The innovation imperative: technology and US–China rivalry in the twenty-first century

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International Relations (IR) scholars have long recognized that technological innovation plays a key role in power transitions and international politics more broadly. Starting in the 1970s, Robert Gilpin emphasized that major advances in technology allow new nations to rise to political pre-eminence, though over time technological knowhow and 'inventiveness' diffuse to other countries.[1] Subsequently, 'long cycle' theorists argued that emerging powers become dominant because they develop innovations in new industrial spheres, or 'leading sectors', which undergird the dominant state's economic vitality and military power.[2] Other work considered how the dominant state tries to maintain its technological lead by erecting (or loosening) export controls.[3] IR scholars have also begun to explore the relationship between politics and innovation in different countries, including dominant and rising states.[4]

Yet while IR scholars recognize that innovation is important in international politics, the field still lacks an overarching framework to illuminate how dominant and rising states interact in this realm. This question is increasingly important as innovation has become a site of growing transnational collaboration in recent

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1 Robert Gilpin, *US power and the multinational corporation: the political economy of foreign direct investment* (New York: Basic Books, 1975), p. 67, and *War and change in world politics* (Cambridge: Cambridge University Press, 1981), p. 182.

2 William R. Thompson, 'Long waves, technological innovation, and relative decline', *International Organization* 44: 2, 1990, pp. 201–33; George Modelski and William R. Thompson, *Leading sectors and world powers: the coevolution of global politics and economics* (Columbia: University of South Carolina Press, 1996).

3 Gary K. Bertsch, *Controlling East–West trade and technology transfer: power, politics, and policies* (Durham, NC: Duke University Press, 1988); Michael Mastanduno, *Economic containment: CoCom and the politics of East–West trade* (Ithaca, NY: Cornell University Press, 1992); Matthew Fuhrmann, 'Exporting mass destruction? The determinants of dual-use trade', *Journal of Peace Research* 45: 5, 2008, pp. 633–52; Hugo Meijer, *Trading with the enemy: the making of US export control policy toward the People's Republic of China* (Oxford: Oxford University Press, 2016).

4 Daniel Drezner, 'State structure, technological leadership and the maintenance of hegemony', *Review of International Studies* 27: 1, 2001, pp. 3–25; Mark Zachary Taylor, *The politics of innovation: why some countries are better than others at science and technology* (Oxford: Oxford University Press, 2016); Andrew B. Kennedy, 'Slouching tiger, roaring dragon: comparing India and China as late innovators', *Review of International Political Economy* 23: 2, 2016, pp. 1–28; Joel W. Simmons, *The politics of technological progress* (Cambridge: Cambridge University Press, 2016).

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decades.[5] Recent work focusing on US policies has highlighted how societal interest groups, including powerful high-tech interests, shape the dominant state's degree of openness in different policy domains.[6] Yet what drives the decision-making of the rising state in this realm—and when will strategic interests compel the dominant state to resist it? To answer these questions, this article begins by explaining that the rising state faces an 'innovation imperative'—the need to acquire and develop new technologies in order to overcome the structural challenges facing middle-income states and continue its international ascent. The way in which the rising state pursues this imperative, in turn, shapes its interactions with the dominant state. We argue that innovation activities can have two distinct strategic effects, each of which can motivate a response from the dominant state. In the first case, the dominant state experiences a significant impairment of its security environment as a result of the rising state's activity—the phenomenon of *negative security externalities*. In the second case, the dominant state experiences a threat to its preferred international order as a result of the rising state's activity—which we term *negative order externalities*.

In theorizing the technological rivalry between rising and dominant states, we move beyond the traditional focus on military conflict in power transitions and offer new insight into current dynamics in US–China relations. In the next section we describe the innovation imperative facing the rising state and note the different types of policies available to the rising state in responding to this imperative. The following section then explains how the rising state's activities can engage the interests of the dominant state by generating the two types of strategic externalities, thus triggering a response. Our empirical section presents two *plausibility probe case-studies* of rising power innovation activities to examine the potential validity of the framework developed in the first two sections.[7] The final section concludes.

The innovation imperative

Power transition theory broadly recognizes that economic resources are the foundation of military strength and many other forms of power. Yet the literature tends to focus on the relative decline of the hegemon to explain differential growth rates—emphasizing diminishing returns on investment in the dominant state and its tendency to engage in 'imperial overstretch'.[8] The sustained economic growth of the rising power, meanwhile, is seen as unproblematic. A. F. K. Organski's original presentation of power transition theory cited industrialization as the means through which new nations rose to prominence, and treated the process

[5] Daniele Archibugi and Simona Iammarino, 'The globalization of technological innovation: definition and evidence', *Review of International Political Economy* 9: 1, Spring 2002, pp. 98–122.

[6] Andrew B. Kennedy, *The conflicted superpower: America's collaboration with China and India in global innovation* (New York: Columbia University Press, 2018).

[7] Alexander George and Andrew Bennett, *Case studies and theory development in the social sciences* (Cambridge, MA: MIT Press, 2005); Harry Eckstein, 'Case study and theory in political science', in Roger Gomm, Martyn Hammersley and Peter Foster, eds, *Case study method: key issues, key texts* (London: Sage, 2000), pp. 119–64. Eckstein (p. 140) writes that plausibility probe case-studies 'involve attempts to determine whether potential [theoretical] validity may reasonably be considered great enough to warrant the pains and costs of testing'.

[8] Gilpin, *War and change in world politics*; Paul Kennedy, *The rise and fall of the Great Powers* (New York: Vintage, 1987).

as exogenous.[9] Organski and Jacek Kugler later referred more broadly to 'socio-economic and political development' as fuelling the rise of new states, and noted that this was a multifaceted process; but it remained beyond the purview of their theory.[10] More recent extensions of power transition theory have also taken for granted the rising power's continuing ascent.[11] For his part, Robert Gilpin acknowledges variation in rising states' uptake of new technology, but does not present its acquisition as a policy challenge for those states to overcome.[12]

Economic scholarship makes it clear that we cannot take the rising power's ascent for granted. Economists once expected rich and poor economies to converge, since growth was understood as the process of capital accumulation subject to diminishing returns.[13] We now know that convergence is far from guaranteed; in particular, developed economies may maintain their lead through innovation, which increases the efficiency with which units of capital and labour are employed.[14] Such increases need not face diminishing returns and may (in theory) be sustained indefinitely. Innovation, in short, has emerged as the economic saviour of the developed world. Moreover, technological advances can be expected to accumulate in developed countries thanks to knowledge spillovers from production,[15] as well as research and development (R&D) activities motivated by the monopoly rents generated by new discoveries.[16]

This implies that rising states face a more daunting challenge than IR scholars have typically imagined. It is not sufficient for such states to rely on diminishing returns in the developed world to catch up; they must become more efficient through innovation, by which we mean the acquisition and creation of new technologies (including both products and industrial processes).[17] This is especially important for middle-income states that have passed the first stage of industrialization, for which further capital investment faces diminishing returns while rising wages remove the previous advantages of low-cost labour, undermining export industries—a

