

Impact Assessment of Technological Innovation Policy on The Competitiveness of Spain's Cloud Computing Market

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Abstract. This paper discusses the impact assessment of technological innovation policy on the competitiveness of Spanish cloud computing market. The research points out that under the wave of digitalization, cloud computing technology has become the key to promote the development of informatization. As an important economy in Europe, the development of Spain's cloud computing market is of great significance to digital transformation. The technological innovation policies introduced by the European Union and the Spanish government, such as GAIA-X project, Industry 4.0 strategy and carbon neutrality goal, not only promoted the development of cloud technology, but also promoted the prosperity of the Spanish cloud computing market. GAIA-X project has brought opportunities for cooperation and competition for Spain, while Industry 4.0 strategy and carbon neutrality goal have stimulated the demand of enterprises for cloud computing. At the same time, Spain's domestic policies such as "Digital 2025 Plan" and Microsoft and Amazon's investment in data centers in Spain provide a good environment and opportunities for the cloud computing market. These policies have promoted the standardized development of the cloud computing market and enhanced the market competitiveness. Spain's public cloud market is growing steadily and is expected to continue to expand in the next few years. The establishment of a data center in Spain by cloud vendors not only promoted the country's position in the global cloud computing network, but also brought significant feedback effects to the local cloud computing market. The research reveals the mutual promotion relationship between policy and market, emphasizing the key role of policy in creating favorable environment and promoting market demand growth, while the development of market promotes the improvement and innovation of policy. This paper provides valuable insights and suggestions for the further prosperity of Spanish cloud computing industry.

Keywords: Spain; Cloud Computing Market; Technological Innovation Policy; Competitiveness.

1. Introduction

Today, with the wave of digitalization sweeping the world, cloud computing technology is gradually becoming the key cornerstone to support the information development of all walks of life with its flexibility, scalability and efficiency. It can not only provide flexible computing resources, but also effectively reduce the operating costs of enterprises, so it has been widely concerned and applied. Spain, as an important economy in Europe, the development of its cloud computing market is of great significance to the digital transformation of the national economy. However, the competitiveness of the cloud computing market depends not only on the technology itself, but also on the technological innovation policies at home and abroad.

In recent years, the Spanish government and the European Union have launched a series of technological innovation policies aimed at promoting the rapid development of the cloud computing industry. These policies not only inject new vitality into the cloud computing market, but also provide more development opportunities for enterprises [1-2]. In this context, it is particularly important to study the impact of technological innovation policies on the competitiveness of the Spanish cloud computing market. This will not only help us to understand the relationship between policy and market development, but also provide useful reference for the further prosperity of Spain's cloud computing industry. Therefore, this paper aims to deeply discuss and analyze how the technological innovation policy affects the competitiveness of the Spanish cloud computing market, with a view to providing valuable insights and suggestions for relevant enterprises and policy makers.

2. Policies of EU and Spain and their influence on cloud computing

2.1. The impact of EU policies on the Spanish cloud computing market

In the field of cloud computing, the EU's policy orientation has a far-reaching impact on its member states, including Spain. Through a series of policies and projects, the EU not only promoted the development of cloud technology, but also affected the market structure of cloud computing in member countries.

GAIA-X, as a major project led by the European Union, aims to build an autonomous and controllable data infrastructure and cloud service ecosystem in Europe [3-4]. For Spain, the promotion of GAIA-X means that its cloud computing market may usher in more opportunities for cooperation and competition. On the one hand, Spanish cloud service providers can participate in the ecological construction of GAIA-X and expand their market share by providing services that meet the standards; On the other hand, GAIA-X may also attract more international cloud service giants to enter the European market, including Spain, thus intensifying market competition.

The EU's Industry 4.0 strategy has played a positive role in promoting the Spanish cloud computing market. With the in-depth implementation of Industry 4.0, more and more enterprises began to seek digital transformation, and cloud computing, as one of the key technologies of digital transformation, naturally increased its demand. In Spain, many traditional enterprises responded to the call of EU Industry 4.0 and began to migrate their business processes to the cloud to improve efficiency and flexibility. This process has undoubtedly brought huge business opportunities to the Spanish cloud computing market [5]. In addition, the EU's carbon-neutral goal has also promoted the pace of Spanish enterprises going to the cloud to some extent. In order to achieve carbon neutrality, enterprises need to optimize energy consumption and reduce carbon emissions. Cloud computing helps enterprises to reduce energy consumption and carbon emissions through centralized resource management and efficient energy utilization [6]. Therefore, in response to the EU's carbon-neutral goal, many Spanish companies began to migrate their business to the cloud, which further promoted the development of the Spanish cloud computing market.

