Testimony before the U.S.-China Economic and Security Review Commission
Made in China 2025—Who Is Winning?
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I have been an analyst and consultant in the aviation and defense industry since 1988, with extensive coverage of the China market, Western involvement in China aviation, and of China's own aviation industry. My public writings about the industry can be found at www.richardaboulafia.com.

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My testimony aims to provide a brief overview and assessment of China's progress in civil aviation. I have followed the Commission's guidance in addressing eight questions:

1) Please evaluate how successfully China met specific aviation goals laid out in its Made in China 2025 policy document and other relevant industrial and technology plans.

This is an industry with extremely high entry barriers. Since World War 2, with the exception of Embraer of Brazil, no company or country has successfully entered the civil jet transport manufacturing sector. And Embraer has yet to enter what can be termed the large jet market; all of its products seat fewer than 120 passengers. Airbus, Boeing, and the other manufacturers who have since exited the industry were created from companies that have existed for over 100 years. The USSR had its own jet industry, of which only an uncertain remnant survives in Russia today.

Therefore, there is no denying what China and Commercial Aircraft Corporation of China (COMAC) have achieved: they have successfully entered this very exclusive industry. China's CAAC regulatory agency certified China's first production jetliner, the ARJ21 (rebranded C909 in November last year), in 2014. This 70/80-seat regional jet is now in full-rate if limited production; about 150 have been delivered; all but three of these have been to Chinese customers. The three export planes have gone to an Indonesian airline that is effectively owned by China.

COMAC's C919 is a more significant achievement. As a 150/170-seat mainline (i.e., for longer routes and not regional ones) jet, it is firmly in Airbus and Boeing territory, and considerably more ambitious and expensive than anything Embraer has developed. The large jetliner "club" now consists of Airbus, Boeing, and COMAC. Therefore, the biggest "headline" Made In China 2025 aviation goal – "Accelerate the development of large aircraft" – has been achieved.

Made In China 2025 includes many other aviation and aerospace goals. Beyond that one big headline objective (development of a large jet), stated goals in the industrial policy[1] include the following:

- Initiate the development of wide-body passenger aircraft in a timely manner
- Encourage international cooperation in the development of heavy-duty helicopters
- Promote the industrialization of trunk liners and regional aircraft, helicopters, unmanned aerial vehicles (UAVs), and general purpose aircraft.
- Achieve breakthroughs in the technologies of high thrust-to-weight ratios and advanced turboprop (turboshaft) engines and turbofan engines with large bypass ratios and establish an independent industrial system for engine development.
- Develop advanced airborne equipment and systems to form an independent and complete aviation product chain.

The first of these might be a translation problem, or merely a nomenclature mistake. Widebody jets are twin aisle models for international routes. For years, China has been studying a C929 (formerly CR929) twin aisle, which I will discuss below. But this was merely a concept when Made In China 2025 was formulated, and it's possible that the term "wide-body" was merely applied to any jet larger than a regional one. Just below that, it uses the term "trunk liners" which is kind of an old fashioned way of referring to any mainline jet;

Other than that, China has made remarkable progress with UAVs. It has made very little progress with heavy helicopters, some limited progress with other helicopters, and relatively little progress with general purpose aircraft (although it has made some interesting acquisitions of Western general aviation companies).

Then there's the last two items, engines and equipment and systems. These will be essential for China to establish itself as an autonomous (or autarkic) aviation power. There has been progress with these, through a mix of joint ventures (JVs) with Western companies and probably with intellectual property theft. But China is a long way from being independent here, particularly with engines, as discussed later in this testimony.

2) What do the capabilities of COMAC's C909 and C919 indicate about how advanced China's aerospace sector is today?

While developing and delivering jets is a noteworthy achievement, there are four problems with COMAC's position in the industry and market. The first is that the C909 can be termed a deeply flawed product. It is massively overweight relative to its competitors.

The table below shows the three first Chinese airliners in the context of their peers. "EIS" refers to entry into service, the date the plane entered, or will enter, commercial revenue service. "Pax" refers to the typical number of passengers the plane transports. "OEW" refers to the aircraft's

[1] https://cset.georgetown.edu/wp-content/uploads/t0432_made_in_china_2025_EN.pdf

operating empty weight. The final column divides weight by passenger, a good way of judging the relative appeal of designs with similar ranges and operating characteristics.

Plane	EIS	PAX	OEW (lbs)	OEW/PAX
Dash 8Q300*	1989	50	26,042	521
ATR72	1989	72	29,983	416
MA60*	2000	60	30,203	503
ERJ170	2011	72	44,423	617
CRJ705	2001	75	47,245	630
E175	2005	78	48,260	619
Fokker 70*	1994	79	49,985	633
C909	2016	78	55,017	705
A320	1988	158	82,078	519
A320Neo	2016	158	97,700	618
C919	2023	158	100,751	638

China's MA60 turboprop – now largely out of production – is considerably heavier on a per-seat basis than its closest competitor, one of many reasons why it failed to sell in more than token numbers (it is also notably unreliable and regarded by some as unsafe). But the C909, a 78-seat regional jet, is disastrously heavier than its closest competitor, Embraer's E175. All of the systems used on the C909 are basically equal to or inferior to those on the E175. The engines are basically the same (General Electric CF34). Therefore, the economic differential between the two jets comes down to weight.

