

## Article

# Economic Innovation Caused by Digital Transformation and Impact on Social Systems

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**Abstract:** The purpose of this study is to review studies on innovation and identify factors that affect the acceleration of digital economic innovation. This study also analyzes the impact of economic innovation on social systems. A systematic literature review method was used to analyze the findings of extant studies on digital transformation and economic growth. Results indicate that different drivers trigger economic innovation in different times. Our analyses reveal that digital economic innovation results in changes in the industrial structure and helps productivity improvement and cost reduction in the production sector. Results show that the impact of economic innovation on technology and society spheres interacts with economic innovation. This study contributes to the literature by providing a comprehensive framework of how economic innovation and social systems are connected and how technology, economy, society, and policy sectors coevolve within the enormous framework of social systems.

**Keywords:** economic innovation; digital transformation; social systems; economic growth; technology innovation



**Citation:** Yoo, I.; Yi, C.-G. Economic Innovation Caused by Digital Transformation and Impact on Social Systems. *Sustainability* **2022**, *14*, 2600. <https://doi.org/10.3390/su14052600>

Academic Editors: Yeong-wha Sawng, Min-Kyu Lee, Suchul Lee and Minseo Kim

Received: 6 January 2022

Accepted: 21 February 2022

Published: 23 February 2022

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## 1. Introduction

This study is a follow-up to a previous one by Yoo and Yi (2021) [1], which defines the concept of economic innovation caused by digital transformation. Our previous study [1] offers a new definition of the concept of economic innovation capitalizing on changes in the technological environment. However, it does not include discussions on what drivers facilitate and affect innovation and how innovations in the technology, society, and economy sectors are interconnected and interact with one another. Therefore, we intend to address them in this study.

Efforts have been made to continue to analyze and explain the relationship between technological changes and economic growth from the past to the present, and it is considered an undeniable fact that technology innovation is a key driver for economic growth [2–8]. On the economic front, technology innovation has brought about changes in the industrial structure and economic system [9]. For businesses, they have generated structural changes related to profit-seeking activities, such as new business models, production methods, and employment [9–11]. For individuals, they have changed consumption behavior and the way they work [11–13]. The recent trends of digital transformation have intensified this phenomenon [10].

Digital transformation has been accelerated by the core technologies of the Fourth Industrial Revolution (4IR), including artificial intelligence (AI) and autonomous driving [14–16]. It has affected not only economic paradigms but also social systems, disrupting existing practices and order [11,17]. The 4IR can be conceptualized as dramatic advances, convergence, and innovation to be driven by AI, robotics, Internet of Things (IoT), autonomous vehicles, nanotechnology, and life sciences [7,8,11,17,18]. Besides these, the

components of the 4IR are qualitatively differentiated from semiconductors, computer hardware and software, and the Internet, which formed the core of the Third Industrial Revolution [17,18]. It has also been interpreted as total innovation itself, in which physics, biology, and digitalization converge, enabled by AI and deep learning [11,17,18].

There has been no discussion from integrated perspectives that take into consideration the economic sector as well as society and policies surrounding the economic sector. Among the numerous efforts to analyze the relationship between technological change and economic growth, there was no discussion on economic innovation and its impact on the literature. Moreover, there is little discussion about the relationship of interaction between economic innovation and social systems. In general, studies exploring the impact of digital transformation on the economic front involve a fragmented analysis focusing on a specific industry or phenomenon [8,10,14]. The majority of reviews that have been published e.g., [19–21] on economic innovation, focus on technology innovation and subsequent economic growth and development. A number of recent studies [22–27] also discuss the economic impact of digital transformation and future policy directions. Among them are similar studies e.g., [7,8,13,15–17,23,25] that discuss economic changes and ramifications derived from digital transformation. This study will comprehensively discuss the results of economic innovation by technology innovation and its impact on the social systems from a bilateral perspective, rather than from the unilateral perspective of technology and economic innovation. Discussions from integrated perspectives expand understanding of innovation drivers and the interactions between innovations, contributing to decision makers taking comprehensive policy decisions. Therefore, we would like to specifically address the following research questions: What factors enabled the acceleration of digital economic innovation (which has the tendency of being very rapid even when compared with the core technologies of the Third Industrial Revolution) [13]? Furthermore, owing to this acceleration, how are economic innovation and social systems connected, and how should technology, economy, society, and policy sectors coevolve rather than grow independently within the enormous social systems?

Our study is different from previous studies. This is a comprehensive discussion of the consequences of economic innovation caused by digital transformation and how technology, economy, and society interact within the social systems. First, previous studies have focused only on changes or growth in the economic structure caused by digital transformation [15–17]. There is no discussion on what causes economic innovation to accelerate more rapidly due to digital transformation. Therefore, this study contributes to the literature through discussions on the drivers of digital economic innovation. Second, previous studies did not comprehensively describe the relationship between technology, economy, and society, but only described cross-sectional relationships [23,28–30]. Our research shows how technology, economy, society, and policy sectors should coevolve rather than grow independently within the complicated social systems. Therefore, the results of this study complement previous studies by broadening the understanding of interrelationships between innovations and providing a comprehensive framework. In addition, these results will be helpful in the policy-making process of decision makers, be they individuals, companies, or governments.

This paper is organized as follows: This study adopted the approach of systematic literature review. Thus, the next section seeks to understand how the role of technology—as it continues to evolve—has changed in terms of economic growth by looking into changes in the relationship between technology and economic growth as well as economic changes brought about by digital transformation through systematic literature review. Section 3 provides a detailed analysis of changes in digital economic innovation, from the perspective of innovation, based on the Korean and other international literature brought together for analysis. Section 4 discusses the effects that the positive and negative changes of digital economic innovation have on social systems. Lastly, the implications and limitations of the study and further research works are discussed.