The first health data space policy established by the European Union has also had a positive impact on the cloud computing market in Spain. With the continuous growth and complexity of health data, cloud computing provides strong support for storing, processing and analyzing these data [7]. In Spain, medical institutions and research institutions began to use cloud services to manage and analyze health data to improve the quality and efficiency of medical services. This has not only brought new growth points to Spain's cloud computing market, but also promoted the digital transformation of Spain's medical and health industry.

2.2. The impact of Spain's domestic policies on the development of cloud computing

The Spanish government has formulated policies to support the development of cloud computing in many aspects, which involve key areas such as AI research, data management and digital transformation, and have significantly promoted the cloud computing market. The Spanish government has made active efforts to promote the development of cloud computing and provided a good environment and opportunities for the development of the cloud computing market by formulating relevant policies and attracting international technology giants to invest locally (Table 1).

Table 1 Overview of policies related to the development of cloud computing in Spain and their impacts

Project name	Release time	Contents of a project	Influence
Spanish Digital 2025 Plan	2021	1. Improve national digital connectivity and realize high-speed network coverage of the national population. 2. Effectively utilize radio spectrum resources and accelerate the deployment and application of 5G networks. 3. Strengthen the training of digital skills of workers, so that 80% of the workforce has basic digital skills. 4. Promote the digital transformation of public management departments and enterprises. 5. Accelerate the digitalization of production modes in agricultural products production, health and tourism industries.	The plan aims to improve the country's digital connectivity and economic efficiency through 10 reform goals, including: 1. Achieve full coverage of the national high-speed network. 2. Accelerate the deployment and application of 5G networks. 3. Improve the basic digital skills of 80% of the workforce. 4. Promote the digital transformation of public management departments and enterprises. 5. Enable 50% of public services to be processed through mobile applications. 6. Increase the e-commerce revenue of small and medium-sized enterprises by at least 25%. 7. Accelerate the digital production models in industries such as agriculture, health, and tourism. Reduce carbon dioxide emissions by 10% within 5 years.
Microsoft and Amazon invest in data center in Spain	2024	Microsoft announced plans to invest 6.69 billion euros to develop a new data center in the Aragon region of northeastern Spain. Amazon also announced in May this year that it plans to invest 15.7 billion euros in Spain to expand its cloud computing infrastructure.	The investment plan will promote Spain's economic development and employment, create technical and management jobs through the construction and operation of data centers, and drive the growth of power, communications, construction and other related industries.

In AI research, the Spanish government has invested a lot of resources to encourage enterprises and research institutions to develop and apply AI technology. This support promotes the integration of cloud computing and AI technology, promotes the development of intelligent cloud services, and provides enterprises with more efficient data analysis and business decision-making tools.

In terms of data management policy, Spain established the position of national data chief officer and data office, which strengthened data governance and protection. These measures enhance the trust of enterprises in cloud computing services, because cloud service providers need to meet strict data protection standards. This indirectly promotes the standardized development of the cloud computing market. Spain's "Spain Digital 2025 Plan" is dedicated to promoting the digital transformation of the whole country [8-9]. The plan provides a broad development space for the cloud computing industry and encourages enterprises to adopt cloud computing technology to improve business efficiency and innovation ability. Compared with some other EU countries, Spain's policy

environment in these areas is more relaxed, which provides more flexibility and innovation opportunities for enterprises, thus stimulating the vitality of the cloud computing market.

Spain's policies in AI research, data management and digital transformation have created favorable conditions for the development of the cloud computing market. Compared with other EU countries, the loose policy of Spain has injected more vitality into the market, and promoted the wide application of cloud computing technology and the rapid development of the industry.

