Industrial Convergence of Manufacturing and Producer Creative Industries
—An Comparative Analysis of China and Czech

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Abstract—Selecting the producer creative sectors that closely linkage with manufacturing from creative industries, the paper measures the convergence degree of manufacturing and producer creative industries in China and Czech and uses the gray correlation analysis method to measure the correlation between industrial convergence and manufacturing update. The results show that: (1) considering convergence occurring between PCIs and MI, China’s convergence degree is higher than that of the Czech Republic, but it is volatile over time. From the perspective of sub-sectors, the convergence of Czech’s manufacturing and producer creative sectors is much more balanced than that of China. For effect of convergence, the positive impact of industrial convergence on manufacturing upgrading in Czech is more remarkable.

Keywords—producer creative industries; industrial convergence; manufacturing upgrading; gray correlation analysis

I. INTRODUCTION

Under the pressure of transformation and upgrading of China’s manufacturing industry, the strategy “Made in China 2025” is proposed in 2015 in order to promote manufacturing innovation and international competitiveness. Some developed countries have formulated “re-industrialization” strategy to start a new round of manufacturing revolution. In 2016, Czech also proposed the “Industry 4.0 plan”. China and Czech have the same goal to promote industrial transformation and upgrading. Under the “One Belt, One Road”, the two countries can cooperate in the field of industrial innovation to achieve the goal.

Industrial convergence shows positive impact on industrial upgrading. Convergence means that boundaries of industry is becoming blurring through the convergence of elements such as value propositions, technologies, and markets (Choi and Valikangas, 2001[1]; Bröring and Leker, 2007 [2]). Convergence can promote industrial structure (Changqi Tao et al., 2015 [3]). Creative industries can stimulate transformation and upgrade of manufacturing by putting creative factors into manufacturing production( Jian Hua, 2014 [4]). Creative sectors such as industrial design, marketing and et al. not only increase value-added of manufacturing, but also promote industrial structure (Wu wei L and Huiming W, 2006 [5]). By providing various creative inputs and human capital, creative industries can promote innovation in other industries (Bae and Yoo, 2015 [6]). CIs have played a strategically significant role in economic growth, job creation, innovation and economic development (Raul Gouveaa and Gautam Vora, 2018 [7]; Rafael Boix-Domenech, Vicent Soler-Marco, 2015 [8]).

The creative industries are defined as knowledge-intensive activities based on individual creativity to provide services or products, and with the potential to create wealth (UNCTAD 2010 [9]). With further study, a number of different models have been put forward to analyse the structural characteristics of the creative industries. Such as DCMS model to classify creative industries, concentric circles model, WIPO copyright model and symbolic texts model. Based on these models, UNCTAD made a classification of creative industries and divided CIs into four groups: heritage, arts, media and functional creations. For functional creations, it included design, new media and creative services( UNCTAD, 2010). On the other hand, some scholars divided creative industries into the producer creative industries and the consumer creative industries (Xiaopeng Hu, 2006 [10]; Yuanpu Jin, 2014 [11]).

Considering the above, few scholars make further study on inner structure of creative industries. In addition, despite there is a handful of studies focusing on economic effect of CIs, few scholars focus on its impact on a certain industry. What’s more, there are few studies specifically focused on empirical analysis of effect of CIs on manufacturing. Due to this fact, based on industrial convergence theories, this paper investigates the effect of CIs on manufacturing upgrading in China and in Czech and aims to explore the path of industrial upgrading. Firstly, the paper gives definition and classification of producer creative industries which are intermediate creative inputs into manufacturing production. Secondly, based on theories of industrial convergence, the paper measures convergence degree of China and Czech at both industrial level and creative sectors level. Finally, the paper uses the gray correlation analysis method to quantify the effect of convergence between manufacturing and PCIs.

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II. PRODUCER CREATIVE INDUSTRIES

A. Definition

Producer creative industries (PCIs) are those creative industries in the service sectors, characterized as intermediate inputs to serve manufacture production.

B. Classification

Zhicheng Wang et. al (2007) [12] classifies producer creative industry into two groups, R&D, design and consultant Junlin Liu (2010) [13] divides it into product design, market research, consulting planning and advertising. Based on the definition of PCIs and previous studies, this paper classifies the PCIs 7 groups, which are consultancy activities, marketing & advertising research, computer and software services, R&D, design, architecture, and other professional services.

III. INDUSTRIAL CONVERGENCE DEGREE

A. Industrial Convergence Degree

This paper bases on intermediate-input method (Meiyuan Wang, 2007 [14]; Yingzhi Xu, 2009 [15]) to measure the convergence degree. The function:

\[ C = \frac{100 \times X}{M} \]

Where C is convergence degree, X is producer creative industries as intermediate inputs to manufacture, and M is output of manufacture.

B. Data

Data of PCIs comes from the national input-output tables of WIOD(2016). Based on the definition of PCIs, this paper selects 6 main sectors, which are computer & consultancy & information service activities(J62_J63), Legal & accounting & management consultancy activities(M69_M70) architectural & engineering activities(M71), scientific research and development, advertising & market research (M73), and Other professional services (M74_M75).

