CHAIR
Globalization

By
Lionel Fontagné

Climate and the changing geography of the world economy

In this policy brief, Lionel Fontagné and his co-authors show how a macroeconometric model can be used to project world economic growth to 2050. This exercise highlights the upheaval in the global hierarchy of economies brought about by globalization and discusses how this matters for the fight against global warming.

Growing uncertainty about China's growth prospects is making headlines while India's population surpassed China's in April 2023. Thinking about the future of the global economy requires both a theoretically sound representation of growth drivers and data for the largest sample of countries. In a recent paper, we show what can be learned from a macroeconometric model used to project the economic growth of 166 countries over a generation horizon. This exercise highlights the major upheaval in the global hierarchy of economies caused by globalization and discusses the implications of this reorganization of the world economy for the fight against global warming.

Mapping the drivers of economic growth

The theoretical framework

Economic growth is made of labor force, capital accumulation, efficient combination of the two (another wording for technical progress), and last but not least energy and efficiency of its use. In technical terms, we need a representation where the economic size of a country at a given date is determined by the quantity of three factors of production – labor force, capital, and energy – and by two productivities – the usual total factor productivity and the energy efficiency. With this three-factor representation of economic growth, also used for climate policy modelling, we here rely on the so-called principle of "conditional convergence" (Barro and Sala-i-Martin, 2004) and on growth accounting (Easterly and Levine, 2001).

A country's labor force is the result of its demographics (size and age composition of the population) and its activity rate, the latter being linked to the duration of education and, above all, to the female participation in the labor market. Demographics also play a role in determining national savings: a country's savings rate depends not only on its per capita income, but also on the age structure of its population, given that the savings rate evolves over the course of an individual's life cycle. A country's overall savings determine, to a certain extent, the amount that can be invested in the economy. But only to a certain extent, because a country's degree of openness to international capital flows determines the contribution of foreign savings to finance the investments needed to sustain growth: equipment and buildings have to be periodically renewed, while new generations of investments incorporate technical progress. The composition of the population in terms of age, gender and education therefore ultimately determines the labor force and the amount of capital that can be combined with it.

The leading countries in terms of efficiency in the combination of labor and capital determine a technological frontier towards which other countries converge at a given speed, while the frontier itself moves upwards. We consider such frontier to be made up of the five most efficient countries over the last five years. As technology evolves, the composition of the leading group may indeed vary. This process of catching up towards a moving frontier is empirically determined by the distance to the frontier and by the proportion of the working-age population with a secondary or higher education diploma.

Mapping out the dynamics of energy efficiency is the most difficult part of the exercise. Two decisive factors need to be taken into account. The first is **catching up with the technological frontier** in terms of energy efficiency. This works in the same way as the technological frontier mentioned above. Indeed, countries on the energy efficiency frontier may differ from countries on the technology frontier, insofar as technological resources are not necessarily geared towards energy savings. The speed of catch-up is here governed by international transfers of green technologies. The second determinant has more to do with **collective preferences**. Countries at different levels of development differ in their marginal utility of consumption and their discount rate: poorer countries attach more utility to current consumption and less to investments in technologies that reduce greenhouse gas emissions, thus refraining from investing in projects with long-term benefits. A synthetic representation of these legitimate differences must take into account differences in the wealth of nations, which leads here to the introduction of a second catch-up term for energy efficiency, in terms of per capita income.

The empirical approach

Once estimated using historical data (1980-2018), the model is used for projections. Exogenous determinants are then inserted into the estimated functional relationships. We firstly introduce each country's demography by five-year cohort and gender, which determines the future workforce. The second exogenous determinant is the price of fossil fuels, which will ultimately determine energy efficiency (e.g., investment in green technologies or renewable energies), subject to the catch-up and preference dimensions linked to countries' level of development.

Our projections findings

Before we present the conclusions of our projection exercise, it should be stressed that we are talking about projections ("what the world would be like in a generation's time, based on our assumptions and the best we can draw from the data available to date"), not forecasts: the world will be very different in a generation's time, and hopefully much more efficient in terms of energy use than the model predicts, thanks to stringent environmental policies and technological breakthroughs.