[9] A. F. K. Organski, *World politics* (New York: Knopf, 1961), pp. 303–304.
[10] A. F. K. Organski and Jacek Kugler, *The war ledger* (Chicago: University of Chicago Press, 1981), p. 63.
[11] Douglas Lemke, *Regions of war and peace* (Cambridge: Cambridge University Press, 2002), pp. 26–7.
[12] Gilpin, *War and change in world politics*, pp. 63, 176–81. More recent work has emphasized the extent of the challenge that China faces today, given the overall technological gap between China and the United States and the difficulty of developing and using top-end military equipment in particular. See Stephen G. Brooks and William C. Wohlforth, *America abroad: the United States' global role in the 21st century* (New York: Oxford University Press, 2016), pp. 22–31, 50–62.
[13] Robert M. Solow, 'A contribution to the theory of economic growth', *Quarterly Journal of Economics* 70: 1, 1956, pp. 65–94, and 'Technical change and the aggregate production function', *Review of Economics and Statistics* 39: 3, 1957, pp. 312–20.
[14] Paul M. Romer, 'The origins of endogenous growth', *Journal of Economic Perspectives* 8: 1, 1994, pp. 3–22; Stephen L. Parente and Edward C. Prescott, 'What a country must do to catch up to the industrial leaders', in Leszek Balcerowicz and Stanley Fischer, eds, *Living standards and the wealth of nations: successes and failures in real convergence* (Cambridge, MA: MIT Press, 2006), pp. 17–39; David Coe, Elhanan Helpman and Alexander W. Hoffmaister, 'International R&D spillovers and institutions', *European Economic Review* 53: 7, 2009, pp. 723–41.
[15] Paul M. Romer, 'Increasing returns and long-run growth', *Journal of Political Economy* 94: 5, 1986, pp. 1002–37; Robert E. Lucas, 'On the mechanics of economic development', *Journal of Monetary Economics* 22: 1, 1988, pp. 3–42.
[16] Gene M. Grossman and Elhanan Helpman, *Innovation and growth in the global economy* (Cambridge, MA: MIT Press, 1993), pp. 43–111.
[17] See Romer, 'The origins of endogenous growth'; Elhanan Helpman, *The mystery of economic growth* (Cambridge, MA: Harvard University Press, 2004).

situation commonly labelled the 'middle-income trap'.[18] While there is debate about whether this description is the most appropriate, it is widely recognized that middle-income economies need to upgrade the technological sophistication of their economies, among other things, to enjoy continued long-term growth.[19] We label this dynamic the 'innovation imperative', and it constitutes a background condition of our theoretical framework.

The innovation imperative means that the rising state must attempt to acquire and create new technologies to meet specific short- and long-run growth objectives. In the short run, growth is achieved through technological 'catching up'—the introduction of existing advanced technologies to specific firms or the broader economy.[20] The challenge for the rising power is to develop a strategy and policies to acquire these technologies from the advanced wealthy states that developed them. In the long run, as its economy approaches the technological frontier, the rising power must develop products and processes that are new to the world. Economic theory is clear that innovation is essential for sustained economic growth; rising powers that aspire not merely to Great Power status but to primacy, therefore, have no choice but to elevate the pursuit of innovation to the status of major national interest.

In general, we see rising states acquiring new technology through three distinct pathways: 'making', 'transacting' and 'taking'.[21] *Making* consists of supporting domestic producers in the development of new technologies. Such support may take a variety of forms, including direct subsidies, tax credits and protection from foreign competition. The goals of the 'making' efforts themselves may be more or less ambitious. Some may merely be 'creative' imitations or adaptations of existing technologies, while others could represent attempts at innovation, whether incremental or radical in nature.[22] While making promises greater self-reliance and (potentially) greater profit in the long term, it may be infeasible in the short term, given the rising power's stage of development.

This necessitates either or both of two other kinds of activities—transacting and taking—each of which aims to reduce the time lag between the invention of a new technology elsewhere and the rising state's adoption of that technology.[23]

[18] Homi Kharas and Harinder Kohli, 'What is the middle income trap, why do countries fall into it, and how can it be avoided?', *Global Journal of Emerging Market Economies* 3: 3, 2011, pp. 281–9.

[19] 'Middle-income claptrap', *The Economist*, 16 Feb. 2013, http://www.economist.com/news/finance-and-economics/21571863-do-countries-get-trapped-between-poverty-and-prosperity-middle-income-claptrap; Kharas and Kohli, 'What is the middle income trap?', p. 287; Indermit S. Gill and Homi Kharas, *The middle income trap turns ten*, policy research working paper no. 7403 (Washington DC: World Bank Group, Aug. 2015), p. 15; Alejandro Foxley and Fernando Sossdorf, *Making the transition: from middle-income to advanced economies*, Carnegie Paper (Washington DC: Carnegie Endowment for International Peace, 2011), pp. 18–19.

[20] Vernon proposed a 'product cycle theory', an element of which involves developing countries acquiring technology via the foreign investment and physical presence of multinational corporations, thus representing a middle phase prior to catching up: Raymond Vernon, 'International investment and international trade in the product cycle', *Quarterly Journal of Economics* 80: 2, 1966, pp. 190–207.

[21] This typology builds on Phillip Charles Saunders and Joshua K. Wiseman, *Buy, build, or steal: China's quest for advanced military aviation technologies* (Washington DC: National Defense University Press, 2011).

[22] Tai Ming Cheung, 'The Chinese defense economy's long march from imitation to innovation', *Journal of Strategic Studies* 34: 3, 2011, pp. 327–32.

[23] Note that mean adoption lags fell significantly in the twentieth century. See Diego Comin and Bart Hobija, 'An exploration of technology diffusion', *American Economic Review* 100: 5, 2010, p. 2049.

Transacting entails concluding commercial transactions with foreign entities that result in technology transfer. Given its nature, transacting requires the cooperation of those entities. Examples include purchasing or licensing technology from a foreign source and investing in foreign companies with desired technological assets. Transacting also includes the regulation of foreign firms that provide incoming foreign direct investment to the domestic economy, particularly when pressure is put on those firms to share technology with domestic actors in exchange for market access. In general, transacting is most productive when accompanied by indigenous innovation efforts.[24]

Taking entails the acquisition of existing technology from the outside world through non-transactional means. It includes actions aimed at accelerating the general process of diffusion, where knowledge naturally spreads from high-tech to low-tech countries over time.[25] This could occur through the deliberate collection of open-source knowledge, whether from the collection of published or other material in the public domain or from interaction with knowledgeable foreign experts. Taking also encompasses the acquisition of knowledge that is not in the public domain from non-consenting targets. Specific methods include a permissive approach to industrial espionage or tolerance of intellectual property (IP) theft, and perhaps even government sponsorship of such activities. Like making and transacting, taking faces considerable challenges of its own.[26]

While all rising middle-income states face the innovation imperative, they may respond to it differently. A given state may invest relatively little in making, for example, rendering it more reliant on external sources of technology. Brazil and India have typically fallen into this pattern; both countries have traditionally low levels of national R&D spending relative to the size of their economies. In contrast, another state may respond energetically on all three fronts. China generally fits this profile, as this article will show. In addition, the policies of the dominant state may constrain the options of certain rising states in specific cases, as discussed below.

In short, IR scholarship envisages an important role for technological progress in explaining power transitions, but to date has neglected the challenge this creates for the rising state. Recognizing this challenge allows us to consider how the need for technology, and the process of pursuing technology, might constrain and expose rising states as they look to sustain their rise. Moreover, it allows us to consider the technology and innovation arena as a unique locus of Great Power interaction, in so far as the innovation activities of the rising state may directly affect the strategic interests of the dominant state. Indeed, what makes the innovation domain theoretically and empirically interesting for IR scholars is its external effects, bringing matters typically associated with political economy into broader questions of security, hegemony and order. We consider these questions in the next section.

