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Looking Ahead to 2050: Where are the Current Dynamics Steering the Global Economy?

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Pandemics, global warming, food security, ageing, depletion of certain raw materials... our economies are faced with global problems, calling for long term actions and raising intergenerational issues. To guide economic policies, it is therefore essential to have a sound framework for reflection. The MaGE (Macroeconometrics of the Global Economy) model, developed by CEPII, makes it possible to draw the fundamental trends of the world economy in the long term, up to 2050. Assuming that the current dynamics of growth and technological catch-up will continue, and taking into account demographic dynamics, the balance of economic power will be strongly transformed over the next generation. Above all, energy consumption is expected to continue to grow at a sustained rate, and even double, despite efforts to improve energy efficiency. Ambitious policies to decarbonize our economies will be necessary to make these prospects for economic growth sustainable.

The development of our modern societies brings with it the challenges of the Anthropocene. The economic, geopolitical and, above all, environmental risks that weigh on future generations call for immediate adjustments to economic and environmental policies. To guide this inflexion, it is necessary to be able to foresee and therefore look at where the current trends in the world economy are pointing. In presenting a credible scenario for future developments, it is not sufficient to simply extrapolate past growth rates. Two approaches can be contemplated. Multidisciplinary prospective analysis builds scenarios and tries to identify the weak signals that may lead to bifurcations and the occurrence of major shocks. Macroeconomic projections, on the other hand, are intended to identify the drivers of economic development in order to determine long-term growth paths. For the past fifteen years, CEPII has been building modelling tools and databases based on this logic of macroeconomic projections.[1] This brief presents an update of the projections obtained with the MaGE model, gathered in the EconMap database.[2]

Projecting is not forecasting

Having a consistent framework for the future of the world economy requires the use of a model. As in any exercise of this type, one loses information to gain understanding, and this requires simplifications and assumptions. The model developed here is largely based on assumptions of technological catch-up, for total factor productivity and energy efficiency, and of catching up in terms of educational attainment. In this framework, the further away from the technological and education frontiers a country is, the higher its expected growth.

Once the model has been calibrated and estimated for the past, it is used to describe future developments, assuming that the trends identified are prolonged. The result is a set of projections. These are not forecasts or expert opinions. A macroeconomic projection is what is expected to occur, all other things being equal, as the main drivers of growth evolve along the paths described by the model. This approach draws a

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1. See Poncet, S. (2006), The Long Term Growth Prospects of the World Economy: Horizon 2050, *CEPII working paper* n° 2006-16 for the first modelling exercise, and the first release of the MaGE model in Fouré, J., Bénassy-Quéré, A. & Fontagné, L. (2013). Modelling the world economy at the 2050 horizon. Economics of Transition 21(4): 617-654.

2. See details in Fontagné, L., Perego, E. & Santoni, G. (2021), MaGE 3.1: Long-Term Macroeconomic Projections of the World Economy, *CEPII working paper*, forthcoming.

scenario that ignores the unforeseen events and decisions that could disrupt countries' development pathways. For instance, the economic shock resulting from the Covid-19 pandemic is not included in these projections. The health crisis has led to the sharpest contraction of the world economy since World War II, and it is obviously unwise to assume that it will not have implications for future growth. However, in 2021, the expected effects on the long-term growth trajectories of economies are still a matter of conjecture; it is too early to judge how to incorporate them into our model.[3]

The macroeconomic framework

The projections presented here are derived from the MaGE model, which combines three factors of production – labor, capital and energy – and two components of technical progress total factor productivity and energy efficiency.

The first step in the empirical analysis involves calibrating the parameters of the production functions and estimating the dynamics of factor accumulation and technical progress. The estimation of the functional relationships of the model is carried out for 166 countries over the period 1990 to 2017.

Labor-force growth is determined jointly by demographic trends and activity rates by gender and by five-year cohort. To predict the trend in these participation rates, it is necessary to estimate the dynamics of the female participation rate, which is rapidly evolving in some countries. The female participation rate is modelled as a function of secondary and tertiary education levels.

