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On the Role of the Digital Industry in Reshaping Urban Economic Structure: the Case of Hangzhou, China

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ABSTRACT

The digital economy industry plays a transformative role in reshaping the global production networks, the local division of production, and the integration and innovation of business forms. However, to what extent the industry enables the high-quality development and upgrading of urban economies is unclear. Based on the census data of digital economy enterprises in Hangzhou in 2008, 2013 and 2018, this paper verifies the characteristics of the digital economy industry and its enabling mechanism for high-quality urban economic development. It is found that: firstly, the digital economy industry has three main forms for the economy, namely, the sharing, scale and scope economy. Secondly, the industry has four major mechanisms to improve the quality of urban economies. That is, it can restructure the global industrial division of labor and value chains, promote the transformation of scale economy from the supply side to the demand side, enable the softening and servitization of industrial structure, and generate the scale of economies. This paper thus contributes to understanding the evolution of enterprise organizational structure and industrial competitiveness and the endogenous technological change under the digital economy.

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1. Introduction

In the last few years, data has become a new factor and resource for production in economic growth theory (Mueller & Grindal, 2019) and an emerging core engine for economic growth and industrial transformation. The digital economy, as the carrier of data, has increasingly had a profound impact on the internal development and evolution logic of urban development, by virtue of the presence of network information technology facilitation, especially the flow of production factors such as information, data and knowledge. Recently, China's digital economy has been developing rapidly. Data from Chen (2022) about the China Academy of Information and Communications Technology shows that in 2021, China's digital economy reached 45.5 trillion-yuan, year-on-year growth of 16.2%, which accounted for 39.8% of GDP. Moreover, the industrial scale of the digital economy reached 8.4 trillion yuan, a nominal growth of 11.9% year on year, accounting for 7.3% of GDP. Since China's digital economy is ever-expanding its scale and relies on data value mining to stimulate the vitality of data elements, studying the impact of the digital economy industry on urban economic growth is an inevitable requirement to achieve high-quality economic development.

The Yangtze River Delta is one of the regions with the strongest economic vitality and the greatest concentration of innovative factors in China. Hangzhou, a core city in China's Yangtze River Delta region and a sub-central city in the southern wing of the world-class urban agglomeration in the Yangtze River Delta, has led the digital economy to become an important local driving force for Chinese urban economic and social development and technological improvement (Ren et al., 2022; Zhang et al., 2021). *Yangtze River Delta Digital Economy Development Report* published by both China Information and Communication Academy and Zhejiang Tsinghua Yangtze River Delta Research Institute points out that in 2021, the business revenue of Hangzhou's core digital economy reached 1,633.1 billion yuan, accounting for 55% of Zhejiang Province. Since Hangzhou has an ever-developing industry scale and well-established infrastructure. In this sense, studying the development and evolution of Hangzhou's digital economy industry in China is highly topical and representative.

In terms of the driving force of urban economic development, there are two main theoretical strands of scholarly research. On the one hand, many scholars have highlighted that agglomeration and spillover effects are two major forces of urban economic development, which goes beyond the single view of technological factors (Golubchikov, 2006). The agglomeration effect is generated based on the physical co-location of enterprises, population, industry, capital, technology, information, facilities and policies (Jones, 2017; Ōtsuka, 2017). Such co-location can generate spillover effects which lead to the spatial accumulation of trust, social capital and economies of scale (Tabuchi, 2013; Hu et al., 2022). On the other hand, the study topics on evolutionary economic geography differ from those on agglomeration economics. On the other hand, evolutionary economic geography (EEG) research mainly combines the theories of path dependence, General Darwinism and complexity systems to examine the evolutionary mechanism of industries and regional economies. EEG draws on the notion of proximities to analyze the role of technological relatedness in generating agglomeration externalities for regional economic evolution (Boschma & Frenken, 2011). Much research has been made by adopting the concept of path dependence to understand regional agglomeration economics. Some notions, such as industry developmental path, co-evolution and regional resilience have been developed to understand how regional economies evolve over time and space (Boschma & Frenken, 2018).

While existing studies on the topic have provided valuable theoretical tools and empirical evidence to understand how regional industries, particularly manufacturing industries, evolve and thus impact regional economic structure, less attention has been paid to understanding how the emerging digital economy industry shapes regional economies, and to what extent it impacts on economic structural change. In the existing literature, studies on the digital economy industry have mainly focused on exploring industrial features (Yin et al., 2019) and characteristics (Vu et al., 2022), fields of application (Olbert & Spengel, 2017), and the impact and contribution to

economic development (Nakamura et al., 2017; Richter et al., 2017). It is suggested that investment in telecommunications technologies and Internet applications can significantly help to enhance the technological innovation of firms and organizations (Paunov & Rollo, 2016; Cardona et al., 2013). The key argument in this point is that digital technologies can reshape the traditional model of division of labor, reorganizing the industry chain and making higher productivity. It can also bring about positive externalities not only to firms but also to the development of regional economies (Becchetti & Adriani, 2005; Jorgenson et al., 2007; Tranos et al., 2021; Zhu & Chen, 2022; He & Yang, 2023; Ma & Zhu, 2022).

Although the digital economy industry is a new form of business in urban economies, it still depends on, and at least relates to agglomeration economics and evolutionary economics (Wang et al., 2018). Examining the role of the digital economy industry in urban economic development and evolution is of importance to the understanding of the current urban development, but is also of relevant to the developments of EEG and agglomeration economics theories (Chu et al., 2023). In order to make up for the shortcomings of existing studies, this paper draws upon the theories of agglomeration economics and EEG to explore the characteristics of agglomeration in the digital economy. In particular, it aims to analyze the role of the digital economy industry as a whole in generating new modes of agglomerations and spatial divisions of labor for urban economic development.

This paper takes Hangzhou's digital economy industry as an example and attempts to answer two key research questions: (1) from a geographical perspective, what is the core driving force of the digital economy industry (2) from the perspectives of agglomeration economics and EEG, what is the relationship between the digital economy industry and the evolution of urban economic structure. The paper thus is organized into four sections. The following section (Section 2) introduces the origins and conceptions of the digital economy. Section 3 theoretically explains the nature of the digital economy and particularly its general role in affecting urban economic development. By addressing the data and methodology in Section 4, Section 5 takes the development of Hangzhou's digital economy industry between 2008 and 2018 as an example and quantitatively examines how the economy evolve over time and space and how it shapes the development path of Hangzhou's economy. Section 6 concludes.

