GVC Evolutions: New Trends and China's Policy Response

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Abstract: *In today's digital economy, new technologies such as artificial intelligence, big data, and the internet of things (IoT) have stronger influence on global value chains (GVCs). As GVCs overcome physical boundaries, the space economy is becoming a new agent of growth. Developed countries dominate the rules of regional trade agreements, leading to endogenous restructuring in GVCs. In multi-tiered GVCs, certain countries garner a large portion of value-added. With the new trend in GVCs in mind, China should consolidate its strengths in the digital economy as new growth agents replace old ones, gain a favorable position in the space economy with the Chinese space station, create a global trading network through the Belt and Road Initiative (BRI), and acquire more value-added by capitalizing on the sophisticated global value chain.*

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1. Introduction

More than two thirds of world trade takes place through the means of global value chains (GVCs). Multi-stakeholders, specialization and the service trade have become new characteristics of GVCs (Cheng and Wang, 2017), which influence a country's competitiveness, economic development, labor market, and trade costs (Jones *et al*., 2019). GVCs yield the most profits at both ends of the smiling curve, and with their growing influence on the economy (Yuan, 2016), exert great control over world trade development. For many countries, participation in GVCs has become an important way to integrate into the world economy. China is no exception. From 2005 to 2015, China's participation rate in GVCs averaged 10%, far higher than the 6.5% average for developing Asian economies (World Trade Organization, 2019). High GVC participation has buttressed China's status as a leading trading nation. Yet the development of GVCs is not straightforward. The inclusion of numerous Chinese companies into the US entity list for export control presents barriers to China's rise in GVCs (Li, 2019). How will China cope with sudden GVC disruptions, strengthen its role as a key player in simple GVCs and move towards sophisticated ones? These issues are vital to China's economic future.

2. Literature Review

Since the concept of GVCs was invented, most studies on them have focused on their driving forces, measurement, governance, and evolution. GVCs are considered to be either producer-driven

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or purchaser-driven (Gereffi and Korzeniewicz, 1994) or both (Zhang, 2006). Some academics have identified economic and trade liberalization amid the declining technological, political and economic barriers as key forces driving GVCs (Amador and Cabral, 2016). An example is the reduction of transportation cost. The cost of each day in transportation is equivalent to 0.6%-2.3% of *ad valorem* duties. Most time-sensitive commodities involve trade in parts and components. A sharp decrease in air transportation cost is correlated with increasing specialization in international trade (Hummels and Schaur, 2012).

GVCs can be measured at the macro level and at the micro level (Johnson, 2018). Measuring GVCs at the macro level requires the creation of a global input-output table based on national input-output tables to estimate the value-added in trade, the length of the value chain, and the price correlation between countries. For instance, Antras and Chor (2018) conducted a study based on the world input-output database of 1995-2011. Studies on GVCs at the micro level focus on firm-level activities such as how firms decide to outsource inputs and organize their production networks and how imports are correlated with exports. These firm-level studies help us gain a better understanding of substitutability and productivity in the global production network (Timmer, 2017). Ostensibly, macro and micro level studies on GVCs vary considerably. Yet Johnson (2018) considered that these two dimensions would converge.

GVC governance involves such critical issues as the distribution of value-added. GVC governance models can be classified into market, network, quasi-hierarchical and hierarchical models (Humphry and Schimitz, 2000), or market, relational, modularized, leadership, and hierarchical models (Gereffi *et al*., 2005). It is equally important for the upgrade of GVCs in terms of products, processes, functions and supply chains (Humphry and Schimitz, 2002). In the views of Barrientos *et al*. (2011), GVCs' upgrade includes economic and social upgrades. For China, the goal of industrial upgrade is to develop a supply chain led by large retailers (Xu and Sheng, 2012).

There is a U-shaped relationship between China's GVC position and its transition from manufacturing (Yu and Tian, 2019). To date, participation in GVCs has significantly boosted China's industrial low-carbon factor productivity (Xu *et al*., 2019) and trade interests (Wang, 2019). Yet China's low-end position in GVCs presents a risk of low-end lock-up (Lv *et al*., 2018; Yan, 2019). For instance, US anti-dumping practices have weighed on China's participation in GVCs (Huang and Pan, 2019), which indicates the existence of lockup effects in the GVC division of labor (He, 2019).