Major trends of the world economy at the 2050 horizon

The first result of this exercise is to put the era of **great globalization into perspective** by highlighting the dramatic changes that have taken place in the geography of the world economy since 1990. In 1990, the US economy was 9 times larger than China's, and Japan's 5 times larger. Germany, France, Italy and Russia were each at least twice as large as China. Spain had a GDP comparable to that of China. Switzerland and India had the same economic size. What is eventually meant by globalization, beyond the reduction in trade costs, the relocation of many industries and the international splitting of value chains, is the reversal of this relative economic importance of the major economies. By 2020, China's economic size was already three quarters that of the USA, twice that of Japan, three times that of Germany, four times that of France and six times that of Russia. India, meanwhile, was larger than France or the UK in 2020.

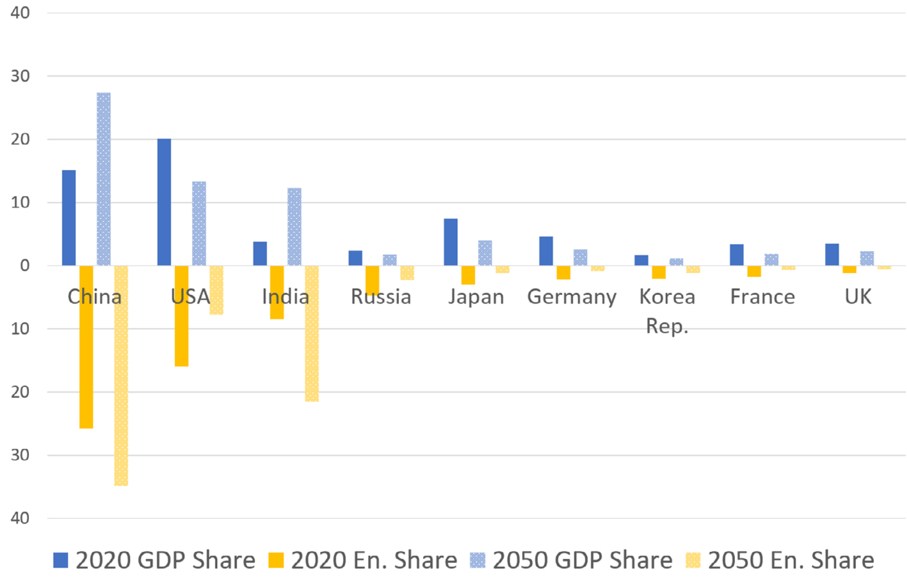
In terms of its **prospective dimension**, this exercise announces that China will overtake the United States, in terms of economic size, by the end of the decade. And by 2050, on the basis of current information available in terms of education attainment, investment, technological catch-up, or demographics, China's economic size should be twice that of the USA. China would also be seven times bigger than Japan, more than ten times bigger than Germany or the UK, or 16 times bigger than Russia by then. Undoubtedly, many currently unpredictable shocks will reshape the global economy over this horizon. In addition, restrictions on the international exchange of technology in sensitive industries, as well as the return of industrial policies based on aggressive subsidy or tax credit programs, may push the world economy away from its projected trajectory. However, a second expected upheaval, less popularized by prospective studies, is the fact that **India** should be, under the same assumptions, of a similar economic size to that of the United States by the same horizon. Indonesia would be larger than France, while Russia and Turkey would have the same economic size.

Climate policies

Faced with this recomposition of the global economy, which risks jeopardizing the multilateral approach to solving global problems, if there is one area of international cooperation that must be preserved, it is climate policy, where the problem of collective action arises (Fontagné and Schubert, 2023). The forward-looking exercise we have carried out is highly informative in this respect.

A first conclusion on the future of the global economy thus projected concerns energy consumption. As already mentioned, the underlying model is based on three factors of production, one of which is energy. The results on future energy consumption and long-term energy efficiency are unequivocal (*Figure 1*).

