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**Global Challenges from the Rapid Rise of China<sup>1</sup>**

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<sup>1</sup> The volume in which this paper is contained is due to be published by Routledge Publishing under the title *The Role of China in Global Economic Recovery* (ed. Xiaolan Fu).

## **Global Challenges from the Rapid Rise of China<sup>2</sup>**

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Over the last 30 years there has already been a significant power shift to developing world in general and to China in particular. This shift is being accelerated as a result of the 2008/2009 economic crisis. The rapid rise of China raises economic and environmental sustainability challenges to the world.

Section A tracks the shift in economic power to China by looking at shares of global GDP in terms of purchasing power parity. China's share has increased from 2 % in 1980 to 12.5% in 2009. Section B provides a short analysis of the 2008/2009 crisis and its implications for growth. The crisis originated in the US and spread to the rest of the world. The full recovery will be long. The eventual rise in the cost of capital will lead to lower overall growth. The crisis has accelerated the power shift from the US and Europe to Developing Asian economies, particularly to China.

Section C looks in more detail at China. China was less negatively affected by the crisis. It has also recovered faster for structural and policy reasons. China is also likely to continue to grow faster than the rest of the world in spite of some serious internal and external challenges.

Section D examines some of the challenges raised by the rise of China. Its growth will continue to put significant adjustment pressure on the global system. This will be in terms of the increasing competitiveness of its manufactured and service exports. It will also mean additional competition for raw materials and commodities in general, and energy in particular. Compounding the challenges, its expanding energy use will contribute significantly to increased CO2 emissions. This raises complex issues of development and environment, as well as of equity and burden sharing.

Section E concludes that promoting cooperation rather than increasing frictions will require adjustments among all major stakeholders, particularly the US and China.. Changing economic power and the global warming constraint will also require adjustment in the governance of the global economic and political systems, as well as increased international financial and technology transfer to developing countries. Finally it will also require developing and implementing more sustainable development models.

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<sup>2</sup> Revised version of paper originally presented at Economic Association (UK Europe) Conference: Global Economic Recovery: The Role of China and Other Emerging Economies Oxford University, July 12-13, 2010.

## A. Economic Power Had Been Shifting to Emerging Asia Before the Crisis

There have been significant changes in the relative size of different economies and regions over the last thirty years. Emerging and developing economies have grown faster than developed economies. They increased their share of global GDP from 36% in 1980 to 46% by 2009 (Table 1).<sup>3</sup> The developing region that has shown the largest increase is Developing Asia. Its share of global GDP more than tripled from 7.2% in 1980 to 22.5% in 2009. By 2005 it had a larger share than the Euro Countries, and by 2009 surpassed the US.

**Table 1: Share of Region/Country GDP as a percent of Global GDP  
In Current Purchasing Power Parity Prices**

	1980	1990	2000	2005	2008	2009
<b>Advanced economies</b>	<b>63.80%</b>	<b>64.04%</b>	<b>62.98%</b>	<b>58.81%</b>	<b>55.13%</b>	<b>53.87%</b>
-Japan	7.89%	9.08%	7.63%	6.86%	6.27%	6.00%
-United Kingdom	3.92%	3.75%	3.60%	3.42%	3.21%	3.10%
-United States	22.50%	22.63%	23.64%	22.39%	20.78%	20.46%
-Euro area	n.a.	n.a.	18.50%	16.71%	15.69%	15.21%
-Newly industrialized Asian economies*	1.70%	2.71%	3.64%	3.75%	3.75%	3.70%
-Other advanced economies (Advanced economies excluding G7 and euro area)	6.06%	6.80%	7.60%	7.50%	7.36%	7.30%
<b>Emerging and developing economies</b>	<b>36.20%</b>	<b>35.96%</b>	<b>37.02%</b>	<b>41.19%</b>	<b>44.87%</b>	<b>46.13%</b>
-Africa	3.16%	2.91%	2.71%	2.97%	3.10%	3.19%
-Central and eastern Europe	4.11%	3.62%	3.36%	3.55%	3.62%	3.48%
-Commonwealth of Independent States**	7.54%	7.56%	3.58%	4.16%	4.55%	4.29%
-Developing Asia	7.24%	10.05%	15.10%	18.24%	20.98%	22.54%
----China	2.00%	3.55%	7.16%	9.41%	11.41%	12.52%
----India	2.24%	2.82%	3.62%	4.18%	4.75%	5.06%
-Middle East	3.88%	3.23%	3.47%	3.84%	4.00%	4.13%
-Latin America and Mexico	10.27%	8.59%	8.80%	8.43%	8.63%	8.51%

\*NIAEs are Hong Kong, Singapore, South Korea and Taiwan.

\*\*CIS are countries in Commonwealth of Independent States which includes Russia

<sup>3</sup> Table 1 figures are based on shares of global GDP in current purchasing power parity dollars to adjust for nominal exchange rates. If the table is done in nominal dollars, the share of global GDP of advanced countries was 70% and that of emerging and developing economies was 30% in 1980 and was roughly the same in 2009. However this masks significant changes. China and India increased their shares from 2.6% and 1.5% to 8.3% and 2.2, respectively, over the 30 year period.

Source: IMF database, accessed 1/28/2010

Japan and the Soviet Union, which had been increasing rapidly between 1960 and 1980 and were seen as the rising powers since WWII had a reversal of fortunes. Japan had a major financial/economic crisis in 1991 from which it had not fully recovered even before the 2008/2009 crisis. Between 1990 and 2009 Japan lost one third of its share of global GDP (from 9.1% to 6.0%). The Soviet Union fragmented in 1991 into many republics, all of which (including Russia) went into major recessions in the early part of the 1990s. In 2000 their share had fallen to 47% of their 1980 level, but recovered to 57% by 2009 due to growth based largely on a rapid expansion of natural resource exports, particularly energy.

The two countries with the most impressive performance were China in the East Asia region, and India in South Asia. China's share increased more than six fold from 2.0% of world GDP in 1980 to 12.5% in 2009. By 2001 it surpassed Japan and by 2009 it reached 61% the size of the US. India more than doubled its share of global GDP from 2.2% in 1980 to 5.1% in 2009.<sup>4</sup>

## **B. The 2008/2009 Financial and Economic Crisis**

The 2008/2009 financial and economic crisis is not another cyclical business downturn, but a major structural change.<sup>5</sup> It is the most serious global crisis since the Great Depression. The crisis started in the US and spread throughout the world. The causes of the crisis were an asset bubble created by artificially low interest rates in the US, financial innovations, financial excess, and lack of appropriate regulation. The US Federal Reserve lowered interest rates to stimulate the US economy after the dot com crash in 2001. The lower interest rates led to a rise in demand for housing. The development of mortgage backed securities increased available credit. In addition there was an increase in adjustable rate mortgages to borrowers who would barely qualify—appropriately called sub prime mortgages. The increase in the prices of houses allowed persons to increase borrowing against the increased equity value of their homes. This stimulated greater consumer credit that included increasing imports from the rest of the world. Another financial innovation was the development of credit default swaps through which investors insured themselves against the risk of defaults of investments such as mortgage back securities. Mortgage backed securities and credit default swaps were sold to investors in other countries—mostly other advanced countries. In addition, these financial innovations were also adopted in the financial markets of other advanced countries.