2.3. Impact of industry-specific policies

The Spanish government has actively guided the public sector to the cloud by implementing a series of policies for specific industries, including the digital government, the digital medical bill and the blockchain direction bill. The digital government policy promotes the online and data-based government services, and urges government departments to adopt cloud computing to improve service efficiency and data management capabilities. This not only reduces the IT cost of government operation, but also improves the accessibility and response speed of public services. The implementation of the Digital Medical Act encourages medical institutions to use cloud computing technology to store, share and analyze patient data, so as to improve the quality and efficiency of medical services. This policy promotes the digital transformation of the medical industry, and also strengthens the protection and privacy of patient data. The blockchain direction bill supports the development and application of blockchain technology by using cloud computing resources, which promotes the transparency and credibility of data and provides technical support for the trust construction of public industries. These industry-specific policies work together to provide clear guidance and support for cloud computing in public industries and promote the wide application of cloud computing in public services.

3. Competition pattern of Spanish cloud computing market

3.1. The rising demand for cloud in enterprises and the response of cloud vendors

With the continuous promotion of policies, the demand of Spanish enterprises on the cloud has increased significantly. The policy encourages digital transformation of enterprises to improve efficiency and competitiveness, which has prompted more and more enterprises to move their business to the cloud. At the same time, the flexibility and scalability of cloud computing also meet the needs of enterprises to respond quickly to market changes. To meet this growing demand, the world's leading cloud vendors have set up data centers in Spain. Giants such as Azure, AWS and GCP all plan to expand their infrastructure in Spain to provide cloud services closer to users and with low latency [10]. The establishment of these data centers not only improves the performance of cloud services, but also further intensifies the competition in the Spanish cloud computing market.

At present, the scale of Spain's public cloud market shows a steady growth trend (Table 2). With the deepening of enterprises' awareness of cloud computing and increasing demand, the market scale is expected to continue to grow. In terms of market competition, in addition to global cloud vendors, local cloud service providers in Spain are also making active efforts, forming a certain competitive pattern.

Table 2 Spain's public cloud market size

Time	Market size (in billions of US dollars)	growth rate
2023	293.93 million US dollars	8.73%
2024	Expected to reach 320 million US dollars	Expected growth of 9.3%
2029	Expected to reach 590 million US dollars	Expected compound annual growth rate of 8.73%

The above data shows that the scale of Spain's public cloud market shows a steady growth trend. With the continuous promotion of policies and the rising demand for digital transformation of enterprises, it is expected that the market scale will continue to grow in the next few years. Spain's cloud computing market is welcoming a period of rapid development opportunities. The rising demand for cloud in enterprises and the positive response of cloud vendors have jointly promoted the prosperity of the market. In the future, with the progress of technology and the maturity of the market, the competition pattern in the Spanish cloud computing market will be more intense and diversified.

3.2. Cloud vendor data center plans to feed back the Spanish cloud computing market

The importance of Spain as a data center node is self-evident. Its geographical location is superior, connecting key network hubs in Europe, Africa and America, making data transmission more efficient and convenient. In addition, the Spanish government has also given strong support to the construction and operation of the data center, providing a good policy environment and infrastructure. These factors work together to make Spain an ideal choice for overseas enterprises to land. Cloud vendors set up data centers in Spain, which not only brought advanced technology and management experience, but also promoted employment and economic growth. More importantly, these data centers provide more convenient and efficient cloud services for local Spanish enterprises, and promote the digital transformation and innovative development of local enterprises.

In Spain or the European Union, data leakage incidents occur from time to time. In the first half of 2024, there were many major data leakage incidents around the world, some of which involved companies in Spain or the European Union. For example, AT&T suffered a data breach, and 73 million customer accounts were exposed. In addition, the medical data of "most Americans" were stolen from Change Healthcare, the Synnovis ransomware attack caused extensive shutdown of hospitals in London, and the Snowflake hacking incident caused 560 million records of Ticketmaster to be stolen. These data security concerns have prompted nations worldwide to place heightened emphasis on data sovereignty and data autonomy. Consequently, there is an increasing demand for vendors to establish localized data centers within national borders to ensure the integrity and security of data assets. Emerging industries such as Web3 have also shown great development potential in Spain. Web3 is the next generation Internet based on blockchain technology, which has the characteristics of decentralization, data security and user's independent control. The Spanish government has paid great attention to the development of blockchain and Web3 technology, and actively promoted the innovation and application of related industries. With the continuous maturity of Web3 technology and the expansion of application scenarios, its demand for cloud computing resources will continue to grow, thus further promoting the development of the Spanish cloud computing market.

