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China's Efforts in Civil-Military Integration, Its Impact on the Development of China's Acquisition System, and Implications for the U.S.

January 8, 2020

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Abstract

Under the leadership of Xi Jinping, China is significantly stepping up its efforts to pursue military-civil fusion (MCF) as an integral component of its whole of nation development strategy to build a technologically advanced and militarily powerful state within the next one to two decades. This paper examines the making, nature and implementation of Xi's grand MCF undertaking. This paper offers an analytical framework that seeks to provide a coherent and holistic view of the many moving parts and disparate elements of MCF through an innovation systems perspective. This framework identifies seven categories of factors that are important in shaping the structure and process of the MCF system: catalytic, input, institutional, organizational, networks, contextual, and output factors. Key dynamics that are examined in detail in the paper include high-level leadership engagement, the influence of external threats and technology environments, application of new financial mechanisms such as hybrid state-private sector investment funds, the role of key state and military agencies, and the evolution of the Chinese defense acquisition system to embrace MCF. This analytical perspective also helps highlight the barriers to implementing the MCF project, particularly as it moves beyond central level planning to execution within a complex subnational political economy. The paper concludes with analysis of how the MCF grand strategy is impacting China's own military modernization efforts and what the implications are for the United States and its defense acquisition base.

Key Words: China, Defense Industry, Military-civil Fusion, innovation system, state-owned enterprises.

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Introduction

The defense and civilian economies in China co-exist side-by-side, but their relationship has been far from harmonious or close. They are separated by deep-seated structural, normative, and operational dynamics that have limited their mutual interactions and linkages. This division was originally by design. The Communist state's founding fathers wanted to maintain tight secrecy over defense activities and prioritize the forging of the defense industrial base over civilian economic development during the height of the Cold War between the 1950s and 1970s. This rigid civil-military compartmentalization became so deeply entrenched that succeeding regimes in the post-Mao reform era have struggled mightily to bridge this yawning gap--with mixed results.

From Deng Xiaoping in the 1980s to Xi Jinping today, Chinese leaders have pursued an assortment of strategies to straddle the civil-military divide for different reasons. Deng sought to divert large segments of the defense industrial base from military to civilian production to support broader economic development. Jiang Zemin and Hu Jintao pursued an incremental approach of reducing barriers between the civilian and defense economies to promote an expanding overlap of economic activities, such as allowing civilian firms to compete for military orders and permitting defense firms to tap into the capital markets.

Xi Jinping has made civil-military integration (*Junmin Yitihua* 军民一体化), or what he calls military-civil fusion (MCF -*Junmin Ronghe* 军民融合), a key element of his grand development strategy to establish a technologically advanced and militarily powerful Chinese state. He has replaced the gradualist approach of his immediate predecessors in favor of a far more ambitious, high-powered, and expansive strategy that aims to establish a tightly integrated dual-use economy during his reign. To ensure that his goals and vision are carried out, Xi put himself in direct charge of this fusion initiative.

To address the title question of whether Xi can build a truly effective and

integrated civil-military economy, this paper examines the making, nature and implementation of his grand MCF effort. This paper offers an analytical framework that seeks to provide a coherent and holistic view of the many moving parts and disparate elements of MCF through an innovation systems perspective. This framework identifies seven categories of factors that are important in shaping the structure and process of the MCF system. These factors will be examined in detail in the rest of the paper. This paper begins by providing a brief overview of the development of MCF policy in China from the beginning of the 21st Century to its embrace by Xi Jinping during the first term of his rule in the mid-2010s.

Background and Literature Review

Defining Chinese Approaches to MCF

The study of MCF in China is greatly complicated by the lack of a clear definition. This is in part a result of the diversity of MCF activity around the country as well as China's past troubled experience in managing civil-military coordination in the economy. Unlike the U.S. defense sector, which is largely privatized and allows for a more organic linkage of military and civilian work within the same companies, even if the actual work is divided, China's defense industrial base is state-owned and separated from the rest of the economy. The integration of the military and civilian economies in its broadest definition is an effort to remove the longstanding institutional and regulatory barriers between the two systems and fuse them into a single entity able to produce for both civilian and military needs. In reality, however, the two separate spheres interact in highly disparate ways depending on the local political economies in which they are embedded. Many of the terms used resemble their western counterparts but also take on unique characteristics in the Chinese context.

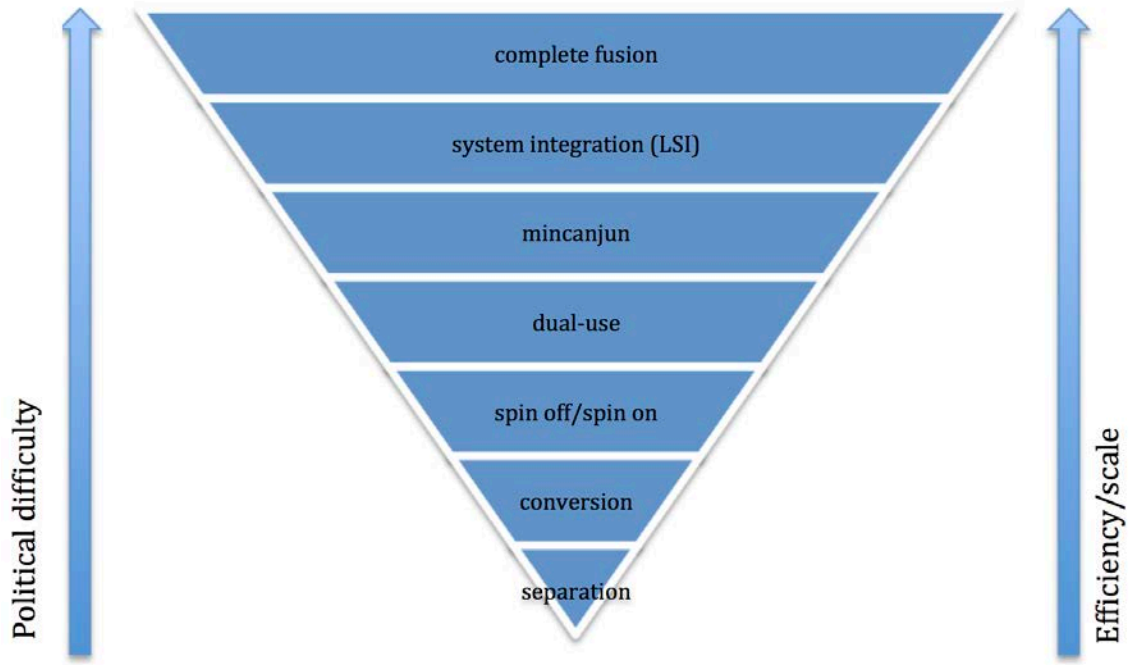

Figure 1. MCF Types

The way MCF is discussed in China can be summarized by grading its related activity on a scale of integration, a MCF value chain if you will, which reflects both the efficiency and innovation gains in the system through collaboration. See Figure 1. At the bottom is a complete division between the defense and civilian economies, a condition that has no integration in the system, is inefficient and produces little collaborative innovation. Although simplified, this was largely the state of affairs in China during the 1960s and 1970s.

The next level is defense conversion (*junzhuanmin)*, which dominated civil-military interaction from the beginning of the reform era (1978) to the late 1990s. With some exceptions, this period was marked by a diversion of excess capacity in the defense industrial base, precipitated by decreased defense budgets while maintaining the sector's productive force. Integration with the civilian sector was low as this was in the main a one-way conversion process. While it helped spare the defense industrial base, efficiency and technological collaboration were low as the sector competed with the civilian sector in low tech, consumable goods.

Since the defense industry reforms of the late 1990s, a number of additional forms of MCF have come to characterize the Chinese economy including spin off (or military to civilian transfer, *junzhuanmin*[1]*)* and spin on (civilian to military transfer, *minzhuanjun).*[2] Spin off is the commercial application of a product or technology originally conceived for military purposes, while spin on is the reverse; technologies developed entirely within the commercial sector and adapted for defense. Both are common in the Chinese economy, which can lead to efficiency gains (particularly with relevant commercial-off-the-shelf (COTS) products). However, while some interaction is inherent in such spillover economic activity, collaboration greatly varies and is often minimum in the Chinese system.

Dual-use activity (*junmin liangyong)*, on the other hand, particularly the Chinese context, implies a closer relationship between the defense and civilian sectors. While some degree of dual-use potential is intrinsic to many

technologies, this refers to science and technology (S&T) programs that intentionally serve both defense and non-defense outcomes. This type of program began in earnest with China's 863 Program in the late 1980s, but has since been a central component of many national innovation projects such as Medium and Long-Term Science and Technology Development Plan 2006-2020, Strategic Emerging Industries initiative, Made in China 2025, Internet Plus and others.[3] While the level of civil-military cooperation required for such programs is substantial, these dual-use programs are frequently focused on particular technologies and limited in their effect in breaking the barriers of separation between defense and civilian participants within these programs, much less the broader economy.

The next level that has become a leading mantra of defense innovation scholars is the so-called *mincanjun,* or the participation of civilian, commercial entities in defense projects. As China's commercial sector increases its investment in research and development (R&D) and its capacity to lead the defense industry in many emerging technologies, the military is looking to encourage their participation in defense projects. Yet, the many barriers to entry that remain in a monopolized defense sector generally limit much of this contribution to third- and fourth-tier component work. It remains extremely rare for non-defense or private enterprises to participate in defense work as first or second tier subcontractors. Thus, *mincanjun* clearly has the potential to produce a higher form of civil-military interaction and incorporate a much larger swath of economic and technological activity for defense purposes. But efficiency and innovation gains will be modest as long as the commercial sector is limited to lower tier participation.

The final phase is marked by a complete fusing of defense and civilian productive forces (*yitihua, or junmin ronghe)* into a single industrial and technological ecology able to produce for both military and the national economy as needed. Such full integration would enable China to achieve maximum efficiency and technological innovation gains. While this unified system is more of a long-term aspiration than an immediate goal, Xi Jinping has emphasized that a

fully integrated or fused 'national strategic system' is his primary policy focus. [4]

Overview of Chinese Efforts to Pursue MCF in the 21st Century

MCF has been promoted in China since the early 2000s but with little tangible success because of a limited leadership engagement, unclear strategy, ineffective implementation, and weak civil-military coordination. Despite the weak progress, Chinese civilian and military authorities have viewed MCF as essential in the drive for original innovation and defense modernization.

Hu Jintao attempted to broaden MCF's scope and pushed for deeper implementation during his tenure between 2002 and 2012, although with limited success. Ultimately, Hu's aim to implement "overall coordination" stalled due to persistent obstacles such as poor coordination among top level decision-making bodies, insufficient regulatory structures to allow transfer of technology between civilian and military entities, poor intellectual property rights (IPR) protection, especially for defense industry-originated IPR, and lack of universal industry and technology standards across civilian and military sectors. While Hu's attempt at top-down leadership support should have been enough to catalyze MCF implementation, it proved insufficient to mobilize all the needed actors and agencies.

Two modest successes of Hu's push were: 1) broadening the thinking on MCF away from its former limited understanding of "combining the military and civilian sectors" [*Junmin Jiehe* 军民结合] to an understanding more reflective of the deep implementation required for "integration" or "fusion" of civilian and defense sectors; and 2) broadening the scope of MCF to include all available economic resources in the promotion of the defense industry, including capital, technology, human capital, facilities, and information.[5]

When Xi became China's supreme leader at the 18th Party Congress in November 2012, MCF was included in major leadership speeches and policy documents to show that the incoming regime would continue to pay attention to this issue. There was little indication of a new direction in MCF policy. The 18th

Communist Party Congress work report issued in November 2012 detailing Xi Jinping's policy agenda for his first term pointed out that the country would "continue to follow a Chinese-style path that integrates the development of the military and civilian sectors, combine efforts to make the country prosperous and the armed forces strong, and strengthen strategic planning, system building as well as related laws and regulations to boost the development of military and civilian sectors in an integrated way."[6]

A year later at the Third Plenum of the 18th Party Congress in November 2013 that laid out an ambitious roadmap of economic reforms, Xi and his lieutenants offered intriguing but vague hints that they were looking to inject new thinking and initiatives on MCF as part of the broader goal of undertaking comprehensive reforms of the economy and military establishment. The Third Plenum decision noted the importance of "promoting the extensive development of military civilian fusion. Establish mechanisms for unified leadership, coordination between the military and localities, linking needs and demands and resource sharing at the national level so as to promote the joint development of the army and the people… and guiding superior private enterprises to enter into areas of military material research, development, production and maintenance."[7] What stood out were the references to the promotion of "extensive" MCF development, creating "mechanisms for unified leadership", and "guiding superior private enterprises" into military activities.

This initial slow public embrace of MCF by the Xi leadership was also reflected in its omission from the early drafting of the innovation driven development strategy (IDDS), the country's new national development strategy, from 2013 to the beginning of 2015. But this apparent lack of leadership attention to MCF was misleading as there was considerable leadership and bureaucratic activity behind the scenes to develop new MCF initiatives. This became evident in March 2015 when Xi designated MCF as a national priority and referred to it as a development strategy. According to Xi, a central goal of the MCF development strategy was to build an "integrated national strategic system and strategic capabilities." The development of such a strategic system and capabilities will

allow China to “implement key science and technology projects and race to occupy the strategic high ground for science and technology innovation.”[8]

Key elements of this national strategic system are detailed in some of the MCF implementation plans that have been formulated since the adoption of the MCF development strategy. This includes the 13th 5-Year Special Plan for Science and Technology MCF Development issued jointly in 2017 by the Central Military Commission Science and Technology Commission (CSTC) and the Ministry of Science and Technology (MoST) that detailed the establishment of an integrated system to conduct basic cutting-edge R&D in artificial intelligence, bio-technology, advanced electronics, quantum, advanced energy, advanced manufacturing, future networks, and new materials “to capture commanding heights of international competition.”[9] This plan also noted the pursuit of MCF special projects in areas such as remote sensing, marine-related technology, advanced manufacturing, biology, and transportation.

Methodology

Framework for the MCF Innovation System

As a starting point, it is crucial to understand that MCF is arguably the most ambitious industrial policy program China has ever embarked on. MCF not only incorporates numerous traditional industry sectors (from shipping to aviation), but the industry chain of each sector including upstream R&D to downstream manufacturing. In so doing, it requires the coordination of an enormous range of bureaucratic stakeholders governing the economy. Additionally, the divide between private and state-owned firms in the economy must be managed for MCF to be effective. As much of China's economy is operated at the local level, a center-local dynamic also plays an important role given the national level goals and actors that MCF embodies. This decentralized system accentuates the diversity of China's economy geographically, a phenomenon that profoundly impacts a coherent national MCF strategy. If all of this weren't sufficiently challenging, underlying all of the above is the separation between the military and civilian systems within China that first and foremost must be tackled for MCF to be conceivable.

One analytical approach to address this complexity and confusion is to view MCF as a hybrid ecosystem comprised of institutional arrangements, organizations, networks, inputs, outputs, and various other factors. This paper applies the notion of an innovation system derived from the systems of innovation and public policy process literature to examine the Chinese approach to MCF. Innovation systems are complex, constantly evolving ecosystems that include "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations".[10] Innovation is of central importance to MCF because its mantra is about finding new or improved ways of meeting defense and dual-use needs faster, better, and cheaper.

A diverse array of factors are involved in the MCF innovation process, and the framework distinguishes seven categories:

- **Catalytic Factors:** Catalysts are the principal motivators of this collosal undertaking and are the sparks that ignite innovation of a more disruptive nature. These powerful factors are normally external to the MCF innovation system and their intervention occurs at the highest and most influential levels of the eco-system and can produce the conditions for enabling considerable change and disruption.
- **Input Factors:** These are material, financial, technological, human and other forms of contributions that flow into the MCF innovation system. Most of these inputs are externally sourced but can also come internally. Resource allocations and technology transfers and talent are important input factors.
- **Institutional Factors:** Institutions are rules, norms, routines, established practices, laws, and strategies that regulate the relations and interactions between actors (individuals and groups) within and outside of the MCF innovation system.[11] Rules can be formal (laws, regulations, and standards) or informal (routines, established practices, and common habits). Norms are shared prescriptions guiding conduct between participants within the system. Strategies refer to plans and guidance that are devised by actors within and outside the defense innovation system.
- **Organizations and Other Actors:** The principal actors within the MCF innovation system and main units of analysis of the framework are organizations, which are formal structures with an explicit purpose and they are consciously created. They include firms, state agencies, universities, research institutes, and a diverse array of organized units. Other types of actors are also involved, such as individuals, and they are taken into consideration.
- **Networks and Subsystems:** Social, professional, and other types of personalistic networks are invaluable means for connecting actors within and beyond the MCF innovation system. Networks provide invaluable means of sharing information, often more quickly and effectively than traditional channels and they help to overcome barriers to innovation such as rigid compartmentalization that is a prominent feature of innovation systems.[12] Subsystems are issue or process-specific networks that link organizations and other actors with each other to produce outputs and outcomes.[13] Numerous subsystems exist within the overall MCF innovation system and they can overlap or be nested with each other. The procurement and research and development subsystems are two of the most prominent subsystems.
- **Contextual Factors:** This category covers the diverse set of factors that influence and shape the overall MCF innovation environment. Contextual determinants that exert strong influence include historical legacy, domestic

political environment, development levels, geographical diversity and the size of the country and its markets.

- **Output Factors** are responsible for determining the nature of the products and processes that come out of the innovation system. They include the production process, commercialization, the role of market forces such as marketing and sales considerations, and the influence of end-user demand.

The remainder of the paper looks at each of these factors in this vast MCF ecosystem that China is attempting to achieve. A comprehensive portrait of this innovation system is beyond the scope of this paper; rather, it will focus on the novel elements that are being forged under Xi's leadership and which are most indicative of its future success.

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Results and Analysis

1. Catalytic Factors: The Role of High-Level Leadership Engagement and the Threat and Technology Environments

Although MCF has attracted attention and support from Jiang Zemin and Hu Jintao between the early 2000s and early 2010s, much of this interest and engagement was sporadic and superficial and lacked sufficient political clout and credible commitment to overcome the difficult structural obstacles that blocked the path of meaningful progress in integrating the civil and defense economies. Xi Jinping's active and sustained interventionalist engagement in MCF affairs since 2015 appears to be having a profound impact in reshaping the dynamics and momentum of MCF policy making and implementation.

