

China Searching New Ways of Development: Can Technology Innovation Solve All the Problems?

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Abstract

In 2015 Chinese government faced a number of evidences of economic development model crisis existence. Rising labor costs (also due to stimulation of internal demand and social stability goals), rise of new competitors, especially in high-value market niches, new technology development and other challenges indicated that PRC economy have to be transformed in a new way and under new circumstances. In 2015 a new government program “Made in China 2025” was released. It was aimed at transforming national manufacturing sector through the implementation of advanced manufacturing technologies and structural changes. In the 13th Five-Year Plan (2016) technological innovation was also named as the ultimate solution to existing and forthcoming challenges and a key to global economic leadership of China in the next 50 years. But still there are numerous unsolved socio-economic issues, including institutional ones (demography, gap in regional development levels, income gap, etc.), which are likely to negatively affect ambitious goals of PRC. Although there are some policy measures concerning these problems in the 13th Five-Year Plan, it seems that PRC elites still believe that all the problems will be resolved through the development and large-scale adoption of innovation technologies. Proposed paper deals with the possible bottlenecks for these strategic technology-driven measures, including use of disruptive innovation and technology diffusion theories, and reviews possible consequences of new PRC policies.

Keywords: Development; Economic/Financial Crisis; Innovation; China; Political Economy; Technology (New/Modern/Innovation)

The preconditions for implementing advanced manufacturing technologies.

Since economic reforms were initiated in 1978, in China as well as in the other fast-growing economies, the manufacturing industry was a basis of the future development of Chinese economy and has become the key factor for growing exports, FDI and employment. Starting in 2000, China holds its position as a leader due to the share of manufacturing in the GDP structure, moreover, in 2012 China has surpassed the US and has become the largest industrial center (in terms of value added). Furthermore, the growth of high-tech industry has been impressive, as since 2006 China remains the world’s largest exporter and manufacturer of high-tech products.

For a long time, low labor costs were China’s key advantage, but in the 2000s and especially in 2010 it began to grow. According to the International Labor Organization, China accounts for about 45% of the global wage growth rate, which is due not only to the size of the country's population, but also to the growth rate of salaries. In 2001-2003, Chinese workers’ wage per hour grew by about 12% per year, and these high growth rates persisted until 2010, and with a slight decline this trend continues. From 2010 to 2016 the average monthly salary in China increased about 2 times from 1120 yuan to 2190 yuan. According to analysts, by 2019 the hourly salary of Chinese worker will be 177% of the corresponding figure in Vietnam and 218% in India.

At the same time, the key problem is not the increasing costs of Chinese workers themselves, but the faster growth of wages relative to the dynamics of changes in labor productivity (see Figure 1) and the skills of the employed.

In 2015 the growth of labor productivity was the slowest for the last 15 years - it grew by only 6.6% (in 2010 - about 9%). In terms of price / quality ratio, Chinese workers in some cases and in some industries gave place, on the one hand, to the United States and Western European countries (by skill level), and on the other hand, - to Vietnam, India and Indonesia and other developing countries of the Asia-Pacific region (by the price). Significant can be considered the fact that the China-based enterprises are already forced to transfer their production to countries such as Vietnam and Bangladesh.

