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# **A new regional classification for mobile telecommunications diffusion policy in China: using the innovation and imitation coefficients**

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## **ABSTRACT**

While Chinese telecommunications industry has been continuously developing, the penetration rate of mobile telecommunications by province in China is distributed from less than 40% to larger than 100% in 2009. This regional disparity in terms of mobile telecommunications penetration rate is due to various socioeconomic factors such as income level, occupation structure, education level. The purpose of this paper is to suggest a new approach for regional classification based on the diffusion characteristics of each province for more effective and efficient mobile telecommunication's diffusion policy and strategy. First, this paper estimates diffusion parameters, including an innovation coefficient and imitation coefficient of 31 provinces using mobile subscription data, and then classifies the provinces into six groups using cluster analysis based on the estimated innovation coefficient and imitation coefficients.

The clusters are also significantly different in terms of socioeconomic perspective such as income level. The results of cluster analysis imply that the traditional regional classifications are too simple and should be divided more in detail in terms of innovation and imitation coefficients in the case of developing mobile telecommunications strategies. This new regional classification (six clusters) can be used for not only 3G diffusion policy but also the future mobile telecommunications technology diffusion policy. In China, 3G service was started in January 2009 as Chinese government awarded 3G cellular licenses. Finally, the managerial and political implications are addressed based on the new

regional classification.

*Keywords:* Regional classification, Innovation coefficient, Imitation coefficient, Cluster analysis, Mobile telecommunications, China

## 1. Introduction

China has grown as the world largest mobile telecommunications market according to the International Telecommunications Union (ITU)'s statistics (See Table 1). In addition, during the last ten-years, Chinese telecommunications industry has been continuously developing, and, in January 2009, 3G market started as Chinese government awarded 3G cellular licenses: a TD-SCDMA license to China Mobile, a CDMA 2000 license to China Telecom and a WCDMA license to China Unicom (Kshetri, Palvia & Di, 2011). The number of 3G subscribers is rapidly increasing from 12,322 thousand in the end of 2009 to 80,510 thousand in the end of July 2011(MIIT<sup>1</sup>). The proportion of 3G subscribers out of total mobile telecommunications subscribers is increased more than 5 times from 2009 (1.6%) to July 2011 (8.7%) as shown in Table 2, which shows that 3G service has been growing very rapidly. However, the mobile telecommunications subscriptions in China show significant provincial disparities.

**Table 1**

Country ranking of mobile cellular subscribers \*

Country	Mobile cellular subscribers		World Ranking
	2009	2010	
China	747,214,000	859,003,000	1
India	525,090,000	752,190,000	2
United States	274,300,000	278,900,000	3
Russia	230,500,000	237,689,224	4

\* Source: ITU, Key 2000-2010 country data

**Table 2**

The proportion of 3G subscribers over total mobile telecommunications subscribers

Year	Number of Mobile phone Subscribers (1,000 subscribers)	3G Mobile Phone Subscribers (1,000 subscribers)	3G proportion
2009	747,384	12,322	1.6%
2010	859,003	47,050	5.5%
2011.7	920,540	80,510	8.7%

China is a vast country with a long history, and regional characteristics vary in terms of ecological

1 Ministry of industry and Information Technology

conditions, natural resources, and accessibility to international markets (Song, Chu & Cao, 2000). Status of Chinese mobile subscribers at the end of the 2009 also shows a big difference by region; eastern region 346.254 million, central region 227.708 million, and western region 173.265 million<sup>2</sup>. Mobile communication penetration rates are also different from each other such as 79.1% for eastern region, 47.5% for central region, and 49.8% for western region. The province with the highest penetration rate is Shanghai (110%) which is also located in the eastern region.

This regional disparity in terms of mobile telecommunications penetration rate is due to various socioeconomic factors such as income level, occupation structure, education level (Nam, Kim, Lee, Duan & Meng, 2008). And therefore, the mobile penetration rate might also be different from each other because mobile phones have had a strong relationship with economic growth (Waverman, Mesch & Fuss, 2005) and because the classification of three regions in general reflect three levels of economic development (Chen & Song, 2008).

