

Construction Path and Simulation Deduction of Cross-border Financial Cooperation Mechanism in Guangdong-Hong Kong-Macao Greater Bay Area

-- Based on System Dynamics Model

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Abstract. The financial environment of the Guangdong-Hong Kong-Macao Greater Bay Area involves many aspects such as politics and economy. It is a complex dynamic process. In order to explore the impact of different influencing factors on the financial environment of the Guangdong-Hong Kong-Macao Greater Bay Area, this paper starts from three subsystems including economic growth, financial development, and government behavior. Carrying out simulation, through empirical analysis, we put forward policy recommendations to promote the financial environment of the Greater Bay Area.

Keywords: System Dynamics; Financial Environment; Guangdong-Hong Kong-Macao Greater Bay Area.

1. Introduction

The Guangdong-Hong Kong-Macao Greater Bay Area consists of nine cities in the Pearl River Delta, including Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou, and Zhaoqing, as well as the two special administrative regions of Hong Kong and Macau. This area covers an area of 56,098 square kilometers and has a total population of 86.17 million. This area is currently one of the areas with the highest degree of openness and the strongest economic vitality in China. In 2020, the GDP of the Guangdong-Hong Kong-Macao Greater Bay Area has reached US\$1,668.86 billion, accounting for about 12% of the country's total economic output. The third largest economic bay area in the world with the New York Bay Area. With the rapid economic development, the Guangdong-Hong Kong-Macao Greater Bay Area is also forming an attractive financial market. In the 29th Global Financial Centers Index, Hong Kong ranks fourth, Shenzhen ranks eighth, and Guangzhou ranks 22nd. In total, three major financial centers are located in the Guangdong-Hong Kong-Macao Greater Bay Area. The agglomeration of the three major financial centers also gives the Guangdong-Hong Kong-Macao Greater Bay Area a unique advantage in the development of the financial industry. Therefore, the government's promotion of financial cooperation between Guangdong, Hong Kong and Macao has become the government's construction of a high-quality, high-level world-class bay area important part.

2. Literature Review

The financial industry in the Guangdong-Hong Kong-Macao Greater Bay Area is a complex system covering various factors such as politics, economy and financial foundation. Changes in various factors in the financial industry may have an impact on other factors and even the financial system as a whole. The complex and diverse action mechanisms and feedback relationships among various elements of the financial industry make it difficult for conventional theoretical analysis and econometric models to explain the logical relationship clearly. Therefore, in order to construct an effective path to promote the financial development of the Guangdong-Hong Kong-Macao Greater Bay Area, we need to conduct an overall dynamic analysis. Based on this, based on the perspective of system dynamics, the author constructs a simulation model of the financial industry ecological

environment system in the Guangdong-Hong Kong-Macao Greater Bay Area, finds out the main factors affecting the financial industry in the Guangdong-Hong Kong-Macao Greater Bay Area, and proposes an optimization plan, which will help the government to build a high level of economic development. Provide a basis for the high-quality and high-level financial environment of the Bay Area.

System Dynamics (SD) was founded in 1956 by Forrester, an MIT scholar. It is based on system theory, decision theory, etc. This theory can carry out hierarchical and structured analysis of the research object, analyze the function relationship between system elements, and use the simulation experiment platform to simulate, and finally realize the internal function of the system. Mechanism visualization. System dynamics was first applied to the industrial field. However, with the growth of the world economy, the globalization of the economy and the decreasing natural resources, in the early 1970s, foreign scholars began to try to use system dynamics to solve the sustainable development of composite systems. problem. In China, system dynamics has been widely used in forecasting research on system changes of economy, society, environment, resources and sustainable development. System dynamics has been widely used in the field of financial research. For example, Zhang Qingjun established a system dynamics model, which simulated financing constraints, credit mismatches and investment fluctuations. Scholars conducted dynamic simulation and prediction of the model by adjusting the parameter values of monitoring variables. Policy recommendations are made to eliminate or reduce credit mismatches. Tong Xin, Pang Jiaqi, Dong Zhi and other three people based on the system dynamics model, by setting different scenarios such as monetary policy and international agreement arrangements, scholars analyzed the economic variables of each economy on the financial crisis rescue under the situation of implementing different financial rescue policies. The policy effects have been studied in depth. However, in the area of regional financial development, domestic scholars still seldom use the system dynamics model to study the coordinated development of regional finance.

