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A study on the correlation between technology innovation and the new-type urbanization in Shaanxi province

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ABSTRACT

In the past three decades, China has experienced vigorous urbanization. However, the economy-centered urbanization caused social issues and is being replaced by the new-type people-centered urbanization. Technology innovation plays a key role in urbanization. Previous studies examine the relationship between technology innovation and the traditional economy-centered urbanization. But the relationship between technology innovation and the new-type people-centered urbanization remains unknown. As such, this paper develops a comprehensive evaluation index system for technology innovation and the new-type urbanization based on the data from Shaanxi province between 2000 and 2014. A variation coefficient method is applied to determine the weight of each index. Then a model is proposed and tested. At the end, conclusions are reached based on the results of the tests on the model. Recommendations for dealing with technology innovation and the new-type urbanization are provided.

1. Introduction

Urbanization is an integral element of rapid income growth and industrialization throughout the world (Fan, 2017; Feng and Xu, 1992, Feng, 1993, Feng and Xu, 2000; Henderson et al., 2009). According to United Nations (2010), 70% of the world's population will live in cities in 2030. Technology innovation plays an important role in the process of urbanization. For example, urbanization in the U.K. began at the time when the first technological revolution occurred. During the second and the third technological revolutions, urbanization processed quickly in the U.S. The continuous introduction of foreign technologies and continuous innovation from 1950s to 1970s changed Japan into a science, technology and economic power. The urbanization rate in Japan rose quickly from 33% to 70% in this period. In recent years, industry development has been driven by advanced ICT including IoT (Internet of Things) (Gürdür and Asplund, 2018; Kim, 2017; Li et al., 2015, Li et al., 2018; Oliverio, 2018; Wang et al., 2016; Viriyasitavat and Martin, 2017). Because manufacturing and service production are more efficient when undertaken in urbanized areas, urbanization is critical to the success of modernization (Henderson et al., 2009). Urbanization changes population distribution, production mode, life style, and ecological environment.

China's urbanization has been a notable global event (Li, 2013, 2017; Li and Zhou, 2013). In the past three decades, market reform and globalization drove dramatic growth and structural changes in the Chinese economy, society, and spatial organization (Lin and Yi, 2011). As economy grows, China is experiencing a massive rural-urban migration and expansion of cities and towns (Fan, 2008; Henderson et al., 2009; Hsing, 2010; Lin, 2009; McGee et al., 2007). In 2013, China's urbanization rate rose to 53.7%, with an urban resident population of 770 million (Wang et al., 2015). However, compared with developed countries which have an average urbanization rate of 80%, the urbanization rate in China is still low.

Rapid urbanization has put significant stress on city infrastructure because it may lead to a reduced per-capita access to subsistence resources in urban areas (Homer-Dixon, 1999; Homer-Dixon and Blitt, 1998). According to Buhaug and Urdal (2013), rapid urbanization can seriously constrain local governments' ability to provide basic public services, including employment, education, housing, electricity, water, sanitation, healthcare, enforcement of law and order. In order to reduce costs, improve efficiencies, and deliver the quality of life, cities rely more on information and communications technology and new working practices (Naphade et al., 2011). As Nam and Pardo (2011a) point out, the smart city approach is emerging as a way to solve tangled and wicked problems inherited in the rapid urbanization (Nam & Pardo, 2011). However, the transformation to smart cities require innovation

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in technologies, planning, management, and operation (Naphade et al., 2011). According to Porter (2011), innovation driven development stage is an important stage of economic modernization.

In China, the traditional economy-centered urbanization has created notable economic and social benefits as well as adverse impacts, such as the loss of arable land, the phenomenon of ghost cities, and the urban heat island effect (Chan, 2014; Chen et al., 2016). Thus, the National New Urbanization Plan (2014–2020) unveiled by the Chinese Central Government revealed a new path for urbanization (Chen et al., 2016). Different from the traditional economy-centered urbanization, the new-type urbanization is people oriented and places more emphasis on the universal coverage of social and public services, the service economy, the integration of local culture and urban development, ecological and environmental protection, and innovation in urban and rural management (Fang et al., 2015).

So far research on urbanization through the lens of integrating technology innovation and urbanization are missing. Accordingly, this paper develops a comprehensive evaluation index system for technology innovation and the new-type urbanization. After data from Shaanxi province between 2000 and 2014 are loaded into this index system, a variation coefficient method is applied to calculate the comprehensive level of technology innovation and the new-type urbanization. Then a model is proposed to describe the relationship between technology innovation and the new-type urbanization. Tests are performed to examine the proposed model. Finally, conclusions are reached based on the results of the tests on the model. Recommendations for dealing with technology innovation and the new-type urbanization are provided.

2. Literature review

Urbanization is the increase in the urban share of the total population (Henderson et al., 2009). It is the result of natural agglomeration of population (Zhou, 2015). According to Buhaug and Urdal (2013), urbanization is driven by reproduction rate, rural-urban migration, and reclassification of rural land. Rural-to-urban migration is the consequence of high and increasing population pressure on scarcity of renewable resources (Homer-Dixon, 2010) as well as labor moving from under-employment in low-productivity rural activities to full employment in higher-productivity urban manufacturing activities (Henderson et al., 2009). In recent years, advanced ICT including IoT (Internet of Things) facilitate industrialization across the world (Bi et al., 2014; Chen, 2017; Cheng et al., 2018; Duan and Binbasioglu, 2017; Lu, 2017; Xu, 2011, 2016a; Wu et al., 2009; Xu and Duan, 2018; Xu et al., 2014; Xu et al., 2018; Xu and Viriyasitavat, 2014; Xu et al., 2017; Xu et al., 2018; Yang et al., 2017). Urbanization becomes critical to the success of modernization because manufacturing and service are more efficient when they are undertaken in urbanized areas (Henderson et al., 2009).

