An Empirical Study on Development Countermeasures of Wuhan Urban Circle Based on the Double-S Model

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Abstract   With the rapid evolution of technology and international circumstance, regional economy development steps into a new stage. In the perspective of Double-S Model, this paper conducts an empirical study on the development countermeasures of Wuhan urban circle through comparison with Yangtze River Delta, in order to explore the development trend of economic disparity. Besides, Logistic curve and multiple regressions are introduced into the model to estimate the relationship between economic growth and key influencing factors in regional economic development. Based on the results, some proposals are put forward for Wuhan urban circle, such as keeping stable investments in infrastructural facility construction, absorbing capital from surrounding regions, etc.
Key words   Wuhan urban circle; Development countermeasures; Regional economic disparity; Double-s model; Logistic growth curve

1 Introduction

Wuhan Urban Circle has become one of the largest urban circles in central and western regions of China and its total economic output accounts for more than half of that in Hubei Province. Great efforts need to be taken to make Wuhan Urban Circle become China's "Fourth pole" in Economic Growth and also a major growth point in central China. On one hand, among the four major city clusters in the central China, Wuhan Urban Circle has a relatively high rate of urbanization, as well as urban density index, extent of urban agglomeration development, and the first ranking indicators such as per capita GDP, density of population and economy. Furthermore, it boasts a special location for transport, industry and the unique advantages of science and education in Central China; On the other hand, Wuhan Urban Circle also has defects in some aspects such as resource utilization rate, technological innovation investment, industrial structure and infrastructure construction which lead to a great gap behind other regional economies.

Since the 1990s, the driving functions of regional economy featuring metropolises as the major growth pole become increasingly significant. Among the ten major economic regions in China, Yangtze River Delta, which is the biggest economic region with the most acknowledged development potential, gradually turns into one of the most powerful engine of China's economy. Because Wuhan Urban Circle and Yangtze River Delta both locate in the Yangtze valley, they share some similarities in resource, transportation and industries. Therefore we can conclude certain useful countermeasure via detailed contrast between the two regional economies.

So far, the studies on regional economy mostly focused on technological, ecological, financial, cultural, especially political aspects. J.G.Williamson (1965) deemed regional economic disparity would increase first and then decrease when those less developed regions advance forward, which means the regional gap would change in an inverted-U curve, while it was controversial for a long time [1]. However, in China Liu Jianguo (2010) pointed out that since the reform and opening up policy, the east coastal areas took advantage of policy and capital to grab a precious development opportunity while the other regional economies grew in a relatively slow speed. Thus he holds the point that policy is the main reason of regional disparity [2]. Nevertheless, WangHu(2007) conducted an empirical research to prove FDI impacted per capita GDP largely, so that he argued the difference in FDI led to regional economies, thus less developed regions need to make more efforts to attract more FDI [3]. Li Tinghui(2010) emphasized the significance of regional innovation and established an evaluation index system to define the regional innovation capacity. The studies showed that the government's effort in supporting scientific and technological innovation and the region's industrial structure greatly affects the regional development [4]. For Wuhan Urban Circle was established in the year of 2007, when there are limited researches aimed at economic development countermeasure through comparing the disparity between different economic regions. In this paper, the inverted-U theory was updated into a new perspective---double-S model. And it was first time to utilize the double-S model to analyze the economic disparity Wuhan Urban Circle and Yangtze River Delta based on which rationalization

proposals are given.

2 Sampling and Modeling

2.1 Sample selection

Wuhan Urban Circle located at the east of Hubei Province and covering an area of 57,800 square kilometers, consists of 9 cities, Wuhan, Huangshi, Ezhou, Xiaogan, Huanggang, Xianning, Xiantao, Qianjiang and Tianmen. It has a population of 3071.7 million people, GDP 399.98 billion Yuan, accounting for 31.3% of Hubei Province and 1.3% of the whole country.