## 2. Theoretical Background

This section explores how the relationship between technology innovation and economic growth has evolved and presents the analytical framework of this study by putting together changes in economic structure driven by digital transformation.

### 2.1. *Changes in the Relationship between Technology and Economic Growth*

In the past, the technology–growth relationship was defined in terms of quantitative growth, with a focus on firm size. In the late 1990s, this relationship started to expand with the spread of knowledge and the formation of innovation networks, moving in the direction of emphasizing interactions between technology and society elements [19,20,31]. After a review of existing research results, this study found that the relationship between technology and economic growth has changed (1) from producer-driven innovation and economic growth (2) to growth in potential values and profits expected due to innovation, (3) and growth driven by networks and platforms. The details are as follows:

#### 2.1.1. Producer-Driven Innovation and Economic Growth

Technology innovation has been believed to play a key role in economic growth since the early years of innovation research. Schumpeter said that entrepreneurs take a leading role in enabling economic growth through a new combination of production factors, such as labor, land, and production resources. ‘New combination’ here is a fundamental driver of economic growth as it plays an important role in economic growth by introducing new products, new production methods, and new economic organizations, developing new markets, and discovering new sources of raw materials [32]. In the meantime, key innovation actors have also changed. In the early stage of innovation (e.g., the early 1990s), it was entrepreneurs who led innovation, but in the later stages, large companies with an R&D center became mainstay innovators [32,33].

Innovation by entrepreneurs and enterprises has served as a driving force behind economic development over the long term by disrupting existing industries or making new industries grow. Therefore, genuine economic development is change (innovation), and this change must be achieved on its own within the economic structure. Producers within the economic structure played a leading role in commercializing and selling the outcomes of technology innovation, such as interacting with consumers. On the other hand, consumers had limited roles, such as suggesting ideas for technology innovation by informing providers of problems that they found while using their goods or services. From this traditional viewpoint, we can see that the economic structure is centered around producers [34–36].

#### 2.1.2. Increases in Potential Values and Profits Expected from Innovation

Before the 2000s, discussions on the technology–growth relationship focused on firm size and technology innovation. Scholars from Smith to Solow believe that while technology has an impact on economic growth over the long run, long-term balanced growth is externally determined. This made it necessary to come up with a new growth theory that could explain the continued growth of the capitalist economy that included technology. Endogenous growth theories qualitatively restructured existing production factors. They also described the dynamic structure of factors triggering and promoting technology innovation as result of internal forces and focused on the external effects of knowledge generated through investment in innovation and learning from it [21,37–40].

Human capital also worked as an external effect. Human capital accumulation tends to cause technology transfer, producing increasing returns to scale [21]. This implies that the bigger the market is, the more it facilitates technology innovation activities. Enterprises strengthened technology innovation activities to underpin their emphasis on firm size and property rights. As a result, they could achieve exclusive excess profits, and expectations of exclusive profits served as an incentive for developing new products and increasing R&D investments further [38].

Taken together, market size and property rights protection were seen as key to technology innovation. The bigger the market and the stronger the property rights protection became, the higher the tendency was for potential values and expected profits from technology innovation to increase [19,41,42].

### 2.1.3. Growth Driven by Networks and Platforms

Since the 2000s, discussions on technology innovation have been expanded to include not only technological and economic growth but also social relationships, such as how technology can change the economic structure and what contributions it makes to society as a whole, such as organizations and culture, focusing on how knowledge is connected together and utilized.

Industrial and market structure changes are accelerated by the sharing and exchange of technology and knowledge between a diversity of actors. Synergy effects from this interaction are found not only in offline markets but also in the online virtual space. For example, product and service providers compete and collaborate on platforms; as a result, new industries emerge and markets expand. In other words, the scope of innovation actors has expanded from individuals to organizations and has been expanding further to include platforms and networks, especially since digital transformation [31].

In the early stage of innovation research, innovation was thought to be driven by individuals. Since digital transformation, however, this individual-based stage has led to an organization-based stage and then to a platform-, network-, or field-based stage.

## 2.2. Economic Changes Caused by Digital Transformation

While the previous section explored changes in the technology–economic growth relationship, this section discusses economic changes caused by digital transformation.

It can be said that the fundamental difference between the Fourth Industrial Revolution and the previous ones lies in digital transformation. The lexical definition of digital transformation is to innovate the traditional social structure by applying information and communication technology (ICT), such as the Internet of Things, cloud, big data, mobile, and artificial intelligence (ICBMA) across the spectrum of society [43]. In other words, it means a business activity that incorporates ICT and non-technological elements to transform business models and change the way organizations work and provide services [44–46].

In particular, artificial intelligence and robots will be integrated into most people's daily lives. They will be embedded in the algorithm architecture of numerous functions of business and communication to increase the relationship between information and efficiency [47,48]. For example, AI is involved from distant manufacturing processes to daily activities such as speech recognition (for example, Siri) and image recognition (face recognition in consumer cameras).

In this study, digital transformation refers to the use of technology by economic agents to improve values and propose new directions for the industry through the integration of ICT and physical elements. In this respect, we explore economic changes caused by digital transformation by classifying them into micro-changes among businesses and individuals and industry-focused macro-changes.

### 2.2.1. Changes in Businesses and Individuals from a Micro Perspective

In the age of digital transformation, knowledge and information serve as important factors for economic activity to expand business areas around digital platforms and consequently increase consumer benefits and utility. Manufacturers produced products following sequential processes up until the 1990s, but digital transformation has enabled the industry to carry out a series of production activities from product production to marketing and sales at the same time. This has reduced costs and time, giving producers more room to lower product prices [1]. It also allowed businesses to expand their reach by entering new fields of business or converging with other areas. In short, digital transformation has expanded the scope of profit-seeking activities.

