

Zhang, Hailun; Xu, Sheng

Article

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International Journal of Management and Economics

Provided in Cooperation with:

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Suggested Citation: Zhang, Hailun; Xu, Sheng (2017) : The innovation-driven impact on economic structure transition: The case of China, International Journal of Management and Economics, ISSN 2543-5361, De Gruyter Open, Warsaw, Vol. 53, Iss. 4, pp. 9-26,
<https://doi.org/10.1515/ijme-2017-0023>

This Version is available at:

<https://hdl.handle.net/10419/309646>

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Hailun Zhang¹**Sheng Xu²***Ocean University of China, China*

The Innovation-Driven Impact on Economic Structure Transition. The Case of China

Abstract

The research measures the driving force of innovation in economic structure transition. In order to change the pattern of economic development, China is implementing a strategy of innovation-driven development. China's capacity of innovation has been increasing, especially since 2012, and China's innovations have taken a leap-forward development. Nowadays, innovation has become a main driving force in China's economic development and hi-tech industries particularly make a great contribution. Although China's tertiary industry has been dominant and its share in three industrial sectors has been exceeding 50% since 2015, a problem still exists in China's economy that the proportions of primary and secondary industries are relatively higher compared with developed countries. In this paper we use PLSR model to measure the impact of innovation on China's economic structure transition. It is found that innovation can expand the tertiary industry through shrinking the proportions of primary and secondary industries, transforming China's economic structure into a more advanced pattern. Additionally, China is also devoting itself to the "Belt and Road Initiative", which should be combined with China's domestic innovation-driven development and realize sustainable development of economy worldwide.

Keywords: innovation-driven impact, economic structure transition, tertiary industry, PLSR model, "Belt and Road Initiative", sustainable development

JEL: O39, L16

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Introduction

Schumpeterian endogenous growth theory refers to the incentives of technological knowledge for a long-run economic growth. In Schumpeter's view, creative destruction generated from innovative activities can promote technological advancement, which has a profound influence on economic growth [Aghion, Howitt, 1989]. Under the pressure of economic downturn, China is carrying out a new pattern of economic growth, which is the strategy of innovation-driven development. The process of economic growth can be divided into four phases [Porter, 1990]. Now, China is on the phase of transition into an innovation-driven country.

Though development experiences vary over time and across countries, there is sufficient uniformity within them for the industrial structure transformation to reveal consistent patterns of modern economic growth [Syrquin, Chenery, 1989]. William Petty and Colin Clark classified the whole industries into three sectors, which are primary industry, secondary industry and tertiary industry, respectively. According to Petty and Clark's theory, with the development of economy, the proportion of primary industry decreases first, which results in the increasing proportion of secondary industry, and when economy puts forward development, the proportion of tertiary industry increases relatively. The proportion changes in three industrial sectors mean the evolution of industrial structure, and tertiary industry should account for the highest proportion in an advanced structure.

Endogenous and exogenous factors drive simultaneously the process of innovation. From an endogenous perspective, innovation defines intrinsic motivation that determines individual creativity, which is also influenced by work environment [Amabile, 1997]. Innovation is a learning process and a mechanism of creating new knowledge through solving problems [Chesbrough, 2003]. Also, innovation can be seen as an exogenous process or a by-product of investment in machinery and equipment [Grossman, Helpman, 1991]. As a result of dual properties of innovation, an enterprise not only is taking the role of "innovation-makers", but also is being forced to act as an "innovation-taker" [Ghezzi et al., 2015], so it acquires innovation exogenously and drives innovations generated endogenously.

Based on microcosmic theory, the technological advancement and innovation can shape the industrial structure. As early as in the 1970s, the scale of manufacture in western countries has been cutting down, which can be attributed to the emergence of new computer-based technology that improved the quality and productivity of small and medium scale businesses [Bo, 1989]. Industrial entry is often used as a vehicle for introducing new technology [Geroski, 1995], and a good environment can also help innovation to occur across the economic spectrum and for a robust and sustainable industrial base, which is aimed at the industrial transition [Lahorgue, Cunha, 2004]. Furthermore, technological innovation can intensify the competition between new industries and the old ones and

form a brand-new industrial system through process and production innovations [Klepper, 2002]. At the industrial level, the structural shifts can result from the diffusion of knowledge such as technologically sophisticated methods of production [Peneder, 2003]. But there are a few significant differences between service and manufacturing industries in terms of the impact of different types of innovation strategies [Evangelista, Vezzani, 2010].

Based on macrocosmic theory, innovation plays a role in changing economic structure. South Korea and Taiwan are catching up with technology and are transforming into innovation-based economies [Wang, 2007]. As an emerging developing country, China needs to transform the input-based economic growth pattern into an innovation-based one, and the new economic growth driven by innovation is mainly initiated by the transmutation of entrepreneurship [Zheng, Hu, Wang, 2008]. In terms of Greece's currently planned institutional reforms for limited economic growth, it should add innovative sectors to its economic structure to strengthen its competition in industry [Herrmann, Kritikos, 2013]. Anyway, innovation is the key for the world to fight the economic crisis, and innovation policy of structural shifts towards service-related industries can stimulate economies [Policy responses..., 2009].