Capital accumulation is described by a permanent inventory approach, allowing for yearly investment and for the depreciation of capital stock. The model takes into account imperfect capital mobility, so that investment depends on national savings and the degree of financial openness of economies.

The improvement in the joint productivity of labor and capital (total factor productivity) is estimated by measuring the speed at which technological catch-up occurs. The latter depends on countries' level of education and their distance from the technology frontier (a moving average, for each year, of the productivity levels of the five leading countries over the previous five years). The productivity of countries at the technological frontier is assumed to grow at the average rate observed over the last 15 years. Energy consumption is a function of energy efficiency, GDP and the price of oil. It is assumed that energy efficiency depends on countries' standard of living, but that it also follows a process of convergence towards the frontier.

In addition, the change in education levels is modelled as a convergence process, where the countries with the lowest education rates are progressively catching up. This convergence process is estimated for each world region and for each educational level.

In a second step, the evolutions of the variables not determined by the model must be imported for the years for which the projection is to be carried out: the demographic paths by country established by the United Nations ("central" scenario) and the long-term trends in energy prices provided by the International Energy Agency.

The final step is to combine these data with the set of functional relationships that were estimated or calibrated in the first step, in order to project the different variables of the model for each country and year until 2050. The global nature of the projections stems from the fact that the dynamics of education, productivity and energy efficiency are interdependent across countries. In addition, there is a requirement of global current account closure, which ensures that international flows of savings wash out at the global level.

The projections presented here are in volume terms, at 2011 prices and exchange rates. They do not include valuation effects that would further amplify the growth of emerging countries. Such a comparison in volume is more appropriate when it comes to describing the consumption of raw materials and energy.

When No. 10 in the class overtakes No. 1

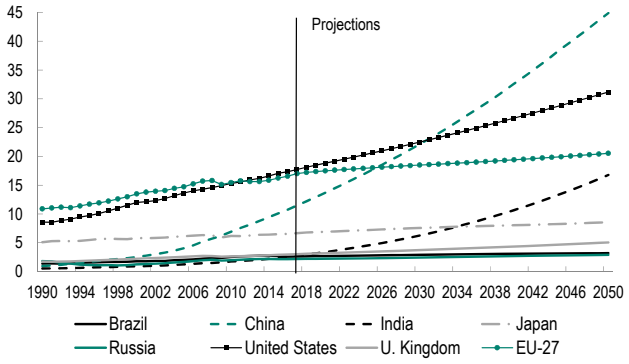
If there are no major inflexions in the course of the world economy, how will it be transformed within a generation, by 2050? Of course, we expect to see the continued rise of China, catching up and overtaking the United States. But at what pace and in what proportion? And what are the mechanisms underlying this catching up?

A generation ago, in 1990, the US accounted for nine times the GDP of China, while France weighed the equivalent of "two Chinas". In 2020, China's GDP is 72% of US GDP and more than four times that of France, making it the world's second largest economy in terms of GDP. It has overtaken Japan, whose GDP is now only 37% of the United States', against 59% in 1990. By 2050, China is expected to overtake the United States by a wide margin: its economic size would be 44% larger. As Figure 1 illustrates, this overtaking is expected in 2031. This near-term prospect sheds light on the deterioration of Sino-American trade and diplomatic relations, but should not mask other major disruptions in the

3. In its 2010 exercise, the CEPII initiated projections in 2013 and used the IMF's forecasts for the period 2008–2012, rather than actual data, on the assumption that the financial crisis would be "absorbed" by the world economy by that time. But this forces the GDP taken into account to be disconnected from its determinants during the period considered. We adopt a different approach this time; data are observed up to 2017; projections start in 2018 and are benchmarked against IMF forecasts for the period 2019–2024 as published before the Covid crisis in July 2019. Our projections are broadly in line with those of the IMF for the first few years of the exercise.

