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# Global Growth Projections for The Conference Board Global Economic Outlook 2019

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## Abstract

This paper presents the methodology for The Conference Board Global Economic Outlook 2019 which includes growth projections for 11 major regions and individual estimates for 33 mature and 36 emerging market economies for 2019-2023, and 2024-2028. The projections are based on a supply-side growth accounting model that estimates the contributions of the use of factor inputs—labor and capital—, and total factor productivity growth to the growth of real Gross Domestic Product (GDP). While labor input growth rates are estimated using data on demographic changes and participation rates—including an estimation to adjust for the change in the composition (or quality) of the workforce—capital input and total factor productivity growth are econometrically estimated using a wide range of related variables during past periods. The obtained trend growth rates for the period 2019-2023 are adjusted for possible deviations between actual and potential output in the short run.

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## 1. Introduction

Since 2008, The Conference Board publishes its annual global economic outlook, projecting GDP growth for 69 countries using growth accounting techniques.[1] The projection methods have been improved over the years by refining the underlying model specification and expanding and improving the pool of historical data. This paper describes the methodology and sources underlying the projections of growth of Gross Domestic Product (GDP) in the 2019 edition of *The Conference Board Global Economic Outlook* (GEO).[2] More details on the results of the GEO model can be found on The Conference Board's GEO website. Historical growth accounting data are sourced from *The Conference Board Total Economy Database™* (TED) more details on which can be found on The Conference Board's TED website.

The projections in this paper cover the period 2019-2028, with separate projections for the medium term (2019-2023) and the long term (2024-2028). The outlook covers 69 economies across 11 regions, including 33 mature economies and 36 emerging and developing economies (see table 1 for a list of countries included). Trend growth is estimated based on an extrapolated growth accounting model. To arrive at GDP projections, the model estimates the factor inputs, which are labor quantity, labor composition (the effect of heterogeneity among workers in terms of educational attainment), capital services and total factor productivity (TFP), a measure of overall production efficiency. Broadly speaking, the measures for labor quantity (Section 3.1) are based on projections of employment (2019-2022) and labor force (2023-2028) from the International Labor Organization (ILO), combined with working-age population projections from the United Nations (UN). The measures on labor composition (Section 3.2) are based on projections of returns to education by skill type. Capital services and total factor productivity (Section 4) are estimated using regression models which are largely based on relevant past-period variables.

Projections of all input factors are combined to provide projections of trend GDP growth. These growth rates can be interpreted as a representation of the trend growth of each economy. In the long run, countries grow according to their trend.[3] In the short run, however, countries deviate from their long-run path due to temporary fluctuations primarily due to business cycle

[1] Earlier editions of the GEO included 55 countries, expanded to 65 countries in 2015 and to 69 countries in 2017.
[2] The projection methodology used in the 2019 GEO is largely unchanged from last year's model, see Erumban and de Vries (2017), which builds upon Chen, V., B. Cheng, G. Levanon, A. Ozyildirim and B. van Ark (2012).
[3] Our long-term trend growth rates may be seen as a proxy to the growth rate of potential output. But as our estimates do not explicitly account for a non-inflationary constraint on our growth measure, and our estimates are not accompanied by a measure of potential output, we prefer to use the term "trend growth". Our estimates are essentially derived from past growth trends.

dynamics. Moreover, shocks can occasionally occur which can have a deep impact on the structure of the economy and can permanently change the course of the trend. The 2008/09 recession represents a combination of business cycle dynamics and structural factors, which has led to such a change in the trend growth.

The remaining of the paper is organized in six sections. Section 2 outlines the growth accounting methodology. In section 3, we discuss the approach to project labor input and in section 4 the approach to measure capital services and TFP are described. Section 5 describes the medium-term adjustments to the trend growth estimates obtained from the extrapolated growth accounts. Section 6 discusses the methodology used to split capital services into the contributions from quantity and quality, and section 7 concludes.

*Table 1: List of countries included in the Global Economic Outlook*

| Mature Economies | |
|---|---|
| | Japan, United States |
| Europe | **Euro Area countries:** Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Poland, Portugal, Spain<br><br>**Other Europe:** Czech Republic, Denmark, Hungary, Iceland, Norway, Sweden, Switzerland, United Kingdom |
| Other Mature Economies | Australia, Canada, Hong Kong, Israel, New Zealand, Singapore, South Korea, Taiwan |
| Emerging Markets and Developing Economies | |
| | China, India |
| Other Developing Asia | Indonesia, Malaysia, Pakistan, Philippines, Thailand, Vietnam |
| Latin America | Argentina, Brazil, Chile, Colombia, Mexico, Venezuela |
| Middle East & North Africa | Algeria, Bahrain, Egypt, Iran, Kuwait, Morocco, Oman, Qatar, Saudi Arabia, United Arab Emirates |
| Sub-Saharan Africa | Ethiopia, Ghana, Kenya, Nigeria, South Africa, Tanzania |
| Russia, Central Asia and Southeast Europe | Belarus, Kazakhstan, Russian Federation, Turkey, Turkmenistan, Uzbekistan |