On the other hand, the role of individuals in the past was limited to consumers. Now in this age of digital transformation, prosumerization is gaining ground, enabling individuals to serve as consumers, producers, and distributors simultaneously. Individual consumption behavior is also shifting towards subscribing or sharing rather than owning. That is, digital transformation has expanded business areas through digital platforms and has given rise to new consumer trends characterized as ownerless and personalized [27,28].

### 2.2.2. Industrial Change from a Macro Perspective

Digital transformation is going beyond the development and use of ICT to change existing practices and order. Specifically, unlike the traditional siloed industrial structure, cross-industrial convergence is taking place vigorously, creating new markets. Furthermore, the value chain in the industry is changing from the vertically integrated industrial structure of the past to an open and networked structure. This industrial change will ultimately include sweeping economic and social effects across all industries [1,23,45,46,49–51].

Rapid advances in intelligent information technology will increase reliance on networks by making all areas hyper-connected and hyper-intelligent. Moreover, the integration of daily life and the virtual world is expected to build platform-based business models, bringing about innovation across the economy and society. As a result, the product-based industry will be transformed into a service-based industry, and personalized production will be expanded, blurring the boundaries between manufacturing and services and thus intensifying convergence between industries.

Table 1 gives a comprehensive summary of prior studies on economic changes arising from digital transformation. It is a well-known fact that technology innovation plays a key role in economic growth over the long term, and economic innovation enablers have expanded from knowledge and information produced by innovation to digital technology [52–54]. This has changed the economic structure and the way economic activity is performed. It has also brought about fundamental changes to the economy as a whole, including consumption behavior and the work environment [55–59].

**Table 1.** Digital transformation and economic changes.

Time		Early Stage of Digital Economy (2001–2015)		Age of Digital Transformation (2016–)	
Key drivers		Knowledge and information		Internet and R&D	
Study	Knowledge and information	<ul style="list-style-type: none"><li>• Schmid (2001) [52],</li><li>• Bresnahan, Brynjolfsson and Hitt (2002) [53],</li><li>• Carlsson (2004) [54].</li></ul>	Internet and R&D	<ul style="list-style-type: none"><li>• Fagerberg and Verspagen (2002) [55],</li><li>• Perez (2002, 2010) [56,57],</li><li>• Rosenberg (2004) [58],</li><li>• Manyika and Roxburgh (2011) [59].</li></ul>	Digital technology
Key findings	Knowledge and information	<ul style="list-style-type: none"><li>• Business operations can be managed across the board through the digitization of information,</li><li>• Contributions to cost savings and productivity improvement.</li></ul>	Internet and R&D	<ul style="list-style-type: none"><li>• Economic growth is a process of constant change,</li><li>• Contributions to changes in business space, institutional context, and culture,</li><li>• Difficulty in forecasting the impact of new technologies.</li></ul>	Digital technology

Digital transformation is shifting economic paradigms. Established companies expand their business areas or develop new ones, whereas startups built on new digital technologies adopt new forms of business models. This allows businesses to expand their market



leadership by maximizing efficiency and creating new customer values [13,24–26]. In other words, digital transformation can be seen as innovating existing industrial sectors using platforms as a means to an end.

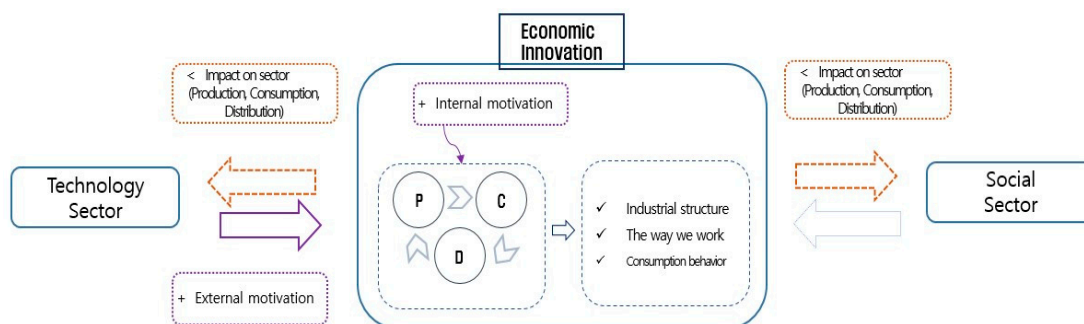
### 2.3. Analytical Framework

It can be seen from the foregoing that technology innovation has continued to be a driver of economic growth. Meanwhile, perspectives for technology innovation have also expanded from being entrepreneurial-oriented to platform- and innovation-network-oriented.

In this respect, we will use the analytic framework presented below to ascertain what has made economic innovation caused by digital transformation spread faster than the first three industrial revolutions and what factors have had an impact across all social systems.

Economic innovation discussed in this study refers to digital economic innovation, and Yoo and Yi (2021) [1] define digital economic innovation as activities aimed at maximizing utility in public and private sectors by (1) enabling innovative changes across the value chain, from ordering to production, consumption, and distribution, (2) creating new business models and customers, and (3) seeking economic growth and development (4) through the introduction and use of digital technology. Therefore, this study will discuss the impact of digital economic innovation on the premise of the above definition.

Figure 1 is a schematic diagram of the analysis framework used in this study in which solid-line arrows represent economic innovation drivers and dotted-line arrows indicate the effects of economic innovation on technology and society sectors. It is also assumed that the sectors are interconnected and interact with each other.