The penetration rate of mobile telecommunications by province in China is distributed from less than 40% to larger than 100% in 2009. Table 3 shows the provinces which have the high penetration rate over 70% are concentrated in eastern coastal region.

**Table 3**

Status of 2009 mobile telecommunications penetration in China mainland (31 provinces)

Penetration rate (%)	Province
more than 100	Beijing, Shanghai
90-100	Guangdong
80-90	Zhejiang, Tianjin
70-80	Fujian
60-70	Inner Mongolia, Liaoning, Jiangsu, Shaanxi, Ningxia
50-60	Hebei, Shanxi, Jilin, Shandong, Hubei, Hainan, Chongqing, Qinghai, Xinjiang
40-50	Heilongjiang, Henan, Hunan, Guangxi, Sichuan, Yunnan, Tibet, Gansu
less than 40	Anhui, Jiangxi, Guizhou

There should be concerted efforts by government and industry to resolve the regional disparity in mobile telecommunication diffusion. To propose a policy about the balanced diffusion of mobile

<sup>2</sup> The provinces included in each region are described in page 4.

telecommunication, a reasonable regional classification is needed. However, a classification used in previous studies such as Eastern, Central, and Western is too simple to reflect the diffusion characteristics of each province.

The purpose of this paper is to suggest a new approach for regional classification based on the diffusion characteristics of each province. First, this paper estimates diffusion parameters, including an innovation coefficient and imitation coefficient of 31 provinces using mobile subscription data. Then, this paper classifies the provinces into several groups using cluster analysis.

## 2. Literature review

Regional classifications in China were made using different criteria by different authors based on their research purpose. As an example of broad geographical regional grouping, Liu & Li, (2006) examined disparity in factor contributions between coastal and non-coastal (inner) provinces<sup>3</sup>. Fujita and Hu (2001), based on this regional division, found that the income disparity between the coastal area and the interior had been increasing during the period 1985-1994. Sometimes, four regional groupings- Northeast, East, Central, and West- were used in agricultural issues (Chen & Song, 2008; Chen, Huffman, & Rozelle, 2009), differing from each other in geography, natural endowment, and most importantly, the level of economic development. Demurger et al. (2002), analyzing geographical and economic characteristics of China in the post-1978 period, suggested six regional groupings. Six regional groupings are Metropolis, Northeast, Coast, Central, Northwest and Southwest<sup>4</sup>. Cui and Liu (2000) proposed seven regional groups based on economic development and consumer purchasing power: South, East, North, Central, Southwest, Northwest, and Northeast<sup>5</sup>.

However, China has typically divided the country into three administrative regions: the eastern,

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<sup>3</sup> The coastal provinces are Beijing, Tianjin, Hebei, Liaoning, Jiangsu, Zhejiang, Shandong, Guangdong, Hainan, Shanghai and Fujian. The non-coastal provinces are Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Sichuan and Tibet.

<sup>4</sup> The metropolis includes Shanghai, Beijing and Tianjin. The Northeast region includes Jilin, Liaoning and Heilongjiang. The coast region includes Guangdong, Fujian, Zhejiang, Jiangsu, Hainan, Shandong and Hebei. The central region includes Henan, Hubei, Anhui, Jiangxi, Hunan and Shanxi. The Northwest region includes Xinjiang, Inner Mongolia, Shaanxi, Gansu, Ningxia and Qinghai. The southwest region includes Yunnan, Sichuan, Guangxi and Guizhou.

<sup>5</sup> The northwest region includes Inner Mongolia, Shanxi, Shaanxi, Gansu, Ningxia, Xinjiang, Qinghai and Tibet. The Southwest China includes Sichuan, Guangxi, Guizhou and Yunnan. The central China includes Henan, Anhui, Hubei, Hunan and Jiangxi. The northeast China includes Heilongjiang, Jilin and Liaoning. The north China includes Beijing, Tianjin, Hebei and Shandong. The East China includes Shanghai, Zhejiang and Jiangsu. The south China includes Guangzhou, Fujian, Hainan and Hong Kong.

central and western regions<sup>6</sup>. According to the official definition of the National Bureau of Statistics of China (NBS), the regions in China are divided into eastern, central, and western regions, based on the geographical location and level of economic development. Many researchers used this official regional division. Zhang et al. (2001) used this simple classification and found especially the eastern and the western regions have converged to their own specific steady states over 1952–1997. Other researchers also used this classification for their work (Chi, 2008; Nam et al, 2008; Nam, Kim, Lee, & Duan, 2009; Narayan, Nielsen, & Smyth, 2008).