3. Simulation

The system dynamics model takes the existing system as the premise, and establishes a dynamic simulation model according to historical data, practical experience and the internal mechanism relationship of the system. Indirect relationship, the model forms a dynamic analysis system with multiple positive and negative feedback loops, and then obtains the variable equation of each factor, and finally simulates its dynamic change trend through computer simulation, so that the model makes a policy judgment.

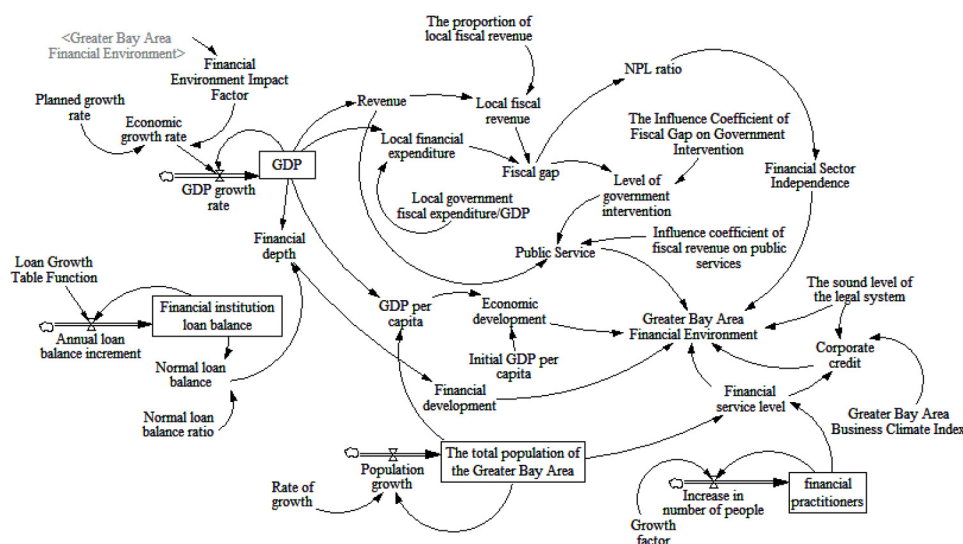


Figure 1. Schematic of System Dynamics

Using the modeling principles of system dynamics, the author takes the Guangdong-Hong Kong-Macao Greater Bay Area as the spatial boundary and 2005-2025 as the time boundary, and then combines the actual development of the Greater Bay Area to establish a sustainable development system model. Through SD software, the author closely links the three subsystems of economic development, financial development, and government behavior in the Greater Bay Area. These subsystems influence and restrict each other, and there is a causal feedback relationship with each other. The relationship between them is quantified., and build a system model flow chart. In the whole model, 4 level variables, 4 rate variables and 30 auxiliary variables are selected to simulate the financial environment of the Guangdong-Hong Kong-Macao Greater Bay Area.

The specific system model structure flow chart is shown in Figure 1.

4. System Analysis of System Dynamics Model

4.1 Economi Growth Subsystem

The financial ecological environment is closely related to the degree of economic development. Economic growth can support the development of the financial industry to a large extent. Economic growth provides financial support for the financial industry, and economic growth is conducive to creating a good financial ecological environment. The most intuitive indicator to measure the economic development of a region is the per capita GDP. The development of the financial industry will bring a new round of investment, and investment will become a new economic growth point. Therefore, this model also takes into account the impact of the financial ecological environment on the economic growth rate.

