THE GLOBAL ECONOMY IN 2050

The CEPII has recently released a projection of the global economy at the 2050 horizon, which suggests an acceleration of the shifting of the global economy towards emerging and developing countries. In China and India, GDP in volume could increase by a factor of thirteen in 40 years' time, while that of the United States might only double, and the European Union would only see an increase of 60%. Taking the articipated charge in relative prices into account, China could represent 28% of the global economy by 2050, ahead of the United States (14%), India (12%), the European Union (11%) and Japan (3%). Based on the 2005 PPP rates, the standard of living in China would get close to the United States, but not until around 2050.

■ Better than a rough calculation

It is always tempting to extrapolate observed growth rates to gain an idea of how the global economy might change over the coming decades. Based on such extrapolation, at an annual growth rate of 8% over a period of 40 years, the Chinese economy would grow by a factor of 21 by 2050. At the same time, the 2% growth rate in Europe would imply an increase in its size by only 121%. Indeed, this type of rough calculation based on past trends is misleading. In China, for instance, the working force will decrease in the future, and capital accumulation is certain to slow down, meaning that the average growth rate observed over the past few years is set to drop appreciably.

In 2006, the CEPII[1] published projections for 103 countries at the 2050 horizon, based on a classical, Solow-type growth model.[2] In this type of model, growth is a result of the accumulation of two production factors, capital and labour, and Total Factor Productivity (TFP). Investment, and therefore the accumulation of capital, was then modelled as a direct result of the level of savings in each country, itself a function of the demographic situation and relative development level. The TFP was a function of accumulation of human capital measured in years of education and relative development level. Valuation effects were ultimately added to the projected growth in volume, based on an assessment of real appreciation of the currency in catching-up countries (the Balassa-Samuelson effect).

Taking account of the effects of relative prices, our 2006 results suggested that China could account for 22% of global GDP by 2050. Between the years 2005 and 2050, the Chinese economy would grow by a factor of 13 and the Indian economy by a factor of 10. During the same period, GDP in most advanced countries would "only" double (Germany, France, Japan), and would at best only triple in the United States. The United States would however not lose its position as the world's leader by 2050. Japan's number two position would be taken by China, whilst India would leap from thirteenth to fifth place.

The 2008-2009 global economic crisis means we have to rethink our projections for two basic reasons: (1) advanced economies suffered more from the crisis than emerging and developing economies, accelerating the major shifting of the global economy's centre of gravity towards the emerging world, particularly Asia; (2) global imbalances have proved more persistent than expected, and applying the simplifying assumption of investment equalizing savings for each country is questionable. Beyond factors relating to the economic crisis, existing projections do not take account of the energy issue, and this is becoming less and less acceptable.

Although obviously fraught with the possibility of error and always debatable, this type of long-term projection is essential

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1. S. Poncet (2006), "The Long Term Growth Prospects of the World Economy: Horizon 2050", *CEPII working paper*, No 2006-16, October.
2. R. M. Solow (1957), "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics*, vol. 39, No. 3, p. 312-320.

for obtaining some orders of magnitude that can be used when designing economic policies. Such projections also form the reference for structural policy simulation models (such as the CEPII's MIRAGE - model), reasoning in percentage change from a dynamic baseline.

The CEPII has therefore worked out a new long-term growth scenario for 128 countries at the 2050 horizon.[3] Growth is now modelled as the result of three production factors (labour, capital and energy) and two kinds of technological progress (one specifically concerned with energy efficiency). As in the previous model, direct use is made of demographic projections made by the United Nations Organisation and the International Labour Organisation to estimate the changes in the workforce. A more refined estimate of investment levels has been made, based not only on domestic savings, but also on imperfect international capital mobility: whenever the gross saving rate increases by one percent of GDP in a country, the investment rate increases by less than one percent of GDP in the long run, with the excess in savings being invested abroad.[4] Technical progress and its effects on labour and capital are modelled in a similar way to the 2006 exercise: the TFP catches up with the US level more quickly in countries that invest more in human capital, as the number of years of education catches up with the US level, but at a varying rate depending on different regions throughout the world. There is a dual dynamic to the catch-up rate in energy efficiency due to technical progress and its effects on energy use (see below). The energy issue therefore makes itself felt through the increased cost of energy, but is also attenuated by increased energy efficiency.[5]

The 2008-2009 global economic crisis is factored in by using International Monetary Fund forecasts between 2008 and 2012, as the CEPII simulation itself starts in 2013, when it is presumed that the output gap has been closed. Finally, real growth and relative price variations are identified through a Balassa-Samuelson effect that is consistent with the growth model.