However, the research about the regional classification based on diffusion characteristics of mobile telecommunications never been conducted, although it might be more suitable and necessary for more effective and efficient mobile telecommunication's diffusion policy and strategy. This paper tries to suggest a new regional classification for the issues related to mobile telecommunications diffusion in China.

### **3. Methodologies**

#### **3.1 Bass diffusion model**

The innovation and imitation coefficients represent the diffusion characteristic of each province. They are well-known for the Bass diffusion model. It is widely used to investigate diffusion patterns and forecast the demand for new products and services with S-shaped diffusion curves.

$$S_t = (p+q \cdot Y_{t-1}/N)(N-Y_{t-1}) = Y_t - Y_{t-1} = \text{Number of new subscribers in year } t$$

$Y_t$  = Cumulative number of subscribers

$N$  = Potential market size (= ultimate number of subscribers)

$p$  = Innovation coefficient

$q$  = Imitation coefficient

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<sup>6</sup> The eastern region includes Beijing, Tianjin, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. The central region includes Hebei, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan. The western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

Innovation coefficient ( $p$ ) is corresponding to the probability of initial purchase at the beginning of the product's life cycle and is related to the size of the initial critical mass of adopters, *the innovators*. Imitation coefficient ( $q$ ) refers to the size of the group of remainder of possible future adopters, *the imitators* (Michalakelis, Vaoutas, & Sphicopoulos, 2008). The innovation and imitation coefficients may reflect the characteristics of innovators and imitators. The Innovators' decisions to adopt the service are independent from the decisions of the rest of the population (Michalakelis et al, 2008), and they have characteristics of 'Opinion leadership', and 'Consumer innovativeness'. Opinion leaders are "individuals who exert an unequal amount of influence on the decision of others", and consumer innovativeness is related to the concept of both "the individuals who do not rely on interpersonal communications in making the purchase decisions" and "individuals who have the desire to seek out new product information"(Chau & Hui, 1998). The imitators are often influenced by interaction with innovators (word-of-mouth) and by external influences such as mass media communication and other communication channels (Michalakelis et al, 2008). Therefore these coefficients were considered that they reflect the diffusion characteristic of mobile telecommunication.

To draw the innovation and imitation coefficients, this study employs China's mobile subscription data for 1987–2009. Data sources are Chinese Statistical Year Book from the NBS and Statistical Analysis Data for Communication Industry from the MIIT. All data were available on their websites.

As a parameter estimation method, the nonlinear least squares (NLS) method was used; it is the most widely used method and outperforms the OLS and MLE methods (Srinivasan & Mason, 1982). In using NLS, we place sign constraints on  $p$  and  $q$ . The initial values of  $p$  and  $q$  were those for the whole of China: 0.005 and 0.3, respectively. For 1987–2000, because there are no province-level subscription data, we estimate provincial data by multiplying the ratio of each province's subscribers to the total number of subscribers in China<sup>7</sup>. In calculating the ratio, data for 2001 were used. We use actual data for the years 2001–2009, obtained from the NBS.

### 3.2 Cluster analysis

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7 The number of users in province  $i$  in year  $t$  = total number of users in year  $t$   $\times$  (the number of users in province  $i$  in 2001 / total number of users in 2001). \*  $t$  = 1987, 1988 ... 2000.  $i$  = BJ, SH ... XJ.



Traditionally, cluster analysis has been used for empirical classification of object (Okazaki, 2006). It is a technique that is frequently employed to search for groups in data, using measures of similarity or dissimilarity to determine membership either within a given group or across different groups (Banerjee & Ros, 2004). In this paper, the “k-means cluster algorithm” was used to group the 31 Chinese provinces into several groups according to the innovation and imitation coefficients. For input data, the innovation and imitation coefficients of each province was used.