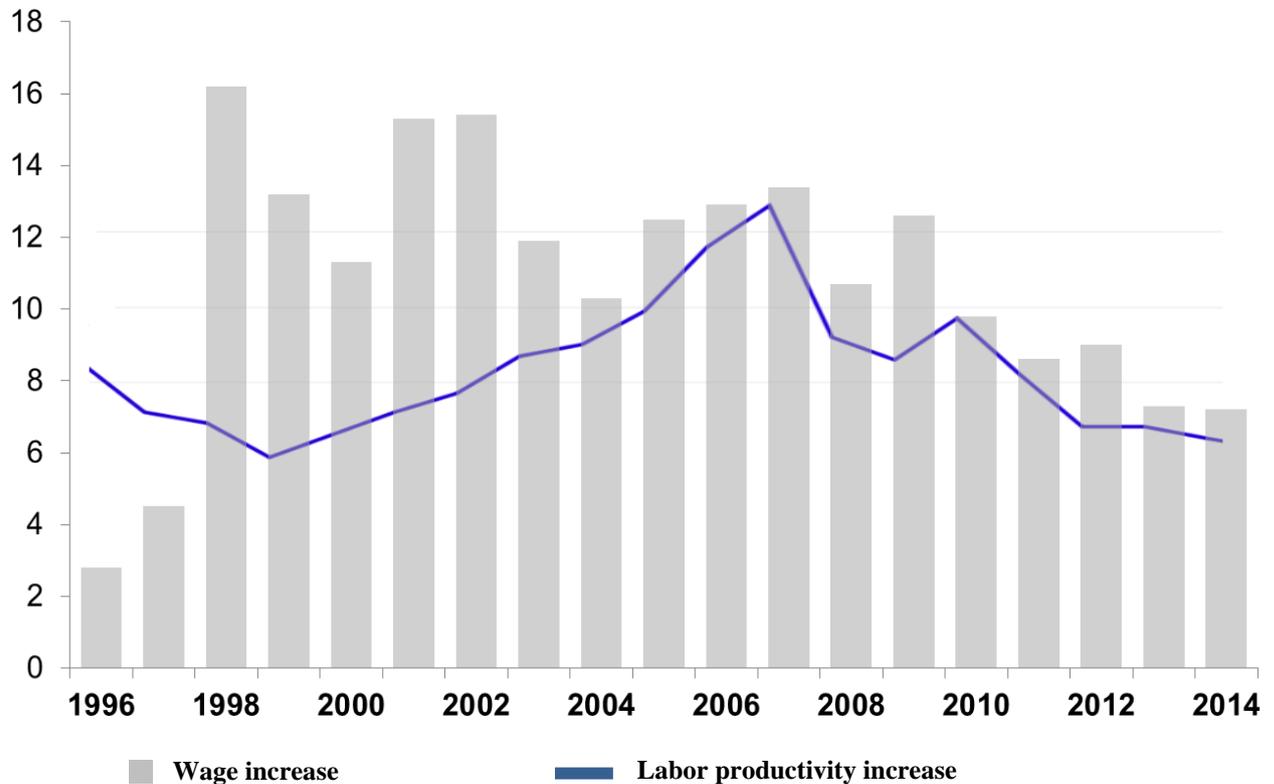


Figure 1 – The rate of average annual increase in labor productivity and average wages (incl. inflation)

In addition, there is severe shortage of qualified personnel in the PRC, especially it concerns perspective areas of competence. In particular, foreign researchers specify, that with a significant absolute increase in the output of specialists with a higher education, specialists with high-demanded engineering education do not have the necessary skills to work at enterprises. For example, international experts believe that in Dongguan alone - by Chinese standards an "average" industrial center - there is a shortage of about a million skilled workers.

Another critical issue for the PRC is the increasing the level of production technological complexity, as well as designing its own - not borrowed and not "imitating" innovations. China is heavily dependent on imports of the most complex and expensive components, subsystems, services, along with some complex products from developed countries. The share of import in production cost of export remains high, which is reported both by experts and in OECD databases (TiVA project). Similarly, a small number of innovative solutions can be recognized as complete Chinese, with a good deal of it related to deep reverse engineering, the so-called. "lean" innovation, etc.

Demographic processes are of great importance. Despite the absolute growth of the population (according to the World Bank, in 2015 the PRC population was 1.37 billion people), the proportion of the working-age population is declining, the proportion of the population over

60 years is increasing. In 2015, the population of China over 60 years was 180 million people, and by 2020 it is projected to be 240 million, and by 2030 - 360 million people, that is, 20% and 27% of the total population of China respectively. These processes make the increase of labor productivity uncontested. However, the issue of future employment, especially among young people - despite the fact that its share in the population structure is decreasing- still remains critical. In the 12th Five-Year Plan it was noted that there is a need to create annually approximately 25 million jobs in cities, but it is possible to create no more than 9 million. At the same time, due to socio-economic changes and rising expectations of the population, it is necessary to gradually move away from the former emphasis on low and medium-low-skilled occupations with the transition to the creation of high-performance jobs.

