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This testimony follows the format of the six questions proposed by the Committee, slightly rearranged.

1. Does China view itself as in an economic and technological competition with the United States? If so, how has its approach evolved over the past 15-20 years? Please address the impact of recent U.S.-China trade tensions.

Chinese leaders certainly see themselves as being in economic and technological competition with the United States. The drive to “catch up and surpass” developed countries has been almost constant in Chinese policy-making since the foundation of the People’s Republic in 1949. In 1958, China adopted the target of catching up with the U.S. in steel production in fifty years. Although this (Great Leap Forward) push collapsed and China retreated into near-isolation during the Cultural Revolution (1966-1976), the desire to surpass always closely follows the goal of catch-up.

In 1978, China discovered that it was in fact hopelessly behind the US; had lost ground in relative terms over the preceding 20 years; and would take a long time to catch up. Direct competition was de-emphasized and “catch-up” was repositioned as a distant future objective. During the 1980s and 1990s, traditional five year plans repeatedly failed, and policy-makers sensibly scaled back the process, prioritizing economic reforms and growth-by-any-means. This policy orientation culminated during the Premiership of Zhu Rongji (1998-2003), the recent Chinese leader most committed to market institutions. Foreign investment was the main source of technology transfer, economic reform was the primary goal of policy-makers, and WTO membership was seen as a culmination of a process of domestic institutional change. At first, the subsequent Hu Jintao-Wen Jiabao administration (2002-2012) seemed set to maintain this policy orientation. However, things began to change immediately after 2006. Under question two, I will show how during the 15 years since 2006, China has steadily shift towards a more interventionist approach to the economy and a more directly competitive approach toward the US. To understand this shift, though, we should acknowledge the elements of competition that were present, but submerged, in the relationship through the twenty years before 2005.

China is ambitious: policy-makers benchmarked almost exclusively against the United States, never against other developing countries. An educated audience enjoyed watching China’s climb upward on various international rankings, including those of “comprehensive national power” (basically GDP augmented by hard and soft power). Deng Xiaoping carried out a foreign policy of international restraint, but even his dictum “hide your capabilities and bide your time” (韬光养晦) contained an implication of later rise and possible future pay-back. It is obvious that the collapse of the Soviet Union and the lopsided US victory in the first Gulf War were huge shocks. At first these shocks confirmed the basic economic orientation—they were

far behind and not necessarily closing the gap—but they also sparked fear and seeded a determination to gradually resume a program of national strengthening, including military strengthening.

China's authoritarian political system contributes greatly to its international strategic view. Through 2005, China greatly relaxed political controls and partially institutionalized the authoritarian system and the bureaucracy, but it remained authoritarian and since 2012 its authoritarian nature has intensified. This political system reinforces China's traditional Confucian culture that saw social relations as being intrinsically hierarchical. Chinese policy-makers overwhelmingly see the global order as also being hierarchical. The U.S. is the dominant power and "older brother." However, since China is a large and rapidly growing country, in this view there will inevitably be a time when it clashes with the "older brother" and China should be prepared for the possibility that the elder brother will not give way. Through 2005, then, there persisted in China a strong strategic culture which incorporated visions of future competition and the possibility of conflict.

However, through 2005, there was *not* any kind of coherent planning for specific industrial development, and certainly not for any target to displace the United States. In the first place, displacing the United States in *any* industrial sector was simply not conceivable twenty years ago. Broad Chinese Five Year Plans and industrial policies through the turn of the century displayed a consistent record of failure, a reality acknowledged by Chinese planners when they took a completely different approach toward "planning" in setting the broad development objectives in the 2005 11th Five Year Plan. Market-oriented economic reform and continued internationalization were the prerequisites for that program, and intensified competition and potential conflict was not at all fore-ordained at that time. Indeed, it would give far too much credit to China's planning to claim that China had a hidden plan for growth or development (or for displacing the United States) in the decades from 1978 to 2005. The authoritarian Party state is no better than anybody else at foreseeing the future, and indeed is probably worse.

