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ABSTRACT

Integration of Technological and Social Components in a Smart Urban Development Model: A Case Study of China

The path of urbanization around the world and in particular in China has been rapid. This study addresses measurement of a composite index of networking among key components of societal infrastructure and how it affects the process of urbanization. This study has a number of objectives. First we identify key determinants of public infrastructure components in China at the province level. Second a multidimensional index of the networking among the components is computed. The index belongs to parametric family of composite indices. It is composed of a number of components: Economic, Hospitality, Public Facilities, Human Development, and Communication Facility. Each component of the index is composed of a number of indicators. The index is used to rank provinces in China by development of level of the networking among public infrastructure components. In another step we estimate the effects of the composite index and its underlying components on urbanization. Finally, the findings is used to achieve smooth urbanization strategy for Chinese provinces. The empirical results are based on China's province level data covering the period 2005-2014. Our investigations provide evidence that integration of technological and social components are necessary to promote the development of an optimal and a smart urban development model. The necessity of an optimal and targeted urban infrastructure investment strategy emerges from our analysis. We briefly discuss the possible lessons learned from some of the successful provincial urbanization strategies.

JEL Classification: D31, I10, I20, I30, J13

Keywords: multidimensional index, composite index, principal component, urban infrastructure, China's provinces

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1. INTRODUCTION

Nowadays, "People-Oriented Smart Cities" and challenges related to their constructions are among the hot research topics around the world. People-oriented smart cities are considered to be the next generation of our modern cities in which humans are at the center of their innovation models (Christopoulou et al., 2014). Urban development with its focus on people-oriented smart cities has the potential to create not just economic benefits but also social benefits for the people who live in them. That is why most developed and developing countries have noticed the need for further changes and transformations of their large cities (Carpenter, 1960; Connell, 1984; Mohan, 1985; Cohen, 2006; Aerni, 2010). City leaders and practitioners from all over the world, are targeting this new urban development transformation to improve the quality of their citizen's lives.

Despite all the great ideas developed on how to design people-oriented smart cities and to make them more sustainable and livable, less is known on what attract a large number of rural populations into such modern cities. Adoption of our modern cities to the gradual increase in their populations requires an in-depth understanding of how various social, economic, cultural and technological factors impact the process of urbanization. This actually is in line with Castells' vision of the network society where networks have become the basic units of a modern society and they shape its structures (Castells, 2011).

In this article we argue that the networking among key components of infrastructure within our societies influences urbanization. This networking leads to the emergence of a network among variety of societal constructs such as culture, economic, education, environment, infrastructure, housing, human development, social security and services, technology, and utilities. This network represents the dynamic interplay among the key components of infrastructure within our societies which impacts people's lives, and it consequently attracts more people to regions where infrastructure is most developed. Therefore, in this paper, we aim to show that different components of infrastructure within our societies may have different level of influence on the process of urbanization. Identification of key components of infrastructures with the highest level of influence has this potential to explain how and why cities grow and consequently they transform to modern cities.

This study addresses measurement of a composite index of networking and how it affects the process of urbanization. The empirical results are based on China's province level data covering the period 2005-2014. This study computes a multidimensional index parametrically. This index is composed of a number of components each composed of several indicators. The index is used to rank provinces in China by level of the networking among public infrastructure. Our investigations provide evidence that integration of technological and social components are necessary to promote the development of an optimal and a smart urban development model. The necessity of an optimal and targeted urban infrastructure investment strategy emerges from our analysis. We discuss strategies to promote the development of an optimal urban development model that is conductive with urbanization in China.

Rest of this study is organized as follows. Section 2 reviews urbanization and its development in China. Section 3 describes the data and variables used. Estimation of the key components of the societal infrastructure is presented in Section 4. The results and variations in urbanization and infrastructures across the provinces, regions and over time is discussed in Section 5. The relationship between urbanization and its determinants is analyzed in Section 6. The final section concludes and provide policy recommendations.

2. URBANIZATION IN CHINA

China similar to other countries has started undertaking its urban development transformation, following the EU's success during the course of urbanization. China with the largest urban population in the world has been experiencing a dramatic growth in urbanization since 1978 (Chen, 2007). According to National Bureau of Statistics of China at 2010, nearly 40% of people living in urban areas are migrants. The number of cities with the population more than 1 million or more keeps on rising while the number of those with fewer than 20,000 inhabitants has decreased substantially (Lin, 2002).

Despite the existence of some controversies (Chang and Brada, 2006), most scholars and China's policy makers have considered the country's growing urbanization levels as a sign of progress. Hence, acceleration of urbanization has become a central part of China's strategy for sustainable growth (Liu et al., 2003). Urbanization has its advantages as well as disadvantages which we briefly point to some of them in the following.

In particular, urban areas are valued because one can select from verities of opportunities and a wider array of goods, one can obtain a superior school education versus what is available within rural boundedness (Guldin, 1996). However, there are also risks associated to the process of urbanization. For instance, Peng Gong et al. in (Gong et al., 2012) discussed health risks associated with urbanization and they argued that health benefits continue to accrue to urban populations, who have better access to health services and education and higher incomes than do their rural counterparts. The authors pointed to the fact that high quality health care can be considered as a factor driving migration to urban areas. Using the community and individual level longitudinal data, authors in (Van de Poel et al., 2009) also estimated the net health impact of China's unprecedented urbanization. They constructed an index of *urbanicity* from a broad set of community characteristics and define urbanization in terms of movements across the distribution of this index. The results of that study revealed negative causal effects of urbanization on health. Risks associated with urbanization are not only limited to the case of health. Urbanization results in heavier environmental pressures such as an increased food supply gap (Zhu, 2011). It also increases the risk of soil pollution through waste disposal and acid disposition derived from urban air pollution (Chen, 2007).