3. New Trends in GVC Changes

3.1 New Forces Driving GVC Upgrade

The world economy has seen an upsurge in the internet of things (IoT), big data analysis, 3D printing, robotics, artificial intelligence (AI), and cloud computing. These technologies have become new drivers of GVCs, reshaping producers and influencing consumers. Transition from a service-based economy to a knowledge-based, data-driven economy has unveiled the era of the digital economy.

In the digital economy, citizen-consumers are endowed with a new role. They are now active market participants, content producers, distributors, and a major source of economic value (Lammi and Pantzar, 2019). The generation, access, accumulation and mining of data have become elements of various business model innovations. Data is seen as a new means of production, and computing is seen as a new form of productivity (Ma, 2016). In this context, global data governance has emerged (Su, 2019). The data-driven upgrade is becoming a new trend in the upgrading of the global value chain.

The new forces driving GVCs have led to the consumer market's growing influence over the prices of final products. Specifically, whether a firm decides to integrate the upstream or downstream links of GVCs is subject to the price elasticity of demand for its final products (Alfaro *et al*., 2019). With

artificial intelligence, big data and cloud computing, firms are better positioned to respond to consumer demand, streamline business processes, and improve goods and services. Yet the digital economy cannot simply be equated with "Industry 4.0" or "Made in China 2025". In other words, Industry 4.0 does not guarantee digitalization. While Industry 4.0 is conducive to operational and functional upgrading, it does little to narrow the gaps between multinational corporations (MNCs) and their local manufacturing subsidiaries in regards to value creation. The digital economy, however, helps MNCs identify market opportunities, adopt differentiated competition strategies, and build competitive strengths vital to capturing value (Szalavetz, 2019).

3.2 New Growth Potentials from the Space Economy

In the 20th century, GVCs covered the land and the sea. In the 21st century, GVCs have been rapidly extending into outer space. According to Goldman Sachs, about three fourths of space investments since 2000 have been made in the past five years (Zhan, 2018).

3.2.1 Crowdfunding: A new solution to funding space R&D

Globally, there has been an upsurge in space budgets across countries. This is particularly evident in BRIC countries and the Next Eleven countries (Table 1). Despite the falling share of GDP, space budget remains the largest spending for the US government.

For the convenience of international comparison, Table 2 provides major economies' R&D spending for space programs. By purchasing power parity (PPP), US R&D spending for space programs totaled 11,638.393 million dollars, far exceeding that of other developed countries like Japan, France, Germany, and Switzerland. Britain's space R&D spending, which only represented 3.8% the US level in 2015, has been rising steadily. After the Outer Space Act in 1986, Britain adopted the Space Industry Act on March 15, 2018 to steer the development of its space economy.

For both developed and developing countries, access to material and energy resources in the solar system is of great significance to the sustainability of the space economy and relevant infrastructures (Crawford, 2016). Yet the tremendous funding and R&D capabilities for space exploration are far beyond what governments may afford. Globally, public and private partnership has become the dominant mode of the space economy. For instance, the British government aims to

Table 1: Countries' Space Budgets as a Share of GDP

	Space budget as a share of current GDP (%)	Space budget as a share of GDP by 2030 (%)
BRIC countries	10.3	28.1
Europe and Canada	15.7	10.8
Japan	3.8	2.4
Next Eleven Countries	1.9	2.8
US	67	54.5
Other countries	1.3	1.3

Source: Kessler and Peeters (2011).

Notes: (i) BRIC countries refer to Brazil, Russia, India and China.

(ii) The Next Eleven (known also by the numeronym N-11) are the eleven countries – Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, Turkey, South Korea, and Vietnam – identified by Goldman Sachs investment bank and economist Jim O'Neill in a research paper as having a high potential of becoming, along with the BRICs, the world's largest economies in the 21st century.

Table 2: R&D Spending for Space Programs (in million US dollars)

Country	Year	Amount	Country or region	Year	Amount
US	2016	11,638.39	Belgium	2015	236.68
Russia	2009	3,381.63	Argentina	2012	202.01
Japan	2016	1,922.64	China's Taiwan	2016	120.70
France	2016	924.78	The Netherlands	2016	150.50
Germany	2016	1,591.02	Switzerland	2014	123.50
Italy	2015	892.50	Norway	2016	63.92
South Korea	2015	567.10	Czech Republic	2016	34.88
Britain	2015	442.22	Sweden	2015	28.14
Spain	2015	377.42	Denmark	2016	15.68
Canada	2013	276.93	Finland	2016	23.25

