A Damping Measurement Model of China's Urban-Rural Digital Gap to the Urbanization

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Abstract. Urbanization is an irresistible trend in the IT times and an important process in the integral development of urban and rural information society. But information revolution also creates digital gap between urban and rural areas, an increasingly obstacle to China's urbanization. A damping measurement model of China's urban-rural digital gap to the urbanization is built in this paper. Some theory analysis and two hypothesis are given, and research results are put forward by Pearson correlation analysis.

Introduction

Urbanization is an irresistible trend in the human history and an important process in the integral development of urban and rural economy. Today every country across the world are pushing forward urbanization with economic development and technology advancement brought about by information revolution. While at the same time information revolution also creates digital gap between urban and rural areas, an increasingly obstacle to urbanization.

Damping Factor is a term used in tribology, indicating the innate capacity of the consumption power in an object which can produce Damp. The magnitude of damp can be expressed by the multiplication of damping factor and the dynamic of the object. Economist Romer has put forward the notion of damping theory in economic growth in order to examine the damp power that resource limitation has on economic growth. Some later scholars introduced this notion to the study of urbanization, focusing on the damping power that resource limitation has on economic growth. Since the urban-rural digital gap produce damping power in urbanization in China, then to which extent does this gap damps the dynamic of urbanization is of great significance to promote urbanization in China by means which can limit the digital gap.

Literature Review

Currently foreign and domestic study in this field focus mainly on measuring the damping power of resource constraint to urbanization and constructing damping factor measure model with econometric model. The basis of these studies is just Romer's Damp Theory. For example, Liu(2009) constructed a damping factor measure model to examine the relationship between resource constraint and urbanization, using the auto-regression distributed Lag[1]. Black(2012) constructed the damping factor measure model to examine relationship between land and water resource constraint and economic growth with the Multiple Linear Regression model, finding that there is positive relationship between water and land resource shortage and damping factor. In recent years, as digital gap becomes wider in urban and rural development, some scholars begin to explore the outward manifestation of the relationship between digital gap and urbanization. But the study of this damping factor is rare[2]. For example, Chatterjee（2010）believe that the negative influence urban-rural digital gap has on urbanization is indicated in its hindering informatization in rural enterprises and upgrading of industrial restructuring[3]. Kim and Lee（2010）think that the digital gap hampers rural residents' ability to communicate with information technology impeding the modernization of rural cultural life[4]. Bruckner(2012)[5] and Henderson(2015)[6] hold the idea

that the damping factor consists in its preventing rural residents from immigrating to cities and its inability to reduce nonfarm payrolls.

parameter estimation method requires presetting the functional relation among variables which is not plausible to figure out the negative influence that urban-rural digital gap has on urbanization, a complicated problem. In practice this usually means a preset error which leads to inaccuracy of the result of damping factor measurement . In this dissertation I will use the concept of damping factor in viscous tribology for the first time to construct damping factor measurement model in the digital gap and urbanization relationship in China,   using non-parametric estimation.

Measurement Model Construction

Thinking of Model Construction

The damping factor is measured indirectly through examining the dynamic power of an object and its damping power. According to the definition of viscous tribology, it's possible to see whether a system belongs to damping system based on three features. Firstly, in a damping system there is moving object which moves with passing of time; secondly, there is viscous object which has friction with the moving object therefore hinders the movement; thirdly, the speed of moving object fluctuates with the passing of time. The damping factor in China's digital gap-urbanization relationship matches those features.

(1)If measuring the level of urbanization by the proportion that urban residents take up in total population, then China's urbanization level increases year by year from 26.41% in 1990 to 56.3% in 2014, therefore the process of urbanization in China can be regarded as a moving object.

(2)The urban-rural digital gap impedes the industrial upgrading and restructuring, modernization of rural cultural life and increase in non-farm payrolls, thus stand in the way of urbanization. So urban-rural digital gap can be seen as a viscous object.

(3) If the speed of urbanization is expressed by the disparity in the urbanization level between current year and the previous year, the speed of moving object(urbanization) presents fluctuation.