According to (Chen, 2006), China has underrepresented urbanization statistics due to industrial growth in rural areas not being counted as part of the urbanized population (as nonagricultural work). Urbanization in China appears to have fallen behind its nonfarm employment and industrialization because statistics fail to represent it accurately (Yixing and Ma, 2003; Chen, 2006). Other researchers also suggested that the nonagricultural population of the designated cities and towns is a more appropriate indicator of China's urbanization level (Ma Laurence and MaCui, 1987; Song et al., 2012), and that is because mobile population in China (i.e., those who are living temporarily in the designated cities and towns but maintain household registration) have never been systematically enumerated in the indicators of urbanization.

The rate of China's urban growth has been driven by many important factors such as economic reforms, migration policies, income disparities, surplus agricultural laborers, and conversion of farmland for urban use (Gong et al., 2012). This rate of urbanization continuum may differ between north and south, coast and interior, and prosperous and less developed areas. Most mega cities in China are located at the coastal areas with the eastern coast urbanizing the most (Zhang, 2008).

There are some studies in the literature that consider a specific China's province and aim to link its level of urbanization with its economic development, and to address the socioeconomic repercussions of the urbanization process. Using the example of Fujian to address urbanization in China, Chen argues that issues of how to create nonfarm jobs and the socioeconomic consequences of urbanization need to be addressed (Chen, 2006). In discussing Fujian, the author describes several unique features, including their costal economy, smaller agricultural economy, a lighter state enterprise burden (due to failing SOEs) and the regionally higher rate of urbanization in southern Fujian as compared to northern. Most importantly as in the case of Fuijan the government fails to be able to answer the question of how to create jobs for farmers who are leaving their land. In addition to that another study, using the example of Guizhou province, authors suggest that migrants in China's eastern region are more likely to remit. This indicates that the eastern region of China is already linked to the development of the migrant-sending province of Guizhou (Liang et al., 2013)

Comparing to previous studies on urbanization in China, the present study, with its focus on the key components of infrastructure within China's provinces, aims to address the followings. First we identify key determinants of infrastructure components in China at the province level. Second a multidimensional index of the networking among the components is computed. The index is used to rank provinces in China by the development level of the networking among public infrastructure components. In another step we estimate the effects of the composite networking index and its underlying components on urbanization. Finally, the findings is used in an effort to define an optimal and targeted urban infrastructure investment strategy. We quantify the level and temporal patterns of networking for ranking provinces in China. Our proposed networking index belong to parametric family of composite indices. The index is composed of a number of components: Economic, Hospitality, Public Facilities, Human Development, and Communication Facility. Each component of the index is composed of a number of indicators. The indicators are selected such that they are highly correlated within the specific component but independent between individual components. The composite index reduces the complexity of the set of indicators and simplifies the ranking of provinces. Our investigations provide evidence that integration of technological and social components are necessary to promote the development of an optimal and a smart urban development model.

3. THE DATA

The data set used in our analysis is collected from China's National Bureau of Statistics (NBS) for the period 2005-2014. Our dataset includes a large number of attributes related to key components of public societal infrastructure within 31 China's provinces (distributed in 6 regions). Therefore, in total we have 310 observations in our dataset. The dataset includes attributes related to culture, economy, education, environment, infrastructure, housing, human development, social security and services, technology, and utilities. We selected 28 attributes (variables) out of the existing ones and we define our 29^{th} variable as the combination of those 28 attributes introduced in our model. According to our data, we first identify key determinants of networking among infrastructure components in China at the province level. Then, we make use of the panel data structure to build a multidimensional index of networking among infrastructure components. Later, we use our multidimensional index to rank provinces in China by the development level of the networking among public infrastructure components.

We estimate five composite urbanization indices including: Economic, Human Development, Communication Facility, Public Facilities infrastructure and Hospitality. Each of these indices have been estimated based on several indicators. A sixth composite index which embodies all the above mentioned 5 components is also estimated.

The first index (component) in our model is the Economic index. The Economic index is selected based on the idea that regions which have better economic conditions attract more migrants. This index of our model is composed of four indicators. These indicators are: Total Population, Per Capita Annual Consumption/Expenditure of Urban Households, Overall Labor Productivity (In Terms of Value-added), and finally Minimum Living Indemnification and Social Assistance. These economic indicators are among key factors enhancing urbanization flows.

The second index (component) in our model is the Human Development index. This index consists of four indicators which include Gross Regional Product, Population Life Expectancy, Number of Schools and Students in Undergraduate (or Specialized Courses in Institutions of Higher Education), and finally Total Value of Technical Market. A large variety of goods and services at rural areas encourage urbanization. Education and its access, for example, are drivers of urbanization.

The third index (component) of our model is labelled as Communication Facility. This component is constructed using four indicators. These include Business Volume of Postal and Telecommunication Services, Main Communication Capacity of Telecommunications, Telecommunication Services, and Main Indicators on Internet Development.

The fourth index (component) is the Public Facility index. It consists of six indicators which include Housing Conditions of Rural Households, Municipal Infrastructure in Cities, Public Transportation in Cities, Level of Public Facilities in Cities, Parks and Green Areas in Cities, and finally Community Service Facilities in Urban Areas.

The fifth index (component) of our model is labelled as Hospitality. This component has ten indicators which include statistics on Art Performance Places, Museums, Public Libraries, Population Coverage of Radio and TV Programs, Number of Published materials in China (i.e., Books, Magazines and Newspapers), Certified Athletes by Technical Grade, Certified

Coaches by Grade, Earnings from International Tourism and Composition, Number of Oversea Visitor Arrivals, and finally Assets and Liabilities of Enterprises (i.e., Size of Hotels).

