Technological Competition and the World Order

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The role of competition and technological domination in changing the world order is analysed. There are constraints in 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 necessity of cooperation in meeting contemporary global challenges and staving off new forms of devastating warfare are underscored.

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That economic competition drives technological development is an investigation introduced by Karl Marx and later developed by Joseph Schumpeter through his analysis of the drive to secure monopoly profits through technological development supported by intellectual property rights (IPRs). 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 South 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.

Long Waves of Techno-economic Paradigms

The world economy has been going through long waves of technological change driven by knowledge. Technologies create techno-economic paradigms, which includes not only the input–output technological relation but also "organisational 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 techno-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 makes for a techno-economic paradigm. Each age also has its characteristic environmental footprint, a topic that has not been much researched (Kaplinsky 2021).

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 (US). 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 US remained the leader in the shift from electricity and mass production to ICTs. Who will lead the shift from ICT to artificial intelligence (AI) and quantum computing? There clearly is a race between the US 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 which 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 et al (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 affecting 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.

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. On the other hand, 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 (Bresnits 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 is 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 AI is combined with 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 has now. It will lead to the reorganisation of the manner of production (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 any country or 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, as 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 general-purpose and a dual technology, that is, both civil and military, it has become central to geopolitical competition.

AI can be seen by itself, or in combination with 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 less training to master a task, while AI is being used to help design quantum computation (Chou et al 2025). While the US has concentrated on developing quantum-computing capabilities, China has concentrated on quantum communication technologies, which can make communication difficult to intercept (Krause 2024). Together, such technological development will shape the economy and military 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 Cecilia Rikap and Bengt-Ake 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 rivals, just as West European militaries achieved a strategic advantage over their Asian rivals in the precolonial 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. "If access to quantum computers is limited to one or a few governments, it could upset the balance of power between different countries" (de Wolf 2017).

China's State Council issued the new generation artificial intelligence plan development (AIDP):

> Artificial intelligence has become the new focus of international competition. Artificial intelligence is thought to be the strategic technology leading the future, the world's major developed countries regard the development of artificial intelligence as the major strategy to increase national competitiveness and enhance national security, therefore they intensify the introduction of plans and policies and the deployment of the core technology, top talent, standards etc. trying to grasp the initiative in the new round of international science and technology competition. (China State Council Document No 35 2017)

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.

In our identification of the centrality of technological competition in geopoltical conflict, we differ from some other analyses of changes in the world order in the pages of this journal. Jawahar Bhagwat (2024) and Branko Milanovic (2024) see the size of economies as the basis of multipolarity, while Anuradha Chenoy (2024) understands multipolarity through the lens of financial systems of the BRICS. Deepak Nayyar's (2025) analysis has some resonance with our paper, as he points to the impact of technological change and the US's technological cutting edge in the world order. Nayyar's (2025: 47) "profound technical changes" is what we identify as the core or GPTs of the era of AI and to which we give central importance in determinations of the world order.

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 development (R&D) agenda, or in fostering links between the different knowledge circuits. Firms operate in the context of national policies for higher or STEM education. All the connections of these organisations and the incentives for knowledge creation have been brought together in the concept of national innovation system (NIS) (Lundvall 1992). While using these nation state-based concepts, it is, however, necessary to situate them within global interactions and global roles, whether mainly as users or creators of technology.

Right from the 19th century, attempts of the US and Germany to catch up with Great Britain's 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 (Ostry and Nelson 1995: 61) is not something new. The US government played a key role in the development of various technologies, whether of the internet or various pharmaceuticals, or the now-ubiquitous touchscreen (Massucatto 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, like the Chinese action against Google or the Indian and US actions against TikTok, and US attempts to deny China access to advanced chips.

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 from copying their advanced technologies (Chang 2000; Nathan 2024). Techno-nationalism in the capitalist world, however, has also been the prelude to expansionism. This happens as successful techno-nationalist policies lead to the development of monopolies, with their knowledge protected by IPRs, and these monopolies seek to both extend their markets and even to secure rents or high profits through external concessions as nation state also try to expand their spheres of influence. This expansionism of monopoly capital allied with national states was analysed by Hobson et al as the basis of imperialism and the concomitant inter-country struggle over spheres of influence. Later analysis by Giovanni Arrighi (1994) and Ho-fung Hung (2022) separately treat these two factors: market expansion by monopoly capital and state creation of colonies or spheres of influence.