China has entered an important period of economic development. This paper focuses on the strategy of China's innovation-driven development and attempts to measure the impact of innovation on the transition among three industries. It will answer the questions: How does the development of innovation look like in China? Is the innovation driving the economic structure effectively?

Theoretical Hypothesis

This research focuses on technological innovation on the basis of science and technology. There are three main factors in innovation-driven process, including innovation circumstance, innovation input and innovation output. Specifically, innovation mainly offers basic support such as manpower, material resources and infrastructure. Once inputs are put into the innovation process, outputs can be produced that can be converted into driving force of economic and social progress. Specifically, one country can stimulate technological innovation when its economy, education and informatization reach a certain level. Besides, good situation of economy and society provides conditions and basis for development. The government invests in R&D conducted on tertiary universities and in research institutions, cultivating lots of creative talents and also encouraging Industry – University – Research institutions collaboration. After a period of accumulation of knowledge, technology and experience, innovations will appear such as research papers and invention patents, a part of which can be converted into enterprises' production technology while other parts can be used to produce new products through business transformation. Eventually, one can achieve sustainable development of economy based on innovation.

Economic structure transition is based on industrial structure transition and upgrading, namely expanding the tertiary industry with the simultaneous limiting of primary and secondary industries, and also increasing added value of productions in all industries. Therefore, economic structure transition can be conducted two-dimensionally. Productivity of primary industries should be restrained by redistributing resources while the development of secondary and tertiary industries should be put forward, especially new hi-tech industries, which can achieve the goal of economic structure transition from industries based on the input of materials. Besides, all industries should increase the efficiency of productivity and meanwhile cut down production costs by pursuing technological research, which can improve value of production and strengthen enterprises' core competences, and promote the optimization of industrial productivity. Actually, both industrial restructuring and industrial upgrading rely on technological advancement. Under the restraint of production factors, it is necessary to transform the mode of production and increase the production efficiency with high technology to maximize resource utilization, by which inter-industry and intra-industry can reach Pareto efficiency and economy a sustainable development.

Innovation and economic structure transition are an interactive whole rather than two separate systems. Economic structure transition needs the support of science and technology, which can be gained from foreign countries and also can be developed by enterprises themselves. In fact, it is difficult to bring in core cutting-edge technology from other countries, so the feasible and fundamental way is that enterprises increase their own independent innovation capacity, and then the new technology can be learned across the whole industry by industrial agglomeration, which can promote the industrial optimization and achieve the continuous development of economy. Based on the analysis of the relationship between innovation and economic structure transition, hypothesis of this paper is as follows:

H: Innovation has a positive impact on economic structure transition, which leads the optimization of industry and helps one to achieve the sustainable development of economy.

China's Innovation-Driven Development

In 2016, China drafted Outline of the National Strategy of Innovation-Driven Development. It identifies three stages for implementing the strategy of innovation-driven development, which is proposed in 18th CPC National Congress, including becoming an innovative country by 2020, moving to the forefront of innovative countries by 2030 and being an innovation power by 2050. The general outline is a petition for industrial structural transformation.

For a long time, China had a reputation of a big manufacturing country and has been a major trade power. An interesting thing is that commodities made in China are being

sold worldwide, while many goods imported from foreign countries sold in China are made in China. But with the increase of salary of Chinese labor force, the advantage of labor-intensive industries in China has not been obvious recently, and lots of manufacturing factories are being moved to Eastern Asian countries. In the meantime, pollution from low-end industries is destroying health of Chinese citizens. As can be seen in Figure 1, the trend of China's GDP growth rate is slowing down, which indicates that China has heavier downward pressure on domestic economy. However, the traditional driving force generated by investments, consumption and export has been undermined by fast change of worldwide economic situation.

FIGURE 1. GDP growth rate of China (at a constant price) in the years 2006–2015

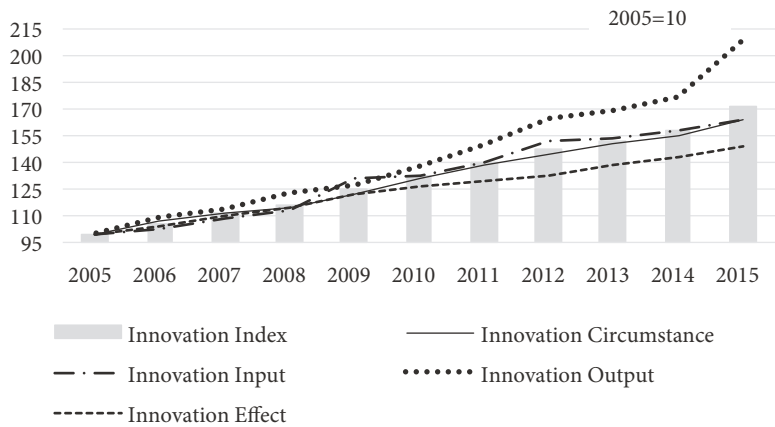


Source: National Bureau of Statistics of China (NBS of China).