Figure 1 – GDP prospects dominated by rapid growth in China and India

GDP in volume, trillions of 2011 dollars



Source: Authors' calculations based on the EconMAP 3.1 database.

global balance of power. The other ifast-growing country is India, which has overtaken its former colonizer in a generation and moved up 10 places in the international ranking. As it continues catching up economically, India is expected to be the world's third largest economy by 2050 (fourth if the EU-27 is considered as a whole), with a GDP three times that of the United Kingdom. The other three major emerging countries in the BRICS group – Brazil, Russia and South Africa – do not seem to be on the path to comparable success. On the other hand, Nigeria and Indonesia are expected to grow rapidly and their GDPs to exceed those of most European countries. These two countries could become the seventh and eighth largest economies in the world by 2050 (Table 1).

To understand the mechanisms at work and to design the resulting policy options, it is necessary to examine the contribution of the various engines of growth. Table 1 proposes, for the 10 largest economies in 2050, a breakdown of the contribution to growth between 2020 and 2050 of each component of GDP. Unsurprisingly, technical progress plays an essential role. This is true for emerging countries such as China, India and Indonesia, whose economic size increases largely because of technological catch-up and investment in education. Overall productivity is increasing by 236%, 171% and 103% respectively in the latter countries. The expected productivity gains are also spectacular in Nigeria, because of the catch-up margin allowed by its very low initial level. Productivity growth is naturally not as strong for countries close to the technological frontier. However, it continues to play an essential driving role. Projections indicate productivity growth of 35% in the United States, 24% in Germany and 18% in France, with the United Kingdom expected to see the most sustained growth (36%), due to the effort to make up its productivity deficit, a dynamism expected to hold in the coming decades.

The entry of Nigeria and Indonesia into the world's top 10 in 2050 also reminds us that demography is one of the drivers of long-term growth. In the extreme case of Nigeria, labor-force growth accounts for a quarter of economic growth over a generation. Conversely, in several countries growth is hampered by adverse demography. This is the case in China, where the effects of an ageing population will begin to be visible, but even more so in Germany and Japan: in these two countries, demography cancels out between 30% and 45% of the growth drawn from the other engines of economic development. The problem is particularly acute in Japan where, unlike China and Germany, capital accumulation is not sufficient to offset the decline in the labor force.

Table 1 – Technical progress is the main driver of growth between 2020 and 2050 of the 10 largest economies

		GDP growth (%)	Annual average growth rate (%)	Rank variation	Contribution to GDP growth			
					Labour and Capital productivity	Capital	Labour	Energy
1	China	230	4,1	+1	171	83	-21	-2.2
2	United States	65	1,7	-1	35	21	9	-0.5
3	India	403	5,5	+2	236	132	39	-4.5
4	Japan	23	0,7	-1	36	7	-19	-0.2
5	Germany	24	0,7	-1	24	9	-10	-0.3
6	United Kingdom	58	1,5	0	36	16	5	-0.2
7	Nigeria	837	7,7	+17	409	222	208	-2.7
8	Indonesia	195	3,7	+8	103	61	31	-1.2
9	France	27	0,8	-2	18	9	0.3	-0.3
10	Turkey	143	3,0	+7	82	49	12	-0.8

Note: The Energy column gives the contribution of the energy factor combining energy efficiency and energy consumption.

Interpretation: Productivity growth contributes 35 percentage points to the 65% increase in US GDP between 2020 and 2050; 21 percentage points are contributed by capital accumulation and 9 percentage points by active population growth; the negative contribution of the energy factor is negligible.

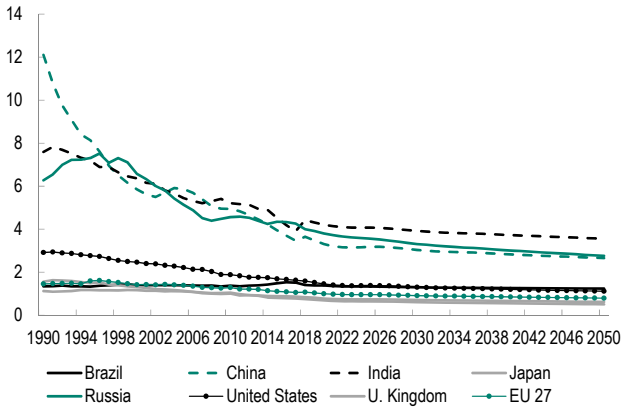
Source: Authors' calculations based on EconMap 3.1 database.

