*Oxford Review of Economic Policy*, 2024, **40**, 374–386
https://doi.org/10.1093/oxrep/grae012
**Article**

OXFORD

# China, global economic disintegration, and the climate change challenge

**Ross Garnaut***

*Melbourne Institute of Applied Economic and Social Research, University of Melbourne, Australia, e-mail: ross.garnaut@unimelb.edu.au

I acknowledge helpful comments from the editors of and contributors to this issue of the *Oxford Review of Economic Policy*, particularly David Vines, and from Ligang Song and other colleagues at The Australian National University, and from Yiping Huang and other colleagues at Peking University.

## Abstract

China has a large national interest in the success of the international effort to hold human-induced increases in temperature to 1.5 degrees above pre-industrial levels—and therefore in global net emissions falling to net zero by 2050. China is essential to the success of the global effort—as a supplier of competitively priced equipment for the zero-emissions world economy and as the world's largest current source of greenhouse gas emissions. Success is more likely for China and the world with international specialization in line with global comparative advantage in goods production for the zero-emissions economy. This requires open international trade, with China supplying equipment to and drawing zero emissions semi-processed goods from abroad. Contemporary tendencies in international political economy make that difficult but not impossible.

**Keywords:** China, climate change, international cooperation, zero carbon

**JEL classification:** F64, Q50, Q54

## I. Introduction

Over the 45 years of economic reform and opening to the outside world from 1978, China has moved from being a poor country with an economy of marginal importance to development elsewhere, to a higher-middle-income country that is centrally important to every major international question. Nowhere is China more critical to global outcomes, or global outcomes more critical to China, than on climate change. The international community's success in controlling human-induced increases in temperature depends on Chinese approaches to decarbonization at home and abroad. In turn, the Chinese government's success in achieving its development goals depends on the world managing effectively the challenge of climate change.

This paper examines the role of China and its interaction with the rest of the world in the global response to climate change. Section II discusses Chinese economic development as the apotheosis of the international trade and development system established at the end of the Second World War. Rapidly increasing trade within an open global trading system underpinned extraordinary Chinese growth in output and incomes in the four and a half decades following the gradual shift from autarchic central planning to market exchange and international economic integration commencing in 1978. China having relative resource endowments very different from the average for the world caused the gains from open trade to be exceptionally large. A large, rapidly growing country's reliance on fossil carbon for energy and industrial inputs raises its cost with successful economic development, placing a brake on global economic development. Dealing successfully with the climate challenge by breaking the connection between economic growth and fossil carbon use removes what would have emerged as a barrier to continued economic growth on the model of the twentieth century: the increasing cost of fossil carbon as a source of energy and industrial inputs with depletion of the natural resource stocks that can be exploited at lowest cost.

Section III discusses China's vulnerability to climate change and its national interest in finding a global solution. China is centrally important to the problem and the solution. It is the world's largest emitter of greenhouse gases, and by far the world's main producer of most of the capital goods that are essential for timely achievement of zero global emissions. It has played an important role in international discussion of solutions. It is important that it continues to do so. But progress will be challenged by tensions and tendencies in the contemporary system of relations among states. Section IV discusses how China has become the world's largest trading country and the largest bilateral trading partner of most countries. Specialization in line with comparative advantage has underpinned Chinese economic success. It will be crucial to success on climate change. Section V examines major elements in Chinese domestic policies to reduce greenhouse gas emissions. The foundations for suitable policies have been laid, but major policy development is necessary.

Cooperation between the US and China is necessary for successful mitigation of climate change. After initial progress during the Obama administration, there was a dangerous stand-off under President Trump. Section VI discusses how productive relations on climate change have been re-established under President Biden, although they remain vulnerable to geo-political tensions and require continuing effort for success. Sections VII and VIII discuss more generally what can be done to establish a framework for wider international cooperation on climate change when direct Sino–US relations are constrained and periodically disrupted by geo-political and geo-strategic tensions. Section IX discusses some particular challenges to climate change cooperation emerging from the Covid-19 crisis and the Russian invasion of Ukraine.

Section X concludes by acknowledging the case for despair, but recognizing as well episodes in earlier periods of global geo-strategic tension and the recent history of climate change cooperation that encourage continued effort.

## II. The context provided by global and Chinese economic development

China's economic development over these past four and a half decades is the apotheosis of the system of open international economic exchange that was established after the Second World War. Chinese participation was delayed by the Cold War restrictions on open multilateral trade and the autarchic central planning policies of the communist government of the People's Republic of China after 1949. Two inter-related developments in the 1970s underpinned China's productive integration into a global economy. Belated recognition in the early 1970s by the United States that China was not indelibly aligned with the Soviet Union, and shared strategic interests with the West, allowed countries allied with the US and then the US itself to remove barriers to trade and investment. And by the late 1970s, dominant elements in the Chinese leadership had come to understand the failures of autarchic central planning and the economic development advantages of open trade and investment. The Chinese reforms to make greater use of market exchange and international economic integration moved onto a higher plane of opportunity with entry into the World Trade Organization (WTO) in late 2001.

Open trade is more valuable to countries with relative endowments of economic resources that are very different from the world as a whole. Differences increase the gains from trade. China and the other densely populated high-income countries of North-east Asia—Japan and South Korea—are exceptional today for their high ratios of capital to natural resources, including renewable energy resources. So are the countries of central and northern Europe. Securing the gains from trade was an underlying motive and at times an explicit rationale of European and then Japanese imperialism. The dismantling of the old Empires was largely completed in the first two decades of the post-war political and economic system. Global development in the first three post-war decades demonstrated that international trade and investment could be undertaken commercially on a scale vastly greater than anything achieved under imperialism.

China's success greatly expanded the scale of the open international economy. It enhanced conditions for trade expansion and economic development everywhere. It gave Australia its China resources boom, with high terms of trade and by 2008 average incomes as conventionally measured higher than the United States for the first time in a century. The last decade of the twentieth century and the early years of the twenty-first were the most successful ever for growth in incomes in developing countries. The first 8 years of the twenty-first century saw rapid trade expansion and rising incomes in most of the developing world, including in many parts of Africa that had previously remained outside modern economic development. Rising labour incomes in China from about 2005, as what had been a Lewisian labour surplus economy entered its turning point in economic development, opened new opportunities for specialization in simple labour-intensive manufactured exports elsewhere in the developing world (Lewis, 1954; Garnaut and Huang, 2006; Cai and Huang, 2013).

