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In What Format and under What Timeframe Would China Take on Climate Commitments? A Roadmap to 2050[1]

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Abstract
In what format and under what timeframe China would take on climate commitments is of significant relevance to China because it is facing great pressure both inside and outside international climate negotiations to exhibit greater ambition and is being confronted with the threats of trade measures. It is of significant global relevance as well because when China's emissions peak is crucial to determine when global emissions would peak and because what China is going to do in what format has significant implications for the level and ambition of commitments from other countries.

In response to these concerns and to put China in a positive position, this paper maps out the roadmap for China's specific climate commitments towards 2050. Taking many factors into consideration, the paper argues that China needs to take on absolute emissions caps around 2030. While this date is later than the time frame that the U.S. and other industrialized countries would like to see, it would probably still be too soon from China's perspective. However, it is hard to imagine how China could apply the brakes so sharply as to switch from rapid emissions growth to immediate emissions cuts, without passing through several intermediate phases. To that end, the paper envisions that China needs the following three transitional periods of increasing climate obligations before

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taking on absolute emissions caps that will lead to the global convergence of per capita emissions by 2050: *First, further credible energy-conservation commitments starting 2013 and aimed at cutting China's carbon intensity by 45-50% by 2020; second, voluntary "no lose" emission targets starting 2018*; and *third, binding carbon intensity targets as its international commitment starting 2023.* Overall, this proposal is a balanced reflection of respecting China's rights to grow and recognizing China's growing responsibility for increasing greenhouse gas emissions as China is approaching the world's largest economy.

JEL classification: Q42; Q48; Q52; Q54; Q58

Keywords: Carbon intensity target; Binding emissions caps; Post-Copenhagen climate negotiations; Energy saving; Renewable energy; Clean development mechanism; China; USA; India

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1. Introduction

In addressing climate change issues, China and India are always put together as the big emerging economies. There are similarities between the two most populous countries, but there exist substantial differences between them. Such differences imply that China needs to come prepared to take on even more stringent greenhouse gas emission commitments and correspondingly to bear the higher compliance costs than India does. Let me explain why.

Both China and India rely heavily on coal to fuel their economies, but coal accounts for a much larger share in China's energy mix than that of India. As the world's largest coal producer and consumer, China produces and consumes about twice as much coal as the U.S., the world's second largest producer and consumer. Coal has accounted for over two-thirds of China's primary energy consumptions for several decades. Coal-fired power plants dominate total electricity generation in China, consuming over half of the total coal use. As a result, China's total installed capacity of coal-fired power plants is more than the current total of the U.S., the United Kingdom and India combined.

Both countries have experienced spectacular economic growth over the past two decades, but China has grown and is projected to continue to grow faster than India for quite some time to follow. Economic structure differs significantly between the two countries. In comparison with other countries at its income level, China has an unusually large share of energy-intensive industrial production and an unusually small share of less energy-intensive service sector. For example, 48% of China's GDP in 2006 originated from the industry sector and 40% from the service sector, while the corresponding figures for India were 28% and 55%, respectively. Moreover, the differing composition of industry affects the levels of energy intensity. China has a larger share of energy-intensive manufacturing in industry than that in India, with manufacturing contributing to 33% of China's GDP in 2006 relative to the corresponding 16% for India (World Bank, 2008). Thus, China uses more energy per unit of industrial output, although the unit energy consumption for major industrial products in China is lower than in India (Zhang, 1995 and 1997). As the workshop of the world, a hefty chunk of China's emissions are embedded in goods that are produced for exports to industrialized countries.