**Figure 1.** Analytic framework for this study.

### 2.4. Methodology

This paper discusses the reasons why economic innovation caused by digital transformation has accelerated faster than the core technologies of the Third Industrial Revolutions as well as the impact of digital economic innovation on social systems. This section describes the literature review process used in this study to find answers to the research questions. This study adopted the approach of the systematic literature review, which is a systematic and explicit method to identify, select, critically appraise, and summarize relevant research, and in itself can be considered as research activity [60].

Discussions on the digital economy began in earnest during the mid-1990s when use of the Internet started to spread vigorously. This is why we reviewed the literature published from 2000 to 2021. Specifically, we went through a total of three stages for a detailed and leveled literature review.

First, we seek to provide a comprehensive summary of changes in economic structure brought about by digital transformation by exploring how the relationship between technology innovation and economic growth has changed. For this purpose, we searched all literature available against keywords, such as technology innovation, economic innovation, economic growth, knowledge, and digital transformation using Google Scholar, and reviewed a total of 66 Korean and foreign research papers, policy reports, and other relevant publications. We reclassified these papers into publications before and after 2000 to delve

into how the role of technology innovation has changed before and after the advent of the digital economy.

Second, we seek to identify factors accelerating digital economic innovation by reviewing papers published after 2000—when discussions on the digital economy kicked into high gear—out of the above-mentioned 66 publications. These papers deal mainly with the topics of innovation, economic growth, digitalization, and digital transformation.

Third, Klaus Schwab said in 2016 that the Fourth Industrial Revolution would bring about new types of businesses and innovative changes in patterns of consumer behavior [12]. Therefore, we reclassified the results of our review on the literature from 2000 to 2021 into those before and after 2016. The period of 2000 to 2015 is classified as the early stage of the digital economy, while from 2016 to the present is defined as the age of digital transformation. Based on this classification, we explored the economic impact of digital transformation as well as differences in phenomena.

Besides these, we conducted an analysis of normative and qualitative data, such as press releases, future forecast reports, and policy outlook and trend reports because there have not been many studies that have examined digital economic innovation and its impact on social systems from the perspective of innovation. We also developed our study further as we delivered presentations at academic forums in and out of Korea between August 2021 and December 2021 and supplemented it in terms of research directions and content by enlisting advice from university and research institute experts.

### 3. Digital Transformation and Digital Economic Innovation

This section analyzes drivers of digital economic innovation in each era and discusses the impact of digital transformation across the economic and social structures.

#### 3.1. Innovative Changes in the Digital Economy over Time According to Digital Technology

To explore the drivers that have accelerated the spread of economic innovation in the wake of digital technology innovation, we analyzed the characteristics of economic innovation at each period around the 2000s when the world started to enter the digital economy in earnest by dividing the times into (1) years before the digital economy, (2) the early stage of the digital economy, and (3) the age of digital transformation.

Economic innovation drivers may be internal to the economic system or may arise from the external environment. Table 2 presents the drivers of economic innovation by time periods, which are classified into internal and external factors.

Key drivers of economic innovation before the digital economy were technology-oriented, that is, new technological convergences and the innovation activities of entrepreneurs were central to economic innovation. At the early stage of the digital economy, the importance of Internet-based infrastructure expansion as well as knowledge and experience came into the spotlight, rapidly spreading economic innovation. At the Davos Forum in 2016, Klaus Schwab adopted the science and technology sector as the main agenda item, making the Fourth Industrial Revolution and Industry 4.0 two of the hottest keywords around the world [12]. Against this backdrop, digital transformation has moved ahead very rapidly and has shifted paradigms of the global economy and society, with networks and platforms at the center. As a result, ICT-enabled economic innovation is progressing very extensively at a very fast pace that is beyond comparison with the first three industrial revolutions. These factors have different degrees of impact in different periods of time, but their impact has continued from before the age of the digital economy to today.

**Table 2.** Economic innovation drivers by time periods.

Classification	Innovation Drivers			Innovation Actors
	Key Drivers	Internal Factors	External Factors	
Before the digital economy (–2000)	<ul style="list-style-type: none"> <li>Technology-driven.</li> </ul>	<ul style="list-style-type: none"> <li>Convergence with new technologies,</li> <li>Innovations by entrepreneurs,</li> <li>Market dominators.</li> </ul>	<ul style="list-style-type: none"> <li>Function of government-supported public research,</li> <li>Total combination of technology, organization, and management revolution.</li> </ul>	<ul style="list-style-type: none"> <li>Driven by entrepreneurs.</li> </ul>
Early stage of the digital economy (2001–2015)	<ul style="list-style-type: none"> <li>Infrastructure- and knowledge-driven.</li> </ul>	<ul style="list-style-type: none"> <li>New product and process innovations,</li> <li>Knowledge and information (experience),</li> <li>Internet (technology).</li> </ul>	<ul style="list-style-type: none"> <li>Building and strengthening infrastructure and clusters,</li> <li>Increasing human capital.</li> </ul>	<ul style="list-style-type: none"> <li>Driven by businesses, and government (and entrepreneurs).</li> </ul>
Age of digital transformation (age of the 4IR) (2016–)	<ul style="list-style-type: none"> <li>Network- and platform-driven.</li> </ul>	<ul style="list-style-type: none"> <li>Digital technology,</li> <li>Digital platforms,</li> <li>Changes in consumer behavior.</li> </ul>	<ul style="list-style-type: none"> <li>Information asymmetry,</li> <li>Environmental trends and regulatory practices,</li> <li>Digital trends.</li> </ul>	<ul style="list-style-type: none"> <li>Driven by platform companies and prosumers (and entrepreneurs, business, and government).</li> </ul>

Innovation actors have also changed over time. Innovation activities were driven mostly by entrepreneurs before the age of the digital economy. In the early years of the digital economy, however, it was businesses and governments that played the pivotal role of leading innovation activities. This was intended to rapidly spread innovation through the expansion of infrastructure based on digital technology and the development of ICT [61,62]. During the digital transition, platform companies and prosumers led innovation activities, which were made possible by the growth of digital platforms and the invigoration of networks.