In essence, China's approach in these decades was to carry out market-oriented reform, but also to invest in capabilities, single-mindedly pursue national interest, and remain flexible and opportunistic. The capabilities in which China invested were the same as those needed to foster economic growth. Chinese investment in human and physical capital has been very high for the past few decades. China has invested more than 40% of GDP on new fixed capital for every year since 2003. Graduates of junior colleges and universities have grown steadily since 1999 and now graduate over 7 million students annually. On these bases—along with successful market reforms—a trajectory of growth was created that of course had implications for international relations. Strategic opportunism is the watch-word of China's national strategy. As China's capabilities grew, China has spent more and more time gaming out specific international outcomes. While not good at predicting the future, the authoritarian Party state is very good at subordinating the activities of national actors to specific definitions of national interest, which are typically short-term, improvised, and again opportunistic. China doesn't have a plan, but it has a strategy of preparation. We must keep this in mind when we turn to specific industrial planning.

This basic strategy of preparation has persisted through the important changes of the past fifteen years and it has not been fundamentally changed by the recent US-China trade tensions. Indeed, if anything, the aggressive US response to the China challenge has confirmed the Chinese

suspicion that the incumbent power would eventually move to block their rise. They congratulate themselves on their suspicious foresight and are almost completely blind to the role that their own policies have played in triggering what is now a global backlash. This framework gives us perspective on specific changes of policy in the last 15 years, to which we now turn

2. Did China have a plan to achieve a dominant position in certain industries, technologies, or supply chains? If so, in what sectors did it plan to achieve this dominance? Was this reflected in their five-year and other long-term economic development plans over the last 20 years?
3. What are the main features of Beijing's strategy to achieve "indigenous innovation" and global dominance in the industries and technologies of the future? To what extent do these goals involve China taking steps to achieve "decoupling" from the United States?
4. To what extent does Beijing perceive that it needs to supplant the United States in key industries and technologies to achieve its goals? Have these perceptions been reflected in any of China's five-year and other economic development plans over the past 20 years?

In 2006, China released its Long and Medium Plan for Scientific and Technological Development (hereafter LMP). The plan, in its public form, was initially welcomed by outside advisers. It had a broad definition of innovation, and called for strengthening overall innovative capabilities in a way that corresponded to common understandings of innovation. However, tucked inside this broad, contradiction-filled document were three small provisions that would become steadily more important in Chinese policy-making. The first was a call for "indigenous innovation"; the second was a reference to "core technologies"; and the third was the initiation of 16 "megaprojects" that would be the beginnings of a new Chinese approach to industrial policy.¹ In the 15 years since, these provisions have each become more prominent, more specific, and much, much bigger. This turn—gradual at first, but steadily gaining momentum—has put China on a collision course with the United States and the world.

Continuity with the fundamental orientation of strategic opportunism can be seen by examining the strategic rationales which have accompanied successive waves of industrial policy. This can be clearly seen in the three successive waves of industrial and technological policy.

Wave 1: 2006-2010. Based on the concepts included in the MLP, China began to move beyond passive acceptance of foreign investment and the Chinese role in global production networks, which had been the dominant forms of technology absorption through the mid-2000s. Now, China began a concerted effort to invest in domestic capacity and develop command over certain (ill-defined) core technologies, those which Xi Jinping later said "cannot be bought, and cannot be attained by bargaining or by wishful thinking."² Core technologies have never been defined,

¹ Chen, Ling and Barry Naughton. "An Institutionalized Policy-making Mechanism: China's Return to Techno-Industrial Policy," *Research Policy* 45 (2016), pp. 2138-2152.

² Miao Yu {Minister of Industry and Information Industry}. "Strengthen efforts to master core technologies; promoted the development of high quality manufacturing," Qiushi. July 16, 2018. Accessed at <http://www.miit.gov.cn/n1146285/n1146347/n1147601/n1147604/c6260533/content.html>

in part because there is no coherent definition—core technologies are important technologies that China *doesn't* possess right now—and in part because defining them would reveal the priority targets of China's technology acquisition efforts. But this was clearly the beginning of the Chinese effort to expand the scope of their direct mastery of technology, including an effort to build up domestically held intellectual property rights.

