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Climate Change and the Limits to the Growth-Oriented Model of Development: The Case of China and India

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Abstract

This paper discusses the interplay between the rise of China and India in the world economy and the global climate emergency. It considers alternative growth scenarios for China and India. The results show that, to meet their respective global climate obligations, both China and India need to accept much slower economic growth rates and possibly economic stagnation in the coming decades. This clearly indicates that both China and India need to revise their growth-oriented model of development. Only a new development strategy focused on social and environmental progress, rather than economic growth, can be compatible with climate stabilization.

JEL classification: O53; P30; Q54

Keywords

climate change, China, India, economic growth

1. Introduction

In 2009, world capitalism experienced the most severe economic crisis since the 1930s. However, a much bigger challenge is underway. Humanity is now confronted with climate change, which is primarily caused by carbon dioxide emissions associated with fossil fuels consumption. An increase in global temperatures will lead to rising sea levels, widespread droughts and floods, melting of ice sheets and permafrost, and ocean acidification. The impending ecological catastrophes could potentially lead to the total collapse of the Earth's ecological systems and threaten the survival of human civilization.

The Western world has been responsible for most of the historical carbon dioxide emissions, but the emissions of developing countries have been growing rapidly in recent years. According to the latest BP *Statistical Review of World Energy*, China is now the world's largest carbon dioxide emitter, accounting for 25 percent of world emissions. India has become the world's

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third largest emitter, accounting for 5 percent of world emissions (BP 2011). Without serious commitments from both China and India in a global emissions reduction effort, there is little chance for climate catastrophes to be prevented.

This paper discusses the interplay between the economic rise of China and India and global climate change. It argues that to meet their global climate stabilization obligations, China and India will have to accept much lower economic growth rates and possibly economic stagnation in the coming decades. This implication is in fundamental conflict with China and India's current model of development, which is based on the pursuit of economic growth at the expense of rising inequality and growing environmental costs.

2. Global and National Carbon Budgets

The global average temperature is now about 0.8 degrees Celsius (0.8°C) higher than the pre-industrial era, and is currently growing at a rate of about 0.2°C per decade. If the global average temperature rises by more than 2°C relative to the pre-industrial era, it could lead to large-scale glacial losses, the extinction of 15 to 40 percent of plant and animal species, and extensive drought and desertification in Africa, Australia, Southern Europe, and the western United States. If the global average temperature rises by 3°C, the northern hemisphere could become free of glaciers and ice sheets, the global sea level could rise by 25 meters, and the Amazon rainforest could be destroyed and transformed into savannah. World food production would be severely affected, and potentially billions of people would be forced to migrate from the sub-tropical areas to the mid-latitudes (Spratt and Sutton 2008).

More importantly, if the global average temperature rises by more than 2°C, the climate system could reach major tipping points, which would initiate ocean and terrestrial carbon feedbacks leading to the release of more greenhouse gases and causing irreversible, runaway global warming that is out of human control. In that event, the global temperature could jump by several additional degrees, turning much of the world unsuitable for human inhabitation. For this reason, scientists generally consider the 2°C warming as the "safe limit," a threshold below which humanity must make every possible effort to stay (Spratt and Sutton 2008).

According to the IPCC (2007), to prevent global warming by 2-2.4°C, the global emissions of carbon dioxide must fall by 50-85 percent by 2050 from 2000 levels. In 2010, world carbon dioxide emissions from fossil fuel burning were 25.6 billion tons (BP 2011). If one takes the IPCC minimum target, the target of 50 percent reduction from 2000 to 2050, then by 2050 world carbon dioxide emissions need to fall to 11.8 billion tons.

How should the global "carbon budget" in 2050 (that is, the amount of global carbon dioxide emissions allowed for by climate stabilization objectives) be distributed between nation states? While different schemes are conceivable, one reasonable criterion is that every person on Earth at the beginning of the 21st century should be entitled to the same share of the future global carbon budget. Any scheme that diverges significantly from this criterion is likely to be opposed by a significant number of nation states on equitable grounds.

From the Chinese and Indian point of view, both countries had per capita emissions that were lower than the world average in 2000. Thus, a distribution of the 2050 global carbon budget according to their population in 2000 would likely be more in their favor than any possible alternative (such as distribution based on world share of GDP or based on world energy emissions).

In the rest of this paper, we assume that China and India's share of the global carbon budget in 2050 would be proportional to their population in 2000. In 2000, the Chinese and the Indian populations accounted for 21 percent and 17 percent of the total world population, respectively. It follows that China is entitled to a carbon dioxide emission budget of 2.7 billion tons, and India is entitled to a budget of 2.1 billion tons in 2050.

In 2010, China's carbon dioxide emissions from fossil fuel burning reached 8.3 billion tons (BP 2011). To meet the 2050 carbon budget, China needs to reduce its emissions by 67 percent from 2010 to 2050, with an average annual reduction rate of 2.8 percent. India's emissions were 1.7 billion tons in 2010 (BP 2011). This gives India a small space of growth for its carbon dioxide emissions. India's emissions are allowed to grow by 24 percent from 2010 to 2050, with an annual average growth rate of 0.5 percent.