With increasing urban populations and expanding industrial activities, China has experienced vigorous land urbanization and an uneven population distribution pattern since 1978 (Chen et al., 2016). The rapid and unprecedented process of urbanization was created by the history's largest flow of rural-urban migration in the world (Lin and Yi, 2011). During the period of 1978–2013, China's urban population has risen from 170 million to 730 million, and the level of urbanization has reached 53.7% in 2013(Wang et al., 2015). Rural-urban migration has made dominant contributions to Chinese urban population growth (Zhang and Song, 2003), and reshapes the economic, demographic, and social landscapes of the Chinese city and countryside (Fan, 2008).

However, rapid population growth in urban areas causes cities to face a variety of risks, concerns, and problems, including deteriorating conditions in air and transportation and unemployment (Nam and Pardo, 2011b). In China, rapid urbanization causes issues such as big city malaise, unbalanced regional development, and urban-rural contradictions (Chan and Hu, 2003; Fan, 2008; Zhou and Ma, 2003; Pannell, 2002). Urbanization, economic growth, technological progress, and environmental sustainability drive cities to become smarter in managing their infrastructure and resources to cater to the existing and future needs (Naphade et al., 2011). The rapid urban population growth requires sustainable development and better livability (Nam and Pardo, 2011a). Making a city smart has recently emerged as a model to mitigate and remedy current urban problems and make cities better as places to live (Nam and Pardo, 2011b). To achieve sustainable development, Chinese government has adopted an innovation driven development strategy, which applies technological innovation to support social productivity and comprehensive national strength (He, 2014).

According to Toppeta (2010), a smart city combines information and communication technology (ICT) and Web 2.0 technology (He et al., 2009) with other organizational, design and planning efforts to speed up bureaucratic processes and to identify new, innovative solutions for improving sustainability and livability. Smartness in the urban context indicates utilizing cutting-edge of ICT as well as importantly management and policy concerns (Nam and Pardo, 2011b). A smart city supports long-standing practices for running the city in a more efficient way, making the city perceptual, interconnected and intelligent, and improving the quality of life based on advances in ICTs and infrastructures (Harrison et al., 2010).

Infrastructures are central to a smart city. A smart city relies on combination, connection and integration of systems and infrastructures (Al-Hader and Rodzi, 2009). The competitiveness of a city relies on its ability to continuously develop, accumulate, and exploit specialized knowledge assets (Herstad et al., 2011). A city gains competitive advantages by developing information processing and knowledge diffusion infrastructures (Simmie, 2003), and linking a set of technologically related and globally networked actors and industries (Frenken et al., 2007; Giuliani and Bell, 2005; Graf, 2010; Lazaric et al., 2008). In specific, innovation is a primary source of economic growth, industrial change, competitive advantage, and public service (Beckett and Vachhrajani, 2017; Boyne et al., 2006; Christensen et al., 2004; Hisrich et al., 2016; Tidd et al., 2001; Xu et al., 2016).

Technology is key to being a smart city because ICT can transform life and work within a city significantly and fundamentally (Hollands, 2008). Smartness in the technology context implies the automatic computing principle like self-configuration, self-healing, self-protection, and self-optimization (Spangler et al., 2010). By integrating complex organizational and physical systems, technology innovation can help model and simulate the implications of decisions in cities (Dodgson and Gann, 2011). Technology innovation is "a mechanism to change and upgrade technological tools to improve services and create conditions where the tools can be better used" (Nam and Pardo, 2011b, p187). The drivers of technology innovation are primarily reduction in delivery time, increase in operational flexibility, and lowering of production costs (Boer and During, 2001). According to Damanpour et al. (2009), technological innovations are directly related to the primary work activity of the organization and mainly produce changes in its operating systems. A smart city can be considered as a contextualized interplay among technological innovation, managerial and organizational innovation, and policy innovation (Ianuale et al., 2015; Nam and Pardo, 2011b).

Rapid urbanization stimulates innovations (Dodgson and Gann, 2011). Urban areas are the major contributors to the supply of and demand for innovation (Simmie, 2001). Cities are generally portrayed as centers of innovation (Isaksen and Aslesen, 2001; Simmie, 2004). Creativity is the heart of innovation and successful innovation activities positively contribute to an urban region's economic competitiveness (Krätke, 2012). Cities have fostered creative systems that multiply the capacity for networking and encourage the generation of knowledge and innovation (Camagni and Capello, 1999). In cities, it is easier for firms to learn from other firms about new technologies, to hire the workers with the exact skills they need, and to purchase and transport intermediate inputs (Duranton and Puga, 2004; Rosenthal and Strange, 2004). Cities provide the environment for incubating innovations and developing sophisticated skills via schooling and training systems (Henderson et al., 2009). Cities also employ more tertiary educated people than elsewhere (Dirks and Keeling, 2009). Cities stimulate creativity and entrepreneurship, which further spurs economic activity (Naphade et al., 2011).

Scholars have explored the connection between technology innovation and urbanization. For example, Lewis (1954) proposes a binary economic development model of agriculture and industry, and asserts that technology innovation will give birth to some industries, which would absorb the surplus labor force and promote the coordinated development between urbanization and industrialization. Chenery (1975) points out that interaction exists between industrialization and urbanization, that urbanization and the balanced development of the national economy are the inevitable result of this interaction, and that technology innovation would promote the transfer of rural surplus labor to urban areas. Button (1976) notes that there is positive connection among urbanization, industrialization, and technology innovation. He argues that industrialization and technological progress are the foundation of urbanization, and that they play an important role in promoting urbanization. Huang (2006) notes that because there are non-synergetic factors between urbanization and industrialization development in China, measures for deepening the structural reform, strengthening technology innovation, and promoting the synergetic development among urbanization, industrialization, and agricultural modernization should be taken. Gu (2012) believes that the factor driven urbanization development model adopted by China should be abandoned because this model relies on cheap land and cheap labor force. He further argues that the factor driven urbanization must be replaced by innovation driven urbanization, namely a transformation from extensional extension to connotative development. Ding and Chen (2013) assert that the progress of technology is the basis of industrialization and urbanization, and that technology revolution triggered by technology innovation is the decisive force for promoting urbanization. Zhen (2013) finds that technology innovation is closely related with the process of new urbanization, and that the core of science and technology innovation is to change the traditional pattern of rural industries, and to change the patterns of the farmer, farming and countryside fundamentally. Gan (2014) finds the disconnection between technology innovation and urbanization in China and proposes to narrow the city radius and to achieve the coordinated development between industrial upgrading and new urbanization with technology innovation. Yuan and Liu (2014) conclude that technology innovation is a strong power to propel the development of a city, and that urbanization accelerates the emergence and development of urban innovation and is assumed to be a key factor to promote technical creations. Urbanization and technology innovation have a mutual promotion and rely on each other all the time (Yuan and Liu, 2014).