2. The Digital Economy: Origins and Concepts

The digital economy was first introduced by Don Tapscott (1997), whose work 'The Digital Economy' elaborates on the socio-economic impact of the Internet. Negroponte (1997) further clarified the development trend, the application and the value of information technology. Since then, governments worldwide have been taking steps to promote the digital economy as a new engine to enhance economic growth. For example, in 1997, the Japanese Ministry of International Trade and Industry began using the term 'digital economy'; meanwhile, since 1998, the US Department of Commerce has published several annual research studies with the theme 'The Digital Economy'. After the financial crisis in 2008, many countries have been making strategies in the digital economy to tackle the recession (Arceo et al., 2016). Additionally, according to the concept defined at the 2016 G20 Summit in Hangzhou, China, the digital economy refers to economic activities which make use of digital knowledge and information as the key factor of production, and take advantage of ICT for efficiency and economic structural optimization.

Following this vein, the digital economy can help create a new socio-technical system in which information, commerce and production activities are digitized in a manageable system (Welfens, 2007). It includes software, networks and terminals and encompasses digitalization, intelligent applications and services in various industries and business fields. According to the development sequence, the digital economy originates from the information economy (Shade, 2016). With the advancement of technologies, the information economy develops into digital economy after digital mining and application. In this process, information is systematically utilized, processed, and applied into a wider range of industrial fields and scenes, namely, informationization transforms into digitalization.

According to China's white paper on digital economy development, the relationships among these concepts are shown in Figure 1 below. The information economy covers the largest scope, followed by the digital economy, the network economy and the Internet economy. In this sense, the network economy and the Internet economy are two manifestations of the digital economy (Currah, 2006), while the Internet Economy is a brand-new branch of the Network Economy (Wang et al., 2022).
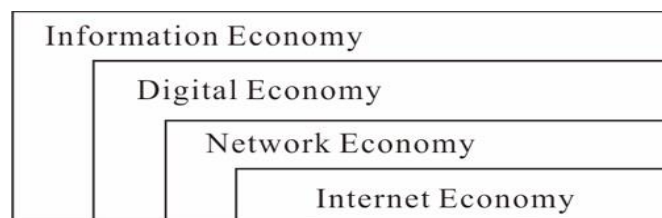

Figure 1. The relationships of the four concepts (Adapted from China's White Paper on Digital Economy Development).

The information economy focuses on the direct value-added application of information technology and facilities. It refers to a broader sense of economic informationization which include the use of various technological tools such as the Internet, AI, big data, and telecommunication technologies to empower the production, consumption and circulation in the economic system. The digital economy is a part of the information economy, which mainly focuses on the remining, analysis, transmission, decision-making and control of data. It relies on the use of data-oriented technological means to enhance the economic efficiency and productivity of cities. The network economy is more of a shared and integrated model form in the digital economy, which involves applying various digital technologies to make different actors, assets, and markets well-connected and to form a network effect for economic development. The Internet economy is a particular division in the network economy, which focuses on product transactions and the control of transaction costs by using Internet technologies and platforms. The differential characteristics in definition among the four forms of economies are shown in Table 1. In a nutshell, the key difference among the four economies is that the digital economy disallows the existence of data islands and inconsistent standards while the other three all allowed the existence of data islands.

Table 1. The Essential Characteristics and Application Differences of The Four Concepts (Authors' own induction and collation).

	Essential characters	Intrinsic differences
Digital Economy	A model that technologically means focusing on data mining, analysis, transmission, decision-making and control. Techniques to determine productivity.	• Disallowing the existence of data islands and inconsistent standards; • Relying on databases and cloud computing platforms to carry out data algorithms and calculations.
Information Economy	Direct value-added application of information technology, industry, facilities and informatization.	• Allowing data islands; • Allowing decentralized processing and application of information; • Allowing information carriers to take many forms.
Network Economy	An economic model based on network tools and typified by integration and bearing.	• Allowing data islands; • Allowing business, social, urban, transport, etc. to act as subjects of network effect.
Internet Economy	An economic form that relies on online tools to reduce transaction costs and sell products.	• Allowing data islands; • Allowing top-level design; • Focusing on commercial transactions and platform organization.

3. What Drives the Development of the Digital Economy: A Conceptual Framework

3.1. Three features

The digital economy has three mean features. Differing from traditional enterprises' linear incubation and derivation along the mainstream supply chain, firms in the digital economy form feedback and sharing alliances through two pathways, namely, homogeneous derivation and heterogeneous derivation. The digital economy generates network production and economies of scale through both physical agglomeration and virtual agglomeration. It also forms constraint equilibrium and scope economy through outward tension and cohesive gravity.

3.1.1. Homogeneous and Heterogeneous Derivatives Form Feedback Alliances and Sharing Economies

Traditional companies tend to follow the mainstream supply chain pattern for linear incubation and derivation. However, the digital economy gives birth to different ways of the diversification and incubation of firms/industries. It shows that driven by the shared effect of 'cloud, network and end' facilities, the external transaction costs of firms decrease more significantly than the internal transaction costs do. In such a case, digitalization contributes to the integration and innovation with other forms of business, which eventually creates more opportunities for innovation and entrepreneurship that restructure the original industrial organization. In this process, many technical staffs of large digital companies are likely to either quit or set up new firms as supply chain branches of large mother companies. This phenomenon prompts large companies to incubate small businesses and enables the latter to become more capable of adapting to massive personalization and to market changes. These incubated companies have close economic ties with both the parent company and other incubated sub-companies. As such, they could ally and constitute a new network if necessary.

This process results in a collaborative development model of incubation, transfer, feedback, and alliance for digital economy business clusters (Gautier & Lamesch, 2021), creating a shared economy with shared platforms, information, talents and markets (see Figure 2). In general, the incubation process of digital economy enterprises can be summarized as two different kinds - homogeneous incubation and heterogeneous incubation (Sun et al., 2020). The former refers to the high similarity between the digital economy sub-companies and the parent company in terms of business content, production methods, product brands and management models. The latter refers to the fact that digital economy parent companies are inclined to incubate specialized sub-companies that complement their production business in order to reduce transaction costs.
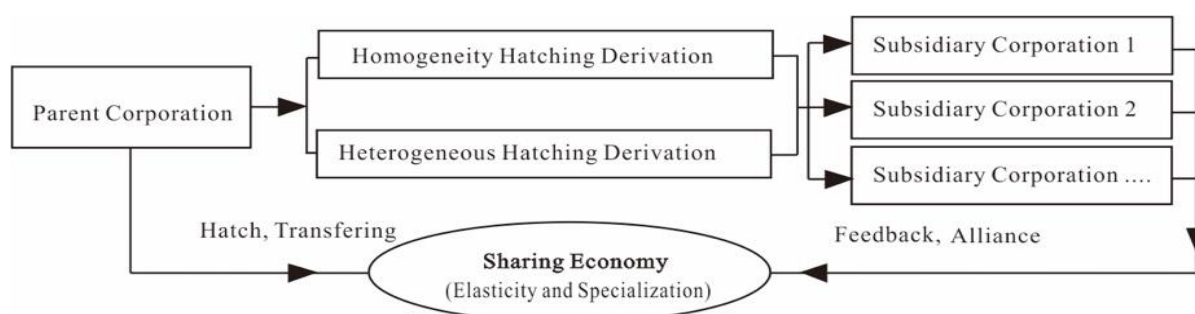

Figure 2. The Incubation and Derivation Process (authors' own composition).