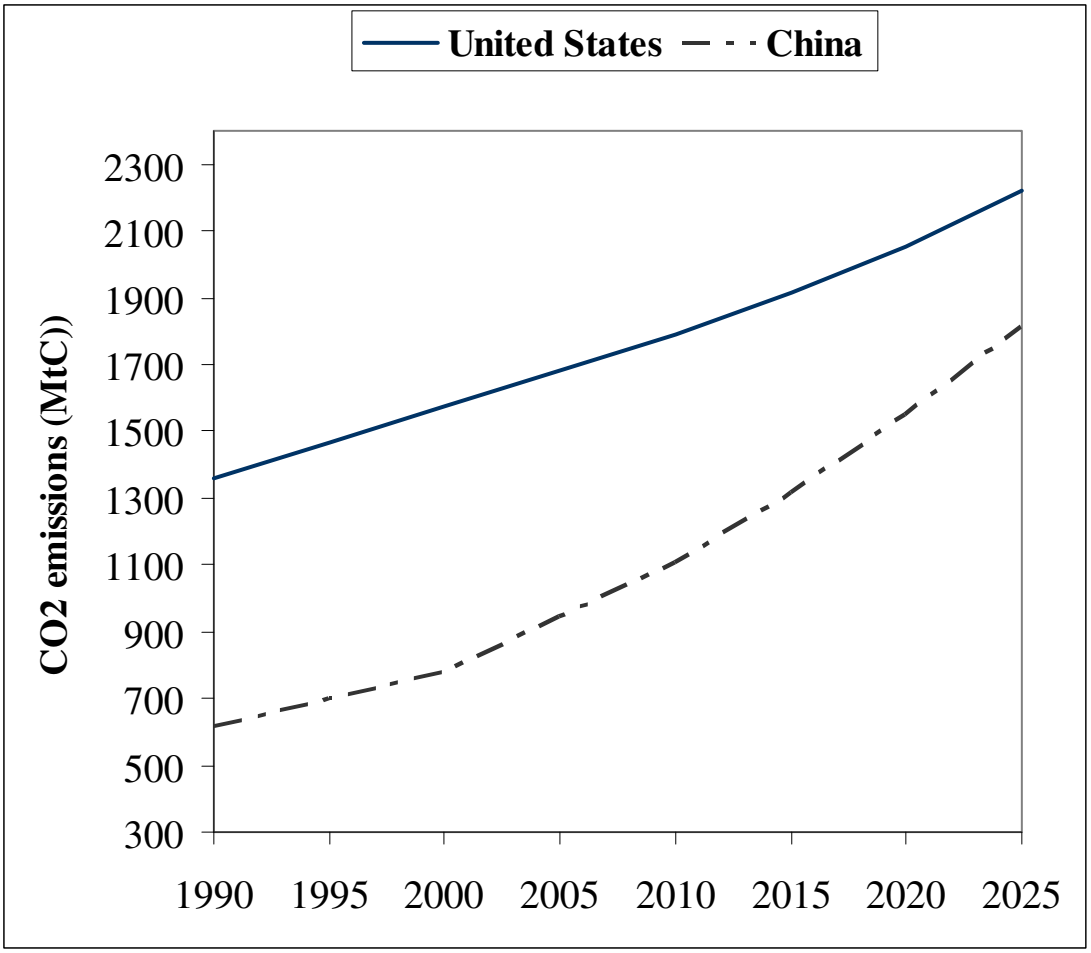
China is the world's most populous country, and has experienced a very low rate of population growth through implementing its strict family control programs. By contrast, the world's second most populous country grows at a much higher rate than China does, and is expected to take over China before 2030 (UNDESA, 2009).[2]

All the factors combined lead to that both China's total and per capita greenhouse gas emissions are much higher than India's. This gap between China's per capita CO_2 emissions and India's is projected to even widen in the future. By 2030, China's per capita carbon emissions are projected to be well above the world's average under the

[2] UNDESA (2009) projects that China's population would peak at 1462.5 millions around 2030, while India's population would be projected to be at 1484.6 millions in 2030 and further grow to 1613.8 millions in 2050.

business as usual scenario, whereas the corresponding India's are expected to be below the world's average (EIA, 2009; IEA, 2009). The Indian Climate Change Ambassador Shyam Saran was quoted as saying that "India is not at the same level as China". Saran argued that simply categorizing India as the world's third largest emitter "masks the fact that between No. 1, No. 2 and No. 3, there is a huge gap" (ClimateWire, 2009). India proposed basing future commitments on per capita emissions. This would potentially lead to differentiation between China and India and among developing countries because China would fall into a more demanding emission reduction category than India. So, if both countries were required to cut their emission levels to the world's average on a per capita basis, then China would experience higher compliance cost than India.

Figure 1 CO_2 Emissions in China and the United States, 1990-2025
Source: Drawn based on data from EIA (2004).



Indeed, if China's energy use and the resulting carbon emissions had followed their trends between 1980 and 2000, during which China achieved a quadrupling of its GDP with only a doubling of energy consumption, rather than surged since 2001, then the position of China in the international climate debate would be very different from what it

is today. On the trends of the 1980s and 1990s, the U.S. Energy Information Administration (EIA, 2004) estimated that China's CO_2 emissions were not expected to catch up with the world's largest carbon emitter until 2030 (see Figure 1). However, China's energy use has surged since the turn of this century, almost doubling between 2000 and 2007. Despite similar rates of economic growth, the rate of growth in China's energy use during this period (9.74% per year) has been more than twice that of the last two decades in the past century (4.25% per year) (National Bureau of Statistics of China, 2009). As a result, China became already the world's largest carbon emitter in 2007, instead of "until 2030" as estimated as late as 2004. This is mainly because China is still in the course of rapid industrialization and urbanization, which in turn requires to consume energy to produce energy-intensive steels, cements, glasses etc for cars, buildings, houses and public infrastructures, and partly because China failed to keep the expansion of inefficient and highly polluting industries under control and to implement its own set industrial restructuring and sustainable development policies.

While China should take the main responsibilities for this, the U.S. factor has also played a role here. To see why, let us go back to international climate negotiations prior to Kyoto and subsequently until the U.S. withdrawal from the Kyoto Protocol. Prior to Kyoto, developing counties' demand for the U.S. to demonstrate the leadership and the EU proposal for a 15% cut in emissions of a basket of three greenhouse gases below 1990 levels by 2010 put collective pressure on the U.S., which led the world in greenhouse gas emissions at that time. At Kyoto, the U.S. had made legally binding commitments. The Kyoto target is seen as not enough but yet not unreasonable given that the U.S. economy would not be disrupted unreasonably. This may give the U.S. some "moral" right to persuade developing countries to take meaningful mitigation action. After Kyoto, the ball was kicked into China's court. The U.S. had made it clear that bringing key developing countries, including China, on board had been and would continue to be its focus of international climate change negotiations. According to some U.S. Senators, it will be countries like China, India and Mexico that will decide whether the U.S. will ratify the Kyoto Protocol. It is therefore conceivable that the pressure will mount for China to make some kind of commitments at the negotiations subsequent to Buenos Aires. The world's media will undoubtedly bring attention to China's non-participation, which will be seen as holding up the ratification of the Protocol by the U.S. Senate and possibly even be blamed for "blowing up" subsequent negotiations aimed at dealing with developing countries' commitments. The U.S. commitments at Kyoto and diplomatic and public pressure on China had put China in a very uncomfortable position.[3] It looked like China would be pressured to take on commitments at much earlier date than what China wished.