Urbanization is thought of as an approach for absorbing surplus labor force from rural areas in previous studies. However, with the development of economy and society, urbanization has exhibited different characteristics. Other than absorbing surplus rural labor, urbanization is an important approach for achieving industrialization, informationization, and agricultural modernization (He, 2014). The traditional economy centered urbanization has trouble to continue. It should be replaced by technology innovation driven urbanization. The new-type urbanization is a policy approach gradually developed by the government in the process of China's urbanization. Different from the traditional one, the new-type urbanization focuses more on people than on economy. It calls for efficient, harmonious, and ecologically livable development in the process of urbanization (Liu et al., 2017). Population agglomeration, land use, income increase, and the equalization of public services and cultural heritage are the main focuses of the new-type urbanization (Fang et al., 2015).

Table 1
Index system of new urbanization and technology innovation.

Index system of the new-type urbanization		
Population urbanization	x_1	Proportion of non-agricultural population (%)
	x_2	Proportion of the employment in tertiary industry (%)
	x_3	Proportion of urban employment to total employment (%)
	x_4	Amount of doctors per thousand persons
Economy urbanization	x_5	Per capita GDP in Shaanxi (yuan)
	x_6	Total investment in fixed assets (billion yuan)
	x_7	Proportion of tertiary industry output value to GDP (%)
	x_8	Total retail sales of social consumer goods (billion yuan)
Society urbanization	x_9	Urban per capita disposable income (yuan)
	x_{10}	Per capita income ratio of urban and rural residents (%)
	x_{11}	1-Engel's coefficient
	x_{12}	Number of public transport vehicles per ten thousand person
Index system of technology innovation		
Knowledge innovation	y_1	Number of students per one hundred thousand population of higher education institutions
	y_2	Number of published science papers
Technology innovation	y_3	Number of authorized patents
Innovation environment	y_4	The number of normal higher education institutions
	y_5	State budgetary funds for education (ten thousand yuan)
	y_6	R&D funding internal expenditure in R&D institutions (ten thousand yuan)

3. An index system and model

3.1. An index system for technology innovation and the new-type urbanization

The index originates from the *National New-type Urbanization Plan (2014–2020)* (China's National Development and Reform Commission, 2014) and *Evaluation of Regional Urbanization Level the Perspective of New Urbanization: A Case Study of 10 Cities in Shaanxi Province*.

The data about Shaanxi province from 2000 to 2014 are collected from China Statistical Yearbook, Statistical Yearbook of Shaanxi Province, Chinese Science and Technology Statistical Yearbook, and Wind Financial Terminal. The details of the index systems are listed in Table 1.

3.2. Index weight determination

First, the data are processed with a dimensionless method. Then the weight of each index is determined with the variation coefficient method.

3.2.1. Data dimensionless

The dimensionless data $X_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})}$.

Where:

X_{ij} is the jth value of X_i, $i = 1,2,3\ldots;j = 1,2,3\ldots$.

3.2.2. The variation coefficient method

Variation coefficient $V_i = \frac{\sigma_i}{|\mu_i|}$.

Where:

σ_i is standard deviation, $\sigma_i = \left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2\right)^{\frac{1}{2}}$.

μ_i is mean value, $\mu_i = \frac{1}{N}\sum_{i=1}^{N} x_i$

Table 2
Weight of each index.

Index of the new-type urbanization												
Index	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
Weight	0.084	0.049	0.088	0.084	0.092	0.105	0.054	0.094	0.084	0.040	0.117	0.103

Index of technology innovation						
Index	y_1	y_2	y_3	y_4	y_5	y_6
Weight	0.1151	0.1357	0.2573	0.0959	0.2159	0.1801

Table 3
The level of technology innovation and urbanization.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
UR	0.1441	0.1892	0.1969	0.2019	0.1887	0.2221	0.2639	0.2694	0.2948	0.3928	0.4543	0.5360	0.5954	0.6922	0.8992
A	0.0000	0.0385	0.0697	0.0954	0.1371	0.1909	0.2338	0.2976	0.3560	0.4392	0.5307	0.6270	0.7341	0.8450	0.8725

Weight $W_i = \frac{V_i}{\sum_{i=1}^{i} V_i}$, the weights of each index are calculated respectively in this way and the results are shown in Table 2.

3.3. The level of technology innovation and urbanization

The level of urbanization UR $= \sum_{i=1}^{i} w_i x_{ij}$
The level of technology innovation A $= \sum_{i=1}^{i} w_i y_{ij}$
The values of *UR* and *A* are shown in Table 3.