As the economy enters a new standard, China faces the risk of “middle-income trap”. Internationally, it’s a problem of many countries because of inferior economic structure. Few countries such as Japan and Singapore in Asian zone managed to get through middle-income trap due a fact that they changed economic development mode based on innovation. It is time for China to develop a new engine of innovation in order to change development pattern and upgrade industries, and finally realize a sustainable economic growth. In recent years, China’s innovation-driven development has made a progress with the rapid expansion of some hi-tech industries lead by network industry. In the future, main tasks of industries in China will include promoting ability of self-innovation, mastering core technologies, producing high value-added products and propelling industries to a high-end level.

Since 2011, NBS of China has begun to publish China Innovation Index (CII), which shows China’s innovation power every year.

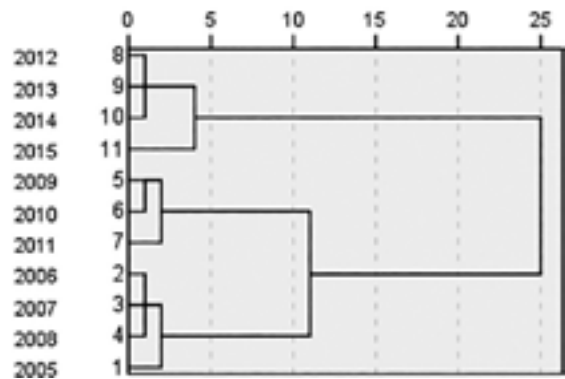
FIGURE 2. Innovation growth rate of China in the years 2005–2015



Source: NBS of China.

The fact that China’s innovation power is increasing gradually can be seen in Figure 2. Over 10 years, China’s innovation power has increased 1.7 times compared to 2005. Obviously, the innovation output index increases the most among the 4 sub-indices, growth rate of which exceeds that of innovation index. It means that innovation output is the most important factor for the growth of China’s innovation. However, the trends of innovation input and innovation circumstance are similar and always maintain the same level with innovation index, while the growth of innovation effect is the slowest, which drags down the whole innovation development.

FIGURE 3. Dendrogram of cluster analysis



Source: data is from calculation result of SPSS.

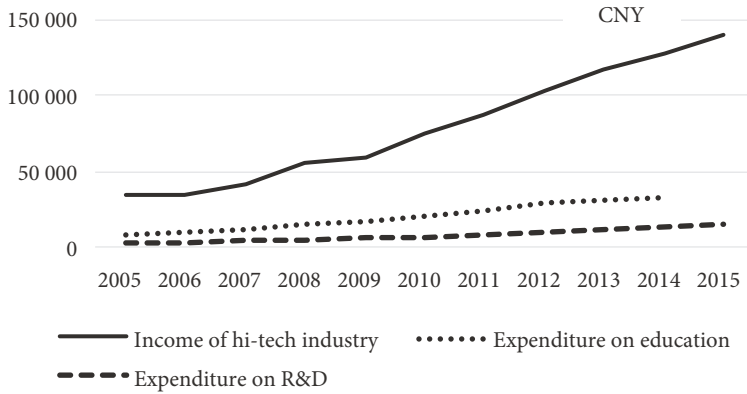
By using original innovation index from NBS of China, the method of cluster analysis can divide China's innovation development into phases, as shown in Figure 3. Eleven-years process of China's innovation-driven development is divided into three stages. Phase 1 – from 2005 to 2008, phase 2 – from 2009 to 2011 and phase 3 – from 2012 to 2015. The distance between phase 1 and phase 2 is relatively small, which means that these two phases have similar characteristics. But there is a big difference between first two phases and phase 3, which suggests that the year 2012 was a turning point in the process of China's innovation development. The period from 2005 to 2011 is primary phase of innovation development, but since 2012, China's innovation capacity has achieved a leap-forward promotion and China's innovation has been developing rapidly.

China's 12th five-year plan was implemented in 2011–2015 and it emphasized that enterprises in China should speed up the increase of innovation capacity and convert technological outcome into real productivity force. It also pointed out that China's economy should rely on science and technology as driving force. China's government has stressed the importance of innovation in industrial production and economic development and many documents were published afterwards, including 12th industrial technology innovation plan, 12th national independent innovation capacity building plan, 12th national major innovation based construction plan and so on. The year 2011 is the first one of China's 12th five-year plan, relative innovation plan published and implemented since 2012. Therefore, China's innovation capacity has rapidly increased since 2012 so that innovation development has witnessed substantial progress from 2012 to 2015, which is a brand-new and significant period of development.

