THE INFORMATION SOCIETIES OF CHINA AND INDIA: MULTIVARIATE AND GEOSPATIAL COMPARISON AND IMPLICATIONS FOR THE DIGITAL DIVIDE

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ABSTRACT

This paper compares and contrasts geographic patterns of information and communications technologies (ICTs) in thirty-one administrative units of China and twenty states of India. The novelty of this study is Indo-Chinese digital divide comparison at the sub-national level. The Chinese municipalities of Beijing and Shanghai and the Indian capital city-state Delhi – hotspots of trade and economic activity, industry and innovation, and education and knowledge production are unique poles of high technology utilization. The study further posits socio-economic, educational, innovation and social capital independent variables to be associated with indictors of ICT adoption and utilization in both nations. We determine that innovation resulting from publications of books in China and registered newspapers and periodicals in India is a significant correlate of ICT utilization in both nations. While cooperative society membership, a proxy for social capital is important for Indian states, export commodities value is the most significant correlate of technology utilization in Chinese provinces. Regression findings and geographic patterns of technology utilization are thoroughly compared. Policy recommendations for bridging the intra-national digital divide in both nations are recommended.

INTRODUCTION

As two of the most populous nation in the world, China and India's internet users number 674 million and 354 million [4] rendering them as nations with the highest base of internet users globally in 2014. Together they account for almost a third of all internet users worldwide, yet they both rank outside the top one hundred in terms of internet penetration (internet users per 100 population, [4]). In fact, China and India are ranked sixty-second and eighty-third respectively in terms of the World Economic Forum's Networked Readiness Index [10]. As the information societies of China and India have exploded in numbers – especially manifesting in hundreds of millions of internet and mobile cellular subscribers and both nations have made significant strides for economic development, interest in the digital divide in both nations has also increased. This research has been motivated by China's economic development spurred by manufacturing especially in electronics hardware and the development of a knowledge services economy and focus on and business process outsourcing in India. A recent study [7] found that IT services sectors in China and India are distinctively different and have developed along different paths. China's well established hardware sector and IT services sector are primarily geared to satisfy domestic demand; in contrast, India's IT services sector is predominantly export oriented and focused on meeting demand in Western markets. Therefore, due to their complementary nature, Chinese and Indian IT services sectors are unlikely to compete against each other in the near future, a finding that is contrary to popular perception. These findings have been reinforced in another recent study [1] which has cautioned that overdependence of Indian firms on selling low-value services to a few countries and a lack of focus on domestic demand make them vulnerable to global competition and downturn in global economies. Neither study [1,7] has however attempted to examine the state of ICT diffusion among the Chinese and Indian populations. In fact, comparative studies of the digital divide within China and India – given the vastness of both nations and their huge populations are missing from prior literature. This paper attempts to fill this gap. The objective of this paper is to build on prior work done by the authors [5,6] and systematically compare the adoption and utilization of ICTs in the provinces of China and the states of India. The study's research questions are as follows:

1. What is the appropriate conceptual model for examining spatial patterns of ICT adoption and investigating the digital divide in Chinese provinces and Indian states?
2. What similarities and differences exist between spatial patterns of ICT adoption and utilization in the provinces of China versus the states of India?
3. What similarities and differences exist between socio-economic correlates of ICT adoption and utilization in the provinces of China versus the states of India?

Predicated upon findings of these research questions, policy recommendations are provided for Chinese provinces and Indian states for alleviating the digital divide in both nations.

CONCEPTUAL MODEL OF TECHNOLOGY UTILIZATION

To examine and compare correlates of adoption and use of ICTs in China and India, we employ our Spatially Aware Technology Utilization Model (SATUM). SATUM posits associations of traditionally acknowledged demographic, socio-economic, economic development, market structure, policy, and infrastructure-related factors with indicators of ICT adoption and use dependent variables. Indicators for traditional and well-known independent correlates of technology utilization, for example, college education, per capita services workforce, percent of urban population, governmental support for ICT, and others are induced from prior literature. In addition, SATUM also includes societal openness as an independent correlate since an open and free society is more likely to foster the use of technology to communicate and exchange information. SATUM has been further refined to include indicators of social capital as socially connected individuals and communities support the technologically challenged and provide access to resources [2].