increase Britain's share in the global space economy from 6.5% to 10% by 2030 in partnership with British firms (China National Defense Science and Technology Information Center, 2018). Amid the transition from government-led to public-private partnership for space exploration, new modes of financing, such as crowdfunding, have emerged. Representative crowdfunding space exploration programs include Cornell University's KickSat, Southern Stars' SkyCube, and Planetary Resources' Arkyd-100 space telescope project (Li and Xu, 2015). Based on their survey of space crowdfunding projects in Moscow and the Silicon Valley, Pomeroy *et al*. (2019) found that crowdfunding, though not an effective solution to R&D funding gaps, was conducive to a democratic space exploration environment and would influence the scientific research of space exploration and the power structure of the space industry.

3.2.2 Outer space: A new arena for international competition

Outer space is viewed by many nations, including the US, as a new arena for competition and a key part of their military strategies.

In 2015, the US Congress adopted the Space Act to allow the US public to engage in space exploration and utilize space resources. Aside from NASA spacecraft launch systems, the US is inviting private capital to the base economy. Since the Obama administration's announcement of a plan to build an international commercial space station, space exploration activities independent from government funding have thrived. For instance, Space-X has launched sub-orbital space tourism (Kessler and Peters, 2011) and partnered with Boeing and other commercial space companies to develop spacecraft capable of reaching the international space station. E-commerce giant Amazon has also joined the fray, planning to launch space tourism services.

Developed countries, led by the US, view outer space as a new domain for global competition and part of their military strategies. In August 2018, the US Air Force Space Command (AFSPC) was established. On December 18, 2018, the Japanese Cabinet adopted the National Defense Program Guideline (NDPG) for fiscal year 2019 and beyond and the Mid-Term Defense Program (MTDP) for

Table 3: Space Technology Ladder

Space technology ladder	
13	Launch capability: high orbit satellite
12	Launch capability: low orbit satellite
11	High orbit satellite: built locally
10	High orbit satellite: built through international cooperation
9	High orbit satellite: built locally with foreign aid
8	High orbit satellite: outsourced
7	Low orbit satellite: built locally
6	Low orbit satellite: built through international cooperation
5	Low orbit satellite: built locally with foreign aid
4	Low orbit satellite: built with partner facilities
3	Low orbit satellite: outsourced with training services
2	Aerospace agency: built current space agency
1	Aerospace agency: built the first national space agency

Source: Wood and Weigel (2012).

2019-2023, which identified outer space as a strategic military domain and planned to increase battle power in such new domains as outer space, cyberspace and electromagnetic forces. In March 2019, India shot down one of its own low-orbit satellites with an anti-satellite missile, making it the fourth country to possess anti-satellite technology. On July 13, 2019, France approved the establishment of a space command within its air force. NATO planned to list outer space as a new battlefield together with land, sea and air and cyberspace.

Due to the extreme importance of the space economy, many developing countries are also attempting to advance their capability in space technology. The concept of space technology, put forth by Wood and Weigel (2012), is a standard path for developing countries in their development of space capabilities (Table 3). Based on this path, Argentina planned to launch its first low-orbit satellite at the end of 2020 (Lopez *et al*, 2018).

3.2.3 Advanced economies set new rules for regional trade deals amid endogenous GVC restructuring

Membership in the World Trade Organization (WTO) has been steadily increasing since the 1990s and 164 countries are now members. Broad WTO representation lays a solid foundation for a multilateral trading system, and presents great potentials for GVCs. As a new trend in international trade, countries have signed a growing number of trade deals.

As shown in Figure 1, there has been a substantial increase in regional trade deals over the 1980-2019 period. Since the dawn of the 21st century, there has been a rapid rise in the number of regional trade deals. On October 3, 2019, a total of 302 regional trade agreements were in effect, including 149 on goods trade, two on service trade, and 151 involving both goods and services. Europe recorded 100