Ugo Pagano (1995)[1] brought in additional factors to account for competition between nation states as imperialism. These are symbolic utility a la Robert Nozick, "the utility that we get from what we think we are" (Pagano 1995: 17); and positional goods, in Hirsch's (1977) analysis, the exercise of power and domination which necessarily means 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 too felt that dangerous tendencies could be channelled into the accumulation of wealth. But as Pagano (1995: 27) 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.

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 Donald 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 US as a "White Christian nation" (Du Graz 2025). As both China and India try to define themselves as civilisation states and not just nation states, the notions of greatness are also intertwined with ideas of domination, whether of the world or of regions, identified as civilisational spaces. Civilisations are defined by central world views, whether Confucianism in China or Hinduism in India; all other world views within the civilisational space, whether of Buddhism or Islam, have secondary status.

At different time, the chief of the Rashtriya Swayamsevak Sangh (RSS), the ideological fountainhead of the ruling Bharatiya Janata Party (BJP), has said that *Akhand Bharat* (Greater India) would be a reality in the coming years (*India Today* 2022) and that whoever comes in the way of India's rise would be eliminated (*Week* 2024). This is the language of expansionism in the form of civilisational identity. Is this a 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 US tries to technologically and militarily shore up the weakening US-dominated world order. But, is the currently growing multipolar order only an interregnum, a likely transition to a bipolar world?

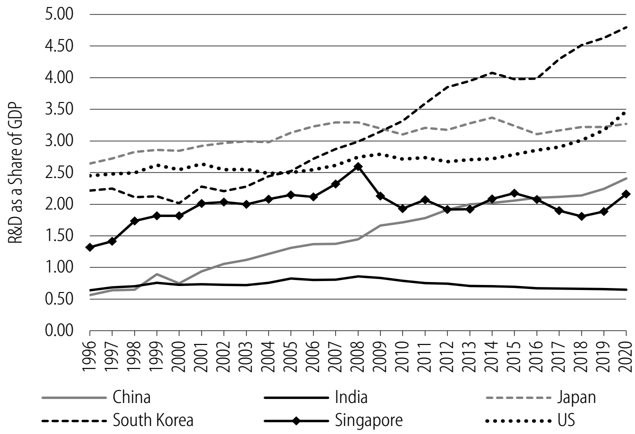
If these two lead in these core technologies, then there would be, all else being the same, a big extended power rivalry. China's DeepSeek AI model, however, has demonstrated that a foundational AI model could be built with much less money than has been the case with the earlier US models. This opens the door for more countries to participate in the competition to build AI technology. This could strengthen the trend to multipolarity rather than a new unipolar world order. However, going back to the centrality of the competition for technological leadership, along with the emergence of Asia as a whole, there is a central global competition for technological leadership between China and the US in the GPTs of AI and quantum computing.

Differences in Knowledge Strategy in Asia: Demand for New Technologies

We now turn to the knowledge and technology development strategies of major Asian economies, China, India, Japan, and South Korea. We take R&D expenditure as a percentage of gross domestic product (GDP) as an indicator of strategy or demand for 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, or demand for, 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.

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.SS).

Why are there differences between countries in Asia, specifically China, India, South Korea, and Japan in the emphasis they place on knowledge creation, measured by R&D, in Figure 1?

An analysis of why countries differ in their commitment to R&D was put forward by Mark Taylor (2016). Countries face two types of conflicts—internal and external. Dealing with internal conflicts, which are basically over the distribution of national income, does not require technological transformation. External conflicts, which may be both economic or military, however, require an economy to be at the technological frontier, with continuing investment in R&D. The combination of the two types of conflicts, internal and external, leads to what Taylor terms creative insecurity, which 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 South Korea—in comparison to the US.