3.1.2. Virtual and Physical Agglomeration Create Network Production and Economies of Scale

The traditional division of labor and business expansion depends on companies seeking local production space supply chains and products to specialize and expand the division of labor. However, companies and products are

incapable of becoming the driving force. Cartel agreements further point out that even in some monopolistic industries, price formation is often decided by dividing spheres of influence according to space and territory (Salvador et al., 2013). In addition to the characteristics of geographical-spatial physical agglomeration, digital economy enterprises are also characterized by virtual agglomeration on market demand and organizational division of labor. The mechanism of virtual and geospatial agglomeration has been summarized in Figure 3. As to market demand, the first characteristic is to create spatial clustering and competitive advantage in conventional network supply and demand. The second is to create a wider clustering of market information and precise customer matching demand information with the analysis of big data and cloud computing.
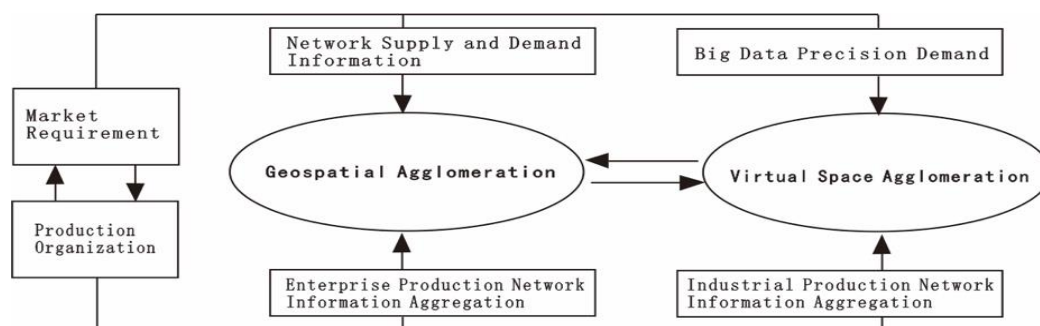

Figure 3. The Mechanism of Virtual and Physical Agglomeration (authors' own composition).

As to the division of labor, firstly, with the help of the Internet, the process, flow, organization and division of labor of products have enhanced organizational efficiency. It also promotes the spatial agglomeration of network production per unit of time. Secondly, through the periodic collection of individual enterprise production data and industry data collection, collation, analysis, and decision-making, it is possible to achieve a greater spatial and temporal scope of supply chain configuration in the virtual space of transaction exchange. For comparisons, the economies of scale pursued in the industrial economy era are achieved by expanding the scale of production to reduce long-term average costs and maximize returns. However, the economies of scale pursued in the digital economy are achieved by increasing the scale of users through virtual and physical agglomeration, which meanwhile reduces time costs and creates greater network externality (Cassell, 1999).

3.1.3. Outward Tension and Cohesive Gravity Contribute to Constrained Equilibria and Economies of Scope

Because of the emergence of the Internet, geographical space is no longer an important constraint. Benefiting from the new generation of information technology, the digital economy has greatly broken through physical, spatial and time limitations. When considering the spatial location of industry, digital economy enterprises can choose peripheral locations with comparatively convenient transportation and low costs as their registration sites. They have more expansion power to move from urban centers to the periphery (see Figure 4). However, as to the system level, in the cross-border integration and innovation of the digital economy with various industries and entities such as government, transportation, healthcare, finance, education, consumption and manufacturing, the inherent characteristics of integration and innovation of the digital economy make it necessary to establish an innovation ecosystem with efficient feedback, multiple sharing, sophisticated division of labor and exchange and collision. Besides, it is noteworthy that this system is also extremely sensitive to the time and space transaction costs of transportation and business services. Benefiting from the joint influence of spatial expansion and spatial cohesion elaborated on above, digital economy enterprises can fully comply with market forces, resolve spatial mismatches, balance expansion and cohesion, and form a constraint equilibrium that adapts to the development needs of local cities. At the industry level, digital economy enterprises can also fully share platforms, information, talents,

knowledge, data and basic hardware in integrating multiple industrial sectors, making the economy of scope more obvious.
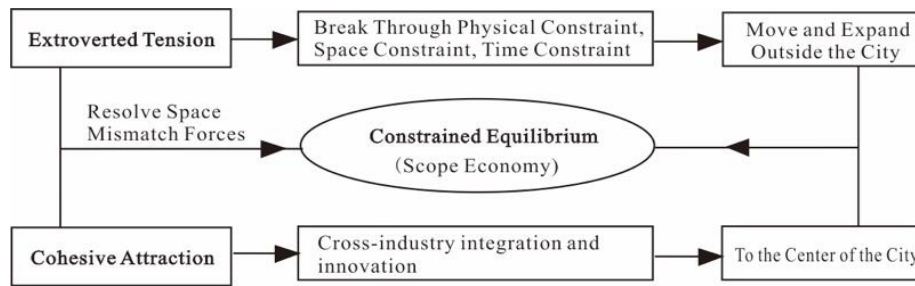

Figure 4. The Equilibrium of External Tension and Cohesive Attraction (authors' own composition).

