MEASURING THE DRAG COEFFICIENT OF URBANIZATION FROM URBAN-RURAL DIGITAL DIVIDE IN CHINA

Weixian Xue, Economics and management academy of Xi'an University of Technology, NO.58, Yanxiang Road, Xi'an, Shaanxi, 710054, +8618629294069, wxxue2002@163.com
Xinghua Dang, Economics and management academy of Xi'an University of Technology, NO.58, Yanxiang Road, Xi'an, Shaanxi, 710054, +8613909189561,gsg1005@sina.com
Jun Liu, Economics and management academy of Xi'an University of Technology, NO.58, Yanxiang Road, Xi'an, Shaanxi, 710054,+8618185117560, 479095320 @qq.com
Rongka Li, Economics and management academy of Xi'an University of Technology, NO.58, Yanxiang Road, Xi'an, Shaanxi,710054,+8618229084161,lirongkai1989@163.com

ABSTRACT

The purpose of this study is to estimate the drag coefficient of urban-rural digital divide (URDD) on the Chinese urbanization process, whereby to identify its clouts on urbanization impetuses. The study, on the ground of the resistance theory in tribology, constructs a model for measuring the drag coefficient of urbanization from URDD in China, and conducts an empirical analysis concerning drag coefficients by using non-parametric methodology. The results indicate that the coefficients vary ranging from 0.06898 to 0.08799 and at around 0.07695 on the whole in China, with a slight fluctuation latitude and the anti-urbanization is an inherent attribute to URDD. The study concludes with policies for narrowing URDD and promoting urbanization development for China.

INTRODUCTION

Urbanization, registering a surge in decades across the world, plays a vital role in the process of the urban-rural economic and social development integration. Countries in the world are taking advantage of the information revolution to promote urbanization. However, along with the rapid development of information technology, URDD is increasingly becoming a factor hindering the development of urbanization. URDD, proposed by an American communications and Information Administration (NTIA) in 1995 [12], is defined as the urban-rural difference of information technology access, usage, the user's consciousness and access circumstance, reflecting the urban-rural discrepancy of information. As the greatest developing country in the world, China is trying to accelerate urbanization through informatization for achieving span development. However, serious URDD is widening the urban-rural information difference, extending urban-rural knowledge isolation, and blocking the transformation of duality economy [17]. Thus, its negative impact on urbanization impetus can not be overlooked over the information era when urbanization is growing at a fast pace [1] [10].

LITERATURE REVIEW

Drag coefficient is a concept which comes from tribology, a branch of physics disciplines, and it characterizes the inherent capacity of dissipating impetus. It was first employed by economist David Romer to deal with issues in economics by proposing the notion economic growth drag from resource constraints in 2001 [13]. Since then, following Romer, researchers at home and abroad have gotten involved in economic topics by virtue of drag theory, mainly focusing on the measure of urbanization drag coefficient from resource constraints. Yaobin Liu (2009) established the drag model of energy constraining urbanization by using autoregressive distributed lag model, and the results show that the drag coefficients fluctuate slightly with the change of energy shortages [7]. Yongkun Wan (2012) used multiple linear regressions to construct the measure model of the water and soil resource constraint drag coefficient, and they found that the worse shortage of water and soil resources, the larger drag coefficients were [8]. In recent years, with the impact of URDD on urbanization, studies concentrate on external performances from URDD drag in process of urbanization, but few explore the drag coefficient of the urbanization from URDD. Both Duncombe (2002) and Chatterjee (2010) considered that URDD impeded rural businesses access to information and the adjustment and upgrading of industrial structure [6] [4]. Inkinen (2006), Kim and Lee (2010) indicated that URDD had affected the social communication between urban and rural residents by means of information tools, and cumbered the modernization of rural cultural life [8] [9]. Taubenbock (2009) and Bruckner (2012) considered its inhibition performances lay in cumbering population transformation from rural to urban and reducing the non-farm payrolls [14] [3]. Weixian Xue and Jun Liu (2013) presented an overview concerning URDD, urbanization, and their relationships, and then established a model for a measurement of urbanization drag in China by drawing on Romer theory of economic growth drag and the hyperbolic tangent function [17].

Notwithstanding much literature on URDD drag on urbanization, few directly figure out the drag coefficient of some country. Only if the drag coefficient from URDD is quantitivly analyzed, the clag on urbanization can be accurately computed whereby to put forward scientific countermeasures. This study is aimed at developing the use of Romer theory of economy growth drag for reference, and applying non-parametric estimation methodology to build a measure model for calculating the urbanization drag coefficient from URDD.