At the same time, these intentions were still compatible with a broader developmental impulse and an understandable effort to develop stronger innovation resources and a better environment for innovation. There was no particular rationale for which technologies should be targeted, beyond the obvious, such as semiconductors. The “megaprojects” were 16 specific areas where the government would provide direct research funding. They have no unifying rationale. They are not primarily pure research, but rather applied research in industrial sectors where China might have an emerging comparative advantages. A few—including three undisclosed military projects—have strategic importance, but most are designed to contribute to China's industrial growth. The funding amounts were limited, and there was no coherent strategy for selecting sectors. However, it was the beginning of something much bigger.

Wave 2: 2010-present. Strategic Emerging Industries (SEIs). The formulation of the SEI program in 2009-2010 represented a new departure. For the first time, this was a true industrial policy, in the sense that the state began to provide support for targeted sectors that were expected to lead growth. Moreover, SEIs had a new rationale: targeted sectors were those that were new on a global scale, and as a result, did not have powerful entrenched competitors. Rather than targeting “catch-up” in existing industries, like high-grade steel or gasoline-powered vehicles, the SEI identified areas where there could still be first-mover advantages for late-developing economies like China. These included solar and wind power, electric vehicles, mobile internet, and biomedical engineering. To be sure, these rationales were not entirely consistent: some SEI programs were little more than an *ex post* rationale for the enormous subsidies that the Chinese government had doled out in 2009, during the Global Financial Crisis, and some were existing industries with potentially bright catch-up prospects, such as civilian passenger aircraft. Nevertheless, the SEIs clearly marked a new departure: a response to opportunity presented by technological change, combined with a much more aggressive effort to foster domestic competitors. “Surpass” became conceptually as important as “catch-up.” A popular slogan of the new program was “seize the commanding heights of the new information economy.” These programs have continued and expanded through the present.

Wave 3: 2016-present. Innovation-Driven Development Strategy (IDDS). Within a few years, Chinese planners had become convinced that technological changes were coming together in a distinctive pattern that constituted a new technological revolution. In response, they pulled together a still more ambitious development program they called the Innovation-Driven Development Strategy, endorsed at the highest level of the Communist Party and government. It is important to emphasize that while the program targets “innovation,” what it actually means is technological mastery of a range of inter-related and economically significant technologies. (Innovation just sounds better.) The authoritative document issued in May 2016 can speak for itself:

A new round of global technological revolution is occurring, and sectoral and military change is accelerating....A cluster of revolutionary new technologies that are intelligent, green and ubiquitous has triggered a major adjustment of the international division of

labor,... reshaping the global competitive landscape and changing the relative strength of nations... We not only face a rare historical opportunity to catch up and surpass, we also face the serious challenge that the gap might widen again.³

Thus, we can see that the arrival of a new technological revolution is seen by Chinese policy-makers as an extraordinary once-in-a-lifetime opportunity. It is not that China expects to achieve a dominant position in any single industry. Realistic policy-makers understand that the US still has an absolute scientific and technological edge in virtually every individual sector. But they believe that China has made enough progress in each constituent element of the several sectors that together make up the core of the technological revolution that they can be the dominant actor in the whole space defined by these emergent technologies.

These technologies are “general purpose” technologies, with applicability in virtually every sector of the economy and the military. Mobile high-speed internet; 5G telecommunications networks; ubiquitous sensors and monitors; programmable robots; and artificial intelligence individually and especially in combination have positive productivity implications for every economic sector. That means that the potential spill-over benefits (positive externalities) from these technologies are unusually large, justifying government intervention to accelerate adoption. Moreover, China, they believe, has a unique ability to combine unified management of the Internet, ubiquitous sensors, telecommunications and smart transport/city networks, along with artificial intelligence. The US may be ahead in every one of these individual sectors, but the prospect for the US combining management and control of these networks is virtually zero. Therefore, China has the potential to reap the overall benefits of these general purpose technologies, catapulting it into a position parallel to the United States. At the same time, the negative externalities of these technologies in enabling enhanced government surveillance and top-down control are welcome by the Chinese government and have so far evoked little opposition among Chinese citizens.