## 2. The growth accounting framework

The medium- and long-term projections are based on the growth accounting framework as developed in Jorgenson, Gollop and Fraumeni (1987) and more recently used in Jorgenson, Ho and Stiroh (2005) and Jorgenson and Vu (2009a and b, 2013). The growth accounting methodology uses a production function, which decomposes output growth into components associated with changes in factor inputs, which are capital and labor, and a residual that reflects technological progress and production efficiency, known as total factor productivity (TFP). Assume a production function of the following form:

$$Y = Af(H, K) \tag{1}$$

Where $Y$ is Gross Domestic Product, $H$ is labor input, measured as $H = L.Q$ with $L$ being labor quantity and $Q$ being the composition of the workforce based on educational attainment. $K$ is capital services and $A$ is TFP. Under the assumption of perfectly competitive factor markets where inputs are paid according to their marginal product, and constant returns to scale, the above general production function can be transformed into the following growth accounting framework:

$$\Delta \ln Y_t = \Delta \ln A_t + \bar{v}_{L,t} \Delta \ln L_t + \bar{v}_{L,t} \Delta \ln Q_t + \bar{v}_{K,t} \Delta \ln K_t \tag{2}$$

In the above equation, growth of output in a given year $t$ ($\Delta \ln Y_t$) is decomposed into the contributions of total factor productivity growth ($\Delta \ln A_t$), labor quantity ($\Delta \ln L_t$), labor composition ($\Delta \ln Q_t$) and capital services ($\Delta \ln K_t$).[4] In the remainder of this paper $A$ will be referred to as $TFP$. The contribution of factor inputs, $L$, $Q$ and $K$ are obtained as the product of their growth rates over the current and previous periods and their compensation share ($\bar{v}$) in total nominal GDP averaged over the the two years:

$$\bar{v}_{L,t} = 0.5 * (v_{L,t} + v_{L,t-1}) \tag{3}$$

and

$$\bar{v}_{K,t} = 0.5 * (v_{K,t} + v_{K,t-1}) \tag{4}$$

where $v_{K.t} = \frac{P_L.L}{P_Y.Y}$ and $v_{K.t} = \frac{P_K.K}{P_y.Y}$, with $P_L$ being the price of labor (i.e. the wage rate), $P_K$ the price of capital (i.e. the rental price) and $P_y$ the price of output. Under the assumption of constant returns to scale, the cost shares of labor and capital sum to unity, $\bar{v}_L + \bar{v}_K = 1$.

Equation (2) illustrates that output growth is driven by share weighted input growth and TFP growth, a residual that captures all sources of growth which are left unexplained by labor and capital inputs. Thus, projections of output growth require projections of each individual input component and TFP growth on the right-hand side of equation (2). The following sections discuss the projection methodology used for each factor input.

[4] In this paper, all growth rates are calculated as the difference in the log of the levels of each variable unless otherwise specified.

# 3. Projections of labor input

## 3.1 Labor quantity

The growth in labor quantity for our projection periods are based on projections of employment rates (2019-2022) and labor force participation rates (2023-2028) sourced from the ILO combined with projections of the working-age population (ages 15-64) from the UN. While population growth can be projected with a certain degree of accuracy, predictions on employment rates and labor force participation carry a greater degree of uncertainty as they are affected by unpredictable factors such as policy changes affecting for example retirement plans, cultural changes, such as preferences for work vs. leisure, as well as cyclical fluctuations.

## 3.2 Labor composition

An adjustment for changes in the composition of the labor force in terms of different skill-levels is made in order to measure labor's effective contribution to output growth. The change of labor composition—sometimes referred to as labor quality—is constructed based on weighted measures of different skill-level groups (low, medium and high skilled workers according to their educational attainment) in the workforce:

$$\Delta \ln Q_t = \sum_i \bar{s}_{i,t} \Delta \ln h_{i,t} \tag{5}$$

where $\bar{s}_{i,t}$ is the compensation share of $i^{\text{th}}$ labor type (where $i$=low, medium and high skilled) in total labor compensation averaged over two years (in similar fashion as equations 3 and 4 illustrate for the capital and labor share) and $h_{i,t}$ is the share of $i^{\text{th}}$ labor type in the total workforce.

For the projection period, labor quality is estimated by extrapolating employment shares $h$ in equation (5) using projections on the educational attainment of the working-age population (ages 15-64) available from Wittgenstein Centre data and updates of Barro and Lee. The distribution of labor compensation $s$ by educational attainment is estimated using the following panel regression equation:

$$\ln W_{j,t} = a + \beta_1 \ln YS_{j,t} + \beta_2 \ln CPI_{j,t} + \beta_3 D_j + \eta_j + \varepsilon_{j,t} \tag{6}$$

where $\ln W_{j,t}$ is the log of the annual wage rate per worker for country $j$ in year $t$, expressed in purchasing power parity (PPP), for any give educational category, $YS$ is the average years of schooling, $CPI$ is the relative level of consumer prices—where consumer prices of each country are taken as a ratio of prices in the United States, as wage rates are expressed in PPP terms—, and $D$ a regional dummy. $\eta_j$ and $\varepsilon_{j,t}$ are respectively the country fixed affects and the error term.