By most accounts, the ARJ21/C909 design and manufacturing system was based on McDonnell Douglas's MD-80 jetliner, which was built in relatively small numbers in China during the 1980s. The MD-80 was a larger 130/150-seat design, which means the Chinese derivative is carrying a lot of the structure and other components needed for a larger jet. As a consequence of this heavy weight, the C909 almost certainly has a relatively high cost per available seat mile (CASM). It is not likely to be competitive at all outside China, and even Chinese airlines will have a hard time operating the type without extensive subsidies.

Considering its weight relative to its closest peer (Airbus's A320neo), the C919 looks better than the C909, and differing seat counts might erase much or all of this difference with the A320neo, although the C919's range capabilities do appear to be somewhat inferior to its Airbus and Boeing competitors. COMAC's own site gives a range of "4,075 to 5,555 kilometers" (2,200–2,999 nautical miles).[2] Airbus's A320neo, according to Airbus, has a range of 3,400 nautical miles.[3]

[2] http://english.comac.cc/products/ca/

[3] https://aircraft.airbus.com/en/aircraft/a320-family/a320neo

But the C919 faces the second problem confronting COMAC airplanes. As I will discuss in the fourth section of my testimony, the overwhelming bulk of the systems and technologies that make the C919 a functioning jetliner either have Western origins or are directly supplied by Western contractors. This is most notably true for the aircraft's engines.

Thus, the C919 is just as dependent on the global aerospace ecosystem as any other jetliner. Any PRC Government aspirations of air transport autarky with this product need to be tempered by this sourcing reality.

The third problem with COMAC's position is that it has no real track record in product support. Airlines depend on extensive networks of aftermarket products and service to keep their jets operating constantly, with thousands of hours of utilization per year. Airlines have razor-thin profit margins, and idle equipment means lost revenue without commensurately lower expenses (i.e., high fixed costs).

As Air Lease Corporation founder Steve Udvar-Hazy put it, "My biggest question as an aircraft lessor investor, is what is the residual value of a C919 10 years from today? I have no idea, because they don't have a global support network."[4] Creating a worldwide product support network that's as elaborate as Airbus and Boeing's will be extremely expensive.

The fourth problem confronting COMAC is that we don't know how the company will perform at volume production. Last year, COMAC delivered ten C919s, and only around 13 have been delivered so far. The ARJ21/C909 maximum production rate has been in the range of two planes per month, or just slightly higher.

Volume production of conforming aircraft (i.e., building the same plane, without any production modifications or corrections) is one of the key skills needed for any jetliner prime contractor. In addition to maintaining quality standards and keeping production line cadence, a manufacturer must manage an extremely complex (and global) supply chain that delivers the strong majority of the value of any aircraft. This is a hard-learned skill.

Last year, Airbus delivered 766 jets. Boeing, at its peak (before the 737MAX problems) delivered 806 jets (in 2018). COMAC aspires to deliver 50 C919s by 2026, and then a steady ramp to 120 per year. There are no guarantees that COMAC will be able to reach these goals in the planned timeframe.

Finally, because the early stages of production in any jetliner program tend to be extremely capital intensive and money-losing, there are no guarantees that funding will be provided. It's safe to say that it will be a very long time before any COMAC jetliner program turns cash-positive on a recurring basis, let alone profitable on a program basis.

3) What policy instruments helped develop China's current capabilities in aviation, especially as regards COMAC's development of the C919?

[4] Victoria Moores, "Straight Talker," Air Transport World, January/February 2025, page 45.

Perhaps the most important aspect of China's aviation industrial policy is that it has been extremely patient. China has attempted to build a national jet for decades, without success. The closest it got for 35 years was the Shanghai Y-10, a Boeing 707 knockoff that was built and flown in prototype form in September 1980. After a very poor flight test, it was cancelled after two prototypes were built.

The dream persisted. In the mid 1980s, one Western observer of China's aviation plans commented:

> Aircraft manufacturing is considered as the 'flower of industry,' reflecting the industrial level of a nation, and the Chinese are determined to reach parity with the West. Achievement of parity is proving to be elusive. The plan first to build small and medium airplanes and then expand to larger and more sophisticated machines is good in principle, but is progressing much more slowly than the Chinese planners had anticipated.[5]

There were several Chinese jet projects in the 1980s and 1990s, as China liberalized and opened up to JVs with Western companies (as opposed to the Y-10, which was not at all cooperative, and merely a stolen copy). The most notable new-start program was the MPC-75, a 75/90-seat regional jet in the ARJ21/C909 class proposed in the late 1980s. This was a cooperative project between China's CATIC and Germany's MBB, now part of Airbus.