[24] Xiaolan Fu, Carlo Pietrobelli and Luc Soete, 'The role of foreign technology and indigenous innovation in the emerging economies: technological change and catching-up', *World Development* 39: 7, July 2011, pp. 1204–12.
[25] Robert J. Barro and Xavier Sala-i-Martin, 'Convergence', *Journal of Political Economy* 100: 2, 1992, pp. 223–51.
[26] Industrial espionage, for example, involves multiple processes posing distinct challenges. See Jon R. Lindsay and Tai Ming Cheung, 'From exploitation to innovation: acquisition, absorption, and application', in Jon R. Lindsay, Tai Ming Cheung and Derek S. Reveron, eds, *China and cybersecurity: espionage, strategy, and politics in the digital domain* (New York: Oxford University Press, 2015), pp. 53–6.

Theorizing Great Power interaction in the realm of innovation

In a number of ways, the rising state's interest in innovation may be welcomed by the dominant state. As the world technology leader, the dominant state is best positioned to profit from the rising state's purchases of foreign technology. The dominant state could also welcome increased opportunities for cross-border collaboration in R&D, and it might view the 'taking' of open-source knowledge as relatively innocuous. In other ways, however, the rising state's innovation activity has the potential to challenge the dominant state's strategic interests. In particular, we argue that two characteristics of innovation activities form the link between technology and strategic competition. Both arise from the fact that innovation may generate different types of externalities, defined as impacts that are external to the individual motivations of the actors (such as firms) engaging in the innovation activities. We identify two types of external effects that are germane to the strategic relationship between the rising power and the dominant state: security externalities and order externalities.

Security externalities have been defined as the security implications arising as a by-product of economic interaction and may take a variety of forms.[27] Previous scholarship has argued that all trade with potential adversaries generates negative security externalities, particularly in bipolar systems, since the Ricardian gains and resultant wealth accumulation may be used to augment military capabilities.[28] A different vein of research focuses on the externalities associated with trade in 'dual-use' technologies—commercial technologies with the potential for military application.[29] This latter strand of research is particularly relevant for our purposes here, since the acquisition of technologies with military applications is most likely to generate Great Power tension.

We theorize that the rising state's activity will generate negative security externalities for the dominant state when two conditions are satisfied. The first is a concern on the part of the dominant state about the possibility of military conflict with the rising state. This is obviously possible, but it is not always the case. The United States was not concerned with fighting Japan during the Cold War, and it is not concerned with fighting Brazil or India today. Second is that the rising state's acquisition of a given technology will improve its relative warfighting capability (or degrade that of the dominant state). This will normally be the case when the technology is purely military or dual-use in nature, and the rising state's acquisition of it offers no countervailing security benefit for the dominant state. In some cases, of course, such a countervailing benefit for the dominant state will exist. The rising state's purchases of foreign technology may strengthen

[27] William J. Norris, *Chinese economic statecraft: commercial actors, grand strategy, and state control* (Ithaca, NY: Cornell University Press, 2016), pp. 12–13.

[28] Joanne Gowa and Edward D. Mansfield, 'Power politics and international trade', *American Political Science Review* 87: 2, 1993, pp. 408–20; Joanne Gowa, *Allies, adversaries, and international trade* (Princeton: Princeton University Press, 1995); Michael Mastanduno, 'Do relative gains matter? America's response to Japanese industrial policy', *International Security* 16: 1, 1991, pp. 73–113.

[29] Meijer, *Trading with the enemy*; Fuhrmann, 'Exporting mass destruction?'; Mastanduno, *Economic containment*; Bertsch, *Controlling East–West trade and technology transfer*.

important producers of dual-use technology in the dominant state, for example, reinforcing the latter's primacy.[30] In the absence of such countervailing benefits, however, the net effect on the dominant state's security will be negative.[31]

Order externalities arise because the character of the international system tends to reflect the interests of its most powerful members. The dominant state thus has an interest in preserving and strengthening the rules, practices and institutional arrangements that emerged under its leadership.[32] With regard to technology and innovation in particular, the dominant state naturally prefers a regime that allows it to extract rents from its position as the global technology leader. In a rules-based order, this entails strong protections for IP, which not only maximize the dominant state's economic gains from international commerce but also satisfy powerful domestic producer interests within it. As such, efforts by the dominant state to promote and enforce IP rights serve both the long-term goals of locking in a favourable rules-based order and the short-term goals of maximizing the profits of domestic producers.

Whereas the dominant state seeks to extract rents from its position, the rising state will be motivated to access foreign technology as cheaply as possible. We argue that the rising state's behaviour will generate negative order externalities when two conditions are satisfied. The first is that the behaviour somehow contradicts the order—because the rising state specifically violates the order's rules, practices or norms, disregards existing institutional arrangements, or acts to create alternative rules or institutions that challenge the authority or legitimacy of the status quo. The second is that these contradictory actions threaten the integrity or legitimacy of the order, either because they occur on a scale that undermines the order or because the rising power's behaviour presages the emergence of a rival order at odds with the dominant state's interests. One form of the latter situation is where the rising state resists the dominant state's efforts to extend the existing order, instead promoting an alternative that facilitates its making, transacting or taking strategies. For example, Brazil, China and India have all at times during the present century resisted US efforts to promote 'TRIPs plus' provisions, which would raise international standards for IP protection.[33]

The dominant state will be powerfully motivated to respond when it becomes aware of activities that generate negative strategic externalities. Security externalities associated with a rising power are important, given the latter's potential to challenge the dominant state militarily. Order externalities associated with the

[30] Hugo Meijer, for example, has shown that the US decision to relax some dual-use export controls with China in the post-Cold War era reflected a view that this would strengthen American security, particularly by strengthening American firms that were also important suppliers to the US military. See Meijer, *Trading with the enemy*, pp. 145–64.

[31] There could be cases in which technology transfers to friendly states also generate negative security externalities for the dominant state, particularly if it seeks to control the spread of particularly critical military capabilities. Our focus here is on dynamics between the dominant state and rival powers, where such externalities are likely to be more widespread.

[32] Gilpin, *War and change in world politics*, p. 34; G. John Ikenberry, *After victory: institutions, strategic restraint, and the rebuilding of order after major wars* (Princeton: Princeton University Press, 2001), pp. 50–79.

[33] The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs Agreement) came into force on 1 Jan. 1995. The TRIPs regime is discussed below.

rising power's capacity for innovation also matter because the rising power has the greatest potential to undermine—and, indeed, sponsor replacement of—the existing order.[34] However, the nature of the dominant state's reaction to the two types of externalities is likely to be different.

To address security externalities, the dominant state is likely to act directly to cut off supply of the relevant technology where it can. This would involve intervention in the marketplace to curtail or otherwise prohibit particular transactions that arouse concern, at least when the technology is not available from other countries.[35] To address order externalities, the dominant state must act to defend and strengthen the rules, practices and institutional arrangements that regulate state interactions within the specific domain. This would include threatening or punishing violation by the rising state in order to promote regime compliance. When the order is well established, the dominant state will be motivated to use whatever enforcement tools—bilateral or multilateral—are at its disposal. When domain-specific rules are underdeveloped, the dominant state will work to develop and extend them. This could entail promoting and leading negotiations with like-minded states, pressuring opposing states, or both.