Our final index (component) is a composite index of networking among key components of societal infrastructure. This component combines all the 28 introduced indicators of previous components in our model. The components include Economic, Human Development, Communication Facilities, Public Facilities, and Hospitality. The summary statistics of the urbanization data used in this study are presented in Table 1.

Insert Table 1 here

4. ESTIMATION OF THE KEY COMPONENTS OF SOCIETAL INFRASTRUCTURE

In this study, we utilized principal component analysis (PCA) to create our composite index (Hotelling, 1933; Kang, 2002; Grupp and Mogee, 2004; Heshmati and Oh, 2006). The composite index is constructed by the combination of five different sub-indices (i.e., Economic, Human Development, Communication Facility, Public Facility, and Hospitality). The main goal of applying a PCA analysis is to identify patterns in our data and to detect the correlation between introduced variables. PCA attempts to reduce the dimensionality of our data by finding a strong correlation between variables within same component. By finding the directions of maximum variance in high-dimensional data, and by projecting it onto a smaller dimensional subspace, we can retain most of the valuable information in our dataset. As we can see, the desired goal in PCA is to reduce the dimensions of a d-dimensional dataset by projecting it onto a k-dimensional subspace (where $k<d$). This results in increasing the computational efficiency while retaining most of the information. During PCA analysis, the computed eigenvectors (the principal components) of our dataset will be collected in a projection matrix. Each of those eigenvectors is associated with an eigenvalue. Eigenvalues are the magnitude of the corresponding eigenvector. Reduction of the d-dimensional dataset via PCA onto a smaller k-dimensional subspace is reasonable, if some eigenvalues have a significantly larger magnitude than others. Therefore, we can drop the less informative Eigen pairs.

PCA re-expresses our data as a linear combination of its basis vectors. Let X and Y be $m \times n$ matrices related by a linear transformation P.

(1) $$Y = BX + E$$

X is the original data set ($n \times j$ matrix, where j represents first j principal components and the n rows are the number of observations). E is a $p \times n$ matrix of residuals. B is the matrix of eigenvectors that transforms X into Y. Y is a re-representation of that data set ($n \times p$).

The first principal component (PC1) is the linear combination of x-variables that has maximum variance, so it accounts for as much variation in the data as possible. The second principal component (PC2) is the linear combination of x-variables that accounts for as much of the remaining variation as possible, with the constraint that the correlation between the first and second component is 0. Similarly, all subsequent principal components (PC i) have this same property, they are linear combinations that account for as much of the remaining variation as possible, and they are not correlated with the other principal components. The lack of correlation between different components is useful because it indicates that the indices measure different dimensions.

After measuring key determinants of infrastructure components by PCA, we build a multidimensional index. The model is estimated in both unrestricted and restricted forms. The unrestricted urbanization model is expressed as:

$$(2) \qquad Urban_{it} = \alpha_0 + \sum_{j=1} \alpha_j Index_{jit} + \mu_i + \alpha_t t + \alpha_{tt} t^2 + \varepsilon_{it}$$

where dependent variable is share of urbanized population (Urban) of province i in year t. The composite infrastructure indices (Index) are index components related to economics, human development, communication, housing facilities, and hospitality services. In addition province dummies (μ) a time trend (t) and its square are also included to capture the unobservable province and time effects. The error term (ε) captures random variations and measurement error in urbanization and effects of left out explanatory variables.

The model is estimated in unrestricted form with 5 composite infrastructure indices accounting for various dimensions, while in the aggregated form the overall index is used. In addition, the model specification controls for province and time-specific effects by using province dummies and time trend and time trend squared.

$$(3) \qquad Urban_{it} = \alpha_0 + \alpha_1 Index_{it} + \mu_i + \alpha_t t + \alpha_{tt} t^2 + \varepsilon_{it}$$

where Index is an aggregated infrastructure index for networking composed of the file components listed above in disaggregated form.

5. ANALYSIS OF THE RESULTS

We utilized a principal component analysis (PCA) to create our composite index. The obtained results of the principal component analysis of the introduced components and the overall index are presented in Table 2. Since eigenvalues are the variance of the principal components we only pick those which are bigger than 1.00 and utilize them in the computation of different indices. As an example consider Economic index. Only two of the Eigenvalues are bigger than one. The first principal component in Economic index has a variance of 2.03, explaining 51% of the total variance. The second principal component has a variance of 1.08, or 27% of the total variance. Therefore, the first two principal components explain the sum of the variances of the individual components, or 51+27=78% of the total variance. In case of indices where more than on principal component has eigenvalues bigger than one the principal components are aggregated using their shares of total variance explained. Traditionally researchers use only the first principal component in their analysis. The weighted average approach has the advantage that it utilizes contributions of all indicators to the index component constructed.

Insert Table 2 here

Similarly, we can obtain the number of Eigenvalues bigger than 1.00 and calculate the share of variance explained by these principal components for other indices. Our results show that the Human Development index has 1 Eigenvalue bigger than 1.00 which can explain 60% of the total variance. The Hospitality index has 3 Eigenvalues bigger than 1.00 which can explain 68% of the total variance. The Public Facility index has 2 Eigenvalues bigger than 1.00 which can explain 78% of the total variance. The Communication Facility index has 1 Eigenvalue bigger than 1.00 which can explain 66% of the total variance. Also, in overall index 5 principal components are bigger than one and all together explain 73% of all total variations. The contribution of the components to the explanation of the variance is reduced from 46% by the first component to 3% by the last component.

