

Analysis of Informatization on Economic Development of Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract: The construction of the Guangdong-Hong Kong-Macao Greater Bay Area is a momentous national development strategy for China. In recent years, the cities in that area have been investigating new paths for connectivity. The “9+2” cities empower each other, and enrich the connotation of the principle of “one country, two systems”. The Greater Bay Area policy also plays an important role in global economic and cross-cultural communication. Informationization will be a key point in promoting and facilitating economic integration throughout the Greater Bay Area. This paper analyzed the impact of informationization on the economic development of the Greater Bay Area by testing two variables which are the number of mobile phone year-end subscribers, and the number of Internet broadband access subscribers. The results showed that the Internet broadband access subscribers significantly contribute to the economic growth, however, the number of cell phone year-end users failed to showed any significant correlation. The result indicates that there is a long-term and stable relationship between the level of Internet development (expressed by the number of Internet broadband access users), and economic development in the Guangdong-Hong Kong-Macao Greater Bay Area, which means informationization can support the economic growth of the region. This paper also provides some policy recommendations based on these four areas, which are, optimizing and upgrading the construction of information infrastructure, strengthening investment in new-generation information infrastructure, promoting the expansion of bandwidth at international Internet entrances and exits, and proposing the development of new businesses in the digital economy.

Keywords: Guangdong-Hong Kong-Macao greater bay area; Informatization; Economic development; Empirical analysis

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1. Introduction

In recent years, the “9+2” cities in the Greater Bay Area have been supporting each other to play an important role in the global economic growth. Informatization showed to be an important key driver in supporting and facilitating the economic development of the Guangdong-Hong Kong-Macao Greater Bay Area. In 2019, the Communist Party of China (CPC) Central Committee and the State Council issued outline of the developmental plan for the Guangdong-Hong Kong-Macao Greater Bay Area. One of the goals stated in the outline is to enhance the support on infrastructures such as transportation, energy, information, and water conservancy, which further can improve the capacity of urban development and operation.”

Informationization act as an important factor involved in the optimizing and enhancing the information infrastructure in order to build a smart city cluster with improved level of network security, in term of,

stronger protection of communication networks, crucial information systems, and high reliability data resources. Additionally, actively promoting the usage of advanced technologies in Hong Kong, Macao, Guangzhou, Shenzhen, and other cities, as well encourage the usage of the confidential communication technology in government departments and financial institutions. Establishing and improving the network and information security system as an early-warning mechanism, augmenting real-time monitoring, and during emergency response are important.

In December 2021, the State Council re-emphasized the importance of accelerating the integrating of information network infrastructure, with information communication technology (ICT). The 14th Digital Economy Development Five-Year plan, proposed to develop the digital economy as a new economic form, that promotes fairness and efficiency followed by the agricultural, and industrial economy. In the future, it will be the main economic form, which use data resources as the key element, modern information networks as the main carrier, fusion applications of ICT, and digital transformation as essential impetus.

2. Literature review

Many studies have been conducted in the recent years, to show the influences of information network in the country development. Ishida et al.,^[1] illustrates that, in Japan, ICT investment contributed to a moderate reduction both in the short-term and long-term in energy consumption, however, heavy ICT development created a major loss to the Japanese economy. Zhang and Danish et al.,^[2] show that during the time of study, the mobile phone usage help in the economic growth in the Asian countries, however, same association was not observed for Internet users. Similar finding was observed by Haftu et al.,^[3] in the selected 40 countries of Sub-Saharan Africa (SSA), which, empirically analyzed the impact of mobile phone and Internet on per capita income from 2006 to 2015.

In the year 2020, Tripathi and Inani^[4] employed an augmented Cobb–Douglas production function analysis by incorporating ICT with capital and labor, subsequently obtained a positive and a significant effect of ICT on the economic growth among countries in the South Asian Association for Regional Cooperation (SAARC).

