SCIS Working Paper | Number 69

TECHNOLOGICAL COMPETITION AND THE WORLD ORDER

D Nathan and S Rahul | *April 2025*

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SOUTHERN CENTRE FOR INEQUALITY STUDIES

Abstract[1]

This paper deals with the role of competition and technological domination in changing the world order. It points out that there are constraints in the major Asian economies, which could hamper their ambitions of building technological dominance. Acknowledging that competition and monopolisation dominate the history of technological development in global capitalist history, the paper points to the necessity of international cooperation in meeting contemporary global challenges and staving off new forms of devastating warfare.

Keywords: Technology competition, technological domination, world order, Asia, China, artificial intelligence

Introduction

That economic competition drives technological development is an analysis introduced by Marx and later developed by Schumpeter (1942) through his analysis of the drive to secure monopoly profits through technological development supported by intellectual property rights. More recently, Carlota Perez (2002) developed the Kondratieff model of long waves of technological change into that of changing techno-economic paradigms, which include not only technology but also how production is organised.

This paper looks at aspects of this knowledge and technological development in the current global economy with a focus on Asia's role. Technological change provides opportunities for latecomers to even dominate the general purpose technology (GPT) of an era, identified in a techno-economic paradigm. Next we deal with the role of technological competition in changing the world order. We then look at the strategies of Asian economies, mainly China and India, but also Japan and Korea. Acknowledging that competition and monopolisation dominate the historical trajectory of technological development and the creation of hegemony, the paper draws attention to the necessity of cooperation in technological development and deployment in meeting the challenges of climate change and staving off new forms of devastating warfare.

---

[1] This is a revised version of a Keynote paper presented at the IGU-CDES Conference 'Asia in the Transforming Global Economy,' at Peking University, 21 and 22 June 2024. Thanks to Govind Kelkar and Will Milberg for discussions over a long period of time.

Long waves of techno-economic paradigms

The world economy has been going through long waves of technological change that have been driven by knowledge. Technologies create techno-economic paradigms that include not only the input–output technological relation but also "organizational habits in technology, the economy, management and social institutions" (Perez, 2002: 7). Capitalism is now in its fifth techno-economic paradigm. The five techno-economic paradigms are Machine and Factory Production of the Industrial Revolution; Steam and Railways; Steel and Electricity; the Automobile and Mass Production; Information and Communication Technology (ICT) and Decentralised Production. The Age of each tecno-economic paradigm is identified by its core technologies and forms of organisation. The core technologies include a GPT that is central to the set of technologies of that Age – mechanisation, steam power, electricity, ICTs, etc. Each Age also has its characteristic form of organisation of production – such as factory, mass production, splintered and decentralised production. The combination of technology and the organisation of production make for a techno-economic paradigm. Each Age also has its characteristic environmental footprint (Kaplinsky, 2021), a topic that has not been extensively researched.

In the transition from one technological paradigm to another, there arise opportunities for latecomers. The new technology requires new competencies in which no economy may hold an edge. This provides an opportunity for countries other than the current leaders to play the key role in the development of the new technology. Consequently, there can be a shift in the technological leader. This happened in the shift from mechanisation and steam power to electricity and mass production as the leadership of the technological core of the new GPT shifted from Britain to the United States of America (USA). Of course, such a shift does not necessarily have to take place. Britain remained the leader in the shift from mechanisation to steam and steel, while the USA remained the leader in the shift from electricity and mass production to ICTs. Who will lead the shift from information communications and technology (ICT) to artificial intelligence (AI) and quantum computing? There clearly is a race between the USA and China to be the leader in this technological development, and to enclose the technology so that they can get monopoly returns from it.

We do not have a generally accepted name for this technological transformation that is yet to be installed or even fully developed. We could call it the Age of AI, as in the title of the book by Henry Kissinger, Eric Schmidt and Daniel Huttenlocher (2021). The core of AI is machine learning, which itself has gone through many transformations, with the most important perhaps being that from "hand-crafted knowledge to machine-learning from data" (Russell and Norvig, 2020: 52). It is certainly a GPT that affects not just all areas of production but even any intellectual task. In parallel, there is the development of quantum computing, which could work with AI to magnify the transformation of both civilian and military technologies.

The appearance of radically novel technologies, those that lead to a new technological paradigm, depends on "the constant capture of new natural phenomena and the harnessing of these for particular purposes … Technology builds out not just from combination of what already exists but from the constant capturing and harnessing of natural phenomena" (Arthur, 2009: 22). The capturing of natural phenomena goes all the way from using the heat of fire to quantum phenomena. It is for this reason that advances in radically novel technologies depend on scientific development. Tinkering is unlikely to advance AI or lead to a workable quantum computing machine; they both require the most-advanced and foundational scientific knowledge possible.

Whether a techno-economic paradigm is in its installation or deployment phase makes a difference to the nature of the opportunities that are presented. In the installation phase, it is difficult for a latecomer to break in; rather, it requires a well-developed science and technology research system. It also requires large investments in scientific research and world-class universities to be able to make the development. Conversely, technology deployment or its embodiment as innovation in products and services, which depends on the development of already existing basic technology or combinations of technologies, can be carried out without similarly being at the frontier of scientific development. In the deployment phase, there are opportunities for what Keun Lee (2013: 140) labelled short-cycle technologies, which he also pointed out are "less original technologies", or second-generation production and process innovation (Breznitz and Murphree, 2011), or technologies that represent a new technological paradigm, a radically novel technology from one that continues along a given technological path (Dosi, 1982) – a formulation that fits in with the conception of successive techno-economic paradigms.