We also calculate the variations across the infrastructure components and the overall index. The result of our analysis is presented in Table 3. As it is shown, we categorize the result of our analysis based on the changes over time (Part C), changes among provinces (Part A) and among regions (Part B).

Insert Table 3 here

Average of performance of provinces ranked from high to low levels of the overall index is shown in Figure 1. The average numbers are further decomposed into underlying components of the infrastructure index. The figure provides a clear picture of contribution of specific components to each province ranking. For instance, in relative terms, Guangdon is best in community facility, Beijing in human development, Tiangin in economic, Zhejang in public facility, and Hellongj in hospitality.

Insert Figure 1 here

5.1 Variations across provinces

Table 3 part A reports the mean of five public urban infrastructure components and an overall index for each of the 31 provinces. The second column of this table shows the rate of urbanization in each province. Shanghai, Beijing, Tianjin, and Guangdong have the highest ratios of urbanized population in China. The provinces are ranked by descending order of the overall networking index in this table. The indices are normalized to vary in the interval zero and one measuring percentage performance compared with the best ranked (index value one) province in a given year.

This provincial difference in urbanization correlates strongly with economic situation of each province. In other words, provinces with higher economic index also have higher urbanized population. Based on the presented data in this table it is easy to identify the highest/lowest contributing components to a province. For instance, with respect to the Public Facility component, (Jiangsu/Tibet) province, with respect to Hospitality component (Guangdong/Tibet) province, with respect to Economic component (Guangdong/Qinghai) province, with respect to Communication Facility component (Guangdong/Tibet) province and finally with respect to the Human Development component (Beijing/Tibet) province, each has the highest and the lowest contributing values. Guangdong has the highest score for the Economic, Communication Facility and Hospitality components while Beijing has a better score with respect to the Human Development component. Except for the economic component, almost all of the remaining components have low scores in Tibet province. Beijing, Guangdon, Jiangsu, Shanghai, Zhejiang are ranked as the five provinces which have the highest networking index while Gansu, Guizhou, Ningxia, Qinghai and Tibet have the lowest scores for the networking index.

5.2 Variations across regions

We grouped the provinces by regional location into 6 groups as North, North East, East, Central, South East and North West regions. According to Table 3, part B, the North region has the highest ratios of urbanized population and South East region has the lowest. The highest/lowest contributing components to regional rank are: (East/North West) region for the Economic component, (East/North West) region for the Public Facility component, (East/North West) region for the Communication Facility component, (Central/ North West) region for the Hospitality component, (East/North West) region for the Human Development component. Again normalization of the indices allows for metric comparison of the regions with the region with the best performance in a given year.

5.3 Variations over time

We also calculate the variation of indices over the study period. The result of our analysis is shown in Table 3, Part C. Urbanization rate increases from 36% (0.358) in 2005 to 47% (0.467) in 2014. Values related to the Economic component decreases from 2005 to 2009. However, it follows an increasing trend from 2010 to 2012. In 2013 this component reaches its lowest value (0.33) while in 2014 we observed the highest value (0.44) for it. Human development values show a decreasing trend. The values of the Communication Facility component are almost constant over time. The values of networking index show a decreasing trend from 2005 to 2011, however, during 2012 to 2014 the index values has been increased.

Table 4 reports correlation coefficients among different public urban infrastructure components and urbanization. Urbanization was positively correlated with all of urban infrastructure components and time. This correlation is very high (more than 0.5) for the Economic and Human development components. Correlation between urbanization and other components are positive and statistically significant. Various indices are positively and mostly significantly correlated among themselves. Human Development, Public Facility and Hospitality components are negatively and significantly correlated over time, while the Economic and the Communication Facility components are positively correlated with time.

Insert Table 4 here

6. RELATIONSHIP BETWEEN URBANIZATION AND ITS DETERMINANTS

In this part of our experimental analysis we aim to run six regression models of the urbanization on its determinants. These models differ by generalization of the basic model with five urban infrastructure components (indices), inclusion of unobserved time and province effects. The estimation method is fixed effects dummy variable heteroscedastic consistent. We used them to study and capture the impacts of various societal constructs on China's urbanization. The dependent variable is urbanization rate which is measured by urban share of population in each province at any year of study period. The estimation results from each regression model are reported in Table 5.

Insert Table 5 here

The first three restricted models (Model 1, 2 and 3) ignore unobserved province-specific effects but the models account for time-specific effects. In the first model, we captured the effect of main urban infrastructure components (i.e., Economic, Human Development, Communication Facility, Public Facility, and Hospitality) on the rate of urbanization. In the second model, we estimate the effects of time trend and overall networking index on urbanization. The third model is constructed by adding a time and time squared, an overall index and its square, and interaction of the index with time. Unrestricted fixed effect models of previously built models (Model 4, 5 and 6) are also built to study the differences between provinces. F-test based on residual sum of squares and better fits of the models based on R^2 suggest that the unrestricted models are the preferred and accepted model specifications. A fixed effects estimation method is employed because the sample and population of the provinces are the same.

According to Model 1, Economic and Human Development components have positive and significant effect on China's urbanization. The effect of the Hospitality component is also significant, but it is negative. In all six models the effect of time (i.e., trend) is positive and it significantly affects the urbanization. The effect of the time squared (i.e., $trend^2$) in Model 3 and Model 6 are not statistically significantly different than zero. The effect of the networking index (i.e., SocNet) is significant and positive in all models (i.e., Model 2, 3, 5 and 6). However, its squared effect is not significant (i.e., $SocNet^2$). Model 4 indicates that Communication Facility and Hospitality have significant positive effect on urbanization. Surprisingly, the effect of Economic and Human Development components on the increase in urban population is not significant. In fixed effect models, Beijing is used as a reference province. Models 5 and 6 indicate that Shanghai and Tianjin's urbanization rates are significantly more than Beijing, and Tibet has the lowest rate of urbanization.