3.2. Mechanisms on Urban Economic Development

The digital economy has four major mechanisms driving urban economic development, which have been summarized and displayed in Figure 5.
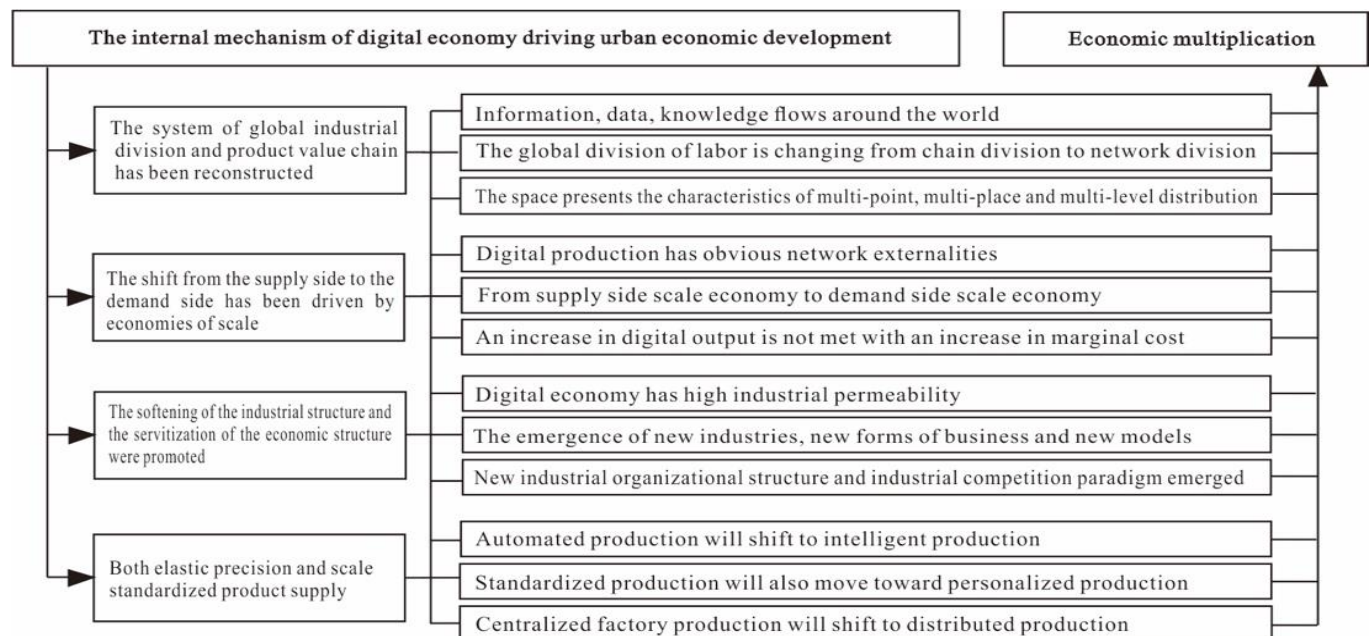

Figure 5. The Mechanisms on Urban Economic Development (authors' own composition).

3.2.1. Reconstructing Global Industrial Division of Labor and Product Value Chain System

The digital economy has achieved high efficiency in resource allocation at a global scale by means of facilitated network information technology. As a result, as the main driving force of the Fourth Industrial Revolution, whose most obvious feature is the reorganization of innovation (Daemmrich, 2017), the digital economy, could shape and then reshape the global industrial division of labor from a chain-based division of labor to a network-based division of labor gradually (Scott, 1986). What's more, the digital economy would accelerate the pace of the generation, diffusion and expansion of new technology and product will increase unprecedentedly. In such an economy, the innovation space will be characterized by distributed innovation at multiple points, locations, countries and levels (Carayannis et al., 2015). Meanwhile, the global industrial division of labor and value chain system are being restructured at an accelerated pace, accelerating the development of the global economy and urban economy.

3.2.2. Driving the Transformation of Economies of Scale from the Supply Side to the Demand Side

From the perspective of economies of scale, traditional enterprises achieve supply economies of scale, while Internet platforms will achieve Demand Economies of Scale (Tovar & Wall, 2012). As described by Metcalfe Law, the value of a network is an economic phenomenon that grows at the rate of the square of network nodes, so the digital platforms show significant network externalities (Janeba, 2007). In digital production, factors of production such as data and information are non-competitive and non-exclusive. As a result, on the basis of given production inputs, the increase in the quantity of digital goods and their services would not lead to increasing marginal costs (Kirner et al., 2015). Thus, this is possible to extend the production possibility frontier outwards. Meanwhile, unlike supply-side economies of scale, demand-side economies of scale do not suffer from diseconomies of scale. This is because they increase in size, while their increasing marginal returns contribute significantly to the development of urban economies.

3.2.3. Promoting the Softening of the Industrial Structure and the Servitization of the Economic Structure

The digital economy industry is highly permeable (Tsai et al., 2008). By the use of digital information technologies, data mining and analysis techniques, the digital economy is deeply integrated with manufacturing, finance, education, healthcare, trade, retail, tourism, transportation, catering, accommodation and other urban economic producer services. Meanwhile, the division of labor in processes and services, the innovative demand and its organizational structure on the consumer side are being explored and created with higher value. In this sense, the deep matching between supply and demand has been achieved in the digital economy, leading to the emergence of new firms, industries, markets and business models. Moreover, this personalized, efficient and flexible new production paradigm overturns the existing economic structure, industrial competition paradigm and global competition pattern. It can improve labor productivity in urban economies and promotes deep structural change in the economy.

3.2.4. Enhanced Elasticity Precision and Scale Standardized Product Supply

Traditional and standardized production modes are increasingly overwhelmed when facing the demands of the emerging market with varieties. Such modes cannot cope with consumers' ever-changing personalized needs (Kirzner & Sautet, 2011). To tackle this problem, with the convergence of digitalization and manufacturing, automated production could shift to intelligent production, where traditional production companies can realize the simultaneous operation of smart factories and smart decisions. Meanwhile, producers can flexibly adjust product design, production and marketing. This shows that the digital economy is able to drive the transformation of rigid production systems designed for mass production into reconfigurable systems for personalized scale customization. The digital economy breaks through the traditional centralized production process in which employees of a company can only produce at scale in a specific, limited geographical space. Moreover, because of established connections with users and social resources, enterprises could improve their production capacity and expand their operational boundaries of enterprises through modular production and social collaboration.

4. Data and Methodology

4.1. Data Source and Acquisition

This study's empirical research object is Hangzhou City, Zhejiang Province, China's one of the most developed digital economies. The data includes the number of information enterprises and their basic attributes in the Second (2008) and Third (2013) National Economic Census Data provided by the Municipal Bureau of Statistics of Hangzhou, as well as the information enterprises and digital information enterprises registered by The Bureau of

Industry and Commerce in Hangzhou, in April 2018.[1] According to the data, the upward trend clearly shows that the number of information enterprises and digital information enterprises increased from 3,852 in 2008 to 10,068 in 2013 and 35,825 in 2018. These enterprises are mainly small and medium-sized enterprises focusing on providing services in digital forms and/or to large digital leading companies. Meanwhile, our data on the attributes of the enterprise includes enterprise name, address, industry type, registered capital, operating income, legal person, establishment time, administrative division, business scope, etc. Our data is fully provided by public authorities and legitimized as an important statistical source to capture firm-level activities in the digital economy.