According to analysis above, the damping power urban-rural digital gap in China has on its urbanization can be regarded as a viscous tribology damping system. In this essay I will take the following steps to construct a model: first, I will use the analyzing method of correlation and Granger causality analysis to explore the dynamic power in China's urbanization process. Then I will calculate the damping factor with the formula: "the damping factor urban-rural digital gap in China has on its urbanization=its damping power/dynamic power in urbanization". The damping factor thus get symbolizes the innate capacity of "object"(urban-rural digital gap) in damping the dynamics of the subject(urbanization).

Theory Analysis and Research Hypothesis

After analyzing the dynamic theory, I put forward two hypothesis in this essay:

Hypothesis 1   Economic development, technological advancement and Chinese urbanization are highly related in a positive way. So, with the stable growth of economy and constant progress in technology, urbanization in China also advances.

Hypothesis 2   The urbanization process in China is attributable to economic and technological development. Hypothesis 1 shows that economic development and technological advancement are the motive powers in promoting China's urbanization. Hypothesis 2 further proves these two factors are origins of the dynamic power in urbanization process. Thus the two hypothesis logically confirms that economic and technological advancement are the original powers in China.

Testifying the Research Hypothesis

To avoid spurious regression in the correlation and Granger analysis, we need to test the co-integration and stability of the time series for U. After testing their stability through ADF method in Eviews7.1 software we get the result as seen in Table 1.

Table1　Testifying Result of Time Series Stability

| | （C,T,n） | ADF | Critical value | | | （C,T,K） | ADF | Critical value | |
			1%	5%				1%	5%
U	C,T,1	-3.35	-4.94	-4.24	U	C,T,1	3.33	3.22	2.51
EG	C,T,1	1.06	-4.22	-3.65	EG	C,T,2	4.66	4.93	4.16
TA	C,0,1	-4.19	-4.74	-4.36	TA	C,0,2	4.34	4.95	4.174

According to the testifying result, there is co-integration among U, EG and TA despite that the time series are unstable, so they can be analyzed with correlation theory and Granger Causality theory.

(3) The Correlation Analysis Between Urbanization and Economic , Technological Development

The most frequently used correlation factors are Pearson, Spearman and Kendall, of which Pearson correlation index fits interval variable, the latter two fit the sequencing variable. Since U、EG、TA are all interval variables, Pearson correlation factor is used to analyze data here.

If the year 1990 is seen as the first year of urbanization(that is year 1990 i=1, then the later years is expressed the same way by analogy). Then the correlation index Pearson reflecting the level of urbanization and economic growth rate is shown as follows:

$$r_{U1} = \frac{\sum_{i=1}^{22}\left(EG_i - \overline{EG}\right)\left(U_i - \overline{U}\right)}{\sqrt{\sum_{i=1}^{22}\left(EG_i - \overline{EG}\right)^2 \sum_{i=1}^{22}\left(U_i - \overline{U}\right)^2}} \quad (1)$$

$$r_{U2} = \frac{\sum_{i=1}^{22}\left(TA_i - \overline{TA}\right)\left(U_i - \overline{U}\right)}{\sqrt{\sum_{i=1}^{22}\left(TA_i - \overline{TA}\right)^2 \sum_{i=1}^{22}\left(U_i - \overline{U}\right)^2}} \quad (2)$$

Using software SPSS19.0 we can get the result in table 2. According to the criterion of judging correlation index, if the absolute value of correlation index is bigger than 0.8, then the index means high correlation. Therefore from the table we can reasonably say that EG, TA are highly related in a positive way.

Table2　Result of Pearson Correlation Coefficient

| | EG | | TA | |
	r_{U1}	P	r_{U2}	P
U	0.94327**	0.04142	0.92208*	0.06535

Note：*、 ** are indicators that the statistics are notable above 10% and 5% respectively.