In China there is a clear differentiation between Beijing and Shanghai in terms of the distinct role they play in the global architecture: Beijing focusing on the political, financial, scientific, and technological; while Shanghai specializing in financial networks and global trade.

7. CONCLUSIONS AND POLICY RECOMMENDATIONS

In this article we argued that networking among key components of infrastructure within our societies influences urbanization. This networking leads to the emergence of a network among a variety of societal constructs such as Economic, Communication Facility, Hospitality, Human Development, and Public Facilities. This network represents the dynamic interplay among the key components of infrastructure within our societies which impacts people's lives, and it consequently attracts more people to regions where infrastructure is most developed. Our experimental results showed that provincial differences in urbanization correlate strongly with the economic situation of each province. Urbanization was positively correlated with all of the urban infrastructure components which we have introduced in our study. Analysis of our results also showed that two components had significant positive effect on urbanization in China which were the Communication Facility and the Hospitality components.

Communication infrastructures are essential for citizens of a society because it makes them functional, it is a means for their communications with each other. The importance of communication infrastructures is also noticeable at the level of functional and economic interactions, it offers greater opportunities and better services to citizens of a society. Similarly, cultural amenities can also be one of the main sources of urban growth. Adding a spatial dimension to the networks of cultures, and the networks of people, has value making potential and leads to economies of synergy. That is to say, higher levels of communication facilities and hospitality within a society creates the possibility of adding value as the result of a variety of interactions. Therefore, we can expect the emergence of people-oriented smart cities if they provide better communication facilities and concentrate on providing public places for joined activities to their citizens.

People migrate to megacities in search of a better life (Bianchi et al., 2005; Godfrey and Julien, 2005), however, most people feel a strong regional or local identity. Megacities attract resources and accumulate opportunities to increase wealth and power. They become an attractor of capital, labor, and innovation. However, decision making policies in megacities are hardly implemented on behalf of the needs of the local people there. They impose the logic of the global over the logic of the locals. As we mentioned in the introduction section of this paper, people-oriented smart cities are considered to be the next generation of our modern cities in which humans are at the center of their innovation models during the process of urban development. That is why future urban development strategies and visions need not just to consider the economic benefits, but also social benefits for the people who live in smart cities. Many cities have the potential to be smart cities, however, before engaging and integrating them in smart city solutions we need an in-depth understanding of how various social, economic, cultural and technological factors impact people's lives there. That is because in the next generation of smart cities the focus should be on people and their social needs, not solely on technology.

As Castells (2011) argues in his book, networks have become the predominant organizational form of every domain of human activity. Communication technologies have added another dimension to people's lives and that is actually the virtual world around them. Communication technologies have introduced new ways of socializations and people experience socialization processes in different ways depending on how their lives are structured and practiced in the cities where they live. In our future work we aim to target and to capture the level of innovation generated by the networking interactions out of communication infrastructures within different societies.

According to our obtained results, growth of small cities with respect to their communication facilities and hospitality factors, might stem the flow of rural migrants. Therefore, further development of small cities needs to be supported with respect to their scales, their infrastructures, and their technological conditions. This way, we can expect that China's northern and eastern region migrants (Castells, 2011), to have a higher likelihood of remittance.

Although findings from our study and its effectiveness would be case specific, our methodology can be extended to other societies with people of different characteristics.

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Table 1. Summary statistics, urbanization data, 2005-2014, N=310 observations.

Variable	Definition	Mean	Std. Dev
Urban	Urban share of population at year end	50.30	14.90
A. Hospitality			
Hosp1	Assets and Liabilities of Enterprises above (Size of Hotels)	246.59	271.07
Hosp2	Foreign Exchange Earnings from International Tourism	1624.77	2583.53
Hosp3	Number of oversea visitor arrivals	2.70	5.10
Hosp4	Statistics on performance of arts performance groups	191.80	204.30
Hosp5	Public libraries	78.40	56.50
Hosp6	Museums	94.00	44.60
Hosp7	Certified Coaches by Grade	44.04	51.34
Hosp8	Certified Athletes by Technical Grade	1355.35	1042.58
Hosp9	Number of Published materials in _China	8836.74	20076.61
Hosp10	Population Coverage of Radio and TV Programs	95.94	3.84
B. Economic			
Econ1	Total Population	4278.63	2706.30
Econ2	Annual Cons./Exp. of Urban Households Per Capita	12783.60	4863.29
Econ3	Overall Labor Productivity (In Terms of Value-added)	125504.76	152721.05
Econ4	Minimum Living Indemnification and Social Assistance	256.95	71.90
C. Human development			
HD1	Total Value of Technical Market	135.11	358.50
HD2	population life expectancy	74.90	2.70
HD3	Number of Schools and Students in Undergraduate or Specialized Courses in Institutions of Higher Education	72.14	36.80
HD4	Gross Regional Product	14369.10	13337.52
D. Public facility and infrastructures			
Hous1	Housing Conditions of Rural Households	33.59	10.66
Hous2	Municipal Infrastructure in Cities	0.93	0.88
Hous3	Public Transportation in Cities	12530.00	9594.70
Hous4	Level of Public Facilities in Cities	94.00	7.22
Hous5	Parks and Green Areas in Cities	6.40	7.30
Hous6	Community Service Facilities in Urban Areas	6528.40	9045.40
E. Communication facility			
Comf1	Telecommunication Services	85.481	37.04
Comf2	Business volume of Postal and Telecom	640.19	612.75
Comf3	Main communication capacity of telecom	47.49	45.03
Comf4	Main indicators on internet development	1271.19	1207.14