China's Scientific and Technological Development

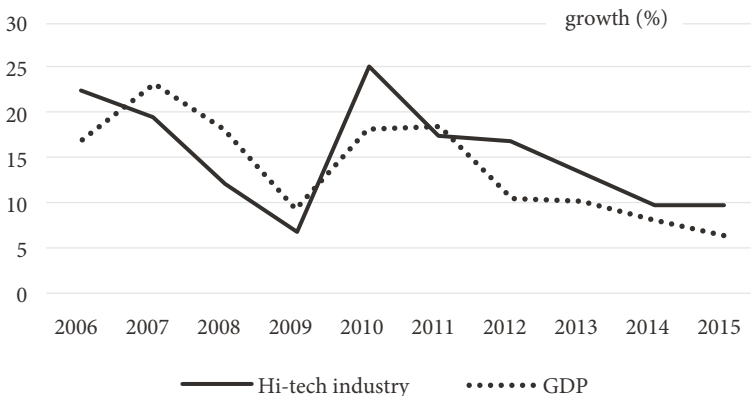
The process of innovation is underpinned by science and technology. It needs multiple factors ranging from research and education to industrial production, which are worth paying more attention to, in order to investigate the development of China's innovation. We analyze the income of hi-tech industry, expenditure on education and R&D in order to measure their development.

As can be seen in Figure 4, income of hi-tech industry, expenditure on education and R&D have been increasing to a different degree over these eleven years. Especially, income of hi-tech industry makes dramatic progress and it increases more than three times compared with the 2005. Conversely, the increases in the expenditure on education and R&D are not apparent. The expenditure on education and R&D are two key inputs of innovation, while income of hi-tech industry can be seen as an output of the whole innovation process, which indicates that the conversion rate of input to output is high in China's innovation process and confirms that China's innovation is efficient.

FIGURE 4. Development of China's science and technology

Source: NBS of China.

Hi-tech industries contribute to China's innovation-driven development the most. Industries connect the research, patents and consumer market, which can converse the outcomes from research institutes and universities into real productivity. So, it is hi-tech industry that is playing the most important role in the process of China's innovation-driven development. China's hi-tech industries are categorized into five sectors including pharmaceuticals, aircraft and spacecraft, electronics and communication equipment, computers and office equipment as well as medical equipment and measuring instruments. The practice of China's innovation-driven strategy provides hi-tech industries with a broader space for development.

FIGURE 5. Nominal growth rate of China's hi-tech industry and GDP

Source: NBS of China.

Figure 5 shows the growth of China's hi-tech industry and GDP at current prices. It can be seen that the development of China's hi-tech industry has almost identical trend with GDP, namely that they always increase and decrease at the same time in the period of 2006–2015. At first, the growth of hi-tech industry fell behind China's GDP from 2007 to 2009 and also it had a similar downward trend with GDP. In 2011, China's hi-tech industry began to develop rapidly, and has been exceeding the growth of GDP for 5 years. In fact, the butterfly effect of financial crisis brought severe damage to China's economy, which compelled China to transform the mode of economic development. Since then China has found a way to realize continuous growth of economy drove by science and technology. Under the background of innovation development, China's hi-tech industry seized the opportunity and has advanced with leaps and bounds. Until 2015, China had 29 631 hi-tech enterprises and 146 hi-tech industrial development zones were located across the whole country.

Innovation and Economic Structure Transition

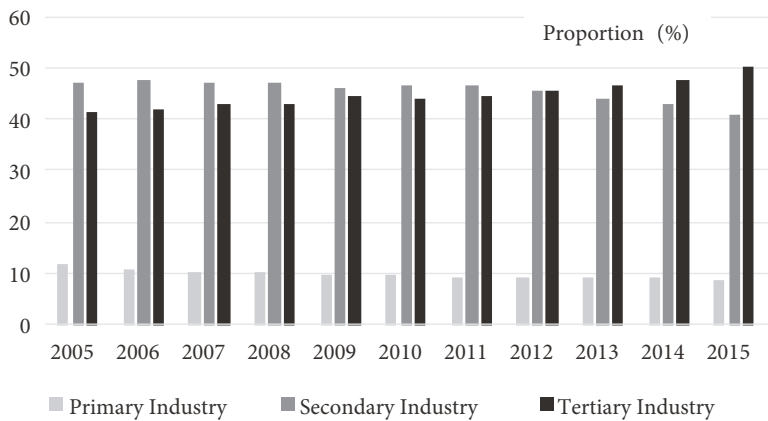
China's Economic Structure

Fundamentally, innovation-driven development was proposed and upgraded as a national major strategy for economic structure transition under current situation of China's New Normal. The main task for economic structure transition is to enlarge the proportion of tertiary industry. Tertiary industry is the foundation of China's innovation-driven strategy, with high-tech industry being the leader. As an important sector in modern tertiary industry, hi-tech tertiary industry has strong innovation ability and development potential. After the implementation of "Guidance of State Council on Accelerating the Development of Hi-tech Tertiary Industry" in 2011, hi-tech tertiary industry is playing more and more important role in promoting industrial structure transition. Unlike hi-tech tertiary industry, China's entire tertiary industry is underdeveloped, and accounts for 50% of the whole industry, while its proportion in developed countries can reach 70% and even 80%.