[3] Under these circumstances and in anticipation that the U.S. would take on the more stringent commitments in the post-2012 period, I envisioned a decade ago the following six proposals that could be put on the table as China's plausible negotiation position. **"**First, China could regard its active participation in CDM as 'meaningful participation'. Second, China could commit to demonstrable efforts towards slowing its greenhouse gas emissions growth at some point between the first commitment period and 2020. Third, China could to make voluntary commitments to specific policies and measures to limit greenhouse gas emissions at some point between the first commitment period and 2020.

This situation changed once the U.S. withdrew from the Kyoto Protocol. The U.S. withdrawal from the Kyoto Protocol in 2001 not only led current U.S. emissions to be well above their 1990 levels and the world to lose eight years of concerted efforts towards climate change mitigation and adaptation, but also removed international pressure on China to take climate change mitigation actions at a time when the Chinese economy is rapidly growing. It is since 2002 that China reversed a decline trend in its energy intensity over the last two decades in the past century, experiencing faster energy consumption growth than economic growth (see Figure 2). It would be silly to blame this for the U.S., but if the U.S. would not withdraw from the Kyoto Protocol, for its own competiveness concerns alone the U.S. would keep pressuring on China just like it did immediately after Kyoto and is currently doing, China's actual greenhouse emissions would be lower than their current levels.

After what is viewed as eight years of lost time under President Bush, the U.S. is now determined to fully engage with international community to seal a global deal to succeed the Kyoto Protocol. There is no better way for the U.S. to show its leadership than it committing to quantified emissions cuts because it matters most to the ongoing climate talks and is deemed essential to a global pact. However, whether such commitments would emerge rests with the U.S. Congress. Understandably, in the course of the U.S. House of Representatives debating and voting the American Clean Energy and Security Act (the so-called Waxman-Markey bill) and the U.S. Senate shaping its own version of a climate change bill, the U.S. Congress will push for major emerging economies and even use the threat of trade measures, such as carbon tariffs,[4] to induce developing economies, such as China and India, to go beyond the defined policies and measures as demonstrated when the U.S. Senate debated the Lieberman-Warner Climate Security Act in 2008. The senior officials under the Obama administration signal that the U.S. is not going to

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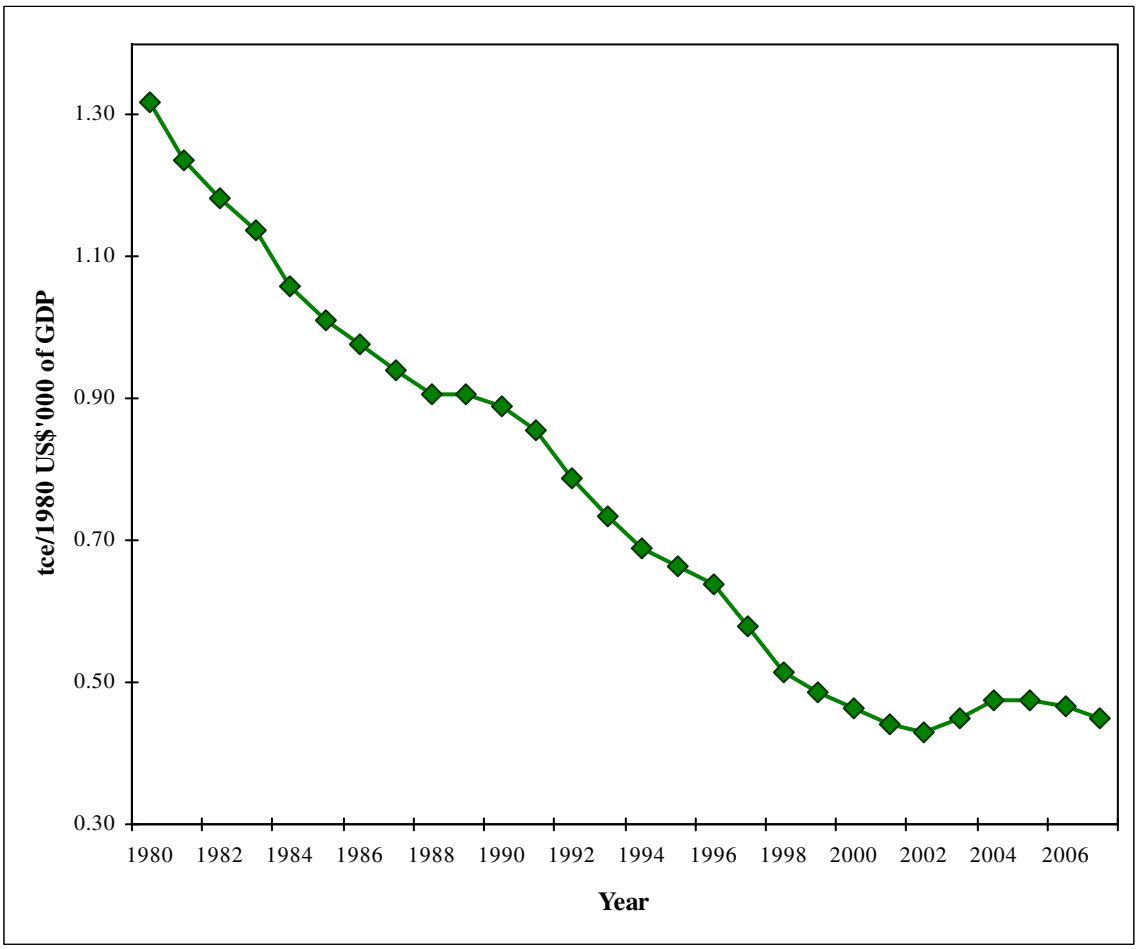
Policies and measures might need to be developed to explicitly demonstrate whether or not China has made adequate efforts. Fourth, China could make a voluntary commitment to total greenhouse gas emissions per unit of GDP at some point around or beyond 2020. The fifth option would be for China to voluntarily commit to an emissions cap on a particular sector at some point around or beyond 2020. Taking on such a commitment, although already burdensome for China, could raise the concern about the carbon leakage from the sector to those sectors whose emissions are not capped. This leads to the final option that China could offer: a combination of a targeted carbon intensity level with an emissions cap on a particular sector at some point around or beyond 2020." (Zhang, 2000).