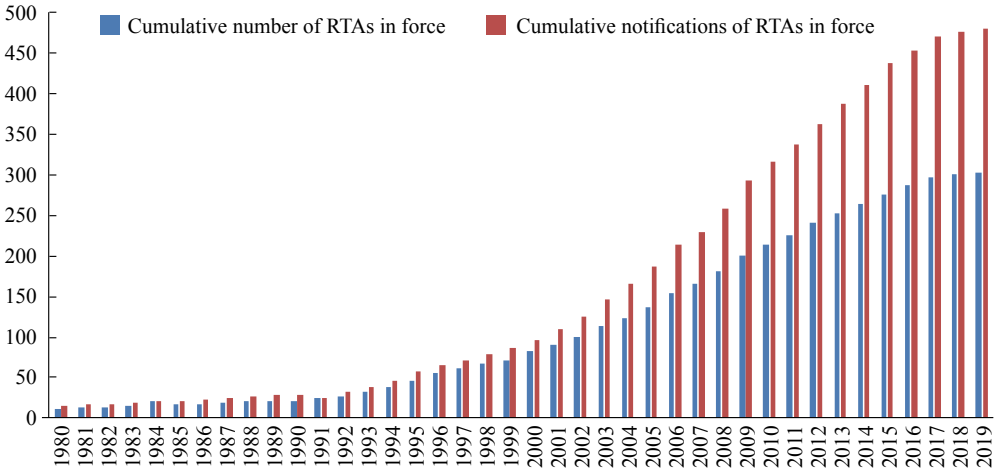

Figure 1: Regional Trade Agreements (1980-2019)

Source: WTO. http://rtais.wto.org/UI/charts.aspx

regional trade agreements, the highest number in the world (Figure 2). For member states that joined the EU after 2004, the closer they are to the center of GVCs, the faster firm productivity growth these member states experienced (Criscuolo and Timmis, 2018).

Regional trade agreements influence economic growth and welfare in signatory countries, but the effects vary greatly between developed and developing countries. Regional trade agreements with high provision coverage and statutory commitments boosted economic growth significantly in developed countries. Having benefited from regional trade agreements, developed countries proactively pursue a transition in regional trade agreements from "WTO+" to "WTO-X" (Sun *et al*., 2010). The reason is that regional trade agreements formulated under different rules would lead to different effects. Non-WTO rules, e.g., investment and competition policies, drive South-North trade in parts and components; WTO clauses, e.g. tariff exemptions and customs clearance facilitation, drive South-South trade in parts and components (Laget *et al*., 2018).

Globally, there has been a growing momentum in the signing of regional trade deals among developed countries. Examples include the Japan-EU trade agreement of 2018 and the Japan-US trade agreement of 2019. Laget *et al*. (2018) maintained that countries signed trade deals to promote and facilitate GVC operations. Sector-wise, meaningful trade deals may promote and integrate high-value industries.

Not all regional trade deals are necessitated by economic determinants. In many cases, trade negotiations act as an external policy instrument. In this sense, the geographical scope of regional trade deals is endogenous in nature (Fontagne and Santoni, 2018). The geographical endogeneity of regional trade deals, whose optimality evolves under GVCs, is particularly evident in two-way free-trade deals. As a result of endogenous restructuring in the value chain, two-way trade becomes more responsive to falling trade cost. Yet the responsivity of world trade to trade cost did not increase with multi-stage production (Johnson and Moxnes, 2019). This implies that with the increase of regional trade deals, the core links of GVCs take root in various regions. Through deepening regional trade agreements, advanced economies led by the US, the EU and Japan break up and reorganize the global production network in the interest of their dominant GVC positions.

3.2.4 Advanced economies dominate high-value links of GVCs

GVCs become increasingly multi-tiered over time. Take the manufacturing industry for instance.

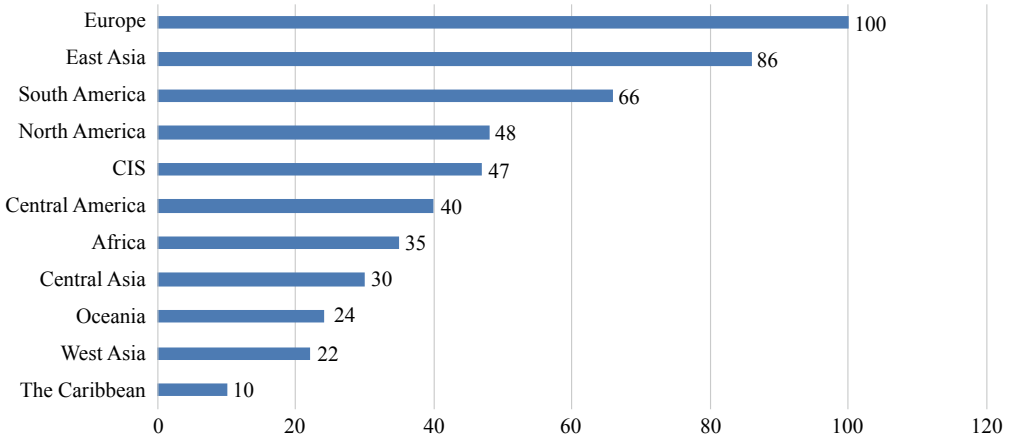

Figure 2: Number of Regional Trade Agreements in Effect for Various Regions

Source: WTO, date of retrieval: October 2, 2019.