Moreover, in terms of facilitating innovation activities, the role of people adopting digital technology is more important than the technology itself. In other words, the success of innovation activities depends on continuous communication on the innovations introduced [63,64].

Section 2 discusses how the role of technology has evolved over time to facilitate economic growth and change economic structure. Section 3 presents our analysis results on critical changes in digital economic innovation in the Korean and foreign literature. Section 4 discusses the effects of digital economic innovation on social systems. To this end, we intend to discuss the overall impact of digital economic innovation on the economy and society sectors by dividing it into positive and negative aspects. Section 2 first looks at the positive economic impact of digital transformation.

### 3.2. The Positive Impact of Technology Innovation on the Economy

This section addresses positive changes that are largely classified into changes in the production and consumption sectors. Economic changes related to distribution typically effect jobs and income and are negative in nature, and they will be discussed in detail in Section 3.

#### 3.2.1. Changes in the Industrial Structure and Work Environment of the Production Sector

Positive changes from digital transformation in the production sector can be divided into industrial structure and work environment changes, and our analysis is as follows: First, the industrial structure changes to enable mass customization. In the past, it was a common practice, especially in manufacturing, to achieve economies of scale and scope through mass production. Currently, advances in digital information technology fueled



by digital transformation enable the combination of AI and data analytics, the application of innovative automation systems, and mass customization. For example, new business models have emerged, led by platform companies, to provide desired services in a timely manner based on an accurate understanding of consumer demand and preferences [14].

Second, digital transformation has the effect of reducing production costs. Before the age of the digital economy, production was a sequential process, but digital transformation now allows product improvements, purchases, marketing, and sales to take place simultaneously through networks. Consequently, it is possible to reduce costs or create new values throughout the value chain of a company [1,65]. Here, value creation drivers tend to move from tangible assets such as machinery and equipment to intangible assets such as software, R&D, and databases.

Third, innovation in industrial structure also changes the way we work. New business models emerge, replacing existing jobs and creating new jobs at the same time. For example, the combination of platform economy and gig work creates new jobs and changes the types of labor. Places where we work are also changing due to changes in the relationship between work and residential spaces, such as flexible work arrangements and smart work. Digital transformation in particular, which is centered on platforms and networks, serves as an opportunity to change the work environment further by revitalizing non-face-to-face, contactless, and online practices.

### 3.2.2. Value Shift in the Consumption Sector

In addition to such changes in the production sector, the following changes are occurring in the consumption sector. First, the focus of consumption is changing from owning to subscribing or sharing. A typical example is sharing economy. In the past, the sharing economy was limited due to regional constraints, but advances in digital technology are expanding the scope of sharing all across the world. The sharing economy built on digital technology has a significant impact on value creation and consumption, and objects of sharing are diversifying from tangible assets such as things and spaces to intangible assets such as knowledge and experience. The sharing economy is, among other things, transforming the industrial economy centered on enterprises and capital into an individual- and experience-oriented the digital economy.

Second, consumer values are changing. The sharing economy started with the sharing of unused resources at the early stage of the digital economy, but is now attracting attention as a new sustainable business model in line with changing consumer values. This leads providers to place more emphasis on maximizing user experiences with their products than maximizing profits by cutting down on product life cycles. The spread of awareness about the seriousness of resource waste and environmental pollution, which has continued since the Rio Declaration in 1992, is driving the explosive growth of related markets, along with changes in the economic, technical, and cultural environments.

### 3.3. *The Negative Effects of Technology Innovation on the Economy*

The preceding section discusses the positive effects of digital economic innovation. We will explore its negative effects in this section. As negative effects are largely related to jobs, income, and monopolistic corporate behaviors, we will focus on the distribution sector here.

#### 3.3.1. Changes in Jobs and Income

The first issue that arises when technology advances is discussions on job-related negative effects. The first problem is labor replacement due to job automation. Automation technologies including AI and robotics are replacing simple labor and threatening jobs for humans. Consistent with the finding of Morikawa (2020) [66] and Nakamura and Zeira (2018) [67], we argue that the adoption of automation technologies can lead to less demand for low-skilled labor due to discrepancies between workers' competencies and automation technologies, whereas demand for high-skilled labor grows [68,69]. It should

be particularly noted that AI technology, which is replacing labor, can reduce the share of income going to workers in gross national income (GNI), worsening the welfare of workers. Consequently, the wage gap between low-skilled and high-skilled workers will widen further over the long run, with the percentage of the middle class in the overall economy highly likely to dwindle [70,71].

Second, the platform economy can cause various problems and conflicts such as gig labor and other unstable jobs. Typical examples include conflicts between ride-sharing services, such as Uber and Tada, and taxi operators as well as conflicts between delivery platform companies, such as Baedal Minjok and Coupang Eats, and delivery service providers. Platform companies play only the role of a broker who connects the demanders and suppliers of services through an ICT platform, while service providers enter into an agreement as freelancers or independent contractors. This arrangement excludes service providers not only from the social protection systems for laborers but also the benefits of the social security systems, putting their socioeconomic status in places that are not very different from that of non-regular workers [72]. In the end, labor issues and conflicts arising from sharing economy and other platforms contribute to the issues of the fundamentally unstable labor market and consequent income inequality.

### 3.3.2. Emergence of Non-Competitive Behavior by Enterprises

Platform business models often give rise to “winner-takes-all” problems. The first problem is platform companies’ control over data. Platform operators collect and manage a broad range of data through user feedback including user-provided information, user reviews, and testimonials. It should be particularly noted that platform operators are first-movers and therefore enjoy the network effect, thanks to the data already obtained, as well as a competitive advantage over late-movers. That is, the big data held by first movers act as a tool to restrict the entry of competitors into the platform market [71,73].