Two of these Asian economies, Japan and South Korea—have security alliances with the US 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-World War II recovery, utilised its penchant for reverse engineering (a capability for which it was known from the time it closed its economy in the late 19th century) and by the early 1970s, it had reached a level which was "… in many respects equal to that of other advanced industrial countries" (Morris-Suzuki 1994: 210). After this, it 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, though 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, South 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 concentrating on higher-value-capturing pre-production functions of design and production management. The major push, however, was to develop new, even if only incrementally new, products in electronics. These were in the short-cycle technologies identified by Keun Lee (2013). South Korea's commitment to building new knowledge-based products can be seen in its increasing share of R&D to GDP, going up from 2.2% in 1995 to 4.8% in 2020 (Figure 1).

China too shows a sustained increase in the share of R&D to GDP. Starting below India in 1995, it is now way above India at 2.5% in 2020. There are two inflexion points in China's (and South Korea's) trajectory—around 2000, after the 1998 Asian financial crisis and around 2010 after the Great Recession. China 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 of 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, it also invested in the core technologies themselves. Soon after the defeat in Go by an AI machine, 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, South 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 IT services but not in manufacturing, where there is still much protection, including through anti-dumping tariffs. South Korea and Japan have faced this external competitiveness challenge despite the military umbrella provided by the US. In the case of China, as it competes with the US, it has been forced to compete at the frontier of technology both in economic and military spheres, including the growing multipurpose technology. In the case of India, however, external conflicts have resulted in substantial investment in military R&D, but not in commercial and industrial technologies. Internal conflicts in India are reflected in the competitive electoral welfarism, and coupled with a lower share of tax revenues to GDP, around 17% for India (Malhotra et al 2023) compared to over 20% for China and 32% for South Korea (ADB and OECD 2024), leads to lower investment in R&D.

Research and Technologies

Technologies are usually based on research publications. The extent of research outputs is a sign of an economy's role in what could become technologies. The Australian Strategic Policy Institute (ADPI) tracks research outputs in 67 technological areas, ranking them on the basis of being highly cited during five-year periods, say, 2003–07 and 2019–23. Table 2 clearly shows that China has advanced to lead research outputs in 57 technological areas, while the US leads in just seven research areas. China has advanced on a broad scientific basis, having led in just three areas in 2003–07 when the US led in 60 technological areas. India, while not leading in any technological area, however, is among the top five in 45 technological areas, an advance from having been among the top five in just four areas in 2003–07. This does show a substantial advance in scientific research, even if, as pointed out above, it is not yet reflected in the patents acquired.

Table 2, on top-cited research publications, confirms that the current technological race is just a two-horse race, but that China is substantially ahead of the US on a broad front. India could also come up, not in the current period but possibly in the not-too-distant future, provided the commitment to scientific research and patents are ramped up. Many of the Indian top five rankings are in military and space technologies, such as high-specification machining, aircraft engines, and drones, due to the public sector research institutes of the Defence Research and Development Organisation (DRDO).

A summary of the position of 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 gives the gross R&D expenditures in purchasing power parity for 2022.

The gap between the first two is notable, the US and China, and the rest. India, of course, is way behind. This statistic shows the countries that 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 data sets, which are versatile and suitable for numerous downstream applications), the US leads in 2023 with 109 models, followed by China with 20 models. Google, Meta, and Microsoft released 18, 11, and nine models, respectively,

Table 1: Gross R&D Expenditures in PPP$, 2022, India 2020–21

	Country	R&D in PPP$ Billion
1	US	760
2	China	620
3	Japan	180
4	Germany	134
5	South 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 2022–23.

Table 2: Top Cited Research Publications, Ranks in 64 Critical Technologies

Country	Leading in 2003–07	Leading in 2019–23
China	3	57
US	60	7
	Within Top 5	Within Top 5
Japan	32	8
South Korea	7	24
India	4	45

Source: Leung et al (2024).

in 2023 (Stanford University 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 US and China. In this, however, China accounts for the largest number of patent applications, followed by the US, and has also invested more than the US or the EU.[2]

China also has the largest share of patents in quantum computing between 2020 and 2022; Japan is third. Korea and India are also in list—but from India it could be from global capability centres (GCCs) of Fortune 500 companies, not Indian companies (Lee et al 2024).