[4] See Zhang (2009a,c,d) for detailed discussion on the WTO scrutiny of emissions allowance requirements (EAR) under a cap-and-trade regime proposed in the Lieberman-Warner bill in the U.S. Senate and in the Waxman-Markey bill in the U.S. House of Representatives, whether an EAR threat would be effective as an inducement for major emerging economies to take climate actions that they would otherwise not, and methodological challenges in implementing EAR.

change its suggested emissions cuts for 2020,[5] which is far below what developing countries call for, claiming that that there is a little room. Similarly, there is a little room left for developing countries before 2020, although for reasons very different from those of the U.S.. Therefore, the key issue is *post*-2020, not *pre*-2020. Moreover, we are facing the political reality that, while U.S. commitment to cut emissions is essential to a global pact, how China is going to do in that context is a crucial, if not decisive, factor in both determining the ambition of that commitment and taking on that commitment.

Figure 2 Energy use per unit of GDP in China, 1990-2007 (tons of coal equivalent per US$ 1000 in 1980 prices).
Source: Drawn based on *China Statistical Yearbook*, various years.



[5] U.S. Energy Secretary Steven Chu indicated that Washington was not interested in retooling its percentage goal for 2020. He was quoted as saying that "I think that rather than debating a few percent, the best thing we can do is to get started as soon as possible" (Reuters, 2009b). Todd Stern, U.S. Special Envoy for Climate Change, was quoted as saying that signing up for cuts of 25-40% below 1990 levels by 2020 would be "a prescription not for progress, but for stalemate" in the U.S. Congress (ClimateWire, 2009).

This paper is organized as follows. Section 2 discusses a realistic date on which China would be expected to take on absolute emissions caps. Section 3 envisions what kinds of credible interim targets we would expect China to take on during this transition period from the second commitment period to taking on binding emissions caps. Section 4 draws some concluding remarks.

2. When would China be expected to take on absolute emissions caps?

China is already the world's largest carbon emitter, and its emissions will continue to rise rapidly as it is approaching the world's largest economy. Thus, China is seen to have greater capacity, capability and responsibility. The country is facing great pressure both inside and outside international climate negotiations to exhibit greater ambition. Moreover, China will always be confronted with the threats of trade measures, as long as it does not signal well ahead the time when it will take on the emissions caps. Given these facts, there is no question that China must eventually take on absolute greenhouse gas emissions caps. The key challenges are 1) to decide when that would take place and 2) to determine the credible interim targets that would be needed during the transition period. These results will no doubt be a combination of China's own assessment of its responsibility, the economic and political benefits, and the climate change impacts, taking also into consideration the mounting diplomatic and international pressure and the give and take of international negotiations. In this section, I focus on the first question, arguing that around 2030 is the timing of China taking on absolute emissions caps. The next section will address the second one.

Many factors need to be taken into consideration in determining the timing for China to take on absolute emissions caps. Taking the commitment period of five years that the Kyoto Protocol has adopted, I think the fifth commitment period (2028-2032), or around 2030 is not an unreasonably expected date on which China needs to take on absolute emissions caps for the following reasons. While this date is later than the time frame that the U.S. and other industrialized countries would like to see, it would probably still be too soon from China's perspective.