To really reap the economic benefits of the technological revolution, however, China has to upgrade its generally low-to-medium technology industrial base into smart, automated factories (“Industry 4.0”). “Made in China 2025” is simply a component of the broader IDDS, but it is important because it targets a weak link in the “new technology” ecosystem. China’s existing industry is huge, cost-effective and fast, but it is far behind the US, Japan, Germany and Korea in terms of process control, complex mass production, and ability to customize. “Made in China 2025” has been especially controversial because it lays out specific quantitative targets that are obvious violations of the spirit and letter of China’s WTO market access commitments.

The emergence of the IDDS illuminates a particularly clear example of China’s adaptation of strategic opportunism to a particular set of international and technological conditions. Chinese policy-makers believe that the Global Financial Crisis was a key turning point revealing the weakening relative position of the United States. Policy-makers have long said that the first twenty years of the 21st century were a period of “strategic opportunity,” meaning that China could grow rapidly under the auspices of the American-led global system, closing the gap with the United States, which should be exploited but without rocking the boat too much. After the

³ Chinese Communist Party Center and State Council, “Outline of the National Innovation-Driven Development Strategy (in Chinese),” Xinhua News Agency, May 19, 2016, accessed at http://www.xinhuanet.com/politics/2016-05/19/c_1118898033.htm

global financial crisis (GFC), though, policy-makers began to perceive additional opportunities. In their view, the GFC weakened the U.S. economically and in terms of the “soft power” attractiveness of the American model. This created an additional opportunity to catch up with and surpass the United States.

This global strategic moment is logically completely separate from the arrival of the technological revolution referenced in the IDDS, and the two have arrived together by coincidence. However, Liu He, now Vice Premier and the crucial brains behind China’s economic policy, has argued that this accidental conjuncture reflects a broader historical pattern. Liu led a small team to study the two global crises of the 1930s and post-2008. He concluded that global crises are generally followed by sudden, sharp re-configurations of global power associated with technological mastery. After 1945, the U.S. emerged as the dominant power because of its technological position and its economic size. Acting as a responsible creditor nation, the U.S. then carefully consolidated its position and constructed a global system in accord with its interests. China today, Liu argues, should do what the U.S. did after 1945: rely on its economic competitiveness and emerging technological capabilities, act cautiously as a creditor nation, but begin to systematically shape global institutions and interactions in China’s interests.⁴ The final step is left unstated, but clearly implies displacing the U.S. as the world’s dominant power. Liu’s approach perfectly exemplifies the way that China’s authoritarian system mobilizes resources to move decisively in response to perceived strategic opportunity.

In addition to the changing strategic orientation of China’s industrial and innovation policy, there have been several key features which have characterized those policies since 2006. I here highlight four features, each of which is dynamic and steadily increasing in importance across the three waves of policy outlined above.

1. Steady proliferation of specific targets and objectives. While the 2005 11th Five Year Plan had a handful of targets and several subsidiary plans, the 2020 14th Five Year Plan will have scores of targets and well over 50 subsidiary plans that will contain hundreds of targets and indicators. To be sure, these are not plan targets in the sense of the old planned economy. There are no general command channels to compel the achievement of a compulsory plan target. However, these targets serve an information and guidance function. They tell local governments and enterprise decision-makers what national priorities and objectives are. They validate the spending of financial resources that are under decentralized control. If an official takes steps to support a local champion or hobble a foreign competitor, and keeps it secret, or invests resources in failed projects, he has been offered some protection if his actions are consistent with the “plan.”

These targets are sometimes absurdly unrealistic, and are often discarded without having been fulfilled. This is a weakness, but also a strength. They can be abandoned, but they still provide valuable information. For example, electric vehicle subsidy programs began in 2009, and the State Council laid out an ambitious plan to produce 500,000 electric vehicles by 2011. In fact, China produced only 8400 electric vehicles in that year (less than 2% of the target). In the SEI in 2010, the government adjusted targets to the more realistic two million new energy vehicles per year by 2020. In fact, production peaked at 1.26 million in 2018, amidst massive unhappiness at

⁴ Liu He, chief editor. *A Comparative Study of the Two Global Crises [in Chinese]*. Beijing: Zhongguo Jingji, 2013. Pp. 39-42.

low quality vehicles and a subsequent reduction in subsidies.⁵ Still an impressive performance, it hardly justifies faith in government planning and targets.