Also, China built 35 MD-80s under license to McDonnell Douglas. It also almost built the MD-90, but this was cancelled. In the mid-1990s Airbus, AVIC, and Singapore Technologies worked on the AE-100, a 100-seat jetliner. It went nowhere. The next project was the closely related Airbus/AVIC AE31X, also a 100-seat design that was cancelled in June 1998.

In December 2005 Airbus signed an MoU with China's National Development & Reform Commission (NDRC) to establish an A320 final assembly line (FAL) in China. The first plane rolled off the line in June 2009. This line is still quite active today, building large numbers of A320neos (a direct C919 competitor).

The first reference to what would become the C919 came in 2006 when the PRC announced its 2006-2010 five-year plan. It referred to a "jumbo" jet, but initial drawings indicated something in the 767 class. In February 2007 the PRC State Council declared that China needed a large jetliner, with an anticipated delivery date of 2020. This was later brought forward to 2016.

The C919 received official launch approval, albeit without orders, in May 2008. The same month, COMAC was formed, although initially it was referred to as CACC. COMAC is not part of AVIC, but it is made up of AVIC assets, including the Shanghai Aircraft Manufacturing Factory (SAMF).

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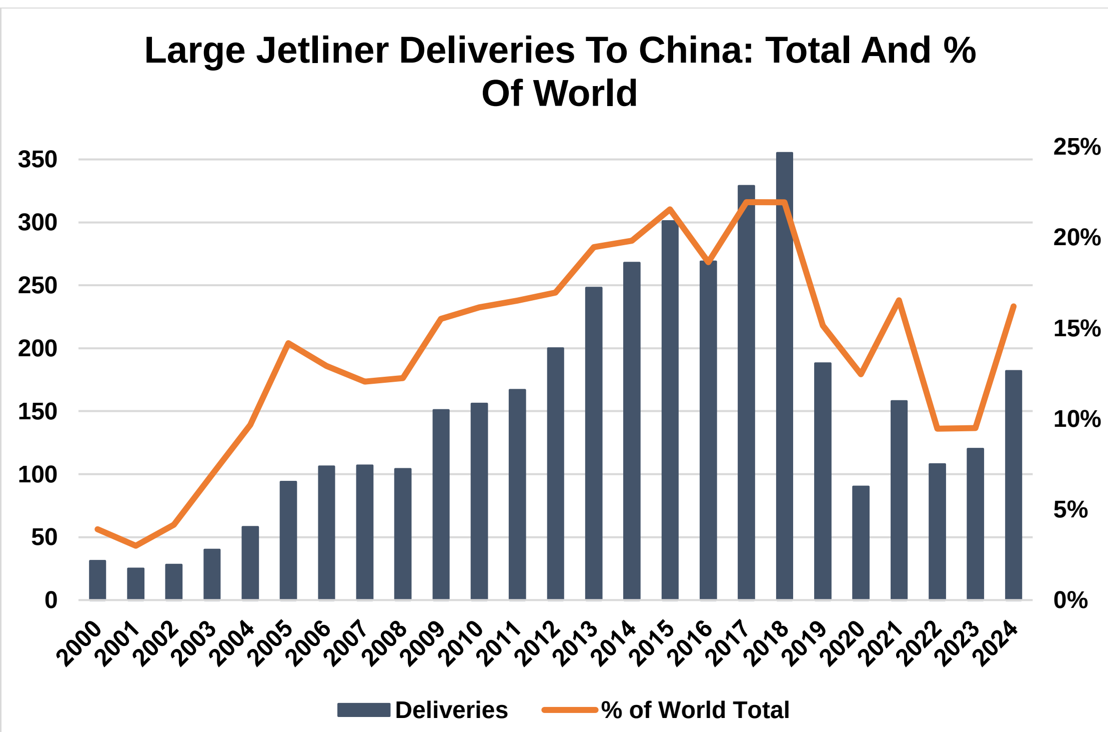
[5] E. E. Bauer, *China Takes Off: Technology Transfer and Modernization*, Seattle: University of Washington Press, 1986, page 290

Beyond the magic ingredients of time and patience, PRC Government policy took multiple forms. There was the direct government support needed to create COMAC as a state-owned enterprise (SOE). Some of this funding came from the NDRC. There was also local government support, particularly from Shanghai, where COMAC is based.

There was also the support provided by the Made in China 2025 industrial policy, which clearly prioritized aviation and aerospace as key sectors. This policy also made it clear that civil and military aviation and aerospace development were intertwined, guaranteeing a higher level of funding and support.

Next, there were government efforts to cultivate COMAC and Chinese industry progress outside of creating the jets themselves. The government established stated requirements for Western aerospace companies to form JVs with Chinese companies, in exchange for China domestic market access (as described later in this testimony).

These JVs mandated technology transfer, also tied to market access. As the chart below indicates, China's market, at its peak, absorbed 22% of the world market for large (120+ seat) jetliner deliveries, making it the largest single export market country by a considerable margin. The PRC Government was able to use the enticement of this large and growing (until 2019) market to entice international manufacturers to agree to aggressive technology and work transfer terms.