3.4. Model

The progress of technology and the improvement of agricultural productivity increase the surplus labor force in rural areas and then prompt the surplus labor force to move to the secondary industry and the tertiary industry. At the same time, the improvement of the living conditions in rural areas changes rural people's values and lifestyle. As a result, the demand for the secondary industry and the tertiary industry in rural areas rises and causes the upgrading of the industrial structure. The progress of technology and people's skills interact with each other. People with technology skills promote changes in employment. The changes trigger the adjustment in industrial structure and further promote urbanization. The development of economy requires more high-quality public services. Technology progress will improve the quality of public service (e.g. electronic approval) and facilitate the integration of urban and rural social security (e.g. Golden Insurance Project in China). In this way, labor cost drops. Furthermore, the progress of technology promotes energy saving and emission reduction, improves the efficiency of resource utilization, improves the ecological environment of human settlements, and spurs the flow of population from rural areas to urban areas. Therefore, urbanization is promoted by technology progress. Because technology innovation promotes the development of new-type urbanization via upgrading of the industrial structure, optimizing the employment structure, accelerating the integration of urban and rural areas and the equalization of public services, and improving the ecological living environment, this paper proposes a model for the relationship between technology innovation and the new-type urbanization as shown below:

$$\ln UR_t = \alpha_1 + \alpha_2 \ln A_t + \varepsilon_t \quad (1)$$

where:
UR_t is annual level of new urbanization
A_t is annual level of science and technology innovation
a_1 is constant term
ε_t is stochastic error, $\varepsilon_t \sim N(0, \mu^2)$

4. Empirical analysis

4.1. Test of time series stationarity

We use ordinary least squares regression (OLSR) to analyze the relationship between technology innovation and the new-type urbanization. The assumption for OLSR is that data are stationary. If data are not stationary, breach of data consistency will occur. Because data consistency is the basis of statistical inference in large samples, breach of data consistency will cause issues in regression. Therefore, we use the ADF unit root test to examine the stationarity of the time series. EViews 8 is applied to test the stationarity of the data of science and technology innovation (lnA) and new-type urbanization (lnUR). The results are shown in Table 4.

The results of the ADF test show that the second order difference of lnA and lnUR are all stationary. Therefore, the time series data of these two indexes meet the requirement of stationarity. In other words, we can conduct OLSR on the data of these two time series.

4.2. OLSR analysis

We load the data in Table 3 into model (1) and use EViews 8 to

Table 4
ADF test results of lnA and lnUR.

lnA	1% level	5% level	10% level	t-Statistic	Prob.	Conclusion
Original sequence	−2.7549	−1.9709	−1.6036	−1.4262	0.1368	Non-stationary
One order difference	−2.7549	−1.9709	−1.6036	−0.7039	0.3921	Non-stationary
Second order difference	−2.7719	−1.9740	−1.6029	−1.9097	0.0566	Stationary ***
lnUR	1% level	5% level	10% level	t-Statistic	Prob.	Conclusion
Original sequence	−2.7406	−1.9684	−1.6043	7.0030	1.0000	Non-stationary
One order difference	−2.7549	−1.9709	−1.6036	0.7753	0.8684	Non-stationary
Second order difference	−2.7719	−1.9740	−1.6029	−2.5936	0.0144	Stationary **

Note: * is 1% significant level, ** is 5% significant level, *** is 10% significant level.

Table 5
Regression results of lnA on lnUR.

Variable	Coefficient	Std. error	t-Statistic	Prob.
lnA	0.725389	0.053973	13.43977	0.0000
C	0.104989	0.025017	4.196754	0.0010
R^2	0.932861	Mean dependent var		0.369393
Adjusted R^2	0.927696	S.D. dependent var		0.222577
S.E. of regression	0.059849	Akaike info criterion		−2.670404
Sum squared resid	0.046565	Schwarz criterion		−2.575997
Log likelihood	22.02803	Hannan-Quinn criter.		−2.671410
F-statistic	180.6275	Durbin-Watson stat		0.898950
Prob (F-statistic)	0.000000			

conduct regression analysis on the relationship between lnA and lnUR. The results are shown in Table 5.

According to the results of the regression shown in Table 5, the estimated regression formula of model (1) is:

$$\text{lnUR} = 0.101989 + 0.725389\text{lnA} \quad (2)$$

and

$R^2 = 0.9328861$
Adjusted $R^2 = 0.927696$
Prob (F-statistic) = 0.000000

R^2 of Formula (2) shows that 93.2861% of the total variation of the observed value of the dependent variable can be explained by Formula (2). Adjusted R^2 is 0.927696. This shows that the goodness of fit of Formula (2) is good. Prob (F-statistic) = 0.000000. This shows that Formula (2) passes the significant test at the 1% significant level. That is to say, the model is significantly effective on the whole. The independent variable lnA (1%) passes the significance test of regression coefficient (t-Statistic) at the 1% significant level. This means that the independent variable lnA has significant effect on the dependent variable lnUR. Overall, the results show that from 2000 to 2014, there is a positive relationship between the level of technology innovation and new-type urbanization in Shaanxi province, and that the level of technology innovation has significant effect on the level of new-type urbanization.

4.3. Co-integration test

Co-integration test is to examine whether the causal relationship described by the regression equation is a pseudo one. In other words, it tests whether there is a long-term stable relationship between the variables. For example, variable *A* and variable *B* are influenced by variable *C* simultaneously. *A* and *B* rise or fall with the same trend. If we analyze the relationship between A and B with regression analysis, we will find that they are highly relevant. However, this regression is a pseudo one.

Because the second order difference of lnA and lnUR are all stationary, lnA and lnUR meet the premise of co-integration test. Co-integration test usually applies the JJ method proposed by Johnson (1990) and Juselius (1992). When we conduct JJ test, we choose the status when linear trend in time series exists, trend in co-integration equation exists, and intercept in co-integration equation does not exist. we use AIC and SC criteria to determine the optimal lag order of the VAR model, reduce it by 1, and then get the lag order of co-integration equation.

We use EViews 8 to test the optimal lag order of the VAR model of lnA and lnUR. The results are shown in Table 6.

Table 6 shows that the optimal lag order of the VAR model for lnA and lnUR is 1. So the lag order of the co-integration equation is 0. After determining the parameters of co-integration test, we use JJ method to conduct co-integration test on lnA and lnUR. The results are shown in Table 7.

Table 7 shows that after the trace statistics method and the maximum eigenvalue statistics method are applied, there is only one co-integration equation of technology innovation (lnA) and new-type urbanization (lnUR) at the 5% significance level. In other words, there is a long-term stable equilibrium relationship between lnA and lnUR. The regression is not a pseudo one.