Figure 1: Theoretical model

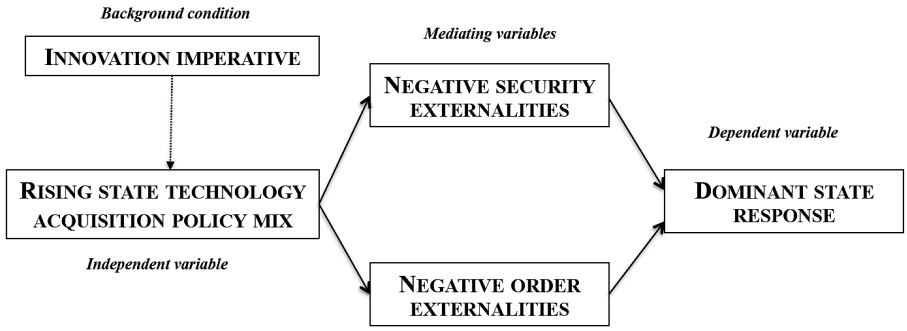


Figure 1 sets out a basic summary of our theoretical model. The innovation imperative is a background condition to which rising states respond with a mix of making, transacting and taking policies. Under certain conditions the rising state's approach to this challenge generates negative strategic externalities for the dominant state, which responds accordingly. However, we recognize that there are other considerations, such as industrial policy, that may compel the dominant state to respond as we predict it will. Our argument is that the dynamics of Great Power competition play an independent and meaningful role, and in the empirical section that follows we put this contention to the test by focusing on the specific interests and mechanisms we have highlighted above. We begin by considering how China as a rising power has responded to the innovation imperative in general

[34] Randall Schweller, 'Managing the rise of Great Powers: history and theory', in Alastair Iain Johnston and Robert Ross, eds, *Engaging China: managing a rising power* (London and New York: Routledge, 1999); G. John Ikenberry and Darren J. Lim, *China's emerging institutional statecraft* (Washington DC: Brookings Institution, 2017), https://www.brookings.edu/research/chinas-emerging-institutional-statecraft/.

[35] Mastanduno, *Economic containment*; Dong Jung Kim, 'Trading with the enemy? The futility of US commercial countermeasures against the Chinese challenge', *Pacific Review* 30: 3, 2017, pp. 289–308.

terms since the mid-2000s. We then turn to two case-studies, which we employ to probe the plausibility of our theoretical model.

Empirics: China's search for technology and innovation

While China's preoccupation with acquiring advanced technology dates back to the nineteenth century, the analysis here focuses on its behaviour in the present century. The discussion that follows is not designed to provide an exhaustive account of China's policies, which is beyond the scope of this article. Instead, we begin with a broad overview of how China has responded to the innovation imperative, noting that in many ways this response has been a welcome development for the United States. We then explore how some of China's activities have challenged US strategic interests in national security and international order, drawing on the theoretical framework outlined above, and note how the United States has responded.

China's response to the innovation imperative

China has responded to the innovation imperative with considerable purpose and energy. Whereas in the 1990s the country became a hub for the assembly of many high-tech products, in the past decade it has emerged as an increasingly important player in high-tech innovation. This change reflects a clear shift in national priorities. While China has sought to boost domestic innovation for decades, its efforts have increased dramatically in the twenty-first century, reflecting a strong conviction that the country must move up the economic value chain. In 2006, the National Medium- and Long-Term Programme for Science and Technology Development (2006–2020), or MLP, declared that China would become 'a world power in science and technology' by the middle of the twenty-first century.[36] A number of initiatives have followed in its wake, including the Strategic Emerging Industries Initiative, the Internet Plus plan and the Made in China 2025 programme. China's initiatives have targeted what is widely regarded as the current leading sector, information and communications technologies (ICT). Yet they have also invested in a range of emerging areas, including artificial intelligence, new energy, biotechnology, new materials and electric vehicles, among others.

China's pursuit of innovation has been underpinned by remarkable increases in national R&D spending. By 2013, China's annual R&D spending had reached US$337 billion (in PPP terms)—second only to the United States at US$457 billion.[37] Moreover, the R&D intensity of the Chinese economy—the fraction of the economy represented by R&D spending—has grown impressively in recent years. As shown in figure 2 below, China's R&D intensity has recently surpassed that of the EU, although it has yet to reach the levels attained by the United States and Japan.

[36] State Council of the People's Republic of China, 'Guojia zhongchangqi kexue he jishu fazhan guihua gangyao (2006–2020 nian)' [National Medium- and Long-Term Programme for Science and Technology Development (2006–2020)], 9 Feb. 2006, http://www.gov.cn/jrzg/2006-02/09/content_183787.htm.

[37] US National Science Foundation, *Science and engineering indicators 2016* (Arlington, VA: National Science Foundation, 2016), pp. 4–45.

Figure 2: R&D intensity of China, EU, Japan and United States, 2000–2016

Some of China's innovation activities have been unobjectionable from the US perspective. China's 'taking' of open-source scientific information, for example, has included collecting 1.2 million foreign conference papers in its national science and technology institutes.[38] In other ways, China's activities have clearly benefited the United States. On the 'transacting' front, for example, China has become an important customer for many US high-tech products. In 2016, the value of US exports to China totalled US$115 billion, of which more than US$33 billion was accounted for by 'advanced technology products', including aerospace, ICT, electronics and biotech products.[39] On the 'making' front, the United States has increased its collaboration with China extensively. US firms spend more on R&D activity in China than those of any other country—and by a wide margin.[40] The United States is also the leading source of R&D alliance partners for China, according to the most comprehensive database on such collaborations.[41] Collaboration between US and Chinese scientists has been particularly impressive. In 2013, US scientists and engineers published nearly 31,000 articles with Chinese collaborators. That total was roughly equal to the number of articles US scientists published with counterparts in the United Kingdom and Japan combined.[42]

In short, China has responded to the innovation imperative with a great deal of energy, and its response has had important benefits for the United States. In other respects, however, China's activities have challenged US strategic interests, generating conflict between Beijing and Washington. It is to those other respects that we now turn.

[38] William C. Hannas, James Mulvenon and Anna B. Puglisi, *Chinese industrial espionage: technology acquisition and military modernization* (New York: Routledge, 2013), p. 24.

[39] US Census Bureau, Foreign Trade, 'US trade with China in advanced technology products—monthly and cumulative data', 2017, https://www.census.gov/foreign-trade/statistics/product/atp/2016/12/ctryatp/at p5700.html.

[40] Andrew B. Kennedy, 'Unequal partners: US collaboration with China and India in research and development', *Political Science Quarterly* 132: 1, 2017, pp. 71–2.

[41] Thomson Reuters, 'SDC Platinum Database', 2015, accessible by subscription only.