The equation is estimated separately for each educational category $i$ to arrive at annual wage rates per worker for each educational category. The resultant wage rates are then used to compute the distribution of labor income across different educational groups as:

$$\hat{v}_{i,t} = W_{i,j,t} / \sum_{i=1}^{3} W_{i,j,t} \tag{7}$$

where $j$ refers to country subscripts.

# 4. Projections of capital services and total factor productivity

## 4.1 Model specification

Projections of capital services and total factor productivity (TFP) are estimated by a system of equations which uses explanatory variables—both economic and institutional—as suggested by the literature. We estimate three endogenous variables, which are TFP growth, the saving rate, and capital services growth. The saving rate is included because it is closely related to investment in capital that in turn determines growth in capital services. Moreover, as savings represents the part of income that is not spend on goods or services, it is implicitly related to demand, which is a welcome addition to our otherwise supply-side based model. All other variables are either exogenous or predetermined.

The three equations are specified as follows:

$$\begin{aligned}\Delta \ln TFP_{j,t} = {} & \alpha_0 + \alpha_1 \Delta \ln TFP_{j,t-1} + \alpha_2 \ln LP_{j,t-1}^{US} + \alpha_3 COR_{j,t} + \alpha_4 \Delta \ln R\&D_{j,t} + \alpha_5 HDI_{j,t} \\ & + \alpha_6 \Delta \ln ICT\_KL_{j,t} + \alpha_7 \ln R\_XR_{j,t} + \alpha_8 \Delta \ln PREV\_K_{j,t} + \alpha_9 CRISIS\_D \\ & + \alpha_{10,j}\, REGION\_D_j + \varepsilon_{1j,t}\end{aligned} \tag{8}$$

$$\begin{aligned}SAVING_{j,t} = {} & \beta_0 + \beta_1 DEP_{j,t} + \beta_2 \ln GDP\_PC_{j,t-1} + \beta_3 \Delta \ln GDP_{j,t-1} \\ & + \beta_4 SERVICES_{j,t} + \beta_5 \ln R\_XR_{j,t} + \beta_{6,j}\, REGION\_D_j + \varepsilon_{2j,t}\end{aligned} \tag{9}$$

$$\begin{aligned}\Delta \ln K_{j,t} = {} & \gamma_0 + \gamma_1 SAVING_{j,t} + \gamma_2 DPRN_{j,t} + \gamma_3 \ln KL_{j,t-1} + \gamma_4 \Delta \ln WAGE_{j,t} \\ & + \gamma_5 \Delta \ln ENERGY_{j,t} + \gamma_6 Z\_INFL_{j,t} + \gamma_7 \ln ECO\_GLOB_{j,t} + \gamma_8 IR_{j,t} \\ & + \gamma_9 \Delta \ln PREV\_K_{j,t} + \gamma_{10} CRISIS_D + \gamma_{11,j}\, REGION\_D_j + \varepsilon_{3j,t}\end{aligned} \tag{10}$$

where $\Delta \ln X$ denotes the log growth rate of variable $X$ over period $t$ and $t-1$, $\ln X$ indicates the log level of the variable $X$. The subscripts $j$ and $t$ refer to country and time respectively. The definition of the variables and the data sources are listed in table 2 on the next page.