4.4. Correlation test

The influence of technology innovation on new-type urbanization can be manifested through three indicators: (1) technology innovation's influence on employment structure in population urbanization; (2) technology innovation's influence on industrial structure in economy urbanization; (3) and technology innovation's influence on equalization of public services and the integration of urban and rural areas in society urbanization. We conduct Pearson correlation test on technology innovation and all indices of new-type urbanization to find out whether the indices of new-type urbanization are significantly correlated with technology innovation. X_1–X_{12} represent the indices of new-type urbanization. We use SPSS20.0 to conduct Pearson correlation test on technology innovation and all the indices of new-type urbanization. The results are shown in Table 8.

Table 8 shows that the Pearson correlation coefficient between technology innovation and the proportion of non-agricultural population, the proportion of urban employment to total employment, per capita GDP in Shaanxi province, total investment in fixed assets, total retail sales of social consumer goods, urban disposable income per capita, and the amount of public transport vehicles per ten thousand people are 0.991 0.982, 0.996, 0.982, 0.994, 0.998, 0.978, respectively. These values indicate that the positive correlation between technology innovation and these indices are very high at the 1% significance level. The Pearson correlation coefficient between technology innovation and the amount of doctors per thousand people is 0.667, which indicates that the positive correlation between them is moderate. The Pearson correlation coefficients between technology innovation and the proportion of tertiary industry output value to GDP, income per capita ratio of urban and rural residents are −0.589 and −0.600, respectively. This indicates that the negative correlation is moderate at the 5% significance level. The Pearson correlation coefficient between technology innovation and the proportion of employees in the tertiary industry and the 1-Engel coefficient are −0.443 and 0.190, respectively. The two values are not significant neither at the 1% level nor at the 5% level. Overall, the results the correlation test indicate that the correlation between technology innovation and the 10 indices out of the 12

Table 6
Lag order test of VAR model.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	17.08722	NA	0.000278	−2.514537	−2.433719	−2.544458
1	59.32702	63.35969*	4.84e-07*	−8.887836*	−8.645383*	−8.977601*
2	60.19107	1.008065	8.89e-07	−8.365179	−7.961090	−8.514787
3	62.44683	1.879796	1.49e-06	−8.074471	−7.508747	−8.283923

Note: * indicates the optimal number of lag order selected by the corresponding criteria.

Table 7
Results of co-integration test.

Unrestricted co-integration rank test (trace)

Hypothesized no. of CE(s)	Eigenvalue	Trace statistic	0.05 Critical value	Prob.**
None *	0.875643	30.96935	15.49471	0.0001
At most 1	0.119705	1.784973	3.841466	0.1815

Unrestricted co-integration rank test (maximum eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Max-Eigen statistic	0.05 Critical value	Prob.**
None *	0.875643	29.18437	14.26460	0.0001
At most 1	0.119705	1.784973	3.841466	0.1815

Note: * is 1% significant level, ** is 5% significant level.

indices of new-type urbanization are significant. These results support that there is a positive correlation between the level of technology innovation and new-type urbanization in Shaanxi province.

5. Conclusions

The unprecedented rate of urbanization requires smarter ways to manage the accompanying challenges in urban areas (Nam and Pardo, 2011b). Technology innovation is approached to solve tangled and wicked problems inherited in the rapid urbanization. In the past three decades, market reform and globalization drove a massive rural-urban migration in China (Lin and Yi, 2011). China has experienced vigorous urbanization since 1978 (Chen et al., 2016). This economy-centered was thought as a means of GDP growth rather than a natural historical process of aggregation of resources in China. The misunderstanding of urbanization and the extensive development of urbanization caused social issues in the past, such as high housing prices, land finance, housing demolition contradiction. Accordingly, the coordinated development between technology innovation and new-type urbanization must be achieved. Sustainable development is the correct approach to promote population urbanization, economy urbanization, and society urbanization (Hu and Wang, 2012).

To explore the relationship between technology innovation and the new-type urbanization, this paper develops a comprehensive evaluation index system. Data from Shaanxi province between 2000 and 2014 are loaded into this index system. Then a variation coefficient method is applied to calculate the comprehensive level of technology innovation and the new-type urbanization. Based on the result of calculation, this paper proposes a model to describe the relationship between technology innovation and the new-type urbanization. Tests are performed to examine the proposed model.

The following conclusions can be reached based on the test. (1) From 2000 to 2014, the level of technology innovation and new-type urbanization in Shaanxi province grew rapidly. (2) There is a positive correlation between technology innovation and new-type urbanization. Technology innovation significantly impacts on new-type urbanization. There is a long-term stable equilibrium relationship between them. (3) There are significant positive correlations between technology innovation and the indices of population urbanization, economy urbanization, and society urbanization on the whole.

The results of the test in this paper also show that science and technology are the first productive forces and the powerful driving forces for new-type urbanization. At present, Shaanxi province is taking urbanization as the core of its strategic development. Guanzhong Urban Agglomeration is a pattern for new-type urbanization with the characteristics of One Core, Two Axes, Three Corridors, and Four Poles.

Here are some recommendations to achieve comprehensive development of population urbanization, economy urbanization, and society urbanization. (1) Promote population urbanization with technology innovation. Strengthen personnel training and team building, because technology talent is the key to realize the role of technology innovation in new-type urbanization. New-type urbanization requires technology projects and pertinent financial funds, which need talents badly. (2) Promote economy urbanization with technology innovation. Promote industrial upgrading. Increase investments in science and technology. Take advantage of traditional science and technology resources in Shaanxi province, especially in Xi'an City. Catch opportunities in the Belt and Road strategy (Xu, 2016b). Promote the transformation of science and technological achievements through college-enterprise union and patent market. Upgrade high pollution and high energy consumption industries to green environmental protection ones. Pay more attention to the transformation efficiency of science and technological achievements to the tertiary industry. Increase the contribution of technology innovation to the tertiary industry. (3) Promote society urbanization with technology innovation. Achieve equalization of public services between urban and rural residents. Narrow the gap

Table 8
Correlation between technology innovation and the indices of new-type urbanization in Shaanxi province.