Also, the PRC Government has mandated aircraft orders for COMAC jetliners from state-owned Chinese airlines. It should be noted that in the past, there was a resistance by these airlines to purchasing any aircraft made in China. Of the 35 MD-80s built in Shanghai, five had to be reexported back to the US because Chinese airlines refused to buy them. These were put into service with TWA.

One outstanding question is whether PRC Government pressure on airlines to buy C919s will be offset by Chinese airlines' ability to buy A320neos from the Tianjin FAL, which is now ramping up to be capable of building over 100 jets per year. In other words, will airlines be able to show support for local industry through a different fleet plan?

Perhaps as a way of dealing with this question, the PRC is mounting a broader "national pride" strategy for the C919. Some reports indicate a marketing plan involving higher ticket prices for a "luxury" flight in a C919. In the opposite direction, one report indicates a marketing strategy revolving around more mileage awarded for flying in a C919, and that C919 flights have been awarded more appealing time slots. Again, since the airlines are government-owned, all of these plans are feasible.

For C919 export sales, if and when they occur, one frequently asked question involves the PRC's Belt and Road Initiative (BRI). Will recipients of BRI loans and aid, particularly for air travel infrastructure, also be pressured or incentivized to purchase C919s? So far, there is no clear indication that this will be the case, but many observers view it as a strong possibility. On the other hand, most BRI aid and loan recipients represent relatively marginal markets for new jetliners, and new C919s would compete against a plentiful supply of inexpensive used Western aircraft.

Finally, there was the indirect and direct government support needed to create the workforce and institutions needed for China's aero industry development. This encompassed everything from testing facilities to university education and training programs to manufacturing infrastructure to various research institutes. This cannot be quantified but is likely to be large and essential to COMAC's successful jetliner market entrance.

4) In areas where China is behind its stated goals, or did not have the same level of success, what does this suggest about the limitations of its approach and potential policy responses in the future? What are the key bottlenecks remaining for Chinese aviation?

This is a broad set of questions, but they are best examined on a collective basis. For China, there are three areas of concern regarding limitations and bottlenecks.

The first limitation concerns the intellectual property (IP) being transferred by international suppliers to their Chinese JV counterparts. The understandable fear of enabling a Chinese competitor is likely keeping these suppliers from bidding their latest and best technology on COMAC jets. IP rights have been a longstanding concern for Western manufacturers in China, but dealing with state-owned companies (and all Chinese aerospace companies are SOEs) makes the problem even worse.

While there's no clear proof that suppliers are offering less than cutting edge technology, it is not possible to imagine a supplier company's board not asking tough questions about work in China. Foreign companies won't have an easy time against the Chinese Government in an IP dispute.

The fact that the C919 looks like an A320 – as built by Airbus in Tianjin – is all the reason Western manufacturers need to maintain a cautious stance regarding technology transfer.

This cautious stance means that in many cases international suppliers are working with China using slightly (or very) dated technology. Added together, these dated technologies add up to a finished jet that is a somewhat less than state-of-the-art product. Even if only a minority of suppliers are being cautious, that's enough to burden a COMAC jet with less capable systems that impair its competitiveness.

Also, China's aircraft designers have had their options limited. They can only source equipment from Western companies that are willing to transfer technology (old or new). They can't just select the best supplier for a particular task. That too contributes to less than state-of-the-art jets.

Since innovation mostly happens at the subsystem level, aircraft designers need to realize an important lesson: national vertical integration is a very bad idea. Jet builders need to be free to select "best-in-class" content for their jet from a wide range of suppliers with no permanent links to the primes.

That is the primary reason why this industry is a global one. Embraer, for example, isn't just a Brazilian export powerhouse. It's also one of Brazil's biggest importers. They survey the world for the best suppliers and build very little in-house.

Engines are the second big limitation for Made In China 2025, and a bottleneck for future technology development. Engines are the weakest link in China's civil aviation plans. Other aircraft systems and technologies, and even complete aircraft, may be difficult to develop, but jet engines are at a completely different level in terms of barriers to entry.

In fact, only three companies, located in two countries (General Electric and RTX/Pratt & Whitney in the US and Rolls-Royce in the UK) build commercial jet engines. France's Safran plays a role as a partner to GE in the CFM JV (which supplies Leap-1C engines for the C919), but otherwise there are no other engine sourcing options. France, the second most important aviation manufacturing country in the world after the US, has no history of building its own commercial jetliner engines.

Russia is not a commercial jet engine supplier option for China. The Soviet Union had a second-rate commercial aero engine industry for domestic applications, but Russia's efforts to revive it have been uncertain and very slow. Only tiny numbers of obsolete models have been manufactured over the last few decades. There are plans for new engines, but international sanctions, massive corruption, and the brain drain of the past few years have likely doomed whatever chances Russia's aero engine industry once had. Besides, Russia's priority is now military systems. Even there, China is working on replacing Russian engines on its home-grown military aircraft.

This is why there is no Chinese engine JV with Western companies. All three Western engine companies refused to transfer any meaningful engine design and production technology. They wanted to protect their proverbial keys to the kingdom.