Further development of the PRC economy, consequently, implies the need for a qualitative expansion of the capabilities to develop and produce the most advanced solutions with the subsequent creation of original innovations - as a condition for maintaining global competitiveness, increasing revenues from production and exports, as well as addressing social issues.

In the present situation, concerning general "slowdown" of the PRC economy, the country's leadership, business circles, the scientific and expert community came to the conclusion that it is necessary to enhance the complex technical and technological modernization of the manufacturing industry - with an emphasis on the use of new production technologies – as the condition for the emergence of new market niches and even new industries, as well as opportunities for innovative development. Among these the emphasis is placed on advanced manufacturing technologies, additive technologies and computer modelling technologies, industrial and service robotics, new materials, etc.

Government plans and programs for the introduction of advanced manufacturing technologies.

As the government policy still determines scientific, technological and innovative development of the country, the analysis of advanced manufacturing technologies requires the study of PRC national programs and planning documents concerning economic, scientific and technological development.

The first-in-time and the key document in this respect is a 15-year “Medium- to Long-Term Plan for the Development of Science and Technology’ until 2020, which, on the one hand, ensures a long-term "outlook" on the state scientific, technological and innovation policy, on the other hand, specifies the framework of Five-Year Plans in science and technology sphere. The development of advanced manufacturing technologies in this plan is considered as one of the steps towards informatization, increasing labor productivity and “greening” the production industry in the PRC.

In the 12th Five-Year Plan (2011-2015), the priorities listed above were reflected, particularly in the sphere of "high-tech production", but advanced manufacturing technologies were not indicated as a special category. Thus, the level of institutionalization and activities to develop the ADM in the PRC were clearly not sufficient comparing to the scale of the challenges. The process of development policies on technological development and renovation of the national manufacturing industry began after the adoption of the 12th Five-Year Plan.

In 2015 China witnessed the critical moment: the slowdown of China’s economy became evident, forcing the leadership of the PRC to talk about a "new normal" of GDP growth up to 7% per year. In May 2015, after more than two years of development by the Ministry of Industry and Information Technology, the State Council of China presented the program "Made in China 2025". Chronologically, the program was unveiled before the beginning of crisis events on the

Chinese stock exchanges in 2015, and was presented as a large-scale but specialized, sectoral document. In the context of the worsening state of the Chinese economy, it gained a deeper significance - as a response to socioeconomic challenges by increasing technological and innovative capacities in a key group of industries.

The main ideas "Made in China 2025" were borrowed from the German concept "Industry 4.0" and similar documents in Japan, the United States and Great Britain. Moreover, the fact of borrowing was not concealed, but rather, it was even emphasized by the Chinese leadership for a number of reasons. First, it reflected a rational focus on the best world practices as guidelines for the development of China. Second, it is likely that political and psychological patterns related to the ideology of "catching up and overtaking" the leading countries are also strong. Despite all the statements about indigenous innovation and Chinese characteristics, Chinese elites are still in the wake of not only technological, but also conceptual development of Western countries.

The list of 10 key areas of the new program includes new information technology, numerical control tools and robotics, aerospace equipment, ocean engineering equipment and high-tech ships, railway equipment, energy saving and new energy vehicles, power equipment, new materials, biological medicine and medical devices, and agricultural machinery.

At the same time, so as to provide industrial and technological development, "Made in China 2025" includes measures to stimulate the growth of small and medium-sized technology enterprises, which are regarded as the "driving force" of innovations in the sphere of production and services, as well as with the internationalization of the Chinese manufacturing industry.

Changes in the government policy were established in the 13th Five-Year Plan until 2020 (published in March 2016). The 13th Five-Year Plan officially stated "new normal" for the growth of the PRC economy at 6.5% per year. A direct consequence of changing social and economic conditions was that in this Plan - unlike previous similar documents - for the first time the "development strategy with the driver in the form of innovations" was placed first.

"Made in China 2025" and the 13th Five-Year Plan in combination determine the government policy in the field of advanced manufacturing technologies. Moreover, it is advisable to point out the development of new technologies and the technical and technological modernization in different areas, as well as the new industries that will develop through this process, and will allow (theoretically) the economy of the PRC to make a qualitative leap in development.

