INTRODUCTION

With the remarkable growth since the launch of economic reforms in the late 1970s, China’s innovative capacities have likewise grown rapidly. China has also been making tremendous efforts to transform itself from being “the world’s factory” into “a global innovation engine” (Yip & McKern, 2014; Zhou, Lazonick, & Sun, 2016). Chinese leaders are committed to establishing China an “innovative country” and strengthen its independent innovative abilities. The centrally administrated cities are highly anticipated to become innovation centers. The National Innovation-driven Development Strategy Outline (2016) proposes to promote Beijing and Shanghai into globally influential science
and technology innovation centers. Many Chinese cities are strengthening their innovative capacities by attracting scientific and technological talent, increasing research and development (R&D) expenditures, and nurturing innovative enterprises. How to build an attractive environment for innovative activities has become a burning question for China, as well as many other developing countries.

The existing literature shows the efficacy of a tolerant environment in improving innovative abilities. Florida (2002) showed that tolerance is especially important for attracting significant talents and creative people for urban innovation and regional development. Other studies have demonstrated the significance of diversity, openness, or immigrants on urban innovation or productivity (Alesina & Ferrara, 2005; Kerr, 2013; Liefner & Wei, 2014; Liefner, Wei, & Zeng, 2013; Nathan, 2014; Ottaviano & Peri, 2006; Wang, Cheng, Ye, & Wei, 2016). Diversity or immigrants would contribute to introduce more ideas from different cultural background that might be beneficial for innovative abilities (Nathan, 2014). Skilled immigrants have often been attracted to places with tolerance of differences and diverse staff compositions. However, most of these studies are based on the experience of the United States (US) or European countries, which have had long periods of technology development and are highly attractive to immigrants from diverse countries and ethnicities. However, few empirical studies have been based in developing countries like China. There is still a lack of deep understanding of how tolerance affects Chinese urban innovation capacities.

Several differences can be observed in the Chinese experience of tolerance compared with the Western experience. The population of China is dominated by Chinese people. Ethnic or racial conflicts or discrimination are experienced far less frequently in coastal China than in the United States. Second, China has the most stringent household management system worldwide that became the most blamed institution hindering free migration for skilled or migrant labors, although it has been relaxed in recent years (Liu, 2005; Song, 2014). Last, China has been transformed from a planned to a market-oriented economy (He & Pan, 2010; Wei, Bi, Wang, & Ning, 2015). However, as private firms still lack equal rights compared with state-owned enterprises (SOEs) (Wei, 2007), the tolerance for private economic development should also be given more attention.

The main contributions of this paper are as follows: first, we consider the relationship between tolerance and urban innovation from the perspective of a developing country. We not only introduce Chinese-specific indices like hukou, but also incorporate the “gay index” widely used in the Western studies as tolerance indicators.

Second, we introduce the concept of economic tolerance in China’s transitional economy. We argue that tolerance of private economic development is crucial for urban innovation improvement. Last, we overcome the deficiency of statistical data by crawling the big data from social media. We also consider the sorting problems in the econometric estimation by introducing instrumental variables and two-stage least squares models to get rid of potential endogenous problems.

2 | LITERATURE REVIEW

A large body of research has investigated tolerance and its impacts on productivity, innovation, and entrepreneurship. Some of these studies used diversity or openness to indicate tolerance and attempted to explore its impact on regional development.

2.1 | Cultural tolerance

Florida (2002) introduced the concept of tolerance in his 3Ts (technology, talent, and tolerance) model in which he argues that the 3Ts are necessary for facilitating regional development. Tolerance is the
most fundamental factor because it is highly related to the other two Ts (talent and technology) and plays a vital role in regional development (Florida, Mellander, & Stolarick, 2008). However, not enough attention has been given to tolerance in Chinese regional development and innovation. China’s policy designers have placed large resources into attracting talents and technology without noticing the importance of tolerance in facilitating regional development.

Tolerance means low barriers to entry for individuals (Florida, 2002; Florida & Gates, 2001). Tolerant places will attract talented people from different racial, ethnic, or religious backgrounds, and are open to strange ideas and new people, which is crucial for capturing innovative talent and skills. Existing studies associate tolerance with the gatherings of gay or lesbian people and find a positive relationship between the proportion of gay people with regional innovation or development (Florida & Gates, 2001). Due to data limitations, Chinese official statistics do not provide detailed data for gay people. We crawled Sina Weibo’s big data for “gay” and “lesbian” tags and measured the distribution of gay or lesbian tags across cities to verify our hypothesis.