Artificial intelligence and technological competition

AI and quantum computing, as also the climate-change-related technologies, are novel technologies, embodying some newly analysed or newly used natural phenomena. The development of AI is based on machine learning, which is a novel technology of a computer system that is able to learn without having been explicitly programmed to do so (Russell and Norvig, 2010). AI is a GPT in the sense that it can be applied across every sector of the economy and, even, every activity in society and the polity. The nature of innovation and scientific discovery are being transformed by AI (Rikap and Lundvall, 2021). AI is becoming an extension of the human brain, resulting in a likely unimaginable increase in intellectual power. If, at some stage, AI is combined with the still-to-be-developed quantum computing, the combination will result in computing, problem-solving and creative power of many orders of magnitude higher than what the world now has. It will lead to the reorganisation of the manner of production (see, for example, Kaplan, et al 2024), resulting in a new techno-economic paradigm. Of course, like any other technology, there are both positive and negative aspects to this development of AI. Briefly, through autonomous weapons systems, it can increase the potential for devastating wars. Being able to programme itself and thus not be restricted by objectives fed by humans into its algorithms, AI also adds a new threat of an extinction-level event facing human beings (Hinton, 2024).

The advent of this radically novel technology would mean that there is an opportunity for some country, some latecomer, to take the lead in its development. Simultaneously, there continue to be opportunities for the deployment of ICTs in newer areas through short-cycle or second-generation technologies. This has been seen in the growth of e-commerce and social media by American and Chinese firms and the Indian development of hyper-scale identity and payments systems. But the critical technology in the current phase of global history is that of AI. Given its character of being a GPT and a dual – both civil and military – technology, it has become central to geopolitical competition.

AI can be seen by itself or in combination with the still nascent quantum computing, which is able to process many possibilities in parallel, unlike classical computers that process one state after another. Quantum computers need much fewer training sessions to master a task, while AI is being used to help design quantum computation (Chou et al., 2025). Together, such technological developments will shape the economy of tomorrow, and thus are the key areas of technological competition.

There are many forms of competition in the world in the spheres of economic, military and diplomatic power, and even that of soft power. But, at present, the central competition is that for technological supremacy. As Rikap and Lundvall (2021: 2) put it: "… technology has become the central subject of geo-political conflict". It is technology that will provide a strategic advantage over rival/s, just as West European militaries achieved a strategic advantage over their Asian rivals in the pre-colonial era through the military revolution (Parker, 1996). AI and quantum computing with their ability to permeate all weapons' systems may foster a new military revolution, providing a decisive advantage over countries with non-AI, non-quantum weapons' systems.

China's State Council issued the New Generation Artificial Intelligence Plan (AIDP). "AI has become a new focus of international competition. AI is a strategic technology that will lead in the future; the world's major developed countries are taking the development of AI as a major strategy to enhance national competitiveness and protect national security" (Webster et al. 2017, cited in Rikap and Lundvall, 2021: 8). The combination of AI and quantum computing as GPTs and their dual civilian-military use, together justify the identification of mastery over AI and quantum computing as the central subject of geopolitical conflict.

Successful techno-nationalism develops into imperialism

Although global networks and flows are important in the creation of knowledge, there is still a strong nationalist condition in its development. Nation-states play an important role in setting the research and design (R&D) agenda, or in fostering links between the different knowledge circuits. Firms operate in the context of national polices for higher or STEM (science, technology, engineering, mathematics) education. All the connections of these organisations and the incentives for knowledge creation have been brought together in the concept of NIS, national innovation systems (Lundvall, 1992). While using these nation-state-based concepts, it is, however, necessary to situate them within global interactions and global roles, whether as mainly users or creators of technology.

Since the nineteenth century, attempts of the USA and Germany to catch up with Great Britain technology policies have been set at the national level. Thus, government action in support of the high-tech industries of the time or techno-nationalism is not something new (Ostry and Nelson, 1995: 61). The USA played a key role in the development of various technologies, whether of the internet or various pharmaceuticals, or the now ubiquitous touch screen (Mazzucatto, 2013). Nation-states or civilisation-states also set technological standards that might be restricted to their boundaries. Or, they take actions against technologies from other countries, such as the Chinese action against Google or the Indian action against Tik-Tok, and USA attempts to deny China access to advanced chips used in the creation of AI systems.

Thus, when latecomers try to catch up, there is an inevitable techno-nationalism in developing technologies and setting standards. Of course, there is also nationalism in technology leaders trying to stall other countries in copying their advanced technologies (Chang, 2000 and Nathan, 2024). Techno-nationalism in the capitalist world, however, has also been the prelude to expansionism. This happens as successful techno-nationalist polices lead to the development of monopolies with their knowledge protected by intellectual property rights. These monopolies seek to both extend their markets and secure rents or high profits through external concessions as nation-states also try to expand their spheres of influence. This expansionism of monopoly capital allied with national states was analysed by Hobson (1902), Lenin (1917) and Luxemburg (1951) as the basis of imperialism and the concomitant inter-country struggle over spheres of influence. Later analyses of Arrighi (1994) and Hung (2022) treated these two factors separately: market expansion by monopoly capital and state creation of colonies or spheres of influence.

Ugo Pagano (1995)[2] brought in additional factors to account for competition between nation-states as imperialism. These are symbolic utility a la Robert Nozick (cited in Pagano, 1995: 17), "the utility that we get from what we think we are", and positional goods, in Hirsch's analysis (1977, cited in Pagano, 1995), the exercise of power and domination that necessarily mean power and domination over someone or some nation. The attempt to acquire positional goods leads to competition between powers. As Pagano (1995: 21) points out, "'Positional competition' is much harder, and sometimes more violent, than competition for 'private' goods", such as wealth. This positional competition is seen in the geopolitical rivalry to establish or re-establish global dominance.

In contradiction to the analysis of imperialism as a necessary concomitant of monopoly capitalism and national competition, Schumpeter (1919) thought that national competition could be overcome by the desire to accumulate. Keynes (cited in Pagano, 1995), too, felt that dangerous tendencies could be channelled into the accumulation of wealth. But, as Pagano sums it up, "Individuals may wish to define themselves as members of powerful nations and may wish to consume pride and superiority with respect to other national and ethnic groups. Unfortunately, if many national groups share these wishes, then an over-investment in nationalism takes place. This over-investment by possibly rational agents may perhaps help to explain some of the most regrettable aspects of our age" (Pagano, 1995: 27). These additional factors brought into the analysis by Pagano extend the motivations for imperialism beyond monopoly capital to the nation-state and even to the individuals comprising a nation.