2. Steady and massive increase in financial commitment. China's industrial policy and innovation system is not truly centralized. Moreover, money flows through an enormous variety of channels, which nobody can accurately track. Tax reductions, cheap utilities, accelerated depreciation, cheap loans, easy access to loans, etc., are all being used to foster priority sectors. Each of these existed back in 2005-2006, but primarily as multi-purpose instruments in the hands of development-oriented local governments, or as modest preferences for "innovative" firms. Each one has expanded enormously since 2006, and become more targeted. In addition, of course, China's massive state-owned financial system stands ready to back many types of investment that conform to state plans. China Development Bank has this as its primary mission.

Even more important, however, has been the establishment and massive growth, since 2014, of an entire new category of new government funds.⁶ These funds replicate organizational forms common in the US venture capital sector. There is a managing partner and several limited partners. The managing partner has responsibility for the specific project selection and while limited partners review general strategic direction. Rewards for successful managing partners can be substantial. In most of the cases studied, however, essentially all the partners are state-owned entities. Each fund establishes a fund-raising scope, and brings in limited partners up to the designate fund-raising scope. These funds are massive. By early 2019, the aggregate fund-raising scope of all government industrial guidance funds was well over a staggering US \$1.5 trillion. While not all of the funding has been raised, much less actually invested, the rapid growth shows a new level of commitment of financial resources by the Chinese government. The following Table shows the largest such funds.

Largest Government Industrial Guidance Funds

Fund Name	Level	Scale (Billion USD)
Central SOE Structural Adjustment Fund	Central	50
National Strategic Emerging Industries Fund	Central	43
Qingdao New Growth Drivers	Municipal	43
National IC Fund (Rounds One & Two)	Central	41
Jinan New Growth Drivers	Municipal	36
China Optical Valley (Wuhan)	Municipal	36

Slightly more than half of the funds are designated for broad, multi-sector "high tech" investments, such as SEIs, "new growth drivers," or related. Another 7% are single-sector funds for a specific sector such as integrated circuits. Three-quarters of the funding in the IGFs is controlled by local governments. Although they have strong incentives to display their conformity with the objectives and priorities of national policy, the quality of their manpower is lower, their access to cutting edge technologies is often limited. The IC sector, a very high priority area, shows some important patterns. The big National IC Fund has already raised and

⁵ Vest, Charlie, "Technological Upgrading in China's Electric Vehicle Industry." Unpublished UC San Diego Master's Thesis. June 14, 2019.

⁶ For an overview of this development, see Barry Naughton, "The Financialization of China's State-owned Enterprises," in Yongnian Zheng and Sarah Y Tong, eds., *China's Economic Modernization and Structural Changes: Essays in Honor of John Wong*. Singapore: World Scientific, 2019.

fully invested a first round of \$20 billion, and in 2018 completed raising another \$21 billion. Yet this is a small part of the total picture, since there are about 30 local government IC Investment Funds which are in aggregate larger than the single National Fund.

3. Efforts to combine government steerage with market principles. China's willingness to spend money to foster priority sectors means it can potentially scale back some of the most market-distorting government interventions, such as quotas and prohibitions. Indeed, Chinese policy-makers believe they are doing this. They believe they are creating a new model which is "market-driven, and government guided" (市场主导, 政府引导). Indeed, the "Made in China 2025" program explicitly adopts this principle to guide its efforts.⁷ The term "guided" (*yindao*) has a long history in Chinese Communist usage, and it implies a very strong and concerted effort to lead or guide, so in context perhaps "steerage" gives a better sense of the meaning. The Ministry of Finance describes the national IC Industry Fund as "an organic combination of national strategy and the market mechanism."⁸