Figure 1.
Share of World GDP and Energy consumption in 2020 and 2050
Selected countries (percent)



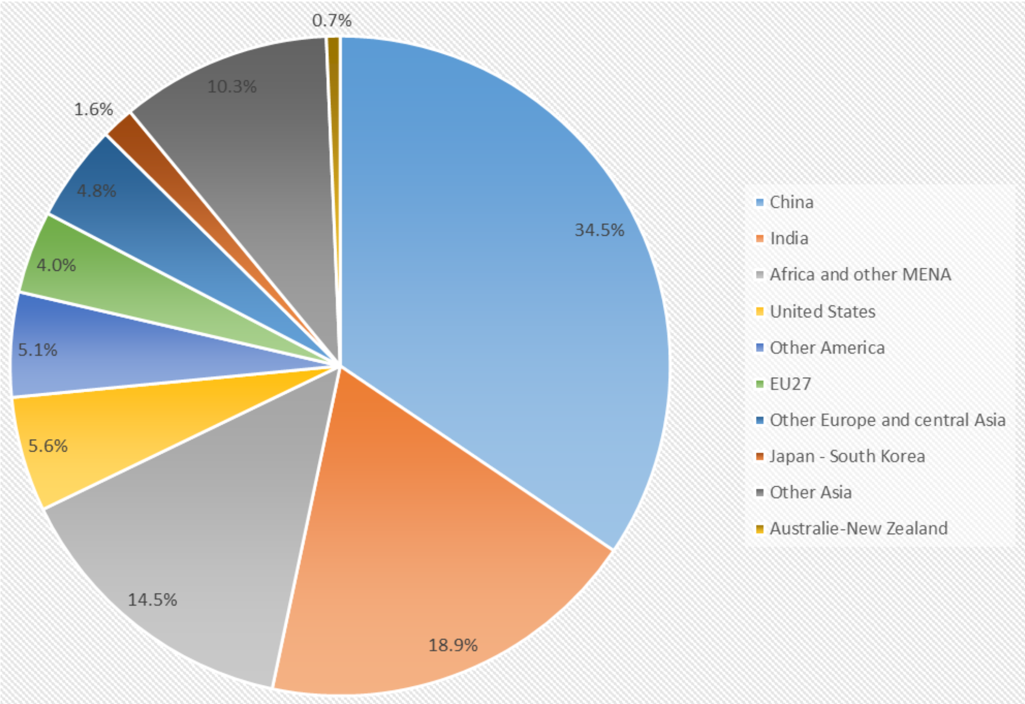
Note: Energy share on an inverse scale. Adaptation from Fontagné *et al.* (2022)

In 1990, the US economy accounted for a quarter of the world's energy consumption, and contributed a similar share to global GDP. China consumed a tenth of the world's energy and contributed just 2% of global GDP. In 2020, the leading economy in terms of energy consumption is China, with a quarter of the world's energy consumption, but with a contribution of only 15% of global GDP, indicating lower energy efficiency, as well as composition effects with a higher share of high-emitting industries. The third-largest country by economic size in 2020, India, is in an even more critical situation, with a share of global energy consumption equal to 8%, despite contributing less than 4% of global GDP. **By 2050, China and India will together consume 56% of the world's energy and contribute 40% of global GDP.** The third largest country in terms of energy consumption will be the US economy, but with only 8% of the total. Countries like Japan and Korea will account for just over 1% of global energy consumption, and Germany, France and the UK for less than 1%.

However, energy is not necessarily derived from fossil fuels. Countries have committed to reducing their GHG emissions with the Paris Agreement and subsequent updates of their Nationally Determined Contributions (NDCs). We can consider the unconditional NDCs as updated at COP26 and ask what each country or region's contribution to global GHG emissions would be in the long term, should these NDCs be achieved. *Figure 2*, which comes from a companion paper (Bellora *et al.*, 2023) shows how global emissions would be distributed given the macroeconomic trajectory of each country described above, and the commitments made in terms of reducing their emissions.

China and India would together still account for 53% of the world's emissions of GHGs. The share of the US in terms of emissions would be close to 6% and the EU27 another 4%, meaning that these two regions engaged in climate policies would represent only a tenth of emissions at this horizon, below Africa and Middle-East countries accounting for 15%. The conclusion in terms of economic policy is quite simple, although its practical implementation is difficult: **negotiations on climate policies must have not only China but also India and Africa and the Middle East as major players.**

Figure 2.
Contribution of each country or region to global emissions of GHG in 2040



Source: Bellora *et al.* (2023)

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✦ **Lionel Fontagné** is professor of Economics at the Paris School of Economics and the University Paris 1 Panthéon-Sorbonne.