China's access to GVCs is predominantly downstream and moving upstream in technology sectors. Japan's access to GVCs is focused on upstream links and helped by superior technology sectors. With its high-tech prowess, the US dominates upstream links of GVCs. The EU is primarily engaged in the manufacturing and export of intermediate and final products (Lai and Zhong, 2017).

Multinational companies dominate GVCs. Their penetration is especially high in low-technology manufacturing sectors such as textiles and apparel and high-technology sectors like automobiles and electronics (Carlos and Trebat, 2017). Normally, fast-growing developing economies participate more actively in GVCs. Over the period 2005-2015, the GVC participation of Asian economies averaged 6.5%. Vietnam, the Philippines, China and India all exceeded this average level, and Vietnam's GVC participation averaged 16.5% (World Trade Organization, 2019). GVCs have increasingly become a main channel of export for developing countries, which may lose far more than they gain from the GVCs (Rodrick, 2018).

First, higher GVC participation does not always improve a country's current balance of payments. There is no evidence that GVC participation directly increases an economy's current account position. On the contrary, backward participation has a negative impact on current account balances. While GVC participation led to thriving exports, such growth did little to shore up price competitiveness or savings rate (Villavicencio and Mignon, 2018).

Second, developing economies enmeshed in GVCs have become more dependent on advanced economies. Take the European Union for instance. Germany was a major trading partner with 10 countries from central and eastern Europe over the period 1995-2011, enabling these countries to participate in GVCs (Ambroziak, 2018). Yet compared with South Europe and the Nordic countries, central and eastern European countries have become much more dependent on global production networks (Grodzicki and Geodecki, 2016).

Lastly, economic growth effects of GVCs vary across countries, affected by such intangible capital as R&D, advertising, marketing, branding, training, and organizational capital. Normally, higher density of intangible capital, which is a key advantage of GVC upstream firms, would lead to greater marginal growth effects of GVC participation (Cecilia and Meliciani, 2019). A firm's tendency to move towards an integrated supply chain is controlled by its relative negotiating power at the upstream rather than the downstream (Alfaro *et al*., 2019). Developing economies, possessing little intangible capital and being less innovative, have a much smaller tendency to move towards supply chain integration. Unable to

climb up the technology ladder and fully benefit from the economic growth effects of GVCs, developing countries have found themselves less capable of accessing value-added in GVCs.

Advanced economies have always dominated in the regulation, control and IPR competition in such areas as innovation, financing, and marketing (Carlos and Trebat, 2017). Compared with developing economies, advanced economies have benefited more from GVCs, to which they have unimpeded access (Mehta, 2018).

4. China's Response to Evolving GVCs

4.1 Fostering the Digital Economy as a New Growth Engine

The changing forces driving GVCs will not put an end to the producer-driven value chain or the consumer-driven value chain. On the contrary, China should fully take advantage of its massive industrial capacity and growing consumer market to merge new driving forces with old ones and foster digital economy strengths.

The digital economy is rooted in the generation, transmission, storage, mining, analysis and governance of data. In such sectors as transportation, telecom and new media, China should create a blockchain-enabled digital economy ecosystem. When appropriate, China should launch its own digital currency to gain its rightful place in global digital payments. Foreseeably, China's sophisticated cross-border e-commerce platforms and mobile payment instruments such as Alipay and WeChat payment will facilitate the operation of its future digital currency. China should further reform and open up its stock exchanges in Shanghai, Shenzhen and Hong Kong to domestic and international capital. China should continue to internationalize renminbi as an international pricing, settlement and reserve currency. Theoretical research should be carried out to investigate China's digital economy practices and contribute Chinese wisdom to global data governance.

4.2 Seizing the High Ground of the Space Economy

On January 3, 2019, China's lunar probe landed on the far side of the Moon. On July 19, 2019, Tiangong-2 space lab deorbited successfully, marking the beginning of China's space station era. China should take this opportunity to strengthen its space industry and seize the high ground of the space economy.