Index	Index code	Pearson correlation	Significance (two-tailed)
Proportion of non-agricultural population (%)	X_1	0.991*	0.000
Proportion of the employment in tertiary industry (%)	X_2	−0.443	0.098
Proportion of urban employment to total employment (%)	X_3	0.982*	0.000
Amount of doctors per thousand persons	X_4	0.667*	0.007
Per capita GDP in Shaanxi (yuan)	X_5	0.996*	0.000
Total investment in fixed assets (billion yuan)	X_6	0.982*	0.000
Proportion of tertiary industry output value to GDP (%)	X_7	−0.589**	0.021
Total retail sales of social consumer goods (billion yuan)	X_8	0.994*	0.000
Urban per capita disposable income (yuan)	X_9	0.998*	0.000
Per capita income ratio of urban and rural residents (%)	X_{10}	−0.600**	0.018
1-Engel's coefficient	X_{11}	0.190	0.498
Amount of public transport vehicles per ten thousand person	X_{12}	0.978*	0.000

Note: * is 1% significant level, ** is 5% significant level.

between urban and rural areas. Currently, public services, facilities, infrastructure construction in rural areas are not well developed. As a result, rural residents do not have convenient access to transportation, health care, and education. Promote the transformation efficiency of science and technological achievements. Increase public transport and use information technology to develop e-learning and to build network for medical treatment.

References

Al-Hader, M., Rodzi, A., 2009. The smart city infrastructure development & monitoring. Theor. Empi. Res. Urban Manag. 4 (2), 87–94.

Beckett, R., Vachhrajani, H., 2017. Transdisciplinary innovation: connecting ideas from professional and user networks. J. Ind. Integr. Manag. 2 (4). http://dx.doi.org/10.1142/S2424862217500166.

Bi, Z., Xu, L., Wang, C., 2014. Internet of things for enterprise systems of modern manufacturing. IEEE Trans. Ind. Inf. 10 (2), 1537–1546.

Boer, H., During, W.E., 2001. Innovation, what innovation? A comparison between product, process, and organizational innovation. Int. J. Technol. Manag. 22, 83–107.

Boyne, G.A., Meier, K.J., O'Toole Jr., L.J., Walker, R.M., 2006. Public Service Performance. Perspectives on Measurement and Management. Cambridge University Press, Cambridge.

Buhaug, H., Urdal, H., 2013. An urbanization bomb? Population growth and social disorder in cities. Glob. Environ. Chang. 23 (1), 1–10.

Button, K.J., 1976. Urban Economics: Theory and Policy. Springer.

Camagni, R., Capello, R., 1999. Innovation and Performance of SMEs in Italy: The Relevance of Spatial Aspects. In: Innovation, Networks and Localities. Springer, Berlin, Heidelberg, pp. 181–214.

Chan, K.W., 2014. China's urbanization 2020: a new blueprint and direction. Eur. Geogr. Econ. 55 (1), 1–9.

Chan, K.W., Hu, Y., 2003. Urbanization in China in the 1990s: new definition, different series, and revised trends. China Rev. 49–71.

Chen, H., 2017. Applications of cyber-physical system: a literature review. J. Ind. Integr. Manag. 2 (3). http://dx.doi.org/10.1142/S2424862217500129.

Chen, M., Liu, W., Lu, D., 2016. Challenges and the way forward in China's new-type urbanization. Land Use Policy 55, 334–339.

Chenery, H.B., 1975. The structuralist approach to development policy. Am. Econ. Rev. 65 (2), 310–316.

Cheng, Y., Chen, K., Sun, H., Zhang, Y., Tao, F., 2018. Data and knowledge mining with big data towards smart production. J. Ind. Inform. Integr. 9, 1–13. http://dx.doi.org/10.1016/j.jii.2017.08.001.

China's National Development and Reform Commission. (2014). Guojia Xinxing Chengzhenhua Guiua (2014e2020) (in Chinese). ("National New-type Urbanization. Plan") Accessed 5.02.15 http://www.gov.cn/zhengce/2014-03/16/content_2640075.htm

Christensen, C.M., Anthony, S.D., Roth, E.A., 2004. Seeing What's Next: Using the Theories of Innovation to Predict Industry Change. Harvard Business School Publishing, Boston, IL.

Damanpour, F., Walker, R.M., Avellaneda, C.N., 2009. Combinative effects of innovation types and organizational performance: a longitudinal study of service organizations. J. Manag. Stud. 46 (4), 650–675.

Ding, M.L., Chen, B.M., 2013. Research on the New Ideas and Countermeasures of New Urbanization Supported by Science and Technology Innovation. Sci. Manag. Res. 4.

Dirks, S., Keeling, M., 2009. A vision of smarter cities: how cities can lead the way into a prosperous and sustainable future. 8 IBM Institute for business, Value.

Dodgson, M., Gann, D., 2011. Technological innovation and complex systems in cities. J. Urban Technol. 18 (3), 101–113.

Duan, L., Binbasioglu, M., 2017. An ensemble framework for community detection. J. Ind. Inform. Integr. 5, 1–5. http://dx.doi.org/10.1016/j.jii.2017.01.001.

Duranton, G., Puga, D., 2004. Micro-foundations of urban agglomeration economies. In: Handbook of Regional and Urban Economics. vol. 4. Elsevier, pp. 2063–2117.

Fan, C.C., 2008. China on the Move: Migration, the State, and the Household. London, UK. Routledge, New York, NY.

Fan, Y., 2017. Research on factors influencing an individual's behavior of energy management: a field study in China. J. Manag. Anal. 4 (3), 203–239. http://dx.doi.org/10.1080/23270012.2017.1310000.

Fang, C., Ma, H., Wang, J., 2015. A regional categorization for "new-type urbanization" in China. PLoS One 10 (8), e0134253.

Feng, S., Xu, L. (1993) Simulating large complex societal systems. Int. J. Comp. Simul., 3, 97–105.