Two sets of economies stand out as being highly complementary to the high-income developed countries of Europe and North-east Asia. One is the set of countries with large endowments of natural resources relative to

population—a few developed countries (first of all Australia and Canada, with large per capita endowments of capital as well as natural resources) and some developing countries. The other is the set of densely populated developing countries, with large endowments of labour relative to capital and natural resources—the economies of South Asia, and increasingly parts of Africa in which past failure of development delayed the fall in fertility and the demographic transition.

Countries with relative resource endowments that are very different from the rest of the world receive the largest gains from trade, and lose most from restrictions on trade. Other important parts of the world economy, notably the United States, have relative resource endowments close to the global average, and so receive smaller if still considerable gains from open international trade.

Jagdish Bhagwati's 'Survey of the Pure Theory of International Trade' (Bhagwati, 1964) six decades ago taught us that differences in relative costs that deliver large gains from trade can come from two main sources. The first is differences in relative resource endowments highlighted by Heckscher (1919), Ohlin (1933), and Samuelson (Stolper and Samuelson, 1941). The second is differences in relative technological efficiency across countries and industries. Bhagwati called these 'Ricardian' sources of comparative advantage, since the classical exemplification of comparative advantage by Ricardo did not depend on differences in relative resource endowments (Ricardo, 1819). All countries gain from increased trade and specialization in production of products in which they are relatively efficient. Such differences can depend on differences in economic history, industry policy, education, capacity for innovation, or chance. All countries also gain from the technological improvement that comes from trade across international borders in technology and goods embodying new technology. All countries generally gain from the greater domestic competition that comes from integration into open international markets.

The post-war international trading system supported expansion of trade and growth in incomes of unprecedented scale and geographic breadth in the six decades after the Second World War. It has come under great stress since the Global Financial Crisis of 2008 (see Guzman and Stiglitz, 2024, this issue). Protectionist pressures have become more influential throughout the developed world. Their influence plumbed new depths in the US in the Trump Presidency from 2017 to 2021, with nearly all restrictions being retained by President Biden.

One source of these pressures is the contraction of employment and depression of labour incomes in some industries that have faced increased import competition. These adverse distributional effects can be offset by distributional measures funded out of higher incomes from increased foreign trade. Where they were so offset, support for open trade has been stronger. Where distributional issues were ignored, protectionist pressures were more effective (Susskind and Vines, 2024, this issue).

Growing strategic rivalry between the US and China increased pressures for trade restriction. As Robertson observed of the interwar period, once trade restriction is said to be associated with military advantage, policy-makers concerned with the wider national interest are pushed to the margins (Robertson, 1936). While a larger economy is generally associated with greater military capacity, there may be circumstances in which some limited and disciplined restrictions on trade can be justified on strategic grounds. Circumstances in which this may be important warrant analysis case by case.

The world faces a great challenge in removing reliance on fossil carbon and hydro-carbon over a few decades. That change will be secured with greater certainty and much lower cost if it occurs within an expanding international trade and investment system. That system has been weakened by developments over the past decade and a half. The world faces urgent demands for international cooperation and exchange to limit damage from climate change at an inopportune time.

Close cooperation between China and the rest of the world will substantially reduce the costs of decarbonization in both. This will occur through three main mechanisms: China supplying capital goods for the new energy and industrial technologies; countries with relatively abundant and rich solar and wind resources and reasonably low cost of capital supplying China with zero-emissions goods embodying renewable energy; and China, alongside the currently developed countries but quantitatively as important as all of them together, supplying capital, capital goods, and technology for zero-emissions development through the developing world.

China benefits from timely global achievement of zero net emissions by avoiding the immense economic, political, and environmental costs of extreme global warming. It also receives large benefits of other kinds from a successful global transition. First, reduction in global coal, oil, and gas use reduces what would otherwise be large increases in world prices (see below, in this section). This constrains the associated deterioration of China's terms of trade. Second, the increasing use of zero-emissions energy reduces China's dependence on imports of energy raw materials from countries that are potentially politically or economically unstable or strategically problematic from a Chinese perspective. It therefore enhances energy security. Third, as the country with the strongest comparative advantage in producing the capital equipment for the zero-emissions economy, China's economic development can

be strengthened by exports of these goods to support the global energy and industrial transition. Fourth, the shift to zero-emissions transport, industry, and residential and commercial heating reduces air pollution, which became a source of serious health problems and degradation of the quality of life in many parts of China through the decades of carbon-based economic growth (Chen *et al*., 2013). Air pollution has become politically contentious within China. It will be greatly reduced by comprehensive decarbonization of the economy.

Even if there had been no climate change problem, global development based mainly on fossil energy would have become increasingly difficult through the twenty-first century. Ever-increasing demand would drive ever-increasing costs of oil, gas, and coal. The coal, oil, and gas resources that have highest quality, that are most easily and cheaply extracted, and that are most accessible to centres of demand, are used and exhausted first. Over time, the fossil carbon mining frontier shifts to more costly resources. World prices rise. The terms of international trade would have continued to move against China and developing countries that have less than their shares of fossil carbon natural resources. The cost of structural transition from backward low-income to modern high-income economies would have increased, and the chances of success diminished.

We saw the process of global development putting upward pressure on fossil carbon prices and threatening to constrain global development in fast forward in the period of exceptionally strong Chinese economic growth in the decade to 2012. World prices of oil, coal, and gas rose by hundreds of per cent over a decade. The energy transition forced by concern to limit climate change has moderated those increases and removed the likelihood that their resumption will damage global development in future.

