exhibit a basic maturity level, 5.9% exhibit an intermediate maturity level, and 9.6% of medium enterprises exhibit an advanced level of maturity.

[39] Includes mining and quarrying, and electricity and water supply.

The total reported results (measuring enterprise adoption in percentages) are presented in Table A.4-2, as follows:

Table A. 4-2.
Israel enterprise adoption

	Basic	Intermediate	Advanced
Large	26.4%	5.5%	11.1%
Medium	24.2%	5.9%	9.6%
Small	24.3%	7.6%	6.4%
Manufacturing	22.99	14.77	11.60
Construction	22.30	9.23	3.37
Wholesale trade	30.94	19.07	14.59
Retail trade	22.60	9.80	9.33
Transportation and storage	22.66	6.03	6.42
Accommodation and restaurants	16.23	2.83	2.25
Information and communication	64.41	47.25	49.27
Real estate	38.98	24.93	5.57
Professional, scientific, and technical	41.80	17.88	12.89
Administrative and support	34.75	19.08	13.09

The data indicates that:

- When measuring cloud adoption by maturity level, adoption is significantly lower than the aggregate 50.85% of cloud usage, which indicates that the majority of adoption is at the basic level. All sectors and enterprise sizes depict the highest maturity at a basic level.
- Firms that have reached the highest level of cloud maturity are significantly less numerous.
- The information and communication sector, which contains most startups (therefore, digital native companies), exhibits the highest level of maturity in terms of cloud usage.

Deloitte.