2019 Asia and Pacific Mathematical Contest in Modeling

Problem B

Analysis and Decision-making of Regional Economic Vitality and Its Influencing Factors

The regional (or urban or provincial) economic vitality is an important part of regional comprehensive competitiveness. In recent years, in order to improve the economic vitality, some regions have launched many preferential policies for stimulating the economy vitality, such as reducing the investment attraction approval steps, providing the capital support to start-ups and lowering the settlement threshold to attract the talented. However, due to different resource endowments, these policies have different effects in different regions. How to seize the key factors and effectively improve the regional economic vitality is a worth study topic.

In order to study how to improve the regional economic vitality, we have obtained some data. Please build a suitable model and solve the following problems based on these data and your own data obtained through survey.

1. The regional (or urban or provincial) economic vitality is affected by variety of factors. Take a region (or city or province) as an example, please build the suitable relational model of influencing factors of economic vitality, and study the program of action to improve the regional economic vitality. Analyze the effects on the regional economic vitality change from the perspective of changing trend of population and enterprise vitality.

2. Select a region (or city or province), and analyze the short-term and long-term effects of economic policies transformation on the economic vitality of such region (or city ore province) based on the suitable data surveyed by you.

3. Measuring the regional economic vitality is a complex issue. Please select the suitable index system, establish the mathematical model which analyzes and measures the regional (or urban or provincial) economic vitality, and rank the economic vitality of cities in Attachment 3.

4. If you are a decision-maker of regional economic development, according to the conclusions for Problems 1-3, provide a development proposal for the region (or city or province) discussed in Problem 2 so that the economic vitality in this region presents the benign sustainable development and the regional competitiveness is stronger.

Attachment

(5 attachments in total)

Attachment 1

The quantity of enterprises is an important index to measure the regional economic vitality. The quantity of enterprises has a direct effect on the available job opportunities, and to what extent the resource circulation is promoted, and decides the economic benefits. According to the data, from 2009 to 2018, there were 40,176,400 registered and established enterprises (excluding individual business, the same below) in total in 31 provinces/municipalities directly under the Central Government/autonomous regions (excluding Hong Kong, Macau and Taiwan Province). As of September 2019, 9,753,800 enterprises were cancelled (cancellation rate of 24.28%), and there were still 30,422,600 surviving enterprises. The quantity of enterprises which were registered and established from 2009 to 2018 and survive up in 2019 is as follows (Unit: 10,000):

Table 1: The quantity of enterprises which were registered and established from 2009 to 2018 and survive up in 2019

Province	**Quantity of Surviving Enterprises in 2019 (Unit: 10,000)**
Heilongjiang	43.6
Jilin	44.4
Liaoning	76.1
Beijing	118.3
Tianjin	43.7
Inner Mongolia	42.1
Xinjiang	31.8
Qinghai	10.0
Tibet	6.7
Ningxia	15.1
Shanxi	55.6
Hebei	134.8
Shandong	243.9
Henan	146.3
Shaanxi	73.0
Gansu	43.3
Sichuan	122.4
Chongqing	69.8
Hubei	105.3
Anhui	113.8
Jiangsu	269.4

Shanghai	157.4
Zhejiang	188.5
Guizhou	64.0
Hunan	79.9
Jiangxi	66.1
Fujian	105.9
Yunnan	60.6
Guangxi	68.7
Guangdong	420.4
Hainan	21.5

Attachment 2

Since 2013, the growth of quantity of enterprises in China has accelerated. Although the growth in different economic regions is obviously different, the annual quantity of newly-added enterprises in all regions is more than that of last year basically. In terms of region, except the total quantity, in the difference of average quantity of newly-added enterprises per province in four economic regions, the eastern region still maintains a great advantage: the provinces in the eastern region have the largest average registration quantity of enterprises per province and the highest growth, followed by the central region. In the west and northeast, the enterprise vitality is relatively weak. The average quantity of newly-added enterprises per province in the northeast may be surpassed by the western region in recent years. In general, there is still a relatively great difference in the enterprise vitality between regions. However, regardless of region, the annual quantity of newly-added enterprises from 2009 to 2018 was relatively stable.