Robotics and robotization in China

Currently, China has become Asia's largest producer of equipment for the automation of production and, to a much lesser extent, classical robotic products. However, this status was achieved due to the amount of equipment produced by foreign companies in China under the contract, as well as extended import substitution - which does not always entails comparable increase in quality and technical characteristics of the products.

There is an intensive diffusion of industrial robots in the PRC. Before 2006, China did not appear in global statistics, but over the past five years sales are growing rapidly, so that the PRC in terms of volume indices started to outrun leading industrialized countries. In 2013 only, sales of industrial robots in China grew by 60%, and in 2014 - by another 56%. In 2014, China as well became the largest market for industrial robots in the world with sales of more than 57,000 units - more than the United States or Japan.

The robotization of enterprises in China is proceeding at the accelerated pace. One of the most significant examples was the Changying Precision Technology in Dongguan, the mobile

phone modules factory, which in 2015 replaced the staff of 600 people with 60 industrial robots. After that labor productivity grew by 250%, and the level of spoilage decreased from 25% to 5% - which is fundamentally important for China. This plant became an example of the "first factory without people" in the country. The remaining personnel are mainly responsible for robot control, maintenance and other kinds of operations. Furthermore, in 2016, Foxconn initiated a program for the integrated robotization of its facilities in the PRC with the possible dismissal of up to 600,000 workers.

As robotization is encouraged and financially supported by the government, a rapid growth of the national robotic industry is witnessed. Sales of robots produced by Chinese companies in 2013 grew by 78% to 16,000 units, and in 2015, Chinese companies have already produced 33,000 units of industrial robots. According to the guideline published by the Ministry of Industry and Information Technologies in April 2016, the production of industrial robots is planned to triple by 2020 up to 100,000 units – that fact is doubtful (from the point of sales, rather than "reported" output). It is assumed that by the mid-2020s, China will transform from net importer to net exporter of industrial robotics.

Finally, China is actively developing service robotics as well- the most promising segment of the modern robot market. Such technologies are in demand in the sphere of services, including public health, scientific research and in domestic sphere. The Chinese Ministry of Science and Technology also announced plans to produce service robotics products for a total of \$ 4.6 billion by 2020.

Challenges of advanced manufacturing technologies implementation (the example of robotics)

The goals set by the government of the PRC demonstrate that rational and objective assessment of China's position in the world and its potential among advanced developed countries has appeared. In this regard, the emergence of official documents - along with the already unaltered rhetoric of "indigenous" innovation - is quite a reasonable idea of an integrated technical and technological modernization of production industry as national development priority.

However analysis of documents and reflections in the Chinese official press proves that the authorities regard technical and technological modernization as almost a universal solution to existing problems: first of all, the slowdown in the country's economic growth and the decrease in labor productivity. At the same time, although the other problems mentioned above are taken into account, their decision is supposed to be an "automatic" consequence of overcoming medium-term GDP growth constraints – including the modernization of the manufacturing industry.

Moreover, as in the case of any other "breakthrough" technologies, this process already has quite real - and even greater possible - challenges for development. As it can be seen from open sources, at the moment the entire complex of effects of new technologies and the consequences of their application on the socio-economic indicators of the PRC are poorly understood and taken into account in the documents of the national level.

First of all, despite rapid growth in sales, China still lags far behind not only the most developed countries, but also the average statistics in Asia on some key indicators, such as the number of robotic complexes installed in the industry per 10,000 employees. The average figure is 66 robotic complexes in the world for 10,000 jobs. The average for Asia (including Japan, Australia and New Zealand) is 54, but in Japan and R. Korea (along with the Germany - the leaders of global robotization), the corresponding figure is 314 and 478 industrial robots per

10,000 employees, respectively. In China, the level of robotization is insignificant - in 2014 it was only 36 units (!) per 10,000 employees.

