

# The study of force assessment on science and technology innovation driving new type urbanization based on SD model

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**Abstract.** Taking the road of new type urbanization becomes major strategies for China's economic and social development in the future. In this paper: Science and technology innovation to drive new type urbanization model of system dynamics theory is established. The measurement system of the new type urbanization development index and the science and technology innovation index respectively is built. The results showed that the driving force amplification coefficient of science and technology innovation in the new type urbanization reached 0.7407, science and technology innovation can drive the new type urbanization construction positively and significantly, but there are 2 years of time-lag effect in the driving process.

**Key words.** New type urbanization; Science and technology innovation; System dynamics model; Amplification coefficient; Time-lag effect.

## 1. Introduction

Urbanization, a natural and historical process, which accompanied by the development of industrialization, non-agricultural industries and rural population gathered in town, is a optimistic trend in the development of human society, and also a concentrated sign of national modernization. This paper will have a discussion on the power and the way how the scientific and technological innovation drives the new-type urbanization, with the purpose of upgrading the scientific and technological innovation as a soft element in the production, and the flow market efficiency of the economic factors like capital and population.

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## 2. Literature review

About the relationship of science and technology innovation and the urbanization, the United States and western countries utilize the progress of the scientific and technology to develop and construct the urbanization practice earlier. The science and technology innovation of the industrial sector will accept department of agriculture surplus labor force, so as to promote the coordinated development of urbanization and industrialization under the promise of none marginal productivity of agricultural labor force under; Money, Quinn (1975) and Searle aimed at the shortcomings of the Lewis' model, pointed out that on the basis of scientific and technological progress and the urbanization and industrialization interacted each other, and thought that urbanization was the inevitable result of the interaction between a variety of performance. From the perspective of history, Simon Joss and Arthur p. Olella (2013)[1] put forward the concept of science and technology to promote urban development, pointed out that use the green technology to solve the environmental problems.

Chinese scholars study the dynamic mechanism of urbanization is mainly focused on its connotation, classification, mechanism, etc., (2013)[2]. From the perspective of national macro strategy, such as Minglei Ding[3] pointed out that the human science and technology innovation accelerated the process of urbanization. Zhenya Hu (2012) from all angles of the industrialization and urbanization, put forward the coordination mechanism of the scientific and technological innovation and industrialization and urbanization, in order to promote the coordination and unity each other effectively. Fuxing Lu (2012) thought that the transformation of scientific and technological innovation could promote the urbanization development.

## 3. Build theoretical framework and index

In order to make the urban road really as the high quality suitable for the development of human settlements, it requires that the low carbon ecological, sustainable development etc put forward more needs for the scientific and technological innovation. At the same time, urbanization driven by technological innovation develops from originally traditional and instrumental support of single way state to diversified and comprehensive state.

### *3.1. The mechanism of new urbanization driven by science and technology innovation*

The mechanism of new urbanization driven by science and technology innovation is a sum that is composed from economic relations to maintain and improve this mechanism and an interrelated and integrated systems composed of organizational system. On the basis of defining demand of science and technology innovation from development of new type urbanization, system dynamics point of view is introduced to analyze structural characteristics of the system and operating mechanism in new type urbanization. More rich and deepening information to provide favorable

theoretical basis for policy-making can be received. (1) Science and technology innovation drives the process of urbanization in rural areas; (2) Science and technology innovation drives economic level of town; (3) Science and technology innovation improves the life-style of urban residents; (4) Science and technology innovation helps to solve environmental problems and energy-driven ecological, intensive urbanization and sustainable development.

Based on the above analysis, theoretical model of system dynamics of new type urbanization driven science and technology innovation is constructed (Figure 1). In system dynamics, there is a causal relationship between the various components in the system part. That front vector is labeled "+" indicates a positive causal link between the elements and that front vector is marked "-" indicates negative causal link between the elements.

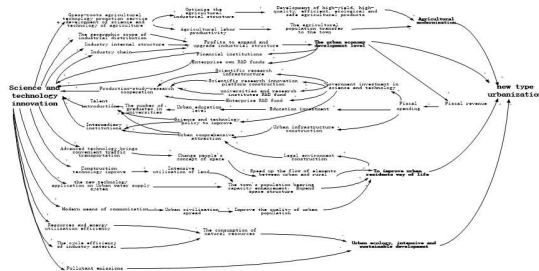


Fig. 1. The System dynamics theory model of new type urbanization driven science and technology innovation.

Because there are two elements in the system dynamics theory models. So we need to construct the two index, which is new type urbanization development index and science and technology innovation index.

### 3.2. The Established measurement indicator system

#### 3.2.1 The Established measurement indicator system

The new type urbanization presented is different from traditional urbanization. The goal of new type urbanization development is summered up as four points: urbanization agricultural target, urbanization economic target, urbanization lifestyle target and urbanization ecological target. At the same time, it will be interpreted from the four dimensions specific content.