That notions of great power recognition are widespread is seen in the popularity of slogans, such as Trump's "Make America Great Again", which can be understood as re-establishing pre-eminence in the world order. Simultaneously, it is also an attempt to redefine the USA as a "white Christian nation" (Blake, 2025). As both China and India try to define themselves as civilisation-states and not just nation-states, the notions of greatness are also inter-twined with ideas of domination, whether of the world or of regions, identified as civilisational spaces. Civilisations are defined by central worldviews, whether of Confucianism in China or Hinduism in India; all other worldviews within the civilisational space, whether of Buddhism or Islam, have secondary status.

At different times in India, the chief of the RSS, a right-wing Hindu nationalist organisation and the ideological fountainhead of the ruling BJP (Bharatiya Janata Party), has said that Akhand Bharat (Greater

[2] This portion owes much to Ugo Pagano (1995).

India) would be a reality in the coming years[3] and that whoever comes in the way of India's rise would be eliminated.[4] This is the language of expansionism in the form of civilisational identity. Clash of civilisations (Huntington, 1996) with a vengeance?

Whether separately or through the BRICS grouping, the rising Asian powers are attempting to create alternative spaces of influence as the USA tries to technologically and militarily shore up the weakening USA-dominated world order. But, is the currently growing multipolar order only an inter-regnum, a likely transition to a bipolar world? Going back to the centrality of the competition for technological leadership, along with the emergence of Asia as a whole, there is central global competition for technological leadership between China and the USA in the general technologies of AI and quantum computing. If they both (along with other countries perhaps?) lead in these core technologies, then there would be, all else being the same, an extended big power rivalry. If these technologies are dominated by just one country, then there could be a new unipolar world order.

Differences in knowledge strategy in Asia

We now turn to the knowledge and technology development strategies of the major Asian economies, China, India, Japan and Korea. We take R&D expenditure as a percentage of gross domestic product (GDP) and as an indicator of strategy or commitment to knowledge creation. Why do these countries clearly differ in their commitment to or policies about knowledge creation, as seen in Figure 1?

There is much analysis of the how of knowledge creation – the role of culture (Weber), of institutions (North) and so on. But there is little discussion of the why of knowledge creation (Taylor, 2016). Marx explained technology creation in terms of competition among capitals, leading to the constant revolutionising of the means of production, or technology in the language we use. Schumpeter (1944) took this further by stating that technology was created and adopted in order to earn monopoly profits, through what Teese (1986) labelled the appropriability of returns to innovation.

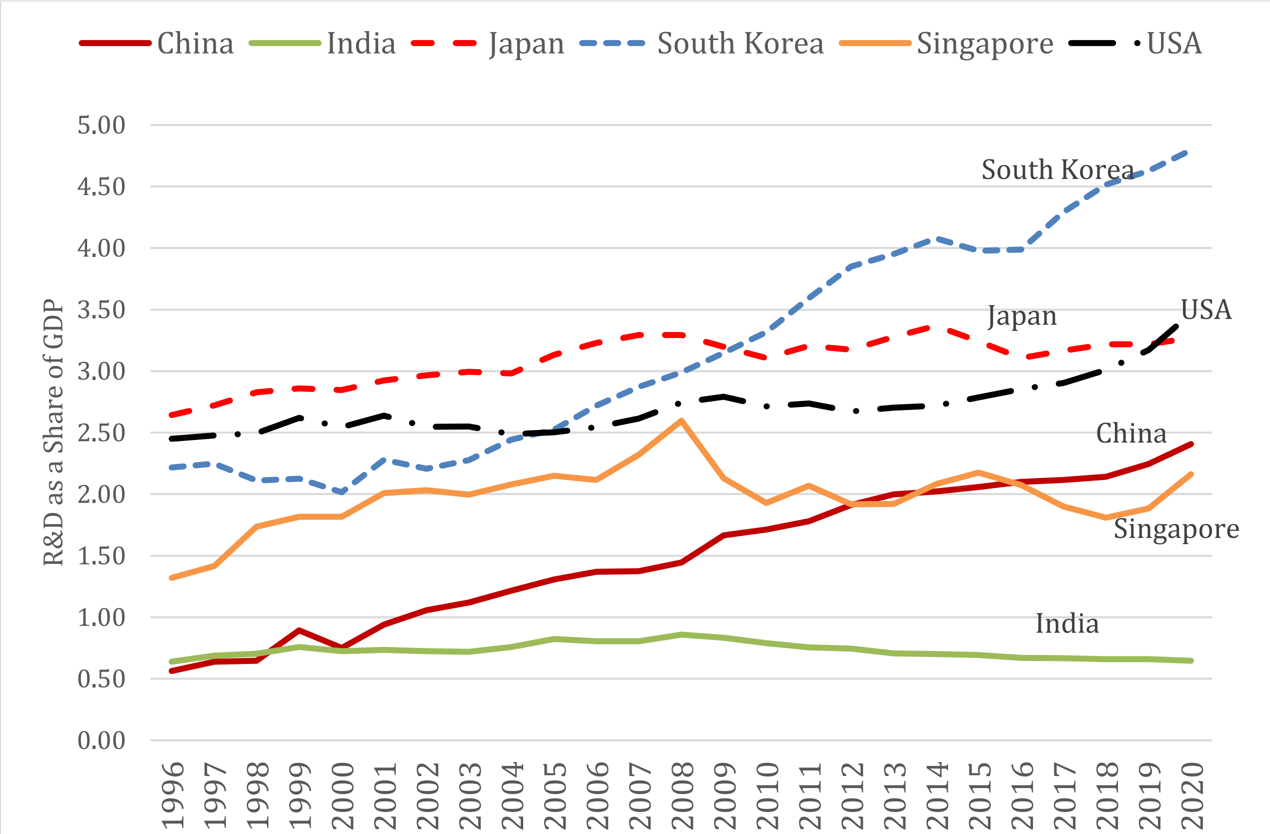
This section deals with the why of knowledge creation. Why are there differences between countries in Asia, specifically China, India, Korea and Japan, in the emphasis they place on knowledge creation. To state the problem to be explained: why are there differences in Figure 1?