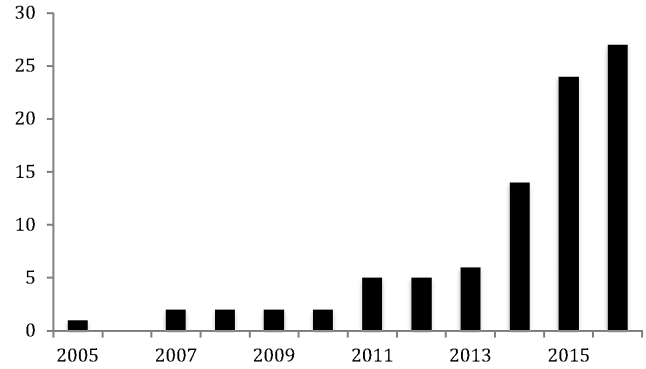
[42] US National Science Foundation, *Science and engineering indicators 2016*, appendix table 5-56.

The Chinese challenge to US strategic interests

China's innovation activities have generated both negative security externalities and negative order externalities for the United States. The following case-studies highlight particularly prominent examples of these phenomena, focusing on China's high-tech investments in the United States and China's approach to IP and cyber espionage. In each case, we begin by documenting China's activity in the arena in question. We then explain how China's activity has generated negative externalities for the United States and how the US government has responded.

Security externalities: China's foreign investment Investing in foreign technology assets is a prominent element of China's response to the innovation imperative and has increased greatly in recent years. From 2005 to 2016, Chinese companies made 90 outward investments, totalling more than US$56 billion, in foreign technology firms (see figure 3). The most active investors include the Chinese firms Huawei, Lenovo and China Mobile, but many others, including Tencent and Baidu, are also active. The United States is a popular destination, attracting 31 of these investments. Most of the investments, moreover, are very recent, 65 of them occurring between 2014 and 2016. Some reflect the active support of the Chinese authorities.

Figure 3: Number of China's overseas technology investments, 2005–2016



Source: American Enterprise Institute (Washington DC), China Investment Tracker, http://www.aei.org/china-global-investment-tracker/.

In 2014, for example, the Beijing government founded a US$22 billion investment fund to promote the development of the domestic semiconductor industry; by March 2016, 81 per cent of the fund had been invested in domestic equity, but 19 per cent went into overseas mergers and acquisitions and other funds.[43] By 2017, China was estimated to have more than 1,000 government-backed investment funds.[44]

[43] Bien Perez, 'China's chip industry bolstered by acquisitions worth US$6.61 billion by government-backed fund', *South China Morning Post*, 30 March 2016.

[44] Yue Pan, 'China's $798B government funds redraw investment landscape, here are the largest funds you must know', *China Money Network* blog, 31 Oct. 2017, https://www.chinamoneynetwork.com/2017/10/31/chinas-798b-government-funds-redraw-investment-landscape-largest-funds-must-know.

Some of China's attempted technology investments have generated negative security externalities for the United States. First, one of the basic conditions for the generation of such externalities is clearly satisfied in this case: the US government is concerned about the possibility of military conflict with China. Potential flashpoints include the Korean peninsula, the Taiwan Strait, the East China Sea and the South China Sea. In this context, the United States is concerned by China's military modernization. As the then US Secretary of Defense Ashton Carter stated in 2016:

> Russia and China are our most stressing competitors. They have developed and are continuing to advance military systems that seek to threaten our advantages in specific areas. And in some cases, they are developing weapons and ways of war that seek to achieve their objectives rapidly, before, they hope, we can respond. Because of this and because of their actions to date, from Ukraine to the South China Sea, DOD has elevated their importance in our defense planning and budgeting.[45]

Second, the military implications of some specific Chinese investments are generating concern. Although the United States is generally open to incoming foreign investment, the US government does weigh the national security implications of some incoming investments in the Committee on Foreign Investment in the United States (CFIUS). Chaired by the US Secretary of the Treasury, CFIUS includes eight other members, among them representatives of the Departments of Defense, State and Homeland Security. It is authorized to review transactions that could result in control of a US business by a foreign person, in order to determine the effect of such transactions on national security. When there is credible evidence that a transaction would threaten US national security, the committee can recommend to the president that it be blocked.

By the end of 2017, a US president had blocked attempted investments by Chinese entities on four occasions following advice from CFIUS. The most recent cases have involved advanced semiconductor technology. In 2016, Fujian Grand Chip Investment Fund sought to acquire Aixtron, a German semiconductor company with a subsidiary in California. Aixtron was known to produce systems for making semiconductors with gallium nitride (GaN).[46] GaN semiconductors are used in some civilian technologies, but given their resistance to heat and radiation, they have military applications as well, including in anti-ballistic missile systems.[47] CFIUS determined that the transaction posed a risk to the US's national security that could not be resolved through mitigation measures. The Treasury Department stated that the risk related 'to the military applications of the overall technical body of knowledge and experience of Aixtron . . . and the contribution of Aixtron's US business to that body of knowledge and experience'.[48] On 2 December, President Barack Obama directed the purchasers and Aixtron to abandon the deal.

[45] US Department of Defense, 'Remarks by Secretary Carter on the Budget at the Economic Club of Washington', 2 Feb. 2016, https://www.defense.gov/News/Transcripts/Transcript-View/Article/648901/remarks-by-secretary-carter-on-the-budget-at-the-economic-club-of-washington-dc/.

[46] 'China's Grand Chip abandons acquisition of Aixtron', *Semiconductor Today*, 9 Dec. 2016, http://www.semiconductor-today.com/news_items/2016/dec/aixtron_091216.shtml.

[47] Paul Mozur and Jane Perlez, 'Concern grows in US over China's drive to make chips', *New York Times*, 5 Feb. 2016.

[48] US Department of the Treasury, 'Statement on the President's decision regarding the US business of Aixtron SE', 2 Dec. 2016, https://www.treasury.gov/press-center/press-releases/Pages/jl0679.aspx.

The United States blocked another Chinese semiconductor investment in 2017. This one involved a Chinese consortium called Canyon Bridge Capital Partners, which sought to acquire Oregon-based Lattice Semiconductor. Lattice was known for making programmable logic chips, which have a wide range of uses because their attributes can be changed using software. Lattice had sold its military design unit in 2012, but still received 3 per cent of its revenue from sales to the US military when the deal was announced.[49] CFIUS recommended that the acquisition not be approved, and on 13 September President Donald Trump agreed. The White House stated that

> the national-security risk posed by the transaction relates to, among other things, the potential transfer of IP to the foreign acquirer, the Chinese government's role in supporting this transaction, the importance of semiconductor supply chain integrity to the United States Government, and the use of Lattice products by the United States Government.[50]

In other cases, the Chinese investor has withdrawn from the proposed transaction after expressions of concern by CFIUS. In January 2016, for example, CFIUS stated that it would recommend disallowing Philips's sale of its Lumileds subsidiary (which had US operations) to a group including Chinese investors. A Philips official indicated that here too CFIUS was concerned about Lumileds's expertise in manufacturing semiconductors using GaN.[51] Following the CFIUS communication, the parties abandoned the deal. In another case, Tsinghua Unigroup cancelled plans to purchase a 15 per cent stake in hard disk maker Western Digital shortly after CFIUS announced that it would review the deal but before any decision had been made.[52] Western Digital products are used in data centres supplying American banks, social media sites and the military.

China's growing activity is fuelling ongoing discussions in the United States on reforming and strengthening CFIUS. A 2017 US Defense Department report raised concerns about venture capital investments in companies with early-stage technologies as well as the jurisdiction of CFIUS more generally.[53] In response, US lawmakers began debating measures to strengthen the committee. Possible reforms include, among others, increasing the number of investments that require CFIUS approval and requiring CFIUS to consider not only specific investments but also broad patterns of investment in a particular industry.[54] As of late 2017, it is not clear where this debate will lead. It is clear, however, that the US government is poised to increase its intervention in the marketplace in response to China's sensitive high-tech investments.