■ Production factors: structural change

In terms of the labour force, the CEPII projection is based on (1) the UN median population scenario for 2050, (2) ILO rates of activity for 2020 and (3), a hypothesis of constant activity rates for each age category between 2020 and 2050. The resulting workforce is shown in Graph 1 for a number of major areas. It falls in China after 2015, whilst it continues to increase in India; in 2050, a little more than 700 million workers are anticipated in both countries. The labour force in the USA also keeps on increasing during this period, although at a moderate

pace: in 2050, there could be 200 million workers in the USA, as against 180 million in 2010. By contrast, the labour force falls continuously in Japan, Russia and the European Union from the year 2015.

Graph 1 – Labour force (millions of workers), 1980-2050*
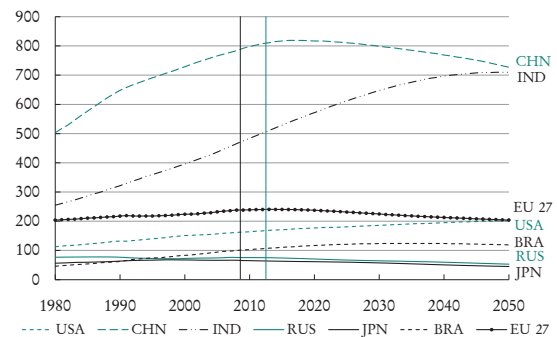
* In these graphs, "CHN" means China, "IND" means India, "EU" means the European Union, "USA" means the United States, "BRA" means Brazil, "RUS" means the Russian Federation and "JPN" means Japan. The vertical black line marks the end of the data (2008) and the green vertical line marks the beginning of our projection (2013). *Source*: CEPII.

Capital is assumed to depreciate at a constant rate (6%), and to be renewed by new investments. The rate of investment is linked to the saving rate through a linear relationship. The saving rate is itself based on a lifecycle assumption where savings habits vary across age categories. The ageing of a country's population brings along a reduction in the saving rate, and this reduction is transmitted to the investment rate, albeit somewhat softened. In China, for instance, the saving rate drops by 12 percent of GDP during the projection period, but the investment rate only falls by 5 percentage points, meaning that the balance of savings over investment (7 percent of GDP in 2010) is totally reabsorbed by 2040. In India, the saving rate increases until the mid 2030's before dropping, whilst the rate of investment declines progressively: the external deficit is reabsorbed by 2020 and then becomes a surplus, culminating at 4% of GDP in around 2040. The United States sees a progressive re-absorption of its deficit from the effect of a reduction in the investment rate, whilst the saving rate stagnates, followed by a shallow decline. Finally, the respective situations of Japan and the European Union are very similar: a slight surplus by 2007, then showing a deficit of around 2% of GDP in 2020. This deficit is finally reabsorbed at a pace comparable to the United States over the three subsequent decades.

Although rapid, capital accumulation in China over the four decades covered by the exercise only allows this country to reach in 2050 the level of capital per worker observed in Europe in 2010. Thus, in 2050, capital per worker is still two times lower in China than Europe. Conversely, Japan

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3. See J. Fouré, A. Bénassy-Quéré & L. Fontagné (2010), "The world in 2050: a tentative picture", *CEPII working paper*, No 2010-27, December.
4. The persisting relationship between savings and investment in spite of the financial globalisation was demonstrated by Martin Feldstein and Charles Horioka in 1980, then confirmed by various econometric studies. See : M. Feldstein & C. orioka (1980), "Domestic Saving and International Capital Flows", *Economic Journal*, 90 (358), 314-329.
5. Strictly speaking, this is energy productivity in the sense of technical progress in use thereof. We use the term energy efficiency here for the purposes of simplification.

compensates for the decline in its labour force with capital accumulation (Graph 2).

Graph 2 – Capital per worker, 1980-2050
(thousands of dollars of 2005)
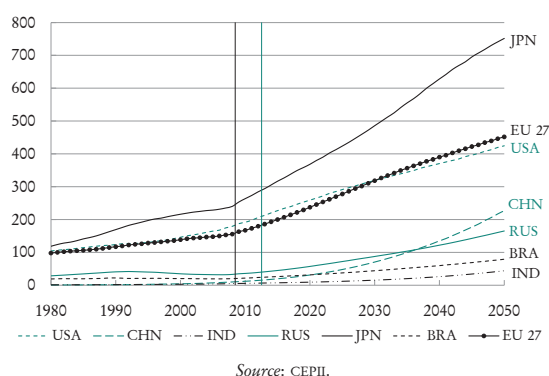
Finally, energy consumption is projected based on energy efficiency and price, the latter being proxied by the average oil price. Developments in terms of energy efficiency are shown further on. Oil prices are taken from the medium scenario by the US energy agency, the EIA, which takes the price per barrel up to 130 dollars in 2030. Beyond this date, oil price is assumed to increase at a constant rate of 1.4% per year, corresponding to the average increase for the period 2025-3030 anticipated by the EIA.