C. Analysis on Industrial Convergence Degree

| TABLE I. CONVERGENCE DEGREE OF CHINA AND CZECH (%) |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | China           | Czech           | China           | Czech           | China           | Czech           |
| 2000            | 0.99            | 1.15            | 2008            | 1.75            | 1.78            |
| 2001            | 1.17            | 1.22            | 2009            | 1.81            | 1.93            |
| 2002            | 1.38            | 1.45            | 2010            | 1.72            | 1.84            |
| 2003            | 1.56            | 1.53            | 2011            | 1.62            | 1.91            |
| 2004            | 1.84            | 1.46            | 2012            | 1.72            | 2.05            |
| 2005            | 2.36            | 1.57            | 2013            | 1.81            | 2.09            |
| 2006            | 2.1             | 1.55            | 2014            | 1.95            | 2.1             |
| 2007            | 1.86            | 1.69            |                 |                 |                 |

Fig. 1. Convergence Degree of China and Czech

Overall, the convergence of PCIs (producer creative industries) and MI (manufacture industry) in Czech shows a steadily increasing trend, while the speed of increase is becoming smaller after 2012, and it shows greater volatility in China. As shown in Fig.1, the convergence degree in Czech increased from 1.15% in 2000 to 2.1% in 2014. After 2008, Czech’s convergence degree is higher than that of China. From 2000 to 2005, China's degree of convergence grew rapidly, reaching 2.36% in 2005, while it drops quickly from 2005 to 2011. After 2011, it shows a steadily increasing trend.

| TABLE II. CONVERGENCE DEGREE AT SECTORS LEVEL (%) |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | J62&J63         | M69&M70         | M71             | M72             | M73             |
| China           | 0.071           | 1.1387          | 0.0005          | 0.3027          | 0.0002          |
| Czech           | 0.2726          | 0.863           | 0.2644          | 0.16            | 0.2089          |
|                 |                 |                 |                 |                 | 0.3275          |

Focusing on sub-sectors, as shown in Table II, the convergence of six major PCI sectors and MI in China represents extremely unbalanced, and the gap between different sectors is large, while the Czech Republic shows more balanced. From the Table II, China’s convergence degrees between manufacturing and sub-sectors, architectural & engineering activities(M71), scientific research and development, advertising & market research (M73), and Other professional services (M74_M75), China is also slightly higher than the Czech Republic.
IV. EFFECT OF INDUSTRIAL CONVERGENCE

A. A Grey Correlation Model

A gray correlation model usually is used to analyse the weak correlation relationship between two elements in a stable system (Zhang et al., 2009 [16]). In respect of system, manufacture industry is a relatively stable system. Based on this, the paper uses Grey Correlation Model to measure the degree of correlation between Industrial Convergence and Manufacture update. In this study, manufacture update is used as a reference sequence, and the indicator of convergence degree is used as a compare sequence.

B. Variables

- Variable 1 is the Manufacture upgrading. Manufacture upgrading means that manufacture can produce higher value-added products (Poon, 2004 [17]). So in this study, we use the indicator, the portion of technology-intensive manufacturing in the whole of manufacture industry, to measure manufacture upgrading.

- Variable 2 is the convergence degree of PMI and MI. Considering the convergence degree of various sub-sectors and manufacturing industry presents a big difference, this paper selects six major sectors of PCI to measure convergence degree of each sector and manufacturing.

C. Empirical Analysis

The indicator of manufacturing upgrading is regarded as the reference sequence Y, and the X1- X6 are regarded as the compare sequence. Considering units of different variables, the data should be nondimensionalized. Then the paper calculates the degree. The results are shown in Table III.

From Table III, the results reflect the impact of industrial convergence on manufacturing update. For China, the impact of industrial convergence on manufacturing upgrading is ranked as follows: M74>M75>M72>M69>M70>M71>M69&M70>M71>J62_J63. The highest gray correlation coefficient is 0.849, reflecting that industrial convergence occurs between professional services and manufacturing has strongest impact on manufacturing update. Followed by computer & consultancy & information service activities (J62_63), the gray correlation coefficient is 0.842, which is higher a lot than that in China. However, the lowest gray correlation coefficient is 0.557, showing that M72 plays the weakest role in manufacturing upgrading.

For Czech, all gray correlation coefficient are greater than 0.5, indicating that the six convergence degree measurement indicators have a greater impact on manufacturing update than that in China. The impact of industrial convergence on manufacturing upgrading is ranked as follows: M69>M70>J62_J63>M74>M75>M71>M73>M72. The highest gray correlation coefficient is 0.849, reflecting that industrial convergence occurs between professional services and manufacturing has strongest impact on manufacturing update. Followed by computer & consultancy & information service activities (J62_63), the gray correlation coefficient is 0.842, which is higher a lot than that in China. However, the lowest gray correlation coefficient is 0.557, showing that M72 plays the weakest role in manufacturing upgrading.

V. CONCLUSION

This study analyzed industrial convergence between PCIs and manufacture in China and Czech. Firstly, this paper gives the definition and classification of producer creative industries. The producer creative industries are defined as creative intermediate inputs, and are those creative industries in the service sectors to serve manufacture production. These creative services are generated by people’s creativity and innovation activities. Based on this definition, we classified PCIs, which are consultancy activities, marketing & advertising research, computer and software services, R&D, design, architecture, and other professional services. Secondly, this study measures the convergence degree between PCIs and manufacturing on basis of industrial convergence theories, and make a comparative analysis between China and Czech. We find that: (1) the convergence of PCIs and MI in Czech shows a steadily increasing trend, while it shows greater volatility in China, and Czech’s convergence degree is higher than that of China after 2008; (2) the convergence of six major PCI sectors and MI in China represents extremely unbalanced. Thirdly, this study used gray correlation method to measure the impact of industrial convergence on manufacturing update. The empirical analysis shows that all gray correlation coefficient are greater than 0.5, indicating that all six PCIs sectors have a greater impact on manufacturing update than that in China.

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TABLE III. THE GREY CORRELATION DEGREE OF CHINA AND CZECH

|       | J62&J63 | M69&M70 | M71 |
|-------|---------|---------|-----|
| China | 0.317   | 0.399   | 0.383|
| Czech | 0.842   | 0.849   | 0.585|
|       | M72     | M73     | M74&M75|
| China | 0.416   | 0.354   | 0.421|
| Czech | 0.557   | 0.572   | 0.791|

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