Table 2. Principal component analysis (I-Index components and II- Overall index)

	Eigenvalue	Proportion	Cumulative
I. Disaggregate index components			
A. Hospitality index			
PC 1	4.10	0.41	
PC 2	1.78	0.18	
PC 3	1.15	0.12	0.70
B. Economic index			
PC 1	2.03	0.51	
PC 2	1.08	0.27	0.78
C. Human development index			
PC 1	2.42	0.61	0.61
D. Public facility and infrastructure index			
PC 1	3.60	0.60	
PC 2	1.13	0.19	0.79
E. Communication facility index			
PC 1	2.66	0.67	0.67
II. Aggregate index			
F. Network infrastructure index			
PC 1	12.84	0.46	
PC 2	4.35	0.16	
PC 3	2.06	0.07	
PC 4	1.49	0.05	
PC 5	1.00	0.04	0.78

Table 3. Network infrastructure components and overall composite index

	Urbanization	Economic	Human dev	Commun. facility	Public facility	Hospitality	Composite
A. By Provinces							
Beijing	0.94	0.75	0.99	0.32	0.53	0.58	1.00
Guangdon	0.64	0.98	0.97	1.00	0.88	0.96	0.89
Jiangsu	0.54	0.74	0.98	0.48	0.89	0.92	0.82
Shanghai	1.00	0.84	0.76	0.37	0.74	0.50	0.79
Zhejiang	0.57	0.76	0.75	0.46	0.86	0.73	0.74
Shandong	0.41	0.70	0.90	0.37	0.72	0.87	0.70
Liaoning	0.60	0.43	0.68	0.28	0.43	0.77	0.57
Hebei	0.32	0.49	0.64	0.26	0.44	0.72	0.50
Tianjin	0.85	0.59	0.57	0.14	0.30	0.29	0.49
Henan	0.24	0.55	0.64	0.35	0.33	0.85	0.48
Hubei	0.40	0.44	0.64	0.22	0.51	0.55	0.48
Fujian	0.50	0.37	0.56	0.28	0.45	0.57	0.47
Sichuan	0.26	0.51	0.58	0.26	0.37	0.78	0.46
Anhui	0.30	0.43	0.59	0.19	0.36	0.62	0.43
Hunan	0.31	0.43	0.63	0.22	0.46	0.47	0.39
Shaanxi	0.34	0.32	0.53	0.18	0.29	0.48	0.38
Heilongj	0.50	0.22	0.53	0.16	0.21	0.63	0.38
Jilin	0.47	0.22	0.46	0.13	0.17	0.40	0.32
Jiangxi	0.32	0.26	0.48	0.14	0.37	0.44	0.32
Chongqin	0.45	0.30	0.44	0.12	0.29	0.31	0.32
Guangxi	0.26	0.32	0.46	0.17	0.26	0.44	0.30
Shanxi	0.38	0.20	0.46	0.16	0.24	0.41	0.29
Mongolia	0.47	0.30	0.39	0.13	0.13	0.39	0.28
Yunnan	0.19	0.27	0.24	0.13	0.21	0.48	0.22
Xinjiang	0.29	0.09	0.26	0.12	0.24	0.35	0.22
Hainan	0.40	0.14	0.31	0.05	0.09	0.15	0.21
Gansu	0.20	0.09	0.26	0.08	0.11	0.38	0.17
Guizhou	0.15	0.18	0.24	0.09	0.19	0.20	0.11
Ningxia	0.38	0.04	0.21	0.04	0.10	0.06	0.10
Qinghai	0.32	0.01	0.08	0.04	0.17	0.06	0.07
Tibet	0.00	0.07	0.00	0.00	0.02	0.01	0.00
B. By region							
East	0.52	0.59	0.72	0.33	0.63	0.67	0.61
North	0.59	0.46	0.61	0.20	0.33	0.48	0.51
Centl	0.37	0.48	0.61	0.34	0.42	0.57	0.46
NEast	0.52	0.29	0.56	0.19	0.27	0.60	0.43
SEast	0.21	0.27	0.30	0.12	0.22	0.35	0.22
NWest	0.30	0.11	0.27	0.09	0.18	0.27	0.19
C. Over time							
2005	0.36	0.40	0.58	0.22	0.44	0.49	0.44
2006	0.37	0.39	0.56	0.21	0.48	0.52	0.43
2007	0.38	0.38	0.55	0.20	0.40	0.50	0.40
2008	0.40	0.38	0.55	0.21	0.36	0.50	0.41
2009	0.41	0.38	0.54	0.21	0.35	0.52	0.39
2010	0.42	0.39	0.52	0.23	0.33	0.51	0.39
2011	0.44	0.39	0.51	0.23	0.31	0.53	0.38
2012	0.46	0.40	0.49	0.22	0.40	0.48	0.45
2013	0.47	0.33	0.48	0.26	0.28	0.44	0.43
2014	0.47	0.44	0.47	0.26	0.31	0.46	0.45
D. Sample mean and dispersion							
Mean	0.060	0.040	-0.026	0.019	0.015	-0.002	0.017
Std. Dev	0.018	0.267	0.027	0.111	0.407	0.197	0.188