It can be seen in Figure 6 that proportions of China's three industries have been changing continuously since 2005. Over eleven years, primary industry had always the lowest share, while both secondary and tertiary industries made great contributions to China's economy. Obviously, the proportion of tertiary industry has increased steadily and even exceeded secondary industry to be the dominant industry in whole industrial economy during recent years. The development of tertiary industry has fell behind the secondary industry until 2013, and afterwards tertiary industry has surpassed secondary industry and the gap on proportion between these two industries has widened. In 2015, the proportion of tertiary industry increased to 50% but it is relatively lower compared

with developed countries, which means China’s tertiary industry and economic structure transition have space for improvement. With innovation-driven development, it is still a top priority for China at the current stage to further increase the proportion of tertiary industry in order to optimize the economic structure.

FIGURE 6. Proportions of China’s three industries



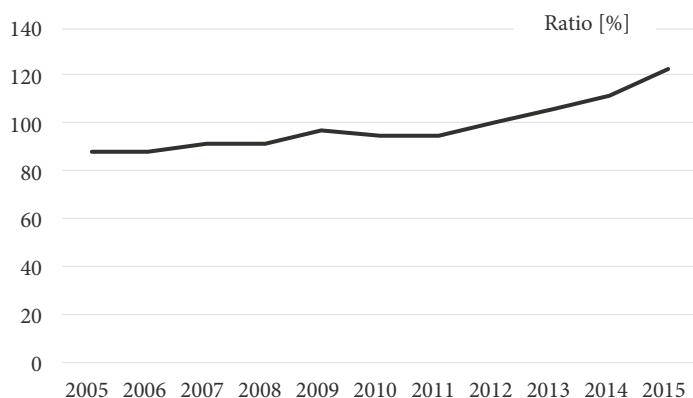
Source: NBS of China.

Innovation-Driven Impact on Economic Structure Transition

Variables and Data

According to the theory of William Petty and Colin Clark, increase of the proportion of tertiary industry with the development of economy is inevitable. In terms of proportions of three industries, China’s aim at economic structure transition is to increase share of tertiary industry with the simultaneous decrease of the secondary industry, so the ratio of tertiary industry to secondary industry can influence the innovation-driven impact of economic structure transition. In our calculations y_1 , y_2 , y_3 and y_4 represent primary’s, secondary’s, tertiary’s industries proportions and the innovation-driven impact of economic structure transition respectively, while x represents innovation-driven index.

China’s Economic Structure Transition (Figure 7) has accelerated since 2011, when China’s economy grew under economic downward pressure. It is obvious that China’s economic structure has upgraded with the increasing proportion of tertiary industry compared with secondary industry, which is the goal of China’s innovation-driven strategy. Nowadays, the levels of China’s innovation and economic structure transition are being improved simultaneously as can be seen in Figure 2 and Figure 7.

FIGURE 7. China's economic structure transition

Source: NBS of China.

Sample interval ranges from 2005 to 2015 (2005=100), since data of innovation index are unavailable for the earlier period. China statistical yearbook provides the data for the three industries, while the official website of National Bureau of Statistics of China is the source of information for China's innovation index.

Correlation Between Innovation and Economic Structure Transition

Pearson correlation coefficient can be used to measure the closeness of relationships between proportion changes in three industries or economic structure transition and innovation.

TABLE 1. Pearson Correlation

	Primary Industry	Secondary Industry	Tertiary Industry	Economic Structure Transition
Innovation	-0.922**	-0.904**	0.963**	0.931**

** Correlation is significant at 0.01 level (2-tailed).

Source: data is from calculation result of Matlab.

Innovation has significant correlations with proportion changes in three industries and economic structure transition under 0.01 level. All absolute values of correlation above 0.9 indicate that innovation has strong correlations with changes in three industries and economic structure transition. A closest relationship exists between innovation and tertiary industry, while the correlation of innovation with economic structure transition is also relatively high, which means that innovation has significant impact on changing the proportions of three industries and transiting economic structure.

Generally, innovation adversely affects the proportion changes in primary and secondary industries, while oppositely it plays positive role in changing the proportion of tertiary industry and economic structure. In other words, with the increase of innovation, the proportion of primary and secondary industries will shrink but tertiary industry will scale up and level of economic structure transition will improve. Therefore, innovation is leading the development of China's economy in a right direction, which is upgrading China's economic structure transition. Namely, expanding tertiary industry with the reduction of primary and secondary industries, which not only maintains an advanced economic structure in China, but also bridges the gap between China and developed countries in the proportion of tertiary industry.