For the purpose of the this study, we use eight indicators of ICT dependent variables for Chinese provinces: (i) broadband subscribers, (ii) internet users, (iii) mobile phone subscribers, (iv) fixed phone subscribers, (v) personal computers used by families in urban areas, (vi) personal computers used by families in rural areas, (vii) webpages, and (viii) domain names. The first four indicators of ICT utilization are also used for Indian states.

For both China and India, two separate sets of a dozen independent variables are posited to be associated with the dependent variables. There is some overlap between the independent variables as well. For example, in the education category, full-time teachers in higher educational institutions is an independent correlate for China, that corresponds to the analogous variable – teachers in colleges and universities in India. Registered newspapers and periodicals is used as an indicator of innovation for India while published books is the corresponding variable for China. Other common variables are export by export oriented units for India versus exported commodities value for China and electrical capacity for India versus electricity output for China – both independent indicators of infrastructure. Overall, five of the twelve independent correlates are common. Each set of independent variables also includes a few that are unique to each nation. For example, social capital manifests itself in the form of cooperative society membership – a variable that is unique to India, whereas innovation funds of Chinese enterprises is unique to China. Overall, our choice of independent variables is grounded in prior literature, yet is pragmatically challenged by the inconsistency in availability of reliable and complete data for all/most provinces or states of each nation. The sample size for Chinese provinces and Indian states are 31 and 20 respectively.

Our research methodology is comprised of the following steps: descriptive mapping of dependent variables using a Geographic Information System (GIS) which provides important visual cues about geographic distributions of technology utilization, testing ICT dependent variables for the presence of spatial autocorrelation using Moran's I inferential statistic, identifying clusters of high and low technology utilization provinces/states using K-means cluster analysis in the event significant spatial autocorrelation is diagnosed, diagnosing statistically significant hotspots and cold-spots of technology utilization using a spatial analytical method Local Indicators of Spatial Association, and finally using OLS regression analysis to test posited associations of independent correlates with ICT dependent variables. Diagnostic teste are used to ensure that OLS regression assumptions are satisfied and OLS regression residuals are tested for the presence of spatial bias.

PATTERNS OF ICT UTILIZATION IN CHINA AND INDIA

K-means cluster analysis yields six clusters based on eight ICT dependent variables for China and four clusters based upon four ICT dependent variables for India.

One-state or One-municipality clusters: In both nations, there are unique one-province clusters that are comprised solely of Beijing and Shanghai in China and India's city-state of Delhi. The one-member "clusters" are highest poles of ICT utilization, comprise national capitals, and are major population centers. In fact, Delhi, Shanghai, and Beijing are the second-, third-, and eighth-largest urban agglomerations in the world with populations of 25, 23, and 20 million respectively in 2014 [9]. This finding is hardly surprising given the recognition of these cities as hotspots of trade, economic, and political activity. Additionally, nationally and internationally reputed centers of higher learning such as Tsinghua University, Peking University in Beijing, Fudan University and Shanghai Jiaotong University in Shanghai, and Delhi University and Indian Institute of Technology in Delhi – enhance ICT adoption and utilization in these clusters. This is particularly relevant in terms of providing a readymade regional labor force for the Chinese and Indian software industry; significant clustering of firms belonging to this industry are located in Beijing, Shanghai, and Guangdong [3]. Similar clustering is found in the National Capital Territory (NCT) inclusive of the cities of Gurgaon and Noida, which is India's second largest cluster of software firms behind Bangalore, a globally renowned destination of IT, BPO, and knowledge services companies. Another noticeable attribute of these one-province clusters in their focus on publishing as a result of being vibrant centers of political, economic, educational, cultural and intellectual activity manifesting itself in the form of very high dominance in webpages and domain names for Beijing and Shanghai in China and similar dominance of registered newspapers and periodicals for Delhi in India. In other words, these unique one-city clusters are knowledge production centers – both in hard copy and electronic format.