As for Chinese scholars, Zhou at el.,^[5] finds that informatization can help to boost innovation ability, which may improve regional economic development. Additionally, in the United States, innovation and the diffusion of information technology in the 1990s, largely improved the economic growth, leading to decreased in the problem with employment problems and inflation^[6]. During the China's 12th Five-Year Plan, a new-generation information technology as one of the seven strategic emerging industries were proposed^[6]. Further, Cha and Zuo et al.,^[7] constructed a dynamic multi-indicator evaluation system reflecting four major elements, and 13 indicators of regional informatization level. Based on the informatization, Zhang et al.,^[8] in 2018, examined the nonlinear effect of residential information technology consumption on the quality of economic growth in China using a threshold regression model, which concluded that, there was a significant positive double threshold between the residential information technology consumption and economic growth. Next, Cao et al.,^[9] uses a panel data vector auto-regressive model (PVAR) to investigate the relationship between industrialization, informatization, and economic growth in the east and west regions of China. They obtained interesting results, where industrialization contributes to economic growth in the eastern region, whereas informatization positively stimulate both economic and industrialization in the western region. Study shows that informatization can incur regional economic development, and the same study examines how the informatization transmission mechanism may drives regional economic development by industry^[10]. China's National Informatization Plan for the 14th Five-Year Plan^[11] proposes to accelerate the construction of digital China, by including more vigorous plans to develop the digital economy, promote the advanced industrial base, and modernization of industrial chains, as wells accelerates the simultaneous development of new industrialization, informatization,

urbanization, and agricultural modernization.

According to the literature search, there is a lot of informatization research were conducted throughout the world which, many has demonstrated fruitful findings, however, the research objectives still need further exploration. Previous studies on the relationship between informatization and economic growth mainly focus on a single country or region, with few studies was conducted on the Guangdong-Hong Kong-Macao Greater Bay Area. In addition, empirical analysis methods with different economic development levels and informatization standards or differences in the study parameters and indicators, may generate differences outcomes. Therefore, based on the experience from previous studies, and the current economic development situation in Guangdong-Hong Kong-Macao Greater Bay Area, this paper incorporates framework analysis between informatization and economic growth, which may have a significant value.

3. Core concepts and theoretical basis

3.1. Definition of informatization

The concept of informatization is originated from Japan in the year 1960 and in the year 1963, the Japanese scholar Tadao Umesao first raised the issues related to informatization as influencing factor in the industrial development, which sparked the interest in many scholars^[12]. Later, in 1967, the Japan Science, Technology and Economics Research Group coined the word “Johoka,” which then was translated into “informatization” by American scholars. Thus, the word informatization was created and widely used and recognized to date^[13].

In China, the word informatization is defines and translated with different meaning by different scholar. Zhong et al.,^[14] considers informatization as an integration of modern information technology into all components of the national economy, increase the proportion of information economy in the gross national product (GNP), thus, improving the social labor productivity. While, in 2008, Zhou et al.,^[15] believes that informatization is a comprehensive transformation of the organizational, and economic structure for the human social production system using modern information technology, consequently resulting in the progress of human society. Informatization is not simply a process of technological progress and technological change, but also a process of “social-technological” that is always change based on the computer revolution, and form a new economic structure and social pattern. The corresponding systems and ideas will form new content, and characteristics that make society closer, more connected, and inseparable.

This strategy of this paper was adopted based on the National Informatization Development from 2006 to 2020 of the Chinese government websites, that informatization is the historical process of utilizing the information technology, developing, and utilizing information resources, promoting information exchange and knowledge sharing, improving the quality of economic growth, and promoting the transformation of economic and social development.

3.2. Economic growth theory

The study of modern economic growth theories began in the year 1940s, from exogenous to endogenous economic growth theories. This paper focused on the role of technological progress, knowledge accumulation and institutional changes in the economic growth, by arranging the representative theories in a chronological order

The classical economic growth theory emphasizes the role of labor and capital in economic growth, as represented by Adam Smith and David Ricardo. In 1956, Solow proposed the famous neoclassical growth model, which includes two-factor production functions, which are the labor and capital as determinants of output with constant beneficial results. The breakthrough of the theory is to affirm the key role of exogenous

technological progress in economic growth. After the mid-1980s, a group of economists, leads by Romer L make a modification on the limitations of the neoclassical growth model, and proposed the theory of endogenous economic growth, to endogenize the relevant factors that may affect the economic growth, such as knowledge and technology, and emphasize their decisive role in long-term economic growth.