Xi's decisive involvement in MCF can be highlighted by two events. The first was his announcement in March 2015 to elevate MCF into a national-level development strategy. Prior to this move, MCF was a sector-level industrial policy being managed by mid-level government and military officials. Xi's intervention quickly catalyzed high-level political and bureaucratic engagement. In March 2016, the Politburo approved a document titled "Opinions on Integrated Development of Economic and National Defense Building" and approved MCF as a national strategy.[14] These opinions formed the basis of the 13th 5-Year Special Plan for Science and Technology Military Civil Fusion Development that was issued in 2017 by the CSTC and MOST.

Another imprimatur of Xi's high-powered MCF involvement was his willingness to become the head of the Central Commission for Integrated Military and Civilian Development (CCIMCD) that was created in January 2017 to oversee MCF matters. Establishment of the CCIMCD was an unprecedented breakthrough with powerful Party, state, and military leaders as members. The CCIMCD will be described in more detail later in the paper.

A second important catalytic factor in promoting major development in the MCF innovation system is the global threat environment, especially technological

threats and opportunities. Xi and the Chinese leadership perceive that the world is currently in the midst of a profound science and technology revolution in both the military and civilian realms and that China needs to be at the forefront of riding this change.

A focal point of this technological transformation lies in the intersection between civilian and military affairs, especially in the information and autonomy domains. These technological revolutions occur infrequently, and in order to take full advantage of this opportunity and leapfrog to the global frontier, the Chinese authorities see the need to have a carefully coordinated undertaking between the civilian and military communities in areas such as artificial intelligence, big data processing, high-performance computing, advanced manufacturing, and robotics. This is being carried out in large-scale industrial and innovation initiatives such as the Made in China 2025 Plan and the Science, Technology, and Innovation 2030 Major Projects Plan.

2. Input Factors: Financial Integration

Input factors are the basic building blocks in the defense and civilian economies needed to advance the goals of MCF. They are tangible 'hard innovation capabilities' and include advanced research and development facilities, firm-level capabilities in R&D and manufacturing, a cadre of experienced scientists and engineers and supporting programs to cultivate human talent, technology transfers, sourced domestically or through international knowledge markets, as well as the availability of funding and investment sources from state and non-state sources.[15] In the case of MCF, it also includes infrastructure projects and markets that create civil-military hybrid industrial and technological clusters. China has made large investments into building up these tangible inputs and infrastructure factors since the turn of the 21st Century and this subject has received much analytical attention.

One of the most significant initiatives of the past few years has been the vast new sources of funding for the defense industry and MCF projects both through the capital markets and government venture funds. Over the past

decade or more, the political and military leadership has come to grips with financial demands of achieving the goals of its expansive military modernization drive.[16] Capitalizing the defense sector, dual-use and MCF activities would require more investment than could be sourced from central coffers. In addition, traditional forms of state-funding--whether from the defense budget, subsidies and loans, or the sector's own profits--perpetuate a high degree of insulation from market forces. Greater opening to the capital markets offers the potential both for a large, new source of financing and the introduction of greater accountability and competitiveness into a closed defense enterprise system. As such, access to commercial financial markets, through asset securitization, mixed ownership reform and government guidance funds, in order to recapitalize and reform the defense industry has risen rapidly as an important dimension in Xi Jinping's MCF strategy. This section will focus on this subject area.

A cursory glance at the state of China's defense technological and industrial base (DTIB) serves as a useful reference point from which to assess the role of financial MCF. The defense sector is in a nutshell, large and growing. It is currently comprised of 11 large state-owned defense enterprises with 1,400 susbsidiary entities, over 300 research institutes and employs over 1.85 million people, comparatively much larger than major western defense firms (Figure 2).[17] Measured by revenue and asset-base ($367 billion and $640 billion), the defense industry in China in gross terms is a thriving sector.[18] Importantly, however, is the rate which the DTIB has grown in the recent past. Figure 2 below captures the overall level of growth of the Chinese state-owned defense sector in the past 10 years. While employee numbers have edged up only modestly, its revenue and asset base have ballooned, in several cases well over 150 percent, much more than its western counterparts, and an amount that could more than double in the next 5-10 years.[19]

The size and growth of the Chinese DTIB is in marked contrast to its meager performance as measured by profit growth and return on assets. Over the past 4 years, while all 11 enterprises have shown profits, they have been modest (averaging RMB 68 billion in the past 4 years), with some exceptions.[20]

More importantly, their average year-on-year growth in profits and return on investment (ROA) have been flat (<1% per annum since 2015), again with a few exceptions in the aerospace and ordnance sectors, while the overall average ROA is a mere 1.7 percent.[21] All in all, the Chinese defense industry, while pronounced in size and output continues to underperform financially and contributes modest profits to its own operations, raising the question of how its large and rapid expansion is being funded.

Figure 2. Defense Industry Growth

Naturally, the defense budget, and in particular the procurement budget, is a substantial source of income for the defense sector (Table 1).[22] However, the growth in the defense budget is abating, reflecting a slowing in the broader economy. Financial transfers, subsidies tax breaks and especially low-interest loans have been the other sources of support and are certainly significant for state-owned enterprises--including the defense industry[23]--but China has made progressive efforts to control direct outlays to these state entities, pushing hard for reform.[24] While these conventional sources of funding are substantial, they do not account for the doubling in size of the defense industry during the last 10 years.[25]

Table 1. Defense Budget 2015-2018 (RMB billion)

	2008-2014	2015	2016	2017	2018
defense procurement expenditure		212	228	241	262
% increase (year on year)	14% ave.	7%	6%	7%	8.1%

Instead, the Chinese government has increasingly turned to new forms of financing to recapitalize the defense industry. These are closely linked to MCF efforts, because these defense monies are being tapped in the commercial and private capital markets. In the late-2000s approval of private investment in the defense sector was granted, laying the groundwork for greater participation of the markets in the defense sector. This trend was slow to develop until the passage of the mixed ownership reform initiative (MOR) in 2015.[26] MOR encouraged the joint equity stakes by government and private shareholders in state enterprises, with the dual goal of expanding the defense industry's capital access and exposing the defense enterprises to greater market forces and thereby accelerating their reform. Moreover, the latest initiatives in defense sector reform have been the restructuring of research institutes, where some of the most productive assets lie. In early 2017, a pilot plan to reform 41 research institutes was confirmed.[27]

Mixed ownership is a vague concept and comes in many forms,[28] but has manifested in the markets in several important ways, the most important of which is what is collectively known as asset securitization.[29] Firstly, defense securitization includes over hundred listed companies on China's primary stock market,[30] most of which are majority controlled by the defense industry groups or other state-owned entities.[31] These companies raised an estimated US$63 billion between 2010 and 2016 through market operations such as selling stocks and bonds, and performing mergers and acquisitions.[32] Another form of defense industry participation in the market has been the rise in asset-backed securities, whereby state-owned non-liquid assets are converted into investment vehicles that can then be sold to intermediary financial institutions to be indirectly traded in primary and secondary capital markets.[33]

The overall asset securitization rate of China's defense industry currently stands at an average of 33 percent, (Appendix 2). An additional boost was given to these transactions with the State Council's release of the "Opinions on Promoting the Deepening of MCF Development of the National Defense Industry" in late 2017, which specifically called on the defense enterprises to greatly expand their market participation. With a current total defense industry asset base of RMB 4.15 trillion ($638 billion),[34] there is the potential to tap an additional several trillion RMB in the market as the defense industry opens up.[35] If the higher predictions of 20 percent annual growth in the defense industry overall for the next 5-10 years is realized, these astronomical figures may not be unwarranted,[36] though many barriers remain to its implementation.[37]

New MCF Funding

Another financial phenomenon that will profoundly impact the future of MCF implementation in China is the tidal wave of government guidance funds (GGFs) that has emerged on the scene in the last 3-4 years (Appendix 3). GGFs are part of a broader state-directed industrial policy to channel national resources into its goals under its 2016 "Innovation-Driven Development Strategy."[38] While these efforts encompass a wide range of traditional and emerging industrial and technological sectors, it consciously links defense and civilian production and R&D capabilities to achieve its goals.[39] Moreover, among the now thousands of GGFs that exist, explicit MCF projects have risen as an important portfolio of many local government sponsored GGFs.

GGFs began in 2008 and were designed as policy funds in areas of industry and technology the government deemed important.[40] These were to act as seed or anchor capital that would attract clusters of subsidiary funds with the participation of private capital—'leveraged social capital'—which would in turn make direct investments in companies that were in the early phase of development.[41] Their growth started slowly, but a rapid uptick in GGFs emerged in 2012-2013 reflecting the launch of the Strategic Emerging Industry initiative during this period, and then peaked in 2015 and 2016, similarly reflecting the

launch of Made in China 2025.[42] Near the end of 2018, there were more than 2,000 such GGFs, which targeted a total leveraged social capital of RMB12.3 trillion (US$1.89 trillion).[43]

While these funds support a wide array of economic activity, a large portion of them go to industrial and technology sectors with substantial overlap between defense and civilian needs or which have explicit dual-use goals in their development plans such as aviation, aerospace, nuclear, electronics, advanced manufacturing and strategic emerging industries (Appendix 6).[44] Moreover, a key goal of the GGFs was the upgrading of technology and infrastructure of state-owned enterprises—including the defense sector. As of 2018, these hybrid funds possibly amount to RMB3.5 trillion (US$517 billion), or 28 percent of the total government guidance funds.[45] The degree to which the GGFs contribute to the defense work specifically is unknown for the majority of them, but even a fraction of the aggregate amount represents a large financial injection into the dual-use economy.

Possibly the most important pattern in GGFs has been the recent rise in MCF-specified funds. These are remarkable both in terms of their recent growth but also with regard to local government involvement, as they have been the primary platforms in establishing them. Virtually every province (and many cities) had set up MCF-dedicated government guidance funds as of late 2018. In aggregate, MCF dedicated funds have amounted to over RMB260 billion (US$40 bn), but are growing fast.

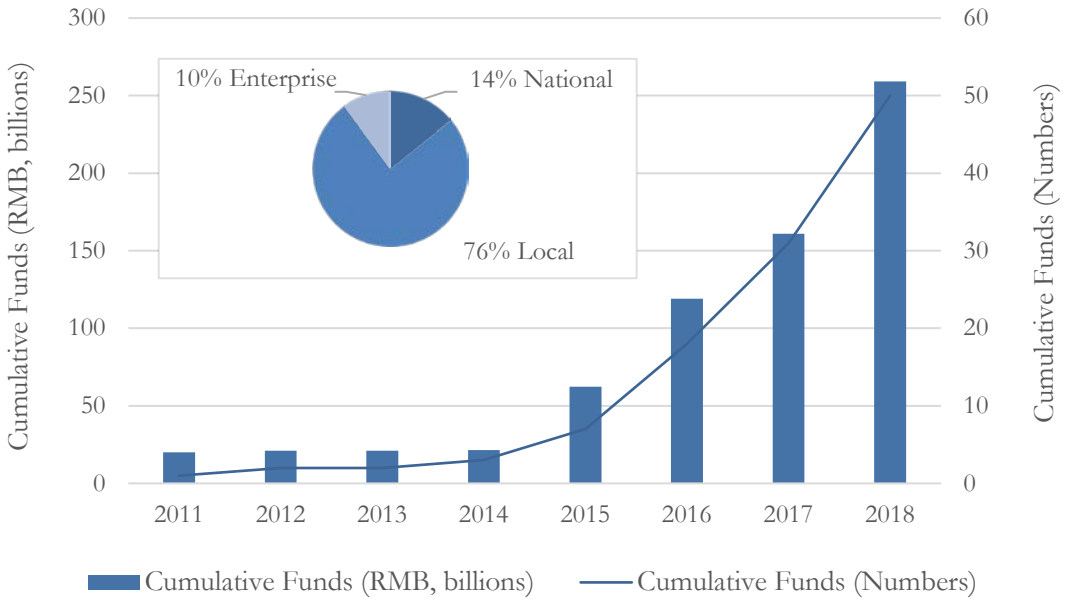

Figure 3. MCF Government Funds

While GGFs represent another huge potential source of funding for MCF and defense-related sectors, their effectiveness as stimulants to the innovation economy has several caveats, particularly in their design to support the SMEs and startups that traditional Venture Capital market was failing to do.[46] In the first place, many of the funds have failed to meet their targets.[47] Moreover, as local governments establish many of the funds, they are geographically restricted, skewing investment incentives toward regional favoritism. This can lead to national redundancy, waste and overcapacity on the one hand, and an under-utilization on the other as many places do not have the projects to invest in, which in turn creates difficulties for attracting social capital investment.[48] Without private capital many of the GGFs have not been invested.[49] The scale and rate at which funds have been established makes it hard for the markets to absorb and invest them.[50] There simply isn't enough expertise in managing large funds, especially for early stage equity investment, which results in a large portion of them managed by government committees and departments.[51] This leads to a conservative orientation in much of the GGF lending, away from seed and early stage firms, as many GGFs were designed to do, and toward growth and mature

stage SMEs and even SOEs.[52]

By way of summarizing the financial landscape of MCF, these new channels of funding in the form of securitization and government guidance funds are significant both in their scale, and in their nature. They represent in aggregate the opportunity for massive financial recapitalization of China's DTIB, but they are being tapped with limited effect on the restructuring and opening up of the defense enterprises to the civilian participation. In fact, the evidence suggests their monopoly position and political status have risen in the past few years. The nature of a state-led investment approach poses inherent contradictions for an MCF economic model that seeks a genuine participation of the civilian private and commercial sectors with the defense sector.

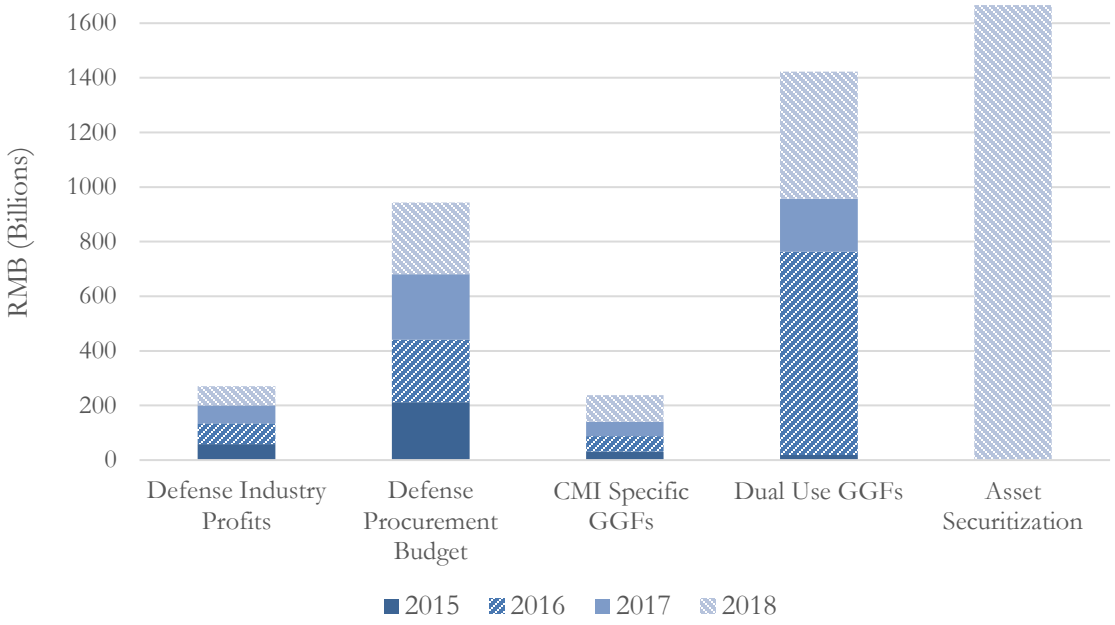

Figure 4. Defense Finances and Resources

3. Institutional Factors: Formal and Informal

The role of institutions is of central importance to innovation systems. Broadly defined, institutions are the norms, routines, habits, established practices and other rules of the game that exit to guide the workings of the system and the

interactions between organizations.[53] These come in formal (such as development strategies, laws and standards) and informal (conventional routines, market incentives, governance norms) variants. The notion of institutions is particularly salient for China's MCF program because of the interplay of so many actors across industrial sectors, state and market entities, central and local governments and civilian and military agencies. Understanding the nature of interactions amongst this panoply of organizations is critical because creating an effective institutional arrangement to achieve this has been one of the most intractable challenges for the Chinese leadership in its pursuit of MCF goal of fostering an innovative and collaborative ecosystem.

Under the Hu Jintao administration, efforts to promote MCF focused primarily on reforms to defense corporations and on establishing a body of regulations, policies, standards and other mechanisms by which to encourage the flow of private-sector technology, talent and investment into defense projects. The work done in building up these institutions is voluminous.[54] The so-called *Document 37,* issued in 2010, is perhaps best representative of this era as it laid the most comprehensive blueprint guiding China's MCF development and still serves as an important template today.[55] In essence, this pre-Xi period laid the *formal* institutional foundations for MCF.

What this phase failed to accomplish however, as pointed out earlier, was to fundamentally alter established social, organizational and cultural patterns of interaction and norms of behavior. In other words, the *informal* institutions relevant to MCF have proven far more difficult to change. Progress was incremental and largely limited to low levels of private participation in defense work, meager technology transfer and dual-use programs that were largely confined to state-owned entities.[56] The problem was a lack of leadership engagement and overarching strategy that led to an ad hoc, structurally misaligned program.[57]

From an institutional perspective, Xi altered the MCF landscape in several important ways. First of all, a raft of new high-level strategies, plans and other

administrative arrangements have been developed following 2015 Xi's decision to elevate MCF to a national strategy that have built on previous institutions and collectively represent a committed effort to reform the defense S&T industrial base and shift behavioral norms and practices. Some of these include the "2015 MCF Special Action Plan" promulgated by SASTIND and the 13th 5-Year Special Plan for S&T MCF Development issued in 2017 (cited previously). These documents build on previous ideas but are much more specific in the sectors and actors involved, and call for closer collaboration between civilian and defense sectors working in these fields. Also, the CCIMCD, in a very short time (four meetings since its establishment in 2017) has also published over a dozen plans, regulations, opinions and laws. Unlike previous institutionalization of MCF, these documents are issued by a superior authority and are directed at both very particular sectors and at lower government levels as well as overarching themes.[58] For instance, "Opinions on Transforming Defense Research Institutes into Enterprises" tackles one of the thorniest issues of MCF, opening up of these secretive bodies. Another calls for establishment of local government MCF leading groups. On the other hand, the Commission is also expected to promulgate a "MCF Development Law" soon, which would enshrine at a supra-national level, many of the fragmented institutions issued up to this point.[59]

A second way in which Xi is altering the institutional environment is by integrating MCF initiatives with the larger innovation-driven development strategy and many of the major national S&T programs associated with it, as discussed in a previous section. By linking strategic plans and initiatives together, and funding resources along with it, the interaction between organizations involved in these pockets of innovation is moving toward a freer, more fluid collaboration and exchange of ideas between defense and government institutions as well as larger private enterprises. This is most apparent in cutting-edge technology fields with strong government support, but it is occurring spontaneously in larger, sophisticated technology centers in China.[60] This indicates a shift in normative behavior or informal institution building.