---

3 https://www.indiatoday.in/india/story/rss-mohan-bhagwant-akhand-bharat-remarks-name-change-debate-india-2431977-2023-09-06

4 https://www.theweek.in/news/india/2022/04/15/rising-india-is-vehicle-with-accelerator-but-no-brakes-mohan-bhagwat.html

Figure 1: R&D as a share of GDP (1996 to 2020)



Source: World Development Indicators (https://databank.worldbank.org/source/world-development-indicators/Series/GB.XPD.RSDV.GD.ZS)

A summary of the position of the technological competition in the world economy is seen in country expenditures of R&D, not as a percentage of GDP but in absolute terms. Table 1 below gives the gross R&D expenditures in purchasing power parity in US Dollars (PPP$) for 2022.

Table 1: Gross R&D expenditures in PPP$, 2022, India 2020-21

	Country	**R&D in PPP$ Billion**
1	USA	760
2	China	620
3	Japan	180
4	Germany	134
5	Korea	119
6	India	58

Source: Statista, for 1 to 5, https://www.statista.com/statistics/732247/worldwide-research-and-development-gross-expenditure-top-countries/ and Department of Science and Technology, R&D Statistics 20222-23.

Notable is the gap between the first two, USA and China, and the rest. India, of course, is way behind. These statistics show which countries are in the race to develop the new technologies of our Age.

Looking at AI, given the high cost, much investment in AI models is carried out in the private sector. In the area of foundational models (trained on large datasets that are versatile and suitable for numerous downstream applications), the USA-led in 2023 with 109 models, followed by China with 20 models. Google, Meta and Microsoft released 18, 11 and 9 models respectively in 2023 (Stanford, 2024). India has no place in the development of foundational AI models; rather it has applied itself to applications, an approach rooted in "a lack of willingness to fund research without clear end goals" (Jasani, 2025).

In the area of quantum computing, too, the race is mainly between the USA and China. In this, however, China accounts for the largest number of patent applications, followed by the USA, and has also invested more than the USA or the European Union (EU).[5] China also had the largest share of patents in quantum computing between 2020 and 2022, with Japan coming in third. Korea and India are also on the list, but from India it could be from Global Capability Centres (GCCs) of Fortune 500 companies, rather than Indian companies (Lee et al, 2024).

That there is a two-horse race to develop the AI and nascent quantum computing technologies is confirmed by the above data. Not only do the USA and China stand apart from the crowd, but the USA is also somewhat ahead of China. The data also show that there is much competition among the tech majors of the USA, something that only benefits the country's attempt at continuing technological domination.

External and internal conflicts

An analysis of why countries differ in their commitment to R&D was put forward by Mark Taylor (2016). Countries face two types of conflict – internal and external. Technological transformation is not required to deal with internal conflicts, which are basically over the distribution of national income. External conflicts, which may be both economic or military, however, require an economy to be at the technological frontier, requiring continuing investment in R&D. The combination of the two types of conflict, internal and external, leads to what Taylor terms creative insecurity. This drives investment in advanced technologies. The higher the creative insecurity, the more the national investment in R&D. With this analytical apparatus of the balance between internal and external conflicts, and overall tax revenue, we look at the experiences of the main Asian economies – China, India, Japan and Korea – in comparison to the USA.

---

[5] https://www.statista.com/statistics/1319273/planned-public-funding-quantum-computing-country/

Two of these Asian economies, Japan and South Korea, have had security alliances with the USA and thus did not have to bear the full burden of dealing with external conflicts. They could, as a result, concentrate on building their national economies. Japan, with its post-Second World War recovery, used its penchant for reverse engineering – a capability for which it has been known since the time it closed its economy in the late nineteenth century – and by the early 1970s, had reached a level which was "… in many respects equal to that of other advanced industrial countries" (Morris-Suzuki 1994: 210). After this, Japan competed on world markets mainly through cheaper products, some of which cheapness may also have been due to adopting the Toyota process innovation of "just-in-time" production, which reduced costs and incrementally improved products.

In 1985 with the Plaza Accord, Japan was forced to revalue. This had the beneficial effect of a move to innovation. "The dramatic revaluation of the yen in 1985, for example, made it more difficult for Japan to compete in world markets for conventional industrial products, forcing them to rely on innovation rather than price competition" (Morris-Suzuki 1994: 222). This led to the rise of Japan as an innovator in new products but not of basic technologies.

In the case of South Korea, too, there is a clear external trade factor leading to a push for export competitiveness. After the 1998 Asian Financial Crisis, Korea moved to shift manufacturing factories in labour-intensive products, such as apparel and footwear, to low-wage locations, such as China and Southeast Asia, while itself concentrating on higher value that captured pre-production functions of design and production management (Nathan, 2024). The major push, however, was to develop new, even if only incrementally new, products in electronics. These were in the short-cycle technologies, as identified by Keun Lee (2013). Korea's commitment to building new knowledge-based products can be seen in its increasing share of R&D to GDP, which increased from 2.2% in 1995 to 4.8% in 2020 (Figure 1).

China also shows a sustained increase in share of R&D to GDP. Starting below India in 1995, it was way above India at 2.5% in 2020. There are two inflexion points in China's (and Korea's) trajectory -around 2000 after the 1998 Asian Financial Crisis, and around 2010 after the Great Recession. Both followed a policy of investing more in R&D in recessionary periods. In contrast to these two, India actually reduced its share of R&D after 2010. From the low 0.8% in 2010, it went back to 0.65% in 2020, a level it had been at in 1995.