4.2. Methodology

First, to capture the spatial and network evolution of the digital economy industry in Hangzhou, this paper used the Amap API interface to search the geographic coordinates of each enterprise's address information. In the following, Arc-GIS10.2 software is applied to transform the enterprise coordinates into vector Point data files. We associate the attributes information of the enterprise and finally construct the POI (Point of interest) geographic database of the third phase of information enterprise in 2008, 2013 and 2018. The database overlays the shape file of urban land use status in Phase III provided by Hangzhou's Municipal Bureau of Planning and Natural Resources Geographical and City Situation platform (see Figure 6). It also includes thematic data such as population, road network and public facilities[2]. Moreover, Moreover, the number of enterprises in the specific point position was counted and displayed at different levels, and then the temporal and spatial evolution of the increasing number of enterprise division incubation based on administrative units was analyzed.
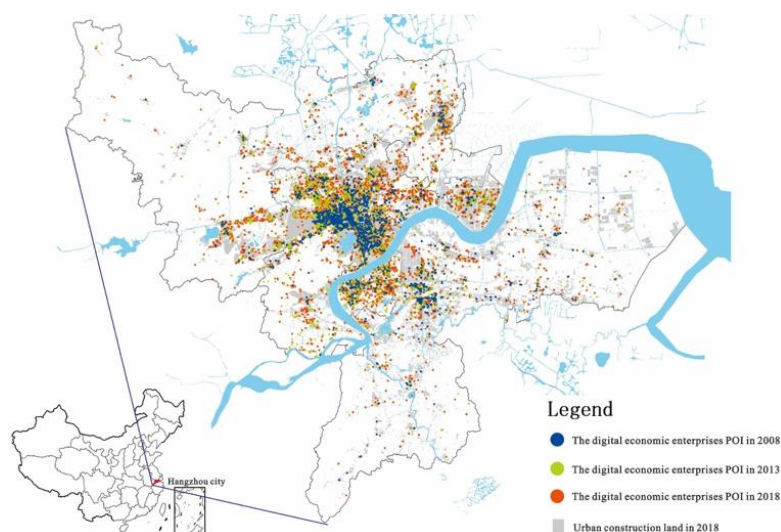

Figure 6. Digital Economic Enterprise POI Overlay City Land Use in 2008, 2013, and 2018.

[1] From the perspective of logical inclusion, digital economy originates from information economy (Shade,2013). The digital economy enterprises in this study are based on the categories of 'Information Transmission, software and information technology Service Industry' in China's Classification of Industries of National Economy (GB/T 4754-2017). It covered telecommunications, radio and television transmission services, satellite transmission services, Internet access and related services, Internet information services, Internet platforms, software development, integrated circuit design, information system integration, Internet of Things technical services, operation and maintenance services, information processing and storage support services, information technology consulting services, digital content services and other major categories of the information industry. Digital information manufacturing is not included due to the limitation of the research scope.

[2] Considering the consistency of industrial statistical standards of three digital information enterprises in the past 10 years, the research scope is limited to 8 districts in the eastern part of the city. Namely, Shangcheng District, Xiacheng District, Gongshu District, Jianggan District, Xihu District, Binjiang District, Yuhang District and Xiaoshan District, covering a total area of 3,068 square kilometers (Fuyang District and Lin'an District were excluded since they were successively set up as additional two new districts in 2015 and 2017, respectively).

Second, to understand the relationship between the agglomeration of the digital economy and urban economic development, we use the generative space weight matrix method and XY to line method of ArcToolbox tool kit and then analyze the network relations among enterprises in a digital economy based on economic weight. Besides, by adopting the kernel density model of ArcToolbox toolkit, we would be able to break through administrative units and quantitatively capture the evolution process of enterprise spatial pattern. With 0.01 square kilometers as the measurement unit and 1 kilometer as the search radius, the kernel density was generated. Using the circle analysis method, 14 concentric circle layers were constructed with Wulin Square as the center and 2-5 km as the circle layer, and the number of enterprises in each circle layer was counted.

5. Empirical Results

5.1. Spatial Evolution

The number of digital economy enterprises in Hangzhou increased from 3,832 in 2008 to 10,068 in 2013, with an increase of 2.63 times in five years. Subsequently, in 2018, the number of companies was 35,825, a 3.55-fold increase compared to that in 2013. Since the general life span of current small, medium and micro technology enterprises in China is five years, the number of digital economy enterprises incubated and derived in Hangzhou from 2008 to 2013 is at least 15 times. Taking streets and towns as fundamental administrative units, the stage change in the spatial division evolution pattern of digital economy enterprises in Hangzhou is clearly shown in Figure 7. In early 2008, there were three birthplaces of agglomeration in the city center, in the south and the east of the city. Alibaba was the leading enterprise in the city center, Hikvision and NetEase were dominant in the south of the city, while the main enterprises in the east of the city were small and medium-sized enterprises formed by manufacturing informatization and digital services. Although the number of enterprises increased significantly in 2013 and 2018, the enterprises were still basically located at the original three birthplaces as the core, meanwhile distributing their derivatives to the surrounding areas. This further indicates that the division of labor incubation of digital economy enterprises can neither be distributed uniformly nor solely stay away from the parent company because of the improvement of information technology level and the reduction of transportation costs.
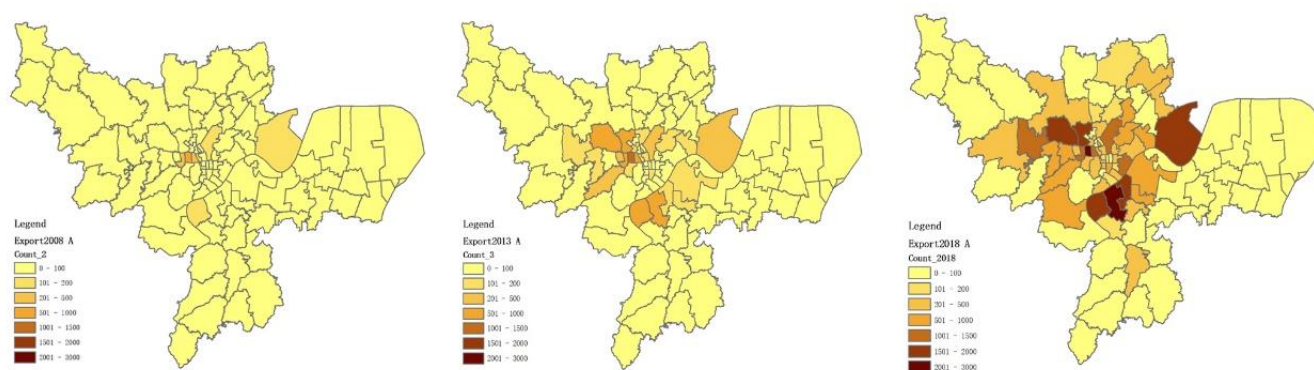

Figure 7. The Evolution of Spatio-temporal Division in Enterprises with Street as a Unit in 2008, 2013, and 2018.