#### 4. Results

Mobile subscription data for 31 provinces in mainland China are used to estimate innovation coefficient ( $p$ ) and imitation coefficient ( $q$ ). NLS is used for parameter estimation, the results of which are presented in Table 4.

**Table 4**

Estimates of the innovation coefficient ( $p$ ) and imitation coefficient ( $q$ ) in 31 provinces

Province	$p$	$q$	R-squared	Province	$p$	$q$	R-squared
Beijing	0.009	0.51	0.712	Hubei	0.002	0.33	0.888
Tianjin	0.005	0.33	0.833	Hunan	0.002	0.29	0.917
Hebei	0.004	0.36	0.884	Guangdong	0.006	0.48	0.871
Shanxi	0.003	0.37	0.760	Guangxi	0.005	0.32	0.842
Inner Mongolia	0.003	0.36	0.920	Hainan	0.001	0.35	0.891
Liaoning	0.004	0.30	0.785	Chongqing	0.007	0.48	0.816
Jilin	0.006	0.42	0.811	Sichuan	0.003	0.26	0.860
Heilongjiang	0.008	0.31	0.764	Guizhou	0.001	0.35	0.896
Shanghai	0.009	0.42	0.704	Yunnan	0.003	0.28	0.908
Jiangsu	0.004	0.29	0.754	Tibet	0.001	0.36	0.772
Zhejiang	0.007	0.33	0.819	Shaanxi	0.002	0.36	0.904
Anhui	0.002	0.26	0.868	Gansu	0.000	0.39	0.916
Fujian	0.004	0.31	0.742	Qinghai	0.004	0.32	0.785
Jiangxi	0.005	0.31	0.779	Ningxia	0.005	0.34	0.855
Shandong	0.003	0.36	0.940	Xinjiang	0.005	0.40	0.696
Henan	0.003	0.44	0.980				

Innovation coefficients of 31 provinces are distributed between 0.000 and 0.009, and imitation coefficients are distributed within the range from 0.26 to 0.51. According to the value of coefficients of innovation ( $p$ ) and the coefficients of imitation ( $q$ ), provinces are sorted as shown in Table 5. While imitation coefficients does not show any big relative differences among provinces, the classification of provinces based on the innovation coefficients shows interesting results.

The provinces with the highest innovation coefficient of 0.009 are Beijing and Shanghai, where the mobile penetration rates were over 100% in 2009, which means that the higher the innovation coefficients, the higher the penetration rate is. In addition, the income and education levels of Beijing and Shanghai are the highest in China. The provinces with the innovation coefficients between 0.006 and 0.008 are mainly located in eastern coastal region except Chongqing. The province where the range of innovation coefficient is less than 0.005 and greater than 0.002 is located in a mixed area of eastern, central, and western regions. The provinces with innovation coefficients less than 0.001 have characterized as the provinces of the smallest population or the lowest income level. For example, Tibet and Hainan have the smallest population (2.9 million and 8.64 million, respectively), and Guizhou and Gansu have the lowest income levels in China (ranked by 27<sup>th</sup>, 31<sup>st</sup>, respectively) in 2009.

**Table 5**

Province classification by value of innovation coefficient (p) and imitation coefficient (q)

Range of p	Province	Range of q	Province
p≤0.001	Hainan, Guizhou, Tibet, Gansu	q≤0.3	Anhui, Sichuan, Yunnan, Jiangsu, Hunan, Liaoning
0.002	Anhui, Hubei, Hunan, Shaanxi		
0.003	Shanxi, Shandong, Henan, Sichuan, Yunnan, Inner Mongolia	0.3<q≤0.4	Hebei, Shanxi, Shandong, Hainan, Guizhou, Tibet, Gansu, Xinjiang, Inner Mongolia, Shaanxi, Tianjin, Heilongjiang, Zhejiang, Fujian, Jiangxi, Hubei, Guangxi, Qinghai, Ningxia
0.004	Hebei, Liaoning, Jiangsu, Fujian, Qinghai		
0.005	Tianjin, Jiangxi, Guangxi, Ningxia, Xinjiang		
0.006	Jilin, Guangdong		
0.007	Zhejiang, Chongqing	0.4<q≤0.5	Shanghai, Guangdong, Chongqing, Henan, Jilin
0.008	Heilongjiang		
0.009	Beijing, Shanghai	0.5<q	Beijing