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<sup>4</sup> Another group that increased very rapidly was the four Newly Industrialized Asian Economies (NIAEs) of Hong Kong, Singapore, South Korea and Taiwan. Although these four countries were considered developing countries in 1980, they are currently considered developed economies because of the level of GDP per capita they have achieved. Their share of world GDP more than doubled from 1.7% in 1980 to 3.6% in 2000, but has not increased much since then.

<sup>5</sup> See Altman (2009b) for an argument of why the 2008 crash was a major structural shift. See Altman (2009a) for an interesting view of the implications of the crash for globalization.

The whole house of cards unraveled when interest rates rose in the US and subprime borrowers could no longer make the higher payments on their mortgages. As housing foreclosures increased and these properties were dumped on the housing market, the price of houses fell. As the market value of houses fell below the amount owed on them, many borrowers turned in the keys and abandoned their properties, accelerating the decline in housing prices as more entered a saturated market. As the mortgage backed securities when bad, the credit default swap market also collapsed. This brought down financial institutions in the US, the UK and other European countries.

Thus the financial crisis that started in the US spread to the rest of the world through three mechanisms. One was directly through the defaults on sub prime mortgages and credit fault swaps and the failure of Banks and other financial institution. This affected the US, and Europe directly.<sup>6</sup> A second was the indirect financial effects as investors pulled out their foreign investments to cover their domestic losses. This affected Europe as well as developing countries. There was also a flight to quality as investors brought funds back to their home countries as governments in these countries put together stimulus packages, expanded credit, and extended government guarantees to failing financial institutions. Ironically a lot of international capital flows were invested into US Treasuries. Many countries experienced capital flight and exchange rate depreciations This affected European countries as well as most developing countries, including India and the NIAEs, but not China.

The third effect was the indirect effect on the real economy. The fall in consumption led to a drastic fall in demand for imports. This affected world trade. Overall trade fell by 11% in 2008. The fall in trade was larger for advanced economies than for developing economies (Table 2). Thus even countries that were not directly affected by the first two effects, such as China, did suffer the negative effects of the crisis though the reduction in demand from the countries most directly affected by the crisis.

In 2008 world output growth fell from 5.2% in 2007 to 2.8% in 2008 and to negative 0.6% in 2009. This was the first time aggregate global GDP growth was negative since 1970 The fall was much greater in advanced economies than in emerging and developing economies, whose aggregate growth remained positive. In fact, overall growth for the emerging and developing countries was 2.5% in 2009, while it fell 3.2% in the advanced economies (Table 2). Global trade was also negatively affected and had the largest fall since 1970.

### **C. Future Growth Prospects—Further Shift in Economic Power to Emerging Asia, and China in Particular**

Table 2 provides more detail on the performance of major countries and key country groupings. Among the advanced countries, Japan, the UK and the Euro area countries,

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<sup>6</sup> Several European countries like the UK and Ireland also had their own internal financial sector problems so the spread of the financial crisis was not just contagion from investments in the US, but also from systemic financial sector weaknesses that also imploded at the same time.

Japan took the hardest hit with a fall of 5.2%; the UK had a fall of 4.9%. The Euro countries as a whole had a fall of 4.1% followed by the US with a fall of 2.6% and Canada with a fall of only 2.5%.

Among the emerging and developing economies, growth was more varied. Russia suffered a fall of 7.9%, largely because of the very steep fall in oil prices after their ramp up until the crisis in the second half of 2008. The countries in the Commonwealth of Independent States, suffered a fall of 6.5%; countries in Central and Eastern Europe had a fall of around 3.6 % because of financial outflows as well as the collapse of trade. The Latin American Region suffered a fall of 1.7 %, although Mexico had a much larger fall of 6.5% because of its greater dependence on oil and on trade and remittances from the US which also fell steeply. However, the rest of the emerging and developing countries continued with positive growth. Most impressive were China and India which managed growth of 9.1% and 5.7%, respectively. This was, in part, because they were not directly exposed to the financial problems that plagued the advanced economies. Nevertheless both were negatively affected by the collapse of demand for exports of goods and services. In the case of China, even though it was more dependent on exports, another important factor helping to offset the decline in exports was a strong fiscal stimulus package implemented by the government, as well as significant expansion of bank lending.<sup>7</sup>

### ***Short Term Prospects***

Full recovery from this crisis will take longer than usual because of the global collapse of exports. When the crisis affects only one or two regions recovery is easier because demand from the growing countries helps to pull the others out of recession. However when the fall affects all the developed countries which are the main markets for the world, recovery will take longer. The massive stimulus packages; monetary expansion; and government takeovers of failing banks, financial, and other firms; are helping go get the world out of the recession. However, there are risks that the recovery will stall if the government stimuli are withdrawn too quickly. On the other hand there is the risk that continuing with the stimulus and monetary expansion for too long could be inflationary and further undermine the recovery.<sup>8</sup> In addition the 2010 financial crisis of Greece and Ireland are shaking investor confidence in Portugal, Spain and Italy and threatening the whole Euro zone countries and the stability of the EU itself. This also has repercussions for other areas of the world that export to the EU or have major financial investments in the Euro zone. Thus the world is not out of the woods yet.

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<sup>7</sup> See Roach (2010) for details.

<sup>8</sup> See IMF (2009) and IMF (2010) for more details.

**Table 2: World Output and Trade Growth 2007-2009 and Projections 2010-2011**

	2007	2008	2009	2010** Estimate	2011** Estimate
<b>World Output*</b>	<b>5.2</b>	<b>2.8</b>	<b>-0.6</b>	<b>4.8</b>	<b>4.2</b>
<b>Advanced Economies</b>	<b>2.7</b>	<b>0.5</b>	<b>-3.2</b>	<b>2.7</b>	<b>2.2</b>
-United States	2.1	0.0	-2.6	2.6	2.3
-Euro Area	2.7	0.5	-4.1	1.7	1.5
-Japan	2.3	-1.2	-5.2	2.8	1.5
-United Kingdom	2.6	-0.1	-4.9	1.7	2.0
-Canada	2.5	0.5	-2.5	3.1	2.7
-Other Advanced	4.7	1.7	-1.2	5.4	3.7
--NIAEs***	5.7	1.8	-0.9	7.8	4.5
<b>Emerging &amp; Developing</b>	<b>8.3</b>	<b>6.0</b>	<b>2.5</b>	<b>7.1</b>	<b>6.4</b>
-Central & Eastern Europe	5.5	3.0	-3.6	3.7	3.1
-CIS****	8.6	5.3	-6.5	4.3	4.6
---Russia	8.1	5.2	-7.9	4.0	4.3
-Developing Asia	10.6	7.7	6.9	9.4	8.4
---China	13.0	9.6	9.1	10.5	9.6
---India	9.4	6.4	5.7	9.7	8.4
-Middle East & N. Africa	6.2	5.0	2.0	4.1	5.1
-Sub-Saharan Africa	6.3	5.5	2.6	5.0	5.5
-Latin America and Caribbean	5.7	4.3	-1.7	5.7	4.0
<i>[Memorandum: European Union]*****</i>	<i>3.1</i>	<i>0.9</i>	<i>-4.1</i>	<i>1.0</i>	<i>1.8</i>
<b>World Trade Volume (Exports + Imports)</b>	<b>7.3</b>	<b>2.9</b>	<b>-11.0</b>	<b>11.4</b>	<b>7.0</b>
<b>-Imports</b>					
---Advanced Economies	4.7	0.4	-12.7	10.1	5.2
---Emerging & Developing	13.8	9.0	-8.2	14.3	9.9
<b>-Exports</b>					
---Advanced Economies	6.3	1.9	-12.4	11.0	6.0
---Emerging & Developing	9.8	4.6	-7.8	11.9	9.1