The background tolerance of various peoples is associated with diversity. Previous research has confirmed that diversity can effectively improve regional development and innovative abilities (Jacobs, 1961, 1969; Quigley, 1998). The studied diversity was related more to industrial- or firm-based diversity (Duranton & Diego, 2000; Glaeser, Kallal, Scheinkman, & Shleifer, 1992); however, individual diversity is also important (Jacobs, 1961) and could positively affect innovative abilities. Groups consisting of individuals from diverse birthplaces tend to include an enlarged pool of available perspectives and solutions (Kemeny & Cooke, 2018), and these individuals will provide a larger proportion of alternative solutions for problems. Talent from diverse backgrounds could provide a variety of ideas that could be recombined to generate innovations (Hong & Page, 2001, 2004). People from different backgrounds could communicate and generate new thoughts and innovations by combining their existing knowledge. Indeed, innovation is essentially new combinations of existing knowledge (Qian, 2013; Schumpeter, 1934). Florida (2002) emphasized the significance of the diversity of creative professions in R&D in high-tech industries. Diverse perspectives may generate better solutions than perspectives from homogenous groups (Hong & Page, 2004). Ottaviano and Peri (2006) found that birthplace diversity is positively related with productivity because immigrants contribute to the diversity of cities. Tolerant cities mean lower barriers to immigrants with complementary skills to native residents; in addition, they may bring different skills for the same tasks (Ottaviano & Peri, 2006).

Cultural diversity may increase the variety of goods available for consumption and promote residents’ welfare. The variety of preferences is the starting point of the theory of spatial development; that is, a large variety of goods in an area can help improve residents’ utility. Thus, tolerance could bring diversified people with various consumer preferences, which helps to introduce various products aimed at people from different cultural backgrounds (Florida et al., 2008; Ottaviano & Peri, 2006).

However, diversity may also lead to lower trust and poor communication because of misunderstandings by different cultures. This results in less cooperation among different ethnic groups and hampers innovation (Nathan, 2014). Different ethnic groups can find it hard to cooperate across their cultural divides (Van Knippenberg & Schippers, 2007).

Tolerance might also be better for knowledge spillovers among different groups of people. Low barriers to migration mean a higher agglomeration of people with various skills and talents (Lee, Florida, & Gates, 2010; Qian, 2013); therefore, it is easier for innovative ideas to spread between different people. Company executives could quickly transform innovative ideas into innovative products and thus promote their region’s innovative abilities.

China differs substantially from Western countries because it does not have many foreigners, with only 0.7% of residents being foreigners. By 2016, only 9,600 foreigners had obtained a Chinese
green card (Liu, 2017). In addition, scarcely any foreigners visit the underdeveloped regions of China. Among native Chinese, over 90% are ethnic Han Chinese; therefore, most of the Chinese minorities have been assimilated by the dominant Han culture and cannot be distinguished by appearance. Accordingly, the number of foreign immigrants or ethnic diversity are unsuitable factors for denoting regional tolerance in China.

Nevertheless, this observation does not mean that no discrimination is experienced by different population communities in China. On the contrary, China enforces strict geographical segmentation with strict regulations for residents’ migration. The hukou system requires people to live and work only where they have official permission to do so (Liu, 2005). The hukou status of children is determined by their parents, this can be changed using official channels such as acquiring a university degree, having a salaried job, or owning houses in small cities (Liu, 2005; Song, 2016). The hukou quota in big cities is designated almost entirely for the super-rich or highly educated; therefore, it is unachievable for most migrant workers (Song, 2014, 2016). Although the importance of hukou has declined remarkably due to hukou reforms and other socioeconomic transitions, it is widely believed that hukou registration systems still play an important role in the migrant worker's life in modern China (Zhan, 2011). There is a great divide between nonlocal and local workers in many cities in terms of obtaining work opportunities or children's education and medical care. A large number of migrant or skilled workers move to big cities looking for highly paid work opportunities, but without possessing a local hukou in big cities, they could not access a variety of public service or welfare programs, such as children's education, medical care, or social security coverage.