4.2 Financial Development Subsystem

Financial depth is the main indicator to measure the degree of financial development of a country or region. This paper uses the ratio of the normal loan balance of financial institutions divided by GDP to measure the financial depth of the Guangdong-Hong Kong-Macao Greater Bay Area. The higher the ratio, the stronger the capital agglomeration capacity of the region. There are many indicators to measure the level of financial services. Considering the availability of data and the operability of the model, this paper selects the number of financial practitioners per 10,000 people as the main indicator.

4.3 Government Behavior Subsystem

The government behavior subsystem is mainly composed of public services, the independence of the financial sector, and the sound level of the legal system. This subsystem mainly studies the impact of changes in government revenue on the financial ecological environment under the condition of economic development. According to existing research, the stronger the government's fiscal capacity, the stronger its ability to regulate economic growth and financial development. Government revenue can ensure the stability of economic and financial policies, which can effectively prevent potential financial risks. The continuous improvement of the sound level of the legal system can reduce the untrustworthy behavior of related companies, improve investment confidence, and create a good financial ecological environment.

5. Model Validity Check

Based on the availability, validity and completeness of data sources, the author selects the annual data of 11 cities in the Guangdong-Hong Kong-Macao Greater Bay Area from 2005 to 2015 as an empirical study. Since the three places of Guangdong, Hong Kong and Macao have their own currency systems, for the convenience of research, this paper converts the currencies of the three places into US dollars according to the exchange rate at the end of the year. Among them, the data for the nine cities in the Pearl River Delta are mainly from the "Guangdong Statistical Yearbook" and

the statistical yearbooks of various cities. The data for Hong Kong and Macau come from the "Hong Kong Statistical Yearbook" and "Macao Statistical Yearbook", as well as the Hong Kong Special Administrative Region Government Statistics Department and the Macao Special Administrative Region Government. Website of the Statistics and Census Service and the World Bank database. By substituting the relevant statistical data from 2005 to 2015 into the model, the author has repeatedly revised, adjusted and tested. Finally, the author compares some of the simulation results with the actual historical data. The author sets the test index as the GDP of the Guangdong-Hong Kong-Macao Greater Bay Area, and the output results are shown in Table 1. The error rate = (simulated value - actual value) / actual value $\times$ 100%. It is generally believed that the simulation error of system dynamics is kept within 10%, the simulation results are basically consistent with the actual values. This shows that the entire model can more accurately reflect the financial ecological environment of the Guangdong-Hong Kong-Macao Greater Bay Area. Therefore, the author's analysis and prediction based on this are all well-founded.

Table 1. Relative error table of simulation results

Year	GDP		
	Analog digital	Actual numbers	Relative error
2005	4222.29	4222.29	0.00%
2006	4897.86	4889.22	0.18%
2007	5681.51	5862.94	-3.09%
2008	6817.82	6837.73	-0.29%
2009	7635.95	7144.20	6.88%
2010	8552.27	8401.60	1.79%

6. Policy Simulation

The system dynamics model can not only predict the development trend of the main variables, but also by modifying the relevant parameters, the author can set changes in various virtual scenarios. Our decisions are scientifically informed. This paper sets up three schemes (as shown in Table 2) to compare the dynamic changes of the financial environment in the Guangdong-Hong Kong-Macao Greater Bay Area under different schemes.

Table 2. Tables produced by comparing different schemes with each other

	The sound level of the legal	The sound level of the legal system Business climate index of the Guangdong-Hong Kong-Macao Greater Bay	Area Normal loan balance ratio
Original model	30	50	0.9
Option 1	60	50	0.9
Option 2	30	80	0.9
Option 3	30	50	0.98

According to the operation of the above three schemes, the scheme has the most obvious impact on the financial ecological environment, namely improving the legal environment, followed by the third and second schemes, indicating that the government actively optimizes the business environment of enterprises and can also benefit from improving the financial ecological environment. However, simply increasing the normal loan ratio has little effect. This kind of plan needs to be combined with other measures to improve the financial ecological environment.