First, the fourth assessment report of the Intergovernmental Panel on Climate Change recommends that global greenhouse gas emissions should peak by 2020 at the latest and then turn downward, to avoid dangerous climate change consequences. With China already as the world's largest carbon emitter (MNP, 2007; EIA, 2009), the earlier China takes on emissions caps, the more likely that goal can be achieved. So, Hu (2009) argues that China should mirror this global roadmap, and thus suggests that China's carbon emissions should have peaked by 2020 and be cut to their 1990 levels by 2030. However, given China's relatively low development stage and its rapidly growing economy fueled by coal, its carbon emissions are still on the climbing trajectories. The IEA (2009) projects China's baseline carbon emissions in 2020 to be 4.36 times their 1990 levels, and to be expected to continue to grow afterwards, climbing to 5.27 times their 1990 levels in

2030.[6] While energy use in China is projected to grow somewhat slower in the 2020s than in the 2010s, China's carbon emissions would be still on the climbing trajectories beyond 2030, even if some energy saving policies and measures have been factored into such projections. It should thus come as no surprise that Hu's proposal has received very negative reactions from China's delegation to the United Nations conference on climate change.[7]

Second, even if 2020 is considered unrealistic, then what is a realistic date to expect China to take on emissions caps? It should be pointed out that before legally binding commitments become applicable to Annex I countries, they have a grace period of 16 years starting from the Earth Summit in June 1992 when Annex I countries promised to individually or jointly stabilize emissions of CO_2 and other greenhouse gases at their 1990 levels by the end of the past century to the beginning of the first commitment period in 2008. This precedent points to a first binding commitment period for China starting around 2026.

Third, with China still dependent on coal to meet the bulk of its energy needs for the next several decades, the commercialization and widespread deployment of carbon capture and storage (CCS) is a crucial option for reducing both China's and global CO_2 emissions. Thus far, CCS has not been commercialized anywhere in the world, and it is unlikely, given current trends, that this technology will find large-scale application either in China or elsewhere before 2030. Until CCS projects are developed to the point of achieving economies of scale and bringing down the costs, China will not feel confident about committing to absolute emissions caps.

Fourth, developing countries need reasonable time to develop and operate national climate policies and measures. This is understood by knowledgeable U.S. politicians, such as Reps. Henry Waxman (D-CA) and Edward Markey (D-MA), the sponsors of the American Clean Energy and Security Act of 2009. Indeed, the Waxman-Markey bill gives China, India and other major developing nations time to enact climate-friendly measures. While the bill called for a "carbon tariff" on imports, it very much framed that measures as a last resort that a U.S. president could impose at his or her discretion not until January 1, 2025 regarding border adjustments or tariffs, although in the middle of

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[6] The EIA (2009) projects China's baseline carbon emissions to be 4.11 times their 1990 levels in 2020 and 5.12 times their 1990 levels in 2030.

[7] One member of China delegation to the international conference on climate change at Bonn considered his suggestion "irresponsible utopian speeches", and wrote that "the author mentions none of China's relevant basic conditions in his speech about climate change problems. Instead he focuses on empty talk about international fairness and justice. The author lacks intrinsic knowledge about how climate change problems have appeared and lacks any common sense of history or knowledge of the current situation of international politics. Because of this, his conclusions could mislead readers, which is irresponsible and without vitality". Available at: http://www.chinadialogue.net/article/show/single/en/2892-A-new-approach-at-Copenhagen-1-.

the night before the vote on June 26, 2009, a compromise was made to further bring forward the imposition of carbon tariffs.

Many studies point out the structural limitations of CDM, and suggest that if developing countries would take on sectoral or absolute emissions caps, then that will move the CDM from a project-based mechanism to a wholesale mechanism and allows developing countries to sell emission permits at the same world market price as developed countries whose emissions are capped, relative to the lower prices that developing countries have received for carbon credits generated from CDM projects. However, no institutional and infrastructure supports exist in the majority of developing countries for operating emissions trading. Developing countries including China need time to develop and operate such a scheme. Take the establishment of an emissions trading scheme as a case in point. Even for the U.S. SO_2 Allowance Trading Program, the entire process from the U.S. Environmental Protection Agency beginning to compile the data for its allocation database in 1989 to publishing its final allowance allocations in March 2003 took almost four years. For the first phase of the EU Emissions Trading Scheme, the entire process took almost two years from the EU publishing the Directive establishing a scheme for greenhouse gas emission allowance trading on 23 July 2003 to it approving the last national allocation plan for Greece on 20 June 2005. For developing countries with very weak environmental institutions and that do not have dependable data on emissions, fuel uses and outputs for installations, this allocation process is expected to take much longer than what experienced in the U.S. and the EU and put a trading scheme into operation (Zhang, 2007a). That is the reason why I suggest to have voluntary no lose targets during the third commitment period (2018-2022), instead of immediately having such targets during the second commitment period. That will leave some time for developing countries to design and implement an emissions trading scheme which economists argue that developing countries would benefit from.

Fifth, another timing indicator is a lag between the date that a treaty is signed and the starting date of the budget period. With the Kyoto Protocol signing in December 1997 and the first budget period staring 2008, the earliest date to expect China to introduce binding commitments would not be before 2020. Even without this precedent for Annex I countries, China's demand is by no means without foundation. For example, the Montreal Protocol on Substances that Deplete the Ozone Layer grants developing countries a grace period of 10 years (Zhang, 2000). Given that the scope of economic activities affected by a climate regime is several orders of magnitude larger than those covered by the Montreal Protocol, it is arguable that developing countries should have a grace period much longer than 10 years, after mandatory emission targets for Annex I countries took effect in 2008. In the meantime, absolute emissions caps on developing countries need to be markedly below their baseline levels by 2030. I think that one way to ensure this is China committing to binding carbon intensity targets during the fourth commitment period (2023-2027).