## III. The climate change challenge to Chinese and global development

Chinese scientists have identified and published extensively within China on the country's vulnerability to global warming. Attention has been drawn in particular to damage to water supply and agricultural output in the North China plain; the destabilization of flows in the Yangtse, Yellow, and other great rivers from deglaciation of the Tibetan Plateau; and the impact of rising sea levels and the increased intensity of extreme weather events on that large proportion of Chinese economic activity near the river deltas and other low-lying areas of coastal China. China would share with all countries damage from destabilization of the international political and economic order from impacts of climate change in South-east, South, Central, and West Asia. Chinese scientists have had institutionalized access on climate issues to the Chinese leadership for over one and a half decades. This has informed Chinese domestic policy and participation in international discussions.

China has been part of the UN discussion of climate change from the early years. It played an important role in the Paris conference of the parties of the United Nations Framework Convention on Climate Change (UNFCCC) in 2015 and the Glasgow conference in 2021.

At and immediately after the November 2015 Paris meeting, all the United Nations (UN) members agreed to work together to hold human-induced increases in average global temperatures below 2 degrees and as close as possible to 1.5 degrees. Each country would define its own nationally determined contributions, and the conference of the parties would meet every 5 years to review progress and to strengthen national contributions towards the agreed goals. The operating model is 'concerted unilateral mitigation': concerted because many countries are acting towards similar goals at the same time; unilateral because each takes its own decisions without binding international agreements (Garnaut, 2013; Susskind and Vines, 2024). The first of the 5-year reviews was to have occurred in Glasgow in late 2020, but was postponed until the following year because of Covid disruption at that time. At Glasgow, the focus was more strongly on holding temperature increases to 1.5 degrees, which would require achievement of net zero global emissions by 2050 as well as early movement towards that outcome.

At Glasgow, for the first time, all developed countries joined commitments to zero net emissions by 2050. Among other countries, several of the largest accepted commitments to zero net emissions by specific dates for the first time (China, Russia, and Indonesia by 2060, and India by 2070). China committed to emissions reaching their peak before 2030.

Big as the new Glasgow commitments were, they did not add up to net zero by 2050 for the world as a whole. Meinshausen *et al*. (2022) have suggested that the nationally determined commitments can be reconciled with the global goals by each group of countries moving forward by 5 years the time at which they will reach net zero: the developed countries to 2045; China, Indonesia, Russia, and other countries at intermediate levels of development and climate ambition to 2055; and India and other lower-income developing countries to 2065.

The arithmetic does not add up for net zero global emissions by 2050 without China achieving net zero by 2055 or earlier. China is now the country with by far the world's largest greenhouse gas emissions, currently accounting for around 30 per cent of the global total. This is more than all currently developed countries combined. This is not

surprising, since China has a much larger population than the sum of developed countries, Chinese incomes have grown rapidly for four and a half decades, and China is now at a stage of development at which energy intensity is particularly high.

China is home to around half of the world's emissions-intensive manufacturing. Steel is the biggest of these industrial activities. China accounts for over half of global steel production and 60 per cent of global steel emissions—Chinese steel contributing nearly 5 per cent of total global emissions from all sources (Song, 2022). The emissions intensity of Chinese steel production is higher than in developed countries mainly because the short history of large-scale steel consumption limits the contribution from recycling of steel scrap (scrap's share for China is about 22 per cent compared to about 60 per cent for the EU and about 70 per cent for the US).

In 2023, China installed about 42 per cent of the global total of new solar and wind capacity—more than the total in the developed world. China is demonstrating that zero-emissions technologies can be installed rapidly at an immense scale. In the decade to 2023, solar power output increased about 60 times to more than 500 terawatt hours. Wind increased nearly seven times from a higher base over the decade to nearly 900 TWh. China is the location of nearly half 57 nuclear power plants currently under construction. New hydro-electric capacity continues to grow strongly, but annual output varies with rainfall. Zero-emissions energy has supplied nearly all of the increased Chinese power generation since 2013—more than the total for a few years, and less since 2017. Total zero emissions power generation in 2023 supplied about one-third of total grid power supply—corresponding to a bit over two-thirds of total US grid-scale power generation and use.

Chinese coal use doubled to over 4 billion tonnes in the decade to 2013. This was virtually all of the increase in global coal consumption, reaching over half the world's total. This was the proximate cause of China accounting for most of the world's increase in greenhouse gas emissions over this period. The rapid deployment of zero-emissions power generation after 2013 saw the stabilization of Chinese thermal coal use, with the level in 2021 being similar to that in 2013.

China is by far the world's main producer of the capital goods for the zero-emissions economy. It produces about 80 per cent of the world's photovoltaic panels, and about 60 per cent of wind turbines, batteries, and electric vehicles. It produces a majority of inverters for turning direct into alternating current, hydro-electric generators, transmission cables, and electrolysers for producing green hydrogen from renewable energy. It produces a substantial proportion of value added in most of the world's new nuclear power reactors. Most zero-emissions capital goods produced in China are deployed in China. At the same time, China's capacity for low-cost production of this equipment on an immense scale expands what is possible in global generation of zero-emissions power and reduces the cost of reducing emissions all over the world.

The new technologies of the zero-emissions world make heavy demands on a range of minerals and metals which were less important in the fossil carbon economy (Sandiford, 2022). These include silicon for solar panels, and lithium, vanadium, graphite, cobalt, nickel, titanium, magnesium, manganese, rare earths, and other materials for batteries, electric motor vehicles, and other goods. The International Energy Agency has called these 'critical minerals'. Following Sandiford (2022), I prefer the term 'energy transition minerals'. China has become the dominant world processor into usable products of many of these materials. It produces around 90 per cent of the grade of silicon required for photovoltaic panels. In the case of lithium, which is critically important in current battery manufacturing, it processes about 90 per cent of world supplies through relying heavily on imports of raw materials.

Chinese natural resources for many important energy transition minerals are not particularly large or rich, in comparison with Chinese economic size and domestic demand. Its resource endowments do not suggest comparative advantage in their production. For example, the processing of energy transition minerals—notably silicon—makes heavy demands on zero-emissions energy and other inputs into industrial processes that are not relatively abundant in China. Chinese domination of current world production derives from early recognition of the necessity of global transition to net zero emissions, supported by domestic policy. It makes economic sense for China and the rest of the world for China's net exports of these products to decline and in many cases disappear as productive capacity is installed elsewhere. Diversification of supply would also be healthier for global economic stability and security.