Similarly, through his high-tempo and wide-ranging production of laws and

opinions, Xi Jinping is not just ramping up a set of formal institutions but he is sending a strong political signal of commitment to a MCF agenda. This is the aforementioned catalytic factor for China's MCF ecosystem, which has impacted the relationship of other factors, as the innovation literature predicts.[61] Xi's support for MCF is coordinated with resource allocations and the research and development system, linking them together, and among other affects, alters the interaction of organizations and changes mindsets and conventional practices.[62] The gradual rise in enthusiasm for experimenting with MCF projects at the local level is an example of this phenomenon. Also, the publication of product catalogues and technology patents also show this change in conventional practices.[63]

4. Organizational Factors

Organizations and other actors in the civilian and defense economies are central factors in the MCF innovation system. They are the vehicles for technological change in that they carry through and facilitate innovations.[64] Collectively, organizations refer to entities that are directly or indirectly involved in supporting a MCF economy, ranging from private and defense corporations, to government agencies, military entities, and the research and development system, but can also be key individuals in the policy decision-making process. Importantly for this discussion of MCF, changes to or the establishment of new organizations can lead to breakthroughs in the types of innovation in a political system.[65] Since the late 1990s, China has shown flexibility in making deep reforms to the organizational and institutional architecture governing its defense acquisition and procurement, leading to far greater innovation within the defense industrial complex. However, creating a MCF ecosystem, which calls for an additional set of actors and institutions, has been more more difficult given the complexity of managing a much broader group of players and interests in China's political economy.[66] A full account of all the organizations and actors that form China's dual-use and MCF ecosystem is beyond the scope of this paper. Rather, it will focus on one of the critical elements catalyzing China's current MCF

innovation eco-system: the CCIMCD.

The creation of the CCIMCD in 2017 under Xi's leadership was an unprecedented move and is the highest such organization in Chinese history to oversee MCF related work.[67] This Party institution was necessary not only to bring together the various civilian stakeholders within the economy, but bridge the two major parts of the Chinese system: the State Council, China's supreme executive body overseeing the civilian national economy and the Central Military Commission, China's leading military institution. Policy practitioners of the civil-military economy in China have long bemoaned the lack of such a supra-organization.[68] Without it, coordination of these two systems of equal rank in China's body politic in the pursuit of a complex undertaking like MCF is doomed to bureaucratic inertia, as previous efforts had demonstrated.[69]

Below Xi, the CCIMCD is populated with around two dozen senior Party, state and military leaders (Appendix 4). This body is distinctive in several respects. First, the high-level authority of the CCIMCD goes beyond a political symbolism (providing only general policy guidance) and appears to have genuine coordinating and decision-making goals.[70] Given that its General Office director is a member of the Politburo Standing Committee, China's highest decision-making organ, it answers directly to that body.[71] This departs from the conventional practice of placing a lower ranking official to head operations of such an entity.[72] Its importance is best represented by the fact that the body has already convened four meetings, issuing important policy guidance on MCF initiatives with increasingly more specific measures to implement MCF across the country.[73] Second, the CCIMCD is also distinctive in that the military has substantial representation in this body with 5 members (members and vice-chairman of the CMC). This is a significant point given that MCF is an initiative that involves the civilian economy. As one NDRC official pointed out, this brings the military within the orbit of operational authority over the national economy, which has traditionally (and constitutionally) been off limits to the military.[74]

Civilian Actors

The State Council, a supra-agency with chief administrative authority in China, holds a number of departments and ministries responsible for MCF. Two agencies are most relevant in this respect: the National Development and Reform Commission (NDRC) and State Administration for Science, Technology and Industry for National Defense (SASTIND). The NDRC is a core department of the State Council (often called the mini-State Council) with wide ranging powers over major national development projects and their funding. Within this commission is the Department of Economic and Defense Coordination is the body most focused on macro level economic planning involving the defense and non-defense sectors, with particular purview over national economic mobilization. However, as only one of twenty-seven departments under the NDRC, its status is modest and claim on resources gives it limited authority in guiding the MCF strategy. With the NDRC's prominent role over economic planning, it also takes a lead role in MCF activity and is a principal in convening meetings.

SASTIND is a relatively lower ranked body but it is the only agency charged with directly regulating the defense enterprises.[75] It is an agency under the Ministry of Industry and Information Technology (MIIT), the large bureaucracy with a purview over industrial planning and regulation. On the surface, this makes for a rational organizational framework, bringing defense and non-defense sectors under one administrative roof. However, the MIIT itself is a relatively weak department, particularly with respect to oversight the defense industrial base. Moreover, SASTIND and its local offices are in reality substantially independent from MIIT both organizationally[76] and in terms of funding.[77] While SASTIND nominally has regulatory authority over the defense industry, the enterprises that comprise it outrank SASTIND in political status,[78] giving it little sway over the defense sector and therefore making it an ineffective coordinator for the goals of the MCF strategy.[79]

A number of other bureaucracies have a degree of input with respect to MCF implementation, including MoST, which plays a central role in the country's

vast national S&T program—including the planning of S&T parks—much of which has dual-use applications.[80] The State-owned Asset Supervision and Administration Commission (SASAC) and its local branches manage and own state enterprises, including the defense sector. In general, their responsibility is to ensure returns on investment of SOEs, but they also have some input in performance evaluation of state-owned sector leaders. The Ministry of Finance (MoF) is also involved with evaluating and funding development projects and supporting industry parks across the country.[81] The State Intellectual Property Office (SIPO)[82] is in charge of patents, intellectual property and technology transfer in China and works with the CMC to declassify defense patents.[83] The purview of each of these civilian agencies overlaps with the defense industry to some extent but their contribution to MCF is indirect and attenuated by the barriers that separate them from the military system.

Military Actors

The structure of leadership over MCF activity on the military side also involves a number of high-level bodies. The agency formally charged with leading this effort is the CMC Office of Strategic Planning (COSP). Originally a third-level organization subordinate to the General Staff Department, the COSP was elevated to one of the fifteen departments directly under the CMC under the 2015 reforms, and is responsible for the overall configuration of defense resources and the inter-bureaucratic coordination needed to realize the PLA's modernization goals, particularly in science and technological innovation. An important task under this bailiwick is civil-military integration and the department houses the MCF Bureau to manage the military's efforts and is the principal contact with State Council departments working on MCF. While this body represents a clear mandate to centralize and strengthen the CMC's strategic management function over military reform and defense innovation, expertise on MCF and the defense industry is in fact spread among several other military organizations within the CMC.

In particular two are important as sources of expertise with regard to MCF.

One of these is the CMC Equipment Development Department (CEDD), responsible for procurement, acquisition and defense R&D. CEDD was formerly a powerful general department,[84] housing substantial expertise in managing defense projects and had the closest relationship with the defense industry sector.[85] It has traditionally been the principal advocate for MCF in the military and supports the MCF Bureau. Another important player in MCF on the military side is the CSTC, a body also promoted in status under the 2015 reforms, reflecting the importance placed on S&T for military innovation. This institution also holds substantial expertise through its traditional relationship with military research institutes in the defense industrial base.[86] The CSTC works with MoST to identify dual-use and MCF collaboration in key national S&T projects, the product of which was a recently published S&T MCF development plan.[87]

Other departments involved more peripherally in MCF include the CMC Joint Staff Department (CJSD), an organ derived from the former PLA General Staff Department (GSD), and in charge of operations and overall command and control of the armed forces.[88] Also the Strategic Support Force, responsible for space, cyber and electronic warfare, has built ties outside the military, signing cooperation agreements with research universities and software development companies.[89] The National Defense Mobilization Department—another body carved out of the former GSD and placed directly under the CMC—is significant in that defense mobilization planning dovetails with MCF efforts in a number of ways, such as the collaboration of transportation and communication infrastructure development projects to meet both civilian and military needs. In this respect, this organization works with its State Council counterpart to coordinate defense mobilization requirements. But it is also significant for its charge over the Provincial Military Commands (PMC).[90] In short, this branch is the PLA's most direct interface with local (provincial governor) leaders on matters relevant to MCF.[91] The most recent organizational addition to MCF relevant efforts under the CMC is the founding of the Military Science Research Steering Committee (MSRSC), an agency launched in early 2017 that is modeled on U.S. DARPA.[92] Its specific mission is as yet unclear but will likely be to identify priority

areas for investing R&D resources in both defense and civilian sectors and thereby help guide national security development plans.

Local MCF Organizations

There are a number of organizational arrangements at the local level that mirror to varying degrees the national institutions for MCF. The norm at the provincial level is a MCF office administered under the local branch of the NDRC or the MIIT. A region dominated by heavy industry or manufacturing may have the local MIIT leading MCF efforts—given their purview over this sector—while a region strong in service industry or science and technology may have the local NDRC or even MoST as lead agency. Unlike at the national level, a local MCF office typically doesn't have a separate leadership and dedicated staff, but consists of a collection of members from relevant local industry, economic, financial, S&T and defense industry bureaucracies that convene to coordinate MCF activities.

It is at the municipal level and below where the operational authority over the local economy lies and therefore much of the actual implementation of MCF is conducted. The organizational architecture leading MCF tends to be highly diversified at this level, with its constituent make up and the lead agency heavily dependent on the make-up of the local political economy. Moreover, there tends to be more duplication of agencies involved in a complex undertaking such as civil-military integration, where many interests and players intersect and require coordination. Similar to the provincial level government, MCF offices are typically administered under local NDRC or MIIT branch agencies. However, in larger cities where districts have substantial administrative power, such MCF offices can be duplicated under their district branch governments, or even in their resident S&T/industry parks.[93]

The Chinese system also includes ad hoc agencies dealing specifically with state-sponsored MCF projects. These are particularly important for smaller interior cities that lack the bureaucratic and economic clout to draw funding and manage the various civilian and defense actors necessary to facilitate MCF work.

The most notable of these is the Inter-ministerial Coordinating Group; an 18-member body led by the vice-premier and instituted to guide Mianyang's S&T City, a park in this city of Sichuan Province designated a national MCF experiment. This body is remarkable for the political investment placed on this third-tier interior city but also that such high-level attention, along with financial support, is required to operationalize the S&T Park.[94]

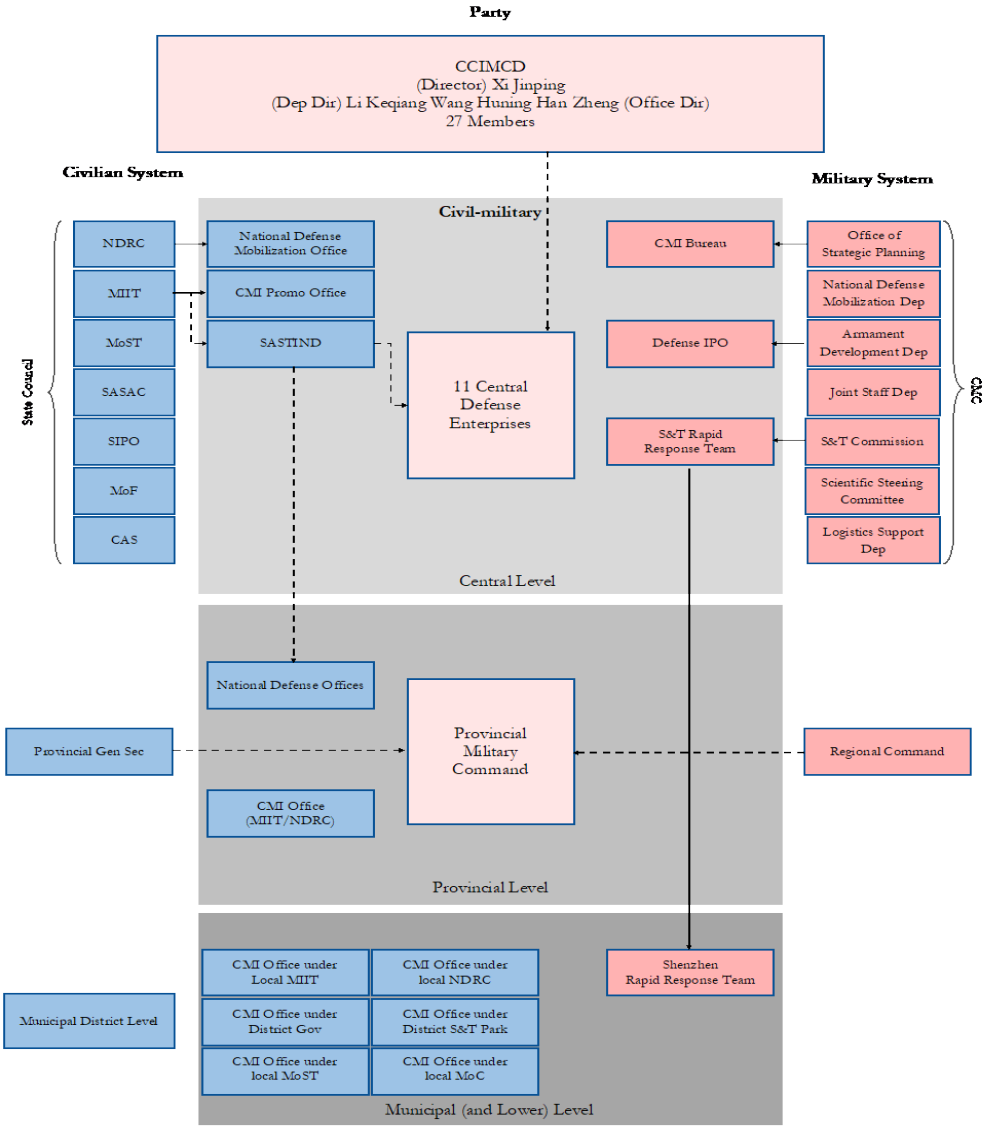

Figure 5. MCF Central and Local Structure

Critique

There are several distinctive features of China's organizational approach to guiding its MCF strategy that point up both strengths and weaknesses in its design. In the first place, the establishment of the CCIMCD serves important functions. With this new institution, led by Xi Jinping, and therefore superior to both State Council and the CMC, the Party leadership has finally resolved a longstanding barrier to joint planning of the defense and civilian components of national economy and S&T innovation system. Second, the formation of this permanent commission, rather than an ad hoc leading group, sends a strong political signal about the top leadership's vision to pursue a long term strategy of MCF and to tackle the fundamental problems in the political apparatus and the separation between the defense and civilian economies that have plagued previous efforts.

Fragmentation[95]

However, while this top-level political championing of MCF has helped focus attention and energy on this national strategy, but it has also led to a proliferation of institutions and planning initiatives at many levels of government. The administrative and functional lines, and their status and authority in decision-making are unclear. In the State Council, for instance, the relationship between SASTIND and the MCF Promotion Bureau—both formally under MIIT—is ambiguous. In fact, SASTIND is the principal regulatory body over the defense industrial base but is notoriously independent from its bureaucratic superior organization. The effectiveness of the NDRC and its subordinate National Mobilization office to coordinate with other offices is also problematic. On the military side, the 2015 reforms have in principle streamlined institutional authority for MCF with the founding of the MCF Bureau under the CMC Office of Strategic Planning. In reality, however, organizational legacies greatly complicate implementation. The MCF Bureau has little specific expertise and must rely on assistance from the CEDDand the CSTC Commission, where relevant competence traditionally was housed. Institutions are sticky and China's

bureaucratic interests have proven notoriously stubborn to reform in the past and there is much evidence to suggest the same is true today. The addition of yet another body to guide R&D efforts in the military sphere, the MSRSC, while impressive on the one hand, raises questions about its distinctive role in MCF, in relation to the MCF Bureau or the CSTC, both of which also has purview over military R&D efforts.[96] In short, the uptick in political commitment to MCF and the rise in organizations dedicated to this effort will help power its implementation but it will also increase bureaucratic bargaining, as China's system has frequently proven in the past.[97]

At the local government level, fragmentation can be even more pronounced because local interests do not necessarily align with central prerogatives, adding an additional element of diversity in implementation, a condition that is reflected by the varying institutional arrangements governing MCF and its related activities. Beijing municipality, for example, has MCF offices under municipal, district government agencies as well as in the Zhongguancun S&T Park (ZGC). Its general MCF office under the city NDRC is largely ineffective due to the competing interests and jurisdictional conflicts of its constituent bureaucracies.[98] As a result, economic and industrial management devolves in large part to district governments, limiting economies of scale that are so important for the success of MCF.[99]

Military Presence

A second feature evident in the organizational architecture is the limited role of the MCF strategy's foremost proponent, the military. While the PLA is substantially represented in the CCIMCD, it has virtually no footprint at the local level. This was not always the case. The PMC (*sheng jun qu*), through its role in national defense mobilization and procurement responsibilities for military region forces had the potential to serve in some capacity as a useful local platform for certain types of MCF activity. And it was this body that the provincial level office, the *paichujigou,* as described in the previous paragraph, would coordinate with in MCF.[100] However, the PMC's purview over local mobilization and army building

was curtailed under the 2015 reforms, effectively constraining the potential of this regional civil-military entity as a platform for MCF.[101] The PLA has an extensive system of military representatives at the local level, however, they are primarily stationed at state-owned and commercial production and research facilities, ensuring quality control and military specifications for equipment contracts.[102] They play an insignificant role in MCF activities.[103] At local level, the military essentially has no direct formal representation to interact with government departments in charge of economic and industrial affairs and therefore has little authority or means to promote a MCF agenda with local development planning.