3.3. Information economics

Information economics are a sub-discipline of economics that emerged in the late 1950s and early 1960s. The concept of information economics was introduced by Marschak in 1959 under the article name “Review of Information Economics”. In general, there is a distinction between information economics in a narrow sense and a broad sense. Information economics derived by Stigler (1961), Vickrey (1961), Akerlof (1970), and others can be classified as “the narrow sense,” and its content are mainly concerned with the problem of incomplete and asymmetric information. In contrast, the information gathered by the economics originated from Malsak, Machlup, Porat, and others can be classified as “the broad sense,” and its contents are mainly about the economy knowledge and information [16].

4. Current situation of the Greater Bay Area

4.1. Overview of socioeconomic development

The Guangdong-Hong Kong-Macao Greater Bay Area consists of “9+2” cities. The number “9” refers to the nine cities in Guangdong Province, namely Guangzhou, Shenzhen, Zhuhai, Zhongshan, Foshan, Dongguan, Huizhou, Jiangmen, and Zhaoqing, meanwhile the number “2” refers to the two special administrative regions which are Hong Kong and Macao. The land area of the Greater Bay Area is about 56,200 square kilometers, accounting for 0.58% of mainland China (excluding Hong Kong, Macao, and Taiwan). The total economic output value of the Greater Bay Area is about USD \$1742.7 billion in 2020, accounting for 11% of China’s total economic output, meaning that this region plays an important role in the China’s economy.

At present, the Guangdong-Hong Kong-Macao Greater Bay Area has favorable conditions in the economic scale, openness, industrial layout, city competitiveness, and regional integration construction. However, the incident of COVID-19 negatively influences the economic development in this area. Additionally, the cities within the Greater Bay Area shows a significantly different levels of economic development. **Figure 1** shows the gross domestic production (GDP) in the Greater Bay Area. The 9 Pearl River Delta (PRD) cities contributed 79% of the total GDP, while Hong Kong and Macao contributed 20% and 1% respectively.

the Greater Bay Area GDP share in 2020

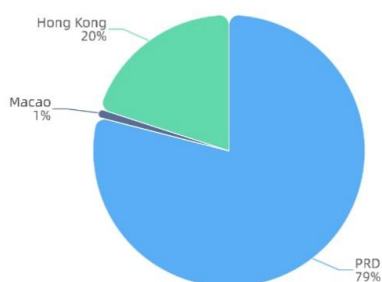


Figure 1. The Greater Bay Area GDP share in 2020

In terms of GDP per capita for the Greater Bay Area, Hong Kong has the highest GDP per capita of \$50,518, followed by the 9 PRD cities with a GDP per capita of \$17,573, and Macao with the lowest GDP per capita of \$3,436, as shown in the **Figure 2**.

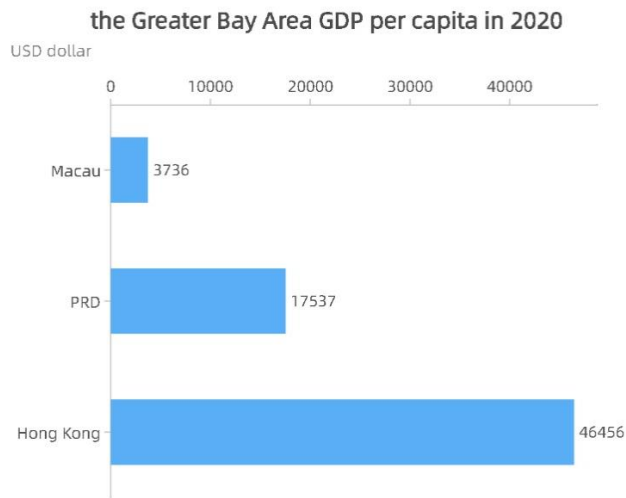


Figure 2. The Greater Bay Area GDP per capita in 2020

However, according to **Figure 3**, the economic growth rate of the 9 cities in the PRD is around 3%, which is much higher than of Hong Kong and Macao in the year 2020. In contrast, the economic growth rates in Hong Kong and Macao in the year 2020 was both negative, at -12% and -57%, respectively, possibly influenced by the pandemic, COVID-19.