Global output of energy transition minerals will need to increase rapidly to meet global demand—the International Energy Agency says seven-fold in the decade to 2030 for some of them. Chinese enterprises and their technology and experience can play a large role in increasing the scale of production in other countries.

China is important to the development of energy infrastructure in the developing world. It is important as a source of capital goods and investment. This is true for both carbon-intensive and zero-emissions electricity. China's official development institutions, like those of Japan and Korea, until recently supported the expansion

of coal-based electricity systems in Asia and Africa. Decisions to cease financing new coal-based power stations in the lead-up to the Glasgow UN conference on climate change in 2021 were of large global significance. More positively, Chinese financing of new investment in the zero-emissions industry and processes and application of zero-emissions technologies is making a substantial contribution to other countries' decarbonization.

## IV. The Chinese economic development context of the energy transition

The expansion of foreign trade played a crucial role in Chinese economic growth through the first four decades of economic reform. Growth rates of foreign trade were more than twice as high as the extraordinarily high rates of output over this long period (Garnaut, 2018). China now is by far the largest participant in international trade. It is the largest trading partner of most countries.

Increased foreign trade supported strong productivity growth. It allowed rapid growth over long periods of China's most productive industries as they changed over time. It eased bottlenecks that otherwise would have constrained Chinese economic growth. Energy and metallic minerals were drawn from abroad in quantities and qualities far beyond what would have been available for Chinese development within the old commitments to self-sufficiency. This was most obviously the case with energy and steel-making raw materials, where China became the world's largest importer of fossil carbon, and overwhelmingly the world's largest market for iron ore. Supply of engineering equipment and technology from the advanced industrial economies also removed or loosened what would otherwise have been binding constraints on Chinese growth. Imports of knowledge and technology directly or embodied in goods and services made an important contribution to the growth process. Imports of education services were also important, with Chinese becoming major parts of the student population in the English-speaking and some other countries.

Chinese international trade in services as well as goods was important in the early stages of the energy transition in response to climate change. This is illustrated in the transformational reduction in costs of photovoltaic panels from early this century. In the early 2000s, climate policies in the European Union, supplemented by national policies in Germany and some other member countries, greatly increased incentives for the deployment of solar photovoltaic electricity generators. The new demand was initially mainly supplied by domestic production of photovoltaic panels in Europe. At around this time, Chinese graduates from advanced electrical engineering programmes at Australian universities were returning home. Several identified a business opportunity in applying their new knowledge commercially to link the growing solar photovoltaic market in Europe with Chinese comparative advantage in manufacturing production at a large scale. Support from Chinese provincial governments facilitated the early development of new companies manufacturing solar panels. Exports to Europe allowed early production at a considerable scale, which reduced unit costs. Lower costs of photovoltaic equipment made solar power more competitive with fossil energy abroad and also in China. That increased sales abroad and at home, further increasing scale of production and reducing costs. Learning by doing and increased scale in manufacturing more than technological change have continued to bring down costs. Now, two decades into the virtuous circle of expanding output and falling costs centred on Chinese manufacturing capacity, the cost of new renewable energy is much lower than the cost of new coal or gas generation in many countries, even after taking into account the cost of storage to balance the intermittency of solar and wind generation. With the high contemporary global prices of coal and gas, the cost of fuel alone for fossil carbon power generation exceeds the total capital and running costs of solar and wind in places with good natural resources for renewable energy. The reduction in renewable energy cost has established a commercial base for decarbonization of electricity in countries with abundant resources, even in the absence of supportive domestic policies. It has also established the foundation for decarbonization of many areas of industrial production that had once depended on fossil carbon and hydrocarbon with high greenhouse gas emissions.

So international trade has been of large importance to Chinese economic growth from early in the reform period, and now for the Chinese transition to zero net emissions. It is crucial for facilitating and reducing the cost of the shift from fossil carbon to renewable energy.

The relationship between global growth, energy demand, and fossil energy prices began to change about a decade ago.

Chinese and world coal consumption reached a local peak in 2012–14 and fell for a while, as China began to implement a new economic development model with less emphasis on investment and heavy industry. However, there was partial reversion to the old model as trade tensions rose with the US, growth slowed, and anxieties about employment and incomes increased from 2017. Chinese coal use began to rise again, to a new peak in 2019. After Covid disruption, post-Covid expansion of old economic activities saw Chinese and global coal use reach its highest level ever in 2023.

This retrogression from 2017 does not violate China's commitment to emissions peaking before 2030. It does, however, raise hard questions about the attainability of global climate objectives. Zero net global emissions by 2050 and holding the average increase to 1.5 degrees above pre-industrial levels now requires earlier peaking and sharper declines in Chinese emissions.

What are the prospects for China achieving peak emissions well before 2030 and net zero by the mid-2050s? They are good in power generation. Now that Chinese wind and solar generation represents a substantial proportion of the total domestic electricity supply, continuation of recent rates of growth would force large annual reductions in generation from fossil carbon. When there is excess total generation capacity, economic forces lead to utilization of renewable ahead of fossil carbon electricity, as it does not have high operating costs from purchase of coal, gas, or oil.

The prospects are good for transport, with the combination of electrification of land transport and decarbonization of electricity supply providing a fast start. For the world as a whole, production of internal combustion cars reached its peak in 2017. Since then, more than the whole increase in demand has come from electric vehicles. In 2022, global sales of internal combustion vehicles were 20 per cent below 2017 levels. China is well ahead of the rest of the world. Nearly half of new car sales in China in late 2023 were fully electric or plug-in hybrid—much higher than the average of developed countries, although less than in Scandinavia. Decarbonization of shipping and long-distance civil aviation is likely to require large-scale imports of zero-carbon liquid fuels made from zero-emissions hydrogen and biomass.