\*Real effective exchange rates are assumed to remain at levels prevailing August 4-September 1, 2010. Country weights used for aggregates based on world PPP weights.

\*\* Estimates and projections account for 90% of world purchasing power weights for advanced countries, and for 77% of the emerging and developing countries.

\*\*\*NIAEs are Hong Kong, Singapore, South Korea and Taiwan.

\*\*\*\*CIS are countries in the Commonwealth of Independent States, which includes Russia.

\*\*\*\*\*EU has been included separately as a memo item, as it has both advanced and emerging and developing economies.

Source: Extracted from IMF *WEO* (October 2009, p. 2; and October 2010, p. 2).

There are also two additional reasons that full recovery will be slow. The first is that global financial system is still impaired. The IMF estimates that only about half the losses of the financial sector have been recognized to date. The second is that interest rates are going to be higher once the full recovery starts. There are two reasons for this. The first is that the crisis has made it clear that risk was being under priced so interest rates will be adjusted up to take risk into account. The second is that many advanced country governments are going to have to issue much greater debt to pay for the stimuli packages, bailouts of the financial sectors (and of the auto industry in the US and some European countries), plus make up for the shortfalls in tax revenues that result from lower GDP growth.<sup>9</sup>

It is also clear that the crisis has had a differential impact. The emerging and developing Asian economies are coming out of the crisis faster than the advanced countries. This is because they were generally in stronger fiscal positions. Second, as noted, they were not exposed to the main financial innovations (the sub prime mortgages and credit default swaps) at the heart of the financial crisis. Third, some of them, like China, reacted faster and put in place massive fiscal and stimulus packages faster.

China is particularly well positioned. It has a very high savings rate (55-54 % in 2007-2009 compared to a weighted world average of 22-21%<sup>10</sup>). Therefore, unlike most other developing countries, it is not dependent on foreign capital. In fact, it is a net capital exporter. In addition, it has the largest foreign exchange reserves in the world at over \$2.4 trillion dollars. However China has been quite dependent on international trade for both imports and exports. Because it is poor in natural resources on a per capita basis, it has to import them.<sup>11</sup> It has also dependent on growing export markets for its manufactured exports. In the short run it has been able to make up for the sharp contraction in the import demand in the US and other advanced economies through its strong fiscal stimulus package as well as a significant expansion of bank credit. However in the medium and long run it needs to switch from its heavily reliance on exports to domestic market. However it is difficult to stimulate domestic demand because of the very high savings of Chinese household and firms. Chinese households have high savings because of weakness and incompleteness of the pension, medical and social security system. The government is aware of these problems and is making efforts to improve and extend social safety nets. India is not at well positioned because it is a still a net capital importer. However an important advantage that it does share with China is a very large domestic market.

Looking to the next two years, the outlook for both countries is positive. Table 2 also presents the IMF's October 2010 growth projections until 2011. China is expected to grow at 10% a year, India at around 9%, the US at around 2.5 % and the Euro zone at

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<sup>9</sup> Based on a study of 800 years of financial crisis, Reinhart and Rogoff (2009) found that the biggest contributor to the rise in national debt in countries that went through financial crisis was the need to finance the gap that arose from the decline in tax revenues that resulted from the economic downturn of the crisis.

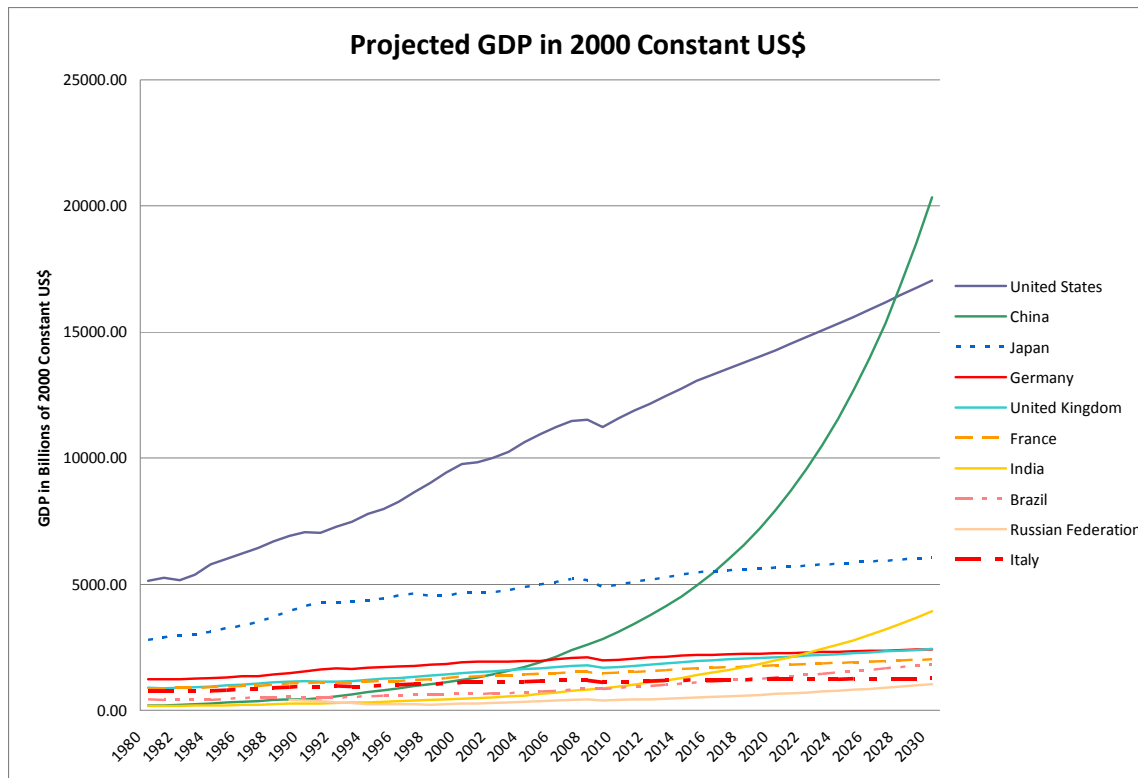
<sup>10</sup> World Bank WDI (2009).