Currently, both the Chinese government and the Indian government insist that as developing countries they have to prioritize economic growth, which is considered to be vital for raising the living standards of their populations. On the other hand, both countries have promised to reduce the "emission intensity" of their economies so that climate stabilization objectives can be achieved through high energy efficiency and the substitution of fossil fuels by "clean energy" (such as nuclear, hydro, and other renewable forms of electricity). The Chinese and Indian governments believe that this would allow them to meet climate stabilization objectives without compromising economic growth. This raises a crucial question: can China and India meet their global climate stabilization obligations while maintaining their current commitment to rapid economic growth?

3. Climate Stabilization and Economic Growth: Are They Compatible?

In this section, we evaluate the compatibility between economic growth and climate stabilization requirements in the case of China and India by considering a scenario where China and India take aggressive actions to reduce their emission intensity.

Currently, both the Chinese and the Indian economies are heavily dependent on fossil fuels. In 2010, fossil fuels accounted for 92 percent of China's total energy supply and 93 percent of India's total energy supply (BP 2011).

Fossil fuels may be substituted by nuclear and renewable energies. Nuclear electricity generation uses uranium, which is a non-renewable resource. Furthermore, nuclear energy has serious security, safety, and waste disposal concerns.

Most renewable energies are currently more expensive than fossil fuels, but costs are expected to decline with the market expansion of renewables (IEA 2011). Wind and solar are the two renewable resources that have a great potential to expand in the future. Techniques for large-scale energy storage to offset the intrinsic energy intermittency of solar and wind are not yet available, but are under development (Luoma 2009). The large-scale development of biomass is limited by the availability of productive land and fresh water. Given the current technical possibilities, some recent studies find that when carbon dioxide releases associated with soil erosion and deforestation are taken into account, biomass production and consumption could result in even more carbon dioxide emissions than the burning of conventional fossil fuels (Trainer 2007). Research and innovation, however, are rapidly expanding to generate cost-competitive and environmentally sustainable biofuels (Fairley 2011).

Despite the limits and possibilities of various energy alternatives, the entire world energy and industrial infrastructure is constructed around fossil fuels. Shifting to a low-carbon economy requires a dramatic transformation of physical facilities and skills, and fundamental changes in energy, transportation, and industrial processes. This process of construction and adaptation to a post-fossil fuel world will not only demand major technical innovations and very large financial investments, but also takes much time to complete.

Below we present a scenario of energy consumption and economic growth for China and India, which is designed to be consistent with their climate stabilization requirements. It assumes certain declines of fossil fuels consumption, very optimistic construction rates of "clean

Table 1. Climate Stabilization and Economic Growth: China and India (2000-2050).

	Fossil Fuels (Mtoe)	Clean Electricity (Mtoe)	Total Energy (Mtoe)	Energy Efficiency ($/toe)	Real GDP (Billion $)
China:					
2000	980	20	1,000	3,400	3,400
2010	2,030	70	2,100	4,300	9,100
2050	670	830	1,500	14,200	21,200
Ave. ann. growth rate					
2000-2010			7.6%	2.6%	10.5%
2010-2050			-0.8%	3%	2.1%
India:					
2000	270	100	280	6,400	1,800
2010	450	160	460	8,300	3,800
2050	550	1,910	720	15,000	10,800
Ave. ann. growth rate					
2000-2010			5.0%	2.7%	7.8%
2010-2050			1.1%	1.5%	2.6%

Note: Million tons of oil equivalent; $/toe: dollars per ton of oil equivalent; Billion $: in 2005 international dollars.
Sources: Historical energy data are from BP (2011). Historical GDP data are from the World Bank (2011).

electricity" (including nuclear, hydro, and other renewable forms of electricity), and equally optimistic rates of improvement of energy efficiency. These assumptions allow one to calculate the implied economic growth rates over the projected period.

For China to fulfill its global climate stabilization obligation, it needs to reduce its fossil fuel consumption by 67 percent from 2010 to 2050. For India, its fossil fuel consumption may still increase by 24 percent from 2010 to 2050.

From 2005 to 2008, China's average annual installation of clean electricity was 23 giga-watts, and the average annual installation of all types of electricity was 93 giga-watts (BP 2011). China accounted for 54 percent of the total world net power plant installations over this period. Such high building rates are unlikely to be sustained over the long run. By comparison, over the same period the United States (with an economy that is still significantly larger than China's) on average built 11 giga-watts of all types of electricity a year. In this paper, we assume that China will build 50 giga-watts of clean electricity a year from 2010 to 2050.

From 2005 to 2008, India's average annual installation of clean electricity was 4 giga-watts, and the average annual installation of all types of electricity was 10 giga-watts (BP 2011). We assume that India will build 10 giga-watts of clean electricity a year from 2010 to 2050.