Sixth, while it is not unreasonable to grant China a grace period before taking on emissions caps, it would hardly be acceptable to delay the timing beyond 2030. China is already the world's largest carbon emitter and, in 2010 it will overtake Japan as the

world's second largest economy, although its per capita income and emissions are still very low. After another twenty years of rapid development, China's economy will approach that of the world's second-largest emitter (the U.S.) in size, whereas China's absolute emissions are well above those of number two. Its baseline carbon emissions in 2030 are projected to reach 11.6 billion tons of carbon dioxide, relative to 5.5 billion tons for the U.S. and 3.4 billion tons for India (IEA, 2009), the world's most populous country at that time.[8] This gap with the U.S. could be even bigger, provided that the U.S. would cut its emissions to the levels proposed by the Obama administration and under the American Clean Energy and Security Act of 2009. By then, China's per capita income will reach a very reasonable level, whereas its per capita emissions of 8.0 tons of carbon dioxide are projected to be well above the world's average of 4.9 tons of carbon dioxide and about 3.4 times that of India (IEA, 2009). While the country is still on the climbing trajectory of carbon emissions under the business as usual scenario, China will have lost ground by not to taking on emissions caps when the world is facing ever alarming climate change threats and developed countries will have achieved significant emissions reductions by then.

3. A Roadmap for China to 2050

I propose that at current international climate talks China should negotiate a requirement that greenhouse gas emissions in industrialized countries be cut at least by 80% by 2050 relative to their 1990 levels and that per capita emissions for all major countries by 2050 should be no more than the world's average at that time. Moreover, it would be in China's own best interest if, at the right time (e.g., at a time when the U.S. Senate is going to debate and ratify any global deal that would emerge from current international climate negotiations), China signals well ahead that it will take on binding absolute emission caps around the year 2030. However, it is hard to imagine how China could apply the brakes so sharply as to switch from rapid emissions growth to immediate emissions cuts, without passing through several intermediate phases. After all, China is still a developing country right now, no matter how rapidly it is expected to grow in the future. Taking the commitment period of five years that the Kyoto Protocol has adopted, I envision that China needs the following three transitional periods of increasing climate obligations, before taking on absolute emissions caps.

Further credible quantified domestic commitments during the second commitment period

China has already committed itself to quantified targets on energy saving and the use of clean energy (Zhang, 2009b), and has got credit for such efforts.[9] It needs to extend its level of ambition, making further credible quantified domestic commitments in these

[8] Under the EIA business as usual scenario, baseline carbon emissions in 2030 are projected to be 11.73 billion tons of carbon dioxide for China, 6.4 billion tons for the U.S. and 2.1 billion tons for India (EIA, 2009).

[9] Todd Stern, U.S. Special Envoy for Climate Change, was quoted as saying that "The Chinese are doing a lot already, …The Chinese have a lot of policy that they have put in place" (Reuters, 2009a).

areas for the second commitment period. Such commitments would include but are not limited to continuing to set energy-saving and pollutant control goals in the subsequent national five-year economic blueprints as challenging as the current 11th five-year blueprint does, increasing investment in energy conservation and improving energy efficiency, significantly scaling up the use of renewable energies and other low-carbon technologies, in particular wind power and nuclear power, and providing additional support policies to accomplish its own ambitious energy-saving and clean energy goals. Currently, China has set to decommission thousands of small, inefficient coal-fired power plants with a unit capacity of 50 MW or less. To increase the benefits of energy saving and the environment, China should consider doubling or even quadrupling that unit capacity to 100 MW or 200 MW below which coal-fired plants need to be decommissioned (Zhang, 2009b).

Calling future goals as challenging as the current ones requires establishment of why the current 20% energy saving goal is considered very challenging. China set a goal of cutting energy use per unit of GDP by 20% by 2010, relative to its 2005 level. In 2006, the first year of this energy efficiency drive, while China reversed a rise in its energy intensity in the first half of that year, the energy intensity only declined by 1.79% over the entire year. Although this decline is a first since 2003, it was far short of the targeted 4%. Among the 31 Chinese provinces or equivalent, only Beijing met that energy-saving goal in 2006, cutting its energy use per unit of GDP by 5.25%, followed by Tianjin with the energy intensity reduction of 3.98%, Shanghai by 3.71%, Zhejiang by 3.52% and Jiangsu by 3.50% (NBS et al., 2007).[10] In 2007, despite concerted efforts towards energy saving, the country cut its energy intensity by 4.04% (NBS et al., 2009). There are still big variations in energy-saving performance among the 31 Chinese provinces or equivalent. Beijing still took the lead, cutting its energy intensity by 6%, followed by Tianjin by 4.9% and Shanghai by 4.66% (NBS et al., 2008). This clearly indicated Beijing's commitments to the 2008 Green Olympic Games. In the meantime, however, there were seven provinces whose energy-saving performances were below the national average. 2008 was the first year in which China exceeded the overall annualized target (4.4%) of energy saving, cutting its energy intensity by 4.59% (NBS et al., 2009). This is due partly to the economic crisis that reduced the overall demand, in particular the demand for energy-intensive products. Overall, energy intensity was cut by 10.1% in the first three years of the plan relative to 2005 levels. This suggests that the country needs to achieve almost the same overall performance in the remaining two years as it did in the first three years in order to meet that national energy intensity target. It will certainly not be easy to achieve that.