<sup>11</sup> In 2007 one third of Chinas' merchandise imports were fuel (12%) ores and mineral (12%), food (4%), and agricultural raw materials (4%). (WDI 2009, p. 220)



1.5%. Therefore the strong differential between the growth of China and India and the advanced countries is expected to continue.<sup>12</sup>

**Figure 1: GDP Growth 1980-2009 and Projections 2010-2030 in Constant 2005 PPP Dollars**



Note: Projections 2010-2015 based on IMF. Projections (April 2010 WEO), 2016-2030 based on simple average 2000-2009 actual and 2010-2015 IMF projections

### *Longer Term Projections*

Longer term growth projections are very risky given much uncertainty about the future and the poor record of past projections. However for illustrative purposes of what the differential growth rates imply Figure 4 projects the growth of the ten largest economies in 2009 based on constant 2005 PPP dollars and a combination of the growth rates from 2000 to 2009, IMF projections to 2015, and a simple average of the two beyond 2015.. China surpasses the US by 2017, and India surpasses Japan by 2013 (it already surpassed Germany in PPP terms in 2008).<sup>13</sup>

<sup>12</sup> The differential between the average GDP growth rates 2000-2007 between China and India versus high income countries was 8 and 5 percentage points, respectively. This gap widened in 2008 and 2009 to roughly 8 to 12 percentage point for China ,and 7 to 9 percentage point for India. They are projected to fall back to the previous differential once the advanced countries recover.

<sup>13</sup> If the projections are done using nominal dollars rather than PPP dollars pretty much the same trends occur, except that it takes an extra 10 years. It should be noted that in nominal dollars, China already surpassed Germany in 2009 to become the third largest economy, and surpassed Japan in the middle of 2010.

These projections are just to show the impact of differential growth rates. There can be many surprises, such as the 2008/2009 economic crisis. In addition China and India face major challenges which can slow down or even derail their growth. Common challenges include rapidly rising inequality, environmental damage, water shortages, and corruption. China specific challenges include weak banking system, tension between authoritarian state and moves toward a decentralized market economy, tensions over Taiwan. India specific challenges include low levels of average educational attainment, underdeveloped infrastructure and the difficulties of implementing reforms because of weak governing coalitions. However, barring any major unforeseen crisis, both countries are likely to grow faster than the rest of the world for the next 10 to 20 years, because they are still behind the technological frontier in most sectors and can benefit from rapid catch-up strategies for many years to come.

#### **D. Challenges from the Rise of China**

The rise of China (and to some extent that of India) will raise economic and environmental challenges to the global system. These stem from their large populations and their rapid growth. The economic challenges include increasing competition from their exports of goods and services, and increasing competition for imports of natural resources. The environmental challenges include the environmental impact of their rapid growth, and in particular, their rapidly rising CO<sub>2</sub> emissions.

##### ***Trade***

The pressure of their increased exports can be appreciated from Table 3. The most impressive has been the increase of China's manufactured exports. These have increased from 2.9 % of the world's total in 1995 to 8.9% in 2008. This is the biggest increase in share for any regional grouping, let alone any country.<sup>14</sup> In absolute volume, in 2007 China surpassed the merchandise exports of the US, and in 2009 it surpassed those of Germany to become the largest merchandise exporter in the world.

The increase in the share of India's merchandise exports has been very modest. Actually the annual increase in merchandise exports from China is greater than the total merchandise exports of India. However what is impressive is the increase in the share of India's service exports. These have gone from 0.6% in 1995 to 2.7% of the world's service exports in 2008. This is the largest increase in share of service exports for any region, let alone any country.

The rapid increase in the exports from these two countries is putting major restructuring pressure on the rest of the world. The manufactured exports from China started mostly as

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<sup>14</sup> While merchandise and service exports from the NIAE's increased significantly between 1980 and 2000, they have not increased since then, and their share of the world total currently is roughly the size of China's.

labor intensive products. But China has been moving up very rapidly in the technology intensity of its exports. In 2007, 30% of China's manufactured exports were classified as high technology in the UNCTAD trade databases. This is in part because a large share of its exports is based on components imported from its more developed Asian neighbors such as Japan, and the NIAEs. It is also because more than 50% of the exports are made by foreign multinational companies. But it is also because domestic firms are acquiring greater technological capability. India's increase in service exports is due to its phenomenal success in exports of information technology enabled services. These constituted 39 % of its total service exports in 2007, and were ten times the value exported by China.<sup>15</sup>

**Table 3: Changing Shares of World GDP, Merchandise and Service Exports  
1995 vs. 2008**

	Merchandise Exports		Service Exports	
	1995	2008	1995	2008
<b>East Asia and Pacific</b>	<b>6.9</b>	<b>12.9</b>	<b>5.2</b>	<b>6.5</b>
--China	2.9	8.9	1.5	3.9
<b>Europe and Central Asia</b>	<b>3.6</b>	<b>7.1</b>	<b>4.1</b>	<b>5.1</b>
--Russia	1.6	2.9	0.9	1.3
<b>Latin America and the Caribbean</b>	<b>4.3</b>	<b>5.4</b>	<b>3.1</b>	<b>2.9</b>
--Brazil	0.9	1.2	0.5	0.8
<b>Middle East and North Africa</b>	<b>1.2</b>	<b>2.6</b>	<b>..</b>	<b>..</b>
<b>South Asia</b>	<b>0.9</b>	<b>1.4</b>	<b>0.9</b>	<b>2.9</b>
--India	0.6	1.1	0.6	2.7
<b>Sub Saharan Africa</b>	<b>1.5</b>	<b>2.1</b>	<b>1.0</b>	<b>1.0</b>
<b>Total Low and Middle Income</b>	<b>18.3</b>	<b>31.5</b>	<b>16.0</b>	<b>20.7</b>
<b>High Income</b>	<b>81.7</b>	<b>68.6</b>	<b>83.8</b>	<b>79.3</b>
--Euro Area	33.7	28.6	34.9	32.3
--US	11.3	8.1	16.4	13.6
--Japan	8.6	4.9	5.3	3.9
--NIAEs				
----Hong Kong	3.4	2.3	2.8	2.4
----Korea	2.4	2.6	1.8	2.0
----Singapore	2.3	2.1	2.1	2.1
----Taiwan	n.a.	1.6	n.a.	n.a.

Source: WDI (2010), 238-240, 246-248.

<sup>15</sup> UNTAD (2009).

Moreover the competition from these exports is likely to increase over time. The increased competitiveness comes from greater investments in higher education, and from increasing investments in R&D.

### ***Higher Education***

The increased investments in higher education can be seen in Table 4 which shows a rapid increase in enrollment rates particularly for China. What is most striking, however, is the very large critical mass both countries have in the actual number of students in higher education. In 2008 China had the largest number in the world with 27 million students (17% of the world's total), followed by the US with 18 million (12%), and then by India with 13 million (9%).<sup>16</sup>

**Table 4: Rising Tertiary Enrollment Rates World and Selected Countries 1986-2008**

	<b>1980</b>	<b>1990</b>	<b>2000</b>	<b>2008</b>
China	2	3	13	22
India	5	6	11	13
World	<b>13</b>	<b>16</b>	<b>24</b>	<b>26</b>

Source: WDI: 2010, 2004, and 2002.