To make a new regional classification, a cluster analysis is conducted using innovation and imitation coefficient as independent variables. K-means cluster analysis was performed and 6 clusters were derived (F-statistic 20.903). The provinces by cluster are listed in Table 6, and those 6 clusters are geographically displayed on the Chinese map (See Figure 1) for better understanding. One of the interesting points is that the provinces in cluster 1, 2, and 3 are distributed mainly in the eastern region. Majority provinces in cluster 5 are located in northern region, while the provinces in cluster 6 are located in southern region. The provinces in cluster 4 are located in central and western regions.

**Table 6**

The result of cluster analysis

	Provinces
Cluster 1	Beijing, Guangdong, and Chongqing
Cluster 2	Shanghai
Cluster 3	Tianjin, Heilongjiang, Zhejiang, Jiangxi, Guangxi, and Ningxia
Cluster 4	Hainan, Guizhou, Tibet, Shaanxi, and Gansu
Cluster 5	Hebei, Shanxi, Inner Mongolia, Jilin, Shandong, Henan, and Xinjiang
Cluster 6	Liaoning, Jiangsu, Anhui, Fujian, Hubei, Hunan, Sichuan, Yunnan, and Qinghai

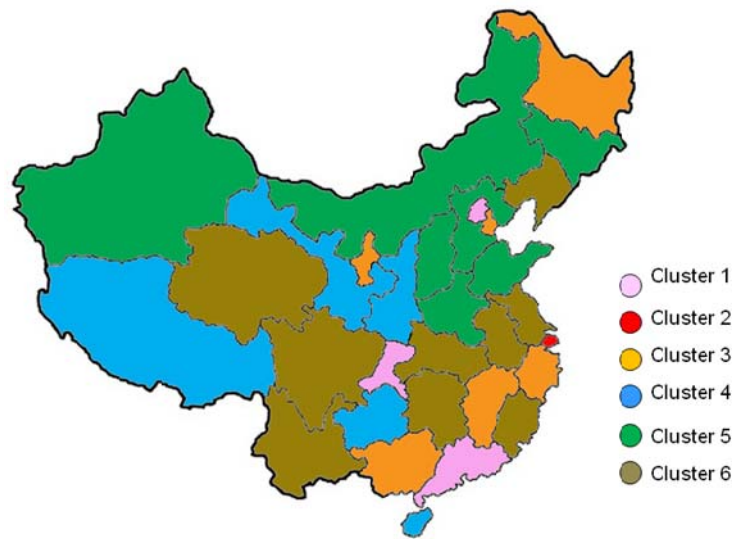


Fig. 1. Cluster display in the map of mainland China

Moreover, to look at how the clusters fit the level of coefficients, the clusters and the coefficients are combined as shown in Table 7, where all 6 clusters are assigned into one of the nine cells which represent different levels of innovation and imitation coefficients. One of the interesting points is that cluster 1 and 2 match with the area of high innovation and high imitation coefficient, and cluster 4 match with the area of low innovation and middle imitation coefficient.

**Table 7**

Cluster division by the level of innovation and imitation coefficients

Range of p, q	Low( $q \leq 0.3$ )	Middle	High( $0.4 \leq q$ )
Low ( $p \leq 0.001$ )		Cluster 4	
Middle	Cluster 6	Cluster 5	
High ( $0.005 \leq p$ )		Cluster 3	Cluster 1, Cluster 2

To show how these clusters are different from each other in terms of socioeconomic perspective, the tests for equality of group means were conducted using socioeconomic variables: fixed phone penetration rate, network capacity, occupation structure, transportation, income, and education. The descriptions of variables are in table 8, and these are the factors influencing mobile subscription in China in previous researches (Nam et al., 2008; Nam et al., 2009).