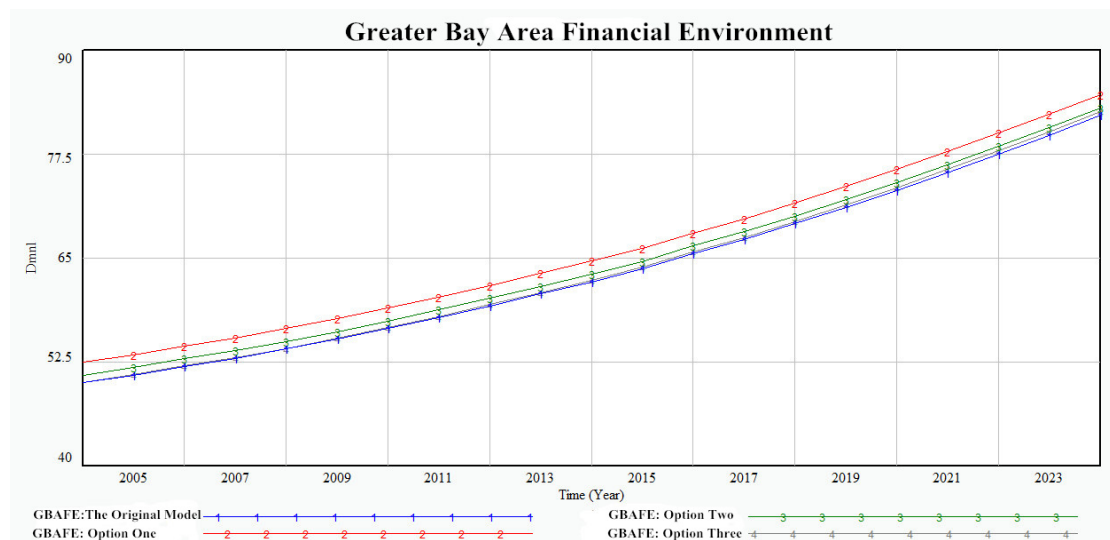


Figure 2. Scheme simulation result diagram

7. Conclusion

Through the analysis of the model simulation results above, we can draw the following three conclusions: First, the legal environment and business environment have a relatively obvious impact on the financial ecological environment; The driving effect still needs to be improved. In view of the above problems, combined with the current actual environment, the author of this paper makes the following conclusions and puts forward relevant suggestions:

7.1 The Government Should Improve the Legal System of the Financial Industry and Improve the Relevant Legal System

This can create a good ecological environment for financial cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area. A sound financial ecological environment needs to be maintained by a sound financial legal system. At present, from the perspective of financial cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area, the legal system in the financial industry is still lacking. In terms of financial entities, imperfect legal systems will hinder the healthy development of financial entities to a certain extent; in terms of financial business, the lack of legal systems will not be able to effectively restrain illegal transactions, which will affect the financial sector in the Guangdong-Hong Kong-Macao Greater Bay Area. Ecology; in financial supervision, the dislocation and loopholes in the legal system will affect the performance of supervision. Therefore, in order to establish a sound financial legal system that meets the requirements of the market economy, the author of this article proposes the following three suggestions: First, based on the concept of modern market economy legislation, government departments should improve the financial laws of the Guangdong-Hong Kong-Macao Greater Bay Area. Starting from the legal system of financial market access, from the perspective of transactions, government departments should formulate and improve financial market rules. In addition, government departments should also improve the legal system with financial property rights as the core, so that the social application order can be emphasized to regulate the development of financial business. The second point is that financial regulatory authorities should improve the efficiency of financial law enforcement to promote the clarity of rights and responsibilities. Relevant government departments should establish a power division and accountability system to ensure financial cooperation between the three places, so as to avoid the fragmentation of the cooperation model between Guangdong, Hong Kong and Macao. Third, government departments should increase public participation in the construction of the rule of law. The "Framework Agreement for Deepening Guangdong-Hong Kong-Macao Cooperation to Promote the Construction of the Greater Bay Area" emphasizes the relevant provisions of "expanding the degree of public participation". The construction of the financial rule of law in the Guangdong-Hong

Kong-Macao Greater Bay Area should involve the participation of the public. Only by improving the status of public subjectivity in the construction of the rule of law can we promote the public's sense of identity with the rule of law.