Voluntary no lose targets during the third commitment period

During the third commitment period (2018-2022), China could commit to adopting voluntary no lose targets. Such targets are defined as certain percentages of reduction

[10] Beijing is the first provincial region in China to establish in 2006 the bulletin system to release data on energy use and water use per unit of GDP, quarterly releasing these and other indicators by county. See Zhang (2007b and 2007c) for detailed discussion on why Beijing met but the country missed the energy-saving goals.

from the country's business as usual emissions. Emissions reductions achieved beyond the no lose targets would then be eligible for sale. That will allow China to sell emission permits at the same world market price as those of developed countries whose emissions are capped, relative to the lower prices that China currently receives for carbon credits generated from CDM projects.

The keys to operate this option involve setting both baseline emissions and no lose targets. To avoid inflating baseline emissions, baselines must be generated by an independent international expert body, not by the Chinese national authority.[11] On setting no lose targets, one option is to take the IPCC (2007) recommendation as a reference, which suggests that developing countries as a group will need to limit their greenhouse gas emissions to 15-30% below their baselines by 2020. Another option is based on China's own set energy or carbon intensity targets, which are then translated into the amount of emissions reductions from the baselines. Because having some quantitative targets is more critical than targets themselves, the no lose targets for China will be set not to exceed the higher of the above two alternatives to encourage China to take on such targets.

What is the yardstick or bound on the energy or carbon intensity of the Chinese economy in 2020? Between 1980-2000, China's GDP quadrupled, but its energy consumption only doubled (Zhang, 2003). China aims to achieve a quadrupling of its GDP with only a doubling of energy consumption between 2000 and 2020, with a 20% cut in the energy intensity between 2006-2010 deemed a crucial step towards that goal. Assuming that China's economy grows at the annual average rate of 7% per year and China is able to limit the growth in energy use to half the growth rate of the economy between 2006-2020, then China's energy use per unit of GDP would be cut by 40% by 2020, relative to its 2005 levels. This assumed rate economic growth is very conservative in China's context. Assuming the most likely growth rate of 8% per year between 2006-2020 and all others remaining unchanged, then China's energy intensity would be cut by 43% by 2020, relative to its 2005 levels. This back of the envelope calculation implies the assumed energy elasticity of 0.5 between 2006 and 2020. While China were able to accomplish that during the last two decades of the past century, going ahead, we should not naturally expect a return to that level, given that China had experienced faster energy consumption growth than economic growth between 2002 and 2005 and, as discussed earlier, is encountering great difficulty in meeting its 20% energy intensity target (Zhang, 2005, 2007b,c and 2009b). Thus, a 40-43% cut in China's energy intensity by 2020 relative to 2005 is considered as an upper bound on China's possible no lose energy intensity targets. With carbon-free energy meeting 7.1% of China's total energy needs in 2005 (National Bureau of Statistics of China, 2009) and that share mandated to be increased to 15%, this 40-43% cut in energy intensity is equivalent to a 48-51% cut in carbon intensity between 2006-2020, implying that China's own proposed carbon intensity reduction by 40-45% by 2020 is little conservative. China should aim a 45-50% cut in its carbon intensity over the period 2006-2020.

[11] Frankel (2009) also suggests to use an independent international expert body to set baseline emissions in his formulas for emission targets for all countries.

Moreover, reducing China's baseline emissions below the no lose targets set by either of the aforementioned two options involves not only abatement costs, but also the costs associated with measurement, reporting and verification requirements that are more complex, demanding and thus costly to comply with than China's own domestic requirements. For a huge developing country like China with very weak environmental institutions and that do not have dependable data on emissions, fuel uses and outputs for installations and all reports have to be in English for this purpose, such costs, which occur to ensure that all the emissions data are properly measured, reported and verified in an aim to generate economically valuable and environmentally-credible credits and thus to ensure that an international emissions trading scheme works properly, are not expected to be trivial. So, combined this with the above upper bound arguments, China could conceivably assume a no lose target less stronger than the one set by its domestic energy or carbon intensity targets.

Binding carbon intensity targets during the fourth commitment period

While China is expected to adopt the carbon intensity target as a domestic commitment in 2011, during the fourth commitment period (2023-2027), China could commit to adopting binding carbon intensity targets as its international commitment. This will be a significant step forward towards committing to absolute emissions caps during the subsequent commitment period. In my view, carbon intensity of the economy is preferred to energy intensity of the economy (i.e., total energy consumption per unit of GDP), because all the efforts towards shifting away from high-carbon energy are awarded by the former (Zhang, 2000). The carbon intensity is set further downwards relative to the third commitment period.

Binding emissions caps starting the fifth commitment period

Having been granted the three transition commitment periods, China could then be expected to take on binding emissions caps starting the fifth commitment period. The exact caps will be a function of many factors. While it would be desirable if China could commit to stringent emissions caps, having China to commit quantified emissions cuts is more critical than its emissions caps themselves because that will hold China's emissions on a contraction path. In my view, there is no need to worry too much now about that emissions caps, given that actions to honor the interim targets during the transition periods will lead to a significant reduction in the growth of China's emissions and will drive them substantially below the business as usual levels. Thus, that emissions caps, no matter what value would be set eventually, would be substantially deviated from China's projected baseline emissions. Moreover, the caps should be set in such a way to aim for the global convergence of per capita emissions by 2050 as recommended by Stern (2008).[12] Provided that the world would agree on this, it will serve as another way for China to carefully set its emissions caps from the fifth commitment period onwards in order to avoid overshooting the caps set based on the world's per capita emissions in 2050.