*Table 2: Definition of variables and expected sign*

| Variables | Description | Expected sign |
|---|---|---|
| | TFP growth equation | |
| $\Delta \ln TFP_t$ | *Total factor productivity growth* | |
| $\Delta \ln TFP_{t-1}$ | Total factor productivity growth in the previous period | + |
| $\ln LP_{t-1}^{US}$ | Labor productivity (measured as GDP per worker) relative to the United States in the previous period | - |
| $COR_t$ | Measure of corruption (based on control of corruption from the World Bank Governance Indicators) | - |
| $\Delta \ln R\&D_t$ | Real Research & Development spending (deflated using investment prices) | + |
| $HDI_t$ | Geometric average of average years of schooling and life expectancy at birth | + |
| $\Delta \ln ICT\_KL_t$ | Information and Communication Technology capital stock per worker (ICT deepening) | - |
| $\ln R\_XR_t$ | Real exchange rate, for definition see equation (11) | + |
| $\Delta \ln PREV\_K$ | Capital services growth in the last year of the previous period | +/- |
| $CRISIS\_D$ | Crisis dummy (period 6 – see table 3) | +/- |
| $REGION\_D$ | Regional dummies | +/- |
| | Saving rate equation | |
| $SAVING_t$ | ***Saving rate, calculated as 1 minus final consumption expenditure as a share of nominal GDP*** | |
| $DEP_t$ | Dependency ratio, defined as the population aged 0-15 and 65+ as a share of the total population | - |
| $\ln GDP\_PC_{t-1}$ | Real Gross Domestic Product per capita in the previous period | - |
| $\Delta \ln GDP_{t-1}$ | Real Gross Domestic Product in the previous period | + |
| $SERVICES_t$ | Share of services industries in nominal GDP | + |
| $\ln R\_XR_t$ | Real exchange rate, for definition see equation (11) | + |
| $REGION\_D$ | Regional dummies | +/- |
| | Capital Services growth equation | |
| $\boldsymbol{\Delta \ln K_t}$ | *Growth rate of Capital Services* | |
| $SAVING_t$ | Saving rate, calculated as 1 minus final consumption expenditure as a share of nominal GDP | + |
| $DPRN_t$ | Depreciation rate of the aggregate capital stock | - |
| $\ln KL_{t-1}$ | Capital stock per worker (capital deepening) in the previous period | - |
| $\Delta \ln WAGE_t$ | Annual wage rate per worker in PPP adjusted US dollars | + |
| $\Delta \ln ENERGY_t$ | Total primary energy consumption | + |
| $Z\_INFL_t$ | Inflation rate minus the mean inflation rate (1979-2018) divided by the standard deviation of inflation (1979-2018) | - |
| $\ln ECO\_GLOB_t$ | Index of economic globalization which measures trends flows of trade, FDI, income payments and restrictions on international flows. | + |
| $IR_t$ | Interest rate, lending rate or long-term interest rate on government bonds | - |
| $\Delta \ln PREV\_K$ | Capital services growth in the last year of the previous period | +/- |
| $CRISIS\_D$ | Crisis dummy (period 6 – see appendix table 2) | +/- |
| $REGION\_D$ | Regional dummies (see appendix table 3) | +/- |

*Note: A + (-) sign indicates that the expected impact of the variable is positive (negative).*

The three equations constitute a simultaneous equation system which is estimated using three-stage least squares, as some of the explanatory variables are dependent variables of other equations in the system. Generalized least squares are used to account for the correlation among the error terms across equations. The regressions are implemented on our sample of 33 mature economies and 36 major emerging economies over the period 1979 to 2018 (see table 1 for a list of countries). The annual variables from the data sources are averaged over 5-year periods (see table 3 for a list of periods). The first period averages, denoted by 0, are only used for the lagged variables.

*Table 3: Period averages used in estimating the equations*

| # | Years included |
|---|---|
| 0 | 1979-1983 |
| 1 | 1984-1988 |
| 2 | 1989-1993 |
| 3 | 1994-1998 |
| 4 | 1999-2003 |
| 5 | 2004-2008 |
| 6 | 2009-2013 |
| 7 | 2014-2018 |

## 4.2 Estimation results of the simultaneous equations

Table 4 reports the results of the simultaneous equation system using the three-stage least squares estimation. The results are largely consistent with theoretical expectations:

- The relative level of labor productivity in the TFP growth equation and the lagged capital deepening variable in the capital services growth equation are specified to test the convergence hypothesis.[5] Both variables are significantly negative, lending support to the convergence hypothesis that the country with higher labor productivity (or capital deepening) levels will show slower growth of TFP (capital services) in the next period.
- The human development indicator (HDI) reflects a country's innovative and absorptive capacity. We combined these two indicators into one single variable, which is similar to the United Nation's Human Development Indicator, except that it does not include per capita GDP in order to avoid serial correlation in the regression equation. Longer life expectancy is closely related to better health conditions, a foundation for faster productivity growth. A better educated labor force is equipped with the necessary knowledge and skills to enhance the productivity in the production process.

[5] Ideally, we want to use the TFP and capital services level of the initial year to test convergence. Since the Total Economy Database does not provide level data on TFP, labor productivity measures as output per worker is used instead in the specification.

- While emerging and developing economies benefit a lot from adopting technologies developed elsewhere, mature economies gain faster productivity growth by innovating. In both cases, R&D spending is crucial in fostering productivity growth.
- Corrupt economies are prone to misallocation of resources, as investment decisions can be heavily influenced by wasteful rent seeking and a distorted bureaucracy.[6] Lack of transparency and accountability have the potential not only to lead to irresponsible investments resulting in misallocation of capital, but can also strangle innovation, and, therefore, corruption is expected to impact productivity negatively.[7]
- In order to account for cyclicality, we include the growth rate of capital services in the last year of the previous period in the TFP and capital services equations. This variable has a negative and significant effect on TFP growth whereas it is positive and significant for capital service growth rate.
- The dependency ratio has a negative effect on the saving rate as the non-working-age population typically does not earn an income and are major consumers of education and health care.
- The negative relationship between the share of the services sector in an economy and the saving rate probably results from the larger presence of government funded social services, education and health care, causing people to have less precautionary savings.
- The real exchange rate $R\_XR$ is measured as:

$$R\_XR = \left(\frac{P_f}{P_d}\right) e \tag{11}$$

where $P_f$ and $P_d$ are the price levels in the foreign and domestic country respectively, $e$ is the exchange rate expressed as domestic currency per unit of foreign currency. Domestic and foreign prices are approximated using consumer price deflators. An increase in the real exchange rate reflects a depreciation of the currency, and a decline an appreciation, both corrected for inflation. The real exchange rate explains to what extent more or fewer goods and services can be purchased abroad (after conversion into a foreign currency) than in the domestic market for a given amount. An appreciation of