Table 1 summarizes the results. In 2010, China produced about 850 terawatt-hours of clean electricity (converted to about 70 million tons of oil equivalent). From 2010 to 2050, China will build 2,000 giga-watts of clean electricity (about twice as large as the present size of the entire U.S. electricity generating capacity). Assuming 50 percent capacity utilization (which could be too high for renewable electricity), China will produce about 9,600 terawatt-hours of clean electricity in 2050 (converted to 1,500 million tons of oil equivalent).

However, it turns out that the projected massive growth in clean energy will be insufficient to offset the required decline in fossil fuels. As a result, Chinese energy consumption will have to decline at an average annual rate of 0.8 percent from 2010 to 2050.

China's energy efficiency grew rapidly from 2000 to 2010 at an average annual rate of 2.6 percent (BP 2011). By comparison, the world average energy efficiency grew at an average annual rate of 1 percent over the same period. We assume that China will be able to maintain very rapid efficiency improvement, and its energy efficiency will grow by 3 percent a year for the entire period from 2010 to 2050.

Real GDP is just the product of total energy consumption and energy efficiency. China's real GDP is projected to grow by 2.1 percent a year from 2010 to 2050, very slow compared to China's recent economic growth rates.

India's energy consumption is projected to grow at an average annual rate of 1.1 percent from 2010 to 2050, reflecting the fact that India is entitled to some further growth in its carbon dioxide emissions. India's energy efficiency grew rapidly at 2.7 percent a year from 2000 to 2010 (BP 2011). But this pace of efficiency improvement may not be sustained for long.

India's energy efficiency is already about twice as high as China's, and higher than the world average. Considering that the world average efficiency improvement rate was only 1 percent over the past decade, we assume that India's energy efficiency will grow at 1.5 percent a year from 2010 to 2050. India's real GDP is projected to grow by 2.6 percent a year over the following four decades.

Thus, in the coming decades, both China and India will have to accept much slower economic growth rates if they are to meet their respective global climate stabilization obligations.

The above exercise assumes that China and India will immediately work on emission reduction and adjust their economic growth rates accordingly. However, if China and India continue to pursue rapid economic growth, their remaining growth space could be quickly exhausted. For example, if the Chinese economy continued to grow at 10 percent a year from 2010 to 2020, its economy in 2020 would rise to 23,600 billion dollars, leaving no space for growth from 2020 to 2050. Similarly, if India continued to grow at 10 percent a year from 2010 to 2020, its economy in 2020 would rise to 9,900 billion dollars, with very little space for further growth to 2050.

4. Conclusion: Limits to the Growth-oriented Model of Development

The leadership in China and India justified China and India's current position on climate stabilization by arguing that China and India are developing countries and need to pursue rapid economic growth in order to improve the general population's living standards. In reality, economic growth in China and India has been accompanied by dramatic increase in inequality and very high environmental costs. When inequality and environmental costs are taken into account, it is not obvious that economic growth in its current form has benefited the great majority of the populations of China and India.

In China, growing income and wealth inequality has been observed between coastal and interior provinces, between urban and rural areas, between sexes, and between different social classes and groups. Measured by the Gini coefficient, China is now among the most unequal countries in the world (Bhaduri 2008). Workers' income has lagged behind overall economic growth. From 1990 to 2005, labor income as a share of China's GDP declined from 50 percent to 37 percent. In addition, the declines of public services have led to surging health care, education, and housing costs, making life difficult for large sections of the working class (Li 2008: 87-91).

In India, economic growth has primarily benefited capitalist profit. But workers' real wage and social welfare have stagnated. Despite rapid economic growth, much of the population stays below poverty. About four-fifths of the population lives on less than two purchasing parity dollars a day (Bhaduri 2008).

China's economic growth has had devastating impacts on the environment. Seven of the ten most polluted cities in the world are located in China. About 60 percent of the water in China's major river systems is classified as not suitable for human contact. Due to soil erosion and pollution, 40 percent of China's arable land is degraded (Li 2008: 167-169).

India's economic growth has also imposed a growing burden on the country's environment. Since the 1970s, India's ecological footprint has increased and its bio-capacity has declined, resulting in widening ecological deficits. India's per capita ecological footprint is now about twice India's own bio-capacity. India's ecological system has clearly been overwhelmed by the current model of development (Global Footprint Network 2008).

In this paper, we consider the possibilities for China and India to meet their global climate stabilization obligations. We find that under plausible and possibly overly optimistic assumptions, if China and India immediately start to reduce their absolute levels of emissions, both countries need to accept much slower economic growth rates to meet their respective climate stabilization obligations. If the actions of emission reduction are postponed by another decade, however, China and India will have to struggle with economic stagnation in the following decades if their respective global climate obligations are to be met.

Although China and India have achieved rapid economic growth in recent years, the very high social and environmental costs have raised serious questions regarding China and India's growth-oriented model of development. The imperative of climate stabilization means that in the future China and India may have to accept much slower economic growth rates. In this context, the improvement of living standards for the great majority of the population will have to come from more equitable distribution of income and wealth as well as improvement in environmental conditions. This may require fundamental transformations of China and India's existing economic and social structures.

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