Table 1 index system to measure a new town development

Target layer	Guidelines layer	Index layer
New town development index	Urbanization	...
	Economy Urbanization	...
	Lifestyle Urbanization	...
	Ecological Urbanization	...

Source: Author finishing

### 3.2.2 Science and Technology Innovation Index

Basing on existing research and practical experience, a evaluation system is built, which includes the regional scientific and technological innovation capacity of investment capacity, supporting capacity and output capacity.

Table 2 the indices system of science and technology innovation index

Target layer	Guidelines layer	Index layer
Scientific and technological innovation	Scientific and technological innovation capability	...
	Technology innovation support capacity	...
	The capacity of technological innovation output	...

Source: Author finishing

## 4. Building Model

In order to analyze the effect of the new urbanization driven by science and technology innovation, models need to be built to measure the amplification factor of science and technology innovation in new type urbanization. The effects of various subsystems of science and technology innovation on new type urbanization system are investigated and discussed.

### 4.1. Model Principle

According to the theoretical model of Figure 1, this study proposes the following two assumptions:

Assumption 1: Science and technology innovation actively drives the development of new type urbanization.

Assumption 2: There is delay effect in the process of science and technology innovation driving the new type urbanization.

Accordingly, it is assumed that the level of development of the new type urbanization is  $U$ , science and technology innovation capability is  $T$  and research year is

t. Therefore, the basic model is set as:

$$U_t = C + \beta T_t + \varepsilon_t$$

In addition, C is a constant term.  $\beta$  is the correlation coefficient between U and T and the final result of the request.  $\varepsilon_t$  is a random error term.

In order that further discussion on response patterns and relationships is made between science and technology innovation subsystem and the new type urbanization system, the vector auto regression (VAR) model and the impulse response function (IRF) are used for analysis. Vector auto regression (VAR) model can be set as follows:

$$Z_t = A_0 + A_1 Z_{t-1} + V_t$$

In addition

$$Z_t = \begin{bmatrix} y_t \\ x_t \end{bmatrix}, A_0 = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix}, A_1 = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}, V_t = \begin{bmatrix} \mu_{yt} \\ \mu_{xt} \end{bmatrix}$$

$\mu_{yt}$  and  $\mu_{xt}$  respectively is the pulse value of (yt) and (xt).

Through the above econometric model, the dynamic process of mutual influence between science and technology innovation subsystems and new type urbanization system can be measured.

#### ***4.2. Measurement methods and procedures Index***

First of all, analytic Hierarchy Process (AHP) was used to determine the weight of each index in the new type urbanization development index system and science and technology innovation index system.

Secondly, maxima standardized method to standardize the raw data is adopted.

Thirdly, a comprehensive evaluation method is used to calculate the new type urbanization development index (or technological innovation index).

### **5. Empirical researches**

Tianjin is located in the center of the Bohai economic circle. It implements the central decision-making earnestly and the strategy of integration on urban and rural development vigorously. After years of development, it walked out of a unique road to new type urbanization.

#### ***5.1. The effect assessment of Tianjin's science and technology innovation in the new type urbanization driven mechanism***

By Consulting the "China statistical y of calendar yearbook", "China's urban construction statistical yearbook" and other related information, the data of the construction of urbanization which ranged from 1991 to 2012 in Tianjin is sorted out. After the standardization of the data, the comprehensive evaluation model to mea-

sure a new type of urbanization development index and the science and technology innovation index of Tianjin was measured respectively. The results can be found in the table below, which is set the overall development index for U, overall innovation index for T support for T1, innovation ability, the innovation input for T2, innovation output capacity for T3.

Table 3 new town development index and technological innovation index in Tianjin

Year	U	T1	T2	T3	T	Year	U	T1
1991	0.3551	0.0699	0.0870	0.0072	0.1642	2002	0.4371	0.0846
1992	0.3663	0.0759	0.0199	0.0097	0.1054	2003	0.4516	0.0866
1993	0.3707	0.0791	0.1424	0.0115	0.2330	2004	0.5061	0.0938
1994	0.3885	0.0741	0.1135	0.0198	0.2075	2005	0.5403	0.1008
1995	0.4034	0.0780	0.1030	0.0236	0.2046	2006	0.5753	0.1062
1996	0.4118	0.0840	0.1031	0.0263	0.2134	2007	0.6066	0.1206
1997	0.4265	0.0772	0.1199	0.0315	0.2286	2008	0.6555	0.1240
1998	0.4234	0.0744	0.1325	0.0396	0.2494	2009	0.6844	0.1256
1999	0.4243	0.0702	0.1436	0.0422	0.2580	2010	0.7822	0.1422
2000	0.4316	0.0902	0.1277	0.0580	0.2759	2011	0.8507	0.1492
2001	0.4257	0.0845	0.1315	0.0698	0.2857	2012	0.9021	0.1634

To judge the stability of the time series of the statistical data, but also to avoid the false regression, unit root test should be carried out on the data. The test results show that the sequence of U, T is under 5% significance level is 1 order single whole sequence, namely UI1, TI1.