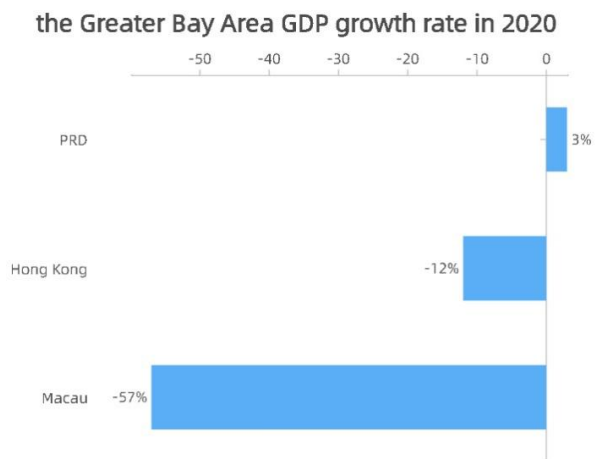


Figure 3. The Greater Bay Area GDP growth rate in 2020

4.2. Overview of informatization development

The total telecommunication service in the 9 PRD cities is about \$22.1 billion, and the revenue is around \$22.4 billion in December 2021. Subscribers for fixed telephone, mobile telephone, 3G, 4G, fixed broadband, and FTTH/O fiber access are approximately 15.41 million, 114.66 million, 1.18 million, 77.43 million, 29.08 million and 27.23 million, respectively.

Based on Hong Kong’s telecommunication industry, in the year 2020, there are almost 3.93 million telephone lines, and 0.14 million facsimile lines. Nearly, 24.14 million units are public mobile subscriptions,

and the number of 2.5G/3G/4G/5G public mobile subscriptions is about 22.97 million units. Meanwhile, the number of people registered for broadband Internet access lines is approximately 2.87 million.

There are only around 0.11 million fixed-line telephones, and 1.62 million mobile telephones in Macao, which is far less than in Hong Kong. Internet users are about 0.63 million. In the year 2020, Macao's communication gross value was only about \$0.4 billion.

5. Empirical analysis

Different experts and scholars, from domestic, or abroad, have conducted various studies and research to measure the degree of informatization. The representative models which are used as measurement tools are the "informatization index" model, the Borat method, the ITU index system, and the information construction index of the International Data Corporation (IDC). Although the above indicators show flexibly for different purposes, in this paper indicators which are more reasonable and have feasible approach was used as a measurement tool.

5.1. Variables selection

The number of mobile telephone subscribers at the end of the year refers to the business outlets of telecommunications operators for account registration procedures, through the mobile telephone exchange into the network, occupying mobile telephone numbers of all types of telephone users, including all kinds of contract users, smart network prepaid users, and wireless Internet card users. The Internet broadband interface is a prerequisite for network communication specifically for computer users, so the more the number of Internet broadband access users, the more perfect the regional broadband infrastructure, the higher the level of informatization in the production and operation of regional enterprises and residents' lives, and the more convenient and fast information exchange and sharing.

Combining the characteristics of informatization development in the Greater Bay Area, considering the consistency and availability of data statistical caliber, and referring to the relevant previous studies, for the impact of informatization on the economic development of the Guangdong-Hong Kong-Macao Greater Bay Area, this paper constructs a linear regression model with the gross domestic product (GDP) as the explanatory variable, and the number of mobile telephone year-end subscribers (Phone), and Internet broadband access subscribers (I) as the explanatory variables. All the data in this paper are obtained from the statistical yearbook of each city, and the study period is between 2012 to 2020.

$$GDP_t = C + \alpha Phone_t + \beta I_t + \mu_t$$

GDP_t denotes the regional GDP in year t , $Phone_t$ represents the number of mobile telephone year-end subscribers in year t , and I_t means the number of Internet broadband access subscribers in year t . C, α, β is the parameter to be estimated, indicating the effect of random disturbance, μ_t indicates the effect of random disturbances, $\mu_t \leq 1$.

5.2. Regression analysis

In this paper, stata16 was used as a regression analysis tool for the time series data and the results are as shown in the **Table 1**.