Therefore, to achieve the desired goal of aviation self-sufficiency, China is now working on its first commercial jet engine. AVIC Commercial Aircraft Engine (ACAE) is designing its CJ-1000A as an alternative to the Leap-1C on the C919. The first of these was scheduled to be built in 2016 but was finally completed in December 2017. Service entry was scheduled for 2020.

Not only did this not happen, but ACAE has been forced to return to the drawing board. The first version of the CJ-1000A was heavily dependent on Western suppliers and contractors.[6] It was apparent to the PRC Government that, as with China's jetliners, China's first attempt at a commercial engine could easily be shut down with Western technology embargoes. ACAE, as a unit of AVIC, is under US Government sanctions as a military end user.

The new CJ-1000A is intended to be completely Chinese. It reportedly made its first observed flight in March 2023.[7] The current plan is for this new, all-Chinese CJ-1000A to be available in 2030, but this will likely prove optimistic.

By several accounts, China is preparing to introduce a new C919 version with purely Chinese systems and the all-Chinese CJ-1000A engines sometime around 2035. This should be achievable. However, both of these issues – JV technology transfer limits and aero engine self-sufficiency limits – speak to the unusual nature of airline economics.

For an airline, capital costs (i.e., buying a jet) are not as important as operating costs (operating that jet, particularly for fuel and maintenance). Airline profit margins tend to be razor-thin. Thus, if an airline competes with another airline using a jet that's, say, 5% less efficient than that competitor's jet, the competitor can out-price and out-profit the airline with the slightly inferior product. This is not the automotive industry or consumer electronics industry, where sticker price and product features matter most. This is an exacting contest of operating costs.

In sum, China may well produce an all-Chinese jet by 2035. But the very idea of a national jet is fundamentally obsolete. Airbus and Boeing jets are global products for a reason – global sourcing guarantees the best product with the best operating economics. An all-Chinese jet might be good for an autarkic future, but as a globally competitive product it will be as disastrous as any all-US or all-French jet would be, and probably to an even greater extent due to China's relative inexperience with aero engine design.

Beyond economics, there is the technical challenge of building a twin aisle, or a widebody jet. To achieve self-sufficiency, China would need these for airline routes connecting the country

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[6] See, for example, Bradley Perrett, "MTU, Avio Will Help China's ACAE Build CJ1000 Turbofan," Aviation Week & Space Technology https://aviationweek.com/mtu-avio-will-help-chinas-acae-build-cj1000-turbofan, accessed February 4, 2025; and https://www.gknaerospace.com/en/newsroom/news-releases/2016/gkn-aerospace-to-supply-engine-shafts-for-cj1000-development-programme/

[7] https://aviationweek.com/air-transport/aircraft-propulsion/chinese-built-turbofan-spotted-wing-avic-y-20-flying-testbed

with the US, Europe, the Mideast, Africa, or Australia. A single aisle model like the C919 simply doesn't have the range.

But here again, entry barriers are very high. Russia, notably, is the only country other than the United States to design and build its own twin aisle jetliner, the Ilyushin Il-86/96 series (itself an economic disaster). European countries only succeeded with twin aisles by pooling their resources through Airbus. No European country succeeded in creating its own.

This is why the C929, COMAC's proposed widebody, was originally the CR929, to be built in conjunction with Russia. But for political reasons (Western sanctions against Russia), and because Russia basically demanded cash for technology without any meaningful level of joint technology development, Russia has been dropped from the program (along with the "R" in the aircraft's designation). China now wants to be the third country in the world to create its own widebody. Or, to put it differently, China now wants to be the second country in the world to create its own successful widebody.

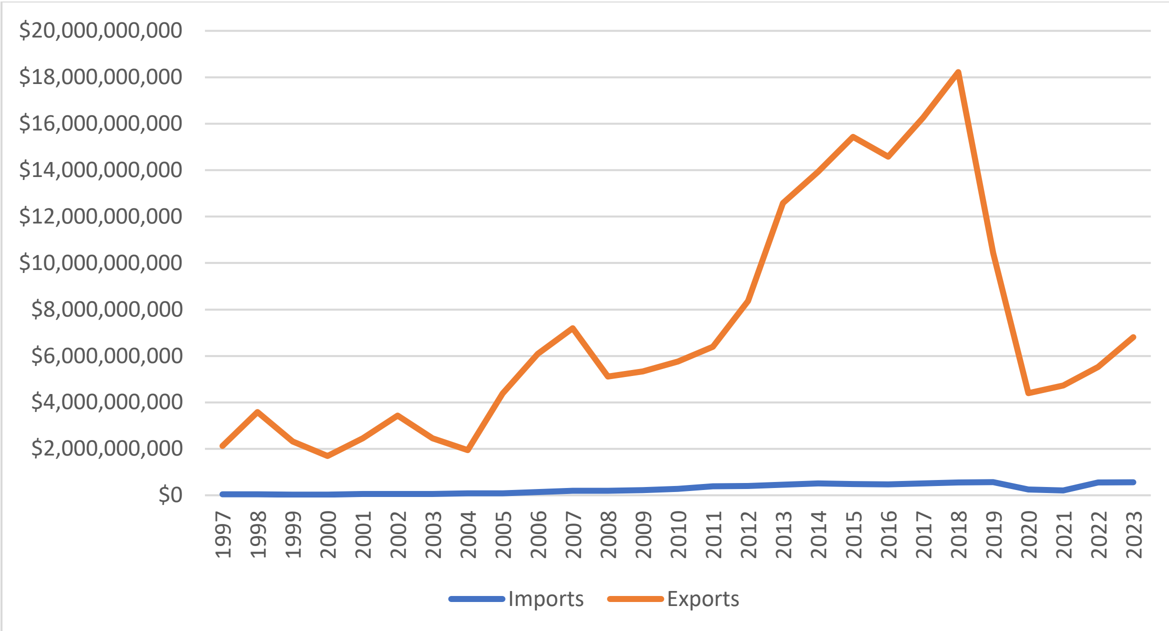
The road to a C929 is likely to be long, hard, and expensive, considerably more than with the C919. And again, without it, China will still be dependent on foreign aviation equipment suppliers.