Measurement of Innovation-Driven Impact

Pearson correlation coefficient reflects the closeness of correlation between innovation and economic structure transition, but it can't measure the specific impact of innovation on economic structure transition. Data are selected for 2005 to 2015 period, a total of eleven years, and the samples are insufficient to build a common regression model which would cause spurious regression, so it is necessary to apply a new method suitable for small sample study.

PLSR is also Partial Least Squares Regression and it combines several statistical methods including principal components analysis (PCA), correlation analysis and linear regression, which can regress a model by using a small sample. If there are p dependent variables y_1, y_2, \dots, y_p and m independent variables x_1, x_2, \dots, x_m , first principal component t_1 can be extracted from independent variables and similarly another first principal component u_1 can also be extracted from the set of dependent variables, and the two first principal components should have the closest correlation. Afterwards, we build a regression equation by using y_1, y_2, \dots, y_p and t_1 . If the precision of the regression is up to a standard then we stop the calculation process, otherwise we continue to extract the second principal component until the precision can be up to a standard. R components are extracted from independent variables, t_1, t_2, \dots, t_r , firstly building the regression equation by using y_1, y_2, \dots, y_p and t_1, t_2, \dots, t_r and then converting it into the model with y_1, y_2, \dots, y_p and x_1, x_2, \dots, x_m , which constitutes a PLSR model.

Main factors that promote economic structure transition include GDP, labor force, technology, domestic investment and FDI. However, China Innovation Index includes sub-indices like GDP, labor and technological advancement but there is no index of investment, so models here should include variables of Fixed Asset Investment (FAI) and Foreign Direct Investment (FDI) other than CII.

The model equation is conducted as follows:

$$Y = \alpha + \beta X + \lambda FAI + \gamma FDI \quad (1)$$

where variables are all in the form of matrix, namely, $Y = [y_1, y_2, y_3, y_4]^T$, $X = [x]$, $FAI = [FAI]$ and $FDI = [FDI]$.

Likewise, standard model can be established as equation (2).

$$\tilde{Y} = \alpha + \beta \tilde{X} + \lambda \tilde{FAI} + \gamma \tilde{FDI} \quad (2)$$

where $\tilde{Y} = [\tilde{y}_1, \tilde{y}_2, \tilde{y}_3, \tilde{y}_4]^T$, $\tilde{X} = [\tilde{x}]$, $\tilde{FAI} = [\tilde{FAI}]$ and $\tilde{FDI} = [\tilde{FDI}]$.

Variables in models have different units so firstly we use Z-score method to process all data for standard forms, then regress models by PLSR. Coefficients of variables in standard equations are shown in Table 2.

TABLE 2. Standard Coefficients

\tilde{Y}	Constant	\tilde{X}	\tilde{FAI}	\tilde{FDI}
\tilde{Y}_1	0	-0.3237	-0.3249	-0.2934
\tilde{Y}_2	0	-0.3085	-0.3096	-0.2796
\tilde{Y}_3	0	0.3314	0.3326	0.3003
\tilde{Y}_4	0	0.3186	0.3198	0.2887

Source: data is from calculation result of Matlab.

Then we convert all variables into original forms and real coefficients can be seen in Table 3.

TABLE 3. Original Coefficients

Y	Constant	X	FAI	FDI
Y_1	0.1275	-0.0001	-1.5788E-08	-1.0011E-09
Y_2	0.5257	-0.0003	-3.8364E-08	-2.4328E-09
Y_3	0.3468	0.0004	5.4144E-08	3.4326E-09
Y_4	0.6018	0.0014	2.0843E-07	1.3212E-08

Source: data is from calculation result of Matlab.

The sign of innovation is the same as in the results of Pearson correlation analysis showed in Table 1, which indicates that PLSR models can also illustrate the correlation between innovation and industrial indices accurately. Specifically, the improvement of innovation has a negative impact on the scales of primary and secondary industries. When China's innovation capacity increases by 1%, the proportions of primary industry and secondary industry decrease by 0.0001% and 0.0003%, respectively. Therefore, innovation can restrict

the development of secondary industry more than of primary industry. Oppositely, the advancement of China's innovation has a positive impact on the proportion of tertiary industry and the process of economic structure transition. When innovation indices increase by 1%, the proportion of tertiary industry and the level of economic structure transition increase by 0.0004% and 0.0014%, respectively. It can be seen that innovation-driven impact promotes economic structure transition twofold i.e., by decreasing primary and secondary industries and at the same by increasing tertiary industry.

FAI and FDI have the similar impact on economic structure as innovation, which has negative impact on primary industry and secondary industry but positively influences tertiary industry and economic structure transition. In terms of absolute coefficients, those of FAI and FDI are remarkably smaller than coefficients of innovation in all of the models, which means that the impact of FAI and FDI on economic structure is weaker than that of innovation. In other words, China's economic structure transition is mainly affected by the innovation and China's innovation-driven strategy is efficient for economy's development.