Feng, S., Xu, L., 1992. Dynamic simulation of demographic-economic systems in developing countries. Inf. Decis. Technol. (formerly Large Scale Systems) 18, 363–374.

Feng, S., Xu, L., 2000. Mathematical modeling of China's state-owned enterprises' contract system. Eur. J. Oper. Res. 124, 235–242. https://doi.org/10.1016/S0377-2217(99)00377-X.

Frenken, K., Van Oort, F., Verburg, T., 2007. Related variety, unrelated variety and regional economic growth. Reg. Stud. 41 (5), 685–697.

Gan, D.L., 2014. Research on the Coordinated Development Policy of Science and Technology Innovation and New Urbanization. Sci. Technol. Prog. Policy 6.

Giuliani, E., Bell, M., 2005. The micro-determinants of meso-level learning and innovation: evidence from a Chilean wine cluster. Res. Policy 34 (1), 47–68.

Graf, H., 2010. Gatekeepers in regional networks of innovators. Camb. J. Econ. 35 (1), 173–198.

Gu, S.Z., 2012. Reflection on the five tendencies in the development of urbanization. Chin. J. Pop. Sci. 3.

Gürdür, D., Asplund, F., 2018. A systematic review to merge discourses: interoperability, integration and cyber-physical systems. J. Ind. Inform. Integr. 9, 14–23. http://dx.doi.org/10.1016/j.jii.2017.12.001.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., Williams, P., 2010. Foundations for smarter cities. IBM J. Res. Dev. 54 (4).

He, X.Q., 2014. Research on the Problems and Countermeasures of Spontaneous Urbanization in China. Sichuan Normal University.

He, W., Xu, L., Means, T., Wang, P., 2009. Integrating Web 2.0 with the case-based reasoning cycle: a systems approach. Syst. Res. Behav. Sci. 26(6), 717–728. (2009). https://doi.org/10.1002/sres.976.

Henderson, J. V., Quigley, J., & Lim, E. (2009). Urbanization in China: Policy Issues and Options. Unpublished manuscript, Brown University.

Herstad, S., Pålshaugen, Ø., Ebersberger, B., 2011. Industrial innovation collaboration in a capital region context. J. Knowl. Econ. 2 (4), 507–532.

Hisrich, R., Ge, B., Gao, H., Sheng, F., 2016. Frontiers on research of innovation and entrepreneurship: review of the keynotes of "the 2015 international conference on innovation and entrepreneurship". J. Ind. Integr. Manag. 1 (2). http://dx.doi.org/10.1142/S2424862216500068.

Hollands, R.G., 2008. Will the real smart city please stand up? City 12 (3), 303–320.

Homer-Dixon, T.F., 1999. Environment, Scarcity and Conflict. Princeton University.

Homer-Dixon, T.F., 2010. Environment, Scarcity, and Violence. Princeton University Press.

Homer-Dixon, T., Blitt, J., 1998. Ecoviolence: Links among Environment, Population, and Security. Rowman & Littlefield Publishers.

Hsing, Y.T., 2010. The Great Urban Transformation. Oxford University Press, New York, NY.

Hu, Z.Y., Wang, R., 2012. Research on synergy of industrialization, Urbanization and Science and Technology Innovation. Sci. Manag. Res. 6.

Huang, H.Q., 2006. Analysis on the Coordinated Development of Urbanization and Industrialization in China. Stud. Explor. 2.

Ianuale, N., Schiavon, D., Capobianco, E., 2015. Smart cities and urban networks: are smart networks what we need? J. Manag. Anal. 2 (4), 285–294. http://dx.doi.org/10.1080/23270012.2015.1023856.

Isaksen, A., Aslesen, H.W., 2001. Oslo: in what way an innovative city? Eur. Plan. Stud. 9 (7), 871–887.

Johnson, D.R., 1990. Co-integration, error and purchasing power parity between Canada and the United States. Can. J. Econ. 839–855.

Juselius, K., 1992. Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK. J. Econ. 53 (1–3), 211–244.

Kim, J., 2017. A review of cyber-physical system research relevant to the emerging IT trends: industry 4.0, IoT, Big Data, and Cloud Computing. J. Ind. Integr. Manag. 2 (3). http://dx.doi.org/10.1142/S2424862217500117.

Krätke, S., 2012. The creative capital of cities: Interactive knowledge creation and the urbanization economies of innovation (Vol. 79). John Wiley & Sons.

Lazaric, N., Longhi, C., Thomas, C., 2008. Gatekeepers of knowledge versus platforms of knowledge: from potential to realized absorptive capacity. Reg. Stud. 42 (6), 837–852.

Lewis, W.A., 1954. Economic development with unlimited supplies of labour. Manch. Sch. 22 (2), 139–191.

Li, L., 2013. The path to made-in-China: how it was done and future prospects. Int. J. Prod. Econ. 146 (1), 4–13.

Li, L. (2017). China's manufacturing locus in 2025: With a comparison of "Made-in-China 2025" and "Industry 4.0". *Technological Forecasting and Social Change*, online published. 10.1016/j.techfore.2017.05.028

Li, L., Zhou, H., 2013. Manufacturing practices in China. Int. J. Prod. Econ. 146 (1), 1–3.

Li, S., Xu, L.D., Zhao, S., 2015. The internet of things: a survey. Inf. Syst. Front. 17 (2), 243–259.

Li, S., Xu, L.D., & Zhao, S. (2018). 5G internet of things: a survey. *Journal of Industrial Information Integration*, online published. 10.1016/j.jii.2018.01.005.

Lin, G.C., 2009. Developing China: Land, Politics, and Social Conditions. Routledge, London, UK.

Lin, G.C., Yi, F., 2011. Urbanization of capital or capitalization on urban land? Land development and local public finance in urbanizing China. Urban Geogr. 32 (1), 50–79.

Liu, Y., Xiao, H., Lv, Y., Zhang, N., 2017. The effect of new-type urbanization on energy consumption in China: a spatial econometric analysis. J. Clean. Prod. 163, S299–S305.