[6] Mauro (1995), among others, show a negative impact of corruption on investment/GDP ratio.
[7] Note that we transform the corruption variable obtained from the source data. In the source data, the corruption indicator ranges from -2.5 to +2.5, where -2.5 indicates weak governance (or high corruption) and +2.5 indicates strong government (or low corruption). This suggests that higher the value of corruption indicator, higher the productivity growth we expect to see. To make regression results read easy, we transform the variable to positive numbers, by taking 2.6 minus the source data, so that we expect a negative coefficient.

the real exchange rate shifts production from traded to non-traded goods, as domestic goods become dearer for foreign consumers, and imports becomes cheaper for domestic consumers. This will hamper productivity and competitiveness of the domestic tradable sector, thus reducing the overall productivity growth of the economy (hence a negative relationship between exchange rate appreciation and productivity)—this is the famous Dutch disease hypothesis. Furthermore, an appreciated real exchange rate affects domestic saving, as it tends to reduce saving and thus depress growth by hampering capital accumulation. While our results suggest positive effects in both cases – i.e. appreciation of currency reduces both productivity and saving – it is significant only in the saving equation. The relationship between real exchange rate and TFP is debatable, as one can question whether TFP affects the exchange rate (the famous Balassa-Samuelson Effect) or the other way. In any case, the lack of significance in our model alone is not enough to lend support to the Balassa-Samuelson hypothesis.

- The standard deviation of inflation in the capital services equation is used as a proxy for the stability of the macroeconomic environment. Even though it has the expected negative sign, so that unstable macroeconomic conditions are expected to deter investment and consequently growth in capital services, it is not significant.
- As labor costs rise, demand for capital is likely to increase due to possible substitution effects. With a positive coefficient for wage growth, our results confirm this hypothesis.
- Energy use is a proxy for capacity utilization. If a large part of the current capital stock is underutilized, firms are unlikely to increase investment, which explains the positive relationship.
- Nominal interest rates—a measure of the price of investment—have a negative and significant effect on the growth of capital services.
- Economic globalization has a positive and significant effect on capital services, as it facilitates cross-border investment and trade flows.

*Table 4: Regression estimation results*

| Independent Variables | TFP growth | | Saving rate | | Capital Services growth | |
|---|---|---|---|---|---|---|
| $\Delta \ln TFP_{t-1}$ | 0.188 (5.10) | *** | | | | |
| $\ln LP_{t-1}^{US}$ | -0.631 (-3.26) | *** | | | | |
| $COR_t$ | -0.423 (-2.28) | ** | | | | |
| $\Delta \ln R\&D_t$ | 0.0312 (2.85) | *** | | | | |
| $HDI_t$ | 0.473 (0.76) | | | | | |
| $\Delta \ln ICT\_KL_t$ | 0.0310 (1.91) | * | | | | |
| $\ln R\_XR_t$ | 0.0486 (1.32) | | 0.583 (3.87) | *** | | |
| $\Delta \ln PREV\_K$ | -0.295 (-10.06) | *** | | | 0.520 (19.01) | *** |
| $DEP_t$ | | | -0.186 (-4.84) | *** | | |
| $\ln GDP\_PC_{t-1}$ | | | 6.768 (7.82) | *** | | |
| $\Delta \ln GDP_{t-1}$ | | | 0.919 (6.91) | *** | | |
| $SERVICES_t$ | | | -0.515 (-9.42) | *** | | |
| $SAVING_t$ | | | | | 0.0723 (4.75) | *** |
| $DPRN_t$ | | | | | -0.187 (-2.22) | ** |
| $\ln KL_{t-1}$ | | | | | -0.889 (-7.07) | *** |
| $\Delta \ln WAGE_t$ | | | | | 0.0883 (3.94) | *** |
| $\Delta \ln ENERGY_t$ | | | | | 0.193 (6.69) | *** |
| $Z\_INFL_t$ | | | | | -0.0908 (-0.82) | |
| $\ln ECO\_GLOB_t$ | | | | | 0.205 (0.58) | |
| $IR_t$ | | | | | -0.00982 (-2.20) | ** |
| Constant | 0.0252 (0.01) | | -7.323 (-0.68) | | 5.221 (3.37) | *** |
| R-squared | 0.34 | | 0.57 | | 0.77 | |

*Notes:* The system of equations is estimated by the 3SLS (three-stage least squares) method; Number of observations: 483; * significant at 10%; ** significant at 5%; *** significant at 1%.