Cities with stricter hukou regulations have higher hukou quota thresholds, which often go to people with excellent college educations. However, migrant workers are more willing to hunt for more career opportunities in big cities. Compared with rural areas in underdeveloped regions, migrants argue that big cities are fairer and more tolerant. Individual development in the big cities rely more on individual efforts other than on “guanxi” as in underdeveloped regions. We consider that migrant labor is also important for China's innovative ability. Innovation in China is established on the continuous upgrading of manufacturing abilities from low-end production to high-tech industries such as electronics industries. These industries not only need highly educated talent, but also need blue-collar workers with middle or high school education. A more-tolerant environment that does not discriminate against nonlocal workers or talents will lead to better innovative abilities.

### 2.2 Economical tolerance

As a transitional economy, China has been gradually transformed from a planned to a market-oriented economy (Wei, 2013; Wei, Li, & Wang, 2007; Wu, Wei, Li, & Yuan, 2018). Marketization of the economy has encouraged the notable development of non-SOEs, including private firms, jointly owned enterprises, and foreign-owned enterprises. In China, SOEs still operate in heavy, capital-intensive, or monopoly industries (Wei, 2013), which is quite different from that of developed countries, where most economic activities are carried out by POEs. There are significant differences between SOEs and POEs in terms of resources acquirement, market access, external environment, and governmental support (Peng, Tan, & Tong, 2004). Most SOEs have priority in obtaining financial or other political resources (Huang, 2002; Steinfeld, 1998) and have a higher hukou quota in big cities like Beijing; therefore, they are more attractive for highly qualified college students (Song, 2016). However, SOEs face lower budget constraints and their officials make conservative decisions concerning the long-term development of the enterprise. Therefore, they are reluctant to adopt radical or groundbreaking innovative development methods (Peng et al., 2004). SOEs’ innovation incentives are weak compared with POEs (Shleifer, 1998). Although POEs are sometimes subject to discriminatory
policies (McMillan & Woodruff, 2002), they are more likely to utilize resources, have stronger propensity for risk-taking, and are more willing to promote their technology and productivity to pursue market profits (Jiang, Waller, & Cai, 2013; Tan, 2002). Thus, POEs are more innovative and efficient (Brandt, Van Biesebroeck, & Zhang, 2012; Dougherty, Herd, & He, 2007; Shleifer, 1998).

However, POEs still experience many barriers in operation because of weaker access to financial resources and face more stringent supervision (Huang, 2002). Governmental attitudes toward private companies varied remarkably across regions, which indicates a variety of levels of governmental tolerance toward economic agencies. For example, few entrepreneurs are willing to invest in northeastern cities because of the poor business environment. Government officials are very conservative and look down upon owners of POEs, which are often overcharged with taxes or inexplicable fees. Thus, the economic tolerance is very low in northeastern China. In contrast, cities in coastal regions, such as Zhejiang and Guangdong, are more willing to provide a favorable environment for POEs. Here, the government behaves more tolerantly toward the development of POEs when the country’s institutions were otherwise hostile to private owners during the initial period of reform and opening up.

Therefore, we consider that economic tolerance is also important for urban innovative capacities, which has been empirically neglected in Western countries. Cities that are more open to private economic developments tend to generate more innovations compared with more-conservative cities.

2.3 | Sorting problems

When considering how tolerance affects innovation, we also should consider sorting problems (Kemeny & Cooke, 2018). A city’s tolerance can be attributed to higher innovative abilities; therefore, innovation could be a factor luring more people from other cities or attracting more entrepreneurs to invest, which causes correlations between the error terms and dependent variables. Thus, sorting problems should be considered in examining the impact of tolerance because they may generate upwardly biased results. We would like to introduce some instruments to solve this problem.

3 | SPATIAL PATTERN OF CHINESE URBAN TOLERANCE AND INNOVATIVE ABILITIES

The number of invention patents is used to denote urban innovative abilities. Although innovation cannot be fully expressed by the number of patents, patents are now well established as providing the most comprehensive technology index (Balland & Rigby, 2017) and are the most reliable proxy variable for innovation (Acs, Anselin, & Varga, 2002). In the Chinese patent evaluation system, invention patents are the most technology-intensive factor that can properly reflect innovative abilities compared with design and utility patents. We use the number of urban invention patents to reflect urban innovation. The data were collected from the China Patent Announcement System on the State Intellectual Property Office’s website. Figure 1 shows the distribution of urban innovation in China in 2016. Most innovation outputs were agglomerated in Beijing–Tianjin, the Yangtze River Delta region, the Pearl River Delta region, and inland Chinese regional centers.