China not only undertook investments in second-generation innovation, that is, the application of technologies in particular sectors of the economy such as in electric mobility, but also it invested in the core technologies themselves. Soon after the defeat in Go by an AI machine in 2017, dubbed China's

“Sputnik moment” (Suleyman, 2023: 120), China made clear its intention to be the world leader in AI. Similarly, with quantum computing. China’s emphasis on developing core technologies sets it apart from the other Asian majors.

With regard to external contradictions, Japan, Korea and China have all had to face the necessity of competing at the frontier of technology in world trade. India has faced this in information technology (IT) services but not in manufacturing, where there is still much protection, including through anti-dumping tariffs. Korea and Japan have faced this external competitiveness challenge despite the military umbrella provided by the USA. In the case of China as it competes with the USA, it has been forced to compete at the frontier of technology both in economic and military spheres, including growing multi-purpose technology. In the case of India, however, internal conflicts seem to overwhelm its external conflicts and, coupled with a lower share of tax revenues to GDP, have lead to lower investment in R&D.

The how of knowledge development

Investing more in R&D, however, only shows a commitment to attempt such development of knowledge and technology. Whether a country will be able to develop such novel technologies depends on many factors that together make up the *how* of knowledge and technology development. Dealing with this issue requires a whole paper by itself. The how of knowledge development is dealt with in great detail in Jurgen Renn (2020), somewhat briefly in Nathan (2024) and by many authors who deal with this question in the wake of the Needham question: why did the scientific revolution not take place in China or India? Here, we discuss just a few crucial points, such as the strength of networks, diversity, cosmopolitanism and openness.

We often think of particular important scientific discoveries or innovations as the work of a person, a heroic person such as Galileo, Newton or Darwin. However, there is a social character of knowledge production, as emphasised by Kenneth Arrow (1994) and John Rawls (1999). While not negating the requirement of providing an incentive for knowledge creation (Sen 2004), the social character of knowledge production is manifest in the role of networks and clusters. Nowadays, networks are international, often linking clusters in different countries. These networks, however, should also link different circuits of knowledge; for instance, those who develop new knowledge and technologies and those who deploy and use them in production. The linking of different circuits of knowledge can lead to feedback loops that magnify returns and create positive cycles, linking practical and propositional knowledge. India has a specific problem of caste exclusions in linking practical and propositional knowledge; while all countries face issues of gender, religious and racial exclusions.

In addition, networks also benefit from diversity (Hidalgo 2015), even diversity of disciplines and occupations. Jacobs (1969) argues that complementary knowledge from diverse firms promotes the creation of knowledge. It is not just diverse firms but even diverse streams of knowledge that benefit from interaction with each other. That Darwin got his theory of natural selection from reading the economist Malthus' theory of population (Arthur 2009) is a prime example of how the interaction of disciplines can benefit scientific advance. Scope, and not just scale, as emphasised by Huang (2023) is important for creative advances.

There has been much discussion of the role of Asian technologies – printing, gunpowder and the compass from China, or the zero and the decimal system from India – in the development of what is called Western science and technology (see Dalrymple, 2024; Goody, 1996, Hobson, 2004, Renn, 2020). Such borrowing, however, requires a cosmopolitan attitude of acknowledging the contributions of others, even if in order to appropriate. A hubris of "We know it all", or, even worse, "We knew it all", is hardly conducive to weaving together various streams of knowledge. After China's defeat in the Opium Wars of the mid-nineteenth century, the "Self-strengthening Movement" argued that China's defeat was due to the military technology gap between China and the West (Kroeber, 2024). Candour is needed if Asia is to attempt to develop technological leadership.

The state will necessarily have a role in technological strategy in deciding on priority sectors. They cannot just leave it to the market to decide this direction. A market-dictated strategy would, for instance, not pay enough attention to the development of climate-change-friendly strategies. But the state or religious doctrines should not have a deciding role in what areas of knowledge can be investigated, or in requiring that answers conform to either state or religious doctrine, or, for that matter, any other philosophical or ideological doctrine.

As scientific paradigms change, established scholars of the paradigm that is being challenged may attempt to restrict such changes. As Cai Yuanpei, president of Peking University in 1917, put it: research should be "… free of restrictions by religion or political parties but also free of constraints imposed by renowned scholars" (cited in Kirby, 2022: 276). Restrictions may be imposed by not just various authorities but also, as we are familiar with in India or China, by non-state actors who may claim that their religious or nationalist sensibilities have been hurt by some analysis or the other.

The weakness of state doctrines to deal with novel situations requiring innovative solutions was seen in the weakness of China's initial response to Covid. "Tragically, local authorities in Wuhan were slow to raise concerns about a scary new SARS-like virus in the early days of Covid-19 … The fear factor of the corruption drive helps to explain the delayed response" (Bell, 2022: 81, see also Huang, 2023).

In the USA, too, there are clear signs of restrictions on inquiry and debate, whether in the banning the teaching of critical race theory in some states, or the actions against students supporting the rights of Palestinians, which is equated to anti-Semitism. But, in comparison to the imposition of a uniform or singular doctrine in China (Huang 2023), or the attempts to fashion and impose a singular doctrine in India, one should note the substantial contestation over doctrines in the USA.

Along with cosmopolitanism, there is also a need to accept the necessary limitation of knowledge. Human society and the universe are still creative and evolving (Kaufmann 2016) and, thus, in the manner derived from Thomas Kuhn (1962), there is not just one scientific revolution but an endless series of scientific revolutions, with knowledge that is always not "true" (forever) but only "more true" (Harding, 2013). What this means is that there is no end to knowledge creation and, thus, no system of thought or analysis can be accepted as a full solution to human problems. In practical terms, it also means that any attempt to restrict either questions or answers as not conforming to some dictates, whether of religion, civilisational identity or the state, will only restrict the development of science. Should we not let a hundred flowers bloom and a thousand schools of thought contend?