The Spanish government supports overseas enterprises to land in Spain through a series of policies, and also shows a positive attitude towards emerging industries such as Web3. In terms of data protection, both Spain and the European Union pay close attention to data leakage and take measures to protect personal privacy. The establishment of data centers in Spain by cloud vendors not only promoted Spain's position in the global cloud computing network, but also brought significant feedback effects to the local cloud computing market.

4. The mutual promotion relationship between policy and market

In the field of cloud computing, there is a close relationship between policy and market (Figure 1). Policies have effectively promoted the growth of market demand by creating a favorable environment and providing incentives; The development and changes of the market and the emergence of emerging technologies in turn promote the improvement and innovation of policies.

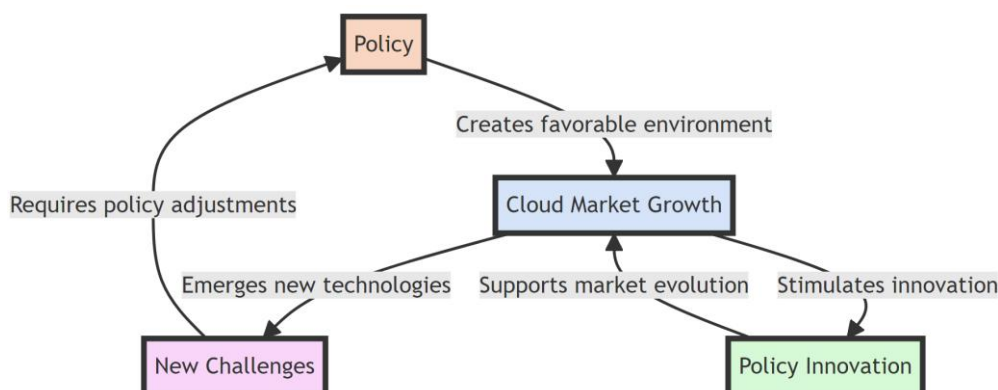


Figure 1 The mutual promotion relationship between policy and market

The promotion of policies to market demand is obvious. By formulating policies to support the development of cloud computing, such as providing tax incentives, financial support and simplifying the approval process, the government has reduced the costs and risks of enterprises adopting cloud computing, thus stimulating the demand for cloud computing services. In addition, the policy also encourages technological innovation and talent training, which provides strong technical support and talent guarantee for the sustainable development of the cloud computing market. At the same time, the development of the market is also promoting the improvement and innovation of policies. With the continuous progress of cloud computing technology and the expansion of application scenarios, new problems and challenges have emerged in the market, such as data security and privacy protection. These problems require the government to adjust and improve relevant policies in time to adapt to the changes in the market. In addition, the emergence of emerging technologies, such as AI and big data, has also provided new directions and ideas for policy innovation. Therefore, there is a dynamic and mutually promoting relationship between policy and market. Policies promote the growth of market demand by creating a favorable environment, while market development promotes the improvement and innovation of policies. The two complement each other and jointly promote the sustainable development and prosperity of the cloud computing industry.

5. Conclusions and suggestions

The technological innovation policy has significantly promoted the development of the Spanish cloud computing market and enhanced its competitiveness. A number of policies launched by the European Union and the Spanish government, such as GAIA-X project, Industry 4.0 strategy, health data space policy and "Spain Digital 2025 Plan", not only promoted the development of cloud technology, but also created more opportunities for cooperation and competition for Spanish cloud service providers, and stimulated the demand for digital transformation of enterprises. In addition, the world's leading cloud vendors set up data centers in Spain, which further intensified market competition, but also brought advanced technology and management experience and promoted employment and economic growth. It is suggested that the Spanish government continues to strengthen its support in the field of cloud computing, especially in key areas such as AI research, data management and digital transformation. We should further improve the relevant policy environment, encourage the competition and cooperation between local cloud service providers and international giants, and strengthen data security and privacy protection to enhance the trust of enterprises in cloud computing services. In addition, the government should pay close attention to the development of emerging technologies, such as Web3, and adjust and improve relevant policies in time to adapt to market changes and technological progress, so as to ensure the continued prosperity and competitiveness of the Spanish cloud computing market.

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