# 5. Trend growth projections

## 5.1 The exogenous variables underlying the projections

Equations (6) – (8) are estimated using period averages in the historical data from periods 1 to 7 (see table 3). The estimated coefficients are then used to derive projections for TFP and capital services growth. Table 5 outlines the sources used for the historical data and the assumptions underlying the projections. Note that this provides a broad overview of the sources used. For example, in some cases the historical data may be only available until 2016, which means projections begin in 2017 onwards. In other cases, country specific sources were used, for example in the case of Taiwan.

*Table 5: Sources of data for independent variables*

| Independent Variables | Source of the data | |
|---|---|---|
| | 1979-2018 | 2019-2028 |
| Category 1 variables | | |
| *HDI* | Schooling: Wittgenstein; Barro-Lee<br>Life expectancy: UN Population Division | Schooling: Wittgenstein; Barro-Lee<br>Life expectancy: UN Population Division |
| *DEP* | UN Population Division | UN Population Division |
| Category 2 variables | | |
| *TFP* | The Conference Board Total Economy Database (adjusted version), November 2018 (TED) | Estimated by the model |
| $LP^{US}$ | TED | Estimates based on projected GDP growth and labor quantity (see sections 2 and 3.1) |
| *KL* | TED | Linear trend assumed using the 2006-2016 period |
| *ICT_KL* | TED | Linear trend assumed using the 2006-2016 period |
| Category 3 variables | | |
| *COR* | World Bank, Worldwide Governance Indicators; Transparency International | Moving average of previous 5 years |
| *R&D* | OECD, UNESCO, Eurostat, investment prices from TED | Moving average of previous 5 years |
| *R_XR* | IMF, World Economic Outlook | IMF, World Economic Outlook; OECD Economic Outlook long-term baseline projections July 2018 |
| *SAVING* | UN National Account Statistics; World Bank World Development Indicators | Estimated by the model |
| *GDP_PC* | TED | Estimates based on projected GDP growth (see section 2) and projections of population obtained from the UN Population Division |
| *GDP* | TED | Estimates based on projected GDP growth (see section 2) |
| *SERVICES* | UN National Account Statistics; World Bank World Development Indicators | Economist Intelligence Unit |
| *K* | TED | Estimated by the model |
| *DPRN* | TED | Linear trend assumed using the 2006-2016 period |
| *WAGE* | TED | In-house projections |
| *ENERGY* | International Energy Statistics | BP Energy Outlook – 2018 edition |
| *Z_INFL* | IMF, World Economic Outlook | IMF, World Economic Outlook; OECD Economic Outlook long-term baseline projections July 2018 |
| *ECO_GLOB* | KOF Swiss Economic Institute Globalization Index data | Linear trend of regional aggregates assumed using the 2005-2015 period applied to individual country estimates |
| *IR* | IMF, International Financial Statistics; OECD statistics | OECD Economic Outlook long-term baseline projections July 2018 |

The first category includes variables whose values for the projection period 2019-2028 can be ascertained by a reasonable amount of certainty, at least over the timeframe of the next ten years. Some of these variables are partly included in others, such as employment being part of labor productivity growth.

The second category includes lagged variables whose long-term values need to be calculated based on medium-term projections: lagged TFP growth, lagged labor productivity and lagged capital deepening. The period 10 value of the first two lagged variables are obtained using the projected value of period 9. The lagged labor productivity level in period 10 is calculated using labor productivity growth, calculated as the difference between GDP growth and employment growth. GDP growth in period 9 is obtained using projected capital services and TFP growth as explained above. The lagged capital deepening in period 9 is calculated based on the projected growth of capital services in period 9 and the projected growth of the employed population.

The third category includes contemporary variables whose period 8 and 9 values are subject to judgment. In some cases, we used projections from the IMF or the OECD, in other cases we assumed a linear trend or a moving average of the previous 5 years and finally in some cases we relied on our own expert assessment.

The lagged values of the relative level of labor productivity—a measure of convergence or catch up—are excluded for a selected number of advanced economies, which seem to have reached a critical level of per capita income, from which they have not moved significantly over the last 20 years.[8] Therefore, it is unlikely that these countries will further improve their productivity due to their catch-up potential. Indeed, they may have other country or region-specific factors that allow them to achieve higher productivity growth, which are captured by dummy variables, but it is unlikely that they will see a productivity level impact. Given the fact that our model is a global model, where we have countries with extremely low levels of productivity (e.g. less developed economies in Asia and Africa), and hence substantial catch-up potential, it is important to include the catch-up variable in the model. For the same reason, it is also likely that the catch-up coefficient will be highly influenced by the presence of these low-income countries as it is a mean regression.

## 5.2 Adjusting trend growth rates for remaining output gaps

The projected GDP growth rates based on the growth accounting framework are to be interpreted as trend growth rates. In the long run, countries grow according to their trend. In the short run, however, countries may deviate from their long-run path due to temporary factors,

[8] The countries for which the lagged values of the relative level of labor productivity are excluded are: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom

such as business cycle dynamics. Occasionally, shocks can also occur which have a deep impact on the structure of the economy beyond the business cycle and thereby permanently changing the course of its long-run trend.