[12] This does not necessarily means that I agree with Stern's suggested value of the global per capita emissions in 2050.

4. Concluding remarks

With governments from around the world trying to hammer out a post-2012 climate change agreement, no one would disagree that a U.S. commitment to cut greenhouse gas emissions is essential to such a global pact. However, despite U.S. president Obama's announcement to push for a commitment to cut U.S. greenhouse gas emissions by 17% by 2020, in reality it is questionable whether the U.S. Congress will agree to specific emissions cuts, although they are not ambitious at all from the perspectives of both the EU and developing countries, without imposing carbon tariffs on Chinese products to the U.S. market, even given China's own recent announcement to voluntarily seek to reduce its carbon intensity by 40-45% over the same period. The influential U.S. congressmen have frequently stressed the importance of China in helping a passage of U.S. domestic, carbon-constrained legislation and a ratification of a global new deal that would emerge from current international climate negotiations. Whether you like it or not, this is a political reality.

However, both sides see a little room before 2020, although for reasons very different from each other. Therefore, the key issue is *post*-2020, not *pre*-2020. With the U.S. aimed to cut its greenhouse gas emissions by 83% from their 2005 levels by 2050, what matters most now is U.S. taking on quantified emissions cuts immediately staring the second commitment period. The U.S. is unlikely to do that until China is politically willing to agree to some measurable, verifiable and reportable goals for greenhouse gas obligations. China is also expected to face increasing pressure from the European Union, who will find it increasingly hard to convince its citizens in general and the companies in particular why the EU has taken the lead but doesn't see China following. In my view, this is not the illegitimate concern as overall competitiveness concerns mean that no country is likely to step out too far in front (Zhang, 2004). That goals that would meet U.S. expectations and at the same time, are considered acceptable by China are an open question. But the bottom line is that what that goals or obligations would be needs to fully respect China's rights to grow, and at the same time should reflect China's growing responsibility for increasing greenhouse gas emissions as its standards of living increase over time. After all, China is a developing country right now, no matter how rapidly the Chinese economy is expected to grow in the future. On the other hand, China is already the world's largest carbon emitter and its emissions continue to rise rapidly in line with its industrialization and urbanization. China is seen to have greater capacity, capability and responsibility. The country is facing great pressure both inside and outside international climate negotiations to exhibit greater ambition. Moreover, China will always be confronted with the threats of trade measures, as long as it does not signal well ahead the time when it will take on the emissions caps.

Given these facts, there is no question that China must eventually take on absolute greenhouse gas emissions caps. The key challenges are to decide when that would take place and to determine the credible interim targets that would be needed during the transition period. These results will no doubt be a combination of China's own assessment of its responsibility, the economic and political benefits, and the climate

change impacts, taking also into consideration the mounting diplomatic and international pressure and the give and take of international negotiations.

In response to these concerns and to put China in a positive position, this paper maps out the roadmap for China's specific climate commitments towards 2050. The paper proposes that at current international climate talks China should negotiate a requirement that greenhouse gas emissions in industrialized countries be cut at least by 80% by 2050 relative to their 1990 levels and that per capita emissions for all major countries by 2050 should be no more than the world's average at that time. Taking many factors into consideration, the paper argues that China needs to take on absolute emissions caps around 2030. While this date is later than the time frame that the U.S. and other industrialized countries would like to see, it would probably still be too soon from China's perspective. However, it is hard to imagine how China could apply the brakes so sharply as to switch from rapid emissions growth to immediate emissions cuts, without passing through several intermediate phases. Taking the commitment period of five years as the Kyoto Protocol has adopted, the paper envisions that China needs the following three transitional periods of increasing climate obligations before taking on absolute emissions caps that will lead to the global convergence of per capita emissions by 2050: *First, further credible energy-conservation commitments starting 2013 and aimed at cutting China's carbon intensity by 45-50% by 2020; second, voluntary "no lose" emission targets starting 2018*; and *third, binding carbon intensity targets as its international commitment starting 2023.* Overall, this proposal is a balanced reflection of respecting China's rights to grow and recognizing China's growing responsibility for increasing greenhouse gas emissions as its standards of living increase over time.

The commitments envisioned for China are basic principles. They leave ample flexibility for China to work out the details, as international climate change negotiations move onward. The value of this proposal lies in the format and timeframe under which China would be included in a post-2012 climate change regime, not in the numerical details. It should not be taken for granted that China can take on such increasingly stringent commitments, because that would entail significant efforts to cut China's projected emissions below its baselines. Political reality may limit the U.S. ability to take on the significant emissions cuts by 2020 that developing countries called for, but as a tradeoff, the U.S. should significantly scale up its technology transfer and deployment, financing and capacity building to enable China to meet the goals. This is the least that the U.S. can and should do, and by example, can encourage other developed counties to do the same. As Winston Churchill said, "[you] can always count on the Americans to do the right thing – after exhausting every other alternative." After what is viewed as eight years of lost time under President Bush, the whole world bets that U.S. will not disappoint us this time. Only history will tell us whether that will be a case.

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