**Table 8**

Socioeconomic variable descriptions

Variables	Description
FIX	Fixed phone penetration rate
Network Capacity	Capacity of mobile phone exchange
Occupation	Percentage of population working in a tertiary industry (service industry)
Transportation	Passenger kilometers using public transportation
Income	Per capita annual disposable income of urban households
Education	Percentage of individuals educated beyond senior high school in the population aged six years and older.

As a result of tests of equality of group means, there exist significant differences in terms of six variables as shown in Table 9. Table 10 shows the detailed data about mean values of clusters. The interesting point is that the cluster with the high level of innovation and imitation coefficients such as Beijing and Shanghai also shows high level of socioeconomic level and vice versa.

**Table 9**

The result of tests of equality of group means

	Fixed phone penetration	Network Capacity	Occupation Structure	Transportation	Income	Education
Wilks' Lambda	.659	.880	.813	.839	.744	.590
F	28.229	7.471	12.548	10.482	18.750	37.972
Sig.	.000	.000	.000	.000	.000	.000

**Table 10**

Mean values of clusters

Cluster	Fixed phone (%)	Network Capacity (Million subscribers)	Occupation structure (%)	Transportation (Billion passenger-km)	Income (thousand yuan)	Education (%)
Cluster1	35.2	38.4	46.7	66.8	14.7	28.1
Cluster2	49.7	23.0	52.9	12.6	19.6	44.6
Cluster3	25.1	17.2	35.0	45.2	11.3	21.7
Cluster4	17.6	7.7	34.5	25.3	9.0	14.5
Cluster5	21.3	22.8	32.2	59.7	9.7	19.7
Cluster6	22.5	22.3	33.8	64.5	10.3	17.3

The results of cluster analysis imply that the traditional regional classification of (1) coastal and inland region or (2) eastern, western, and central region are too simple and should be divided more in detail in terms of innovation and imitation coefficients in the case of developing mobile telecommunications strategies. This new regional classification (six clusters) can be used for not only 3G diffusion policy but also the future mobile telecommunications technology diffusion policy.

## **5. Implications**

### **5.1 Managerial Implications for mobile service providers**

This paper suggests that the managers of telecom companies would better consider the characteristics of innovators and imitators for the active diffusion of new mobile telecommunications service. They are able to increase the effectiveness by segmenting the whole market into several sub-markets and applying different strategies based on the new regional classification, for example, six clusters according innovation and imitation coefficients in this paper. For example, marketing mix strategy of each province might be different from each other, and determining investment priority and the size of the investment might not be the same across the provinces. In the case of 3G, cluster 1 and 2 might be the first target provinces to speed up 3G diffusion because Cluster 1 and 2 are consisted of the provinces with the highest innovation coefficient. Therefore the provinces in those clusters have a high readiness for adoption and, consequentially, the 3G will be diffused faster in those provinces. Beijing, Guangdong, Chongqing and Shanghai are in this category, these provinces are expected to create the tornado effect by expanding distribution coverage and by focusing on the product supply. In the case of the cluster which has a high level of innovation coefficient, the managers should consider the innovators' characteristics for a fast diffusion. On the other hand, the imitators' characteristics should be considered for the cluster with a high level of imitation coefficient.

In addition, the statistics of socioeconomic factors about a province can be a good source for a cluster-specific strategy. For example, managers may consider a subsidy or free mobile phone for the cluster with low income level or increasing advertisements opportunities utilizing public transportation facilities such as subway, bus terminal, and subway/train stations for the cluster with a big volume of

public transportation. Because each cluster has a different socioeconomic level, the differentiation in market strategies might be required regarding the type and price of handset products and services. In this context, a new regional classification could be one of the good alternatives for managers to make their decisions.

## 5.2 Policy implications

The provinces with high innovation and imitation coefficients can be considered as economically highly developed and have a higher mobile subscription than others. Beijing, Shanghai, Chongqing and Guangdong are included in this category (Cluster 1 and 2), and they may be good candidates for the 4G introduction on a pilot basis.