[49] Christopher Wall, 'President Trump issues executive order blocking proposed acquisition of Lattice Semiconductor', *Mondaq Business Briefing*, 20 Sept. 2017.

[50] White House, 'Statement from the Press Secretary on President Donald J. Trump's decision regarding Lattice Semiconductor corporation', 13 Sept. 2017, https://www.whitehouse.gov/briefings-statements/statement-press-secretary-president-donald-j-trumps-decision-regarding-lattice-semiconductor-corporation/.

[51] James K. Jackson, *The Committee on Foreign Investment in the United States (CFIUS)* (Washington DC: Congressional Research Service, 2017), p. 47.

[52] Arash Massoudi, James Fontanella-Khan and Shawn Donnan, 'Tsinghua kills $3.8bn investment plan in Western Digital', *Financial Times*, 24 Feb. 2016, https://www.ft.com/content/c235a154-da37-11e5-98fd-06d75973fe09.

[53] Paul Mozur and Jane Perlez, 'China bets on sensitive US start-ups, worrying the Pentagon', *New York Times*, 22 March 2017.

[54] William Reinsch, *To invest or not to invest*, Stimson Center, 26 April 2017, https://www.stimson.org/content/invest-or-not-invest.

Order externalities: *TRIPs and cyber espionage* Much of China's 'taking' activity, particularly its collection of open-source information, has been innocuous from the US perspective. China's taking of foreign IP, however, has generated negative order externalities for the United States, prompting reactions from Washington. The following discussion considers both China's approach to IP protection following the conclusion of the TRIPs Agreement and China's approach to economically motivated cyber espionage (EMCE) in more recent years.

As China's economy developed in the 1990s, theft of foreign IP became commonplace. The International Intellectual Property Alliance estimated losses due to various forms of piracy in China ranging from US$415 million in 1992 to US$2.8 billion in 1997,[55] reflecting the lack of priority given to protecting IP. In 2000, a survey of business executives for the *Global Competitiveness Report* (*GCR*) gave China a score of 3.6 out of 7 for IP laws and enforcement, higher than Vietnam (2.3) but well below the United States (6.4) and other developed countries.[56] While China acceded to TRIPs when it joined the WTO in 2001, enforcement remained weak and IP theft remained widespread. By 2007/2008 China's *GCR* survey score had improved only to 3.9.[57]

China's activity generated negative order externalities for the United States. To understand why, it is important to appreciate that the US government had been investing in building a global order to protect IP rights worldwide since the 1980s.[58] This resulted in the conclusion of TRIPs at the end of the Uruguay Round of the General Agreement on Tariffs and Trade in 1994.[59] In the 1990s, however, China remained outside the agreement, and given the country's size, its weak protection of IP rights became a persistent problem in Sino-American relations.[60] China's lax enforcement of TRIPs following its accession to the WTO in 2001 was of particular concern to the United States. In September 2005, US Deputy Secretary of State Robert Zoellick made this point while urging China to be a 'responsible stakeholder' in the international system. As he explained:

> The United States will not be able to sustain an open international economic system—or domestic US support for such a system—without greater cooperation from China, as a stakeholder that shares responsibility on international economic issues. For example, a responsible major global player shouldn't tolerate rampant theft of intellectual property and counterfeiting, both of which strike at the heart of America's knowledge economy.[61]

Zoellick's remarks were noteworthy in a number of ways. They indicated that the scale of China's behaviour threatened not simply the profits of individual firms

[55] Andrew C. Mertha, *The politics of piracy: intellectual property in contemporary China* (Ithaca, NY: Cornell University Press, 2005), p. 60.
[56] *Global Competitiveness Report 2002–2003* (New York: Oxford University Press, 2003), p. 603.
[57] *Global Competitiveness Report 2008–2009* (New York: Oxford University Press, 2009), p. 365.
[58] Susan K. Sell, *Private power, public law: the globalization of intellectual property rights* (Cambridge: Cambridge University Press, 2003), pp. 96–120.
[59] The agreement set minimum standards for IP protection, including patents, copyrights, trademarks and trade secrets. The agreement became an integral part of the newly created WTO, and adhering to TRIPs became a requirement for membership in the WTO.
[60] Mertha, *The politics of piracy*, pp. 41–52.
[61] Robert Zoellick, 'Whither China: from membership to responsibility?', US Department of State, 21 Sept. 2005, https://2001-2009.state.gov/s/d/former/zoellick/rem/53682.htm.

but more broadly the sustainability of an open economic order. Other former officials in the Bush administration have confirmed that there was broader concern about the sustainability of the international order at the time.[62] China's behaviour was thus generating negative order externalities for the United States. In addition, Zoellick made clear that there was particular concern about China's lack of protection for IP, which he had earlier described as 'an enormous problem' and 'the number one item on our agenda' with China.[63]

Following an unproductive bilateral dialogue, in April 2007 the United States escalated its efforts by filing a complaint with the WTO regarding the protection and enforcement of IP rights in China; other interested parties joined the action, including Canada, the EU and Japan. The WTO panel partially upheld the US complaint (regarding copyright protection and counterfeit goods) while finding the evidence regarding supposedly inadequate criminal sanctions to be insufficient. Both parties accepted the ruling, marking a partial victory for Washington's efforts to enforce the prevailing order using the mechanisms of the order itself.[64]

In the years that followed, new concerns came to the fore as the United States sought to extend the IP regime. For reasons of space, we focus here on concerns surrounding EMCE. Cyber espionage is generally difficult to document; attribution to a particular actor or even a particular country is an inherently uncertain enterprise, and the Chinese government does not admit to state sponsorship. Over time, however, substantial evidence has accumulated suggesting a steady and significant increase in EMCE emanating from China after 2005.[65] Figure 4 shows publicly reported computer network intrusions attributed to Chinese actors between 2005 and 2013. There appears to be a shift from government to commercial and mixed targets over this period, although this may reflect a greater reluctance of commercial actors to disclose penetrations in the earlier years. Some of these intrusions involved multiple targets: the actor 'APT-1', likely a unit of the Chinese military, was alleged to have penetrated the networks of 141 firms in 15 countries when it was first reported in 2013.[66] This steady rise in reported instances brought China's EMCE to the attention of the US government, with the Obama administration coming to believe that Chinese government actors, including the Chinese military and the Ministry of State Security (MSS), were involved in the activity.[67]

The rise of Chinese EMCE generated negative order externalities for the United States. This was not because the activity clearly violated TRIPs, which was

[62] Former US government official, personal communication, 3 Feb. 2017.

[63] US Department of State, 'Senators laud Deputy Secretary of State nominee Zoellick at confirmation hearing', 16 Feb. 2005, http://archives.uruguay.usembassy.gov/usaweb/paginas/294-00EN.shtml.