5) Please describe the extent to which supply chains for aerospace in the United States and third-country markets rely on technology or inputs produced in China.

At the direct aerospace products level, US and Western aerospace companies are not reliant to any meaningful degree on Chinese-manufactured or designed products. At what might be termed the indirect level – raw materials, or technologies that do not have a dedicated aerospace application – there is somewhat greater cause for concern.

Direct inputs are relatively minimal. The US International Trade Commission Dataweb[8] numbers, illustrated in the chart below, clearly shows that there is an enormous China-US aerospace trade deficit in the US's favor. At its peak in 2018, this deficit stood at $18.2 billion in US exports to China to $548 million in aerospace imports from China.

[8] https://dataweb.usitc.gov/



US aerospace exports to China have fallen in recent years due to the 737MAX de-regulation and production stop, slowing Chinese demand growth, political tensions the Covid-19 pandemic and the resultant air travel depression, but are now recovering as some of these factors diminish. But again, US aerospace imports from China never amounted to very much, coming to $553 million in 2023 (the last year available for the ITC database).

According to the US Aerospace Industries Association, US aerospace industry's revenues in 2024 came to $955 billion, of which 47% is for civil aerospace.[9] This means China's contribution comes to roughly 0.05% of total US output, or 0.1% of civil output. None of China's contribution is irreplaceable, and in our conversations with US producers its clear that most, if not all of them have lined up alternative sources of production. These US producers are mindful of tensions, tariff possibilities, and other factors that would lead them towards alternative production sources.

The ITC numbers also indicate that in 2008 Mexico surpassed China for the first time, becoming the eighth largest aircraft parts supplier to the US. Mexico and other emerging producer countries have continued to grow, leaving China behind, and providing exactly the kinds of alternative production sources sought by US producers.

There are international aircraft manufacturers that import Chinese components that aren't captured by the US trade numbers. But this business is quite limited. In fact, Airbus's Tianjin FAL is effectively a mercantilist creation – all the systems and structures for these jets are imported into China from France, the UK, Germany, and other Western producer countries, and are merely assembled in China.

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[9] https://www.aia-aerospace.org/news/2024-facts-figures-american-aerospace-and-defense-remains-an-economic-powerhouse/

In fact, one key reason for China's minimal role in the global aerospace supply chain is that the country has always emphasized developing and building finished aircraft, rather than building up an in-country components and systems manufacturing capability. Japan represents an interesting contrast with China. Japan became a world leader in designing and manufacturing equipment for global needs. The country has developed an impressive array of aerospace technologies, primarily due to its long-term partnership with Boeing. But its occasional efforts at being a civil aircraft manufacturer have resulted in half-hearted failures.

China's industrial role in aerospace supply chains around the world is further complicated by the fact that it can play no role whatsoever in defense products for any Western or allied company or country. These Western aviation companies are also mindful that sanctions and other considerations mitigate against any kind of civil aircraft work that can ever be part of a defense product.

For example, a small number of Airbus's A330 jetliners are used as KC-30 military air-to-air refueling tankers. If a Chinese company played a significant role in A330 structures or technologies, that would greatly complicate selling the KC-30 to Western alliance countries. Thus, for this and other reasons, there is very little Chinese content on an A330.

However, US industry does consume significant non-dedicated aerospace content coming from China. These imports are beyond the scope of this testimony. But it does appear that with finished products, the US imports considerable quantities of Chinese printed circuit boards (PCBs).[10] US industry may also depend on China for certain types of high-volume electronic components (basic capacitors, resistors, etc.). Also, with regard to raw materials, US industry does depend on China for rare earth element processing.[11]

6) To what extent has the growth of China's domestic civilian aviation sector led to advancements in its industrial base for military aviation technologies?

