Centre for International
Governance Innovation

Global Economic
Scenarios

Economic Growth and Fiscal Capacity Projections

Data and Method

Global Economic Scenarios explores the potential architectures of global economic order, drawing from data-driven insights captured through global projections and trends analysis.

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About the Authors

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Economic Growth Model

Theoretical Model

The economic growth model that we use for our projections is based on the famous model by Solow (1956). Output (Y) is produced using capital (K) and labour (L) according to the constant returns to scale production function

$$Y = K^{\alpha}(A \cdot L)^{(1-\alpha)}$$

where α is capital's share of output. The parameter A is the level of labour-augmenting productivity: it incorporates factors that increase the productivity of labour, such as the current level of knowledge of the workforce, the efficiency of markets and the level of public infrastructure.

It is important to note that this model is not meant to capture short-term macroeconomic fluctuations such as those that arise from demand-side shocks (for example, the great financial crisis or the COVID-19 pandemic). Rather, it is designed to model the productive capacity (the "supply side") of the economy, and so to provide guidance to the medium- and longer-term evolution of the economy, abstracting from short-term fluctuations.

In this model, growth in output can be expressed as

$$\dot{y} = \alpha \cdot \dot{k} + (1-\alpha) \cdot \dot{a} + (1-\alpha) \cdot \dot{l}$$

where $x = \ln(X)$ and a dot is the difference operator. Thus, the growth in output depends on the growth in capital, the growth in labour-augmenting productivity and the growth in the labour force.

It is common in the literature to stop here and use estimates of K, L and A to produce estimates of output. However, in this model, capital is an endogenous variable, the level of which ultimately depends on output. If capital accumulates more rapidly than output, the marginal product of capital will fall below the rental price of capital and capital accumulation will slow until equilibrium is restored. Over the longer run, we expect output and capital to grow at roughly the same rate, so that

$$\dot{y} = \dot{k} = \dot{a} + \dot{l}$$

Output growth is equal to the rate of growth of labour-augmenting productivity plus the growth of the labour force.

We prefer this latter formulation because it allows us to avoid using measures of physical capital in our empirical model. This is useful because physical capital can be quite hard to measure. Rental rates for capital are not always easy to compute because there is not necessarily a rental market for all kinds of capital goods, and assumptions have to be made about depreciation rates. Calculation of the capital stock is, of course, particularly challenging for developing countries, and capital stock data that covers most countries is difficult to obtain. Even for developed countries, the now-central importance of intangible assets, such as intellectual property, has added an extra element of complexity in recent years, and it is not always obvious how to calculate capital's share of output for intangible assets.

The drawback to this approach is that we may miss medium-term fluctuations in growth that are due to departures of capital accumulation from the long-term growth path that is determined by labour-augmenting productivity and labour force growth; however, we feel that abstracting from these fluctuations does not materially detract from our long-term projections.

Empirical Implementation

In order to use the growth model for forecasting, we will need to be able to project both the labour force and labour productivity. For the labour force, we use the population of working age as a proxy: the latter is very easy to forecast over long periods of time as it is a function of very slow-moving demographic variables: birth rates and death rates. Although labour force participation rates do fluctuate over time, these fluctuations are not particularly large for the working age population. The United Nations Population Division has both historical data going back to 1950 and projections out to 2100 for virtually every country in the world by detailed age;[1] we use these as a basis for our projections.

Labour productivity is more challenging. Often researchers will use trend growth to extrapolate a country's productivity growth rate; however, this seems unsatisfactory for longer time horizons as trend productivity can change significantly over time. This can be particularly true for developing countries that are far from the technological frontier and so can grow quickly by simply adopting existing technology rather than having to develop new technology. As a consequence, modellers will sometimes assume that trend productivity growth is a function of how far a country's productivity is from the technological leader (often proxied by the United States): the lower productivity is relative to the leader, the faster it grows.