That there is a two-horse race to develop AI and nascent quantum-computing technologies is confirmed by the earlier data. Not only do the US and China stand apart from the crowd, but the US is also somewhat ahead of China. The data also show that there is much competition among the US tech majors, something that will only benefit the country's attempt at continuing technological domination. In research in overall major technologies, however, China is ahead of the US, as seen in Table 2. This will have its impact on technology creation and patenting in the immediate future, leading to a broad advance of China over the US, though the latter leads in the development GPTs, AI and quantum computing, of the new era.

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 will require a whole paper by itself. The how of knowledge development is dealt with in great detail in Jürgen Renn (2020) and somewhat briefly in Nathan (2024) and 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 will 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. There, however, is a social character of knowledge production, emphasised by Kenneth Arrow (1994). 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. Jane Jacobs (1969) argued that complementary knowledge from diverse firms promoted 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 advancement. Scope and not just scale, as emphasised by Yasheng 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 (Goody 1996; Hobson 2004; Renn 2019; Dalrymple 2024). Such borrowing, however, requires a cosmopolitan attitude of acknowledging, even if in order to appropriate, the contributions of others. 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-19th 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 as in deciding on priority sectors and 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, restrictions may even be attempted by established scholars of the paradigm that is being challenged. 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" (quoted in Kirby 2022: 276). Restrictions may be imposed by not only 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 in dealing with novel situations requiring innovative solutions was seen in the weakness of China's initial response to COVID-19.

> 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 US too there are clear signs of restrictions on inquiry and debate, whether in banning the teaching of critical race theory in some states, or the attacks on academic freedom in Columbia and other universities (Appadurai and Pollock 2025), withdrawal of federal funding for environmental research, health sciences, economic and social issues (Mubayi 2025). But, in comparison to the imposition of a uniform or singular doctrine in China (Huang 2023), one should note the substantial contestation over doctrines in the US and, to an extent, in India.

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 as those following established or conventional modes of analysis oppose and even try to confine new modes of thought. How particular economies, especially the ones we are considering here, the US, China and India, and their scholars respond to these challenges will have much to do with which country or countries establish technological leadership. Though 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 US 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, including India, to join in to develop AI.

The brief summary of critical sociopolitical factors in scientific development shows that while China, in particular, is well poised to challenge the US 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 exports the US tried to restrict. China has also made advances in quantum computing (Chou et al 2025). But there could be a continued US domination of new technologies. It should be noted that Google has recently claimed significant advances in quantum computing. If so, the combination of quantum computing with AI might well see the US keep its technological leadership. There is no guarantee of a Chinese era or an Asian century. For that to happen, both China and India will have to overcome their many civilisational deficits, if there is 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 for its development becomes urgent (Comunale and Manera 2024). The addition of the threats of AI to extinction-level risks, as a creator of AI and a 2024 Nobel Laureate, Geoffrey Hinton (2024) points out, only increases the urgency of cooperative solutions to the global problems of climate change, reducing 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, and nations. 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 crew work means that all three are needed for a full economy.

Without cooperation, we are simply incomplete. As the 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 a 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 "breadwinner" and woman as the provider of unrecognised domestic services. Consequently, as now generally accepted in gender theory, what we have is a situation of cooperative conflict (Sen 1987); that is, along with cooperation in the 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 a 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 now witness in the world. Were many countries involved as creators of technological knowledge it is 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 constitutes the emerging powers of the currently developing multipolar world. Interdependence, greatly enhanced by the development of global value chains (GVCs) itself can be weaponised (Dresner et al 2021) in struggles over spheres of influence. And the current great power struggle can well be seen as an interregnum, awaiting the domination of one power over the GPTs of the emerging AI techno-economic paradigm.

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 (Teese 1986) through technologies enclosed by IPRs, but also by public investments in globally desirable areas such as global public health and climate mitigation. As the COVID-19 experience showed again, it is important to ease the spread of vaccines by at least temporarily suspending IPRs. 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 IPRs to a generalised system of technology sharing through compulsory licensing (Stiglits 2005; Kingston 2004; Nathan 2024) of public health mitigating technologies?

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 fueling 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 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 will also require a reformulation of economic analysis, whether it is 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 in which egalitarian cooperation is the dominant feature?

NOTES

1 This portion owes much to Ugo Pagano (1995).
2 https://www.statista.com/statistics/1319273/planned-public-funding-quantum-computing-country/.

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