Defense Enterprises

A third distinguishing feature here is the central role of the state-owned enterprises in China's defense industrial system. Eleven major defense firms control and operate the majority of China's defense sector research, development and production. Despite ongoing reforms to transform their historically closed off nature—mixed-ownership reforms—the defense industries have so far remained resistant to fundamental change. As described above, these state-owned firms have grown in size and strength under traditional funding and income sources, and continue to capture new forms of resources through industry guidance funds and their asset securitization schemes. Moreover, their political profile has also risen rapidly over the last ten years. With each of the past four Party Congresses (16th to 19th) the number of senior defense industry cadres admitted to the Central Committee has roughly doubled, and seventeen now sit in the 19th Central Committee. (Appendix 5).

Their dominant position in the defense political economy arena of China's system means that they will be instrumental in the outcome of an integrated national development plan that the MCF strategy envisions. On the one hand, these large defense entities are corporatized and fall under the authority of the State Council. The MCF Promotion Department under MIIT develops defense industrial and S&T standards needed to integrate civilian and military products.[104] SASAC, the owner and manager of state-owned assets, ostensibly has some

involvement in setting performance requirements for enterprise managers. However, neither has direct authority or control of the defense industry enterprise operations and real power over them lies within the Communist Party.[105] Since the CCIMCD has not yet been replicated at lower levels of the political system, there is a large power differential between the defense enterprises and the much lower ranking local governments in which they reside, making comprehensive planning needed for MCF arduous.

5. Networks and Subsystems

China's MCF infrastructure is heavily dominated by traditional and formal organizations and institutions, many of which are described in this paper. In fact, the formation of government bodies and the crafting of laws, regulations and planning guidelines are a particular strength of China's state-centric model of industrial policy making. However, as the literature makes clear, networks and subsystems are the 'interstitial connectors' that link actors and processes in the innovation ecosystem and are crucial to mitigating compartmentalization and enhancing information sharing and technology diffusion.[106] Until recently, there has been an absence of such platforms in China's MCF system, a product of its statist approach, and exacerbated by issues such as secrecy, historical legacy and unclear IPRs and the monopolistic behavior of its defense firms. However, that is changing and one of the most exciting new developments in China's MCF efforts is the emergence of a range of novel mechanisms that are enbabling these crucial linkages in the system.

Most prominently are the numerous web-based portals that are appearing both at the national and local levels. The much heralded PLA's Weapons Acquisition Information Network (WEAIN), launched in 2015, provides information on the country's weapons and armament needs, relevant policies, procurement notices.[107] As of early 2018, it has attracted over 16,000 registered entities and listed more than 4,500 technology procurement notices.[108] Moreover, the site also holds over 3,000 defense patents that were declassified in 2017 as part of an effort to increase transparency and encourage the private sector to

engage defense research and production—although there is skepticism as to the utility of this patent release to fostering civilian participation in defense work. [109]. Many local governments and S&T parks have founded similar online platforms.[110]

Another example of new ways in generating cross-linkages are the proliferation of exhibitions where civilian and military enterprises gather to show off technologies and exchange information. The Zhuhai Airshow is the most visible of these, but virtually every major S&T center convenes these events to demonstrate new dual-use projects and burgeoning MCF areas as well as facilitate a two-way channel of communication between private and defense enterprises. SASTIND has been the leading agency in holding exhibitions, but the PLA has also shown increasing interest in directly participating.[111]

The designation of national MCF demonstration bases has also been a prominent strategy to foster interaction between defense and civilian activities. As of mid-2018, there were 32 such bases in 22 provinces and cities around the country.[112] These are important because underlying this strategy is the notion that spatial proximity is key to technology diffusion. Industry clustering fosters a higher degree of interconnectedness that encourages spillover in technology and knowledge—between defense and commercial firms—thus stimulating productivity and innovation.[113] However, the success of these experiments have been the subject of much debate as the quality of the output in these bases have come under scrutiny[114] and with several high profile failures.[115]

One of the most notable developments in China's MCF economy are the intermediary entities that are on the rise in many local governments. These range from government to quasi- and even non-government institutions, which provide an array of liaison, research and consulting services to facilitate information exchange and interactions between civilian and defense actors in the local economy. Such organizations are especially active in thriving economic centers where industrial and technological complementarity with the resident defense industry is higher. These intermediaries are unique in that they either have

experts in-house that have defense industry backgrounds or their staff include retired military officers familiar with defense procurement and acquisition practices.[116]

In Shenzhen for example, a plethora of 'industry alliances' have surfaced that help pool its many small and medium-size enterprises into groups that can better interface with defense and military organizations.[117] 'Research companies' have also formed between defense industries and commercial enterprises that provide valuable information for both sides to identify promising areas of collaboration. But most unique to Shenzhen's experiment in MCF is the platforms of a non-governmental nature that have emerged. For example, the Huachuang Science and Technology Industry Transfer Center brings together experts from the PLA armaments departments, the defense industry and Shenzhen's high tech enterprises to help consult on technologies applicable to military fields. The Huachuang Center is a self-described NGO, "a third party and independent, non-profit organization."[118] This makes it unique in that it is permitted to exist and operate in a space that is traditionally the purview of the government departments.[119]

Such organizations are popping up around the country. In Beijing for instance, the Zhongguancun MCF Industry Alliance, has over 600 members, is involved in hundreds of projects.[120] This is a successful quasi-government alliance that represents firms in the city's sprawling science park, making it the largest group of individual small and medium-sized technology enterprises engaged in MCF at some level. Its ranks also purportedly include a number of defense industry companies, SASTIND and many military organizations under the Central Military Commission.[121] Another notable example is Institute for MCF Research under the Haidian district government.[122] This entity is meant to represent thirteen PLA agencies in presenting defense requirements and specific standards so as to attract and identify high tech companies able to perform defense work.[123]

In sum, these various platforms that are making their debut in the past few

years largely fall outside the conventional actors and institutions of the MCF system. Yet, they constitute a vital enabler for MCF implementation in local economies where the threshold for the majority of commercial and private enterprises is too high to engage in defense work. The provide the connections between the notoriously separate defense and civilian parts of the economy. These emerging entities are helping generate the bottom up collaboration that will be essential if MCF is to succeed.

6. Contextual Factors: MCF Implementation

This category comprises a set of conditions that shape the environment in which MCF happens. In this sense, they are usually broader in scope than other factors (such as inputs and formal organizations) and cover political, institutional, and even ideational aspects of an innovation system.[124] Using the framework of contextual factors is especially useful when examining China's MCF efforts around the country at local levels, where much of the implementation occurs. The complexity of China in terms of geographical diversity, levels of development, governance structures and historical legacies dictate that MCF will be carried out with a high degree of variance in form and substance. And the aggregate of these contextual factors help understand the specific operating environment of MCF and the different outcomes that it leads to.

The set of conditions that impact MCF implementation can be summarized under several overarching variables, which, while not comprehensive, aid in deriving general models and are important indicators of their relative success. The first is what may be called complementarity between the local economic and political context and the resident defense entity. In order for collaboration between the defense and commercial sectors to occur, a local economy must be sufficiently competent (in either industrial or technological aspects) in providing what the defense sector requires; or vice versa, for the defense sector to integrate with the local economy, it must be able to produce goods and technologies the commercial sector demands. Complementarity can include natural endowment in resources or geographical location, or acquired

endowment in political, technological, industrial or financial resources. These conditions vary immensely from region to region and hugely impact the type and degree of MCF that is conducted by a local government.

A second variable that is unique to China's system is the role of center-local relations. The objectives of a national MCF strategy are not always aligned with local development priorities and properly structuring incentives for civil-military collaboration is almost without exception a difficult center-local exercise. The center-local dynamic is also manifested in other ways. China's political system is sensitive to rank and status within the party and government structures. This hierarchy of power and position comes to be an important factor for MCF implementation because the defense industrial enterprises, as central, monopolistic institutions with immense influence at the political Center, are difficult to manage by local officials who are much lower in status. This differential in political power frequently makes coordination and planning in economic activity between commercial and defense entities a challenging process.

A final variable affecting MCF implementation is the notion of governance. In general terms, this is the local government's ability to mobilize and effectively utilize its natural, financial, economic and political resources to pursue a policy agenda—in this case, MCF. In other words, how well a local government can parlay its particular economic and industrial strengths into effective implementation of MCF has an important governance dimension. Naturally, this ability is constrained by the factors of the first two variables, but regional mindsets, cultural proclivities and government action can profoundly alter policy outcomes, which is particularly true in China where there is great diversity in governance approaches and effectiveness.

These variables interact dynamically across the national landscape and shape the implementation of MCF in myriad ways. This complexity at the national level does not lend itself easily to gross assessments, however, there are three relatively coherent models of a MCF economy that can be identified, and which are useful reference points for understanding the diversity of MCF

implementation and the strengths and weaknesses of different regions.

MCF Models[125]

The first model is best represented by China's legacy Third Front areas. These cities are located in China's western interior provinces such as Sichuan, Guizhou, Shaanxi and Gansu, and were allocated important defense industrial assets in the 1960s and 70s for strategic rationales.[126] In this model, complementarity is often low because despite significant defense industrial endowment in these regions, the local economies often cannot match them in productive capacity or technological sophistication. Mianyang, a remote city in Sichuan Province, is a quintessential example of this model. Its local economy does not adequately complement the resident defense industry, the Chinese Academy of Engineering Physics (CEAP)—China's nuclear weapons designer and manufacturer. This is true, despite the fact that Mianyang was China's first designated MCF Park (called S&T City) and granted significant financial and political investment.[127] The disconnect between the defense industry and the local economy is caused by the glaring power imbalance between the two. The CEAP, as a central institution ranks much higher than Mianyang, making local development planning difficult. Finally, local governance is notoriously poor. As a backwater, third-tier city, bureaucratic torpor is a common complaint by resident businesses. An Inter-ministerial Coordination Group (mentioned above) was formed to overcome political and economic barriers and facilitate the operation of the S&T City, but success has been modest, despite official rhetoric to the opposite. As a result, MCF in this model is typified by a low level of civil-military integration and dominated by defense conversion, where defense enterprises unilaterally spin off subsidiaries to produce for commercial markets.

Vibrant coastal regions with open markets and a strong commercial sector in either industry or science and technology best represent a second model. The exemplar city in this archetype is Shenzhen, one of China's fastest growing cities with a highly dynamic economy of advanced manufacturing and emerging technologies that the military is keen to exploit for its military modernization

program. It is also home to some of China's largest high-tech companies like Huawei, ZTE and Tencent. In this respect, Shenzhen's industrial structure complements many high-end military needs—in its drive to achieve 'informatization'—and even has the potential to do higher-tier participation in defense programs. Yet, the city is devoid of major defense industry enterprises and their research institutes, constraining its ability to collaborate with this sector. Shenzhen's relations with the central government also gives rise to conflicting incentives in serving MCF goals. On the one hand, its freewheeling, experimental mindset that evolved under its designation as Special Economic Zone since the early 1980s has been the root of its economic success. But this process has also begotten a degree of independence and distance from the political Center, demonstrated by a lack of central institutions such as state-owned enterprises, a government sponsored R&D base, or even key universities, all of which hamper its ability to implement MCF. The city's governance style is touted as 'small state, big society,' which also serves its competitive, market-oriented approach.[128] Political and economic entry barriers to the defense system are high for private and commercial firms and require strong governmental support to overcome them. Thus, a minimalistic government is a handicap when it comes to managing the civil-military relationship. As a result, while this model offers substantial gains for defense in terms of component supply and discrete technological participation, but there is little evidence to date that higher-level integration is occurring in Shenzhen.[129]

A third model is characterized by large metropolitan centers with high levels of central government investment, S&T capabilities, industrial diversity, robust commercial markets and a substantial defense sector. These cities are the political and economic backbones of the Chinese system and are important national centers of development. Beijing is the most important example given its overwhelming endowment as political, scientific, educational and defense industry center of the country.[130] In fact, the capital's enormous potential to conduct comprehensive MCF serves to highlight the inherent flaws in its political economy and some of the most enduring obstacles to MCF implementation in

China. For example, Beijing's economic and industrial complementary is almost complete with respect to the defense sector, particularly in terms of basic S&T innovation. Yet, broader collaboration between the defense monopolies and rest of the economy remains stubbornly modest. Technology diffusion across the system, a good measure for integration levels, has only marginally improved in the past decade. Cooperation with the defense entities certainly exists on key S&T and dual-use projects, particularly when they involve state-led R&D centers and key research universities. But efforts to establish larger institutional platforms where the commercial and private sector can collaborate with its defense counterpart have met with limited success.[131] A major contributing factor for this is the fragmented nature of Beijing's governance structure.[132].

The product is a segmented political system that makes comprehensive planning and economies of scale—that are important for MCF—difficult to achieve. Beijing's dual identity as a capital and a local government also hampers its governance style as the vision for the city as a national center clashes with development strategy of the local economy.[133] The resulting MCF activity throughout the city is still substantial given its vast resources—industrial and technological—but is not without vast inefficiencies due to the city's political economy context. By and large, Beijing's MCF activity comes in many forms, from conversion, to spin-off, spin-on, and even participation of the non-defense sector in components and R&D. However, it is in the main piecemeal, ad hoc, top-down and fragmented rather than broad-based, institutionalized and bottom up.

Table 2. MCF Models

	Region	Rep City	Variable 1	Variable 2	Variable 3	MCF	MCF
	characteristic		Complementarity	Center-local relations	Governance	Implementation	Dominant type
Model 1	Interior, Third front	Mianyang	Low	Imbalanced	Low	Low	Level 2, 3
Model 2	Coastal, commercial,vibrant	Shenzhen	High/low Mix	Autonomous	Mixed	Moderate	Level 2, 4
Model 3	Political/econ Centers	Beijing	High	Fragmented	Mixed	Moderate	Levels 1-4

7. Output Factors: Measuring Implementation

Output in the context of defense innovation and the systems innovation literature is broken down into a number of archetypes, that range from simple copying at the one end to sophisticated disruptive innovation at the other, in the pursuit of "a transformation of ideas and knowledge into new or improved products, processes and services for military and dual-use applications."[134] The notion of output for a MCF economy must differ to an extent because one is not just looking at technological innovations emerging from the system, but the level of collaboration and integration between the civilian and defense sectors that generated the output. In other words, the relational dimension of the civil-military axis is decisive. Therefore, as emphasized throughout this paper, institutional, network and governance regimes are important factors in measuring outcomes in the MCF innovation system.

As a previous section laid out, there are many forms of civil-military activity conducted around the country that fall under the larger rubric of MCF. If conceptualized along a continuum, higher value types of MCF reflect closer collaboration and lead to greater efficiency and innovation gains in the system but they also become more challenging politically as an increasing array of organizations and institutions become involved. These extend from defense conversion with little or no integration on the one extreme to organic fusion of defense and civilian economies on the other (see Figure 1). The current state of MCF is the widening participation of the commercial and private sector in the defense economy (*mincanjun*), though primarily lower (3rd and 4th tier) component supply in addition to discrete, or stand-alone technologies.[135] Quantifying MCF along this value chain is a direct way to measure output of a MCF innovation system.

The problem in measuring MCF output based on this formulation is a paucity of data that stems from the complexity of system as well as secretive and closed nature of the defense industry.[136] A second difficulty is the lack of specificity in documenting the nature of MCF conducted. This is partly for a lack

of commonly held yardsticks when reporting MCF figures, but many local governments and agencies that benefit from "MCF output" are also incentivized to exaggerate figures. For example, in 2015, Mianyang's Party Secretary boasted a MCF output of RMB150 billion, amounting to a seventy percent "degree of MCF" in its S&T City, which was obtained by dividing S&T City's output by Mianyang's total.[137] Many other cities and provinces use similarly crude methods. Without further specificity, such measurements are virtually devoid of significance in both qualitative and quantitative terms because much of that output is simple defense conversion—a defense industry producing low-tech goods for the civilian market—and frequently by firms that are only remotely associated with the defense sector.[138]

That is not to say that all figures published by the government are meaningless. Many MCF reports and white papers put out by government and military agencies provide some quantification, but these are usually top-line figures. For instance, National Defense University's annual MCF bluebook[139] and the Armament Technology Academy[140] report that two-thirds of enterprises approved to do defense work are civilian and a third of those are private firms.[141] The PLA reported recently that by the end of 2017, almost 10,000 firms and over 700 high-tech firms had "entered the ranks of national defense and military construction." These headline numbers are impressive on the one hand, but they represent a miniscule percentage of their respective totals.[142] These figures quantify civilian participation in the defense sector (*mincanjun)*—which is not large—in the most macro sense, but there is no discussion of quality, such as information that would help one gage an enterprises' engagement with the defense sector--R&D, production, design, subsystems, or component off the shelf sales. Sporadically, reports on the level of MCF are also released regarding individual projects, such as China's indigenous aircraft carrier, which apparently was the result of 80 percent civil-military collaboration.[143]

Other, indirect quantitative methods of measuring output are also possible. One proxy for civil-military integration is technology diffusion, which is particularly useful for cities with both a vibrant high-tech market and an endowment of

defense industry and government research institutions.[144] Joint patent activity and joint science and technology paper publications between these actors are frequently utilized to study collaboration in Beijing's innovation economy. Other ways of examining knowledge flow and technology diffusion include the use of patent citation analysis.[145] Although much of the registered patented technology falls into the dual-use realm, all of these methods are imperfect yardsticks, as much of the data is not specifically defense oriented. The release of 3,000 defense patents has provided some bases on which to measure MCF but is also vulnerable to selection bias and incomplete data sets.[146]

A more fruitful approach to measuring MCF progress and impact is qualitative in nature and borrows from the U.S. defense industry concept of the lead system integrator (LSI)—corporate prime contractors that bring together components, subsystems and software to build a weapons platform.[147] Viewing MCF's success through this lens highlights the importance of many of the factors discussed in the systems innovation framework. A Chinese LSI from the private, corporate sector would represent a disruptive innovation at the institutional, political, bureaucratic and economic level. Given the powerful position of the defense conglomerates, discussed earlier, the presence of an outside system integrator would clearly indicate a high level of political support by the leadership. Moreover, LSI would demonstrate genuine change in the monopolistic position of the defense enterprises and a more effective institutional and governance regime to implement collaboration.