### ***R&D***

China and India have also been increasing their innovation capacity. In the period 1995 to 2005 China has increased the number of scientists and engineers doing research and development (R&D) from 530,000 to 936,000, and the number of scientific and technical publications from 9,300 to 42,600. It also increased its research and development spending from .6% of GDP in 1995 to 1.4% in 2006.<sup>17</sup> Measured in terms of PPP it is the third largest R&D spending in the world, after the US, and Japan (Figure 4).

India has not increased the number of scientists and engineers much during the same period, but it has increased scientific and technical publications from 9,600 to 14,600, and spending on R&D as a share of GDP from 0.80 in 1995 to around 1.0% in 2006.<sup>18</sup>

In addition, as part of the global out sourcing trend, many MNCs are increasing their R&D work in developing countries, particularly China and India. By 2006 there were more than 750 MNC R&D labs in China and over 250 in India.

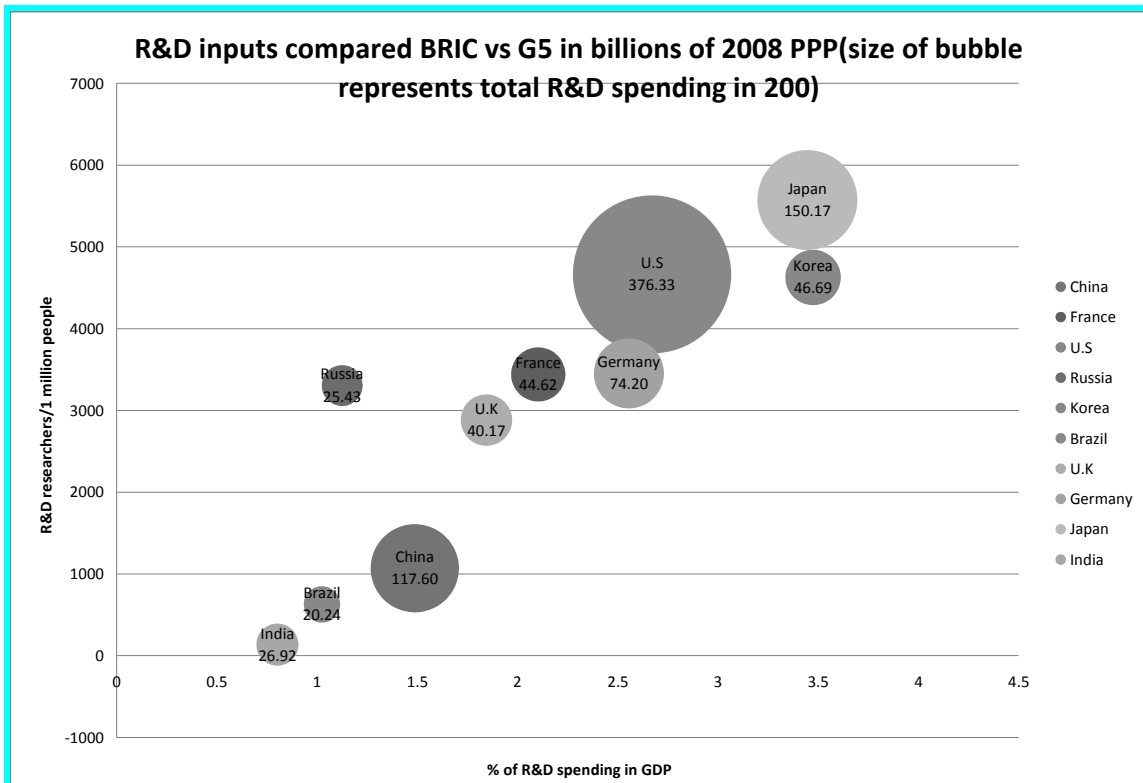
<sup>16</sup> UNESCO (2009) Table 8, pp. 128-127. The quality of the tertiary graduates from China and India is not uniform and is generally much below that of advanced countries. However both countries have some world class higher education institutions, and are working on improving the overall quality of their tertiary graduates.

<sup>17</sup> See Dahlman (2010) for more details on the innovation strategies of China and India.

<sup>18</sup> Dutz (2007).

Also both countries, but especially China, have dramatically increased their patenting over the last decade. In 2008 the number of patents taken out by domestic residents in China was the third highest in the world (after Japan and the US). The number of industrial designs and of trademarks patented by residents in China were the highest in the world.<sup>19</sup>

**Figure 2. Relative R&D Expenditure and Scientists and Engineers per 1000 (Expenditures in 2008 in Billions of PPP Dollars)**



Source: Author's calculations based on data in OECD (2009) on R&D spending as % of GDP and scientists and engineers in R&D combined with data on 2008 GNI in PPP of respective countries.

In short, while both countries have benefited by acquiring knowledge from abroad through the inflow of direct foreign investment, technology licensing, sending students abroad for studying, and copying and reverse engineering, they are now investing a lot more in their own domestic R&D capability. This gives them a greater ability to make use of existing global knowledge as well to develop their own technology.<sup>20</sup>

The increased technological capability of these two countries and the rapid expansion of their exports, manufactured products in the case of China, and information enabled services in the case of India, are putting a lot of restructuring pressure on the global

<sup>19</sup> For more details and time trends see WIPO (2009).

<sup>20</sup> For more detailed comparison on the innovation capability of China and India see Dahlman (2010).

economy. Even before there 2008/2009 economic crisis there were already some protectionist trends. These have been exacerbated by the crisis. The Eight Global Trade Monitoring Report released in October 2010<sup>21</sup> has found that despite the G20 November 20, 2008 meeting where world leaders pledged not to resort to protectionist measures the facts contradict this.<sup>22</sup> The report found that since November 2008 governments had implemented 692 restrictive trade practices likely to harm some foreign commercial interests of other countries. More than a dozen governments had implemented measures that harmed more than 100 of their trading partners negatively. The country hit by the most measures is China with a total of 337 measures, followed by the US (260). Thus there is a risk of rising protectionism.

Since the middle of 2010 the focus has moved to exchange rate manipulation which is an alternative to tariff and non-tariff trade measures. Most of the accusations are that China has been unfairly keeping its currency undervalued by buying US Treasury bond and other assets with its large trade surpluses. But Japan is also intervening to keep the value of the Yen from appreciating to much Germany is benefiting from the depreciation of the Euro as a result of the Euro Crisis. And the US is being accused of manipulating its currency by the large long term bond purchases by the US Fed which are increasing the US money supply. This has led many to say that the world has entered into a period of currency wars which is already a type of trade war, and is likely to escalate as unemployment rates stay high in developed economies and elections approach.

### *Environment*

The environmental challenges can be seen from three dimensions—a country's overall use of environmental resources, projections of their energy needs, and projections of CO<sub>2</sub> emissions.