Thus, all knowledge economies are affected by various political and economic restrictions. There are even scholarly restrictions seen in those following established or conventional modes of analysis who oppose and even try to confine new modes of thought. How particular economies, particularly the ones we are considering here – USA, China and India – and their scholars respond to these challenges will have much to do with which country or countries establish technological leadership. Although we consider all three of these economies, the simple data of the amounts spent on R&D and patents acquired show that the competition for technological leadership is really between the USA and China; India is too far behind to count in this particular phase of global competition. The recent Chinese open-source and low-cost foundational AI model, DeepSeek, however, has opened a way for many others to join in, including India, to develop AI.

The above brief summary of critical socio-political factors in scientific development shows that while China, in particular, is well poised to challenge USA technological leadership, we cannot take it for granted that China will necessarily be successful in this endeavour. China seems to have done well in reverse engineering advanced chips, whose export the USA tried to restrict. China has also made advances in quantum computing (Chou et al., 2025). But, there could be continued USA domination of new technologies. It should be noted that Google recently claimed significant advance in quantum computing. If so, the combination of quantum computing with AI might well see the USA keep its technological leadership. There is no guarantee of a Chinese era or an Asian century. For that to happen, both China and India would have to overcome their many civilisational deficits, if there were to be an Asian century.

Competition and cooperation

While we do not want to restrict the development of science, we may, however, want to restrict the development and deployment of some technologies. For all the weaknesses of international agreements, some restrictions have been internationally accepted on nuclear or chemical technology. We might want to reach similar agreements on the development and deployment of AI technologies, particularly those of lethal weapons systems with autonomous decision-making capabilities. Further, given the potential of cross-border risks from some forms of AI, the need for global cooperation in setting guardrails to its development becomes urgent (Comunale and Manera, 2024). As a creator of AI and a 2024 Nobel Laureate, Geoffrey Hinton points out (2024) that the addition of the threats of AI to extinction-level risks only increases the urgency of cooperative solutions to the global problems of climate change. This reduces the risks of devastating warfare and other extinction-level risks.

Economic analysis, however, at least starting with Malthus and the struggle over scarce resources, has tended to see competition as the key relationship between individuals, classes or social groups, on the one hand and nations, on the other. But other than with the fiction of a one-man Robinson Crusoe economy, there has always been cooperation along with competition. Starting with Adam Smith's pin factory, the division of labour between workers means that the final output is a result of the cooperative endeavours of all workers. Moving on from the factory to the economy, the social division of labour broadly between industry, agriculture and care work means that all three are needed for a full economy.

Without cooperation we are simply incomplete. As the well-known African philosophy *Ubuntu* puts it, "I am because we are". Incompleteness, however, does not mean that all parties in a division of labour have equal status or equal power. There is specialisation based on the division of labour. This specialisation is an adverse specialisation (Nathan, 2024) since one side secures lower returns and faces blocks in attempting to move into higher-value-capturing specialisations. Another example of adverse specialisation is the patriarchal division of labour within a household, between man as the high status "bread-winner" and woman as the provider of unrecognised domestic services. Consequently and as now generally accepted in gender theory, what we have is a situation of cooperative-conflict (Sen 1987); that is, along with cooperation in production of a joint output there is also conflict over the distribution of the resulting income.

As a result of cooperative-conflict, what is needed is to change the terms of engagement in cooperation or interdependence. At present there is domination of the global North over the interdependence. This is changing as economies of Asia advance in knowledge creation. This advance, however, needs to be much more broad based. When it involves just two or three countries, it seems likely to recreate big power rivalry, as we witness in the world currently. Were many countries involved as creators of technological knowledge, it would be likely that the balance of forces in global interdependence might change in a more egalitarian cooperative direction.

In the current international scenario, it is competition that dominates relations between nations, and not just great power competition, but even among the rest that constitute the emerging powers of the currently developing multipolar world. Interdependence, greatly enhanced by the development of global value chains (GVCs) itself can be weaponised in struggles over spheres of influence (Drezner et al., 2021). And the current great power struggle can well be seen as an inter-regnum, awaiting the domination of one power over the GPTs of the emerging AI techno-economic paradigm.

Fostering global cooperation

Nevertheless, there are spheres in which cooperation can be fostered. We have mentioned above the necessity of global agreement to mitigate the risks of potentially species-ending developments through AI. In addition, there are the areas of the provision of global public goods to deal with crises of pandemics and climate change. Investment in R&D can be driven not just by the appropriability of monopoly returns (Teece 1986) through technologies enclosed by intellectual property rights, but also by public investments in globally desirable areas, such as of global public health and climate mitigation. As the Covid experience showed again, it was important to ease the spread of vaccines through at least temporarily suspending intellectual property rights. This had already become apparent during the AIDS epidemic, when the Indian development of generic drugs was crucial in making drugs available at an affordable price in the global South. Can we move from ad hoc suspensions of intellectual property rights to a generalised system of technology sharing through compulsory licensing of public health mitigating technologies (Kingston 2004; Nathan, 2024; Stiglitz, 2005)?

If humans are to in any manner deal with climate change, it will require both large investments in developing the required mitigating technologies and the rapid spread of these technologies. Both development and spread of climate-friendly technologies will require public funds – to direct research in the required fields and to support large-scale production. These measures can both develop the required technologies and bring down the prices of the resulting technologies. China has successfully used public subsidies to increase both the scale of production and bring down the prices of some of the critical renewable energy technologies. "In the space of a decade, prices fell by 80% for solar, 73% for offshore wind, 57% for onshore wind and 80% for electric batteries" (Rodrik, 2024: 17). These measures, as Rodrick emphasises, are good for the planet, and have been referred to as "game-changers" in the race to mitigate climate change. Rather than trying to protect domestic production of electric cars through a 100% tariff, as the USA might do, planet-friendly policies would benefit from "competitive subsidies" to speed up the development and deployment of these technologies. Some of these are in the domains of governance services and reducing transaction costs. Indian development of hyper-scale identification, payment systems and distant medical services could all be provided as non-proprietary software for use by any country.