What about the planet?

Large economies with rapidly increasing populations and purchasing power will put mounting pressure on the world's resources. This pressure is multidimensional: it concerns in particular the use of raw materials, land for food, energy, emissions of greenhouse gases and pollutants, and waste. Ultimately, energy consumption – the outcome of economic activity and energy efficiency – is a good indicator of the environmental impact of growth.

An essential leverage for achieving sustainable growth is the decoupling of growth from energy consumption. According to projections, the productive systems of the world's leading economies should continue to become less energy-intensive (Figure 2). The orders of magnitude are not negligible. The EU27 is expected to increase its GDP by 26% in 2050 with the same amount of energy consumed as in 2020. This figure exceeds 30% for the United States. The gains are somewhat less spectacular in emerging countries, but still significant: by 2050, the energy consumption of 2020 should produce 24% more GDP in China and 18% in India.

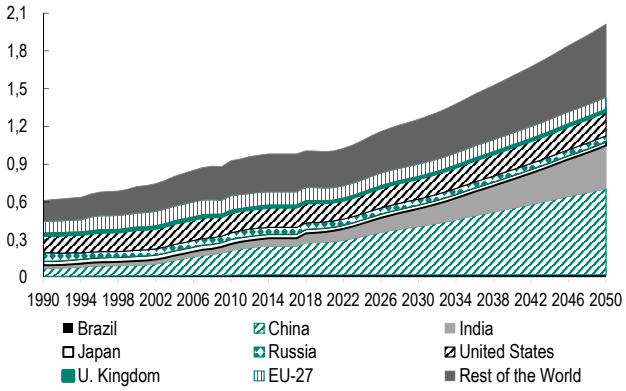
Figure 2 – The decrease in energy intensity is far from negligible…
Energy consumption to GDP in relation to that of the EU-27 in 2020



Interpretation: In 2020, energy consumption per unit of GDP was 3.3 times higher in China than in the EU-27. In 2050, producing one dollar of Chinese GDP is still expected to require 2.7 times more energy than producing one dollar of EU-27 GDP in 2020. It required 12 times more in 1991.

Source: Authors' calculations based on the EconMap 3.1 database.

Figure 3 – ... but energy efficiency gains cannot prevent a doubling of global energy consumption
Energy consumption with respect to the world 2020 value



Source: Authors' calculations based on the EconMap 3.1 database.

Even if the prospect of decoupling growth from energy consumption is promising, the gains generated by the current dynamics will not be enough to halt the steady growth in energy consumption.

For countries with prospects for low growth, such as the European Union and Japan, the reduction in energy intensity of GDP should just about stabilize energy consumption in the coming decades, or at best allow for a very slight decline (Figure 3). However, this is far from being the case in high-growth countries, whose share of global energy consumption is expected to increase: from 25% today for China to 33% in 2050, and from 8% to 16% for India. Conversely, we expect the United States, Japan, the UK and the EU-27, which today consume more than 30% of the world's energy, to see their share drop to 17% in 2050.

Overall, the projections of global energy consumption follow an alarming trend. Even taking into account foreseeable structural changes, as in this exercise, current trends would lead to a doubling of energy consumption by 2050. These figures accounting for all energy consumed, whether fossil or renewable, illustrate the scale of the challenge posed by climate and the depth of the changes required. The latest Intergovernmental Panel on Climate Change (IPCC) report concludes that limiting global warming to +1.5°C by 2100 requires achieving carbon neutrality shortly after 2050. Given the projections of energy consumption, the reduction of greenhouse-gas emissions must necessarily involve a drastic acceleration of efficiency and a major decarbonization of the energy mix. All countries will have to do their part, in a coordinated way. The challenge of the next COP will be to design international cooperation mechanisms, including the largest number of emerging and developing countries, so that the energy consumption projections envisaged here do not involve substantial use of fossil fuels.

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