As a prime example, the 2008-09 recession created a large gap in most mature economies between the actual output level and what could have been produced if the economy had stayed on the trend. In contrast, some major emerging economies have grown beyond their growth trend in the past few years. Therefore, we adjust the 2019-2023 model produced growth rates for remaining output gaps (positive or negative). We make a distinction between average projected growth (trend growth) between 2019 and 2023 and the potential growth rate of the economy averaged over those years. In the long run these two measures are assumed to converge.

Assuming that the potential output in a country grows at the model projected trend growth rates, we estimate the required growth rate for a country to close its current (2018) output gap by the end of the first projection period (2023). For instance, as the United States economy is deemed to have a negative output gap (current economy is above potential), this means the model produced growth rate is lowered over the 2019-2023 period. Table 5 provides an overview of the output gap assumptions that feed into our model. The difference between projected growth and output-gap adjusted growth is allocated to TFP.

*Table 5: Output gap assumptions for the medium-term projections*

| Country | Output gap in 2018 | Source | Year in which output gap closes | Model projected growth 2019-2023 | Forecast growth rate 2019-2023 | Difference |
|---|---|---|---|---|---|---|
| Australia | 0.4 | IMF | 2023 | 2.8 | 2.9 | 0.1 |
| Austria | -0.8 | IMF | 2023 | 1.9 | 1.7 | -0.2 |
| Belgium | -0.1 | IMF | 2023 | 1.8 | 1.7 | 0.0 |
| Canada | -0.2 | IMF | 2023 | 2.3 | 2.2 | 0.0 |
| Chile | 1.7 | OECD | 2023 | 3.0 | 3.4 | 0.4 |
| Cyprus | 1.0 | IMF | 2023 | 2.4 | 2.6 | 0.2 |
| Czech Republic | -1.2 | ECFIN | 2023 | 1.6 | 1.3 | -0.2 |
| Denmark | -0.7 | IMF | 2023 | 1.7 | 1.6 | -0.1 |
| Finland | 0.2 | IMF | 2023 | 2.0 | 2.0 | 0.0 |
| France | 0.6 | OECD | 2023 | 1.5 | 1.6 | 0.1 |
| Germany | -0.6 | BDF | 2023 | 1.8 | 1.7 | -0.1 |
| Greece | 5.7 | IMF | 2023 | 1.8 | 3.0 | 1.2 |
| Hungary | -2.0 | OECD | 2023 | 2.1 | 1.7 | -0.4 |
| Iceland | -2.9 | OECD | 2023 | 2.7 | 2.1 | -0.6 |
| Ireland | -1.8 | IMF | 2023 | 3.6 | 3.3 | -0.4 |
| Israel | -0.2 | OECD | 2023 | 3.5 | 3.5 | 0.0 |
| Italy | 0.8 | IMF | 2023 | 0.7 | 0.8 | 0.2 |
| Japan | -1.8 | BOJ | 2023 | 1.7 | 1.4 | -0.4 |
| Luxembourg | -0.1 | IMF | 2023 | 3.1 | 3.0 | 0.0 |
| Malta | -0.8 | IMF | 2023 | 3.0 | 2.8 | -0.2 |
| Mexico | -0.3 | OECD | 2023 | 2.2 | 2.1 | -0.1 |
| Netherlands | -0.8 | IMF | 2023 | 2.0 | 1.8 | -0.2 |
| New Zealand | -0.2 | IMF | 2023 | 3.5 | 3.4 | 0.0 |
| Norway | 0.2 | IMF | 2023 | 2.4 | 2.4 | 0.0 |
| Poland | -1.8 | OECD | 2023 | 2.1 | 1.7 | -0.4 |
| Portugal | -0.1 | IMF | 2023 | 1.7 | 1.6 | 0.0 |
| South Korea | 0.7 | IMF | 2023 | 3.3 | 3.4 | 0.1 |
| Spain | 1.1 | IMF | 2023 | 1.4 | 1.6 | 0.2 |
| Sweden | -0.6 | IMF | 2023 | 2.1 | 2.0 | -0.1 |
| Switzerland | 1.3 | OECD | 2023 | 1.6 | 1.8 | 0.3 |
| United Kingdom | -0.5 | OECD | 2023 | 1.4 | 1.3 | -0.1 |
| United States | -0.4 | CBO | 2023 | 2.3 | 2.2 | -0.1 |

*Notes:* The output gap is measured as the difference between potential and actual GDP, expressed as a percent of potential GDP.
*Source:* The Conference Board Global Economic Outlook 2019; IMF World Economic Outlook October 2018; OECD Economic Outlook July 2018; CBO-Congressional Budget Office, August 2018; BOJ-Bank of Japan Output Gap and Potential Growth Rate, October 2018; BDF-Bundesministerium der Finanzen Produktionspotential und Konjunkturkomponenten October 2018.