▪ Productivity: China ahead of Russia

The projection is based on a productivity growth rate dependent on the accumulation of human capital, this being a function of an absolute catch-up in terms of years of education to the US level, with different catch-up rates across regions of the world. This results in a marked catch-up in terms of TFP for emerging and developing countries, but a bottoming out for advanced economies (Graph 3). In terms of USD of 2005, China would reach a TFP equivalent to half that of the USA by 2050, with the other "BRIC"[6] distinctly below that level.

It is assumed that the trajectory of the energy efficiency will result from two forces. Firstly, countries will catch up in terms of technology: energy efficiency improves at a faster pace for less efficient countries (the most efficient countries since 1980 being Japan, the United Kingdom, France and Germany). But this effect can be counter-balanced by economic catch-up: when a country develops, it goes through industrialisation and then records a reduction in aggregated energy efficiency; consequently, energy efficiency will slow down for the poorest countries. In total, catch-up
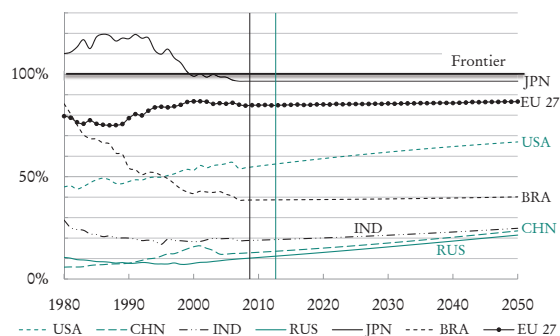
in energy terms is marked for emerging countries and the United States (Graph 4).

Graph 3 – TFP, 1980-2050 (as a % of the USA)
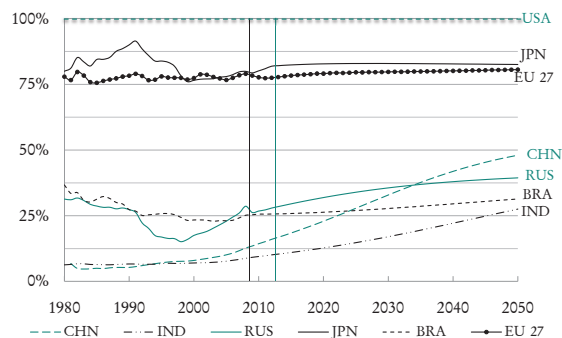
Graph 4 – Energy efficiency (as a % of the frontier), 1980-2050*

* Average of Japan, Germany, France and the United Kingdom.
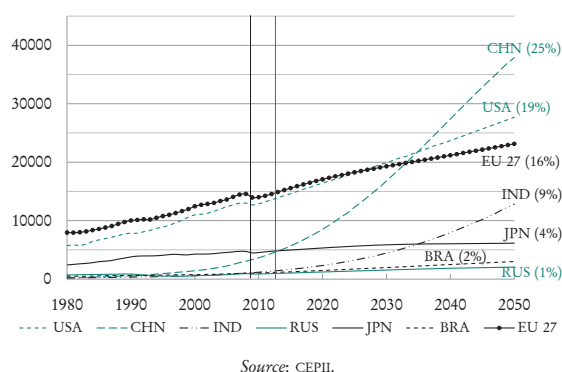
▪ Real growth

Projections of GDP in volume (at 2005 prices and exchange rates) are obtained by combining the three production factors and the two forms de productivity within a nested production function. Results for a number of major areas are shown in Graph 5. According to this projection, GDP in China could overtake the United States around the year 2030, and the GDP of India would overtake that of Japan around the year 2035, based on prices and exchange rates of 2005. In 2050, the four biggest global economies would then be China (7% of world GDP in 2008, 16% in 2025 and 25% in 2050), the United States (27%, 24% and then 19% in 2050), the European Union (30%, 24% and then 16%) and India (2%, 4% and then 9%).