One way to get a broad view of the overall environmental resource use of a country is the Ecological Footprint. It measures the “demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources we use and to absorb our waste.”<sup>23</sup> Table 5 compares the seven countries with the largest ecological footprint with their biocapacity in 2005 and shows the net surplus or deficit of each country in terms of the world's total biocapacity.<sup>24</sup>

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<sup>21</sup> The report is produced by Global Trade Alert, an independent NG coordinated by the Center for Economic Policy Research based in London.

<sup>22</sup> See Everett (2010) for a detailed compilation.

<sup>23</sup> The Ecological Footprint has been developed by the World Wildlife Federation.(2008). “A country's footprint is the sum of all the cropland, grazing land, forest and fishing grounds required to produce the food, fiber and timber it consumes, to absorb the wastes emitted when it uses energy, and to provide space for its infrastructure.

<sup>24</sup> In 2005 the global Ecological Footprint was 17.5 billion global hectares (gha), or 2.7 gha per person (a global hectare is a hectare with world-average ability to produce resources and absorb wastes). On the supply side, the total productive area, or biocapacity, was 13.6 billion gha, or 2.1 gha per person”. (WWF 2008), p. 14.

**Table 5: Ecological Footprint Vs Bio-capacity for Seven Countries with the Largest Ecological Footprint in 2005**

	<b>US</b>	<b>China</b>	<b>EU</b>	<b>India</b>	<b>Russia</b>	<b>Japan</b>	<b>Brazil</b>
Population Millions 2008	298.2	1,323.3	487.3	1,103.4	143.2	128.1	186.4
Ecological Footprint/capita vs. World av. of 2.7 global hectares	9.4	2.1	4.7	0.9	3.7	4.9	2.4
Total Country Ecological Footprint million global hectares	2,803.1	2,778.9	2,290.3	993.1	529.1	627.7	447.4
% of World Ecological Footprint of 17,500 million global hectares	16.0	15.9	13.1	5.7	3.0	3.6	2.6
Bio-capacity per capita vs. world average of 2.1 global hectares	5.0	0.9	2.3	0.4	8.1	0.6	7.3
Total Country Bio-capacity	1,491.0	1,191.0	1,120.8	441.4	1,159.9	76.9	1,360.7
% of World Biocapacity of 13,400 million global hectares	11.0	8.9	8.4	3.3	8.7	1.0	10.2
Net Position in million hectares	-1,312.1	-1,587.9	-1,169.5	-551.7	630.8	-550.0	913.3
Net Position as % of World Bio-capacity	-9.8	-11.9	-8.7	-4.1	4.7	-4.1	6.8
Net Position on per capita basis	-4.4	-1.2	-2.4	-0.5	4.4	-4.3	4.9

Notes: Population figures are for 2008, but footprint figures are for 2005 so there is a small discrepancy

**Ecological footprint** is cropland, grazing land, forests (including for fuel wood), fishing grounds, and build up land (including areas of dams for hydropower), and global hectares needed to absorb CO2 emissions (from fossil fuel consumption as well as from products manufactured abroad),

**Bio-capacity** includes cropland, grazing land, forests, and fishing grounds.

**Source:** Computed from World Wildlife Fund. *Living Planet Report 2008*. Available at: [http://assets.panda.org/downloads/living\\_planet\\_report\\_2008.pdf](http://assets.panda.org/downloads/living_planet_report_2008.pdf), Accessed 11/19/2009.

The US has the largest bio-capacity followed by Brazil, China, Russia, the EU, and India. Even though the ecological footprint per capita of China and India are much lower than those of developed countries ((2.1 and 0.9 respectively vs. an average of 6.4 for high income countries), because both are very resource poor on a per capita basis and have the

largest populations in the world, the largest deficits are China, the US, the EU and India. China's deficit is 11.9% of the world total bio-capacity, the US's is 9.8%, the EU's is 8.7%, and India's is 4.1%.<sup>25</sup>

That China and India have the largest populations in the world (20% and 18%, respectively) and that they are growing three to four times faster than the average for the world means that they will be putting increasing pressure on global environmental resources. Thus it is clear that there will be a global adding up problem. We will need to find more environmentally friendly ways to increase the income and welfare of developing countries. We will also have to adapt the economic and social systems in developed countries too. This will involve not just what is produced and how it is produced, but where; as well as how we live and organize our lives

The demand from China and India for natural resources was already seen in the rapid increase in the price of commodities in the run up to the global economic crisis of 2008/2009. Some of the increase in commodity prices was due to speculation by hedge funds. However, one of the main drivers was the voracious demand of China, and to a lesser extent, India. Commodity prices are already increasing as China's and India's growth pick up and the world begins to recover. Although agricultural raw materials, beverage, and food prices are not expected to rise much in the coming two years, metals and energy prices are expected to rise, though not to their pre crisis peaks, at least for some years.

Table 6, compiled from the International Energy Agency's *World Energy Outlook*, helps to put projected energy and CO<sub>2</sub> emissions from China and India in global perspective. Between 2007 and 2030, 53% of the world's total increase in energy demand will come from just these two countries (39% from China, 14% from India). Because they use a high percentage of carbon based fuels (coal in particular) and because they have less efficient energy technologies, they will account for 67% of the increase of the world's CO<sub>2</sub> emissions between 2007 and 2030 (49% from China, 18% from India). Another way to see the challenges is that by 2030 the CO<sub>2</sub> emission of just these two countries is projected to be 75% of the total CO<sub>2</sub> emissions of the world in 1990. Since it is necessary to reduce global emissions by 2030 to just 50% of the world's total emissions in 1990 in order to be on track to keep global temperature rise to less than 2 degrees Celsius, it is clear both countries will need to do more than what they have committed to so far.<sup>26</sup>

The difficulties in reaching an agreement involve cost, equity, efficiency, collective action, and competitiveness. While some reduction in emissions is cost effective because of the energy savings of adopting the more efficient existing technologies, reducing

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<sup>25</sup> India's total ecological deficit is as large as Japan's, another resource poor country on a per capita basis, but with a much larger ecological footprint per person. The two major countries with significant surpluses are Brazil (net surplus of 6.8% of world's bio-capacity) and Russia (net surplus of 4.7%).

<sup>26</sup> See the IPCC (2007) report.



emissions to below the 1990 levels involves increased costs as well as much more R&D spending to develop more efficient new technologies.<sup>27</sup> Developing countries such as China and India argue that their emissions would not be a problem if the advanced countries had not been emitting CO<sub>2</sub> since the industrial revolution. They object to having to bear the cost of capping their emissions while they are still poor countries (China's per capita income is slightly more than one twentieth that of the US, India's is less than one fortieth). They acknowledge that some of the CO<sub>2</sub> reductions can be achieved more efficiently if done in their countries than in developed countries, but they are unwilling to undertake the costs unless they get technology and resources from the advanced countries to do so. At the December 2009 Copenhagen Summit, the advanced countries pledged to transfer up to \$100 billion dollars a year to developing countries by 2020 to help them mitigate emissions and adapt to global warming. However, no specifics for how this is to be accomplished were put in place

The Obama administration has proposed to lower US emissions by 17% of its 2005 emissions by 2020. That is just barely below US emissions in 1990. The EU and the Japanese have committed to lowering their emissions to 20-30% below their emissions of 1990. They have said they are willing to go even lower if there is a global deal that involves significant commitments by the US and China. China has committed to reducing the intensity of its emissions per unit of GDP by 40% to 45% of its 2005 emissions by 2020. Because of its rapid growth, even a 45% reduction in CO<sub>2</sub> emissions per unit of GDP would still lead to emissions of more than twice its emissions of 1990. India has said that will reduce emission intensity by 20-25% per unit of GDP by 2020.