Model

In the system of viscous friction drag, drag coefficient is measured indirectly by the impetus and the drag of a subject. According to the definition of viscous friction drag system and combing with the drag relationship between urbanization and URDD mentioned above, this study takes the continuous development of China's urbanization process as the moving subject, and URDD as the viscous object. First, we determine main urbanization impetus and then using the measure formula that the urbanization drag coefficient equals to urbanization drag value divides by the urbanization impetus to calculate the drag coefficient.

Modeling Drag

Urbanization is driven by sustainable socio-economic forces. Based on the theory of the dual urbanization impetus [15] [7] [5], this study hypothesizes that economic growth (EG) and scientific and technological progress (TA) are main urbanization momentums, so drag formula is written as

$$K^{\mathrm{du}} = \frac{Drag_{duS}}{\mathrm{U}D(ED, TA)} \tag{1}$$

Where (1), $Drag_{duS}$ is the drag value for URDD cumbering urbanization, and $\mathrm{U}D(ED, TA)$ is the function of urbanization momentums and K^{du} is the drag coefficient.

Non-parametric estimation

Taking formula (1) the equivalent transformation in the following form.

$$Drag_{duS} = K^{du} \mathrm{U}D(ED, TA) \tag{2}$$

Where (2), $Drag_{duS}$ is the dependent variable; EG and TA are the explainable variables, K^{du} is the multiplier, and $UD(\cdot, \cdot)$ is the unknown function. The formula (2) is a non-parametric estimation model. In the drag coefficient non-parametric estimation model, we need to estimate the multiplier K^{du}, so the special multiplier of local linear estimation method in the non-parametric estimation can be used.

Economic growth rate and scientific-technical progress rate are characterizations of economic development and scientific and technological progress respectively, and urbanization rate is characterization of urbanization process. The urbanization level data (U) comes directly from the China statistical yearbook (2012). Economic growth data (EG) are calculated based on the China statistical yearbook (2012). Scientific-technical progress rate data (TA) are directly from the China statistical yearbook of science and technology (2012), and the drag value ($Drag_{duS.}$) are calculated by our research team [17].

In the local linear estimation, the economic growth rate and scientific-technical progress rate are highly correlated, which leads to multicollinearity. Therefore, the principal component regression can be used as a remedial measure. Time series of EG and TA are stationary at the first order and $Drag_{duS}$ at the second order, and there is a cointegration relationship exists between EG, TA and $Drag_{duS}$.

With SPSS19.0 software to conduct principal component extraction of EG, TA, the results are shown in table 1. The first principal components $COMP_1$ contribution rate is as high as 98.88393%, thus $COMP_1$ can be regarded as a new explanatory variable, and the loads on the EG and the TA are 0.71459 and 0.32597, respectively. So, $COMP_1$=0.71459EG+0.32597TA can be obtained.

Table 1 Results of the principal component variables

principal component variables	eigenvalues	contribution rate	cumulative contribution rate
$COMP_1$	1.49908	98.88393%	98.88393%
$COMP_2$	0.19803	1.11607%	100%

According to the local linear estimation method of kernel density function form, this study sets for kernel density function as follows.

$$Fc(COMP_1) = \frac{1}{22 \cdot Bw} \sum_{i=1}^{22} Ke(COMP_1) \tag{3}$$

Where $Ke(COMP_1)$ is the Kernel density, and it meets the condition of $Ke(COMP_1) \geqslant 0$ and

$$\int_{-\infty}^{+\infty} Ke(COMP_1) d(COMP_1) = 1 \tag{4}$$

$$Ke(COMP_1) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{COMP_1^{\ 2}}{2} \right) \tag{5}$$

In formula (3), Bw is the Bandwidth. Because Bw value affects the estimation results mostly, it is of utmost importance in setting Kernel density function to determinate the Bw. The Bw is rather tiny, implying the noise of the random error can not be ruled out while the Bw is pretty large, meaning a massive deviation of estimated result. According to non-parameter estimation, the optimal Bw function is given as follows.

$$\hat{Bw} = \left\{ \frac{\int [Ke(COMP_1)]^2 d(COMP_1)}{\sigma^4 \int [Fc''(COMP_1)]^2 d(COMP_1)} \right\}^{\frac{1}{5}} / 22^{\frac{1}{5}} \tag{6}$$

Where σ is the standard deviation of observation points. Combing with (3), (5) and (6), Kernel density function $Fc(COMP_1)$ can be composed.

Setting $Y_i = Drag_{duSi}$,（$i = 1, 2, \cdots, 22$）, and conducting local linearization at the point of $X_i = COMP_{1i}$, we can rewrite the formula (2) to

$$Y_i = K^{du} \left[Fc(x) + (X_i - x) \frac{dFc(x)}{dx} + \varepsilon_i \right] \tag{7}$$

Where ε_i is the error term after the local linearization.