Table 1. Regression analysis results

Source	SS	df	MS	Number of obs	=	9
Model	39263130.6	2	19631565.3	F(2, 6)	=	35.46
Residual	3321638.4	6	553606.4	Prob > F	=	0.0005
				R-squared	=	0.9220
				Adj R-squared	=	0.8960
Total	42584769	8	5323096.13	Root MSE	=	744.05

GDP	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
Phone	.2259833	.1599999	1.41	0.208	-.1655224	.6174891
I	5.76212	.8419919	6.84	0.000	3.70184	7.8224
_cons	-6459.545	4191.537	-1.54	0.174	-16715.87	3796.777

The P-value of the F-test is 0.0005, less than 0.01, indicating that the model is significant. The Adj-R² is 0.8960, showing a good fit of the model. The P-value of variable “I” in the t-test is less than 0.005, meaning that “I” is significant at the 1% level, and its correlation coefficient is 5.762, illustrating that the effect of Internet broadband access subscribers on economic growth is positive. While the variable “Phone” did not pass the significance test indicating that the ineffective effect of the number of mobile telephone year-end subscribers on economic growth.

6. Conclusions and recommendations

6.1. Conclusion

In conclusion, this paper uses economic growth data, (represented by GDP) as a dependent variable and informatization indicators (represented by the number of Internet access users and mobile telephone year-end subscribers) as independent variables of the “9+2” cities in the Guangdong-Hong Kong-Macao Greater Bay Area to analyze the results, which shows that there is a long-term stable relationship between the level of Internet development (expressed as the number of Internet broadband access users) with informatization infrastructure and economic development of this region. The study demonstrated that, informatization may promote the economic development in Guangdong-Hong Kong-Macao Greater Bay Area.

6.2. Recommendations

Based on the research, and the current situation of informatization and economic development pattern in the Guangdong-Hong Kong-Macao Greater Bay Area, this paper proposes the following policy as a recommendation.

First, optimizing and enhancing the construction of information infrastructure is still an important factor in the informatization and economic development. In the context of building the Guangdong-Hong Kong-Macao Greater Bay Area, information infrastructure and the integrated use of information technology will usher the opportunity for its development. Informatization will accelerate the new innovation and interconnection of the Greater Bay Area, and promote the economic development of that area.

Additionally, increase the investment plan for the new-generation information infrastructure on Internet broadband interconnection, the construction of IPv6, Internet of Things (IoT), and smart city clusters in the Greater Bay Area, as well as facilitate the localization of IPv6 in Hong Kong and Macao will greatly help in the economic development.

Moreover, expanding the bandwidth at international Internet entrances and exits, use this opportunity

to further enhance the traffic capacity, and network speed across the board, promote the construction of wireless network broadband in city clusters, and achieve full coverage of free high-speed wireless networks in tourist attraction areas, office areas, and transportation hubs in the Greater Bay Area. Realizing all fiber optic access to urban fixed Internet broadband, and improving the construction of ultra-high-definition interactive digital home networks.

Lastly, it goes back to the groundwork for the development of a new digital economy. This requires the establishment of a unified standard for cloud computing, opening data ports, and building an interoperable information infrastructure application platform. They vigorously carry out work related to smart networks, smart transportation, smart municipalities, and smart medical care, jointly promote the appropriate diversification of the economic structure of smart cities in the Greater Bay Area, and develop diversified platforms using their advantages.

7. Shortcomings and expectations

To prevent the problem of multicollinearity, and to consider the consistency of statistical caliber and data availability, this paper constructs a relatively simple model, which may not be comprehensive to portrayal the overall informatization. In addition, this paper is mainly focused on the city dimension for empirical research, therefore, the follow-up research can be conducted based on various types of enterprises and residents related to informatization on the micro-level socio-economic impact of the measurement effect.

The Guangdong-Hong Kong-Macao Greater Bay Area is a new policy adopted by the Chinese government in the recent years to promote economic development. The institutions, professional services, trade environment, and technological innovation in this area are creatively significant to China. Besides, the project is bound to radiate and influence other regions in China as well. Informatization will become a new engine to drive the development of cities around that area, ultimately promoting the coordination and sustainable development of the Greater Bay Area's economy, culture, and ecological environment, which may play a vital role in facilitating China's economic in the future.

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Disclosure statement

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Author contributions

Y. H. analyzed the data, and wrote the paper. Haohong Zhang collected the data, and translated the paper.

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