A range of fields in high-tech, disruptive technologies where China is seeking to become globally competitive—and even a leader—are receiving increasing analytical attention. These include from robotics,[148] to artificial intelligence,[149] quantum computing,[150] aerospace,[151] nanotechnology,[152] new materials, drones, high performance computing[153] and others.[154] In many of these, the private corporate sector is beginning to engage seriously in MCF. This engagement ranges from technology contribution, co-licensing as well as partnerships in R&D, such as Baidu has done.[155] It is clear the military and defense sectors are able to leverage significant amount of technology and know-

how from these projects. What is less understood is the degree to which firms are actively participating in these CMI projects or acting as system integrators. Government R&D institutions such as the Chinese Academy of Sciences and defense enterprises, such as China Electronics Technology Group, continue to play an important role. Moreover, beyond these important but specialized technology programs, with their high-level government attention and funding, private enterprises role in defense programs is limited to lower tier component supply. Measuring the level of participation would require deeper corporate profiling.

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Conclusions

This paper represents an attempt to address the basic question of whether Xi Jinping can build a genuinely integrated civil-military economy. The scale and complexity inherent in this undertaking makes a precise answer highly challenging. We have sought to ameliorate this by looking at MCF using a general framework of systems of innovation and public policy process that is well-developed in literature. Through this prism, seven factors are identified as crucial to establishing an effective MCF innovation ecosystem: catalytic, input, institutional, organizational, network, contextual and output factors. Based on this framework, we can draw some conclusions about the most critical determinants if Xi is to succeed.

The first thing to consider here is which factors are essential and which are secondary. Catalytic factors—external threat environment, Xi's leadership of MCF and the urgency in military modernization brought on by the RMA—sit atop the hierarchy. These are the principal motivating elements that are able to drive the enormous change that must take place, the scale of which is unprecedented under a MCF regime, with regard to multiple bureaucratic, political and economic interests. It is implausible to expect such encompassing reform in the absence of these conditions, a point that is reinforced by China's prior failed attempts at MCF, when such catalytic factors were not in place to create an effective system. This is especially true in terms of Xi's leadership. Xi's continued and active long-term engagement in MCF affairs will be crucial to ensuring the forging of a truly integrated and effective MCF innovation system. This appears to be the case, given the level of attention he has given it. However, if engineering a MCF ecosystem is a long term process spanning decades, as many argue, this raises an important issue of policy continuity beyond Xi Jinping's rule. If his successor fails to prioritize MCF with national strategic importance the way Xi has, its implementation will likely flounder or be only partially realized.

Below this, network and subsystem factors will be critical as well because they are instrumental in producing MCF at the inter-firm, inter-industry and inter-governmental level of the economy. The top-down, traditional methods of managing the defense RDA apparatus has led to a compartmentalized, closed-off system, stubbornly resistant to reform. There is promising change here: a MCF-specific subsystem that includes allowing private sector firms to be vetted and approved for bidding for defense work, setting up an acquisition website to provide details of work programs, patent and product catalogue registries, and developing a more transparent acquisition governance regime. These add up to a new MCF acquisition regime that is different from and bypasses the existing monopoly-oriented acquisition system. Its success will be a crucial determinant of progress in MCF. Also, the traditional system will have to give way to new and informal practices to forge MCF forms that are entailed in networks and intermediary platforms which provide invaluable liaison and consulting services. These are key to establishing the linkages across firms, government agencies and sectors, to overcome barriers to innovation. Moreover, as this paper has sketched out, much of this work between actors in the MCF ecosystem is operationalized within the local environment, which is fraught with political, structural and economic contradictions. Thus, the success of networks and subsystems embedded in the larger MCF ecosystem constitute a bottom up integration that will be foundational if MCF implementation is to be effective and sustainable.

Third, institutional factors, particularly informal ones, will play a decisive role if an effective MCF ecosystem is to emerge. China has established a substantial body of laws, regulations, plans and strategies to guide greater integration between defense and civilian economies. However, parlaying these institutions into informal norms, practices and behaviors toward the goal of MCF is a much harder and time-consuming process. A particularly salient example that has been elucidated in our field research is the governance system of many localities that are trying to carry out MCF in their economies and/or S&T parks. Most local economies in China have the potential to engage substantially in MCF

activity and all are governed by a similar set of formal institutions set out by the national and provincial governments. Yet each implements MCF with great variation and degree based in large part on quality of governance and a local government's ability to effectively mobilize its political, financial and social resources.

A final point on viewing Xi's likely chances of creating a MCF economy from this conceptual framework has to do with the relationship between the factors, not just each individually. How the various factors interact influences not only the level but the type of innovation. Under Xi, China fits the profile of a "rapidly catching-up regime". It has many of the same absorption-oriented factors found in "incremental catch-up regimes, characteristic in under-developed countries, but a key difference is that catalytic factors, especially leadership support and threat environment are closely linked with input factors such as resource inputs and instititutional factors like strategies and plans. Moreover, many more of the factors are engaged in the MCF innovation system. However, the factors that promote a deeper MCF economy—such as bottom-up and informal institutions and networks, as well as effective governance regimes that encourage much closer collaboration between the defense and civilian economies—remain in their infancy.

Xi Jinping has crafted some essential elements of the MCF economy, and the trajectory is positive, but the telltale signs of deeper integration of the defense and civilian economies remains limited. Various forms of MCF are evident throughout the economy, from conversion, to spin-on and spin-off and a variety of dual-use programs. But broader involvement by the civilian commercial sector largely remains stuck in a 3rd and 4th tier technology and product component level of *mincanjun* with a few exceptions. The real measure of success of an effective MCF system will occur when barriers to higher forms of collaboration take shape through bottom-up institutional factors and market-based governance regimes leading to civilian enterprises performing higher tier and even systems integration defense work.

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Implications for the U.S.

A central goal of China's MCF strategy is to develop and acquire weapons 'better, cheaper, faster'. The trajectory of that effort will have far-reaching consequences for the U.S. ability to manage the military balance with China. The defense industrial complex itself has, since the turn of the century, greatly improved in its own ability to produce more advanced weaponry. Moreover, state-directed and funded institutions, especially Academies of Science and Engineering, national labs, and defense universities, and to a lesser extent civilian universities represent an important *civilian* body of capabilities that have certainly helped transform China's research, development and acquisition system.

But all the available evidence strongly suggests this has come at a high cost. In aggregate, this state-led defense and civilian sectors capture enormous amounts of national resources, but they are highly inefficient.[156] In short, the system has become better and faster, but not necessarily cheaper. The fact that MCF has been elevated to a national strategy with a sense of urgency precisely at a period when China is making huge strides in its military modernization suggests the leadership views a fix to the inefficiency of the system as essential to sustain this trajectory. However, the goal to fix this—facilitate the participation of China's robust private or commercial economy in defense building—has only begun to achieve results, and its prospects for successful implementation remain highly uncertain despite its high-level attention at the Center. Private and commercial sector engagement in defense acquisition and procurement programs remains limited largely to 3rd and 4th tier component production. The emergence of a genuinely private or commercial entity that acts as lead system integrator for a major defense program would demonstrate deeper reform of the system. That has not yet happened, as the defense enterprises remain largely resistant to fundamental change.

Another important goal of MCF is financial integration. Asset securitization and the ability to tap financial markets represent an important turning point for the

defense industrial base. Access to the market is allowing for a massive recapitalization of the defense industry. A much larger windfall of capital in the years ahead could well materialize as SOE reform moves forward. The expansion of the defense sector in the last decade attests to this increased capture of national resources through the market. This financial aspect of MCF is significant because it falls outside conventional understanding of the resources devoted to China's defense industrial base. It is not a well-understood phenomenon, in large part due to the opaque nature of China's statist market and the complexity of SOE reform. But it is certain to be an important factor in China's military modernization drive. Military procurement budgets, preferential tax treatment, subsidies and loans—all of which are slowing in growth—may not be the biggest determinants of the defense industry. Assessments of China's military modernization trajectory based principally on budgetary and extra-budgetary state largesse misses this new source of funding that will grow in size and importance over time.

Ironically, this aspect of financial integration stands in contrast to the previously discussed MCF goal of increasing innovation and efficiency of defense work through private and commercial sector participation. Ideally, SOE reform and asset securitization is meant to diversify ownership in order to infuse better corporate management and governance, not just increase resources. However, despite the substantial securitization of defense assets, the group corporations remain completely state-controlled, and even its listed subsidiaries are in the main still government owned. In other words, the financial markets are being leveraged to recapitalize the defense sector with little impact on their political or monopoly position in the economy—and in fact may be helping to further consolidate it.[157] The implications here are that military modernization may continue apace despite the lack of progress in MCF in terms of commercial participation. The rise of government industry guidance funds, an equal and possibly larger source of capital, may only accentuate this trend.

While the narrower definition of MCF has direct implications for the state of China's defense industrial base, there is also a broader conceptual goal for the

national MCF plan that has profound implications for U.S. national security and economic relations with China. IDDS explicitly formulates an agenda that closely links defense building with nation building, blurring the lines between defense and civilian domains.[158] Strategic industries and dual-use technologies are targeted for development with the aim of transforming China into a world-class power in economic, technological and military terms. This mobilization of national resources to achieve economic-hard power makes China a techno-security state. This has obvious and direct implications for America's own defense industrial base, but even more troubling are the indirect, less discernible risks to U.S. defense and economic superiority.

The broader challenge for the United States regarding China's MCF strategy is twofold. The first is the nature of many emerging technologies and industries from a dual-use standpoint, some of which have direct and clear defense applications—such as robotics and semiconductors—but many others that have potential for or are foundational to defense purposes that are frequently more remote from or are embedded in a long component defense industrial supply chain—specialized machine tools, artificial intelligence and biotech are examples here. Moreover, most of these technologies have vast commercial potential, which means they are available to anyone and their development is widespread, making their monitoring for national security purposes a highly complex undertaking. The second and interrelated challenge stems from China's own well-defined industrial strategy linking defense and civilian economic goals, and which directly influences both outbound and inbound FDI. This intrinsically dual-use development plan entails the targeting of technologies and industries much farther upstream and downstream in the supply chain—both defense and commercial—than would normally be the case.[159] Similarly, the risks to technologies and components in the defense industrial supply-chain become more widely spread and so much harder to map.[160] Taken together with the variety of financing vehicles that are employed by Chinese investors (acquisitions, mergers, but also minority stake ownership), monitoring is extremely difficult.

To date, the tools used by the U.S. government and Department of Defense are limited, though they have improved recently with the increased attention to Chinese investment behavior in the United States. The Committee on Foreign Investment in the U.S. (CFIUS) is one of the few mechanisms in place today with real power to govern inbound investments with potential national security threat.[161] While originally a blunt tool that only reviewed relevant transactions that resulted in a foreign controlling interest, CFIUS's jurisdiction has recently been expanded under the Foreign Investment Risk Review Modernization Act (FIRRMA) to cover non-controlling foreign interests in critical infrastructure, critical technologies or sensitive personal data, including via indirect investment and if a foreign government is involved.[162] Importantly, however, a radical move to include U.S. outbound investments to China with potential national security implications was removed from the final FIRRMA reforms.[163]

Perhaps the most important lesson for the challenge that China's MCF strategy poses for the United States has to do with political will. China's strong, centralized, state-led system allows for a substantial degree of engineering of industrial and economic goals. Such a state-centric design in industrial policy is unfamiliar to the U.S. free-market system. Even control over broad technology in the U.S. is highly controversial within the commercial technology community, where the largest markets for many foundational and emerging technologies are non-defense in nature. Despite the reforms to CFIUS or other tech transfer measures, several recent major studies argue the U.S. remains vulnerable to loss of critical technologies. It is unclear how the U.S. polity could muster the political will to take a whole of government approach and institute a comprehensive policy tool set to protect against the depth and breadth of the challenge, from supply chain vulnerabilities to targeted investments for tech transfer and industrial espionage. Yet, bold action may be the only means to meet the challenge of protecting U.S. military technological advantage.

Appendix 1: Central Defense Industry Enterprises

Enterprise	Employees	Subsid	Tech Expertise
Aviation Industry Group Corporation (AVIC)	452,000	200	34 RDIs
China North Industries Group Corp (CNGC)	226,000	103	35 RDIs
China South Industries Group Corp (CSGC)	212,000	70	7 RDIs
China Aerospace S&T Group Corp (CASC)	173,000	140	40% tech staff, >41 RDIs, 30 academicians
China Aerospace Industry Group Corp (CASIC)	146,000	180	40% tech staff
China National Nuclear Group Corp (CNNC)*	100,000	246	
China Nuclear Engineering Group Corp (CNEC)	38,000	20	
China Shipbuilding Industry Group Corp (CSIC)	173,000	48	28 RDIs
China State Shipbuilding Group Corp (CSSC)	70,000	31	10 RDIs
China Aeroengine Group Corp (CAEC)	84,000	27	6 academicians
China Electronics Technology Group Corp (CETC)	169,000	26	55% tech staff, 46 RDIs, 10 academicians

* In early 2018, CNEC and CNNC merged.

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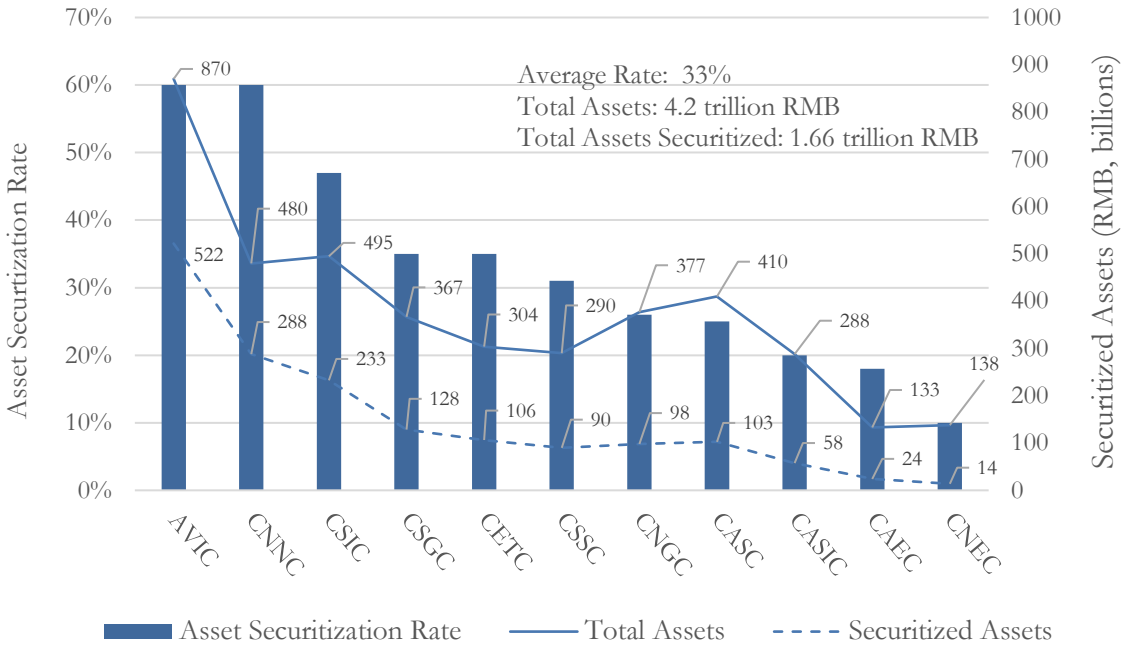
Appendix 2: Defense Industry Asset Securitization



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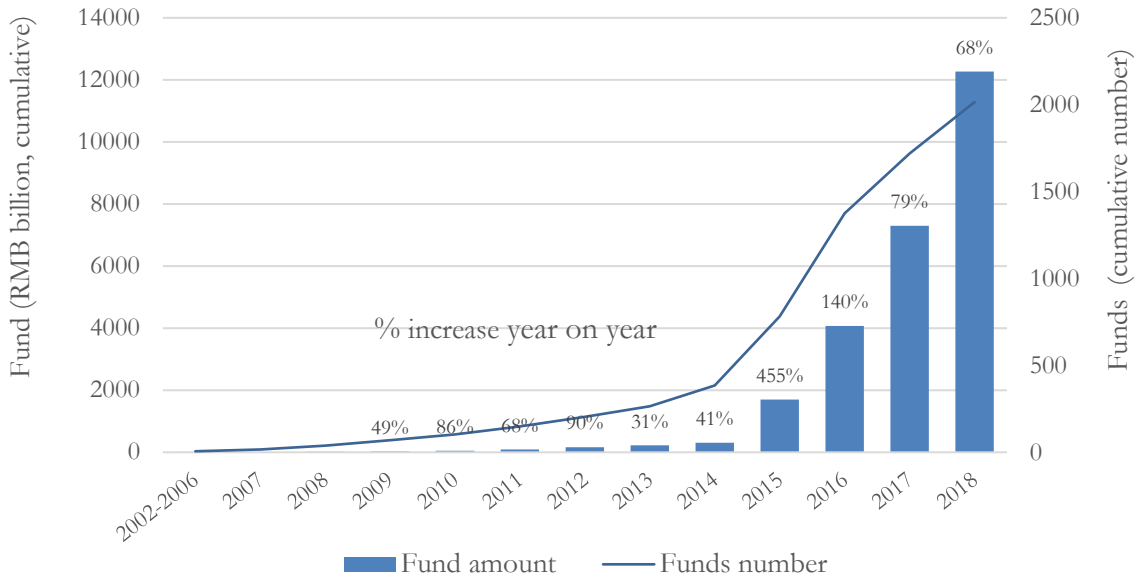
Appendix 3: Government Guidance Fund Growth[164]



Source: Figures come from news reports and government documents, but the most comprehensive website on GGFs is found here, http://www.zero2ipo.com.cn/en/.