Four economic regions are divided as follows:

Eastern region: Beijing, Hebei, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan

Central region: Shanxi, Henan, Hubei, Hunan, Jiangxi, Anhui

Western region: Chongqing, Sichuan, Guangxi, Guizhou, Yunnan, Shaanxi, Gansu, Ningxia, Xinjiang, Qinghai, Tibet

Northeastern region: Heilongjiang, Jilin, Liaoning, Inner Mongolia

Table 2: Trend in Incremental Changes to Enterprises in Four Economic Regions from 2009 to 2018 (Unit: 10,000)

Year	Eastern Region	Central Region	Northeastern Region	Western Region
2009	7.9	4.4	3.3	2.3
2010	9.4	5.0	3.6	2.6
2011	10.3	5.6	3.8	2.9
2012	9.9	5.7	3.6	3.1
2013	12.7	7.2	4.6	3.7
2014	19.5	11.1	7.0	6.0
2015	23.8	12.9	7.1	7.0
2016	30.3	16.4	8.6	8.6
2017	32.8	19.6	10.1	9.8
2018	35.8	22.6	10.3	10.5

Attachment 3

If we look away from economic region and province, and focus on city, in addition to Beijing, Shanghai, Guangzhou and Shenzhen, the second-tier cities are also worth attention. The data of stock and cancellation distribution of enterprises in Beijing, Shanghai, Guangzhou and Shenzhen and some second-tier cities are given as follows. (Unit: 10,000)

Table 2: The data of stock and cancellation distribution of enterprises in Beijing, Shanghai, Guangzhou and Shenzhen and some second-tier cities (Unit: 10,000)

City	Quantity of Newly-established Enterprises from 2009 to 2018	Quantity of Surviving Enterprises in 2019	Quantity of Cancelled Enterprises from 2009 to 2018
Shanghai	204.8	157.4	47.4
Shenzhen	203.1	174.1	29.0
Beijing	152.1	118.3	33.8
Guangzhou	110.2	89.6	20.6
Chongqing	97.5	69.8	27.7
Chengdu	85.0	60.6	24.4
Nanjing	64.6	55.8	8.8
Hangzhou	64.1	48.7	15.4
Suzhou	63.8	53.6	10.2
Tianjin	62.0	43.7	18.3
Qingdao	55.6	41.0	14.6
Dongguan	53.4	43.4	10.0
Zhengzhou	53.3	43.1	10.2
Wuhan	52.6	39.8	12.8

Xi'an	51.4	37.5	13.9
Ningbo	44.4	31.1	13.4
Changsha	36.8	28.5	8.3
Shenyang	33.4	21.8	11.6
Kunming	33.2	23.5	9.7

Attachment 4

The registered capital is an index to measure the enterprise size. In the distribution of enterprise size, there is not so large difference as imagined between the second-tier cities and Beijing, Shanghai, Guangzhou and Shenzhen. The distribution data of registered capital of enterprise entity are given as follows:

Table 3: Distribution Data of Registered Capital of Enterprise Entity from 2009 to 2018 (Unit: 10,000)

	Nationwide	**Beijing**	**Shanghai**	**Guangzhou**	**Shenzhen**	**Second-tier Cities**
>10,000,000	9%	13%	9%	9%	8%	9%
5,000,000-10,000,000	13%	16%	14%	11%	12%	12%
2,000,000-5,000,000	16%	16%	16%	13%	12%	15%
1,000,000-2,000,000	21%	21%	22%	25%	25%	22%
0-1,000,000	40%	35%	39%	42%	44%	42%

Attachment 5

How to narrow the difference in the quantity of enterprises between the second-tier cities and Beijing, Shanghai, Guangzhou and Shenzhen? "Investment attraction" and "talent attraction policy" may be common methods. Therefore, the "talent attraction" between cities presently becomes increasingly fierce. In fact, the resident population in a region is closely related to the quantity of enterprises in this region. The data of resident population in 2019 are given as follows.

Table 4: Data of Resident Population and Quantity of Surviving Enterprises in Some Second-tier Cities in 2019

City	**Quantity of Surviving Enterprises in 2019 Unit: 10,000**	**Resident Population in 2019 Unit: 10,000**
Shanghai	157.4	2419.70
Shenzhen	174.1	1190.84

Beijing	118.3	2172.9
Guangzhou	89.6	1404.35
Chongqing	69.8	683.07
Chengdu	60.6	1194.05
Nanjing	55.8	827.0
Hangzhou	48.7	787.5
Suzhou	53.6	1068.4
Tianjin	43.7	1562.12
Qingdao	41.0	920.4
Dongguan	43.4	826.1
Zhengzhou	43.1	972.4
Wuhan	39.8	1091.4
Xi’an	37.5	992.32
Ningbo	31.1	787.5
Changsha	28.5	731.15
Shenyang	21.8	752
Kunming	23.5	667