The challenge with this approach is that cross-country productivity differences are not simply a function of the technology gap. Productivity also depends on factors such as educational levels, infrastructure, institutions, the business environment and resource endowments. For some of these factors, we might expect some degree of catch-up (education, for example), but not for all. Indeed, while some developing countries have seen rapid productivity growth relative to the United States in recent decades (for example, China), others equally far from the productivity frontier have not. Furthermore, many developing countries that do see higher productivity growth when they are poor seem to hit a "middle income" trap, where growth seems to slow down to advanced country levels, so that these countries do not look as if they will catch up to advanced country per capita income levels on current trends.[2]

We therefore take the approach of modelling the rate of labour-augmenting productivity growth directly by employing the United Nations Conference on Trade and Development (UNCTAD) Productive Capacities Index (PCI).[3] This index covers 193 economies for the period 2000–2018. It has eight components: human capital, natural capital, energy, transport, information and communication technology (ICT), institutions, private sector, and structural change. The last three components measure political stability and institutional effectiveness, the ability of the private sector to function properly and the extent to which resources are moving across sectors. Ultimately, these measures get at the effectiveness of government, both to ensure stability, the rule of law and property rights, while at the same time minimizing corruption and rent-seeking and ensuring that trade and commerce can flourish without excessive state intervention.

The PCI not only has conceptual appeal, but it also seems to work empirically: it has a strong positive correlation with the cross-sectional pattern of GDP per capita,[4] as well as with the Human Development Index. It has also been through an extensive peer-review process. We can therefore have some confidence in its ability to explain long-run growth trends.

We therefore assume that the growth of real labour productivity in country i at time t is determined by

$$\dot{y}_{it} - \dot{l}_{it} = \dot{c} + \dot{pci}_{it}$$

where $\dot{c}$ is a growth factor constant across countries, intended to represent the rate of technological progress in technologies available to all countries, and $\dot{pci}_{it}$ is the rate of growth of the PCI. In our

1 See https://population.un.org/dataportal/home.

2 The "Four Asian Tigers" — Hong Kong, Korea, Singapore and Taiwan — are the only economies that have convincingly gone from developing to developed status in recent decades, if we exclude small energy-rich states such as Qatar.

3 See UNCTADstat, "Productive Capacities Index" (https://unctadstat.unctad.org/EN/Pci.html).

4 See UNCTAD (2021, figure 4). The correlation between the PCI and log GDP per capita is 0.92.

empirical work, we set $\dot{c}$ to 0.6 percent. This number is calibrated so that US productivity grows at an average rate of 1.1 percent, which is the average over the last two decades. We proxy the growth in the labour force $\dot{l}_{it}$ by the growth in the working age population (15–64); we think this approach is reasonable as participation rates for the working age population do not change enormously over time. We also assume that exchange rates are constant, and that GDP inflation is constant at two percent.

The key operational question, then, is how to forecast the index. For this purpose, we separate out the eight components into three categories:

- built capital (human capital, energy infrastructure, transportation capacity, ICT infrastructure);
- endowed capital (natural capital); and
- governance (strength of institutions, ability of the private sector to function, degree of structural change).

The first category comprises those components that are accumulating over time as countries invest in them. Generally speaking, the fastest growth is experienced by the least developed countries. It is therefore reasonable to assume that the growth in the components of built capital will continue, and that it is correlated with distance from the most developed country (this is generally the United States). We implement this empirically by first regressing the growth of each component index (g) from 2000 to 2018 on a constant (α) and on the level relative to the United States in percentage terms in 2000 according to the following equation:

$$g_i = \alpha + \beta \cdot \left(\frac{x_0^{US} - x_0^{i}}{x_0^{US}} \right)$$

We then use the resultant estimates of α and β to forecast the growth of the index using the previous period's values for that country and for the United States. (In the case of energy, the US data shows no trend, so we impose a zero value for the constant term; in the case of transport, the constant is insignificant, so we also set it to zero.)

The second category is the natural capital with which a country is endowed. By and large, this is constant over time (the unweighted average growth for all countries over 2000–2018 is zero), with countries such as Saudi Arabia having relatively high levels of natural capital (40 percent above US levels in 2018), and countries such as Japan having relatively low levels (77 percent of US levels in 2018). We therefore assume it remains constant at 2018 levels in our projections.