As noted above, Made In China 2025 combines civil and military aerospace, with relatively little differentiation. As one geopolitical observer recently put it, "The fact of the matter is, any piece of technology, regardless of its level of sophistication, can be used in military applications - which makes Western export controls flawed by default."[12]

This is particularly true for aerospace. But as a consequence it's very difficult to say when civil developments help in the military realm, and when military development programs contribute to civil ones. For example, much of China's aero engine technology progress has focused on creating Chinese engines for fighter jets and military transports. Thus, China's civil aero engine

[10] https://www.dhs.gov/sites/default/files/2022-02/ICT%20Supply%20Chain%20Report_2.pdf

[11] https://www.areadevelopment.com/logisticsinfrastructure/q4-2024/the-battle-to-break-chinas-rare-earth-supply-chain-dominance.shtml

[12] https://www.geopolitics-insider.com/rus/?ref=geopolitics-insider-newsletter January 26, 2025, accessed January 28, 2025; paywall.

industry will draw from massive investments in military programs. But the CJ-1000A engine development program has also unquestionably helped those military engine development programs.

There are countless other aviation technologies with dual applications. A very short list would include engines, materials, aerodynamics, avionics, flight controls, and power systems.

Then there are the non-technological crossovers. These would include managing aircraft and systems development programs, factory design and organization methods, workforce training and development (and workforces themselves), supply chain management experience, and research and testing facilities and institutions.

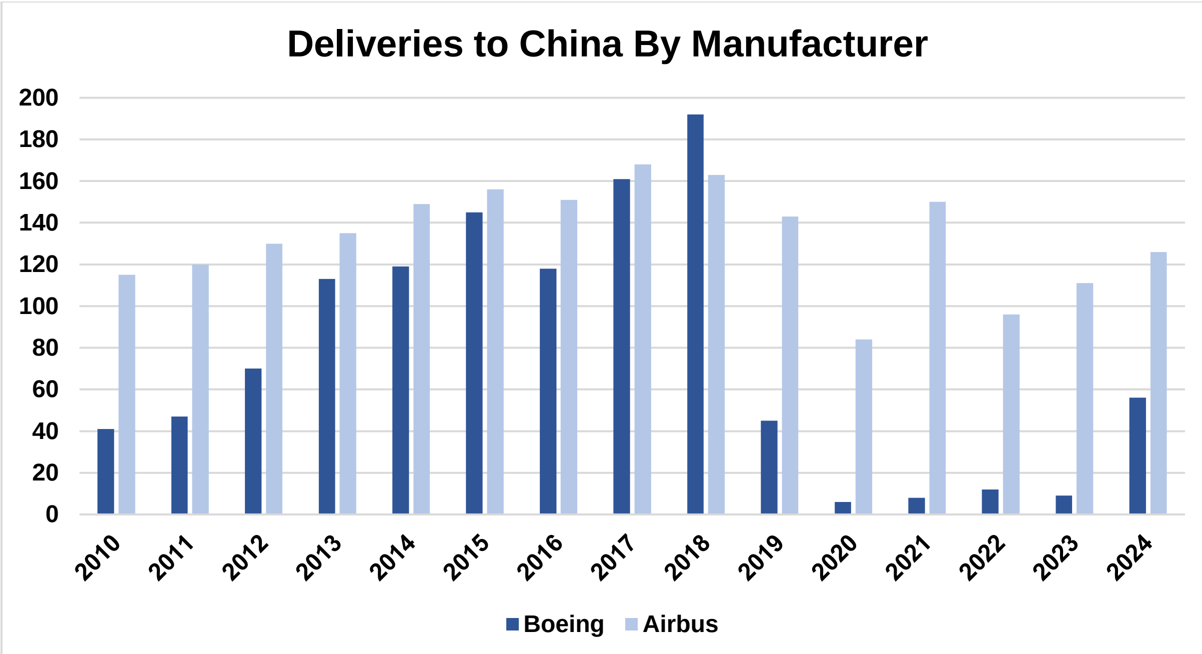
Finally, there are very few aerospace companies worldwide that are not dual civil and military entities in some way. No Chinese companies are not dual entities. China views aerospace manufacturing as an economic and geopolitical whole.

7) What other trends should the Commission be tracking on this topic?

One key trend for the Commission's attention is China's jetliner market, and how open it is, both to Western jetliners and to US-built jets in particular. As noted earlier, this is the largest export market in the world, and a level playing field is essential for the Western jetliner industry, and for Boeing.

So far, deliveries of COMAC jetliners have not been a major factor in this market; after all, a dozen or so C919s out of thousands of Western jets in China hardly registers. But if COMAC starts to ramp up to scores of C919s per year, and possibly over 100 per year, it would control more than half the market on a recurring basis, implying that this was no longer an open market at all.

Another related factor to watch is Boeing's market share. As the chart below indicates, the US company held roughly 50% of China's jetliner market for many years. The MAX grounding, and political factors, basically reduced this share to next to nothing after 2018, but last year saw a rebound, with a roughly 2-1 split in Airbus's favor. Here again, it's essential to keep the China market open, both in general and to both jetliner manufacturers.