Taking into account the scale of the industrial complex of the People's Republic of China, as well as the number of people employed in the manufacturing industry, achieving a qualitatively higher level of robotization will take considerable time. Moreover, it is not only - and even not so much - the formal number of installed RTCs, but all the complex of production tasks, namely: the restructuring of production, administrative (including the update of enterprise software products - ERP and other systems) and business processes; creation of services sector and support for established RTCs and, most importantly, training. The latter, given the already existing situation in other areas of high-tech production, turns out to be the most serious problem, especially with regard to the qualitative indicators of the workforce, both employees of the enterprises themselves and the sphere of specialized services (commissioning and maintenance of production, ensuring effective integration into the factory information systems and the enterprise itself, cybersecurity, etc.). Meanwhile, without the solution of these and other problems, the economic return from the robotization of industries will at best be rather limited, and the costs may be more significant than expected.

Another problem is that mass robotization of industries is stimulated and financed by the state, which raises the question of the economic efficiency of at least part of the decisions made and the need to robotize individual enterprises as such. In the future, it can be assumed that robotics will be carried out in a radical way (as exemplified by the Dongguan plant) when, under pressure from the authorities subject to benchmarks approved in government documents and decisions of higher party and political bodies, enterprises will implement the RTC and fire workers, just to achieve the necessary indicators. A competent model of gradual transition is not yet provided.

Further, as can be clearly seen from the example of all the same industrial robots, China still tends to focus on quantitative rather than qualitative indicators of the development of advanced technologies. In particular, the promotion of growth in the volumes of "national" production and R&D is not accompanied, as one can understand, by a comparable increase in the quality and manufacturability of services, while maintaining an extremely high dependence on imports of key components and subsystems (that is, primarily "simple" solutions). In particular, according to Ma Li, director of the Shenzhen Research Institute at Tsinghua University, a large part of the university's robotics development in the PRC (one of the main sources of new patents for this and other "breakthrough" topics) has only a limited connection with the real demands of the market and does not seem to go beyond the limits of laboratories.

A natural way could be to accelerate the import of technologies, establish alliances and partner scientific and technological programs with leading foreign manufacturers, and similar measures, which do take place. However, it seems that the depth and scope of this process are clearly insufficient; the personnel side of the issue (the qualifications of scientists and engineers), again, raises questions. Moreover, the focus on technological import substitution directly affects the interests of the most developed countries and the largest transnational corporations, which is a source of their significant concern.

However, accelerated robotization and, to a lesser extent, the transition to other advanced production technologies, designed to solve or alleviate existing problems, themselves can lead to large-scale negative social and economic consequences in the medium term. First of all, we are talking about the fall in employment and income of low- and middle-skilled personnel in the Western and Southern provinces and (in the process of development of robotization) in the country as a whole – first of all, among migrants from the villages. Significantly, according to Finnish experts' estimates, if the advanced equipment were used in the construction of

infrastructure facilities in the People's Republic of China, up to 6 million migrant workers from the villages would not get a job.

Experts believe that a way out of this situation may be a kind of semi-automation of production, which will lead to a milder transformation of the labor market, as well as to a lower level of investment and the cost of modernizing production. It's about combining automated production lines and individual lines of manual assembly. This approach solves several problems at once: it preserves jobs with minimal professional development, increases labor productivity due to partial automation, makes production more flexible without significant loss of efficiency, and also reduces capital costs of the manufacturer. So, according to the research of Chinese experts, such production is more effective, in particular, in the production of customized orders and small parts.

China is not yet ready to fully implement the RTC and other production technologies and to transfer to its own innovations in this area. The massive use of advanced industrial technologies, incl. roboization, will not be able to fully resolve the accumulated socio-economic contradictions and asymmetries of development, and can only be one of the tools in achieving the set goals. However, it can be understood that the PRC's sectoral programs often do not fully take into account the real economic situation and emerging challenges, including the social component of the process and characteristics of the national innovation system.

Further development of both robotics and other advanced manufacturing technologies will require certain corrections of the initial approaches from the PRC in the near future. In addition to the necessary and inevitable systematic institutional changes, there will be a further growth in the emphasis on the development of human capital - especially high-qualified industrial and engineering personnel, reduction of dirigist practices in the field of advanced industrial technologies in favor of balance between government tasks and financial and economic realities, as well as the development of a new social strategy. The only question is whether the Chinese government is ready to revise the standard model of "catch up and overtake" and take into account the Chinese specifics so as to achieve successful technical and technological modernization of the country.

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