However, to repeat an old refrain, there is no solution that does not also create a new problem. Identification systems not only reduce transaction costs, they also provide the means for enhanced and continuous surveillance, a real Panopticon. These technologies have been used to foster the degenerations of democracy (Calhoun et al., 2022) leading to illiberal democracy (Zakaria, 2024). It is for the political systems to respond to these new challenges to democracy.

But, should we also put some limits to the development of technology? Arthur (2009: 21) said that "… technology creates itself out of itself". Not quite so, as new technology also requires fresh inputs of human intelligence in applying some new principle. But are we reaching a point where Arthur's "technology creating itself" could be coming true in a literal sense? AI-founder Hinton (2024) thinks that AI could evolve to the point of "making more of itself". In the process we could have "… created a form of intelligence that is just better than biological intelligence". Even if we can stave off such "extinction-level" threats, there is the proximate question of stopping the development of AI-based military technologies with autonomous decision-making capacities. As Hinton points out, there is need for international cooperation of the type that led to the Geneva Convention banning the use of chemical weapons. Of course, there have been violations of this Convention. But it has, by and large, worked. A similar convention putting limits on the military use of AI would be required to halt the development of lethal weapons systems with autonomous decision-making capacities. With this, the scope for international cooperation would extend from promoting the use of global health and climate mitigation technologies to restricting the scope for autonomous lethal weapons development.

Does the fact that we must keep considering ways of restricting what are trends in the trajectory of development point to the need for a new kind of social system – one that places primary emphasis on cooperation rather than competition? In the manner that the growth of exceptions points to the need for the scientific paradigm to be changed a la Kuhn, does the need for dealing with economic-military exceptions point to the need for a new socio-economic paradigm, in place of the current paradigm based on limitlessly and self- expanding capital and competing nation-states or civilisation-states? Even the proponent of the theory of *The Selfish Gene*, which would make competition something that is hard wired into humans, points out, "We are built as gene machines and cultured as meme machines, but we have the power to turn against our creators. We alone on earth can rebel against the tyranny of the selfish replicators" (Dawkins cited in Pagano, 1995: 25).

Conclusion: A new *world order* or a *new world?*

Technological supremacy has been the basis of geopolitical domination, and could be so again. Competition among enterprises is a feature of the market-based economy of capitalism. In this competitive process, firms with new technologies use them to earn higher monopoly profits. This, however, translates into fuelling the process of geopolitical domination by nation-states. This paper ends by posing a question about the processes of socio-economic transformation and geopolitical domination and the necessity of giving primary emphasis to more egalitarian cooperation rather than competition. And if the possible Asian century is to be different from the Anglo-American centuries that the world has gone through, we would need to imagine a "post-nationalist Asia" (Bose, 2024: 18).

Rebelling against the tyranny of selfish replicators would also require transforming economic analysis, currently founded on competition as its core. In using Adam Smith's theory of the "invisible hand" of the decentralised market, we forget its core of cooperation between persons with different skills or capabilities, whether of the tinker, tailor, baker or carpenter. Similarly, we narrowly take Darwin's competition for survival and underestimate collaboration (Kaufmann, 2016: 258). Thus, imagining a post-nationalist world would also require a reformulation of economic analysis, whether it was about the role of cooperation or the doctrine of unintended consequences.

Even while we explore ways of enabling competition to spur technological development, we need to find solutions to the bigger question of what kind of socio-economic transformation might forestall the potentially devastating geopolitical competition for global hegemony. Will this geopolitical competition hasten the climate debacle, or will the looming climate debacle force a socio-economic transformation of which egalitarian cooperation is the dominant feature?

References

Arrow K. 1994. Methodological individualism and social knowledge. *American Economic Review* 84(2).

Arrighi G. 1994. *The Long Twentieth Century*. London: Verso.

Arthur W.B. 2009. *The Nature of Technology: What It Is And How It Evolves.* London: Penguin Books.

Bell D. 2022. Political meritocracy in China. In Khanna T. and Szonyi M (eds). *Making Meritocracy: Lessons from China and India, from Antiquity to the Present.* Oxford: Oxford University Press. 64–82.

Blake J. 2025. White Christian nationalists are poised to remake America in Trump's second term, https://edition.cnn.com/2025/01/12/us/white-christian-nationalism-du-mez-cec/index.html

Bose S. 2024. *Asia after Europe: Imagining Continents in the Long Twentieth Century*. Cambridge, MA: Harvard University Press

Breznitz D. and Murphree M. 2011. *Run of the Red Queen: Government, Innovation and Economic Growth in China*. New Have, CO: Yale University Press.

Calhoun C., Gaonkar D. and Taylor C. 2022. *Degenerations of Democracy.* Cambridge, MA: Harvard University Press.

Chang H.J. 2000. *Kicking Away the Ladder: Development Policy in Historical Perspective*. London: Anthem Press.

Chou C., Manyika J. and Hartmut N. 2025. The race to lead the quantum future. *Foreign Affairs* Jan/Feb.

Comunale M.R. and Manera A. 2024. The economic impacts and the regulation of AI: A review of the academic literature and policy actions. *IMF Working Paper wp24/65*. Washington, DC: The International Monetary Fund.

Dalrymple W. 2024. *The Golden Road: How Ancient India Transformed the World.* London: Bloomsbury.

Dawkins, R. 2016. *The Selfish Gene*. Oxford: Oxford University Press.

Dosi, G. 1982. Technological paradigms and technological trajectories: A suggested interpretation of the determinants and direction of technical change. *Research Policy* 11.

Drezner D., Farrell H. and Newman A. (eds). 2021. *The Uses and Abuses of Weaponized Interdependence*. Washington, DC: The Brookings Institution.

Goody J. 1996. *The East in the West*. Cambridge: Cambridge University Press.

Harding S. 2013. The less false accounts of feminist standpoint epistemology. In Hannan J. (ed.). *Philosophical Profiles in the Theory of Communication*. New York: Peter Lang.

Hidalgo C. 2015. *Why Information Grows*. New York: Hachette Books.

Hinton G. 2024. We'll need universal basic income - AI 'godfather.' *BBC*. Available at: https://www.bbc.com/news/articles/cnd607ekl99o. Retrieved 20 May 2024.