We took Yangtze River Delta, which is a relatively mature economic region featured by rational industrial structure, for comparison. And we selected the data of two regions from 2000 to 2008 to analyze the regional disparity by using the following indicators: per capita GDP, fixed asset investment (FAI), disposable income of urban residents, the proportion of tertiary industry, the actual foreign direct investment (FDI).

Table 1 Key Economic Indicators of Wuhan Urban Circle and Yangtze River Delta

Year	Per Capita GDP(Yuan)		Fixed Asset Investment(Thousand Yuan)		Disposable Income of Urban Residents(Yuan)		Proportion of Tertiary Industry		Actual Foreign Direct Investment (billion US dollars)	
	Yangtze River Delta	Wuhan Urban Circle	Yangtze River Delta	Wuhan Urban Circle	Yangtze River Delta	Wuhan Urban Circle	Yangtze River Delta	Wuhan Urban Circle	Yangtze River Delta	Wuhan Urban Circle
2000	22406	5305	29634702	585	6477	5121	38.5%	39.5%	8304	11
2001	24632	6040	38196917	649	7773	5347	39.1%	41.2%	9370	13
2002	25637	7341	45203579	721	9327	6256	39.5%	42.2%	180634	18
2003	30334	8845	73182736	946	11193	7321	40.1%	41.3%	20013	26
2004	33871	10657	91853866	1242	13431	8022	40.1%	42.5%	18306	21
2005	40175	12840	106737127	1631	16196	8784	40.7%	42.3%	20431	26
2006	46858	15470	120744907	2143	19435	9802	41.9%	43.8%	23075	31
2007	57729	18639	137594803	2814	23322	11486	41.7%	43.9%	25635	37
2008	70944	24698	154244974	3708	27987	13153	41.1%	43.6%	28988	42

2.2 Logistic curve

In mid-19th century, biological mathematician Verhulst proposed Logistic model [5]. Numerous studies showed that many natural, economic problems can be described by it. Furthermore it is also an excellent forecasting and decision-making tool in many fields. We utilized Logistics curve to fit and predict regional economic growth, and establish the following equation which showcases a "slow - fast - slow" growth process of regional economy.

$$S = S(t) = \frac{K}{1 + e^{-(a+bt)}} \tag{1}$$

2.3 Double-S curve model

In contrast, gaps exist in various aspects between Wuhan Urban Circle and the Yangtze River Delta in economic development, under the inverted U theory, regional economic disparities will first rise and then decrease and finally both regions achieve the progressive state of convergence.

At the moment, the two regional economic conditions are at high speed of growth. Inflection point is difficult to show in the short period under the core concept of inverted-U theory. We introduced the double-S curve model in order to fully reflect and illustrate the reasons for the gap between two regions, and explore the mechanisms and trend, thus to guide the coordinated development among regions. Through quantitative analysis method, the regional changes were explored in the general law; the fuzzy inverted-U curve was made into a clear specific equation. Through regression analyses, we got two S-shaped curves, and then on this basis, conducted data analysis, to grasp the trend of the economic gap and features between the two regions. That economic growth is about a function of time, with S = f (t) that the growth function between the two regions, respectively S1, S2. Then the absolute gap between the two regions, equation L, can be obtained

$$L = S_1 - S_2 = V_1(t) - V_2(t) \tag{2}$$

L-equation is an inverted-U shaped curve; we can clearly understand the whole process of the gap

from expansion to narrow. As the study area was in the early growth, we can predict the specific time point inflection point occurs. That is to say the maximum point of L-curve is the zero marginal rate point of L. and it is also the inflection point where the disparity begins to decrease rather than increase.