There is ambiguity about the optimum constitution of industrial structure. The proportion of three industries in the US, for an example, is about 1.3 : 20.7 : 78. At the same time, the proportion in China is approximately 10 : 40 : 50. Therefore, proportions of primary and secondary industries in China are too high and limit the expansion of tertiary industry, which is needed to improve the economic structure. The solution is to cut down the proportion of low-end industries. As can be seen in Table 3, innovation is playing an important role in decreasing the proportions of primary and secondary industries (it decreases the share of secondary industry to a greater extent). At the same time, innovation is driving the rapid development of tertiary industry and also has positive impact on economic structure transition. Therefore, China's economic structure will be more advanced with the innovation-driven strategy.

Innovation-Driven Strategy and the B&R

The Belt and Road Initiative is a heated issue about economic development, which is proposed by China but will contribute to worldwide economic development. China's President Xi raised the Silk Road Economic Belt when he visited Kazakhstan in September, 2013. He advocated to establish the 21st Century Maritime Silk Road when he spoke at a conference in Indonesia in the following month of the same year. The Silk Road Economic Belt and Maritime Silk Road constitute the Belt and Road Initiative, which illustrates that China is taking a bigger role in global affairs. The goal of China is to coordinate production with other countries and to boost their demand by taking the advantage of China's excessive manufacturing capacity, and shifting China's surplus manufacturing capacity to other countries which have relevant demands, so the Belt and Road Initiative is a way to develop mutual benefits and realize a win-win economic cooperation.

In fact, economic entities worldwide are still developing slowly under the shadow of financial crisis in 2008, while the Belt and Road Initiative provides them additional path of economic development. The Belt and Road Initiative includes five aspects i.e., policy coordination, unimpeded trade, financial integration, facilities connectivity and people-people bond. China has led to the establishment of Asian Infrastructure Investment Bank (AIIB) and created Silk Road Fund as the means to support the implementation of the Belt and Road Initiative and to reach those five goals. Many infrastructure projects are pursued in countries under the Belt and Road Initiative and are funded by AIIB, China Development Bank and the Export-Import Bank of China. Also, volumes of trade between China and those countries are increasing rapidly. In 2016, China's bilateral trade volume with countries on the new belt road amounted to about 1 trillion USD, which accounted for 25.69% of China's total volume of trade. Besides, China's FDI in 53 countries along the Belt and Road reached 14.5 billion USD, which made up 8.5% of China's total FDI. Furthermore, fifty-six economic and trade cooperation zones are being built in 20 countries by Chinese enterprises in order to facilitate commercial trade between China and these countries. China's Belt and Road Initiative is contributing to economic development of all countries along the road.

It is a fact that the Belt and Road Initiative can also stimulate worldwide economic development, but it is a narrow approach to focus on superficial economic growth rather than on the improvement in the quality of economic development, which was China's old economic development pattern. Nowadays, China is implementing innovation-driven strategy domestically and the Belt and Road Initiative externally at the same time. By analyzing China's innovation-driven impact, it can be found that innovation has a positive impact on economic structure transition, which is in favor of the out-of-date pattern change of economic development and also introduces new dynamics into economic development under economic downward pressure. With the Belt and Road, China and other countries constitute a community of shared interests and goals. As the pioneer of the Belt and Road Initiative, it is China's responsibility to advocate for the development of a sustainable economy with innovation as a driving force all over the world.

Domestically, China's innovation-driven development strategy is playing a key role in the China's economic development. Through the implementation of the Belt and Road Initiative, China attempts to strengthen cooperation in the field of technological innovation with other countries. In the Belt and Road Forum for international cooperation held in May, 2017, China's president Xi pointed out that the Belt and Road is a creative initiative, which would pave a technological innovation development path, and he insisted to build E-Road. Next, China will take four actions to promote innovation development of the Belt and Road, including the connection of technological talents, the joint establishment of technological laboratories, the cooperation of science and technology parks, and technology transfer. China's government promised that it would invite 2500 young scientists to do short-term research in China and also train 5000 scientific and technological workers

to implement the Belt and Road. China's innovation-driven strategy is applied into the Belt and Road, which will promote regional economic structure transition along the Belt and Road. In the future, innovation will drive China and even the world to realize economic sustainability in more extensive global affairs, which is the essence of economic development, and which is also a goal of the Belt and Road Initiative.