The greatest challenge is in industry, in China and the world as a whole. It is bigger and harder in the country which accounts for around half of global emissions-intensive manufacturing. Research, development, and commercialization of new technologies for steel, cement, petrochemical, and other emissions-intensive industries are in their early stages. Known technologies can remove carbon emissions from production of almost all goods, or can produce zero-emissions substitutes for them. Few of these are feasible without carbon prices at levels commensurate with the social cost of carbon—something no lower than and perhaps in the vicinity of the current price for carbon allowances in the European Trading System. Some products and substitutes would require fiscal or regulatory support at higher levels. It is likely that commercial innovation in these industries, and large-scale manufacturing of the equipment that will achieve decarbonization of industry, will lean heavily on developments in China. This is as it was for electricity and transport. Supply of zero-emissions inputs to industry—including green iron for steel-making; and hydrogen and biomass derivatives for petrochemicals—is likely to require large-scale imports from countries with comparative advantage in producing these materials.

## V. Chinese domestic emissions reduction policies

There are two market imperfections that must be corrected in the process of achieving zero net emissions. The first is the external costs of carbon emissions. Stern (2007) called this the greatest market failure of all time. The second is the external benefits of innovation in the new technologies required in the zero-carbon economy.

On the carbon externality, China has had extensive experience with an emissions trading scheme (ETS) since it was introduced into a number of provinces and cities in 2017. The scheme was extended to the whole of China in 2022. There are many and wide gaps in product coverage, so that it does not yet secure reductions wherever in the economy they can be achieved at the lowest cost. Many permits are allocated to producers without payment, so the scheme does not raise the public revenue that would otherwise be possible without distortion of economic activity. More permits are allocated than would come from a trajectory defined to reduce emissions to zero at an economically optimal rate. The price of carbon dioxide-equivalent emissions has been well below the level necessary to drive the economy towards net zero emissions—$US8–9 per tonne through 2021 and 2022 and a bit over $US10 in late 2023.

At least the mechanism can be tightened and extended relatively easily. Higher prices later can increase pressure for lower emissions. The ETS provides a foundation for an efficient set of policies to achieve zero net emissions by 2055 or 2060. The discussion of international cooperation later in this paper suggests that tightening and extending the emissions trading system could establish a sound basis for Chinese participation in international trade in the goods and services that will be important in the zero-emissions economy. Linkage to international markets will establish and require a much higher carbon price—something like the level now emerging from trade within the European ETS and rising over time.

The second externality—one company's innovation conferring benefits on others—leads to underinvestment in innovation in the absence of public financial support. China has many mechanisms for providing fiscal support for innovation in the zero-carbon economy. Here the task is not to introduce new mechanisms, but to rationalize

established schemes across activities. Fiscal support for public good research in universities and specialized research institutions is warranted and generally provided at relatively high levels. In the early stages of development and commercialization of new technologies and new approaches to economic activity that significantly reduce emissions, the best economic outcomes will be achieved by all innovative investment attracting similar rates of fiscal support.

High fiscal support for innovation from national, provincial, and local governments is accompanied by large efforts to absorb knowledge from innovation abroad, including by Chinese firms investing in companies involved in research, development, and commercialization in zero-carbon activities in Western democratic capitalist countries. This has been controversial in recent years in many countries, so that China may rely more in future on domestic innovation.

## VI. China–US climate change cooperation

Cooperation between China and the US played a significant role in the success of both the Paris and Glasgow conferences. Both meetings were preceded by bilateral agreements that announced substantially increased ambitions for national programmes. Both countries took the bilateral commitments into the conference as national programmes. China's commitment at Glasgow was particularly important for the global effort. It brought the global goal of zero net emissions by 2050 within reach.

It is worth recalling the main elements of the US–China Joint Glasgow Declaration on Enhancing Cooperation, secured by Presidents Biden and Xi on 10 November 2021—the eve of the Glasgow conference. The agreement between the two countries began by recognizing the seriousness and urgency of the climate crisis. The two governments agreed to accelerate actions in the critical decade of the 2020s, as well as to cooperate in multilateral processes to avoid catastrophic impacts. They declared their intention to work individually, jointly, and with other countries during this decisive decade, to accelerate the transition to a global net zero economy.

In particular, the two sides expressed the intention to cooperate on:

(i) regulatory frameworks and environmental standards related to reducing emissions of greenhouse gases in the 2020s; and in the process maximizing the societal benefits of the clean energy transition;
(ii) policies to encourage decarbonization and electrification of end-use sectors; key areas related to the circular economy, such as green design and renewable resource utilization; and
(iii) deployment and application of technology such as carbon capture, usage, and storage (CCUS) and direct air capture.

The two countries agreed that it is necessary to control and reduce methane emissions in the 2020s. The two countries would cooperate to enhance the measurement of methane emissions; to exchange information on their respective policies and programmes for strengthening management and control of methane; and to foster joint research into methane emission reduction challenges and solutions.

The two countries agreed to cooperate on policies that increase shares of low-cost intermittent renewable energy. The US noted its goal of 100 per cent carbon-pollution-free electricity by 2035. China noted that it will phase down coal consumption during the 15th Five-Year Plan (2025–30) and make best efforts to accelerate this work. The two sides recalled their respective commitments to eliminating support for unabated international thermal coal power generation.

Recognizing the importance of eliminating global illegal deforestation to reaching the Paris goals, the two countries agreed to collaborate in eliminating global illegal deforestation through enforcing their respective laws on imports.

Both countries recognized the importance of developed countries mobilizing jointly US$100 billion per year by 2020 and annually through 2025 to assist developing countries on climate goals and stressed the importance of meeting that goal as soon as possible.

A 'Working Group on Enhancing Climate Action in the 2020s' would meet regularly to address the climate crisis and advance the multilateral process, focusing on enhancing concrete actions in this decade.

The US–China Joint Agreement provided an important support for Glasgow. It anticipated continuing to support progress to net zero global emissions through the 2020s.

The agreement was suspended in August 2022 by the Chinese government in response to the visit to Taiwan of the Speaker of the US House of Representatives, Nancy Pelosi. The Chinese government said that this was a breach of the one China principles upon which Sino–US diplomatic relations had been established. Prior to these developments, Sino–US climate change cooperation had continued, even as bilateral tensions escalated. Through 2023

high-level political contact and discussion was resumed, culminating in resumption of active discussion of climate change around the Asia-Pacific Economic Cooperation (APEC) heads of government meeting in San Francisco in November 2023.