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Appendix 4: Central Committee for Integration of Military and Civilian Development

CCIMCD	Person	Political Position
Director	Xi Jinping	CPC Gen Sec, CMC Chairman, President
Deputy Directors	Li Keqiang	Politburo Standing Committee, Premier
	Wang Huning	Sec of Party Secretariat, Politburo Standing Committee
	Han Zheng (CCIMCD Office Director)	Politburo Standing Committee, Vice Premier
Members	Jin Zhuanglong (CCIMCD Office Dep Director)	Chairman of Board, Party Sec, COMAC Member, 19th Central Committee
	Ma Kai	Politburo Member, Vice Premier
	Xu Qiliang	Politburo Member, CMC Vice Chairman
	Fan Chanlong	Politburo Member, CMC Vice Chairman
	Meng Jianzhu	Politburo Member, Chairman Central Political and Legal Committee
	Li Zhanshu	Politburo Member, Director Central Office
	Yang Jing	State Councilor
	Guo Shengyu	State Councilor, Minister Public Security
	Zhang Yang	CMC Member
	Zhao Keshi	CMC Member
	Zhang Youxia	CMC Member
	Chen Xi	Deputy Min, Central Organization Dep
	Huang Kunming	Deputy Min, Central Propaganda Dep
	Xu Lin	Director, Central Cyberspace Leading Small Group Office
	Zhang Yesui	Sec. Ministry of Foreign Affairs
	He Lifeng	Director, NDRC
	Cheng Baosheng	Minister, Education
	Wang Zhigang	Sec, Science & Technology
	Miao Wei	Minister, MIIT
	Huang Shuxian	Minister, Civil Affairs
	Xiao Jie	Minister, Finance
	Yin Weimin	Minister, Human and Social Affairs
	Li Xiaopeng	Minister, Transportation

* military officials in red.
sources: http://news.junminwang.com/2017/xinwen_shehui_0621/230461.html; http://news.ifeng.com/a/20180302/56416887_0.shtml; https://web.archive.org/web/20170904015351/http://www.zzgc.com.cn/art/2017/8/1/art_319_42418.html

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Appendix 5: Defense Industry Leaders in the Central Committee

16th Party Congress (2002)		17th Party Congress (2007)		18th Party Congress (2012)		19th Party Congress (2017)	
Zhang Qingwei	AM	Zhang Qingwei	M	Zhang Qingwei	M	Zhang Qingwei	M
		Kang Ruixin	M				
		Lin Zuomin	AM	Lin Zuomin	M		
		Lin Shiquan	AM	Liu Shiquan	AM	Liu Shiquan	AM
		Jun Zhuanlong	AM	Jin Zhuanlong	AM	Jin Zhuanlong	AM
				Qian Zhimin	AM	Qian Zhimin	AM
				Jin Donghan	AM	Jin Donghan	AM
				Ma Xingrui	M	Ma Xingrui	M
				Xu Dazhe	M	Xu Dazhe	M
						He Dongfeng	AM
						Tang Dengjie	AM
						Cao Jianguo	AM
						Lei Fanpei	AM
						Li Shangfu	M
						Yuan Jiajun	M
						Wang Zhigang	M
						Wang Yong	M
						Zhang Guoqing	M
						Chen Qiufa	M
						Yang Jincheng	AM
Total	1	5		8		18	

AM=alternate member
M=full member

Defense Industry Leaders in Other Senior Positions

Name	Former Position	Current Position
Hu Yafeng	SASTIND Dep Dir Norinco Factory director	Heilongjiang Vice Governor
Huang Qiang	SASTIND Dep Dir and Gen Sec	Gansu Vice Governor
Sun Laiyan	SASTIND Dep Dir, Dir China National Space Agency (CNSA)	Chairman, (SASAC, State-owned Key Major Industry Supervisory Council)
Tan Zuojun	GM of China State Shipbuilding Corp	Liaoning Vice Governor
Wu Yanhua	Dep GM CASC	Dep Dir CNSA
Xu Zhanbin	Dep GM AVIC	Dep Dir SASTIND

Sources include: ChinaVitae, News Releases, as well as, Eric Anderson, "The Political and Bureaucratic Influence of the Defense Industrial Lobby in the Chinese Policy Process," *SITC Research Brief*, January 2015; and Willy Lam, "The Rise of the Military-Space Faction," *Jamestown Foundation China Brief*, Vol. 14, Issue 8, September 25, 2014; Greg Levesque and Mark Stokes, "Blurred Lines: Military-Civil Fusion and the "Going Out" of China's Defense Industry," Dec 2016, *Pointe Bello.*

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Appendix 6: CMI and Defense-related Industry Guidance Funds

CMI Funds	Amount (RMB)	Year
National Funds		
Guohua CMI Development Fund (国华军民融合产业发展基金)	30.2 billion (100 billion)	2015
CITIC Huike CMI Fund (中信惠科基金 (军民融合型基金)	110 million	2018
Subtotal	32.31 billion	
Enterprise Funds		
CASIC CMI Technology Transfer VC Fund (航天科工军民融合科技成果转化创业投资基金)	1 billion	2012
Aerospace Zijin CMI Investment Fund (航天紫金军民融合产业投资基金)	300 million	2015
CSIC CMI Fund (中 船重工军民融合产业发展基金)	20 billion	2016
CSIC Marine Defense (Dalian) Investment Enterprise	n/a	2016
AVIC Blended Securities Investment Fund (中航军民融合精选混合型证券投资基金)	50 million	2017
AVIC CMI Fund (航空工业军民融合基金)	140 million	2017
Subtotal	21.49 billion	
Local Government Funds		
Danyang (Jiangsu) High-tech VC Fund (丹阳高新技术风险投资基金)	400 mn (100 mn annually)	2014
Binzhou CMI Fund (滨州军民融合基金 (并购基金)	500 million	2015
Shenzhen CMI Equity Investment Fund (军民融合股权投资基金（深圳）	10 million	2015
Mianyang S&T CMI Achievements Transfer Equity Investment Fund (绵阳科技城军民融合成果转化股权投资基金)	2 billion	2016
Guizhou CMI Fund (贵州省军民融合基金)	10 billion	2016
Xian CMI Electronics and Aerospace CMI Fund (西安-军融电子航天产业基金)	1.5 billion	2016
Taixing City CMI Fund (泰兴市军民结合基金)	50 million	2016
Jinzhou Binhai CMI Fund (锦州滨海新区军民融合基金)	10 billion	2016
Chengdu City CMI Fund (成都市军民融合基金)	2 billion	2016
Hebei CMI Fund (河北军民融合产业基金)	1.1 billion	2016
Guangming (Shenzhen) CMI Guidance Fund (光明新区(粗军民融合)引导基金)	1 billion	2017
Shanghai CMI Investment Fund (上海市军民融合产业投资基金)	4 billion	2017
Sichuan CMI Fund (四川军民融合基金)	10 billion	2017
Chongqing CMI Development Fund (重庆军民融合发展投资基金)	10 billion	2017

Xian Aerospace CMI Pilot Fund Co Ltd (西安航天军民融合先导基金有限公司)	1.5 billion	2017
Shaanxi CMI Investment Fund (陕西军民融合产业投资基金)	10 billion	2017
Foshan CMI Fund (佛山军民融合产业基金)	10 billion	2017
Fujian CMI Investment Fund福建省军民融合产业投基金集团	N/A	2017
Huzhou CMI Fund (湖州市军民融合基金)	1.2 billion	2017
Shaanxi CMI Fund (陕西省军民融合产业基金)	3 billion	2017
Quanzhou CMI Investment Fund (泉州军民融合产业投资基金)	1 billion	2018
Chengdu CMI Development Fund (成都军民融合产业发展基金)	500 million	2018
Shandong CMI Fund (山东军民融合产业基金)	10 billion	2018
Henan CMI Investment Fund (河南省军民融合产业投资基金)	50 billion	2018
Guangan CMI Fund (广安军民融合基金)	100 million	2018
Xunyou Technologies CMI Special Fund (迅游科技军民融合专项基金)	70 million	2018
Hunan CMI Fund (湖南军民融合产业投资基金)	5 billion	2018
Kaifu District (Changsha) CMI Fund	1 billion	2018
Mianyang CMI IPR Fund (绵阳军民融合知识产权运营基金)	5 billion	2018
(Luoyang CMI Guidance Fund) 洛阳军民融合引导基金	n/a	2018
(Shunde CMI Fund (顺德军民融合产业基金)	n/a	2018
Chengdu Hitech District CMI Development Fund (成都高新区军民融合产业发展基金)	5 billion	2018
Chuannan Integration Investment Fund (川南一体化发展投资基金)	5 billion	2018
Jilin CMI and Aerospace Information Fund (军民融合和航天信息产业发展基金)	100 million	2018
Shenyang CMI Project Fund (沈阳市军民融合产业发展专项基金	1 billion (5 billion)	
Lishui (Zhejiang) Technology Transfer Guidance Fund (丽水首设科技成果转化引导基金)	125 million	2018
Shanxi Taihang CMI Fund (山西太行军民融合产业基金)	500 million (10 billion)	2018
Private Equity		
Dachen VC (达晨创投)	20 billion	2011
Xian High-tech Industry VC (西安高新技术产业风险投资)	10 billion	2016
Yinhe Capital	1 billion	2017
Feilihua CMI Fund (菲利华军民融合基金)	118 million	2018
subtotal	*207.3 billion*	
Total CMI Funds	*261.1 billion*	
Technological Upgrading		
Guoxie (Guotong, Guochuang, Guoxin) New Industry Guidance Fund (国协国同国创国新产业引导基金)	400 billion	2016
China SOE Innovation Guidance Fund (中央企业国创投资引导基金)	150 billion	2017

Advance Manufacturing Investment Fund (先进制造业产业投资基金)	20 billion	2017
Subtotal	570 billion	
Aviation		
AVIC Industry Investment Fund	20 billion	2010
Shaanxi Aviation High-tech Innovation Investment Fund (陕西省航空高技术创业投资基金—有限合伙)	253 million	2012
Nanshan District Industry Guidance Fund (南山区产业发展投资引导基金)	2 billion	2015
Shaanxi Aviation & Aerospace IPR Operation Fund	500 million	2016
subtotal	*22.75 billion*	
Nuclear		
China Nuclear Industry Fund (中核产业基金)	120 million	2011
Nuclear Construction Industry Fund (核建产业基金)	200 million	2016
Subtotal	*320 million*	
Aerospace		
Beijing Aerospace Industry Investment Fund (北京航天产业投资基金)	5 billion	2010
Aerospace Hi-tech (Suzhou) VC-Phase I and II (航天高新（苏州）创投一二期基金)	500 million 615 million	2012 2015
Aerospace Hi-tech (Suzhou) VC Fund 航天高新（苏州）创投基金	500 million	2012
Aerospace Internet of Things Fund (航天物联网基金)	308 million	2012
South China Sea Finance-Technology-Industry Integrated Innovation Fund (南海金融·科技·产业创新融合基金)	3 billion	2014
Haite Aerospace VC Fund (海特航空创投基金)	n/a	2014
Aerospace Hi-tech (Zhenjiang) VC-Phase II (航天高新（镇江）创投二期基金)	555 million	2015
Aerospace Hi-tech (Suzhou) Patent Fund (航天高新（苏州）专利基金)	500 million	2015
CASC Innovation Fund	150 billion	2016
Aerospace and Internet Intelligent Manufacturing Fund (航天工业互联网智能制造产业基金)	1.06 billion	2016
Changchun New District Aerospace City Fund (长春新区通用航空城基金)	10.05 billion	2016
CASIC (Chengdu) Investment Fund（航天科工(成都)投资基金)	10 million	2016
CASC Aerospace Patent Fund	500 mn - 1 bn	2016
Yingchuang Dehong Aerospace Fund (盈创德弘航空基金)	300 million	2018
Aerospace Information Industry Investment Fund (航天信息产业投资基金)	n/a	n/a
Subtotal	*173.3*	
Electronics		
ZSP Emerging Digital Information Industry Fund	250 million	2010

(中关村兴业电子信息产业基金)		
Sichuan CETC Fund	n/a	2014
National Integrated Circuit Industry Investment Fund (国家集成电路产业投资基金)	139 billion	2014
Guizhou Huaxin IC Fund (贵州华芯集成电路基金)	1.8 billion	2015
Semiconductor & Internet Joint Fund (亦合资本半导体及互联网基金)	500 million	2015
Fujian Electronic Information Industry Fund (福建电子信息产业基金)	n/a	2015
Zunyi Electronic Information Fund (遵义电子信息基金)	30 billion	2016
Jiangxi Electronic Information Guidance Fund (江西电子信息引导基金)	1 billion	2016
China Third Generation Semiconductor Fund (中国第三代半导体基金)	2 billion	2016
Shanghai IC Fund (上海市集成电路产业基金	30 billion	2016
Nanjing IC Special Fund (南京集成电路专项基金)	50 billion	2016
Shijiazhuang IC Fund (石家庄市集成电路基金)	1 billion	2016
Xiamen IC Fund (厦门市集成电路基金)		2016
Guangdong IC Fund (广东集成电路基金)	1.5 billion	2016
Shanghai IC Fund(上海地方性集成电路基金)	50 billion	2016
Kunshan Cross-strait IC Fund (昆山海峡两岸集成电路基金)	1 billion	2017
Binhu District IC Design Fund (滨湖区集成电路设计产业基金)	2 billion	2018
State IC Investment Fund (Phase 2) (国家集成电路产业投资基金二期)	150 billion	2018
Shanghai Semiconductor Equipment and Materials Fund (上海半导体装备材料基金)	10 billion	2018
Hanjiang District Microelectronics Industry Fund (邗江区微电子产业基金)	2 billion	2018
Subtotal	*334 bn*	
Advanced/Precision Manufacturing		
Xinglong Advanced Equipment Manufacturing Investment Fund (兴陇先进装备制造投资基金)	300 million	2015
Hainan Advanced Materials VC Fund (海南先进新材料创投基金)	250 million	2015
Jiangmen Advanced Manufacturing Fund (江门市先进制造基金)	4 billion	2016
Nanyang Advanced Manufacturing Fund (南阳市先进制造业基金	2 billion	2017
Guangdong Advanced Manufacturing Fund (广东先进制造业基金	20 billion	2017
Qingyanhuayi Advanced Manufacturing Guidance Fund (清研华亿先进制造投资引导基金)	450 million	2018

Subtotal	*27 billion*	
Strategic Emerging Industries (SEI)		
Danyang SEI VC Guidance Fund (丹阳市新兴产业创业投资发展引导基金)	n/a	2011
Guangdong SEI VC Guidance Fund (广东省战略性新兴产业创业投资引导基金)		2011
Beijing SEI VC Fund (北京创造战略性新兴产业创投基金)	3 billion	2012
Shenyang Emerging Industry VC Fund (沈阳新兴创业基金)	120 million	2012
Yahui New Materials VC Fund (雅惠新材料创投基金)	n/a	2014
Changing SEI Venture Capital Fund (长兴科技成果转化引导基金)	30 million	2014
Shanxi SEI Fund (山西战略新兴产业基金)	2 billion	2014
National SEI VC Fund (国家战略新兴产业创投基金)	250 million	2014
Qinghai SEI Fund (青海战略新兴产业基金)	8 billion	2015
Panyu District SEI Venture Capital Fund (番禺区战略性新兴产业创投基金)	1 billion	2015
Wuchang SEI Fund (武昌战略性新兴产业基金)		2015
Fujian SEI Guidance Fund (福建新兴产业创业投资引导基金)	3 billion	2015
Gansu SEI VC Guidance Fund (甘肃省战略性新兴产业创业投资引导基金)	500 million	2015
Tianfu New District Hi-tech Fund (天府新区新兴高端基金)	1.5 billion	2016
Pinyuan SEI Fund (平远战略新兴基金)	1 billion	2016
Chongqing SEI Fund (重庆三峡战略性新兴基金)	10 billion	2016
Longyan Emerging Industry Fund (龙岩市新兴产业基金)	1.6 billion	2016
Hebei SEI VC Fund (河北战略性新兴产业创投基金)	n/a	2016
Gaoxin-Hualong District SEI Investment Fund (高新区（新市区）华龙-高新战略新兴产业投资基金)	1.8 billion	2017
Liangjiang SEI Service Fund (两江战略性新兴服务业基金)	1 billion	2018
National SEI Fund (国家级战略性新兴产业基金)	300 billion	2018
Caidian District SEI Guidance Fund (蔡甸区战略性新兴产业发展引导基金)	n/a	2018
国信新兴产业创投基金	n/a	2018
Subtotal	*334.8 billion*	
Total CMI-related GGFs	1.2 trillion	

Sources: Consulting and Investment Firm (www.zero2ipo.com) government and private news sources.

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References

[1] Although the Chinese name (*jun zhuan min*) is the same as conversion, described earlier—which was principally the defense industry engaged in production of civilian goods—the current usage is different and typically includes the transfer of technology and the reform of defense research institutes to operate in the market and contribute to civilian technology (from CVSource)
[2] This can go by other names in Chinese, such as *yujunyumin,* or, locating military application in the civilian economy.
[3] Tai Ming Cheung et al, "Planning for Innovation: Understanding China's Plans for Technological, Energy, Industrial and Defense Development," *IGCC*, July 28, 2016.
[4] *Civil-military Integration Development Report*, Bi Jingjing (ed), (Beijing, National Defense University Press, 2016), pp 19-20
[5] Daniel Alderman, Lisa Crawford, Brian Lafferty, and Aaron Shraberg, "The Rise of Chinese Civil-Military Integration" in Tai Ming Cheung, ed., *Forging China's Military Might: A New Framework for Assessing Innovation* (Baltimore: Johns Hopkins University Press, 2014).
[6] Hu Jintao, "Report to the Eighteenth National Congress of the Communist Party of China", *Xinhua News Agency*, 8 November 2012.
[7] "Decision of the CPC Central Committee on Several Major Issues Concerning the Comprehensive Deepening of Reforms", Third Plenary Session of the 18th CPC Central Committee, *Xinhua News Agency*, 12 November 2013.
[8] "Xi Calls for Deepened Military-Civilian Integration," Xinhua, March 12, 2018.
[9] CMC Science and Technology Commission and Ministry of Science and Technology, 13th Five-Year Special Plan for the Development of Military Civil Fusion (十三五科技军民融合发展专项规划), 26 September 2017, http://www.aisixiang.com/data/106161.html
[10] Charles Edquist and Bjorn Johnson, "Institutions and Organizations in Systems of Innovation", in Charles Edquist (Ed), *Systems of Innovation: Technologies, Institutions and Organizations* (Oxford: Routledge, 2005).
[11] Ibid, p46, and Elinor Ostrom, "Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework", in Paul A. Sabatier (Ed), *Theories of the Policy Process* (Boulder, Co; Westview, 2nd Edition, 2007), p26.
[12] Mark Zachary Taylor, *The Politics of Innovation* (Oxford: Oxford University Press, 2016), pp157-168.
[13] Christopher Weible, Tanya Heikkila, Peter deLeon and Paul Sabatier, "Understanding and Influencing the Policy Process", *Policy Sciences*, Vol.45, No.1, March 2012; and Hank C. Jenkins-Smith, Daniel Nohrstedt, Christopher Weible, and Karin Ingold, "The Advocacy Coalition Framework: An Overview of the Research Program", in Christopher Weible (Ed), *Theories of the Policy Process* (Routledge, 2018).
[14] "Consideration of 'Opinions on Integrated Development of Economic and National Defense Building' and 'Outline for Yangtze Economic Belt Development Plan'"), *People's Daily*, 26 March 2016, http://paper.people.com.cn/rmrb/html/2016-03/26/nw.D110000renmrb_20160326_2-01.htm.
[15] Tai Ming Cheung, "The Chinese Defense Economy's Long March from Imitation to Innovation" *Journal of Strategic Studies,*Vol 34, No 3, June 7, 2011.
[16] Chaofeng Huang, *Zhanluexing Xinxing Chanye Junmin Ronghe Fazhan Yanjiu [Research in Strategic Emerging Industry Civil-Military Integration Development]* (Beijing: National Defense University Press, 2014)
[17] All of China's defense group enterprises currently rank in the Global Fortune 500 except for the nuclear corporation (CNNC and CNEC) and Aeroengine Group (CAEC). For comparison, CNGC is ranked 140th and AVIC 161st while Boeing and Airbus are ranked 64th and 105th. Global Fortune 500 ranking is based on total annual revenue.
[18] Data for defense industry was collected from various sources (including www.csindex.com.cn; http://www.fortunechina.com, http://stock.jrj.com.cn) as well as defense industry year end reports and websites.
[19] The total asset value of the defense industry now exceeds RMB 4 trillion compared to just RMB 2 trillion ten years ago. Upper estimates also forecast the defense industry as a whole could grow a phenomenal 20

percent annually over the next 5-10 years, possibly doubling or quadrupling in size. "The Frequent Claim of a Multi-trillion Defense Industry Market is Tempered by the Low Precision in Investment," June 1, 2016 (http://finance.qq.com/cross/20160601/8ZLt7M88.html#0)

[20] Many past studies have used gross income as the primary metric, but in the Chinese context, the net income returned to the group corporation is more accurate as this amount, a fraction of the gross income, is what is plowed back into corporate operations and thus more relevant for understanding the contribution of profit to the defense industry. These figures are also used by Chinese financial consultancies. See, Return on Assets is more applicable as a performance measure for Chinese group corporations than return on investment or return on equity, because they are state-owned and thus much of their assets and holdings are not listed. It also provides a crude metric for performance.