It is extremely unlikely that the mechanisms the Chinese government is developing will actually combine market efficiency with government steerage. Government industrial guidance funds have a theoretically efficient incentive structure, but are actually corrupted by implicit guarantees, low or zero target rates of returns, and widespread expectations of ex post forgiveness of debts. It is likely that these funds will lead in the future to financial disturbance or crisis and massive bailouts. However, they show very clearly what Chinese policy-makers think they are achieving. They see themselves as having substantial advantages in a broad swathe of emerging technologies, and they believe that government can foster and accelerate that transition. Because they are willing to spend massive amounts of money, they can achieve those benefits at a fraction of the cost of traditional inefficient government programs. They will spend money, and get the market to supply the progress they demand.

4. Embrace of national champions, whether state-owned enterprises (SOEs) or private firms. SOEs are important actors in China's drive to establish a new technological revolution. However, Chinese policy-makers recognize that the expertise needed to carry through this revolution is predominantly possessed by private companies, especially the Chinese internet giants, Baidu, Alibaba and Tencent (sometimes called the BAT firms). As part of its industrial policy ambitions, the Chinese government has shown a marked willingness to embrace private firms of all stripes, but especially private firms that have already proven their ability to compete successfully. China's government swings behind private firms after they succeed: again, strategic opportunism is the watchword.

The BAT firms are all dynamic private firms, started in collaboration with American venture capital, that sought to combine Silicon Valley approaches with the vast potential of the Chinese

⁷ State Council, "Made in China 2025." May 19, 2015. Accessed August 15, 2018 at <http://www.miit.gov.cn/n973401/n1234620/n1234622/c4409653/content.html>

⁸ Ministry of Finance, Economic Construction Division, "The operation and investments of the National Integrated Circuit Industry Fund are running smoothly," http://jjs.mof.gov.cn/zhengwuxinxi/gongzuodongtai/201508/t20150828_1438798.html. Last accessed August 25, 2018.

market. They are now being brought into an increasingly close embrace with the Chinese state. Since China is willing to spend massive sums of money and work through the market, it is able to bring private firms along with purchasing contracts and regulatory support. Private firms are being initiated into the “national team” by a rich array of incentives. Besides, they don’t really have the option to say “no.” Recently, a set of artificial intelligence “open innovation platforms” have been established, each of them run by a prominent and successful private company. Of the 15 platforms (2019), Alibaba and three companies in which Alibaba has large stakes account for four; Baidu runs the platform for autonomous vehicles; and Tencent the platform for medical imagery. The platforms are a kind of implicit tax on the companies, requiring them to share their expertise, in return for which they receive recognition and status in a designated realm.⁹

The above discussion of Chinese industrial and technological policy can also help us understand Chinese attitudes toward decoupling. These are complex, since decoupling is not a simple phenomenon. On the one hand, Chinese policy-makers do not want decoupling. They understand very well that they benefit enormously from international production and research links. They both profit and learn from their participation in global production networks. Even more valuable are their participation in education and research networks. Chinese scholars have advanced tremendously in science, technology, and technology applications and they are very aware of the consequent growth in their overall scientific and innovative capabilities. The US has also benefitted enormously from the many joint research enterprises carried out with Chinese scholars and students. Chinese policy-makers have no interest in breaking these ties and recognize they will be hurt by their rupture.

On the other hand, in two important respects, Chinese policy-makers have initiated decoupling, somewhat intentionally but partially inadvertently. First, Chinese leaders have created a Chinese internet that is hermetically sealed off from the rest of the world. China’s aggressive regulatory approach to the Internet, and the insistence on national sovereignty in Internet governance comes primarily from the Communist Party’s desire to control speech within China. Google’s exit from China was primarily because of censorship. However, this level of national control created a protected ecosystem within which Chinese internet giants have flourished. The decoupling of the Chinese from the global internet created an environment in which the Chinese government could effectively consolidate its control over domestic speech while also tying dynamic tech companies into a shotgun marriage, in which both sides had a strong incentive to work together. This is a type of decoupling, and China now seeks to export its alternative model.