There is no unified index for measuring tolerance. Researchers have promoted the gay or Bohemia indices to reflect a city’s degree of tolerance for a city toward aliens and “heterodoxy” (Florida, 2002; Florida & Gates, 2001; Lee et al., 2010). Florida (2012) proposed a “creative index” to denote tolerance, while other researchers used minority index, race diversity, human values-related indices, or human rights (Gagliardi, 2015; Lee, 2015; Nathan, 2014; Niebuhr, 2010; Ottaviano & Peri, 2006). However, empirical research based on China is rare. Qian (2010) used an hukou index to measure
tolerance in China's provinces and found positive influences for talent attraction and provincial innovative output. Although the gay index might seem to be a better indicator for reflecting tolerance, it is hard to obtain the related statistical data in China. Following the existing literature and considering the reality of China, we chose the following indicators to indicate urban tolerance in China: proportion of migrants, rental housing, creative artists, gay people, and POEs.

We used the proportion of migrants (the ratio of people without a local hukou to the resident population) to indicate tolerance. A higher proportion of migrants indicate a higher level of tolerance to the nonlocal population.

The Chinese traditionally buy a house if they are permanent residents, while rental housing is often for nonlocal residents or newcomers. The proportion of rental housing in overall housing (rental housing) is another factor reflecting urban tolerance of migrants.

The proportion of people in cultural and entertainment industries to the overall urban population (entertainment) echoes the “bohemia index” proposed by Florida (2002). A higher value for cultural and entertainment industries means more tolerance of fashion-forward cultures and might indicate higher potential for innovation.

The gay index, the proportion of gay people (gay), is widely used to proxy for regions’ tolerance level for gay people. Data are lacking for gay people in China; therefore, we crawled Sina Weibo’s big data for their users’ information and identified “gay” or “lesbian” tags, which were then aggregated into the city level and divided by the overall users in each city. Sina Weibo is regarded as “Chinese Twitter” and is one of the most popular public social media in China. The number of monthly active users has exceed 392 million in 2017, occupy 28% of the total Chinese population. Users have information such as gender, the city they live in, etc., and can set their personal tags that reflect their personality or hobbies to be easily searched by others. If someone wants others to know he or she is a
“gay” or “lesbian,” such a tag can be set up. Thus, we can easily obtain the general distribution of gay or lesbian people in China.

We use the proportion of privately owned enterprises (the ratio for the gross output value of POEs to all enterprises) (private economies) to measure urban tolerance. We did not include the proportion of foreigners that has frequently been tested in empirical studies in developed countries to proxy for tolerance because the number of foreigners in China is exceptionally low compared with the Chinese population (0.6% of the whole population). Moreover, foreigners in China enjoy a supernational treatment (Zhou, 2013); therefore, they are not suitable for use as an index for tolerance. The patent data came from the National Patent Office website, while the various tolerance variables and College graduates were calculated from the 2010 Sixth National Population Census data. The POEs’ data came from industrial enterprises statistical data in 2013 provided by the National Bureau of Statistics of China. The Gay variable is calculated from the data crawling from Sina Weibo.

The distribution of the tolerance indices is shown in Figure 2. Migrant populations are mainly distributed in Beijing–Tianjin, coastal regions, the middle part of Inner Mongolia, where many migrants were living during the Sixth National Population Census. The renting ratio reflects the agglomeration of migrants. In addition to these three agglomerations, higher renting levels are agglomerated in Lhasa, Tibet, and Erdos, Inner Mongolia. The population engaging in cultural and entertainment activities is highly agglomerated in Beijing, the southeastern coastal area, Hainan, and Lhasa. Gay people are highly agglomerated in big cities and regional central city, beside Beijing, Shanghai, Shenzhen, and Guangzhou, they also like to choose western cities like Chengdu and Wuhan. Cities with a high proportion of POEs are widely scattered in middle and eastern China, and the north to middle and lower reaches of the Yangtze River, but are especially concentrated in the Zhejiang, Jiangsu, Shandong, and Hunan provinces where there are higher levels of marketization and tolerance of POEs.