The Obama administration's 17% reduction proposal still has to be ratified by the US Congress. The US Congress is unwilling to commit to even to that reduction unless China does more. Its concern is that reducing CO<sub>2</sub> emissions is expensive and that to incur that cost would put US industries at a competitive disadvantage to with respect to China and India. Legislation working its way through the US Congress would put border taxes on imports from countries that have lower emissions standards. If passed this would be a threat to the global trading system.<sup>28</sup>

Thus the world is in a deadlock. The US, China and India are the main countries creating that roadblock. Unless these three countries do more to reduce global CO<sub>2</sub> emissions the EU and Japan will not commit to doing more either. To break this deadlock these three countries need to commit to do more. To make progress it is necessary to turn the approach from a zero sum game to a positive sum game. The only way to do this is through significant innovation in energy technology. The Club of Rome's 1972 predictions of the limits to growth<sup>29</sup> proved to be wrong because technology came to the rescue. However technology came to the rescue because increases in the price of raw

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<sup>27</sup> Studies such as IEA (2009) and McKinsey (2008) argue that as much as 25% of the CO<sub>2</sub> reduction required by 2020 can be achieved using existing technology with investments that would pay for themselves from the energy savings. However, they still require investments, and money for that is not readily available, particularly in developing countries.

<sup>28</sup> For a detailed analysis of this legislation and its negative implications for the world's trading system see Hufbauer, Charnovitz, and Kim (2009).

<sup>29</sup> See Meadows (1972)

materials and commodities made it attractive to develop more efficient exploration, mining, and processing technologies, as well as technologies for more efficient use of raw materials and increased agricultural yields.. In addition price increases lead to more efforts and better technologies to conserve and recycle raw materials as well as to consume less.

Therefore the way forward has to address both the demand and the supply side. On the demand side it is necessary to have some sort of price on carbon emissions.<sup>30</sup> That will provide an incentive to reduce energy consumption, to increase energy efficiency, to switch to less carbon intensive energy sources, and to develop more efficient alternative energy technologies.

On the technology supply side it will require a major energy revolution. This will need massive support for innovation in multiple energy technologies over a prolonged period of time. Much of the effort will require a significant advance of basic science. But it will also require extensive prototype development, scale up, and commercialization.<sup>31</sup> Given the magnitude of the challenge this has to be done at a global level. The US, China and India, all have considerable technological capability. If this start this process with real commitment and resources, EU countries, Japan, and many other countries are likely to join. However this is difficult in the current environment of constrained budgets in the US and the strong anti environment lobbies of the US. Nevertheless there is an opportunity for leadership that could help to change the whole approach from zero sum to positive sum and save the planet.

It will also be necessary to develop appropriate mechanisms to transfer existing and new technology as well as financial resources to developing countries to help them reduce CO2 emissions as well as to adapt to global warming. The \$100 billion that have been pledged by developed countries are not sufficient for this. In addition it will be necessary to create greater capability in developing countries to prepare and implement their CO2 reduction and adaptation strategies.<sup>32</sup>

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<sup>30</sup> This can take various forms ranging from a tax on the carbon content of energy used to produce goods and services, to cap and trade systems, to higher taxes on carbon based energy. However the carbon tax would be the most effective.

<sup>31</sup> Weiss and Bonvillian (2009) sketch out what is required for a massive energy revolution in the US. Their framework can be adapted for the global initiative suggested above. The support of basic science can be justified in terms of the global public goods aspect. The development work including scale up and pilot testing can be structured a pre-competitive research. The different country and company partners that participate in the initiative can work out procedures and agreements on intellectual property as has been done in other pre-competitive collaborative ventures like the public private SEMATECH initiative in the US to develop electronics technology in the 1980s and 1990s.

<sup>32</sup> For a detailed analysis of what is at stake and what it means for developing countries see World Bank. (2010). *World Development Report: Development and Climate Change*.

**Table 6: Population, GDP, Energy Demand and CO2 Emissions 1990-2030**

	1990	2007	2020	2020 450*	2030	2030 450*
<b>World</b>						
Population	5,262	6,614	7,608		8,236	
GDP	33.6	67.2	107.		137.0	
Energy	8,761	12,013	14,450	13,600	16,790	14,384
Energy/capita	1.7	1.8.	1.9.	1.8	2.0	1.7
CO2	20,941	28,825	34,500	30,676	40,200	26,386
CO2/capita	4.0	4.4	4.5	4.0	4.9	3.2
<b>China</b>						
Population	1,141	1,327	1429		1461	
% world	22	20	19		18	
GDP	1.5	7.8	18.8		28.5	
% of world	4	11	18		21	
Energy	872	1,970	3,116	2,876	3,827	2,974
Energy/capita	0.8	1.5	2.2	2.0	2.6	2.0
CO2	2,244	6,071	9,600	8,405	11,600	7,072
Share of CO2	11	21	28	27	29	27
Cum. CO2%	5	9	13	13	16	15
CO2/capita	2.0	4.6	6.7	5.9	8.0	4.8
<b>India</b>						
Population	850	1,123	1,319		1,432	
% world	16	17	17		17	
GDP	1.1	3.1	7.1		12.5	
% of world	3	5	7		9	
Energy	318	595	901	833	1,287	1,084
Energy/capita	0.4	0.5	0.7	0.6	0.9	0.8
CO2	589	1,327	2,200	1,911	3,400	2,194
Share of CO2	3	5	6	6	8	8
Cum. CO2%	2	3	3	3	4	4
CO2/capital	0.7	1.2	1.6	1.4	2.3	1.4
<b>EU</b>						
Population	473	496	508		508	
% world	9	7	7		6	
GDP	10.4	15.1	17.9		21.3	
% of world	27	22	18		16	
Energy	1,633	1,757	1,723	1,668	1,781	1,682
Energy/capita	3.5	3.5	3.4	3.3	3.5	3.3
CO2	4,042	3,886	3,600	3,106	3,500	2,270
Share of CO2	19	13	10	10	9	9
Cum. CO2%	27	23	20	20	18	18
CO2/capita	8.5	7.8	7.0	6.1	6.9	4.5
<b>USA</b>						
Population	254	306	343		367	
% world	5	5	5		4	
GDP	8.7	14.1	18.1		22.4	
% of world	23	21	18		16	
Energy	1,913	2,337	2,316	2,167	2,396	2,092
Energy/capita	7.5	7.6	6.7	6.3	6.5	5.7
CO2	4,845	5,742	5,500	4,717	5,500	3,175
Share of CO2	23	20	16	15	14	12
Cum. CO2 %	31	28	25	25	23	23
CO2/capita	19.1	18.7	15.9	13.7	15.1	8.6

\*The 450 scenarios for 2020 and for 2030 are the IEA's proposal of emission levels that would be consistent with stabilizing CO2 to 450 particles per million which would contain global temperature increases to around 2 degrees Celsius.