Second, even though China has benefited more than any other country from the expansion of global production networks (GPNs) Chinese policy-makers have frequently criticized those GPNs and argued that Chinese producers contribute relatively little value-added to high-tech products such as the iPhone. Even though there is now abundant evidence that Chinese firms have been successfully upgrading within the framework of global production networks, Chinese policy-makers have simply ignored this evidence. The fundamental principle of GPNs is that key technological capabilities are distributed among many different economies. In the case of the electronics value chains that are central to this discussion, very important capabilities are possessed by the US, Japan, Korea and Taiwan, and GPNs gain their extraordinary efficiency by

⁹ Ministry of Science and Technology, “Guidance for Work Establishing a New Generation of Open Innovation Artificial Intelligence Platforms,” MOST (2019), No. 265, August 1, 2019, accessed at http://www.most.gov.cn/mostinfo/xinxifenlei/fgzc/gfxwj/gfxwj2019/201908/t20190801_148109.htm

the ability to link these centers of expertise. By proclaiming that “core technologies must be in our own hands,” Xi Jinping launched rhetorical war on the principle of interdependence that lay at the heart of GPNs. This vague proclamation has been accompanied by efforts to pressure multinational corporations to transfer and/or share high-tech production links. Thus, China announced its willingness to use hardball tactics to compel the transfer of as much value-added and technological capability as possible within GPNs.

At the same time, Chinese policy-makers absorbed the lessons of GPNs into their own industrial policy framework. Industrial policy-makers tend to take a “value chain” as a unit of analysis. For example the National Government IC Guidance Fund invested in the best indigenous firms at each stage of the semiconductor value chain (design, fab, packaging, equipment). Do these approaches mean that Chinese policy-makers are willing to give up on GPNs? Absolutely not. It means they want to have it both ways. They hope to foster the continuing presence of GPNs in China—perhaps held there by the attractions of the Chinese market—as a continuing source of technology transfer, while also aggressively squeezing out the foreign links in the GPNs. It shows that Chinese policy-makers value GPNs, but systematically under-estimate the impact of their own aggressive actions in undermining the basis for successful GPNs.

4 / 5. What are the implications of China’s economic and technological development strategy for the United States? In what sectors and technologies does China view itself as weak relative to the United States? In which sectors would “decoupling” jeopardize China’s goals for innovation and tech leadership?

China’s economic and technological development strategy poses a profound challenge to the United States and compels a steady and determined response. At the same time, the nature of the challenge is not a traditional one in which specific industries appear to hold the key to competitive strength. We do not carry out a systematic inventory, as we once did with respect to Japan, to keep score of who is ahead in different industries. If we did, we would see that there is no industry where China has unambiguous technological superiority to the United States, and many where the US has clear scientific and technological advantages. But that traditional form of industry analysis is not as central as it once was.

On one hand, within each industry, there are many stages of production in which expertise is distributed around the world. There are certainly bottlenecks where China is weak, for example in semi-conductors. China is weak and vulnerable in terms of semiconductor fabrication, and even weaker in fabrication machinery. It has notable shortcomings in the area of IP building blocks that are the foundation of complex circuit design in ICs. But China also has strengths in circuit design, packaging and testing, and device manufacture and assembly. In an industry like semiconductors, which the Chinese has repeatedly designated as a core and strategic industry and on which they have spent literally hundreds of billions of dollars without major success, the weaknesses and bottlenecks appear to dominate the strengths. But most crucially, the balance of strength and weakness is something that plays out inside a broad global sector with many players. With a different balance between strength and weakness, this same reality plays out in different sectors, from aeronautics, to precision machinery, to pharmaceuticals and biomedical engineering, to artificial intelligence. There is no single industry that is a magic bullet for China or the source of overwhelmingly strategic vulnerability either. Complete decoupling is simply

not an option either for China or for the United States, and competitive rivalry must be fought out within the compass of complex sectors with many heterogeneous production segments.