In the early stage, predominant digital enterprises such as Alibaba, NetEase and Hikvision took the lead in using data as production and innovation resources. Through the characteristics of high penetration and integration of digital economy, the digital giants promoted the continuous derivative innovation of digital economy and other business forms in a market-oriented way. The government has also set up such digital innovation gathering platforms as Yunqi Town, Dream Town and Internet of Things Town, and established such digital innovation research and development institutions, such as Westlake University, Zhijiang Laboratory and Ali Damo Institute.

Through the rapid spiral accumulation of digital industrialization and industrial digitalization promotion among these institutions, a large number of specialized enterprises are derived from the division of labor, and then constantly cooperating and networking with each other. Later, in the light of close collaboration, the digital enterprises constantly feed back the local labor division network and further strengthen the core node position of leading digital enterprises, thus both producing local market effect and forming obvious economies of scale and scope of digital economy industry.

5.2. Network Evolution

To further analyze the digital economy enterprises in Hangzhou from the parent enterprise division of incubation and network alliance is vital to the study in the enterprise sense. Firstly, the study uses XY To Line tool in Arcgis10.2, combined with the digital economy enterprises' coordinates, to identify the latitude and longitude coordinates between enterprises in the third phase of the survey as the starting point and the ending point. Secondly, the relative value of business income of each enterprise is regarded as the weight of the intensity of economic connection, and then, the one-to-many labor division connection diagram of Hangzhou digital economy enterprises was output (i.e., the economic connection diagram) in Figure 8. It suggests that with the increase in the number of enterprises, the connections between enterprises become closer, and the network connections become more complex. Meanwhile, it is also found that the economic network still presents a tight spatial agglomeration and constraint equilibrium development state.
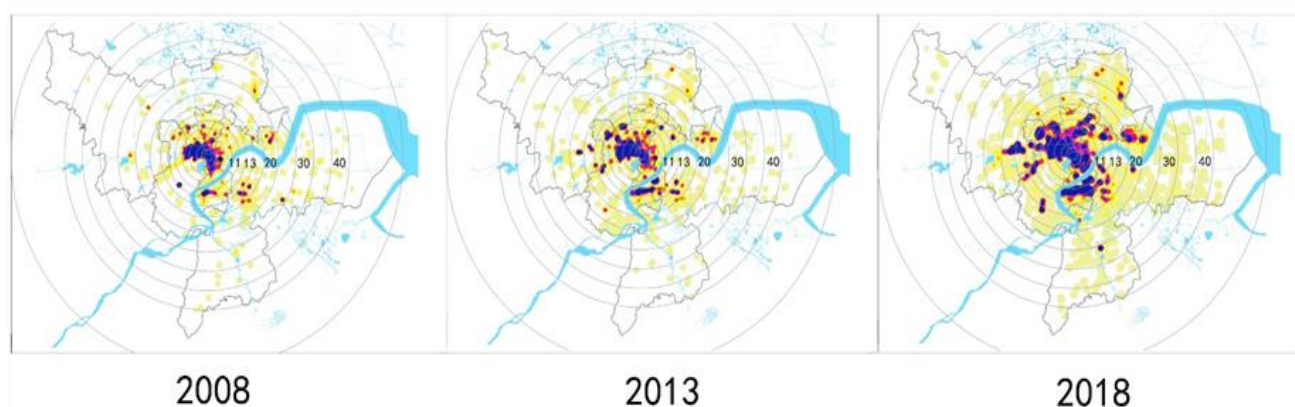

Figure 8. The Enterprise Spatial Network Division of Labor Connection in 2008, 2013, and 2018.

Furthermore, according to the research findings, a large number of digital economy enterprises are characterized by the end function division incubation. Relying on digital information technology, these enterprises weaken face-to-face contact with customers and have greater spatial elasticity while still having a strong degree of spatial agglomeration. In addition, taking the division of labor incubation of e-commerce enterprises as an example. In the past ten years, e-commerce enterprises have carried out rapid incubation and development mainly by networking around the three basic birthplaces of the digital economy industry and by relying on the transformation of old urban industrial zones, professional market areas, college pioneer parks, new business buildings and other carriers.

With the help of *'Tianyan Check'*[3], this study also analyzes enterprises directly controlled by Alibaba Group, Hangzhou. The results (in Figure 9) suggest that Alibaba Group was initially located in the western corner of Hangzhou City in 2008. With the development and expansion, the Group gradually distributed a series of

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[3] https://www.tianyancha.com/. Temporarily excluding enterprises incubated after resigning from Alibaba and a large number of enterprises providing digital information supply chain services such as software outsourcing for Alibaba.

subsidiaries, such as Alipay, Ant Financial, Ali Research, Ali Cloud and other subsidiaries, located around the parent company. With one exception - the Ali Cloud, which locates far away because of the requirement of considerable servers.
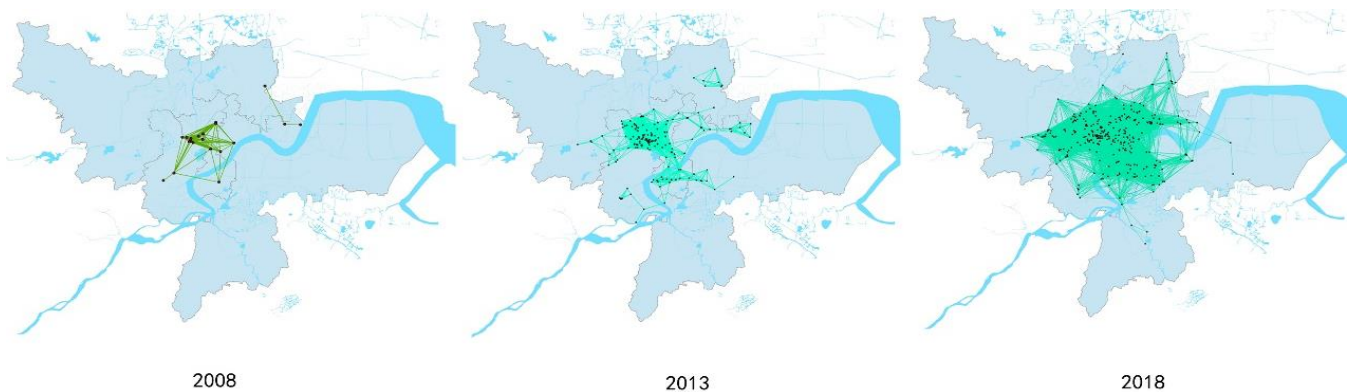

2008   2013   2018

Figure 9. The Division of Labor and Connection Network of Alibaba Group in 2008, 2013, and 2018.