[21] Boeing's and Airbus' average rate of profit increase for this timeframe is 19% and 47% respectively, while their average ROAs over the same period have been 5.5% and 2.1% respectively. See, http://www.fortunechina.com/fortune500/node_65.htm, and Boeing and Airbus websites.

[22] It is important to distinguish between the whole defense budget and the procurement budget. The latter is divided into roughly 3 parts. Only the latter goes in substantial amount to the defense industry. "China's Defence Industry," *Jane's World Defence Industry*, Sept 7, 2018.

[23] There are no comprehensive figures for the extent of subsidies, tax breaks and loans to the defense industry, but one estimate put the amount of subsidies to SOEs at US$310 billion (~2 trillion RMB) from 1985-2005 (nominal terms). Usha C.V. Haley & George T. Haley, *Subsidies to Chinese Industry: State Capitalism, Business Strategy, and Trade Policy* (Oxford University Press: London, 2013), p. 2

[24] Fan Gang and Nicholas Hope, "The Role of SOEs in the Chinese Economy," *China Focus*, 2015. p. 11-12.

[25] Between 2009 and 2018, asset value has gone from roughly RMB2 trillion to over RMB4 trillion, and revenue has gone from RMB1.36 trillion to RMB2.385 trillion.

[26] MOR is a plan with two principle motives of introducing See "Opinions on Promoting the Development of the Mixed-Ownership Economy," State Council, http://www.gov.cn/zhengce/content/2015-09/24/content_10177.htm/.

[27] For instance, CASC, CETC and CSIC published goals of increasing asset securitization of their assets by the end of the 13th FYP in 2020 to rates: 45%, 80% and 70% respectively. None have come close to this to date. CASC remains at 25%, CETC at 35% and CSIC at 47%. "Reform to Classification of Defense Research Institutes Has Been Issued," January 11, 2017 (http://news.cnstock.com/news,bwkx-201701-4002072.htm)

[28] For instance there is an employee stock ownership plan, where 'qualified' employees (government approved) can take up to 30% of enterprise equity—with no one individual holding more than 1% of the total. See, http://english.gov.cn/state_council/ministries/2016/08/18/content_281475420344290.htm.

[29] Asset securitization (证券化) is often used loosely in the Chinese context and applied loosely to refer to any type of market operation, including mergers and acquisitions, issuing of stocks, bonds. But it is composed of distinct classes of market operations. In addition to IPOs and back-door listing, there is also asset-backed securitization, explained below. See, "Structure and Design of Defense Industry Asset Securitization," March 15, 2018 (http://www.sohu.com/a/225643939_778083)

[30] In the primary market (A-shares markets in Shanghai and Shenzhen) investors buy stocks and bonds directly from the company issuing them. For the list of defense related listed firms, see http://www.csindex.com.cn/en/indices/index-detail/399813

[31] Sixty-three of these are considered core defense companies. The average government share control (defense industry group or SASAC) in listed companies is 51%, but can be as high 75%. A small minority, such as Sichuan Haite High Tech, is as low as 1% government controlled, and possibly the only truly private company. Source: "China's Defense Industry Survey", *JP Morgan Asia Pacific Equity Research.* January, 2019, and http://stock.jrj.com.cn/hotstock/2018/11/11120425330035.shtml

[32] Tai Ming Cheung, "Climbing the Innovation Ladder: Reforming China's Defense Science and Technology System for Higher-End Innovation," Workshop on Change, Continuity in Chinese Defense, Science, Technology and Innovation, Washington DC, March 16, 2016.

[33].See Wei Yuwa, "Asset-back Securitization in China," *Richmond Journal of Global Law & Business*, Volume 6, Issue 3, 2007.

[34] This is based on the frequently cited US defense firm securitization rate of 70-80%—the gold standard for many Chinese analysts.

[35] For example, see, "At a Rate of Only 30%, There is Room for 3 Trillion RMB in Defense Industry Asset Securitization Market" Dec 6, 2017, *Securities Daily*) http://finance.sina.com.cn/stock/hyyj/2017-12-06/doc-ifypikwu1287736.shtml)

[36] And in this vein, many of the defense industrial groups have published ambitious goals for greatly expanding asset securitization but it appears progress on this is moving slower than expected, as there remain significant obstacles to achieving these goals. For instance, CASC, CETC and CSIC published goals of increasing asset securitization of their assets by the end of the 13th FYP in 2020 to rates: 45%, 80% and 70% respectively. None have come close to this to date. CASC remains at 25%, CETC at 35% and CSIC at 47%. "Reform to Classification of Defense Research Institutes Has Been Issued," January 11, 2017 (http://news.cnstock.com/news,bwkx-201701-4002072.htm)

[37] An underlying weakness of the DITB is at the heart of the issue with low. There are also many difficulties in managing defense stocks in the commercial markets including lack of disclosure, tracking performance, managing higher volatility rates and long product and technology life cycles, "living with the state" when investing in the defense sector. "90% of Defense Enterprises Cannot Access Commercial Capital: If Defense Business is so Good, Why Isn't Capital Willing to Invest?" *TaiFangwu* August 6, 2018 (https://mp.weixin.qq.com/s/QhkACdCCY_bb1q7HqnJw8w), Yan Xiaojun and Huang Jie, "Navigating Unknown Waters: The Chinese Communist Party's New Presence in the Private Sector," *China Review*, Vol. 17, No. 2, (June 2017).

[38] "Outline of the National Strategy of Innovation–driven Development Background Briefing," Ministry of Science and Technology (http://www.china.com.cn/zhibo/zhuanti/ch-xinwen/2016-05/23/content_38515829.htm

[39] In addition to the Innovation-driven Development Strategy, this linkage is seen in virtually all of China's planning documents since the MLP 2006-2020, including the Strategic Emerging Industry Initiative (updated in 2017), the MIC 2025 and Internet Plus plans, but also in artificial intelligence, robotics, nanotechnology, and quantum computing. See, Scott Kennedy, "Made in China 2025," *Strategic and International Studies*, June 1, 2015 (https://www.csis.org/analysis/made-china-2025) and Tai Ming Cheung et al, "Planning for Innovation: Understanding China's Plans for Technological, Energy, Industrial and Defense Development," IGCC, July 28, 2016.

[40] Initially set out in a 2008 NDRC document "Guiding Opinions on the Standardization of Establishment and Operation of the of Venture Capital Guidance Funds" and subsequently clarified in 2015 with the Ministry of Finance document, "Interim Measures for the Administration of Government Investment Funds," and in 2016 with the NDRC's "Measures for Management and Implementation of Government Guidance Funds" (from Jiang Liang article).

[41] See analysis by Ariel Lu et al, "China's Venture Capital (VC): Bigger than Silicon Valley's?, *Insead*, April 20, 2018.

[42] Both of which were incorporated in the 12th FYP and 13th FYP respectively.

[43] The aggregate fundraising total of the subsidiary fund cluster, total leveraged social capital, is usually four or five times that of the top-tier fund. Jiang Liang, "GGFs: 12 Trillion Difficulties and Contradictions," *Central Bank Observer*, December 14, 2018 (https://m.gelonghui.com/p/226196)

[44] Other funding areas are less obviously dual-use, but still benefit the defense industry, such as one of the largest funds, the Central Enterprise Innovation Fund, a fund of RMB 150 billion meant for technological and infrastructural upgrading of SOEs.

[45] This estimate because it counts only the funds are those more readily identifiable as dual-use. Other estimates are as high as RMB3.5 trillion ($518 billion). Tai Ming Cheung, "The Evolution MCF Under Xi Jinping," presentation to the Deputy Assistant Secretary of Defense, Washington DC Sept 12, 2018.

[46] The 2008 Guiding Opinions and the 2016 Interim Measures (cited above) for guidance funds call specifically for early stage, small and medium startups in innovative, capital-intensive industries such as integrated circuit, computer chip, 3-D printing, semi-conductors, robotics etc.

[47] State guidance funds had only raised RMB3.7 trillion by late 2018, roughly a third of the target amount. In some provinces and cities, capital raised is as low as 7 percent of the intended total Emily Feng, "China's State-owned Venture Capital Funds Battle to Make an Impact," *Financial Times*, December 23, 2018. (https://www.ft.com/content/4fa2caaa-f9f0-11e8-af46-2022a0b02a6c)

[48] The incentive structure is to attract investment and business to a region.

[49] According to various reports, as much as 57% of the total funds amassed have not yet been invested due to the failure to attract social capital, with much of stranded in escrow accounts or term deposits. See Jiang Liang, "GGFs: 12 Trillion Difficulties and Contradictions," *Central Bank Observer*, December 14, 2018 (https://m.gelonghui.com/p/226196) This is because the GGFs were not designed to make direct investments in companies but rather meant to be seed capital to incubate private (social) capital that would then directly invest in companies. This is specified in the 2008 Guiding Opinions.
[50] Part of the problem for private capital is the difficulty of market exit (IPO, merger & acquisition, stock listing and transfer). The data show that only 57 exits have occurred between 2008 and 2017 for GGF-invested projects. Jiang Liang, "GGFs: 12 Trillion Difficulties and Contradictions," *Central Bank Observer*, December 14, 2018 (https://m.gelonghui.com/p/226196)
[51] The China Securities Investment Fund Association reports that as of late 2016 as much as 52% of GGF management teams were directly assigned by government departments.
[52] There is a basic discrepancy in the private and state incentives. There is pressure for governments to preserve and appreciate state-owned assets, and not necessarily higher return (with higher risk) short-term opportunities as the private market would operate in. The result is more conservative, risk-averse investing.
[53] Douglass North, *Institutions, Institutional Change and Economic Performance* (Cambridge: Cambridge University Press, 1990,), pp4-5.
[54] One compendium of these efforts details over 300 major regulations, standards and planning documents, covering a wide range of procurement, intellectual property rights protection and other provisions issued before 2014 by a host of agencies including GAD, the CMC, the State Council, the NDRC, SASTIND, Tang Wenxian et al (ed), "China Military and Civilian Integration Development and Achievements Yearbook" MCF Equipment Technology Research Institute, Dec, 2015.
[55] See Brian Lafferty, Aaron Shraberg, and Morgan Clemens, "China's Civil-Military Integration," *Study of Innovation and Technology in China (SITC) Research Brief*, January 2013; and Daniel Alderman, Lisa Crawford, Brian Lafferty, and Aaron Shraberg, "The Rise of Chinese Civil-Military Integration," in Tai-Ming Cheung (ed.), *Forging China's Military Might: A New Framework for Assessing Innovation* (Baltimore: Johns Hopkins University Press, 2014), pp. 109-135.

[56] Yuke Xie and Zhoulai Lu, "Research on Boundaries of the Defense Industry in Civil-Military Integration," *Science & Technology Progress and Policy*, June, 2014
[57] Brian Lafferty, "Civil-military Integration and PLA Reforms," in, Philip Saunders et al (ed) *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms* (National Defense University: Washington DC, 2019)
[58] "Xi Jinping Presided Over the Plenary Meeting of the MCF Commission", *Central Net, June 20, 2017*
[59] "Bluebook on the Prospects for MCF Development in 2019," *Scidi*, Jan, 2019 (http://www.ccidwise.com/uploads/soft/181220/1-1Q220153F5.pdf)
[60] In Shenzhen and Chengdu, for example, military representative offices (MROs) and quasi-MROs, are holding exhibitions and convening civil-military platforms, and partnering with consulting services both of which are not the conventional purviews of MROs. From Eric Hagt, "MCF: National Strategy, Local Politics," dissertation, publish date, August, 2019
[61] Steven Kline and Nathan Rosenberg, "An Overview of Innovation," in *The Positive Sum Strategy* (Washington DC: National Academy Press, 1986).
[62] For instance, officers from CEDD, AMS and NDU emphasize that past MCF-related efforts were frequently resisted by local if not aligned with its interests, but sustained political attention mitigates that over time. Interviews in Beijing (2017).
[63] Patent release, while logically a positive step for MCF that the PLA supports, there was resistance to its rolling out from some quarters due to security and intellectual property rights concerns.
[64] Charles Edquist and Bjorn Johnson, "Institutions and Organizations in Systems of Innovation", in Charles Edquist (Ed), *Systems of Innovation: Technologies, Institutions and Organizations* (Oxford: Routledge, 2005)
[65] Andrew L. Ross, 'On Military Innovation: Toward an Analytical Framework', paper presented at the Conference on China's Defense and Dual-Use Science, Technology, and Industrial Base, University of California, San Diego, 1–2 July 2010, 14
[66] These authors distinguish between defense and military innovation. Tai Ming Cheung, Thomas G. Mahnken and Andrew L. Ross, "Assessing the State of Understanding of Defense Innovation," May, 2018, SITC Research Briefs

[67] The only comparable precedent was the Ordnance Commission under the CMC, established in 1951, and which had Zhou Enlai, premier and vice chairman of the CMC as its head, with deputies Nie Rongzhen (PLA General Staff) and Li Fuchun (Central Finance Commission). This Commission placed civilian industry under civilian and military dual leadership. *Biography of He Long*, ed. General Staff Department Compilation Group (Beijing: PLA Publishing House, 1991)., p. 567.
[68] Yu Chuanxin, "Reflections on Top-level Design for MCF Development," *MCF Development Strategy* (Beijing: Higher Education Press, 2014).
[69] In general, previous MCF efforts were ad hoc, structurally misaligned, of low policy priority. See, Du Renhuai Cao Chao, "Xin Zhongguo Guofang Gongye Zouxian Junminronghe Shendu Fazhan De Lilun Yu Shijian Tansuo [Exploration of Practice and Theory of New China's Defense Industry Moving Toward Deepening Development of Civil-Military Integration]," *China Conversion* 6 (June, 2016).
[70] You Guangrong, "Significant Practices of MCF Development Since Reform and Opening Up," *Yangshan Zhiku* (http://www.siss.sh.cn/kyxs/yjsy/556452.shtml)
[71] Previously Zhang Gaoli and currently Han Zheng. "Han Zheng Chairs National Symposium on the Work of the CCIMCD," October 29, 2018, *Xinhuashe*, http://www.gov.cn/guowuyuan/2018-10/29/content_5335476.htm
[72] Usually a state councilor or Politburo member according to, Choi Chi-yuk, "In Unusual Move, Xi Appoints Top Party Leader to Lead Daily Affairs of Key Committee," Jun 21, 2017, *South China Morning Post*
[73] The first meetings focused on drafting policy agendas, areas of purview and plans for incorporating MCF into other state plans including the 13th FYP, MIC2025. The most recent one in October 2018, focused on specific issues, such as working to create a dedicated state law to govern MCF practice, and reviewing the variety of regulations and experiments at the local levels and in MCF base areas in order to establish specific strategic areas and bases to concentrate on going forward. Interviews BJ8-29 and "Important Signals at the National MCF Work Symposium", Nov 7, 2018 *MCF Market Service Organization (*http://www.jmrh.cn/news/show/803.html*)*.
[74] This point was made by NDRC officials. Interview BJ27-8.
[75] Other bodies also issue regulations and documents regarding the defense industry, procurement, acquisition, contract bidding, certification, etc such as the former General Armaments Department, the CMC, Department of Finance and the NDRC.
[76] Interestingly, SASTIND is not located in the same building as MIIT, which makes interaction with its superior bureaucracy and other departments in MIIT difficult. Interviews with MIIT thinktank, Beijing, 2016.
[77] SASTIND does have a degree of control over a substantial pot of money (estimated at RMB 100 billion over 10 year period, granted some time in the mid-2000s) meant for technological and infrastructural upgrading of the defense industrial base. But interviewed sources generally admit that SASTIND is relatively weak and without this funding, would have little influence over the defense enterprises. Interviews in Beijing 2015-2017.
[78] SASTIND's political rank is a deputy-ministry level (*fubuji)*, and its head Zhang Kejian, is not a Central Committee member, while most of the central defense enterprises are ministry-level (*buji)* and several of their leaders are on the 19th Central Committee (and many more have been in past Central Committees, see Appendix 2).
[79] In terms of MCF, SASTIND has traditionally been the arbiter of conversion (which has enriched the defense industry) not other types of civil-military interaction.
[80] MoST also works with the CMC S&T Commission on drafting MCF development plans (http://www.janes.com/article/73364/china-releases-civil-military-integration-plan)
[81] Different types of S&T and industrial parks are led by different agencies, including MoST, MoF, MIIT and NDRC.
[82] Renamed CNIPA (China National Intellectual Property Admin) in 2018.
[83] SIPO works with the CMC National Defense Intellectual Property Office, and in early 2017, over 3,000 declassified defense patents were released and were made available through portal www.weain.mil.cn. Also, see, Meia Nouwens, Helena Legarda, "China's Declassification of Defense Patents: Novel But Not (Yet) a Game Changer," Jan 18, 2018, *The International Institute for Strategic Studies.*
[84] The General Armaments Department.