Differences were observed among the tolerance indicators; therefore, we used factor analysis to reduce the dimensionality of factors. The results show that the first two factors can illustrate 81% of the variance of indicators. Therefore, we extracted the first two common factors. The factor-loading matrix is shown in Table 1. The most common factor included over more information about the migrant population, proportion renting, proportion of creative artists, and proportion of gay people. We call them cultural tolerance. The second-most common factors mainly include information about private companies; thus, they can be referred to as economic tolerance. The distribution of cultural and economic tolerance indicators are shown in Figure 3. High cultural tolerant cities are mostly distributed in the southeastern regions and regional centers in western and middle of China, while high economic tolerant cities are distributed in southern and southeastern China, especially in Zhejiang, Jiangsu, and Guangdong provinces.

A tolerance index can be obtained by calculating the composite factor scores based on common factors for tolerance (Figure 3). Highly tolerant cities were mainly distributed in southeastern coastal regions of China, particularly Beijing–Tianjin and the Yangtze and Pearl Delta regions. Chinese cities can be divided into a four-level hierarchy based on the tolerance index grade (Figure 4). The most tolerant cities are Shenzhen, Beijing, Dongguan, Xiamen, Zhuhai, Shanghai, which are mainly the first and second line of cities located in the southeastern coastal regions. These cities have a strong capacity for absorbing migrant peoples and cultures. The second-level cities include Zhongshan, Guangzhou, Urumchi, Hangzhou, Haikou, Suzhou, Wenzhou, Sanya, and other cities in southeastern China. These regions can largely absorb migrants, and have developed private economies and have relatively high tolerance for migrant people. Western Chinese cities have lower tolerance levels; however, provincial capital cities have a higher level of tolerance than other prefecture-level cities in the middle and western parts of China, which have the lowest levels of tolerance. These cities have limited abilities in
attracting migrants and have low private economic development; thus, they are less tolerant to migrant populations, cultures, and unconventional thoughts and ideas.

It is worth noting that Shenzhen's tolerance indicators are not only higher than that for other second-line cities, but also higher than in the national central cities like Beijing and Shanghai. Since the 1980s, Shenzhen has been a special economic zone that enjoys a pioneering system with policy...
advantages. Shenzhen received large quantities of investments from Hong Kong, which it adjoins (Sit & Yang, 1997). Shenzhen is also a typical migrant city, which absorbs all levels and types of talents from the whole country. Thanks to its tolerant hukou policy, Shenzhen not only attracts high-tech professional talent, but also attracts low-skilled, labor-intensive laborers who have contributed to the establishment of Shenzhen’s advanced manufacturing system, which became the fundamental manufacturing support for big electronic companies such as ZTE or Huawei.

Beijing and Shanghai still pursue the principle of elitist migrant absorption that only welcomes high-level talents (Kang, 2014). These cities’ tolerances are lower than in Shenzhen. Taking the allocation of the hukou quota as an example, college graduates can acquire Beijing hukou only if they become civil servants in big central SOEs or public institutions (Zhang, 2014). Shanghai provides hukou to higher education talent using a stringent grading system where only excellent higher education graduates can obtain Shanghai hukou. However, the threshold for obtaining Shenzhen’s hukou is relatively low, that is, college graduates can obtain a Shenzhen hukou. Even someone without a local Shenzhen hukou can easily access most welfare systems enjoyed by local residents, which is quite different from that in Beijing and Shanghai. Such a tolerant environment would contribute much to urban innovation. Although more and more cities are reducing the difficulty of obtaining hukou, there are still many invisible barriers for nonlocal residents to overcome. Many small cities in the middle and western areas of China have a low tolerance for disadvantaged groups and are quite dependent on guanxi in their business operations, which hinders their building of innovative capacities.

The scatterplots further reflect the relation between urban tolerance and urban innovation, as represented by number of authorized invention patents in 2016 (Figure 5). These relationships are particularly apparent in highly innovative cities, that is, the high correlations between these two factors.