Table 4. Correlation among the index components

	urbanization	year	Normalized Urbanization	Economic	Human dev.	Commun. facility	Public facility	Hospitality	Networking Index
Urbanization	1.00								
Year	0.23 (0.00)	1.00							
Normalized Urbanization	1.00 (0.00)	0.17 (0.00)	1.00						
Economic	0.60 (0.00)	0.001 (0.97)	0.61 (0.00)	1.00					
Human development	0.58 (0.00)	-0.13 (0.02)	0.60 (0.00)	0.88 (0.00)	1.00				
Communication facility	0.44 (0.00)	0.08 (0.16)	0.44 (0.00)	0.81 (0.00)	0.77 (0.00)	1.00			
Public Facility	0.45 (0.00)	-0.19 (0.00)	0.46 (0.00)	0.81 (0.00)	0.84 (0.00)	0.77 (0.00)	1.00		
Hospitality	0.25 (0.00)	-0.06 (0.32)	0.26 (0.00)	0.71 (0.00)	0.82 (0.00)	0.75 (0.00)	0.70 (0.00)	1.00	
Networking index	0.71 (0.00)	0.02 (0.71)	0.72 (0.00)	0.90 (0.00)	0.94 (0.00)	0.80 (0.00)	0.85 (0.00)	0.76 (0.00)	1.00

Table 5. Pooled and Fixed Effects estimation results, Dependent variable province's urban share of population.

	Models without province dummies						Models with province dummies					
	Model 1, no trend, and disaggregate index		Model 2, with trend, and aggregate index		Model 3, with trend, interactions, and aggregate index		Model 4, no trend, and disaggregate index		Model 5, with trend, and aggregate index		Model 6, with trend, interactions, and aggregate index	
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Intercept	25.15[a]	1.63	26.62[a]	1.40	22.21[a]	2.92	63.59[a]	5.10	67.47[a]	2.37	60.51[a]	2.79
Economic	13.45[a]	5.39	-	-	-	-	0.92	1.63	-	-	-	-
HumDev	63.57[a]	5.59	-	-	-	-	4.52	5.13	-	-	-	-
CommuFac	0.39	3.95	-	-	-	-	12.64[a]	3.35	-	-	-	-
PublFac	-5.09	4.50	-	-	-	-	1.97[b]	1.03	-	-	-	-
Hospit	-41.23[a]	4.06	-	-	-	-	8.09[a]	1.29	-	-	-	-
trnd	1.62[a]	0.18	1.10[a]	0.20	2.91[a]	0.89	1.24[a]	0.07	1.15[a]	0.03	1.73[a]	0.18
$trnd^2$	-	-	-	-	-0.09	0.08	-	-	-	-	-0.03	0.01
SocNet	-	-	42.53[a]	2.50	41.04[a]	8.71	-	-	11.57[a]	2.30	23.07[a]	4.38
$SocNet^2$	-	-	-	-	12.42	7.86	-	-	-	-	-3.39	4.58
SocNet * trnd	-	-	-	-	-1.83[b]	0.84	-	-	-	-	-0.57[a]	0.17
Tianjin	-	-	-	-	-	-	0.69[a]	1.45	-0.61	1.14	1.05	1.39
Hebei	-	-	-	-	-	-	-40.09[a]	1.33	-35.89[a]	1.12	-34.25[a]	1.39
Shanxi	-	-	-	-	-	-	-30.96[a]	1.87	-29.57[a]	1.47	-26.71[a]	1.65
Mongolia	-	-	-	-	-	-	-23.58[a]	2.04	-23.11[a]	1.49	-20.17[a]	1.66
Liaoning	-	-	-	-	-	-	-22.17[a]	1.24	-18.20[a]	1.00	-16.96[a]	1.27
Jilin	-	-	-	-	-	-	-24.40[a]	1.89	-24.11[a]	1.41	-21.53[a]	1.60
Heilongjiang	-	-	-	-	-	-	-24.97[a]	1.72	-22.61[a]	1.31	-20.39[a]	1.53
Shanghai	-	-	-	-	-	-	4.36[a]	1.04	6.15[a]	0.73	6.58[a]	0.88
Jiangsu	-	-	-	-	-	-	-32.58[a]	0.85	-25.24[a]	0.69	-24.75[a]	0.81
Zhejiang	-	-	-	-	-	-	-27.83[a]	1.22	-22.24[a]	0.78	-21.52[a]	0.99
Anhui	-	-	-	-	-	-	-39.10[a]	1.46	-36.26[a]	1.23	-34.20[a]	1.48
Fujian	-	-	-	-	-	-	-26.65[a]	1.57	-23.61[a]	1.16	-21.82[a]	1.42
Jiangxi	-	-	-	-	-	-	-35.15[a]	1.83	-33.89[a]	1.41	-31.26[a]	1.61
Shandong	-	-	-	-	-	-	-38.72[a]	0.80	-32.33[a]	0.83	-31.46[a]	1.06
Henan	-	-	-	-	-	-	-47.63[a]	1.37	-41.25[a]	1.14	-39.52[a]	1.40
Hubei	-	-	-	-	-	-	-33.17[a]	1.30	-30.55[a]	1.16	-28.70[a]	1.41
Hunan	-	-	-	-	-	-	-37.68[a]	1.34	-34.93[a]	1.30	-32.70[a]	1.52
Guangdong	-	-	-	-	-	-	-32.84[a]	2.04	-19.14[a]	0.65	-18.78[a]	0.69
Guangxi	-	-	-	-	-	-	-39.12[a]	1.84	-37.52[a]	1.44	-34.79[a]	1.63
Hainan	-	-	-	-	-	-	-24.57[a]	2.34	-26.80[a]	1.61	-23.44[a]	1.76
Chongqing	-	-	-	-	-	-	-24.70[a]	1.92	-25.00[a]	1.42	-22.29[a]	1.62
Sichuan	-	-	-	-	-	-	-44.18[a]	1.53	-39.51[a]	1.19	-37.65[a]	1.44
Guizhou	-	-	-	-	-	-	-42.19[a]	2.53	-42.58[a]	1.79	-38.47[a]	1.94
Yunnan	-	-	-	-	-	-	-42.46[a]	2.51	-41.25[a]	1.58	-37.96[a]	1.74
Tibet	-	-	-	-	-	-	-48.03[a]	3.26	-51.30[a]	1.97	-46.34[a]	2.19
Shaanxi	-	-	-	-	-	-	-34.88[a]	1.63	-33.26[a]	1.31	-30.91[a]	1.53
Gansu	-	-	-	-	-	-	-40.36[a]	2.51	-40.19[a]	1.68	-36.53[a]	1.83
Qinghai	-	-	-	-	-	-	-28.23[a]	3.05	-30.79[a]	1.85	-26.40[a]	2.02
Ningxia	-	-	-	-	-	-	-25.02[a]	2.67	-27.57[a]	1.79	-23.44[a]	1.95
Xinjiang	-	-	-	-	-	-	-35.01[a]	2.50	-34.85[a]	1.59	-31.57[a]	1.75
F-value	83.44	-	190.87	-	79.70	-	1239.10	-	1129.20	-	1151.70	-
R^2 adjusted	0.61	-	0.55	-	0.56	-	0.99	-	0.99	-	0.99	-