Hobson J. 1902. *Imperialism: A Study*. Online Library Project.

Hobson J. 2004. *The Eastern Origins of Western Civilization*. Cambridge: Cambridge University Press.

Huang Y. 2023. *The Rise and Fall of the EAST: How Exams, Autocracy, Stability, and Technology Brought China Success and Why They Might Lead to its Decline*. New Haven: Yale University Press.

Hung H-F. 2022. *Clash of Empires*. Cambridge Elements Global China Series.

Huntington S. 1996. *The Clash of Civilizations and the Remaking of World Order?* New York: Simon and Schuster.

Jacob J. 1969. *The Economy of Cities*. New York: Random House.

Jasani N. 2025. Basic technology R&D: Let's wake up before it's too late. *The Mint*, 23 January.

Kaplan J., Gu M. and Sinha M. 2024. Enterprise technology's next chapter. McKinsey Digital. Available at https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/enterprise-technologys-next-chapter-four-gen-ai-shifts-that-will-reshape-business-technology#/. Retreived 13 March 2025.

Kaplinsky R. 2021. *Sustainable Futures: An Agenda for Action*. Oxford: Polity Press.

Kaufmann S. 2016. *Humanity in a Creative Universe*. Oxford: Oxford University Press.

Kuhn T. 2012[1962]. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Kirby W. 2022. Limits of China's modern universities. In Khanna T. and Szonyi M (eds). *Making Meritocracy: Lessons from China and India, from Antiquity to the Present*. Oxford: Oxford University Press.

Kingston W. 2004. Meeting Nelson's concerns about intellectual property. In Nelson's concerns about intellectual property, *David K.L. Working Paper Archive*. Retrieved 2 June 2024.

Kissinger H., Schmidt E. and Huttenlocher D. 2021. *The Age of AI: And Our Human Future*. London: John Murray.

Kroeber A. 2024. Unleashing "new quality productive forces": China's strategy for technology-led growth. *Brookings Institution*. Available at: https://www.brookings.edu/articles/unleashing-new-quality-productive-forces-chinas-strategy-for-technology-led-growth/. Retrieved 14 September 2024.

Lee K. 2013. *Schumpeterian Analysis of Economic Catch-up: Knowledge, Path Creation, and the Middle-Income Trap*. Cambridge: Cambridge University Press.

Lee K., Kim J. and Kim. J. 2024. National Innovation System of India in a Comparative Perspective. *Economic and Political Weekly*. 59, 34.

Lenin V.I. 1917 (1966). *Imperialism, The Highest Stage of Capitalism*. Moscow: Foreign Languags Publishing House.

Lundvall B. 1992. *National Systems of Innovation*. London: Pinter.

Luxemburg, R. 1951. *The Accumulation of Capital.* London: Routledge.

Mazzucato M. 2013. *The Entrepreneurial State*. London: Anthem Press.

Morris-Suzuki T. 1994. *The Technological Transformation of Japan: From the Seventeenth Century to the Twenty-first Century*. Cambridge: Cambridge University Press.

Nathan D. 2024. *Knowledge and Global Inequality Since 1800: An Interrogation of the Present as History.* Cambridge: Cambridge University Press.

Ostry S. and Nelson R. 1995. *Techno-Nationalism and Techno-Globalism: Conflict and Cooperation*. Washington: The Brookings Institution.

Pagano U. 1995. Can economics explain nationalism? In Breton A. *Nationalism and Rationality*. Cambridge University Press, Cambridge.

Parker G. 1996. *The Military Revolution: Military Innovation and the Rise of the West, 1500–1800*. Cambridge: Cambridge University Press.

Perez C. 2002. *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages.* London: Edward Elgar.

Rawls J. 1999. *A Theory of Justice*. Boston, MA: Harvard University Press.

Renn J. 2020. *The Evolution of the Knowledge Economy*. Princeton: Princeton University Press.

Rikap C. and Lundvall B-A. 2021. *The Digital Innovation Race: Conceptualizing the Emerging New World Order*. Palgrave Macmillan.

Rodrik D. 2024. China's clean-tech subsidies are good for the planet we inhabit. *The Mint*. 14 May.. Available at: https://www.livemint.com/opinion/online-views/chinas-clean-tech-subsidies-are-good-for-the-planet-we-inhabit-11715621588145.html. Retrieved 13 March 2025.

Russell S. and Norvig P. 2020. *Artificial Intelligence: A Modern Approach.* Fourth Edition. Chennai: Pearson.

Schumpeter J. 1955[1919]. *Imperialism and Social Classes*. New York: Meridian Books.

Schumpeter J. 1976[1944]. *Capitalism, Socialism and Democracy*. London: Allen and Unwin.

Sen A.. 1987. Gender and Cooperative Conflict. *UNU-WIDER Working Paper 18*.

Sen A. 2004. Merit and Justice. In Arrow K., Bowles S. and Durlauf S (eds). *Meritocracy and Inequality*. Princeton: Princeton University Press. 5–16.

Stanford University. 2024. *Artificial Intelligence Index Report 2024*. Available at: https://aiindex.stanford.edu/wp-content/uploads/2024/04/HAI_AI-Index-Report-2024_Chapter1.pdf.

Stiglitz J. 2005. Intellectual Property – Rights and Wrongs. *Project Syndicate*. https://www.project-syndicate.org/commentary/intellectual-property-rights-and-wrongs. Retrieved 2 June 2024.

Suleyman M. 2023. *The Coming Wave: AI, Power and the 21st Century's Greatest Dilemmas*. London: Bodley Head.

Taylor M. 2016. *The Politics of Innovation: Why Some Countries Are Better Than Others at Science and Technology*. Oxford: Oxford University Press.

Teece D. 1986. Profiting from technological innovation. *Research Policy* 15(6).

Zakaria F. 2024. *Age of Revolutions: Progress and Backlash from 1600 to the Present*. London: Allen Lane.