<table>
<thead>
<tr>
<th>Common factor</th>
<th>1</th>
<th>2</th>
</tr>
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<tbody>
<tr>
<td>Migrants</td>
<td>0.507</td>
<td>0.142</td>
</tr>
<tr>
<td>Entertainments</td>
<td>0.472</td>
<td>0.127</td>
</tr>
<tr>
<td>Rental housing</td>
<td>0.501</td>
<td>0.126</td>
</tr>
<tr>
<td>Gay</td>
<td>0.475</td>
<td>0.015</td>
</tr>
<tr>
<td>Private economies</td>
<td>−0.208</td>
<td>0.974</td>
</tr>
</tbody>
</table>

FIGURE 3 Cultural and economic tolerance indicators for China’s prefecture-level cities
indicates that cities with higher tolerance have higher innovative capacities. The tolerance-level indicators in Shenzhen, Beijing, Shanghai, Hangzhou, and Guangzhou are above 2.5, with more than 5,000 invention patents, while 96% of cities whose tolerance levels are below 0.5 have fewer than 500 authorized invention patents.
The existing literature has explored the factors affecting urban innovation from many perspectives, but the influence of cultural and economic tolerance factors was neglected. We argue that urban cultural and economic tolerance significantly affects urban innovation capacities and hope to introduce a spatial econometrical model to test it. We first introduce the previous cultural tolerance (cult_toler) and economic tolerance (econ_toler) index to measure urban tolerance level.

Based on the existing literature, this study also controlled for the effects of economic-scale R&D input, human capital, and educational level of residence (Furman, Porter, & Stern, 2002; Huggins & Debies-carl, 2015; Lee, 2015; Nathan, 2014; Qian, 2013; Wang, 2015). The local GDP is used to represent the local economic scale (Qian, 2013; Wang, 2015), while urban R&D input (rd) is employed to measure a city’s innovative input (Andersson, Quigley, & Wilhelmsson, 2009; Furman et al., 2002; Wang et al., 2016). The share of the population having a college degree (College graduates) is used to measure human capital (Acs, 2004; Qian, 2013; Wang, 2015). The number of faculties in urban higher educational institutions (College faculty) is employed as a proxy for universities (Wang, 2015). The number of urban authorized invention patents in a year is presented to capture urban innovation capacities as a dependent variable (Nathan, 2014; Qian, 2013; Wang, 2015). Variables including GDP, College faulty and R&D were obtained from the China Urban Statistical Yearbook. The definitions and descriptions of the variables are shown in Table 2.

To reduce heteroskedasticity and obtain an elastic result, the dependent and continuous independent variables were taken using natural logarithms. The dependent variable used 2016 data, while other urban attribute variables used 2015 data to reduce the influence of endogenous problems. In addition to the tolerance variables, Pearson correlations are very low and can be introduced into the model simultaneously.

Ordinary econometric models neglect spatial correlations and cause biases in the regression results; therefore, we used a spatial regression model based on the maximum-likelihood method to obtain a

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Expected sign</th>
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<tbody>
<tr>
<td>Cultural tolerance</td>
<td>Migrants</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>The proportion of people without a local <em>hukou</em> to the resident population</td>
<td></td>
</tr>
<tr>
<td>Entertainments</td>
<td>The proportion of people in cultural and entertainment industries to the total urban population</td>
<td>+</td>
</tr>
<tr>
<td>Rental housing</td>
<td>The proportion of rental housing in overall housing</td>
<td>+</td>
</tr>
<tr>
<td>Gay</td>
<td>The proportion of people with gay tags on Sina Weibo</td>
<td>+</td>
</tr>
<tr>
<td>Economic tolerance</td>
<td>Private economies</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>The ratio for the gross output value of POEs to all enterprises</td>
<td></td>
</tr>
<tr>
<td>Control variables</td>
<td>GDP</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>The local GDP in logarithm</td>
<td></td>
</tr>
<tr>
<td>College graduates</td>
<td>The share of the population having a college degree</td>
<td>+</td>
</tr>
<tr>
<td>College faculty</td>
<td>The number of faculties in urban higher educational institutions in logarithm</td>
<td>+</td>
</tr>
<tr>
<td>RD</td>
<td>Urban R&amp;D input in logarithm</td>
<td>+</td>
</tr>
</tbody>
</table>