3 Results and Discussion
3.1 Curve estimation
With the samples of basic economic index in the Wuhan Urban Circle and the Yangtze River Delta, we use SPSS13.0 for Windows to search the fitting-curve of logistic model, so that we can get the coefficients, significance level and R^2 as follows:

Table 2   Results of Logistic Curve Estimation

Region	Model Summary			Parameter Estimates	
	R Square	F	Sig.	Constant	b
Yangtze River Delta	0.974	264.523	0.000***	5.65E-5	0.866
Wuhan Urban Circle	0.996	1755.154	0.000***	0.00	0.827

Denote: *** means Significance <0.01

The significance is far smaller than 0.01, indicating the coefficients are definitely nonzero. The R^2 are 0.974 and 0.996 respectively, so independent variables can explain the dependent variables quite well. Finally, the expected regression equations are as follows:

$$S_1 = \frac{K}{|5.65E|5|0.866t|}; \quad S_2 = \frac{K}{1+e^{|0.827t|}} \tag{3}$$

We calculate the derivative of equation 1 and get the equation for the increase rate of logistic curve. Then we utilize this equation to depict the economic growth rate, the increase rate is as follows: slow-fast-slow, presenting a unimodal curve.

$$V(t) = \frac{ds}{dt} = \frac{-kbe^{-a-bt}}{(1+e^{-a-bt})^2} \tag{4}$$

Then we calculate the derivative of the increase rate equation and set this value as 0, we can get the break point, which is the fastigium of economic development

$$\frac{dV}{dt} = \frac{Kb^2 e^{-a-bt}(e^{-a-bt}-1)}{(1+e^{-a-bt})^3} \tag{5}$$

Similarly, we derive when $t = \left|\frac{a}{b}\right|$, regional economic development gets a fastigium, which is the most rapidly developing phase.
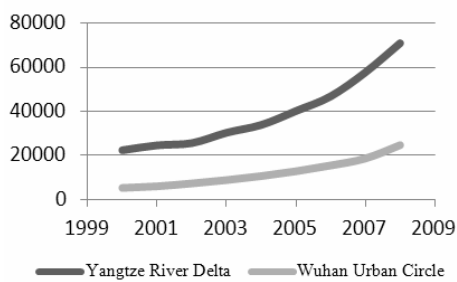
3.2 Change trends of regional economic disparity

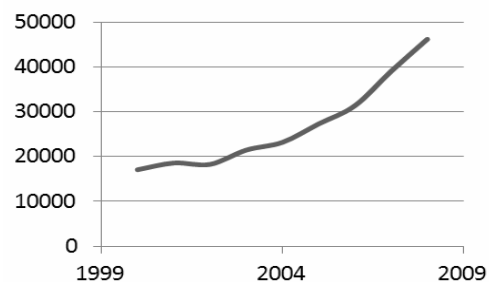**Figure 1   Two Region's Per Capita GDP**

Figure 2   Regional Economic Disparity

In this period, great economic development parities exist in these two regions and we can observe from statistics showing the disparity is still about to enlarge. In order to explore how the disparity will evolve, we use the regression model to stimulate the real situation and then make our predictions. According to double-S theory, economic disparity become the two regions will follow an inverted-U slope, which increases at first then decreases. What's more, after we observe the increase rate in the two regions, we find out that they share a similar law: the rates first increase and then decreases and the later-developed area will enjoy a first lower then faster increase rate than the earlier-developed area.

This is mainly due to the fact that diminishing return, technology, system, and management are likely to give some advantages to the later-developed areas, so that they may catch up with the earlier-developed areas.

To study the exact time for the break point, we further explore our functions.

Transform the equation: $L = (S_1 - S_2)' = V_1(t) - V_2(t)$ to equations below,

$$\frac{d_L}{dt} = (S_1 - S_2)' = \left(\frac{K}{1 + e^{-5.65E-5-0.866t}} - \frac{K}{1 + e^{-0.827t}} \right)' \qquad (6)$$

And set $dL/dt = 0$, we will achieve the point when the disparity between the two regions is the largest and begins to decrease. According to our model and our statistic, we find this point will occur during 2020 and 2022. Regional economic development is influenced by many factors such as resource, environment, and politics. Based on what we have got, Wuhan Urban Circle can make use of its advantages and the governmental policies to make the break point arrive earlier.