Firstly, the China Aerospace Science and Technology Corporation (CASC) should take the lead in the development of key aerospace technologies. Through the "Double First Rate" program - a national initiative to create first-rate universities, aerospace enterprises should partner with universities to foster an echelon of aviation and aerospace professionals. The China International Aviation & Aerospace Exhibition should continue to serve as a platform for international exchange and cooperation.

Secondly, as stated in the Aerospace in China 2016 white paper, private entities should be encouraged to enter the business of rocket development and commercial satellite launch. Hainan Province, home to the Wenchang Satellite Launch Center, may serve as a showcase of civil-military integration in the commercial aerospace industry.

Thirdly, we should enact the Aerospace Law as soon as possible. We should promote the civilian use of aviation and aerospace technologies, an example of which is the BeiDou navigation satellite system. Aviation and aerospace technologies should contribute to the competitiveness of China's agriculture, healthcare and other sectors.

Education plays a pivotal role in fostering the space economy. For China, primary and middle school education should receive special attention. We should encourage students to read science fiction novels such as *The Three Body Problem* and *Wandering Earth* written by Liu Cixin and the stories of space scientists like Qian Xuesen and Deng Jiaxian to instill in them an interest in space exploration.

4.3 Creating a Global Trade Network under the Belt and Road Initiative (BRI)

While preserving the multilateral trading system, China should accelerate the negotiation for and implementation of regional trade deals by making the most of the BRI, not only to seek numbers of regional trade deals, but their quality. In negotiations from the aspect of quality, we should pay attention not only to details and coverage of regional trade agreements in the WTO+/WTO-X areas, but the executive ability of participant states and the eventual effects of punitive mechanisms of the clauses in regional trade agreements on economic growth (Sun *et al*., 2018). In negotiating new trade deals and upgrading existing ones, China should consider the quality, coverage and statutory commitments of the legal clauses to be very important.

Existing studies have found that an Asia-Pacific free-trade area and regional comprehensive economic partnerships would yield the most positive effects on China and the world (Li *et al*., 2018). China should proceed with negotiations over comprehensive economic partnerships, engage in consultations with the Gulf Cooperation Council (GCC), and strive to conclude negotiations over the China-Japan-South Korea free-trade area. In addition, China should commence free-trade talks with countries like Sri Lanka, Israel, Norway, Mauritius, Panama, Moldova, and Palestine. Individual free-trade deals will help create a regional trade network as part of the global trade system.

4.4 Enhancing Gains from Trade under Sophisticated GVCs

China should embrace a fast-changing world with an open mind. It should respond to changing consumer demands in domestic and international markets, including markets in advanced and less developed economies. It should follow a "complete industrial chain" approach led by technology progress (Huang *et al*., 2019). The Chinese government should partner with private actors to develop sophisticated GVCs underpinned by Chinese intellectual property rights.

China is currently highly dependent on petroleum and coal. Yet there is great potential in renewables like solar, wind, tidal and hydropower energies, inflammable ice, and nuclear power. China should improve its energy mix and encourage green energy consumption.

The digital economy is dependent on secure and stable internet services. As an essential infrastructure for internet architecture, root name servers are vital to China's national cybersecurity. With Huawei's 5G technology as a benchmark, we should create a favorable environment for international academic exchanges on communication technology. We should design appropriate R&D incentives and patent protection systems for scientific researchers. We should increase academia-industry exchanges and cooperation, facilitate the commercialization of R&D results, and bring about substantive progress in quantum communication technologies.

Based on the BeiDou navigation satellite system, we should further develop the high speed railway, jumbo jet, oceangoing vessels, and rockets, focusing on engine technology. We should enhance China's independent R&D and manufacturing capabilities for land, maritime and space transportation equipment.

Taking the protection of species diversity as leverage, we will accelerate the development of the Germplasm Bank of Wild Species, to expedite the gene sequencing, mapping and editing of staple grains and vegetable seeds. Based on the scientific research on hybrid rice of Prof. Yuan Longping's team, we should develop China's core competitiveness in global rice farming and safeguard China's food security and technology independence.

We should encourage the development of traditional Chinese medicine (TCM) and cultivate leading pharmaceutical researchers. We should support fundamental research in pharmaceuticals and promote the commercialization of R&D results in the pharmaceutical industry. We should enhance international pharmaceutical cooperation and step up research on cancer and other diseases. We should foster internationally competitive Chinese pharmaceutical manufacturers to increase China's global influence in health products and services.

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