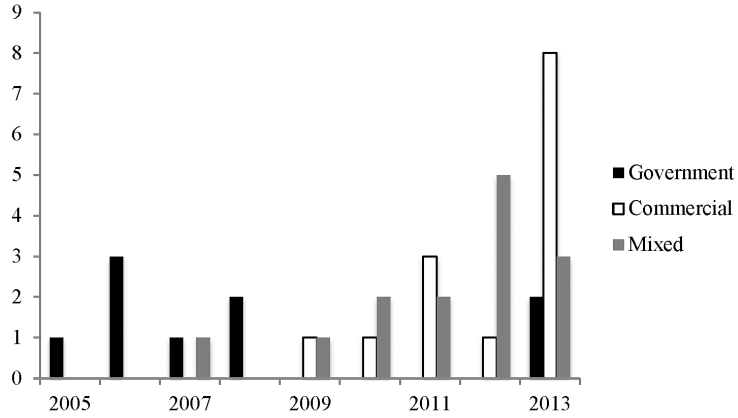
[64] WTO Dispute Settlement, panel report, *China: measures affecting the protection and enforcement of intellectual property rights*, WT/DS362/R, 26 Jan. 2009 (adopted 20 March 2009), https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds362_e.htm.

[65] Lindsay and Cheung, 'From exploitation to innovation', pp. 64–65; Mandiant, *APT1: exposing one of China's cyber espionage units* (Alexandria, VA, 2013), http:// intelreport.mandiant.com.

[66] Mandiant, *APT1*, p. 3.

[67] The military appeared to be particularly active, although it was recognized that the MSS might simply be more proficient at concealing its activity. Author's interview with senior Obama administration official, 22 May 2017.

Figure 4: Number of network intrusions publicly attributed to China



Source: Jon R. Lindsay and Tai Ming Cheung, 'From exploitation to innovation: acquisition, absorption, and application', in Jon R. Lindsay, Tai Ming Cheung and Derek S. Reveron, eds, *China and cybersecurity: espionage, strategy, and politics in the digital domain* (New York: Oxford University Press, 2015), p. 62.

developed before the internet became widely used.[68] Rather, EMCE conflicted with US efforts to extend IP protection in cyberspace, where rules and norms remain less developed.[69] In particular, China's EMCE undermined US efforts to legitimize an important distinction it makes in its own cyber espionage. While the United States does engage in economic cyber espionage (to improve its position in trade negotiations, for example), it claims to refrain from the theft of foreign companies' IP for the benefit of US companies. Setting a baseline for its engagement with other countries, the Obama administration released in 2011 its International Strategy for Cyberspace, a landmark document that laid out the administration's vision of cyber security. On the issue of EMCE, the Strategy warned that:

> Cyberspace can be used to steal an unprecedented volume of information from businesses, universities, and government agencies; such stolen information and technology can equal billions of dollars of lost value. Individual incidents often go unreported or undetected. Results can range from unfair competition to the bankrupting of entire firms, and the national impact may be orders of magnitude larger.[70]

The Strategy listed a set of 'existing principles that should support cyberspace norms', including the idea that 'states should in their undertakings and through domestic laws respect intellectual property rights, including patents, trade secrets, trademarks, and copyrights'.

[68] Jamie Strawbridge, 'The big bluff: Obama, cyber economic espionage, and the threat of WTO litigation', *Georgetown Journal of International Law* 47: 2, 2015, p. 833.

[69] Samantha Bradshaw, Laura DeNardis, Fen Osler Hampson, Eric Jardine and Mark Raymond, *The emergence of contention in global internet governance* (Waterloo, Ont.: Centre for International Governance Innovation, 21 July 2015), https://www.cigionline.org/publications/emergence-contention-global-internet-governance.

[70] Barack Obama, 'International Strategy for Cyberspace: prosperity, security, and openness in a networked world', May 2011, pp. 17–18, https://obamawhitehouse.archives.gov/sites/default/files/rss_viewer/international_strategy_for_cyberspace.pdf.

China resisted the US effort to build a norm against IP theft in cyberspace. Four months after the United States released its cyberspace strategy, China, Russia, Tajikistan and Uzbekistan submitted a draft code of conduct to the UN 'to identify the rights and responsibilities of States in information space'.[71] Diverging dramatically from the US approach, the document failed to mention IP theft, conflicting with the Obama administration's effort to update the IP order, and focused instead on national sovereignty and national censorship. China continued to resist the US approach by launching an annual conclave, the World Internet Conference, in Wuzhen starting in 2014. At the first meeting, the organizers attempted to push through a consensus statement stressing China's priorities while neglecting EMCE, but multiple western delegates refused to support it.[72]

Facing resistance from China, the Obama administration took a variety of actions to promote its preferred cyberspace order. In June 2013, when the two leaders met in California, President Obama explained to the newly installed Chinese President Xi Jinping that Chinese cybertheft could seriously damage the bilateral relationship. That same month, the United States successfully forged a consensus on norms surrounding cybersecurity in a report released by the UN Group of Governmental Experts (GGE). The GGE report stated that 'state sovereignty and international norms and principles that flow from sovereignty apply to State conduct' in cyberspace.[73] While this acknowledgement was welcome to Beijing, the report also affirmed that 'international law, and in particular, the United Nations Charter, applies to cyberspace'—an apparent victory for the United States.[74]

The United States increased the pressure on China to accept the US-preferred order in 2014 and 2015. In May 2014, the US Department of Justice charged five Chinese military officers with stealing trade secrets from American companies.[75] While the indictments were symbolic, they marked a more confrontational approach intended to publicly shame China into changing its behaviour. In April 2015, the President took further measures, signing an executive order authorizing sanctions against individuals or entities involved in 'malicious cyber-enabled activities' directed against the United States.[76] While North Korea was the primary target, China was also very much on the minds of US policy-makers.[77]

[71] UN General Assembly, 'Letter dated 12 September 2011 from the Permanent Representatives of China, the Russian Federation, Tajikistan and Uzbekistan to the United Nations addressed to the Secretary-General', 14 Sept. 2011, https://ccdcoe.org/sites/default/files/documents/UN-110912-CodeOfConduct_0.pdf.

[72] James T. Areddy, 'China delivers midnight internet declaration—offline', *Wall Street Journal*, 21 Nov. 2014.

[73] *Report of the Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security*, United Nations General Assembly, 24 June 2013, p. 8, http://www.unidir.org/files/medias/pdfs/developments-in-the-field-of-information-and-telecommunications-in-the-context-of-international-security-2012-2013-a-68-98-eng-0-518.pdf.

[74] The Chinese representative reportedly agreed to the latter statement only to avoid a confrontation that might complicate the Obama–Xi summit. See Adam Segal, *Chinese cyber diplomacy in a new era of uncertainty* (Stanford, CA: Hoover Institution, 2017), p. 6, http://www.hoover.org/sites/default/files/research/docs/segal_chinese_cyber_diplomacy.pdf.

[75] Michael S. Schmidt and David E. Sanger, '5 in China army face US charges of cyberattacks', *New York Times*, 19 May 2014, http://www.nytimes.com/2014/05/20/us/us-to-charge-chinese-workers-with-cyberspying.html.

[76] White House, Office of the Press Secretary, 'Executive order "Blocking the property of certain persons engaging in significant malicious cyber-enabled activities"', 1 April 2015, https://www.whitehouse.gov/the-press-office/2015/04/01/executive-order-blocking-property-certain-persons-engaging-significant-m.

[77] Author's interview with senior Obama administration official, 22 May 2017.

In August 2015, US National Security Advisor Susan Rice visited Beijing and warned Chinese officials that the United States was preparing sanctions against Chinese hackers, which could be announced before President Xi's upcoming visit to Washington in September unless the two sides came to terms.