In terms of the purchasing power parity (PPP),[7] the global hierarchy for standard of living would only be slightly changed by 2050, except for the quasi convergence (to 90%) of China in terms of GDP per capita (Graph 6).
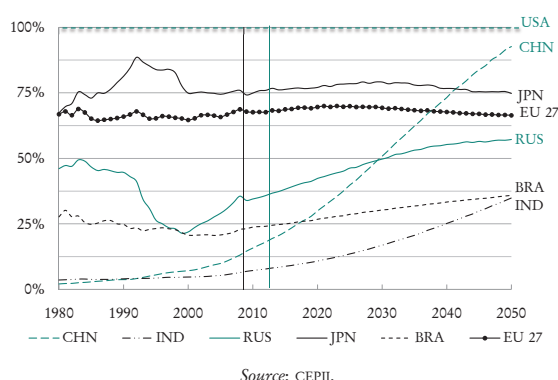
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6 The BRIC acronym stands for Brazil, Russia, India and China.
7. The conversion in purchasing power parity standard leads to raising the GDP per capita of emerging and developing countries, where price levels are lower than in advanced economies. Thus, the GDP per capita of China is doubled through the conversion. Furthermore, the ratio between GDP per capita and labor productivity is positively related to the employment rate, which is especially high in China at the horizon of the projection.

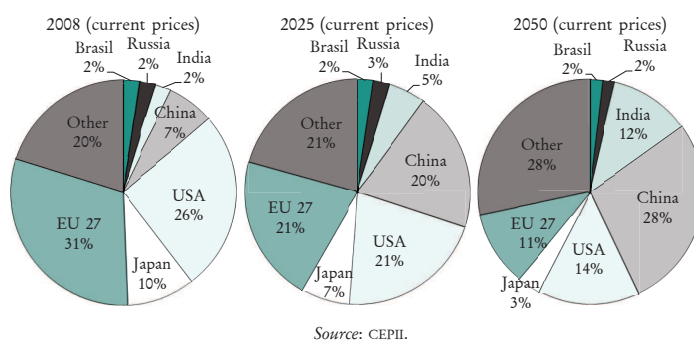Graph 5 – GDP in volume, 1980-2050 (billions of dollars of 2005)

CHN (25%)
USA (19%)
EU 27 (16%)
IND (9%)
JPN (4%)
BRA (2%)
RUS (1%)

- - - USA   - - - CHN   — · — IND   —— RUS   —— JPN   · · · BRA   ●—● EU 27

Source: CEPII.

Graph 6 – GDP per capita, 1980-2050
(Purchasing Power Parity of 2005, as a % of the US level)

USA
CHN
JPN
EU 27
RUS
BRA
IND

- - - CHN   — · — IND   —— RUS   —— JPN   · · · BRA   ●—● EU 27

Source: CEPII.

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■ Valuation Effects

The above long-term projections are for changes of GDP in volume. They provide a sufficient basis for analysing the future status of a range of areas in terms of the global demand for energy and raw materials and their contributions to greenhouse gas emissions. Still, in order to anticipate the relative status as markets or financial powers of countries, we need to put values on real incomes. For example, the progress of China in the global economy will depend on GDP growth in volume, but also on a progressive appreciation of the renminbi in real terms. It is important to make a distinction between these two aspects using long-term projections of real exchange rates. To do this, we apply a Balassa-Samuelson effect, which links productivity growth to the progressive increase in relative prices for non-tradable goods sectors, which triggers real exchange-rate appreciation.

It is not surprising that the projection posts a strong currency appreciation for emerging countries in real terms until 2035. Beyond this date, only the Indian currency continues to appreciate. Taking account of the effects of such appreciation (hence, in "current prices"), China could overtake the USA in terms of GDP as early as 2025, and India could overtake Japan by 2030. In 2050, the Chinese economy would account for 28% of the global economy – twice that of the United States (14%) – and India (12%) would no longer be that far away from the United States (Graph 7).

Graph 7 – Weight in the global economy, 2008, 2025 and 2050
(% of world GDP)

2008 (current prices)
Brasil 2% · Russia 2% · India 2% · China 7% · USA 26% · Japan 10% · EU 27 31% · Other 20%

2025 (current prices)
Brasil 2% · Russia 3% · India 5% · China 20% · USA 21% · Japan 7% · EU 27 21% · Other 21%

2050 (current prices)
Brasil 2% · Russia 2% · India 12% · China 28% · USA 14% · Japan 3% · EU 27 11% · Other 28%

Source: CEPII.

In total, taking account of relative price adjustments, the Chinese and Indian economies would increase respectively by factors of 16 and 20, whilst the US economy would double and the European economy would only grow by 40%.

Set against the projections made in 2006, there is a clear acceleration in the shifting of the global economy towards the emerging and developing world. Naturally, this second series of projections includes a variable that is partially policy-determined: the real exchange rate. With China controlling its nominal exchange rate and partially its inflation rate, the valuation effects given here might be considerably deferred over time.

Although they need to be interpreted with great caution, these results are still useful markers for future studies on the global demand for primary materials, international trade, finance capacity and global powers, *etc*.

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