We can estimate the magnitude of the two variables according to the magnitude of Pearson correlation coefficient. But the coefficient itself may not reflect the real relation between the two variables, generally it exaggerates the relation. So in order to avoid this kind of inaccuracy, it's necessary to calculate the correlation between variables without the influence of other related factors, that's just the function of net correlation coefficient---which can control the disturbance of other related variables.

TA as the controlling variable, to the net correlation coefficient between U and EG :

$$r_{U1,2} = \frac{r_{U1} - r_{U2}r_{12}}{\sqrt{\left(1 - r_{U2}^2\right)\left(1 - r_{12}^2\right)}} \quad (3)$$

In this formula r_{12} represents the Pearson correlation coefficient between EG and TA.

EG as controlling variable, to calculate the net correlation coefficient between U and TA:

$$r_{U2,1} = \frac{r_{U2} - r_{U1}r_{12}}{\sqrt{\left(1 - r_{U1}^2\right)\left(1 - r_{12}^2\right)}} \qquad (4)$$

For the calculation result of $r_{U1,2}$ and $r_{U2,1}$ see Table 3. Compared with r_{U1}、r_{U2}, $r_{U1,2}$、$r_{U2,1}$ are lower, demonstrating that the correlation is weaker without the impact of other related factors yet the result is closer to reality. The final conclusion is drawn from Table 3 that EG、TA are both related to U positively and both pass the significance test of 1% and 5%.

Table 3　Calculating Result of Net correlation Coefficient

	EG		TA	
	$r_{U1,2}$	P	$r_{U2,1}$	P
U	0.83728***	0.00573	0.81252**	0.03962

Note：*、** are indicators that the statistics are notable above 10% and 5% respectively.

To sum up, research hypothesis is able to be testified with 95% accuracy. It has to be mentioned that some documents and studies also show that economic development and technological advancement are positively related to the process of urbanization in China, further confirming the study in hypothesis 1.

The Granger Causality Analysis in the Urbanization-Economic and Technological Advancement Relationship. Taking U as dependent variable, EG and TA as explanatory variable and using the least square method to implement Granger analysis, we can get the results as seen in Table 2. The results show that: Firstly this means that it's 95% certain economic growth is a cause of urbanization; secondly it indicates that economic development has a lasting impact since economic growth in one year can continue to influence the process of urbanization for 4 years; when it's 95% certain that technological progress is the cause of urbanization and further that technological progress in that precise year has lasting impact on urbanization for 3 consecutive years. Therefore hypothesis 2 is confirmed as the course of urbanization can be attributed to economic and technological advancement. Some other studies also proved this point from the perspective of granger analysis.

Suppose the damping coefficient that urban-rural digital gap has on China's urbanization is $Drag_{du,}$ the total dynamic in urbanization is $UD(EG, TA)$, UD is a function expressing the total dynamic resulted from the synergy of EG and TA. Then we can get the formula.

$$K^{du} = \frac{Drag_{duS}}{UD(ED, TA)} \qquad (5)$$

Formula（5）is the measurement formula expressing the damping coefficient that urban-rural digital gap has on China's urbanization.

Policy Suggestions

This essay is aimed at estimating the damping coefficient that urban-rural digital gap has on urbanization and analyzing the extent to which digital gap impairs urbanization. After research, the following conclusions are drawn:

（1）The damping coefficient point-to-point estimation value during 1990-2014 fluctuate a little around the general estimation value 0.07695, that is relatively stable, conforming to the meaning of inhesion implied in the definition of damping coefficient in viscous tribology. This also indicates the damp is positively related to the general dynamic of urbanization for if the general dynamic increases 1% the damping coefficient also increases by 0.07695%. In this way dynamic in urbanization is weakened by urban-rural digital gap, lower the speed of urbanization.

（2）The magnitude of damp is positively related to economic and technological advancement dynamics. If both economic dynamic and technological dynamic increase by 1%, then damping coefficient increase 0.01476%、0.06113% respectively. By comparison we can see the damping

coefficient of technological dynamic is far bigger that that of economic dynamic, signifying the negative impact of digital gap rests mainly on the technological advancement.

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