In response, China came to terms. On 25 September 2015, Presidents Obama and Xi agreed that 'neither country's government will conduct or knowingly support cyber-enabled theft of intellectual property, including trade secrets or other confidential business information, with the intent of providing competitive advantages to companies or commercial sectors'.[78] China proceeded to sign similar agreements with the United Kingdom and Germany. In November, the G20 then agreed that 'no country should conduct or support [cyber]-enabled theft of intellectual property, including trade secrets or other confidential business information, with the intent of providing competitive advantages to companies or commercial sectors'.[79] In December that year, Chinese President Xi Jinping spoke at the World Internet Conference in Wuzhen and even there acknowledged the emerging norm, opposing the use of cyber espionage for commercial gain, though he also listed it among other types of cybercrime including 'cyber surveillance' and attacks on government networks.[80]

Beijing's public endorsement of this element of an emerging US-preferred order was a far cry from the draft code of conduct submitted in its name to the UN, thus representing an important victory for Washington. Even so, contestation over EMCE continues. While the scale of Chinese cyber espionage against private companies declined following the agreement, US officials believe EMCE has become more targeted and calculating, and some suggest it increased in the second half of 2017.[81] These perceptions prompted US officials to warn their Chinese counterparts in November 2017 about 'backsliding' on the agreement.[82] In short, settling on a clear and enforceable order prohibiting EMCE is likely to remain a contested area for some time to come.

[78] White House, Office of the Press Secretary, 'Fact sheet: President Xi Jinping's state visit to the United States', 25 Sept. 2015, https://www.whitehouse.gov/the-press-office/2015/09/25/fact-sheet-president-xi-jinpings-state-visit-united-states.

[79] Ellen Nakashima, 'World's richest nations agree hacking for commercial benefit is off-limits', *Washington Post*, 16 Nov. 2015, https://www.washingtonpost.com/world/national-security/worlds-richest-nations-agree-hacking-for-commercial-benefit-is-off-limits/2015/11/16/40bd0800-8ca9-11e5-acff-673ae92ddd2b_story.html.

[80] Adam Segal, 'China's internet conference: Xi Jinping's message to Washington', Council on Foreign Relations *Net Politics* blog, 16 Dec. 2015, http://blogs.cfr.org/cyber/2015/12/16/chinas-internet-conference-xi-jinpings-message-to-washington/.

[81] FireEye, *Redline drawn: China recalculates its use of cyber espionage* (Milpitas, CA, June 2016), https://www.fireeye.com/content/dam/fireeye-www/current-threats/pdfs/rpt-china-espionage.pdf; Adam Segal, 'The US–China cyber espionage deal one year later', Council on Foreign Relations, *Net Politics* blog, 28 Sept. 2016, https://www.cfr.org/blog/us-china-cyber-espionage-deal-one-year-later; Andy Greenberg, 'China tests the limits of its US hacking truce', *Wired*, 31 Oct. 2017, https://www.wired.com/story/china-tests-limits-of-us-hacking-truce/.

[82] Adam Segal, 'An update on US–China cybersecurity relations', Council on Foreign Relations, *Net Politics* blog, 17 Nov. 2017, https://www.cfr.org/blog/update-us-china-cybersecurity-relations.

Conclusion

IR scholars have long recognized that technology plays a critical role in power transitions, but the discipline has hitherto lacked a framework within which to understand how technology and innovation strategies generate rivalry within such transitions. This article addresses that gap. We began by arguing that middle-income rising powers face an 'innovation imperative' by virtue of their stage of development—at least if they wish to continue developing—that compels them to engage in a range of innovation activities. For the purposes of this article, we note that China is energetically responding to this imperative in a variety of respects. China's particular approach to promoting innovation has been criticized, particularly in respect of the degree of government intervention involved.[83] It is undeniable, however, that China is making great efforts to become a powerhouse of technological innovation.

We argue that the rising state's activities are likely to affect its relationship with the dominant state. In some regards, the rising state's activity will be welcomed, and we note the increase not only in US technology exports to China but also in US–Chinese collaboration in innovation. In other respects, however, the rising state's pursuit of innovation can threaten the dominant state's strategic interests. First, under certain conditions the rising state's acquisition of dual-use technologies has the potential to generate negative security externalities for the dominant state. When this occurs, the dominant state is likely to curtail or prohibit the transactions, if it can. We have explored this dynamic by focusing on China's rapidly increasing investment in US high-tech companies in recent years, and on the concern it has clearly aroused in Washington. In some cases, proposed investments have been blocked, and it is possible that US restrictions on Chinese investment will be expanded in the future.

Second, under certain conditions the rising state's activities will generate negative order externalities for the dominant state, particularly by undermining its preferred rules, practices and institutional arrangements. When the order is well established, the dominant state will be motivated to use whatever enforcement tools—bilateral or multilateral—are at its disposal. When domain-specific rules are underdeveloped, the dominant state will lead in efforts to develop them. We have explored these dynamics by focusing on China's approach to TRIPs and its conduct of EMCE. The United States responded to the former by pressuring China to accede to TRIPs, and after it had done so, by using the WTO dispute settlement framework to increase Chinese compliance. In respect of the latter, Washington responded by working to build an international normative framework that condemns government-sponsored EMCE. This attempt succeeded in developing a publicly acknowledged norm and in changing Chinese behaviour, although the extent to which China has in fact reduced its EMCE remains unclear.

[83] Barry Naughton, 'China's economic policy today: the new state activism', *Eurasian Geography and Economics* 52: 3, 2011, pp. 313–29; Sylvia Schwaag Serger and Magnus Breidne, 'China's fifteen-year plan for science and technology: an assessment', *Asia Policy,* vol. 4, July 2007, pp. 135–64.

More broadly, these findings offer new insights into the interaction between strategic and economic ties in power transitions. To date, the nascent literature in this field has sought to explain why the dominant state would remain open to commerce with rising states, even when its strategic interests are challenged.[84] In contrast, we have highlighted the considerations driving both the rising state and the dominant state. Moreover, we have explained where the two states' interests are likely to conflict and how the dominant state is likely to react when they do.

The evidence presented sufficiently supports the plausibility of our theoretical model to merit further scholarly research, which could deepen and extend this work in a number of respects. First, it is worth exploring the domestic politics surrounding how the dominant state responds to the rising state when it perceives negative strategic externalities. For example, firms and other actors that stand to profit from commerce with the rising state may resist attempts to curtail trade in dual-use technologies, potentially complicating the dominant state's calculation of national interest, particularly if these actors can make the case that their continued prosperity has important national implications.

Second, scholars might interrogate how a rising state's interests change over time as its technological sophistication increases. With regard to international order, the rising state may become more supportive of a system that protects IP and safeguards whatever technological advantages the rising state may be acquiring. In particular, the number and influence of actors with an interest in strong IP protection should increase in the rising state as it moves up the economic value chain, and this can be expected to lead to stronger enforcement of IP protection within the rising state. On the other hand, the scope and scale of negative security externalities for the dominant state may also increase as the rising state approaches, and begins itself to expand, the technological frontier. If so, the political-economic tensions we have documented here could decline in one respect while rising in another.

[84] Meijer, *Trading with the enemy*; Kim, 'Trading with the enemy?'.