**TABLE 2** Definitions and descriptions of variables used
consistent and unbiased estimate (Elhorst, 2014; LeSage & Pace, 2009). Spatial autoregressive (SAR) and spatial error models (SEM) are used in spatial regressions, in which the spatial correlations in the SAR model originate from correlations of the lagged term of the dependent variable, while the correlations of SEM come from the error term of the model. SAR and SEM were introduced to test the influential factors of urban innovation. The best model was chosen using Lagrangian multipliers and the likelihood ratio test. The SAR and SEM models based on Chinese prefecture-level cities were designed in the following equations:

\begin{align}
Y_i &= \rho W Y_i + \beta X_i + \mu + \epsilon_i \\
Y_i &= \beta X_i + \epsilon_i, \epsilon_i = \lambda W \epsilon_i + \mu
\end{align}

where \( Y \) is \( n*1 \) (\( n \) is the number of prefectural level cities) in a dependent variable vector, \( X \) is the explanatory variable matrices of \( n*k \) (\( k-1 \) is the number of independent variables), \( \beta \) is the coefficient of explanatory variables, \( \rho \) is the coefficient of spatial lag terms. \( \alpha \) is the coefficient of spatial error terms, \( \epsilon \) is the error vectors of normalized distribution, \( \mu \) is the disturbance term, \( i \) is a prefecture-level unit, and \( W \) is an \( n*n \) spatial adjacent matrix. The \( W \) element is set as the sum of inverse distances from neighboring cities in a 300-km bandwidth.\(^1\)

Although both SAR and SEM models pass the Lagrangian multipliers test, the SEM model and OLS did not pass the likelihood ratio test, while the likelihood ratio test for SAR is significant at the 0.01 level. Therefore, the SAR results are presented as the baseline for discussion in Table 3.

The SAR model show significant spatial correlations, indicating that innovative abilities in neighboring cities could significantly improve local cities’ urban innovation capacities, which is consistent with the previous studies (Wang, 2015). Urban economic levels, proportion of college graduates, number of higher educational teachers, and R&D input all significantly improve the city’s innovative abilities. A 1% increase in economic output accompanies, a 0.5%–0.6% increase in innovation output. Attracting talents also promote innovative abilities, with a 1% increase in the share of local college graduates will lead to a 12% increase in invention patent outputs, which demonstrates the importance of talents in innovation. Similarly, a 1% increase in the number of higher education teachers will result in roughly a 0.27% increase in patents, and a 1% increase in R&D input will generate roughly 0.2% of the invention output.

The results confirm the impact of tolerance on innovative abilities. Columns 1 and 5 all show that tolerance of cultural and economic differences significantly affects urban innovative abilities. Tolerance of cultural differences is significant at the 10% level, while a 10% increase in tolerance will result in a 1.5% increase in invention patent outputs. Economic tolerance is significant at the 10% level, while a 10% increase in tolerance will result in about 2.2% of innovation output, which indicates that improvement of tolerance for cultural and economic differences can effectively stimulate an increase in urban innovation output. A higher level of tolerance could integrate diverse information and populations, and facilitate mixing of different ideas and promote innovative abilities (Florida & Gates, 2001; Huggins & Debies-carl, 2015; Qian, 2013).

We then introduced the tolerance indexes separately into the model in columns 2–5. The results show that urban migrants can have a positive effect on urban innovative abilities, with a 1% increase in migrants resulting in 2.3% of the innovation output. Migrants are an important resource for urban vitality. Column 3 introduced the proportion of people engaging in cultural and entertainment industries, and found a significantly positive effect at the 10% level, which is consistent with Florida (2002). The cultural and entertainment industries represent the local cutting edge of cultural and fashionable tastes; therefore, they are always distinct from the traditional mainstream culture. The more developed
creative artists are more tolerant of nontraditional things, which is essential for innovative activities (Florida, 2012). Column 4 introduces the gay index and the results indicate a positive relationship with invention patent output at the 10% level. Thus, this is another effective indicator of urban tolerance. The final column introduces the proportion of POEs and found a significantly positive effect for innovation output, that is, an 1% increase in POEs results in an 1.9% increase in invention output, which means that economic tolerance is rather important in improving innovation capacities.