Low-ICT clusters: At the other end of the spectrum, slightly more than a third of the provinces in each country (twelve out of the thirty-one regional entities in China and seven out of twenty Indian states) belong to the lowest ICT cluster. In China, these low-ICT provinces are predominantly in the west, are land-locked, and have not been designated as Special Economic Zones (SEZs) unlike their eastern or coastal peers. In other words, ICT adoption in these regions has been hampered by comparatively low levels of economic activity. Additionally, these provinces have been afflicted by "brain drain" [3]. In contrast, the low ICT states in India include Assam and its neighboring states in the North-East, the central India landlocked state of Madhya Pradesh, and agrarian states in India's Hindi heartland Bihar and Uttar Pradesh. Bihar, Orissa, Madhya Pradesh, and Uttar Pradesh while large and populous have often been associated with agriculture and mining. Each of these states ranks at the very bottom of the pyramid in terms of total teledensity among Indian states in 2011 [8].

High ICT clusters: The high cluster in India is comprised of the states of Himachal Pradesh and Punjab in North India and Tamil Nadu and Kerala in South India. Apart from Delhi, these four states are among the top five states in India in terms of total teledensity in 2011 [8]. In China, Fujian, Guangdong, and Zhejiang province, and Tianjin municipality are in the high ICT cluster, behind Shanghai and Beijing. Guangdong and Fujian were among the earliest provinces to become locations of Special Economic Zones, and as indicated earlier, Guangdong's development has been accompanied by growth of a cluster of Chinese software firms [3]. In addition, Zhejiang and Guangdong provinces are home to a majority of Chinese hardware producers but sometimes suffered from infrastructural problems such as power cuts [3].

Moderate ICT cluster: Moderate ICT adoption and use is found in the southern Indian states of Andhra Pradesh and Karnataka, western Indian states of Maharashtra, Gujarat, and Rajasthan, West Bengal in the east, and Haryana and Jammu and Kashmir in the north. Teledensity in each of these states is moderate too. Karnataka's capital Bangalore and the Mumbai-Pune corridor in the western state of Maharashtra, along with Noida and Gurgaon near Delhi account for 61 percent of Indian software firms [3]. Incidentally, software technology parks set up in Bangalore and Pune in 1990 at the dawn of economic liberalization fostered the development of clusters of software firms not only in Bangalore and Pune, but also in Hyderabad, capital of Andhra Pradesh, a southern Indian state in the moderately high ICT adoption cluster. In China, a moderate-to-low ICT cluster is comprised of 12 provinces in east central China, the island province of Hainan, and the north with the exception of the northernmost province of Heilongjiang. The moderate to low technology adoption in this cluster in China may be illustrated by the city of Suzhou in Jiangsu province, which attracted more than $20 billion in FDI in the 1990s. Suzhou thus became home to several thousand foreign-funded enterprises. However these enterprises contracted out to domestic businesses on a rather limited basis due to a shortage of qualified technical staff and skilled workers in domestic companies. This posed an obstacle to greater technology diffusion in the region [3].

We conclude with the observation that for broadband, internet, mobile phones, and landlines, the extent of difference in ICT adoption between the lowest and highest clusters is rather similar for China and India, when the highest "outliers" of Beijing, Shanghai, and Delhi are excluded from analysis. The digital divide is however exacerbated when the highest ICT clusters are included.

DETERMINANTS OF ICT UTILIZATION IN CHINA AND INDIA

Regression findings for the dependent variables in 2010 show that the most influential factor for all technology subscriber levels is registered newspapers/periodicals. Second in importance are the higher education variables of university teachers (for mobile telephone) and engineering/technical education enrollment (for internet and broadband). The education findings have had consistent support in the digital divide literature for nations. Cooperative society membership is significant for landline telephone subscribers in India. The newspaper/periodicals finding corresponds to a similar finding for published newspapers for the provinces of China [6].