[85] Eric Hagt, "The General Armament Department's Science and Technology Committee," in Tai Ming Cheung (ed), *Forging China's Military Might: A New Framework for Assessing Innovation* (Johns Hopkins University Press: Baltimore, 2014).
[86] Ibid.
[87] Zhang Tao, "China to Boost Military-civilian Integration in Sci-tech," *Xinhuanet*, Aug 23, 2017 (http://eng.chinamil.com.cn/view/2017-08/23/content_7728310.htm)
[88] It has notably been active in partnering directly with civilian companies to supply specific technologies required for joint operations such as situational awareness, navigation, detection, surveillance and telecommunications. For instance, see "The Battlefield Environmental Protection Bureau of the Joint Staff Department Visit Ubinav Company," Dec 3, 2016, (http://ubinavi.com.cn/page85?article_id=22.) and "The first Geology MCF Development Forum is Held in Beijing," *Xinhuanet*, April 27, 2016 (www.xinhuanet.com/mil/2016-04/27/c_128937375_2.htm)
[89] Lorand Laskai, "Civil-military Fusion and the PLA's Pursuit of Dominance in Emerging Technologies," *China Brief*, Volume 18, Issue 6, April, 2018.
[90] "16 Provincial-level Armored Standing Committees, Nearly Half of Them are Commanders," *Beijing News*, Jan 8, 2018.
[91] The PMCs are non-combat commands and are the highest ranking military organization in charge of civil-military affairs such as (de)mobilization, recruitment, reserve and militia forces, as well as army construction, a vague term that includes certain procurement of equipment for armed forces within military district from the local economy. Wei Li, "What is China's National Defense Leadership Management System?" *Chinanet*, July 28, 2014.
[92] Adam Ni, "China Reveals New Military Technology Agency," *The Diplomat*, July 28, 2017.
[93] Moreover, industrial or S&T parks engaged in MCF activity are now widespread in China and are frequently under both local and central auspices, further complicating the local government structures in which they reside and their efforts to comprehensively plan and coordinate economic activities. Beijing's Zhongguancun Science Park is a good example of this problem. From Eric Hagt, "MCF: National Strategy, Local Politics," dissertation, publish date, August, 2019.
[94] Mianyang S&T City Management Committee General Office: Mianyang City Investment Promotion Bureau, ed., *Zhongguo Kejicheng-Mianyang: Zhengce Huibian [China's S&T City-Mianyang: Compilation of Mianyang Policies]*, Vol. 1, 2015)
[95] This discussion of continued bureaucratic chaos comes mainly from interviews with officials in 2017 and 2018, From Eric Hagt, "MCF: National Strategy, Local Politics," dissertation, publish date, August, 2019.
[96] John Grevatt, "China Sets up Agency to Lead Military R&D,", *Jane's Defense Industry*, July 27, 2017.
[97] There is a substantial body of literature on the problems of bureaucratic bargaining for policy implementation. For example, see Kenneth Lieberthal and David M. Lampton, *Bureaucracy, Politics, and Decision Making in Post-Mao China*, Vol. 14 (Berkeley: University of California Press, 1992); Andrew Mertha, *China's Water Warriors : Citizen Action and Policy Change* (Ithaca: Cornell University Press, 2008); Mark Dougan, *A Political Economy Analysis of China's Civil Aviation Industry* (New York: Routledge, 2002).
[98] This problem is not unique to Beijing. For example, Xian, a well-known defense industrial base region, while different in nature from Beijing's ZGC, is also burdened by a fragmented system. Interviews with Xian High-tech Industries Zone officials in 2015.
[99] The fragmented nature of MCF efforts in China derives from Eric Hagt, "Civil-Military Integration: National Strategy, Local Politics," (forthcoming publication), PhD dissertation, Johns Hopkins University.
[100] The Provincial General Secretary is often the PMC First Secretary. Interview with Mianyang City Official, 2015.
[101] Mobilization was centralized under the CMC's National Mobilization and Army Building was transferred to logistics departments of regional combat commands. "Following Reform, PMC Placed Under New Department of the CMC, Major General Explains Major Tasks," March 11, 2016 (http://mil.sohu.com/20160311/n440069952.shtml), Wei Li, "China's National Defense Leaderships Management System," July 28, 2014 (http://www.china.com.cn/guoqing/2014-07/28/content_33079137.htm)
[102] Susan Puska, "Commissars of Weapons Production: The Chinese Military Representative System," in Tai Ming Cheung (ed), *Forging China's Military Might: A New Framework for Assessing Innovation* (Johns Hopkins University Press: Baltimore, 2014).

[103] In some cities with developed technology economies (eg Shenzhen and Ningbo) military representative offices are involved in forums and exhibitions for components and commercial high-tech products, but they are not included in municipal or provincial economic and industry planning systems. Eric Hagt, "MCF: National Strategy, Local Politics."
[104] Brian Lafferty et al, "China's Civil-Military Integration," Jan 13, 2013, *Study of Innovation and Technology in China Research Brief*
[105] Notably, Chen Xi, deputy head of the Central Committee's Organizational Department is a member of the CCIMCD, which has an authoritative role in selecting state-owned enterprises directors and setting their performance requirements.
[106] Mark Zachary Taylor, *The Politics of Innovation* (Oxford: Oxford University Press, 2016), pp157-168.
[107] Reports state the site attracts over 9,000 entities, lists over 2,000 enterprises with approvals to do defense work and … website: weain.mil.cn
[108] Ding Yang, "Three Year Review of the Weapons and Equipment Acquisition Information Network on the MCF Road," *PLA Daily*, Jan 13, 2018
[109] One detailed analysis cites the slowness of their release, the dominance of state-owned firms in developing the patented technology, and narrow technological focus their comprise. Meia Nouwens, Helena Legarda, "China's Declassification of Defense Patents: Novel But Not (Yet) a Game Changer," Jan 18, 2018, *The International Institute for Strategic Studies.*
[110] For instance Xian, Shanghai, Shenzhen, Beijing, Chongqing, Mianyang all have online portals for dual-use procurement in their respective S&T parks.
[111] Interviews with military officials in 2015 reveal that the High-tech Achievements Exhibition held every 2 years since 2014 is the highest profile exhibition by the military ("Private Enterprise High-tech Achievement Exhibition, Fan Changlong Xu Qiliang Attends," *People's Daily*, May 29, 2014
[112] Ministry of Industry and Information Technology, "National MCF Demonstration Bases: Comprehensive Material," Jul7 2, 2018 (http://www.ecorr.org/news/industry/2018-07-02/169431.html)
[113] Dominique Jolly and Fuquan Zhu, "Chinese S&T Parks: The Emergence of a New Model," *Journal of Business Strategy* 33, no. 5 (09, 2012), 4-13
[114] A survey of successes and failures is outlined in emerging economies in Andrés Rodríguez-Pose and Daniel Hardy, *Technology and Industrial Parks in Emerging Countries : Panacea Or Pipedream?* (Cham: Springer, 2014)
[115] For example, the Blue Whale project and the *Sijiqing* parks, both MCF base experiments in Beijing failed to get off the ground. Eric Hagt, "China's Civil-military Integration: National Strategy, Local Politics," dissertation (upcoming publication).
[116] Interviews in Shenzhen and Beijing, 2016-2017.
[117] For instance, there is a robotics industry alliance, an unmanned aerial vehicle alliance, a Beidou application industry alliance.
[118] "Huachuang Zhongxin Chengli Liangnian Tuijian 10 Yu Jia Minqi Jiaru Jundui Wuzi Caigouwang [After Two Years, Huachuang Center Recommends More than 10 Private Enterprises to Enter the Military Armament Procurement Network]." *SZNews.Com*January 17, 2016d.
[119] Local National Defense Office was wary of such organizations doing work traditionally under their purview. Interviews in Shenzhen (2016).
[120] Xu Lili, "Zhongguancun Establishes New Industrial Alliance," *Zhongguancun Science Park News* (Sept 9, 2014).
[121] Ji Huixian, "Junminronghe Shendu Fazhan De Lujing Chuangxin [Innovative Path to Deepening Development of Civil-Military Integration]," *People's Tribune* (June, 2017).
[122] "Zhongguancun Junminronghe Jundi Duijie Pingtai Jia Junfang Lianluochu Jiepai Qudong [ZGC MCF Local-Military Platform Liaison Office Unveiled]," Haidian Park External Cooperation Office, last modified December 27, accessed September 9, 2017.
[123] The 13 PLA agencies are: CMC Joint General Staff Dep., CMC General Logistics Command Dep., CMC Training Management Dep., Army, Navy, Air Force, Rocket Force, Strategic Support Command, Academy of Military Sciences, National Defense University, Armed Military Police, Logistics Academy, and the Air Force Command Academy. ""Zhongguancun Junminronghe Jundi Gongxu Duijie Pingtai" Zhengshi Shangxian [the ZGC MCF Military-Local Supply and Demand Interface Platform" Officially Goes Online]," Ministry of Defense, last modified December 24, accessed February 18, 2018, http://www.mod.gov.cn/

[124] Moses Abramovitz, "Catching Up, Forging Ahead, and Falling Behind," *Journal of Economic History*, Vol 46, No 386, 1986.
[125] Much the discussion of MCF models of MCF implementation derive from Eric Hagt, "China's Civil-military Integration: National Strategy, Local Politics," dissertation (upcoming publication).
[126] Barry Naughton, "The Third Front: Defence Industrialization in the Chinese Interior," *The China Quarterly*, no. 115 (Sep., 1988), 351-386
[127] Mianyang S&T City Management Committee General Office: Mianyang City Investment Promotion Bureau, ed., *Zhongguo Kejicheng-Mianyang: Zhengce Huibian [China's S&T City-Mianyang: Compilation of Mianyang Policies]*, Vol. 1, 2015).
[128] Li Yongqing, *Major Administrative Changes in Shenzhen* (Shenzhen: Haitian Publishing House, 2008).
[129] The best example of this was that China's AWACS system, with similar technologies in the smart city system, in which several of Shenzhen's larger telecoms and internet companies were involved, did not participate. Eric Hagt, "MCF: National Strategy, Local Politics," dissertation, publish date, August, 2019.
[130] In fact, in most respects, Beijing immense endowment makes it unique to any other city in the country.
[131] Liu Mingqi, "Beijing Polytech University and Zhongguancun Development Group Jointly Build Defense Science and Technology Park," *Zhongguowang* (June 29, 2011).
[132] Beijing is a large city divided into relatively powerful and autonomous district governments, resulting in a degree of inter-district competition with regard to economic and development goals. Moreover, a great majority of Beijing's science and technological innovation is done within *Zhongguancun*, its S&T park that is managed by a mix of local and central oversight
[133] For instance, as a national center, manufacturing is being pushed out, which hampers local industry chain integrity and the city's ability to undertake projects—including defense. Eric Hagt, "MCF: National Strategy, Local Politics," dissertation, publish date, August, 2019.
[134] Tai Ming Cheung, Thomas G. Mahnken and Andrew L. Ross, "Assessing the State of Understanding of Defense Innovation," May, 2018, SITC Research Briefs
[135] To date, expos around the country have typically showcased discrete technologies—though increasingly impressive—to sell as stand-alone systems, such as robots, 3D printing, energy storage systems, electronics, navigation equipment and software, cyber security system, high-performance materials and drones (UAVs). Li Guoli, "Thousands of Exhibits Unveiled at 4th MCF High-tech Equipment Achievements Exhibition," *Xinhua.net*, Oct 11, 2018 (http://www.xinhuanet.com/mil/2018-10/11/c_1123546350.htm)
[136] Private enterprises can also be coy about their involvement in defense work to avoid undue attention. Based on interview sources.
[137] Speech by Luo Qiang, Mianyang Party Secretary and Cao Zhiheng, MIIT's MCF Promotional Office staff at Mianyang's International S&T Exhibition in 2014, Mianyang S&T Exhibition Forum Office, *Dierjie Zhongguo (Miangyang) Kejicheng Guoji Keji Bolanhui Luntan Zhuanji (Second China (Mianyang) S&T City International Exhibition on Science and Technology-Forum Proceedings)* Similar claims were made by Peng Yuxing, Mianyang Party Secretary at the same conference in 2015.; Mianyang S&T Exhibition Forum Office, *Disanjie Zhongguo (Miangyang) Kejicheng Guoji Keji Bolanhui Luntan Zhuanji (Second China (Mianyang) S&T City International Exhibition on Science and Technology-Forum Proceedings*
[138] In Mianyang, for instance, Changhong Enterprise, the city's largest firm, was formerly a defense enterprise, but following the defense conversion period of the 1980s and 1990s, was largely converted into a firm producing goods for the commercial market, and minimally involved in defense work.
[139] *Civil-military Integration Development Report*, Bi Jingjing (ed), (Beijing, National Defense University Press, 2016),
[140] Tang Wenxian et al (ed), "China Military and Civilian Integration Development and Achievements Yearbook" MCF Equipment Technology Research Institute, Dec, 2015.
[141] Some sources claim this comprises 40% of the domestic defense contractors. Greg Levesque and Mark Stokes, "Blurred Lines: Military-Civil Fusion and the "Going Out" of China's Defense Industry," Dec 2016, *Pointe Bello*
[142] Less than a tenth of a percent and less than one percent respectively. Du Maorong, "Opportunities and Challenges of "Civilian Participation in Defense," *PLA Daily, Jan 3, 2019.*
[143] "Bluebook on the Prospects for MCF Development in 2019," *Scidi*, Jan, 2019 (http://www.ccidwise.com/uploads/soft/181220/1-1Q220153F5.pdf)
[144] One S&T consultancy in Beijing that provides research on MCF in Beijing uses this method.

[145] By tracking patent citation between three main pillars of technology innovation--domestic firms, research institutions and universities—levels of knowledge spillover and technology sharing within the economy can be measured Jaffe, Adam B. et al, "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations," *Quarterly Journal of Economics* 108 (1993).
[146] Meia Nouwens, Helena Legarda, "China's Declassification of Defense Patents: Novel But Not (Yet) a Game Changer," Jan 18, 2018, *The International Institute for Strategic Studies.*
[147] Jacques Gansler et al, "The Role of the Lead System Integrator," University of Maryland School of Public Policy, Jan 2009.
[148] Jonathan Ray et al, "China's Industrial and Military Robotics Development," U.S.-China Economic and Security Review Commission, October, 2016.
[149] Elsa Kania, "Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power," *Center for a New American Security*, November 2017.
[150] Amit Katwala, "Why China's Perfectly Placed to be Quantum Computing's Superpower," *Wired*, Nov 14, 2018.
[151] Richard D. Fisher, *China's Emergent Military Aerospace and Commercial Aviation Capabiliteis* (Washington DC: U.S.-China Economic and Security Review Commission,[2010])
[152] Patrick Sinko, "State of Nanotechnology R&D in China: Implications for Future US Competitiveness," March 2017.
[153] Bryan Krekel, Patton Adams and George (Northrop Gruman) Bakos, *Occupying the High Ground: Chinese Capabilities for Computer Network Operations and Cyber Espionage* (Washington DC: U.S.-China Economic and Security Review Commission,[2012]).
[154] *Findings of the Investigation into China's Acts, Policies and Practices Related to Technology Transfer, Intellectual Property and Innovation Under Section 301 of the Trade Act of 1974* (Washington DC: Office of the United States Trade Representative,[March 22 2018])
[155] "Baidu Establishes National Engineering Lab of Deep Learning Technology and Application," *China Youth Daily*, Feb 20, 2017.
[156] Feng-chao Liu, Denis Fred Simon, Yu-tao Sun, and Cong Cao, "China's Innovation Policies: Evolution, Institutional Structure, and Trajectory," *Research Policy* 40, No. 7 (2011): 917−31; "Interpret 'Made in China 2025': The Task Is Arduous and Urgent," MIIT website, May 19, 2015, (http://www.miit.gov.cn/n11293472/n11293832/n11294042/n11481465/16595213.html).
[157] Curtis J. Milhaupt and Wentong Zheng, "Why Mixed-ownership Reform Cannot Fix China's State Sector," Paulson Institute Report, January 2016.
[158] Greg Levesque and Mark Stokes, "Blurred Lines: Military-Civil Fusion and the "Going Out" of China's Defense Industry," *Pointe Bello Reportm*, Dec 2016.
[159] Marc Humphries, "China's Mineral Industry and U.S. Access to Strategic and Critical Materials: Issues for Congress," March 20, 2015, *Congressional Research Service (*Washington DC), p. 4-6; "U.S. Strategic Supply Chain Assessment: Select Rare Earth Elements," Bureau of Industry and Security, Department of Commerce, 2016 (Washington DC), p. 3; "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806, September, 2018.
[160] Michael Brown and Pavneet Singh, *China's Technology Transfer Strategy* (Silicon Valley: Defense Innovation Unit Experimental Report, January 2018).
[161] James K. Jackson "The Committee on Foreign Investment in the United States (CFIUS), *Congressional Research Service (*Washington DC), July 3, 2018.
[162] FIRRMA takes the "direct" out of foreign investment review. Therefore other investment types (assets purchased from bankruptcies, or the presence of Limited Partners in a VC fund) can now trigger CFIUS action. Also, filings involving foreign governments are mandatory. See, Steven Croley et al, "How FIRRMA Changes the Game for Tech Co.s and Investors," *Law 360*, Oct 10, 2018, *and;* Roland Oleynik et al, "FIRRMA Expands CFIUS Jurisdiction in 2 Major Ways," Holland & Knight LLP, Aug 18, 2018 (www.hklaw.com).
[163] Shawn Donnan, "Senators Ditch Plan to Review US Outbound Investment," *Financial Times*, May 15, 2018.
[164] Figures come from news reports and government documents, but the most comprehensive website on GGFs is found here, http://www.zero2ipo.com.cn/en/.