Two variables of the original sequence of Engle Granger co integration test is done in the use of U and T. Eviews6.0 software methods of OLS regression was used, and two relations was gotten as follows:

$$U_t = 0.2443 + 0.7407T_t$$

The regression results of the model shows that it has a very significant linear relationship and a long-term equilibrium relationship between independent variable T and the dependent variable of the model U. And the regression model shows that, in the long run, increasing the scientific and technological innovation capacity per unit, the impact of the development of new type urbanization is positive 0.7407 units. Therefore, hypothesis 1 is established.

Our aim is to analyze the dynamic process of interaction between the various subsystems and new type urbanization system. The var model is established and analyzed for stability and lag analysis.

Figure 2 (a) shows the impact that one standard deviation is applied to DlnT1. There is a significant external shock of science and technology innovation capability for new type urbanization; Figure 2 (b) shows that the impact of a standard deviation is applied to DlnT2. The effect of external shocks of science technology innovation support capacity is not significant to the new type urbanization; Figure 2 (c) shows that the impact of a standard deviation is applied to DlnT3. The effect of external shocks of science and technology innovation support capacity is significant to the new urbanization. there is a lag effect in the process of science and technology innovation

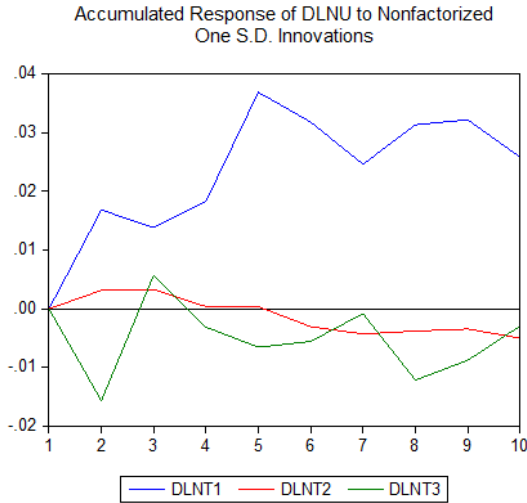


Fig. 2. The response of DLNU to the pulse of the variables

driving new type urbanization. Thus, assuming 2 is proved. However, the lag effect of science and technology innovation input subsystem and support subsystem actively driving new type urbanization is not significant. Figure 2 (d) shows that the promotion of science and technology innovation input capability produces a sustained positive role; Delay effect comes mainly from science and technology innovation output subsystem.

## 5.2. Results analysis

The relevant data of science and technology innovation capability and new development level of urbanization in Tianjin was analyzed. First of all, by analyzing the amplification factor of science and technology innovation on new type urbanization driving force, Tianjin's science and technology innovation actively can drive new type urbanization positively. Among all the factors affecting the construction of new type urbanization, the effect of Tianjin's science and technology innovation is in an important position. The view, which is new type urbanization construction needs got strongly support from science and technology innovation, was effectively validation.

Secondly the results of the impulse response are carefully analyzed. There is two-year lag effect in the process of science and technology innovation forward driving new type urbanization. Delay effect comes mainly from the output of science and technology innovation system. Not only did the output of technology innovation play a catalytic role in the construction of the new type urbanization during the two years, but also bring the inhibition. In addition, we found that the supporting effect of science and technology innovation on the construction of the new type

urbanization was not significant. As a result, it caused viscous effects that science and technology innovation has on Tianjin's new type urbanization. In the process of the construction of Tianjin's new type urbanization, if science and technology innovation can play better and smoother role in the core driver, the obstacles of the process must be gotten rid of to improve the state of this lag.

## 6. Conclusions

From the point of view of system engineering, the new type urbanization is the result of a variety of dynamic mechanism synergy. But the critical in new type urbanization, which creates the change of industrial and social, is science and technology innovation and improvement. Because the viscosity is a kind of inherent physical properties of the fluid, every element is hard to flow and convert in the process of science and technology innovation driving new type urbanization. So in the paper it has put forward that science and technology innovation is the core to promote and build new type urbanization. But the perspectives of effective lagging time are existed in the process. And by introducing a dynamic point of view to analyze the mechanism of science and technology innovation driving new type urbanization, the view was tested on the basis of the qualitative analysis and quantitative measure, and the empirical research. In the current study, however, there has been the cause of time lag effect for detailed analysis. In view of this, to make science and technology innovation driving the construction of the new type urbanization well, the core of the driver effects can be fully revealed, really realize the change of urbanization drive mode, a concrete analysis of the causes which are about the science and technology innovation to drive new type urbanization viscosity and how to eliminate the obstacles, etc. It remains to be further study.

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