Beyond China's open market for jets, in my view the Commission should closely monitor the following:

1. China's progress in displacing Western components, systems, and technologies on its jets with locally designed and built ones.

2. COMAC's progress with the C919 production ramp, and with C919 dispatch reliability rates on par with Western jets (~99%).

3. COMAC's progress in establishing a product support network for its jets outside of China.

4. COMAC's progress in selling its jetliners outside of China.

5. COMAC's progress in designing and creating a twin aisle jetliner (C929, and then C939).

8) What recommendations for legislative action would you make based on the topic of your testimony?

The most important action that the US can take is simple: Keep the Western and allied aerospace industry ecosystem open. China is trying to create a single nation aerospace industry. We've seen this before, in pre-Airbus European countries and, most of all, in the old Soviet Union. China may be bigger, both in terms of resources and as a market, than any of these, but the history of closed industry ecosystems is dismal.

By contrast, the current Western and allied industry ecosystem draws on talent, capital, technology, and innovation from many countries. There are very few barriers to cooperation or market access between the world's leading aerospace producers, particularly the US, Japan, the UK, France, Canada, Germany, Italy, South Korea, and many others. As long as these barriers stay low, with minimal (if any) tariffs or other trade and cooperation limits, it is not conceivable that this global industry would not be able to out-innovate, and indeed marginalize, a single nation's attempts to do everything in-country.

If China wishes to be part of this global industry, they should be welcomed, and indeed they would likely prosper. If they want to seal their borders and cooperate with nobody outside China, they might be able to replicate the Soviet Union's experience, which was not a happy one.

In my view there are three other initiatives that would support the US aerospace industry's overall competitiveness with China. One is to promote a level playing field for US contractors on China's platforms while preventing China from gaining an unfair advantage in world jetliner markets. The second is take defensive measures against sudden decoupling between the US and China. The third is to ensure that the US jetliner industry remains competitive in world markets.

First, in my view US supplier companies should not be prevented from working with China on COMAC aircraft. In addition to the political ill will this would create, the result would be that China would favor European suppliers, and/or accelerate the creation of a domestic supplier ecosystem. In my view it's better to maintain industrial relations and maintain US leverage over China's industry.

Instead, the US should encourage its supplier companies to work with COMAC, but also be prepared to step in as circumstances dictate. For example, China's MA700 70-seat turboprop transport was effectively halted when the US and Canada embargoed its Pratt & Whitney Canada PW150 turboprop engine[13]. China is searching for alternatives to the Western engine, but again given very high jet engine entry barriers, this will take many years and will likely guarantee a second-rate aircraft.

The legal structure for jetliner decoupling is already in place. COMAC's key parent companies are on the US Military End User (MEU) export list[14], which essentially prohibits technology exports to entities that "represent an unacceptable risk of use in or diversion to a 'military end use'" in China and other countries. The MEU list's application to aerospace exports to China is somewhat opaque, perhaps deliberately. All of China's thousands of Western jets use US technology, with a steady need for spare parts shipped from the US. But clarifying the situation, by putting COMAC directly on the MEU list, would be a very simple move by the US Government.

In a recent article, I spelled out a scenario in which the US Government would want to initiate such a decoupling: as a retaliatory move for a PRC decision to provide Russia with armaments in

[13] Greg Waldron, "MA700 faces bleak future after Ottawa denies export permit for engines," Flight International, https://www.flightglobal.com/aerospace/ma700-faces-bleak-future-after-ottawa-denies-export-permit-for-engines/145605.article, accessed February 4, 2025

[14] https://www.bis.doc.gov/index.php/component/docman/?task=doc_download&gid=2714

its war with Ukraine.[15] As discussed in the section above, it's imperative that China keep its market open to Airbus and Boeing (to a roughly equal degree), even if there is an inevitable degree of favoritism for COMAC products. If China decides to close its airline market to the West or to Boeing, this retaliatory decoupling might be an option.

Second, the US Government should help industry hedge against a cutoff of rare earth elements and other key materials needed for aircraft manufacturing. This could take the form of creating or enhancing strategic stockpiles of these materials, or by establishing alternative sources of supply. Gallium would lead this list, followed by refined Magnesium, Tungsten, and various rare earth elements.

Third, the best protection for US industry against COMAC is to keep innovation flowing. COMAC's products are all "me-too" jets, effectively replicating, and not innovating. If the C929 goes ahead, the best-case scenario is that it will be a 787 equivalent. If the C939 goes ahead, it will be a 777 equivalent.

Therefore, supporting new high-risk/high-reward civil aviation technologies – particularly new airframe concepts and propulsion architectures – would be a positive step. This could be done through a combination of NASA and other agency technology development contracts and Department of Defense military crossover programs. Again, per the recommendation at the top of this section, this new aerospace technology cultivation should be done in full partnership with the US's international allies and friends.

[15] Richard Aboulafia, "If China Arms Russia, the U.S. Should Kill China's Aircraft Industry" Foreign Policy, https://foreignpolicy.com/2023/03/20/china-russia-aircraft-comac-xi-putin/; accessed February 3, 2025; paywall