For the third category, governance, specifically institutions and the role of the private sector, there is no reason to suppose that countries will catch up to the United States, given that these features are deeply embedded in a country's culture and history. The data bears this out, with no change in the average level of the index for institutions over the 2000–2018 period, and for the private sector for 2009–2018. We therefore hold the levels of these two components constant at 2018 levels. Finally, for structural change, this has been trending up over time, on average, for less developed countries, although the trend is largely flat for developed countries. We therefore use the same approach as for built capital and estimate a growth equation that predicts future growth as a function of the gap with the United States.

As noted above, this model is designed to illuminate longer-term trends, rather than make predictions at business-cycle frequencies. We therefore use forecasts from the International Monetary Fund's (IMF's) October 2023 World Economic Outlook for GDP to predict the growth of output per person of working age out until 2028. After that, we gradually adjust the forecast over the next six years to align with our long-term projection of output per person of working age that is based on the PCI. By 2034, the forecasts are based purely on the PCI.

Growth Cases

We identify three growth cases, each with a different set of assumptions, that can be applied to the empirical framework described above. Below, we describe these three growth cases as the case of inertia, the case of a stronger China and the case of a US-led technology spurt.

The Case of Inertia

Our inertia case is the projection from the previous section, with the common level of productivity growth due to technological change set to 0.6 percent. As noted in the previous section, this produces a productivity growth rate for the United States of 1.1 percent, with other countries catching up to US productivity depending on how quickly their underlying fundamentals (human capital, infrastructure, etc.) catch up to US levels. Gaps between developing and advanced country institutions remain significant, reflecting experiences of the last two decades.

The Case of a Stronger China

We alter some of our growth assumptions in the case that China's economic growth takes off, along with select other large emerging economies. The changes to projected growth in this case apply to the G20's developing countries, where we take the average labour productivity growth rate for each country between 2024 and 2028 and multiply it by an additional 25 percent. These countries comprise Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, South Africa and Türkiye.

The Case of a US-led Technology Spurt

We also consider a case where the United States, as well as select other developed economies, lead a technology-driven spurt of economic growth. This specifically includes countries with the highest level of human capital and ICT index components of the PCI: Austria, Belgium, Denmark, Germany, Iceland, Japan, Korea, the Netherlands, New Zealand, Sweden, Taiwan, the United Kingdom and the United States. We assume that US productivity growth grows by an additional 0.6 percentage points (so for the United States, the exogenous technology parameter is now 1.2, not 0.6). Thus, growth for the countries listed above will ramp up during the 2029–2034 period. Then, for all other countries, we adjust the forecast between 2028 and 2034 to gradually align with their productivity growth, which would increase by the exogenous technology parameter of 1.2 and a dynamic, geometric average of how close the country is to US human capital and ICT levels.

Fiscal Projections

Theoretical Model

The model we use for our fiscal projections is a simple debt dynamics model based on Escolano (2010). The key equation of motion for the debt-to-GDP ratio is the recursive equation

$$d_{t+1} = (1 + \lambda_t) \cdot d_t - pb_t$$

where d_{t+1} is the debt-to-GDP ratio, pb_t is the primary balance (revenues minus non-interest expenditures) relative to GDP and λ_t is defined as

$$\lambda_t = \frac{r_t - g_t}{1 + g_t}$$

where r_t is the effective rate of interest on government debt, and g_t is the rate of growth of nominal GDP.

If the rate of interest is greater than the growth rate of GDP, then even if the primary balance is zero, the debt-to-GDP ratio will rise over time, giving rise to explosive debt dynamics. Alternatively, if the rate of interest is less than the growth rate, the debt-to-GDP rate will fall, as long as the primary balance is zero or positive.

Empirical Implementation

In order to implement our fiscal model empirically, we use data from the IMF's October 2023 World Economic Outlook, which provides forecasts out until 2028 for the debt-to-GDP ratio, revenues, the primary balance, the overall balance and the growth of nominal GDP. We then forecast these variables for the period 2029–2040.