Conclusions

This paper focuses on the impact of China's innovation-driven development on economic structure transition based on their theoretical relationship. Characteristics of China's innovation development are showed clearly through descriptive analysis. Furthermore, this paper uses PLSR model to measure the innovation-driven impact of economic structure transition and other main influencing factors also involved in the model, including FAI and FDI. China's economy has been bound up with the world and it is not only carrying out innovation-driven development internally, but it also implements the Belt and Road Initiative externally. Thus, this paper also analyzes the necessity to combine innovation-driven development and the Belt and Road. The results of this paper are as follows:

- a. China's innovation capacity has been increasing since China Innovation Index was published in 2005. Elements of China's innovation involve innovation circumstance, innovation input, innovation output and innovation effect, among which innovation output index increases in the fastest way and it exceeds the growth rate of innovation index, while innovation input and innovation circumstance grow on the same level as innovation index. Thus, innovation output makes greatest contributions to innovation index.
- b. The development process of China's innovation can be divided into three phases, the first one – from 2005 to 2008, the second one – from 2009 to 2011 and the third one – from 2012 to 2015. The characteristics of phase 3 differ substantially from another two phases and China's innovation had entered the phase of a rapid development ever since. The year 2012 is a turning point in China's innovation-driven development, which resulted from the fact that many relevant plans were proposed and implemented in this year under the China's 12th Five-Year Plan.
- c. Expenditure on R&D, education and income of hi-tech industry are the most important parts in China's innovation development. Expenditure on R&D and education can be regarded as the input in the process of innovation input, while income of hi-tech industry can be regarded as the output in the same process. Compared with expenditure on R&D and education, hi-tech industry has been growing more rapidly with the development of China's innovation, and its growth has exceeded China's GDP growth, which reflects the efficiency of China's innovation-driven development.

- d. There still exists a problem in China's economic structure that the proportions of primary and secondary industries are relatively high and restrain the expansion of tertiary industry. But the strategy of China's innovation-driven development has achieved good results, which is expanding the proportion of tertiary industry and limiting primary and secondary industries. In terms of economic transition pattern, the strategy of innovation-driven development is effective and it is promoting China's economy to an advanced structure.
- e. Under the global economic recovery, China is playing an important role in global affairs and it has proposed the Belt and Road Initiative that can benefit the economic development of the world. China, as the advocator of the Belt and Road, has the obligation to pursue a sustainable development by applying innovation-driven pattern into this initiative. In the process of the Belt and Road construction, China should improve development quality by developing science and technology and enhancing the cooperation with countries along the Belt and Road in the same fields.

Notes

¹ Author's email address: hailunzhang_ouc@outlook.com

² Author's email address: 13869850555@163.com

References

- Aghion, P., Howitt, P. (1989), A model of growth through creative destruction, *Econometrica*, Vol. 60, No. 2, pp. 323–351.
- Amabile, T.M. (1997), Motivating creativity in organizations: on doing what you love and loving what you do, *California Management Review*, No. 40, pp. 39–58.
- Bo, C. (1989), The evolution of manufacturing technology and its impact on industrial structure: an international study, *Small Business Economics*, Vol. 1, No. 1, pp. 21–37.
- Chesbrough, H.W. (2003), *Open innovation: the new imperative for creating and profiting from technology*, Harvard Business School Press.
- Evangelista, R., Vezzani, A. (2010), The economic impact of technological and organizational innovations. A firm-level analysis, *Research Policy*, Vol. 39, No. 10, pp. 1253–1263.
- Geroski, P.A. (1995), What do we know about entry?, *International Journal of Industrial Organization*, Vol. 13, No. 4, pp. 421–440.

- Ghezzi, A., Cavallaro, A., Rangone, A., Balocco, R. (2015), On business models, resources and exogenous (dis)continuous innovation: evidences from the mobile applications industry, *International Journal of Technology Management*, Vol. 68, No. 1–2, pp. 563–587.
- Grossman, G.M., Helpman, E. (1991), *Innovation and growth in the global economy*. *Innovation and growth in the global economy*, MIT Press.
- Herrmann, B., Kritikos, A.S. (2013), Growing out of the crisis: hidden assets to greece's transition to an innovation economy, *IZA Journal of European Labor Studies*, Vol. 2, No. 1, p. 14.
- Klepper, S. (2002), Firm survival and the evolution of oligopoly, *Rand Journal of Economics*, Vol. 33, No. 1, pp. 37–61.
- Lahorgue, M.A., Cunha, N.D. (2004), Introduction of innovations in the industrial structure of a developing region: the case of the porto alegre technopole 'homebrokers' project, *International Journal of Technology Management and Sustainable Development*, Vol. 3, No. 2, pp. 191–204.
- Peneder, M. (2003), Industrial structure and aggregate growth, *Structural Change and Economic Dynamics*, Vol. 14, No. 4, pp. 427–448.
- Policy responses to the economic crisis – investing in innovation for long term economic growth (2009), *The Journal of E-Government Policy and Regulation*, Vol. 32, No. 4, pp. 216–218.
- Porter, M.E. (1990), *The competitive advantage of nations*, Free Press.
- Syrquin, M., Chenery, H. (1989), Three decades of industrialization, *World Bank Economic Review*, Vol. 3, No. 2, pp. 145–181.
- Wang, J.H. (2007), From technological catch-up to innovation-based economic growth: south Korea and Taiwan compared, *The Journal of Development Studies*, Vol. 43, No. 6, pp. 1084–1104.
- Zheng, J., Hu, Z., Wang, J. (2008), *Entrepreneurship, innovation and economic growth: the case of Yangtze river delta in China*, Mpra Paper.