7.2 Government Departments Should Gradually Optimize the Business Environment for the Financial Industry in the Guangdong-Hong Kong-Macao Greater Bay Area

Focusing on the core of the legalization of the business environment, local governments should realize the liberalization and facilitation of investment in the Guangdong-Hong Kong-Macao Greater Bay Area. A good business environment is an important manifestation of economic soft power. There are political factors, legal factors, and social factors that affect the financial industry. These factors directly or indirectly affect the level of financial services in the region. For the government to create a good business environment that meets the requirements for the development of financial cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area.

7.2.1 The Government's Policies Must be Changed to an Open and Innovative Policy Direction

As the financial industry is a capital-intensive industry, government policy adjustments and close supervision have a greater impact on its growth, while the traditional and inherent local policies of Guangdong, Hong Kong and Macao have inhibited the operating vitality of financial enterprises to a certain extent. On the basis of fully considering the differences in the systems of the three places, relevant local governments can establish mechanisms such as intra-regional tariff reciprocity and currency exchange through administrative agreements to reduce tariff and currency barriers to financial cooperation.

7.2.2 The Financial Supervision Department Should Establish a Set of Effective, Fair, Open and Transparent Financial Regulations and Supervision Procedures

Financial regulatory authorities should fully consider the differences in the legal system and taxation between Guangdong, Hong Kong and Macau to promote the diversification of dispute resolution mechanisms. Guangdong, Hong Kong and Macau can sign judicial assistance to resolve legal disputes, which can provide a sound and sound legal protection for financial transaction activities in the Greater Bay Area.

7.2.3 The Whole Society Should Attach Importance to the Innovative Decision-Making Ability of Financial Entrepreneurs to Create an Atmosphere of Reform and Innovation in the Financial Industry

The governments of Guangdong, Hong Kong and Macao should encourage innovation in financial technology and improve the relevant incentive systems to create a dynamic financial business environment.

7.3 The Government Should Steadily Improve the Level of Financial Public Services in the Guangdong-Hong Kong-Macao Greater Bay Area and Improve Relevant Supporting Measures

Financial public service is a public resource investment based on the improvement of financial infrastructure construction and based on the cooperation of the three governments. With the improvement of the level of financial public services, the stability of the financial system can also be gradually enhanced, thus escorting the high-quality economic development of the Greater Bay Area. In addition, in the post-COVID-19 era, the financial industry can flexibly use a variety of policy tools to hedge against the adverse effects of the COVID-19 pandemic. The government should improve the level of financial public services in the Greater Bay Area. This paper proposes:

7.3.1 Local Governments Establish a Financial Information Resource Sharing Platform in the Guangdong-Hong Kong-Macao Greater Bay Area

Restricted by practical conditions and systems, the financial information resource sharing platform between Guangdong, Hong Kong and Macao has not yet been established. Through the government's establishment of a financial information resource sharing platform in the Guangdong-Hong Kong-Macao Greater Bay Area, this will help the free flow of financial elements between the three places, and to a certain extent, reduce the obstacles caused by the differences in the systems of the three places, and will help the development of the Greater Bay Area. Financial cooperation provides better conditions for development.

7.3.2 Local Governments Should Improve the Level of Information Interconnection based on Internet Infrastructure

Based on the requirements of financial cooperation in the era of big data, in order to ensure the efficient and convenient operation of the financial cooperation and sharing mechanism in the Greater Bay Area, the government can actively promote the application of electronic signature mutual authentication certificates in the financial field to promote the inter-regional electronic payment system in the Greater Bay Area. Connectivity will break down the barriers between Guangdong, Hong Kong and Macau due to currency differences. In addition, government departments can also use the big data platform to improve and guarantee the growth of cross-border financial and insurance markets such as "Bond Connect" and "Shenzhen-Hong Kong Stock Connect".

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