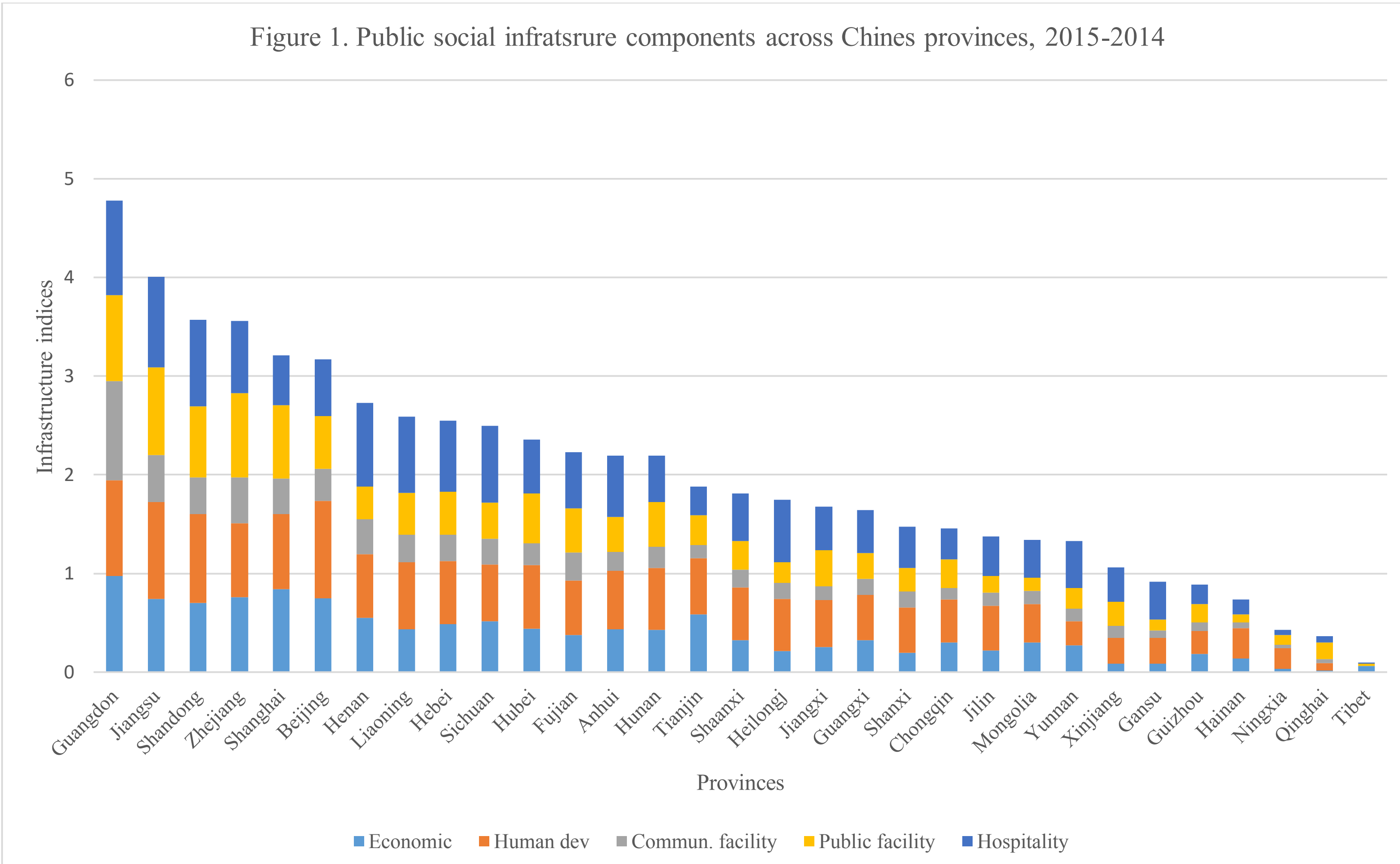
Figure 1. Public social infratsrure components across Chines provinces, 2015-2014
Infrastructure indices
6
5
4
3
2
1
0
Guangdon
Jiangsu
Shandong
Zhejiang
Shanghai
Beijing
Henan
Liaoning
Hebei
Sichuan
Hubei
Fujian
Anhui
Hunan
Tianjin
Shaanxi
Heilongj
Jiangxi
Guangxi
Shanxi
Chongqin
Jilin
Mongolia
Yunnan
Xinjiang
Gansu
Guizhou
Hainan
Ningxia
Qinghai
Tibet
Provinces
Economic
Human dev
Commun. facility
Public facility
Hospitality