The second problem involves costs imposed by platform providers. Platform providers generate revenue by charging a usage fee to both or either side of the services concerned. The levels or structures of usage fees charged by platform operators are influenced by the number of platform users and the size of transactions. This ability of first-mover platform companies to determine market prices works as a barrier to market entry for late-movers. Moreover, high switching costs lock platform users into a specific service, strengthening platform companies’ market position further. Therefore, platform companies’ ability to determine market prices not only increases the inefficiency of resource allocation but also leads to the weakening of market competition, which in turn undermines the ability to innovate.

When all things are taken together, it can be said that platform companies such as Uber, Airbnb, and WeWork set a small target market in the early stage of their business and provide customized services to gain loyal customers. Once secured, loyal customers tend to have a high switching cost, which locks them into their current platform. This works as a high barrier to late-movers, and platform companies tend to repeat this process to develop global monopolistic markets.

## 4. Impact of Digital Economic Innovation on Social Systems

Based on the foregoing discussions, this section discusses how changes brought in by digital economic innovation affect social systems and how negative effects can be improved through social systems.

The dictionary definition of a social systems is a structure designed to meet social needs such as education, healthcare, transportation, and information as well as a system of social relationships created by the roles, status, and interactions of the members of society [74]. This definition offers a broadly similar meaning to the definition of social systems addressed in this study, but is not exactly the same. A concept that is more consistent in meaning with social systems used in this study can be said to be socio-technical systems. The definition of socio-technical systems takes into consideration the integrated and interactive

relationships of technological and social changes [28] and expands the economy-oriented perspective of innovation to include social aspects in the research scope [29,30,75]. In this respect, the social systems of this study is defined as an interactive system that pursues not only economic values but also social values. These social systems consists of various subsystems including economy, technology, society, and policy. Among the subsystems, we will take economy and explore its impact on technological and social domains in the succeeding sections.

#### *4.1. Impact of Economic Innovation on the Technology Sector*

We seek to explore the impact of digital economic innovation on the technology sector by dividing affected areas into production, consumption, and distribution. The details of our analysis are as follows:

First, digital economic innovation in the production domain has an impact on profit-seeking, productivity improvement, and cost reduction. Companies face the challenge of increasing productivity or reducing costs in their efforts to maximize profit-seeking activities. This is when technology innovation occurs, driven by demand for higher productivity and lower costs, and this technology innovation in turn contributes to increasing productivity and lowering production costs, creating a continuous feedback cycle. Advances in ICT in particular revitalize market mechanisms by reducing transaction costs, such as information asymmetry and imbalance as well as costs incurred to acquire information [11,54,76]. There were market information imbalance and asymmetry between providers and consumers prior to the digital economy, but dramatic ICT advances made it easier to access market information. This promoted competition among providers, pushing down product prices, boosting market efficiency, and decreasing uncertainty in information.

Second, in the consumption domain, digital economic innovation has an impact on reinforcing prosumerization. The Internet allows consumers to compare products, services, and their relative advantages, and gives them the ability to decide what to buy from whom and when and where [77]. In other words, the past producer-oriented economic structure is shifting towards a consumer-centric one. Therefore, companies are trying to respond to changing consumer behaviors by concentrating on personalized and hyper-differentiated products and services with the goal of enhancing consumer value. It can be said that powerful prosumerization driven by digital technology leads to changes in the consumption domain [22]. Social media particularly has facilitated consumer prosumerization and is being established as a key means of communication and collaboration.

Third, in the distribution domain, digital economic innovation has an influence on market power. Platform companies acquire and retain initial loyal customers through innovative content and app services, grow rapidly thanks to the network effect, and enjoy an exclusive status in the global market based on these strengths. Besides this, the platforms of innovators are evolving from hardware to software, web to mobile and rapidly emerging as a new economic area. As a good example, IBM's artificial intelligence Watson is expanding its coverage with new services such as healthcare, education, and finance added to its service and support portfolio. In other words, existing platform companies are taking the lead in new industries created by digital transformation and are using them to strengthen their market leadership further.

#### *4.2. Impact of Economic Innovation on the Social Sector*

This section provides a comprehensive summary of the results of exploring the impact of digital economic innovation on the social sector by dividing affected areas into production, consumption, and distribution.

First, changes brought about by digital economic innovation in the production sphere will lead to the emergence of new forms of work and aggravate the imbalance caused by the digital divide. Digital transformation has a positive impact on the economy and society as a whole, with new industries built on new digital technologies and the quality of life improved [25,27,45,50]. The work environment in particular is becoming different from

what it used to be before digital transition. This may be attributed to industrial structure changes, but factors playing a decisive role include decreases in the working-age population due to low birth rates and population aging, subsequent declines in labor productivity, long hours of labor, and the pursuit of a work–life balance. Moreover, non-face-to-face and contactless activities, such as work from home and online learning, have become more prevalent, resulting in the rapid spread of new platform businesses, such as the gig economy. Furthermore, the expansion of platform businesses is driving increases in new forms of labor, such as gig workers, and the spread of remote work. Next, digital economic innovation is likely to broaden the digital divide among social classes. In particular, the vulnerable who are not familiar with new digital technologies may not be able to adapt to digital-based social systems and gain economic and social benefits. Inequality caused by the digital divide may become directly linked to the problem of jobs and survival, aggravating the problem of imbalance further.