Regression Findings for India: Mapping and geographical analysis for the technology dependent variables indicates unique high outlier values for Delhi; in particular, Delhi's level of registered newspapers and periodicals was over seven-fold the level for the next highest state of Maharashtra. Because of this outlier status, we computed an alternative series of stepwise regressions excluding Delhi from the sample. As expected, registered newspapers/periodicals is eliminated as a factor. The significant correlates shift to cooperative society membership (significant for landlines and internet), engineering/technical education enrollment (significant for mobile phones and broadband), and electrical capacity (significant for landlines and internet). Electrical capacity is especially significant for internet subscribers. We explain that it reflects provinces with greater electrical power and communications infrastructure, as well as greater business and individual energy consumption – factors often associated with higher levels of internet use. In fact, India's meager base of internet users reflected in a third of the percent increase in internet penetration compared to that of China, has been partly attributed to inconsistent power supply [8]. Lack of power supply or limited power supply has also been identified as one of the reasons for the digital divide in India and as a hindrance to telephony in rural India [8]. Landline telephone use likewise needs communications infrastructure. Given these associations, electrical capacity's absence as a factor for mobile phones and broadband is unexplained.

Regression Findings for China: The most important correlate is export commodities value which is significant for all indicators of ICT dependent variables. This is followed by published books– a finding analogous to the association of published newspapers and periodicals with India's dependent variables. Tertiary employment (associated with mobile and urban fixed phone subscriptions) and foreign direct investment (associated with webpages and urban fixed phone subscriptions) are also important correlates. Once again, similar to India, when the high-ICT "outliers" of Beijing and Shanghai are removed, published books drops out as a significant correlate. This seems intuitive given the dominance of Beijing and Shanghai as hotspots of publishing. However export commodities value continues to dominate with significant associations for six out of the eight dependent variables. Innovation funds of enterprises is now a secondary correlate associated with webpages and urban fixed phone subscriptions. In this context, the finding that China has systematically moved ahead in creating a self-supporting industrial and innovation ecosystem is relevant [1]. Further, the work done by Chinese software firms to develop fairly standardized yet new products for the domestic market required innovation [3]. For such endeavors, local governments in China assisted with funding by lobbying the state-owned banks, offering guarantees for enterprises that were seeking loans, or creating innovation funds to lend directly to enterprises [3].

POLICY IMPLICATIONS

For India, the key associated determinants of ITS levels are engineering/technical education, newspapers/periodicals, cooperative society membership, and infrastructure measured by electrical capacity. Policymakers in the Indian central government should emphasize the quality and quantity of technical education. We interpret the importance of newspapers/periodicals as related to innovation, since it indicates knowledge is being produced including scientific knowledge. Policies at the national level should be encouraged to stimulate knowledge production. Cooperative society membership reflects the importance of social capital for technology [2]. In India, government policymakers at the national or state level can provide more support for cooperative societies including support for technology investment and/or training. Finally, infrastructure in India is known to be moderate or below international standards and is a national challenge. For instance, in electricity production, India rates 69th out of 144 nations, while it is 120th on internet bandwidth. The Indian policymakers can provide incentives for capital investment to expand the amount and quality of electrical infrastructure.

For China, the major determinants – book publishing, export commodities value, percent of workforce in non-state enterprises, and the minor determinant of innovation – suggest policy steps for its government. Similar to India's newspapers/magazines, we consider book publishing a proxy for knowledge production and innovation. In the prior and current Chinese national 5-year plan, domestic technological innovation and knowledge generation have been encouraged. The non-state-enterprise workforce, i.e. the market sector, which has been grown profoundly, has been a pillar of China's economic transformation in the 21st century. Policies to encourage the market economy are still present under the leadership administration of Xi Jinping, while state-owned enterprises are now being encouraged to modernize.

CONCLUSIONS

This study is the first attempt at systematic comparison of geographic patterns of ICT diffusion and the digital divide in the administrative units of China and states of India. We further compare correlates of ICT adoption at the provincial level in both nations. For both China and India, innovation is a key correlate of technology utilization at the provincial/state level. In China, export commodities value is a dominant correlate followed by foreign direct investment and tertiary industry employment. In India, engineering/technical education enrollment followed by cooperative society membership reiterates the association of education and social capital with technology utilization. The study is limited in considering just four ICT dependent variables for India compared to eight dependent indicators of ICT use for China. Social media variables are not included in this study due to absence of state/provincial data. Incorporation of social media indicators – for example, Facebook, Twitter, and LinkedIn as well updating the time window associated with the variables used will add currency to the study and its findings.

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