None of the Glasgow and subsequent US–China cooperation would have occurred under a Trump Presidency. The prospects look bleak in the event of a return to Trump-like policies in the US from early 2025.

## VII. Geo-strategic tensions and climate cooperation

Both the US and China can continue to move purposefully on their own decarbonization and on emissions reduction with third countries in the absence of formal bilateral cooperation. However, US–China cooperation has been important for successful outcomes in UNFCCC conferences and has the potential to strengthen each country's own decarbonization efforts and the sum of their respective impacts in third countries. Any breakdown in that cooperation is a setback for the global effort.

The disruption of Sino–US trade and investment under the Trump government has continued generally with geo-strategic tensions under President Biden. Strategic rivalry between the US and China is a fact of the contemporary world. For the time being, it seems inevitable that each country will restrict trade in items that seem to have implications for the strategic balance. Global development and prosperity, and more generally the future quality of human society, depends on China and the US being able to manage strategic tension without war, and without loss of global gains from trade beyond items that have direct, large, and clear implications for strategic competition. It is not obvious that restrictions on trade in zero-carbon technology and goods would systematically favour either China or the US in their strategic competition. It is therefore to the benefit of both and to the world as a whole that mutually beneficial trade and investment relations on the zero carbon economy continue, with exclusions for strategic reasons following rigorous analysis. In the unhappy circumstances of continued disruption of Sino–US trade and investment related to climate change, it is important that US–China tensions impose minimal damage on the global progress towards zero net emissions. It is important that third countries interact productively with both on reduction in emissions.

Chinese trade and economic cooperation with other developed countries have been disrupted by political tensions over the past 7 years. Changes in Chinese political priorities and international policy and inward-oriented policies in the US have interacted in ways that have damaged confidence in international economic exchange. Some politically motivated Chinese restrictions on trade and investment with third countries have been damaging to established trade and to the confidence required to support expansion. This has inevitably reduced amounts of and gains from trade, investment, and technological exchange related to the energy and industrial transition.

The increases in barriers to US imports during the Trump Presidency were greatest against China (Corden and Garnaut, 2018). They have not been reduced under President Biden. Indeed, the Inflation Reduction Act (IRA) has extended protection of US production of goods that are important in reduction of greenhouse gases (Garnaut, 2023). China imposed restrictions on trade with the US and several other countries during the Trump period and still retained many of them in early 2024.

The international setbacks and the Covid epidemic and the policy response to it slowed without stopping growth in foreign trade and output in China and the developing world as a whole. Trade in goods and services that are important in the energy and industrial transition to net zero emissions has grown more rapidly than trade in general, in China, the US, and the world as a whole. It is important to achievement of net zero emissions in China and the rest of the world that it continues to do so. Continued expansion in trade in goods and services related to the zero emissions economy lowers the cost of transition and assists its reconciliation with continued global development.

How is the Chinese and global transition to net zero emissions affected by recent US (the IRA) and EU (the Carbon Border Adjustment Mechanism, CBAM), initiatives affecting trade and decarbonization? The initiatives are both motivated and shaped by climate, industry protection, and China-related political objectives.

The IRA on balance has positive effects on global decarbonization (Garnaut, 2023). Two effects are positive. It accelerates US domestic decarbonization. US influence on global political and intellectual trends causes this to lift the priority of climate mitigation objectives in much of the rest of the world. It increases support for innovation and commercialization related to the zero-carbon technologies, with spillover effects everywhere. And it has two negative effects. It is strongly protectionist, favouring US production of many zero-carbon goods, and also production in allied countries for energy transition minerals and some other important inputs into production. This reduces gains from trade in goods related to the energy and industrial transition and increases costs everywhere. And the IRA is part of the set of expansionary fiscal policies commenced under President Trump and extended under President Biden, that has lifted the US budget deficit to by far the largest experienced outside recession or

during or in the aftermath of major wars. The US budget deficit this year will absorb about 2 per cent of global incomes or 8 per cent of global gross savings. The US IRA has been partially emulated in other North American countries, in Europe, and in the developed countries of North-east Asia. The combined budgetary effects have been important causes in the rise of global long-term real interest rates on low-risk debt from around zero to over 2 per cent. Virtually all of the zero-emissions technologies and processes are highly capital-intensive—much more so than their carbon-intensive competitors. The higher interest rates have increased costs in the energy and industrial transition.

The Trump–Biden combination of protection and budgetary expansion has raised the US real exchange rate, and reduced US competitiveness in all other markets. The simple arithmetic says that this has increased the competitiveness of China in the rest of the world's markets.

The EU's CBAM seeks to impose additional taxes on imports of products from countries that apply less rigorous policies than the EU to reduce carbon emissions. From 2026, it will impose additional import taxes on goods entering the EU, to close the gap between carbon taxes and constraints imposed in the countries in which production was located, and carbon taxes that would have been paid on the same activities in Europe. It will systematically favour imports from countries that are doing more to reduce emissions, over those from countries that are doing less. It will encourage trading partners to go further with policies that reduce emissions. The CBAM is likely to be highly and favourably influential in the climate change mitigation policies of trading partners. Major trading partners of Europe with strong commitments to climate change mitigation will have incentives to go further in policies to reduce emissions intensity to European levels. For China, the high current emissions intensity would make that a step too far in the near future. The straightforward medium-term response would be to tighten and extend the Chinese ETS to raise the carbon price and to support trade with Europe in goods and carbon credits. It is in the EU's and global interest that a path be kept open for China when its efforts or achievements in decarbonization are comparable with those of the EU.

There is a risk that CBAM will be applied without regard for announced principles, so that it increases protection in addition to legitimate compensation for differences in carbon policies. Generally favourable effects on the global mitigation effort would then come at a cost to global development.