Second, changes from digital economic innovation in the consumption sector will affect network expansion and consumer values across society. The shift to collaborative consumption led to the expansion of networks, making a hyper-connected society a reality. The shift to collaborative consumption led to the expansion of networks, making a hyper-connected society a reality. Network activities refer to the extent to which a person occupies a position in a network and gains access to information and knowledge available in the network [78–80]. Network activities are open to new ideas and enhance cooperation between individuals [81,82]. Therefore, it can be argued that network-based collaborative consumption is expanding networking not only in the consumption sector but also across the economic and social systems [83]. The expansion of networks is taking place both online and offline. The experience of shared services owing to digital economic innovation has led to a shift in consumer values. Consumers, especially Millennials, tend to value use and experience more than ownership. There are various reasons for this shift, including economic slowdown, climate change, and resource waste, but it is mostly due to the accumulation of knowledge and satisfaction gained from experiencing digital technology directly or indirectly [71,84].

Third, changes in the distribution sphere due to digital economic innovation are bound to exacerbate inequality and other problems of polarization. Drastic changes brought about by digital transformation will increase uncertainty across the economy, and especially job automation is widening inequality in labor and other polarization problems. Digital economic innovation is likely to lead to the winner-takes-all problem and increase inequality in the distribution of resources and income, as a small number of monopoly companies supported by networks and platforms call the shots and take greater benefits [66,85]. Besides this, rising investments in digital technology could increase demand for skilled workers, deepening income inequality and consequently inequality in consumption due to the wage gap with unskilled labor.

#### 4.3. Results and Implications

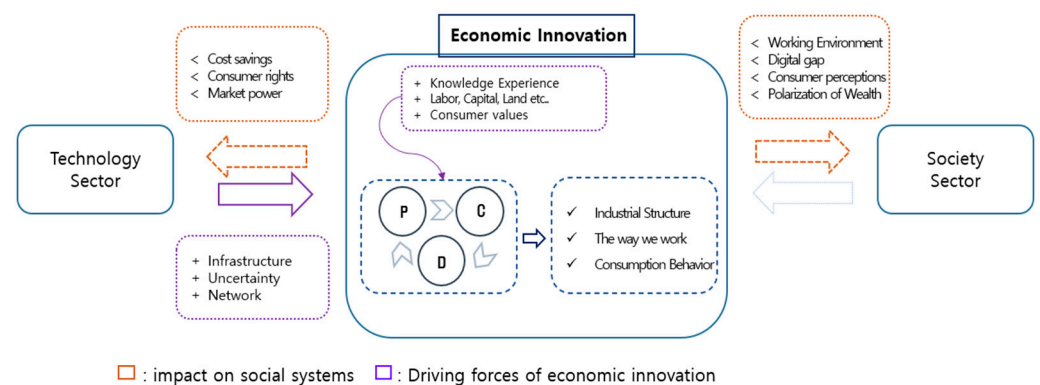
The preceding sections discussed the impact of digital economic innovation on technology and economy sectors in detail. Table 3 shows a schematization of the research results discussed.

The results of digital economic innovation facilitated by digital technology interact not only with the economic sector but also with technology and society sectors. It transpires that the results of these interactions raise the need for technology innovation to enhance corporate productivity and reduce costs in the technology sector, and the expansion of networking as well as the platform market contributes to strengthening prosumerization and the market power of platform monopoly companies.

**Table 3.** Impact of digital economic innovation on social systems.

Technology Sphere		Digital Economic Innovation		Society Sphere	
Pressure on cost reduction	<ul style="list-style-type: none"> <li>Information symmetry between producers and consumers,</li> <li>Higher productivity,</li> <li>Lower prices and higher market efficiency due to the promotion of competition between product providers.</li> </ul>	←	Production	Worsening labor environment.	<ul style="list-style-type: none"> <li>Declining working-age population,</li> <li>Types of work involving long hours of work.</li> </ul>
			→	Widening digital divide.	<ul style="list-style-type: none"> <li>Widening digital divide among social classes,</li> <li>Directly linked to jobs and survival and likely to promote unbalanced growth.</li> </ul>
Strengthened prosumer-ization	<ul style="list-style-type: none"> <li>Able to compare products and services information,</li> <li>Consumer-centric economic structure,</li> <li>Strengthened prosumerization.</li> </ul>	←	Consumption	→	<ul style="list-style-type: none"> <li>The shift in the awareness of sharing.</li> <li>Connected with anyone, anytime, anywhere,</li> <li>Consumers value sharing over owning,</li> <li>Personal satisfaction and experience are more important.</li> </ul>
Stronger market power	<ul style="list-style-type: none"> <li>Monopolistic platform companies,</li> <li>Strengthened market power.</li> </ul>		Distribution	Accelerating polarization.	<ul style="list-style-type: none"> <li>Job automation reduces jobs,</li> <li>Rising demand for skilled workers,</li> <li>Higher inefficiency due to the concentration of wealth.</li> </ul>

On the social front, as a result of interactions across all social systems, the work environment has deteriorated due to the spread of negative perceptions about long hours of work and the declining working-age population, and the digital divide between social classes has also become wider due to a widening gap in access to digital resources among social classes. Furthermore, job losses and a shift in perceptions that value sharing over owning are accelerating income polarization. These effects feedback to the economic sector, causing the technology, economy, and society sectors to coevolve. The digital economic innovation drivers described above and their impact on social systems are summarized in Figure 2.

**Figure 2.** Drivers of economic innovation induced by digital transformation and its impact on social systems.

This paper is built on the premise that digital technology is the most important driver of digital economic innovation. Based on this premise, Figure 2 gives a schematized representation of the discussions of this study on how the outcomes of digital economic innovation have an impact on technology and society sectors. The impact of economic innovation on technology and society spheres returns to affect and interact with economic innovation, but the impact of economic innovation on the social front is addressed in detail in the discussions of social innovation. Changes in the economic sector quickly lead to digital economic innovation due to external factors such as digital technology and infrastructure as well as the extensive impact of internal factors such as experience, knowledge, labor, and capital. Furthermore, the impact of digital economic innovation



on each sector creates a virtuous cycle in which the economic innovation supplements or improves the respective sectors and the improvements have an impact back on the economic sector. Overall, innovation in the individual sectors of technology, economy, society, and policy is completed through the process of coevolution.