Source: IEA *WEO 2009*, pp. 210, 322, 324, 330, 332, 334, 336, 350,352, 358, and 360.

## **E. Conclusions**

Over the last 30 years there has been a shift of economic power to developing countries in general and to China particular. The global economic crisis of 2008/2009 is not a typical cyclical business downturn, but a major structural shift. China was less severely affected by the crisis. It continued to grow even in 2009 and actually widened the differential in growth with respect to advanced economies. Prospects are that it will continue to grow at three to four times the average rate of growth of advanced countries. Thus the shift of economic power to China is continuing, if not accelerating. Its continued rise will challenge the rest of the world in terms of increased competition in trade and pressure on the environment.

China's increased competitiveness in exports comes from its large market and large labor force. The latter is being leveraged with investments in higher education and R&D, and economies of scale in production and global distribution. Because China is natural resource poor on a per capita basis, its rapid growth will continue to put pressure on prices of commodities in general, and energy in particular. Because its population accounts for a fifth of the world's population its continued rapid growth will put increasing pressure on the global environment. Already in 2005, China had a net deficit of 12% of the world's total biocapacity. Because of its size and rapid growth it will account for 39% of the world increase energy demand between now and 2030. Because of its energy mix and lower energy efficiency, over the same period it will account for 49 % of the increase in the CO<sub>2</sub> emissions of the world. So far no workable solution has been found for containing the threat of global warming and none will be workable unless China and the US (and India) are able to do much more to reduce their emissions.

Thus we can expect that there will be increasing frictions on trade and in competition for access to natural resources. We can also expect that it will be difficult to reach agreements on containing CO<sub>2</sub> emissions in China and India because of the equity, cost, competitiveness and collective action problems inherent in this issue. Already there are risks of rising trade protectionism because of the more demanding international trade regime as well a because of the global downturn and high unemployment in most advanced economies. The risks of protectionism will be exacerbated if legislation on carbon border taxes for the import of goods from countries with less stringent environmental regulations is enacted in the US.

The global governance system set up after WWII is anachronistic in terms of its representation of shifting economic power and in terms of the range of global issues it can tackle (global warming being the most glaring example, but the issues also include trade frictions, competition for natural resources, global financial imbalances, and global financial architecture, to name a few). Tackling some of these global issues is difficult because countries find it difficult to give up national sovereignty over critical issues, and there are many problems of collective action and free riders. The main global players- the US, the EU, China, and India have to be careful that in pursuing their own national objectives they do not derail the global system. To avoid having these frictions spiraling

out of control into more serious confrontations it is necessary to manage these frictions carefully and to find cooperative solutions to trade adjustment and global financial imbalances, as well as to set up effective mechanisms to tackle global warming.<sup>33</sup>

The rapid rise of China (and India) also show us that our development models are too resource and environment intensive. It is necessary to implement more environmentally friendly development strategies that involve not just developing more environmentally friendly energy technologies but also more environmentally friendly production and social organizations, from building designs to urbanization and urban planning as well as to location of production and consumption, and lifestyles. This is a tall agenda that we need to work on seriously.

### Bibliography

Altman, Roger 2009a. "Globalization in Retreat" *Foreign Affairs* (July August). Available at <http://www.foreignaffairs.com/articles/65153/roger-c-altman/globalization-in-retreat>

Altman, Roger 2009b. "The Great Crash, 2008." *Foreign Affairs* (January/February). Available at: <http://www.foreignaffairs.com/articles/63714/roger-c-altman/the-great-crash-2008>.

Dahlman, Carl J. (2011 Forthcoming). *Collision Course? Will the World Accommodate the Rapid Rise of China and India?* Palo Alto: Stanford University Press.

Dahlman, Carl J. 2010. "Chapter 1: Innovation Strategies in Brazil, India & China: From Imitation to Deepening Technological Capability in the South". In Xiaolan Fu; and Luc Soete. Editors. *The Rise of Technological Power in the South*. London: Palgrave McMillan.

Dutz, Mark. Editor. 2007. *Unleashing India's Innovation: Toward Sustainable and Inclusive Growth*. Washington DC: World Bank.

Evenett, Simon J. 2010. Everett, Simon J. 2010 8<sup>th</sup> Global Trade Alert Report, *Tensions Contained... For Now*. Centre for Economic Policy Research (CEPR) Available at: [http://www.globaltradealert.org/sites/default/files/GTA8\\_0.pdf](http://www.globaltradealert.org/sites/default/files/GTA8_0.pdf). Accessed 11/20/2010.

Hufbauer, Gary Clyde; Steve Charnovitz; and Jisun Kim. 2009. *Global Warming and the World Trading System*. Washington DC: The Peterson Institute.

International Monetary Fund. 2010. *World Economic Outlook* (October). Washington DC: IMF

McKinsey Global Institute. 2008. *The Carbon Productivity Challenge: Curbing Climate Change and Sustaining Economic Growth*. (June).

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<sup>33</sup> For a fuller development of these points see Dahlman (forthcoming 2011).

- Meadows, Donella H. 1972. *Limits to Growth*. Universe Books.
- Roach, Stephen. 2010. "Consumer Led China." Morgan Stanley Asia, paper prepared for the 11<sup>th</sup> Annual China Development Forum held in Beijing March 20-22, 2010.
- Reinhart, Carmen; and Kenneth Rogoff. 2009. *This Time Its Different: Eight Centuries of Financial Folly*. Princeton: Princeton University Press.
- United Nations Conference on Trade and Development. 2009. **Handbook of Trade**. Geneva. Available at <http://stats.unctad.org/Handbook/TableViewer/chartView.aspx> retrieved 12/20/2009.
- United Nations Educational, Scientific, and Social Organization. 2009. *Global Education Digest 2009*. Montreal: UNESCO Statistical Institute.
- Weiss, Charles, and William Bonvillian. 2009. *Structuring an Energy Technology Revolution*. Cambridge: MIT Press.
- World Bank. 2010. *World Development Indicators 2010*. Washington DC: World Bank.
- World Bank. 2010. *World Development Report: Development and Climate Change*. Washington, DC: World Bank.
- World Intellectual Property Organization. 2009. *World Intellectual Property Indicators 2009*. Geneva: WIPO. Available at:  
[http://www.wipo.int/freepublications/en/intproperty/941/wipo\\_pub\\_941.pdf](http://www.wipo.int/freepublications/en/intproperty/941/wipo_pub_941.pdf)
- World Wildlife Fund. 2009 *Living Planet Report 2008*. Geneva: WWF.