The CBAM may have a role in resolution of Trump-era US tariffs against the EU. The 10 per cent US tariffs on aluminium imports from Europe and the 25 per cent tariffs on steel are the subject of discussion in early 2024. The US has suggested that a 'carbon club' be established—a common tariff region with the EU for these and perhaps other products. One possibility would be for the European CBAM rates of border tax to be applied by both countries, alongside free trade between the US and EU. The rationale would be that, with the IRA, the US is making a similar effort to Europe in reducing emissions. Other countries could join the carbon club if they were making similar decarbonization efforts. The arrangements would be inconsistent with WTO rules. That would not seem to be a barrier on the US side: since early in the Trump presidency the US has not accepted the application of WTO rules to itself. As a matter of pragmatic judgement, the arrangement would probably be favourable for the global mitigation effort, and have low costs from distortion of resource allocation, so long as the protectionist element of the proposed arrangements was small.

The combination of the IRA and associated US budget expansion and protection, and development of a carbon club between the US and the EU, would tend to divide the world into two trading regions, centred respectively on the US and China. China would be the main focus of exclusion and may not be accepted into the club no matter what its mitigation efforts are.

The high budget deficits, protection, and real exchange rate would make the US less competitive in the rest of the world for zero-carbon as well as other goods and services. Some of that high cost structure and reduction of competitiveness would flow through to partners in the club—although less to the extent that the EU resisted pressures to use the CBAM in a protectionist way. China would become more competitive and increase its share of world markets outside the carbon club. The US-centred and China-centred trading regions would be of comparable size, so both are likely to lose similar amounts from reduction of gains from trade. Countries that maintained open trade with both the carbon club and the rest of the world would experience the largest gains from trade. Arbitrage through them would help to reduce costs of global economic fragmentation in both the carbon club and the rest of the world.

The high cost of the Trump budget expansion and protection have continued and been extended under Biden. Things could get worse. The world has to prepare for the possibility of the election as President of the United States in November 2024 of Mr Trump, or an alternative with similar approaches to policy. This would see a reduction in the positive and an increase in the negative contributions of US policy to the global mitigation effort. It would see a large additional reduction in gains from trade in the US and the rest of the world, including China. The rest of the

world would be wise to avoid retaliation on trade or climate, allowing the possibility of a turn in the US political cycle to policies more favourable for good global outcomes. The rest of the world's best response from the point of view of climate change mitigation and global development would be to reduce protection and to increase efforts to reduce emissions. This would occur within the framework of 'concerted unilateral mitigation'—albeit for the time being a concerted effort of countries other than the US.

## VIII. Wider mechanisms for maintaining open trade with China

More generally, there is a large advantage for climate change mitigation and global development in maintaining open trade in zero carbon goods, equipment for building the zero carbon economy, and in carbon credits.

The understanding of comparative advantage and the gains from trade have been assimilated into much Chinese development discussion. At the fourth decadal anniversary of reform in 2018, I remarked that China had become a source of education on Ricardian theory and practice (Garnaut, 2018). Professor Lin Yifu's Center for New Structural Economics at Peking University was a source of knowledge on comparative advantage, influencing development planning to good effect in some African countries (Lin and Wang, 2017). There have been important cross-currents in Chinese trade policy over the past several years, with anxieties about access to developed countries' markets feeding back other tendencies to accelerate self-sufficiency in a number of advanced technological products. It is important for global climate change mitigation and Chinese and global development that these tendencies do not extend into high-volume trade in goods that are important in the zero-carbon economy.

In 2011, important steps were taken to support open trade in 'environmental products' at the Asia–Pacific Economic Cooperation heads of government meeting in Vladivostok. It was agreed that 56 products, including photovoltaic panels and wind turbines, would be subject to tariffs no higher than 5 per cent. As with all APEC agreements, this was within the framework of open regionalism, characterized by concerted unilateral liberalization. Participation was voluntary, and its terms not legally binding. Nineteen of the 21 APEC members joined. Compliance has been much higher than with 'binding' WTO agreements. Four of the 19 participating countries have not comprehensively complied with the agreement. Malaysia and Thailand describe themselves as being on a path to compliance. Chile's general tariff of 6 per cent requires amendment to bring tariffs on the 56 items down by a percentage point. The US complied until the Trump tariffs introduced major breaches, which have not been corrected. With the important US exception, the substantial progress under APEC auspices has survived the trade and political tensions of recent years. It would be helpful to extend the early initiatives and to introduce similar initiatives in the WTO. Pending support from all WTO members, plurilateral agreements could be helpful in themselves and encourage wider multilateral efforts.

It is strongly in the interests of China and its economic partners in the developed world that China is not excluded from developed country markets for goods that are currently made with high emissions but which are capable of being made with net zero emissions. China has a particular interest in open trade in two types of products. One is the capital goods of the zero emissions economy, where China is currently by far the world's largest exporter. It is prospectively a much larger exporter as the world moves to zero net emissions. The second is goods currently made with high emissions that will embody zero emissions in the new economy—zero-emissions iron, silicon, aluminium, and other metals, made with renewable energy or hydrogen from renewable energy in countries with rich mineral and renewable energy resources; or zero-emissions hydrogen embedded in ammonia or in other chemical compounds. Drawing zero-emissions materials from countries with rich renewable energy resources will allow China to remove emissions from its own supply chains at relatively low cost, supporting its continued access to and competitiveness in the markets of developed countries.

## IX. Disruption from the Covid crisis and the Russia–Ukraine war

Long-term progress on the energy and industrial transition has been affected by the dislocation of the Covid pandemic, and now the disruption of global energy markets from the Russia–Ukraine war.

The Glasgow meeting was postponed by a year as a result of Covid, but its outcome does not seem to have been weakened by the delay. The global economic recession caused by the Covid restrictions reduced carbon emissions in 2020. There was a sharp increase in emissions in the recovery from recession. We will soon learn whether the latter were temporary increases that had no long-term consequences, or an unfortunate turning point.

The disruption of the global coal, oil, and gas markets from the war in Ukraine is a larger challenge to the transition. High energy prices in Europe, spreading to the rest of the world, have elevated the priority of short-term energy security and cost over reductions in emissions. This has been a setback for movement to net zero in the

short run, especially in Europe. However, it has drawn attention to the insecurity of reliance on fossil carbon and hydrocarbon imported from potentially unreliable sources. Renewable energy, drawn from local sun and wind, is inherently more secure. Renewable energy embodied in imported products may be similarly or less insecure depending on the country of origin. The long-term effect of the fossil carbon market disruption may be to accelerate the energy transition.