## 5. Conclusions

This study discussed which factors make it possible for digital economic innovations to spread so quickly and explored the impact of digital economic innovation on the technology and society sectors within social systems. We found that different drivers trigger economic innovation at different times. In the age of digital transformation, networks and platforms are central to innovation, through which new industries emerge and consumer roles evolve. Before the digital economy, economic growth had been accelerated through changes in technology and entrepreneur-driven innovations, whereas in the early stage of the digital economy, infrastructure and knowledge were driving economic growth.

Our results, which explored changes in the industrial structure and specific changes caused by digital transformation, show fundamental transformations taking place, such as active inter-industry convergence and creating new markets. Overall, they brought about big changes in jobs and income distribution. In particular, they led to a shift in the values pursued by consumers toward sharing and subscription, rather than ownership, and the emergence of new industries that consequently helped create jobs in new fields. On the other hand, changes in income distribution are largely associated with negative impacts. Changes in industrial structure due to digital transformation have manifested in the form of reduced jobs, increases in unstable jobs, subsequent increases in income inequality, and the increasing market power of monopoly companies.

The results of digital economic innovation triggered by digital transformation have an impact not only on the economic sector but also on technology and society sectors. On the technology front, new forms of technology innovation are required to meet the need to reduce costs as well as to respond to increasing market power and prosumerization. On the social front, they cause such problems as the deteriorating work environment due to the declining working-age population and work patterns relying heavily on long hours of labor, widening the digital divide among social classes, shifting perceptions about sharing among businesses and individuals, and deepening polarization owing to job automation.

In summary, the results of this study indicate that economic innovation triggered by the digital transformation causes fundamental changes in the industrial structure and economic system, which have both positive and negative impacts on the technology and society sectors. When it comes to the impact of economic innovation on the technology and society sectors, the process of feedback to digital economic innovation by internal and external drivers will be repeated. As a result, innovations in the technology, economy, society, and policy sectors will coevolve. Therefore, the negative phenomena occurring in this process cannot be solved by internal efforts within the economic sector alone but will have to be improved through interactions between technology and society sectors within an integrated and interconnected social systems. To summarize, the impact of changes in social systems such as technology, economy, and society on each innovation area will be supplemented or improved. Moreover, these improvements will be fed back to the economic sector, causing the technology, economy, and society sectors to coevolve.

Our findings have several limitations, so we provide suggestions to improve future research. First, to overcome the limitations of the analysis method, it is proposed that future studies use quantitative methods to measure the drivers of digital economic innovation and its ripple effects on social systems, including technology, society, and policies. It is necessary to specifically determine which of the digital economic innovation drivers has played the biggest part in achieving the digital economic innovation that we have today. This study adopted the approach of a systematic literature review in analyzing domestic and overseas literature, policy outlook reports, trend reports, and press releases. We are aware, however, that this analysis method is not comprehensive enough to deliver a highly

accurate understanding of the drivers of digital economic innovation and their effects on social systems. Therefore, we will employ quantitative methods in our future studies to measure the drivers of digital economic innovation and its ripple effects on social systems, including technology, society, and policy. Second, the impact of economic innovation on the social systems should be quantified by factors affecting the technology and society sectors, and the possibility of generalization should be increased by studying whether the research results are consistent with actual cases of various companies and countries. Among the quantified factors, positive ones influencing innovation in each sector could be further strengthened, while negative ones should be diminished or improved upon. Despite limitations, the results of this research are robust enough to assist policy-makers in crafting policy proposals that more effectively achieve innovation in each area.

The discussions herein are significant in that we discussed and suggested academic reasoning for integrating the interactions among technology, economy, society, and policy sectors in the perspective of innovation, in particular among digital transformation, economic innovation, and impacts on the social systems. Until now, innovation studies have focused on technology innovation and discussions on innovation have tended to stagnate. Therefore, this study expanded its scope and subject through an integrated discussion of innovation. The study assumes that technology innovation is the source of various innovations of other sectors and becomes a starting point for discussing that the performance of technology innovation leads to changes in the industrial structure and economic system, and consequently, innovation in the economic and social fields must be achieved simultaneously. Furthermore, the results of this study will serve as a framework for analysis to verify case studies in the future and serve as a theoretical background for discussing innovation activities. In addition, the results of this discussion will broaden our understanding of innovation drivers and the interactions between innovations and will help corporate and government decision makers make policy decisions that reflect diversified perspectives.

Technology innovation and digital transformation as well as the economic change they enabled are already changing much of our lives in economic, social, policy, and cultural areas. These changes are still ongoing today. Some of them may or may not improve the current state. Overall, the result of this study supports the fact that innovations in individual sectors do not stand alone but coevolve as they have a mutual influence on one another.

**Author Contributions:** Conceptualization, I.Y. and C.-G.Y.; writing—original draft preparation, I.Y.; writing—review and editing, I.Y. and C.-G.Y.; visualization, I.Y.; supervision, C.-G.Y.; project administration, C.-G.Y.; funding acquisition, C.-G.Y. All authors have read and agreed to the published version of the manuscript.

**Funding:** This work was supported by the Ministry of Education of the ROK, the National Research Foundation of Korea (NRF-2019S1A5C2A02081304), the Ministry of Science and ICT of the ROK, and the Korea Institute of Human Resources Development in Science and Technology (KIRD) in 2021.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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