This distribution phenomenon fully indicates that in order to share talents and high-end technology elements, digital economy enterprises tend to gather around their parent enterprises for frequent discussion and brainstorming of technology research and development services. This also presents apparent cluster characteristics of the division of labor incubation, transfer, feedback and alliance network.

5.3. The Role in Urban Economic Development

The quantitative spatial characteristics analysis of digital economy enterprises, with streets and towns as the unit, only can represent the average number of enterprises in administrative units; however, it cannot fully reflect the actual agglomeration degree and agglomeration boundary of enterprises in geographical space. Because, in reality, the agglomeration of enterprises in the city often breaks through the boundary of the street and town administrative region.

To further reflect the agglomeration and evolution of Hangzhou's digital economy enterprises, the kernel density tool in Arcgis10.2 was used to analyze spatial agglomeration. Results in Figure 10 & Figure 11 show that, in 2008, digital economy enterprises in Hangzhou were highly clustered in the east, north and northwest of the West Lake, forming an agglomeration circle centered on Wulin Square. At that time, the radius was five kilometers with a peak of 250 enterprises per square kilometer (i.e., 250 enterprises/km^2).
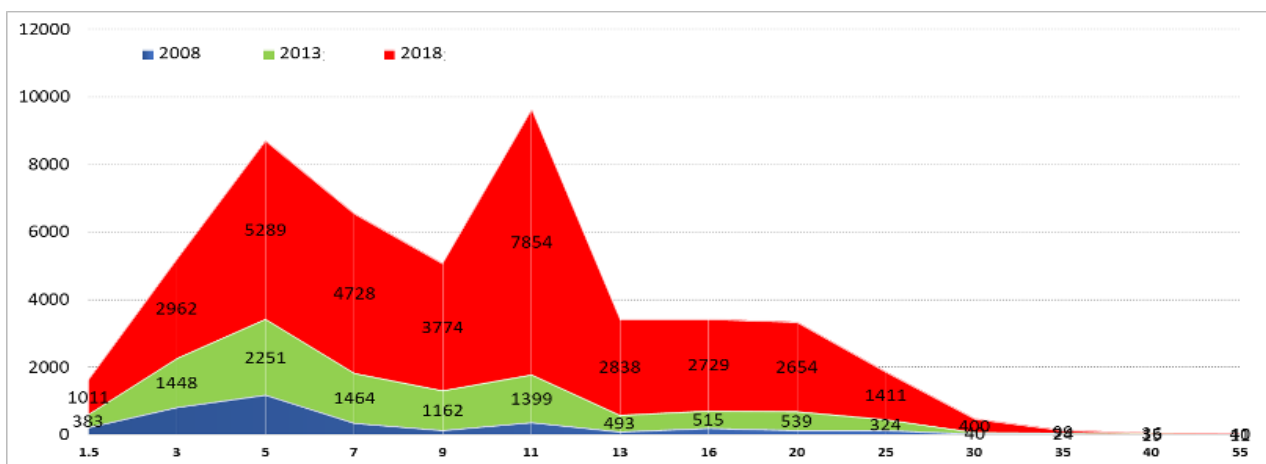

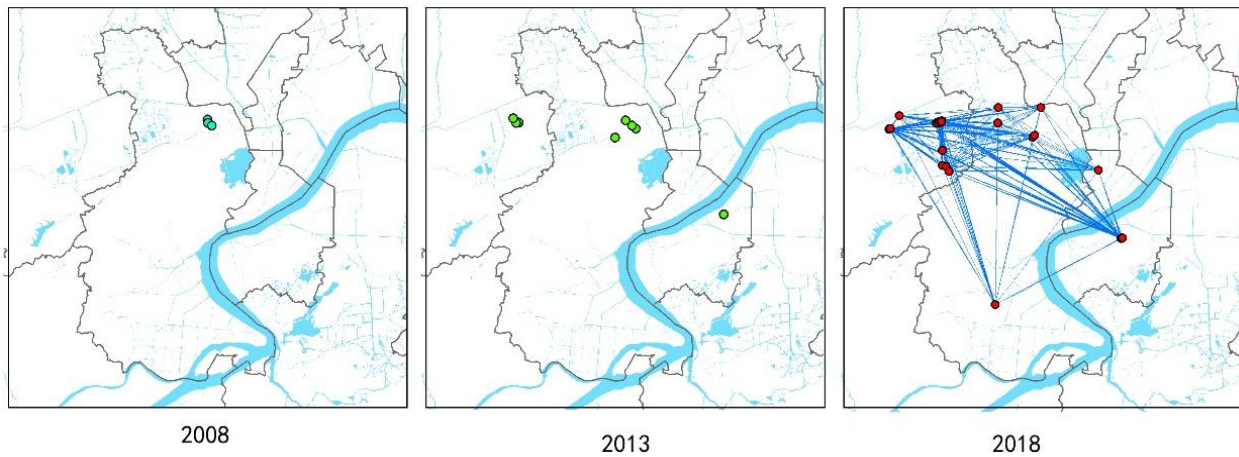**Figure 10.** The Kernel Density of Enterprises in 2008, 2013, and 2018.

Figure 11. The Agglomeration Distance of Digital Economy Enterprises in 2008, 2013, and 2018.

In 2013, digital economy enterprises continued to gather and spread, and a dual-core spatial structure of agglomeration had been formed in which the peak of agglomeration in Wulin Square in Hangzhou was 560 enterprises/km^2, and 350 enterprises/km^2 in Binjiang District of Hangzhou.