## X. Conclusions

China has an immensely important role in reaching the agreed international goal of holding temperature increases close to 1.5 degrees by achieving zero net global emissions by 2050. Success is much more likely and will be achieved at much lower cost if there is close cooperation across national boundaries. Within that success, China is a major source of capital goods for the global transition and a major importer of currently carbon-intensive goods that are more economically supplied from countries with richer relative endowments of renewable energy resources. Geo-political tensions with developed countries are potentially a risk to the required cooperation. China and its partners throughout the world share an acute interest in ensuring that disruption of trade is confined to goods and services in which China or other countries have real and substantial security interests. This would allow the world to continue to benefit from specialization in line with comparative advantage in goods that are important in the energy and industrial transition to zero net emissions.

An unvarnished examination of the current state of international relations in many spheres may suggest bleak prospects for the global and the Sino–US cooperation that is necessary to contain climate change within bounds that are consistent with the continued good health of human civilization. War in the Ukraine and Gaza; geo-political tensions between China and the capitalist democracies; the parlous financial position of the World Health Organization; and the denial of institutional support for the normal functioning of the World Trade Organization—these all caution against hope. But the successes so far in the Paris and Glasgow conferences around the concept of concerted unilateral mitigation, in expanding the boundaries of open trade in environmental products in Asia Pacific Cooperation and in the maintenance of constructive Sino–US cooperation on climate change through the 2020s suggests that continued efforts are warranted. The contribution by Maurice Obstfeld to this issue (Obstfeld, 2024) draws some apt and encouraging parallels from the darker days of the Cold War:

> Historically, new global challenges and opportunities have led to new forms of international cooperation, even in times of stress. During the Cold War, for example, US–Soviet collaboration led to development of the oral polio vaccine and, a much more difficult task, to the eradication of naturally occurring smallpox worldwide by 1978 (Hotez, 2014).
>
> This experience carries at least two important lessons for today. First, universally perceived challenges can prompt productive collaboration between competing superpowers. Second, existing multilateral institutions that are widely viewed as legitimate and more politically neutral are instrumental for channelling superpower competition into positive-sum outcomes that can also attract broad-based international support.

## References


Bhagwati, J. (1964), 'A Survey of the Pure Theory of International Trade', *The Economic Journal*, March; also published with the same title in the same year by *The American Economic Review*.

Cai, F., and Huang, Y. (2013), 'Macro-economic Implications of the Turning Point', in Y. Huang and F. Cai (eds), *Debating the Lewis Turning Point in China*, London, Routledge.

Chen, Y., Ebenstein, A., Greenstone, M., and Li, H. (2013), 'Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy', *Proceedings of the National Academy of Sciences*, **110**(32), 12936–41.

Corden, M., and Garnaut, R. (2018), 'The Economic Consequences of Mr Trump', *Australian Economic Review*, December.

Garnaut, R. (2013), 'Removing Climate Change as a Barrier to Economic Progress', *Economic Analysis and Policy*, **43**(1), 31–47.

—(2018), 'Forty Years of Economic Reform and the Challenges Ahead', in R. Garnaut and L. Song (eds), *China: Forty Years of Economic Reform and Growth*, Canberra, Australian National University Press.

—(2023), 'The Economic Consequences of Mr Trump and Mr Biden', *Australian Economic Review*, December.

—Huang, Y. (2006), 'Continued Rapid Growth and the Turning Point in China's Development', in R. Garnaut and L. Song (eds), *The Turning Point in China's Economic Development*, Canberra, Australian National University Press.

Guzman, M., and Stiglitz, J. (2024), 'International Trade Rules for Global Economic Development and Prosperity: Principles and Power', *Oxford Review of Economic Policy*, **40**(2), 282–306.

Heckscher, E. (1919), 'The Effect of Foreign Trade on the Distribution of Income', *Economisk Tidsktift*, **21**, 497–512.

Hotez, P. J. (2014), '"Vaccine Diplomacy": Historical Perspectives and Future Direction', *PLOS Neglected Tropical Diseases*, **8**(June), 1–7.
Lewis, W.A. (1954), 'Economic Development with Unlimited Supplies of Labour', *The Manchester School*, **22**(2), 139–91.
Lin, J. Y., and Wang, Y. (2017), *Going Beyond Aid: Development Cooperation for Structural Transformation*, Cambridge, Cambridge University Press.
Meinshausen, M., Nichols, Z., Burdon, R., and Lewis, J. (2022), 'The Diminishing Carbon Budget and Australia's Contribution to Limit Climate Change', in R. Garnaut (ed.), *The Superpower Transformation: Making Australia's Zero-Carbon Future*, Melbourne, BlackInc with Latrobe University Press.
Obstfeld, M. (2024), 'Economic Multilateralism 80 Years after Bretton Woods', *Oxford Review of Economic Policy*, **40**(2), 307–28.
Ohlin, B. (1933), *International and Inter-regional Trade*, Cambridge, Cambridge University Press, and Cambridge, MA, Harvard University Press.
Ricardo, D. (1819), *The Principles of Political Economy and Taxation*, accessed as the 1962 edition, London, Dent (Everyman).
Robertson, D. (1936), 'The Future of International Trade', *The Economic Journal*, **46**(184), 695–7.
Sandiford, M. (2022), 'The Net Zero Opportunity for Australian Minerals', in R. Garnaut (ed.), *The Superpower Transformation: Making Australia's Zero-Carbon Future*, Melbourne, BlackInc with Latrobe University Press.
Song, L. (2022), 'Decarbonising China's Steel Industry', in R. Garnaut (ed.), *The Superpower Transformation: Making Australia's Zero-Carbon Future*, Melbourne, BlackInc with Latrobe University Press.
Susskind, D., and Vines, D. (2024), 'Global Economic Order amd Global Economic Governance', *Oxford Review of Economic Policy*, **40**(2), 189–219.
Stern, N. (2007), *The Economics of Climate Change*, London, Cambridge University Press.
Stolper, W. E., and Samuelson, P. A. (1941), 'Protection and Real Wages', *Review of Economic Studies*, **9**(1), 58–73.