There may be an endogenous relationship between tolerance and innovation because higher tolerance might help promote regional innovative abilities, while highly innovative cities might also be more ready to attract migrants, artistic talents, and private corporations; therefore, simultaneous
relationships might exist in the model (Kemeny & Cooke, 2018). To solve this problem, we first introduce the lagged dependent variable to control for the influence of the endogenous problem. Proper instrumental variables are then introduced to get rid of the probable endogenous problem. We introduced crime rate (crime) and the proportion of private industrial output value to the overall industrial value in 2005 as instruments for migrants and POEs, respectively, and introduce a two-stage least squares model to test our hypothesis. The reason for choosing crime rate as an instrument is that a higher rate of migrants might include some people with low morals who would contribute to these higher crime rates, but the local crime rate might not correlate with regional innovations. Similarly, former POEs might affect private economic development for decades, but might not affect regional innovative abilities after many years. The crime rate is measured by the share of population with a criminal record at the provincial level. The data for criminal offenses were collected from the 2010 China Procuratorate Yearbook. The proportion of private economies is collected from a database of Chinese industrial enterprises. Table 4 shows the regression results. The weak instrument test shows that $F$ values are above 100 and the hypothesis of a weak instrument could be rejected. The regression results confirm that the previous econometric result was robust. After getting rid of the endogenous problem, cities with higher tolerance of cultural and economic differences still have higher innovative abilities.

To test the robustness of our results, we changed the dependent variable into the numbers of design and urban utility patents, respectively, with roughly the same result. Urban innovation also might be influenced by foreign direct investment, exports or imports, and gross industrial values, we added these variables into the model and found that the signs of tolerant variables remained almost the same. We did not include these variables in our paper because these variables were highly correlated with economic variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural tolerance</td>
<td>0.167*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Economic tolerance</td>
<td>0.338***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Migrants</td>
<td>2.758*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entertainments</td>
<td></td>
<td>22.771**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.021)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental housing</td>
<td></td>
<td></td>
<td>27.944**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.019)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gay</td>
<td></td>
<td></td>
<td></td>
<td>1.368*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.027)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private economies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.010***</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Control variables</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.821</td>
<td>0.808</td>
<td>0.802</td>
<td>0.809</td>
<td>0.784</td>
<td>0.807</td>
</tr>
</tbody>
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*Note: p in parentheses.  
***p < .01; **p < .05.
Urban innovative abilities are affected by factors such as urban economic scale, human capital, innovation input, and universities. The existing literature seldom considered the impacts of tolerance on Chinese urban innovation. The background of tolerance in China is quite different from that of Western developed countries. China has less ethnic or racial conflicts compared with western countries, but has a stringent *hukou* system hampering free migration of labor. Chinese private firms are still inferior to SOEs in terms of financial or political status despite the transition from a planned to a market-oriented economy. We investigated how tolerance of urban cultural and economic differences affect urban innovative capacity using a quantitative study based on China’s prefecture-level cities.

The proportion of migrants, rental housing, creative artists, and proportion of POEs were used to measure urban tolerance levels. The tolerance was attributed to tolerance of cultural and economic differences using factor analysis. The results show that cities with higher tolerance of cultural and economic differences were agglomerated in three metropolitan areas in the southeastern coastal region of China. Specialized zone and coastal opening cities usually have a higher level of tolerance of cultural and economic differences, while national centers like Beijing and Shanghai have higher levels of tolerance of cultural differences, but comparatively lower levels of tolerance of economic differences. The most tolerant cities are in first-level cities or coastal open cities, such as Shenzhen, Beijing, Dongguan, Xiamen, Zhuhai, and Shanghai, while medium and small cities in the middle and western areas of China have a relatively low score of tolerance. The scatterplots between tolerance score and number of invention patents also demonstrate significantly positive correlations.

The spatial regression econometric model results show that tolerance of urban cultural and economic differences could promote urban patent output and innovative abilities. Further analyses indicated that the rise of tolerance indicators, such as urban migrants, rental housing, ratio of gay people, and employed in entertainment industry all led to an increased urban innovation output. We also introduced crime rate as an instrumental variable and found that the effect of tolerance on innovation was robust.

Chinese central and local governments all highly emphasize promoting urban innovative abilities; however, governments at all levels are rarely concerned with the positive influence of tolerance of cultural and economic differences. In addition, Beijing and Shanghai still place stringent regulations on migrants to satisfy their aims to control their populations. These cities tend to expel low-quality workers or raise the threshold for the newcomers to stay competitive. In addition to innovative inputs, it is important to establish an open and tolerant environment to attract migrants, artists, and entrepreneurs at all levels to foster urban vitality and improve urban innovative capacities.

**ACKNOWLEDGMENTS**

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ENDNOTE

1 We also tried other distance bandwidths with roughly the same results.

REFERENCES


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