On the other hand, the emergence of a new technological revolution, with a new cluster of general purpose technologies, means that rivalry will take place in very broad arenas where industries and standards come together to define huge and complex interacting systems. This will be true in the management of transportation and communications infrastructure; it will be true on the battlefield; it will be true in the operation of financial and payments systems based on emerging Internet-based fintech; and in many other areas. These are not industries in the traditional sense, but rather new forms of large-scale interactive networks. Networks require standards, rules and principles for interoperability. China has spent more time thinking about how to push these networks in directions that support their national interest. The US needs to spend more effort on a parallel exercise.

6. What are your recommendations for Congressional action related to the topic of your testimony?

First, it would be best if we do not make China a partisan issue. China is a long-term challenger with formidable capacity. Its authoritarian system is inimical to ours; it disposes of vastly greater resources than the Soviet Union ever did; and it has a coherent approach to how it deploys its exceptional capabilities. We need a steady and consistent long-run strategy to counter China.

An effective strategy requires the cooperation of our allies, most of whom are just as alarmed at China's aggressive and assertive policies as we are (especially in the wake of the coronavirus experience). In the long run, the most effective response to today's China will be to show them that their assessment of the window of strategic opportunity is wrong, and that they will not succeed in achieving their aims by dividing the world into a group of weak, declining, and squabbling powers. China needs to see that they face an outside world with exceptional innovative and technological capabilities, that is capable of cooperating to produce fair and open global systems. We must ensure that China sees that it cannot hope to achieve unfair advantage inside those systems, and realizes it will be unable to prosper fully outside those systems as well. At that point, there will be an excellent chance that China will return to their traditional pragmatic opportunism, re-assess their options, and change their approach. However, this positive outcome requires a stronger effort on our part.

Second, the US should develop a much more coherent strategy on the development of cooperative and open standards to govern massive information networks, particularly those that regulate smart infrastructure and communications networks. New 5G networks are creating dramatic new technological opportunities as computing moves to "the edge" and semi-autonomous networks spring up in local settings. The US needs to develop those standards as part of the expansion of 5G in any case. Doing so in an attractive, open and international way will have multiple benefits. It will prevent the default global expansion of the Chinese internet ecology driven by Chinese infrastructure investment and expansion of Chinese e-commerce and payments networks. It can provide an attractive alternative to Chinese systems particularly in Asia, where many countries adhere to democratic values and/or are wary of overbearing Chinese

influence. Having a national standards strategy with outreach would give other countries access to open systems for infrastructure, financial transactions, and internet. This effort would also help protect privacy and internet security.

Such an effort is not primarily a matter of hardware, although hardware plays a role. It is primarily a question of creating and enforcing new standards that allow cooperating nations to participate in and reinforce a secure and open network of networks. There is still time to achieve this, and it must be done if we ourselves are to reap some of the benefits of the new technological revolution. It should be an important objective of our international negotiations, as we seek high quality agreements with like-minded countries that include cooperation on regulatory principles for service delivery and fair competition. This should become a national strategic priority of the United States.

Third, we need to make a greater effort to follow the money and create new agreements to control and regulate government spending. China has spent—and often wasted—literally hundreds of billions of dollars on industrial policy initiatives in the past fifteen years, with zero accountability. It is *not* the case that the outcomes from this expenditure have been generally successful and threatening to the United States. In fact, there have been very few unambiguous successes, and many notable failures. China has spent around \$200 billion on semiconductor manufacturing over the past twenty years without narrowing the gap with the United States. This would never be accepted in a country where there was transparency and public oversight over how tax revenues were spent. Still, these recurrent programs, no matter how wasteful, distort the investment decision-making of companies all over the world, create loss-making companies that destroy industry-wide profitability, and handicap healthy innovate approaches everywhere in the world. This expenditure harms our interests whether it fails or succeeds.

The WTO today has elaborate protocols that govern how much a country can subsidize agriculture, placing government support into “green box” (permitted), “yellow box” (subject to quantitative limits), and “red box” (prohibited) subsidies. However, there are virtually no limitations on direct or indirect subsidies of industry (so long as subsidies do not go specifically to the export process). We should begin work immediately on a far more restrictive set of protocols to limit the aggregate amounts and types of subsidy to industry and service providers, perhaps along the lines of what already exists in agriculture.