Most provinces with high innovation-middle imitation coefficients (cluster 3), middle innovation-middle imitation coefficients (cluster 5) and middle innovation-low imitation coefficients (cluster 6) are recently developing provinces whose economic situations including mobile business circumstance might be influenced by Chinese government policy of developing inland. Chinese government announced special policies such as the Great Western Experiment, the Resurgence of the Old Northeast Industrial Base, and the Stimulation of the Central Regions. These policies proposed and implemented a series of instruments explicitly designed to boost the economy of inland region and reduce the income gap between the coastal and inland regions (Chen, 2010). For this kind of provinces, the policy makers would better prepare the booming strategies for expanding mobile subscription. However, the provinces with low innovation-middle imitation coefficients- Hainan, Guizhou, Tibet and Gansu (Cluster 4) - have the lowest economic level and the slowest diffusion speed. The policy makers may consider the strategic investment in telecommunication infrastructure on the concept of extending universal service.

This study suggested the new regional classification based on the innovation and imitation coefficients. It is obvious that the potential digital divide problem among clusters will be happened, because mobile service providers are expected to invest primarily in the provinces with a high innovation and imitation coefficients. To resolve the regional disparity in 3G mobile subscriptions without sacrificing efficiency of resource allocation, policy makers should find ways not only to

encourage investment in telecommunications infrastructure but also to enhance the other environmental and socioeconomic factors in provinces with a low innovation and imitation coefficients. The specific solutions of the digital divide problem would be a good topic for further research.

## **6. Conclusions**

Previously, the research about the regional classification for mainland China based on diffusion characteristics of mobile telecommunications never been conducted, although it might be more suitable and necessary for more effective and efficient mobile telecommunication's diffusion policy and strategy. This paper tried to suggest a new regional classification for the issues related to mobile telecommunications diffusion in China. The paper suggested six clusters of China. Cluster 1 includes Beijing, Guangdong, and Chongqing and cluster 2 includes the only Shanghai. Cluster 3 includes Tianjin, Heilongjiang, Zhejiang, Jiangxi, Guangxi, and Ningxia. Cluster 4 includes Hainan, Guizhou, Tibet, Shaanxi, and Gansu. Cluster 5 includes Hebei, Shanxi, Inner Mongolia, Jilin, Shandong, Henan, and Xinjiang. Finally, Liaoning, Jiangsu, Anhui, Fujian, Hubei, Hunan, Sichuan, Yunnan, and Qinghai are included in cluster 6. Each cluster is also different in terms of not only diffusion characteristics but also socioeconomic factors. For example, the clusters with high level of innovation and imitation coefficients show high level of socioeconomic level such as income level.

The results of cluster analysis imply that the traditional regional classifications are too simple and should be divided more in detail in terms of innovation and imitation coefficients in the case of developing mobile telecommunications strategies. This new regional classification (six clusters) can be used for not only 3G diffusion policy but also the future mobile telecommunications technology diffusion policy. Further research on the specific solutions of the digital divide problem by six clusters suggested by this paper will be useful to the Chinese government.

## Appendix

The Chinese and English name of 31 provinces in mainland China and their locations

The name of Province Chinese-English(abbr.)	黑 龙 Heilongjiang (HL)	河 南 Henan (HEN)	贵 州 Guizhou (GZ)
北 京 Beijing (BJ)	上 海 Shanghai (SH)	湖 北 Hubei (HUB)	云 南 Yunnan (YN)
天 津 Tianjin (TJ)	江 苏 Jiangsu (JS)	湖 南 Hunan (HUN)	西 藏 Tibet (TB)
河 北 Hebei (HEB)	浙 江 Zhejiang (ZH)	广 东 Guangdong (GD)	陕 西 Shaanxi (SHX)
山 西 Shanxi (SHN)	安 徽 Anhui (AH)	广 西 Guangxi (GX)	甘 肃 Gansu (GS)
内 蒙 古 Inner Mongolia(IM)	福 建 Fujian (FJ)	海 南 Hainan (HAN)	青 海 Qinghai (QH)
辽 宁 Liaoning (LN)	江 西 Jiangxi (JX)	重 庆 Chongqing (CQ)	宁 夏 Ningxia (NX)
吉 林 Jilin (JL)	山 东 Shandong (SD)	四 川 Sichuan (SC)	新 疆 Xinjiang (XJ)





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