In 2018, the dual-core structure of digital economy agglomeration had accomplished spatial connection, namely, the east side of the West Lake and the north and south sides of the Qiantang River had achieved the balanced and integrated development of high density. At that time, the agglomeration density exceeded 1000/km^2. As such, an obvious spatial constraint equilibrium state has been formed. It specifically reflects that the peak value of Wulin Square in Hangzhou was 1320 enterprises/km^2, and that of Binjiang District in Hangzhou was 1960 enterprises/km^2. The latter had a higher degree of spatial agglomeration.

After the investigation, it was found that the formation of a balanced space is based on the full utilization of resources. Land space is the primary factor resource that restricts the agglomeration and development of digital economy enterprises in Hangzhou, followed by rental price and traffic congestion cost. As can be seen from Figure 12 (A is educational land, B is commercial land, R is residential land, and M is industrial land), during 2008-2018, land used by digital economy enterprises in Hangzhou changed from residential, educational, commercial and industrial land to commercial and industrial land. The figure depicts that digital economy enterprises in Hangzhou have made full use of various types of land resources in the fission expansion, thus forming the constraint equilibrium and spatial evolution under the joint function of industrial agglomeration and the constraint of land resource supply.
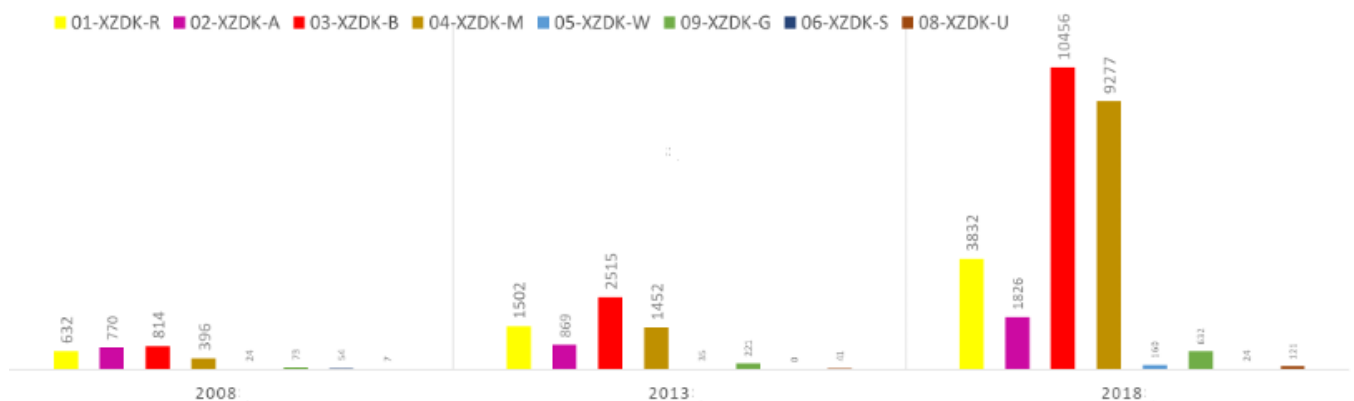

Figure 12. The Changes in The Nature of Land Use of Digital Economy Enterprises in 2008, 2013, and 2018.

6. Conclusions

This paper contends that the digital economy industry as a newly emerging industry can significantly shift the industrial characteristics of a city. Digital economy enterprises have played a key role in promoting the rapid division of labor. They help to generate a new division of labor which in turn bridges the parent enterprises with other incubate enterprises – namely, the emergence of new industries and supply chains and organizational systems. Through a mutual alliance with a wider scale of firms and organizations, they further form a competitive shared economy. In addition to the spatial agglomeration of digital economy enterprises, virtual agglomeration is also formed with the sharing of data and information. Such a kind of agglomeration goes beyond market demand, generating greater power of making in-depth division of labor in the production. It is also evident that the digital economy industry generates a strong effect of network externalities and economies of scale, with a wider range of integrated industry sectors and strong penetration to niche markets. It can essentially overcome the problem of spatial mismatch between firms, labor and organizations, thus achieving a state of constraint equilibrium.

Our second conclusion is that the digital economy industry shifts the traditional driving force of urban economic development. The reason is that it has reconstructed the global industrial division of labor, and promoted the evolution of the global value chain system from the conventional industrial chain to a new dynamic and resilient chain of industries, actors and assets. The digital economy industry promotes a shift from supply-side to demand-side economies of scale. It also enhances the softening and servitization of the industrial structure. On the one hand, the emergence of new technologies, industries and new business models under the integration of the digital economy has overturned the industrial organization structure and reshaped industrial competition patterns under the traditional urban production paradigm. On the other hand, the digital economy industry has enhanced the degree of flexible production at scale, pushing forward the transformation of rigid production systems designed for mass production into flexible innovation for customization (Chu et al., 2023).

Thirdly, the case of Hangzhou manifests the characteristics of digital economy industry and its effect mechanism on the high-quality development of urban economy. Hangzhou's case shows a clear sign of the rapid division of labor under the impact of digital economy enterprises. Specifically, Alibaba Group's subsidiaries, for instance, are clustered around the parent company, showing obvious characteristics of the division of labor, incubation, transfer, feedback and network alliance. It is suggested that while inter-enterprise connections are closer and the network links are more complex, the degree of spatial agglomeration is ever apparent. This means a new industry eco-system and a new form of agglomeration is emerging, which well integrates into the existing industrial system, about to systematically reshape the pathway and mechanism of economic development in the city.

To end up, the virtual and physical agglomeration of digital economy enterprises goes hand in hand and contributes significantly to the integration of the digital economy and the real economy. This can fundamentally reshape the economic structure in terms of the division of labor, production assets, and industry/value chains. In particular, from the case study of Hangzhou, the digital economy industry has four basic roles to reshape urban economies. They are 1) restructuring the global industrial division of labor and value chains; 2) promoting the transformation of scale economy from the supply side to the demand side; 3) enabling the softening and servitization of industrial structure and (4) generating the scale of economies by physical and virtual agglomeration. This paper thus contributes to understanding the evolution of enterprise organizational structure and industrial competitiveness and the endogenous technological change under the digital economy. It also provides some valuable insights to policy practitioners at the regional and urban levels for digital economy development and digital transformation for urban economic restructuring.

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Author Contributions

Conceptualization, Z.X. and Z.H.; methodology, Z.X. and Z.H; software, J.J.; validation, Z.H.; formal analysis, Z.X.; investigation, W.Y. and J.J.; resources, Z.X.; data curation, J.C.E.; writing—original draft preparation, Z.X.; writing—review and editing, J.C.E. and W.Y.; visualization, J.J.; supervision, Z.H.; project administration, J.C.E.. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

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