3.3 Influencing factors

Based on the regression curve and the trend of disparity, we need to further explore the factors which influence the economic development. Via analyzing how investment on fixed assets, disposable income of citizens, the weight of the service sector, and the actual foreign direct investment affect the GDP per capita and the significance level of the coefficients, we utilize SPSS13.0 for windows to conduct a multiple regression of variables and give detailed conclusion of the solutions to the problems in Wuhan economic development.

Table 3   The Results of Multiple Regression

Indicator	Coefficient	Sig.	t	Tolerance	VIF
Constant	497.256	0.035**	2.720	-	-
FAI	0.871	0.000***	19.68	0.239	4.185
Actual FDI	0.143	0.018**	3.231	0.239	4.185

Denote: ***means Sig.<0.01; **means Sig.<0.05

In a quite fitting level, we derive the most related factors by using the multi-factor regression model, in which FAI is the most significant indicator compacting general economic growth in a well significant level (Sig. <0.01) while the Actual FDI ranks the next; all other factors have problems of linearity or insignificance which cannot explain the target function.

4 Countermeasures for the Development of Wuhan Urban Circle

4.1 To keep stable investments in infrastructural facility construction

Investment is one of the most important factors of GDP growth and for stability of the whole economy. Not only in real estate investment but also the construction of infrastructural facilities will pull up the macro-economy to a great extent. Meanwhile, it can also serve as a vigorous foundation of economic development. Moreover, these investments can keep the regional employment rate and maintain social stability, provide inputs for reproduction to keep the sustainability of the economy. Furthermore it also can realize the region's GDP multiplier effects, and all these will promote the rocketing for regional innovations by providing protect for resources and material.

4.2 To absorb capital from surrounding region

Wuhan Urban Circle is between two relatively developed zones: Yangtze River Delta region and Pearl River Delta. On one hand the geographical advantage can promote the regional inter-linkage development; on the other hand, Wuhan Urban Circle can absorb regnant capital to inject more vigor in with both advantages in advanced technology, management and experience of the other two regions.

4.3 To build an attractive environment for FDI

Wuhan Urban Circle needs to improve the preferential policy for FDI and build a circumstance featuring low product cost, well-performing mechanism and talent advantage in an atmosphere of innovation. In this way Wuhan Urban Circle can make full use of its own superiority to improve industrial structure and technological level

4.4 To breakthrough by leading industry to explore Wuhan Pattern

Steel, automobile and shipbuilding are traditional industries of Wuhan urban circle, while the optical information and communications developed vigorously after new policies concerning important high-tech industries are proposed. As Wuhan East Lake High-Tech Development Zone becomes the

second Chinese National High-Tech Development Zone, policies and environments both provide a good foundation to explore the special development patterns for Wuhan. Focusing on technology and resources both at home and abroad for local economy, the regional innovation system is expected to be built in no time. By utilizing the unique ascendency in some leading industries and increasing the budget on R & D personnel, R & D investment and investment in design capabilities such as create favorable environment and infrastructure for innovation, Wuhan Urban Circle is supposed to approach a new pattern marked with its own name.

5 Conclusions

Based on the empirical research of current statistic, we find out that although regional economy in our country enjoys a rapid development, it still develops in extensive growth mode and is largely stimulated by investments. According to double-S theory, with the increasing cost of human resource, capital and land in comparative developed area, the marginal return of production will decrease, R&D cost will increase, and its advantages will decrease. In contrast, later-developed area can attract more investors, technology and experience to realize its self-development;

Economic factors will all face a situation featuring diminishing marginal utility. It is the same with investment or capital. To look forward, regional innovation has to be attached greater significance than simply investment or exporting. So the dominated developing way needs to be reformed. As regional innovation is a kind of management which is associated with local resources and focuses on innovative thought, organization and management, the purpose is to promote the mobility, renewal and transformation of the region's advanced production technology and resources. In prediction, studies in this direction will become more vigorous and practical in the time to come.

Wuhan Urban Circle has rich resources, excellent geographical location, a good industrial base and unique scientific and educational strength, which can be significant advantages for this region to narrow the gaps between other relatively developed economies, and finally realize its goal in "Rise of Central China".

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