Lu, Y., 2017. Industry 4.0: a survey on technologies, applications and open research issues. J. Ind. Inform. Integr. 6, 1–10.

McGee, T., Lin, G.C., Wang, M., Marton, A., Wu, J., 2007. China's Urban Space: Development under Market Socialism. Routledge.

Nam, T., Pardo, T.A., 2011a. Conceptualizing smart city with dimensions of technology, people, and institutions. In: Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times. ACM, pp. 282–291.

Nam, T., Pardo, T.A., 2011b. Smart city as urban innovation: Focusing on management, policy, and context. In: Proceedings of the 5th international conference on theory and practice of electronic governance. ACM, pp. 185–194.

Naphade, M., Banavar, G., Harrison, C., Paraszczak, J., Morris, R., 2011. Smarter cities and their innovation challenges. Computer 44 (6), 32–39.

Oliverio, J., 2018. A survey of social media, big data, data mining, and analytics. J. Ind. Integr. Manag. 3 (2). http://dx.doi.org/10.1142/S2424862218500033.

Pannell, C.W., 2002. China's continuing urban transition. Environ. Plan. A 34 (9), 1571–1589.

Porter, M.E., 2011. Competitive advantage of nations: creating and sustaining superior performance. vol. 2 Simon and Schuster.
Rosenthal, S.S., Strange, W.C., 2004. Evidence on the nature and sources of agglomeration economies. In: Handbook of regional and urban economics. vol. 4. Elsevier, pp. 2119–2171.
Simmie, J., 2001. Innovative Cities. Spon Press, Taylor and Francis, London.
Simmie, J., 2003. Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge. Reg. Stud. 37 (6–7), 607–620.
Simmie, J., 2004. Innovation and clustering in the globalised international economy. Urban Stud. 41 (5–6), 1095–1112.
Spangler, W.S., Kreulen, J.T., Chen, Y., Proctor, L., Alba, A., Lelescu, A., Behal, A., 2010. A smarter process for sensing the information space. IBM J. Res. Dev. 54 (4), 1–13.
Tidd, J., Besant, J., Pavitt, K., 2001. Managing Innovation, 2nd edition. John Wiley & Sons, Chichester.
Toppeta, D., 2010. The smart city vision: how innovation and ICT can build smart, "livable", sustainable cities. Innov. Knowl. Found. 5, 1–9.
United Nations, 2010. World Urbanization Prospects: The 2009 Revision-Highlights, 2010. http://esa.un.org/unpd/wup/doc_highlights.htm.
Viriyasitavat, W., Martin, A., 2017. The reviews and analysis of the state-of-the-art service workflow specification languages. J. Ind. Inform. Integr. 8, 1–7. http://dx.doi.org/10.1016/j.jii.2017.07.002.
Wang, X.R., Hui, E.C.M., Choguill, C., Jia, S.H., 2015. The new urbanization policy in China: which way forward? Habitat Int. 47, 279–284.
Wang, P., Chaudhry, S., Li, L., 2016. Introduction: advances in IoT research and applications. Internet Res. 26 (2).
Wu, S., Xu, L., He, W., 2009. Industry-oriented enterprise resource planning. Enterp. Inf. Syst. 3 (4), 409–424, 2009. http://dx.doi.org/10.1080/17517570903100511.
Xu, L., 2011. Enterprise systems: state-of-the-art and future trends. IEEE Trans. Ind. Inf. 7 (4), 630–640. http://dx.doi.org/10.1109/TII.2011.2167156.
Xu, L., 2016a. Inaugural issue editorial. J. Ind. Inform. Integr. 1, 1–2. http://dx.doi.org/10.1016/j.jii.2016.04.001.
Xu, L., 2016b. An internet-of-things initiative for One Belt One Road (OBOR). Front. Eng. Manag. 3 (3), 206–223. (2016). 10.15302/J-FEM-2016039.
Xu, L., Duan, L. (2018): Big data for cyber physical systems in industry 4.0: a survey. *Enterprise Information Systems*, online published. DOI: 10.1080/17517575.2018.1442934.
Xu, L., Viriyasitavat, W., 2014. A novel architecture for requirement-oriented participation decision in service workflows. IEEE Trans. Ind. Inf. 10 (2), 1478–1485. http://dx.doi.org/10.1109/TII.2014.2301378.
Xu, L., He, W., Li, S., 2014. Internet of things in industries: a survey. IEEE Trans. Ind. Inf. 10 (4), 2233–2243.
Xu, L., Cai, L., Zhao, S., Ge, B., 2016. Editorial: inaugural issue. J. Ind. Integr. Manag. 1 (1). http://dx.doi.org/10.1142/S2424862216010016.
Xu, B., Xu, L., Cai, H., Jiang, L., Luo, Y., Gu, Y., 2017. The design of an M-health monitoring system based on a cloud computing platform. Enterp. Inf. Syst. 11 (1), 17–36. http://dx.doi.org/10.1080/17517575.2015.1053416.
Xu, L., Xu, E., Li, L. (2018) Industry 4.0: state of the art and future trends. *International Journal of Production Research*, online published. DOI: 10.1080/00207543.2018.1444806.
Yang, B., Hu, Y., Fang, H., Song, C., 2017. Research on arrangement scheme of magnetic suspension isolator for multi-degree freedom vibration isolation system. J. Ind. Inform. Integr. 6, 47–55. http://dx.doi.org/10.1016/j.jii.2017.04.003.
Yuan, B., Liu, F.C., 2014. Study on the Identification of Influencing Factors of Interactive Development between Innovation and Urbanization. In: International Conference on Social Science (ICSS).
Zhang, K.H., Song, S.F., 2003. Rural-urban migration and urbanization in China: evidence from time-series and cross-section analyses. China Econ. Rev. 14 (4), 386–400.
Zhen, X.F., 2013. Science and Technology Innovation and the Construction of New Rural Urbanization. J. Northwest A&F Univ. 3.
Zhou, Y.X., Ma, L.J., 2003. China's urbanization levels: reconstructing a baseline from the fifth population census. China Q. 173, 176–196.

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