To do so, we need to make a number of assumptions. First, we assume that countries face a common rate of interest. This is obviously a very strong assumption: some countries, particularly in the developing world, face significantly higher interest rates because their risk of default is higher. Nevertheless, we are most interested in larger, more stable economies, such as those in the G20, which can borrow relatively easily on international capital markets, and for which, as a result, real interest rates are not dissimilar, particularly on longer-term debt.

We set the interest at four percent in nominal terms, which earns two percent in real terms as we assume two percent inflation. This is around what it is for the United States and United Kingdom at the time of writing (January 2024). Four percent is higher than during the decade of the 2010s, but we think that the macroeconomic environment has changed significantly since the COVID-19 crisis, with the resurgence of inflation and more precarious fiscal situations likely to drive significant inflation and default risk premia in government bond markets for many years to come.

We assume that revenues are constant as a percentage of GDP from 2029 onwards. Government revenues as a share of GDP are close to historic highs and do not seem likely to trend downward. Expenditures are also higher than before the COVID crisis and seem unlikely to fall, given unfavourable demographics and the importance of health care and pensions in overall government spending, as well as the upward pressure on defence budgets in many countries. In our growth case of inertia, we therefore assume revenues also remain constant as a share of GDP, which means that the primary balance going forward is kept at the levels forecast by the IMF (2023) for 2028.

In our two other growth cases, we keep revenues fixed as a share of GDP, as we assume that governments will keep effective tax rates at their current levels, so if the economy grows faster, governments allow revenue to grow at the same rate and do not cut taxes in consequence.

However, for expenditures we adopt a different approach, as expenditure is often tied to demographic factors, for example, rather than the size of the economy per se. We therefore keep the growth of expenditures to be the same in all three scenarios. Therefore, if the economy grows faster in one of our scenarios than in the case of inertia, expenditures fall as a share of GDP relative to the inertia case, and fiscal performance is more favourable.

Health expenditure and old age expenditure projections are calculated by growing the percentage of each expenditure by the percentage increase in this proportion for each major economy, starting in the year after the data ends (which varies for each major economy). However, these are not used in the calculation of overall expenditures, largely because we do not have these expenditures for most countries. Data on health expenditure was collected through the World Bank and World Health Organization Global Health Expenditure Database on current health expenditure as a percentage of GDP. Data on old age expenditure was collected through the OECD Social Expenditure Database on public expenditure on old age security for major economies except for China, which was collected through the Statista database as public pension expenditure as a percentage of GDP.

Analysis External to Model

In each of the three cases, demographics are assumed to be independent of the other assumptions and projected to grow based on IMF calculations (October 2023).

In all three cases of our growth projections, technology is factored into growth projections through the ICT component of the UNCTAD PCI. The ICT component estimates the accessibility and integration of communication systems within the population. It includes fixed line and mobile phone users, internet accessibility and server security. Although we recognize there are many aspects of technology beyond ICT that will impact economic growth, these aspects cannot be accurately quantified and are therefore not directly factored into our projections. The additional aspects of technology whose role we analyze outside of our projections include innovation, digitalization, artificial intelligence, robotics, biotechnology and other potentially significant emerging technologies such as quantum computing.

Looming challenges of uncertainty remain a constant exogenous variable, including pandemics, conflict, environmental change and cyberattacks. These are a reminder that the global economy is increasingly shaped by developments beyond the traditional reach of economic policy makers and that a surprise can appear at any point. Any projection over time should broadly assume an increasing probability of a significant disruption resulting from a surprise event — the specific timing or magnitude of which cannot be predicted. While it is possible to build some risks as headwinds over time directly into modelling, such as a gradual impact of climate change on productivity, we have not done so in this work. In our model, some aspects of these broad challenges and uncertainties may be indirectly captured through the eight components of the UNCTAD's PCI, although they are not directly assumed to impact the future projections unless otherwise described.

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