Results and Discussions

Taking the yearly data about $Drag_{duS}$ and $COMP_1$ into the formula (7) and using SPSS19.0 software, the study calculates two kinds of values of K^{du} through the local linear methodology. The results are reported on the table 2. Table 2 shows that the value for K^{du} is 0.07695, significant at the 5% level with the t-statistics being 8.2046.

Table 2 Point estimate value about K^{du} and its test statistics from 1990 to 2011

year	1990	1991	1992	1993	1994	1995	1996	1997
$K^{du}{}_i$	0.07447***	0.07498***	0.07232**	0.07531**	0.08006**	0.08117**	0.08592*	0.08325*
T test statistics	6.46462	6.48058	7.00265	6.20465	7.24248	7.25565	8.0025	8.58632
year	1998	1999	2000	2001	2002	2003	2004	2005
$K^{du}{}_i$	0.06898***	0.07522***	0.07678**	0.08064*	0.08799***	0.07385**	0.07402**	0.07256**
T test statistics	8.70896	8.05532	7.64809	7.64675	7.74036	8.00523	8.05632	7.32547
year	2006	2007	2008	2009	2010	2011	---	---
$K^{du}{}_i$	0.07683**	0.08009**	0.08048**	0.07541***	0.08205*	0.08632**	---	---
T test statistics	8.23137	6.15449	6.0778	7.4502	8.10851	8.57605	---	---

Note: *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

From K^{du} point estimation results from 1990 to 2011, the drag coefficients of the point estimate fluctuated up and down around the 0.07695 within the range of [0.06898, 0.08799].

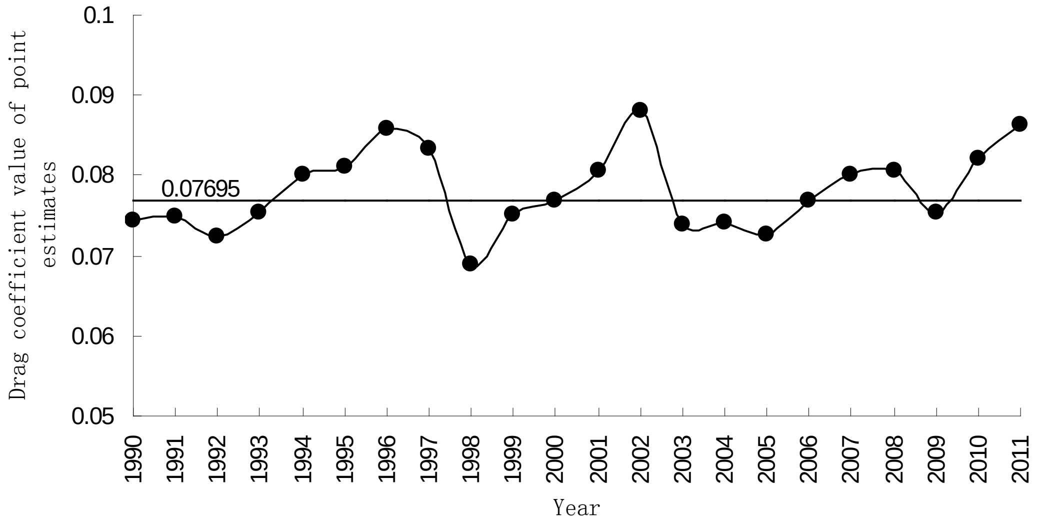

Fig 1. Drag coefficient value of point estimates

Taking K^{du} overall estimate value of 0.07695 into the formula (2), then formula (8) can be taken in the form.

$$Drag_{duS} = 0.07695\mathrm{U}D(ED,TA) \tag{8}$$

It demonstrates that drag value is positively related with urbanization impetus, an increase of one percent of the total impetus leading to a 0.07695% growth of drag. Concretely, if there is a pick up of 12.9955% (=1/0.07695), drag will increase by one percent, displaying an existence of URDD delaying the urbanization process.

CONCLUSIONS AND POLICY IMPLICATIONS

This study was actuated by the need for investigation which can result in a better understanding of the drag coefficient concerning URDD on urbanization in China Mainland. The empirical results suggest that over the time horizon from 1990 to 2011 the drag coefficients fluctuated up and down around 0.07695 within the range of [0.06898, 0.08799], with a comparatively small change. Furthermore, drag value was positively related with urbanization impetus, one percent increase in total impetus inducing the 0.07695% growth of drag value. Therefore, impetus effect is offset by URDD in urbanization.

The results are likely to have important practical implications for government and enterprises in decision-making on diminish the negative effects of URDD on urbanization. One effective step is to increase investment in digital infrastructures for the rural areas, improve rural residents' educational level, and cultivate them to develop the awareness and habit of using internet in their work and life. This is productive to narrowing the URDD and eventually contributes to a reduction of urbanization drag and acceleration of the Chinese urbanization process.

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