## 6. Distinguishing between capital quantity and quality

Capital quality measures to what extend an economy increases its share of highly productive assets, such as general machinery, transport equipment and information and communication technology assets. It is a measure of capital composition, highlighting the effect of the changing composition of assets towards such highly productive ones. As such, our model does not project the capital composition, rather we make use of the historical relationship between capital stock and capital quality to derive capital quality for the projection period as:

$$\Delta \ln KQ_{j,t} = \frac{\Delta \ln KQ_{j,t-1}}{\Delta \ln KS_{j,t-1}} * \Delta \ln KS_{j,t} \qquad (12)$$

where $KQ$ is the quality (or composition) of capital stock and $KS$ is the aggregate capital stock.

## 7. Closing remarks

Projecting future growth is an ambitious undertaking. The only way we can forecast the future is to begin with looking at past performance, supplemented by assumptions on output gaps and some of the future trends in underlying variables. The results will therefore crucially depend upon the assumptions we make regarding the relationships between GDP growth and various factors that are expected to influence growth as well as assumptions about the near-term cyclical factors acting on these economies.

The growth accounting framework provides a good starting point for projecting output growth in the medium and long term. It uses information from projected factor inputs—capital, labor and productivity—to project output growth. Therefore, the final projection results are strongly dependent on the approach to estimate factor inputs, particularly capital and total factor productivity growth rates. We believe that our methodology, combining simple growth accounting and regression analysis using economic variables, is a useful tool in understanding the sources of growth and the drivers of change over time.

## References


Chen, V., B. Cheng, G. Levanon, A. Ozyildirim and B. van Ark. (2012) “Projecting Global Growth”, *The Conference Board Economics Program Working Paper Series*, EPWP #12 – 02.

Corrado, C., J. Haskel, and C. Jona-Lasinio. (2014) "Knowledge Spillovers, ICT and Productivity Growth", *The Conference Board Economics Program Working Paper Series* EPWP #14 – 02.

Erumban, A.A, and K. de Vries (2015) “Global Growth Projections for The Conference Board Global Economic Outlook 2016, *The Conference Board Economics Program Working Paper Series*, EPWP #15-02.

Erumban, A.A, and K. de Vries (2016) “Global Growth Projections for The Conference Board Global Economic Outlook 2017, *The Conference Board Economics Program Working Paper Series*, EPWP #16-07.

Jorgenson, D.W, F.M. Gollop, and B. M. Fraumeni. (1987) “Productivity and U.S. Economic Growth”, Cambridge MA: Harvard University Press.

Jorgenson, D.W, M. S. Ho, and K. J. Stiroh. (2005) “*Productivity, Volume 3: Information Technology and the American Growth Resurgence*, MIT Press.

Jorgenson, D.W, and K. Vu. (2009a) “Projecting world economic growth: The contribution of information technology”, *The Review of Socionetwork Strategies*, 3 (2), 35-49.

Jorgenson, D.W, and K. Vu. (2009b) “Growth Accounting within the International Comparison Program,” *ICP Bulletin*, 6 (1), 3-19.

Jorgenson, D.W, and K. Vu. (2013) “The Emergence of the new economic order: Growth in the G7 and the G20”, *Journal of Policy Modelling*, 35(3).

Mauro, P. (1995) “Corruption and Growth”, *Quarterly Journal of Economics*, 110, 681-712.

## Data Sources

Barro, R. J., and Lee, J. W. (2010). "A new data set of educational attainment in the world, 1950–2010". *Journal of Development Economics*, vol 104, 184-198. Data is available from http://barrolee.com and last revised in July 2018

Dreher, Axel, Noel Gaston and Pim Martens (2008), Measuring Globalisation – Gauging its Consequences (New York: Springer). KOF index data available from: http://globalization.kof.ethz.ch/

Eurostat: http://ec.europa.eu/eurostat/data/database

Independent Statistics & Analysis, U.S. Energy Information Administration, International Energy Statistics, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm

Methodology of the 2015 edition: ILO Labour Force Estimates and Projections: 1990-2050 (2015 edition), available from: http://www.ilo.org/ilostat-files/Documents/LFEP%20Methodology%202015.pdf

International Monetary Fund – International Financial Statistics, http://elibrary-data.imf.org/finddatareports.aspx?d=33061&e=169393

International Monetary Fund, World Economic Outlook Database, October 2018, http://www. imf.org/external/ns/cs.aspx?id=28

Organization for Economic Co-Operation and Development (OECD) – StatExtracts http://stats.oecd.org/

The Conference Board *Total Economy Database*™, November 2018, http://www.conference-board.org/data/economydatabase/

The World Bank (2018), World Development Indicators, http://data.worldbank.org/data-catalog/world-development-indicators

The World Bank (2018), The Worldwide Governance Indicators (WGI) Project, http://info.worldbank.org/governance/wgi/index.aspx#home

Transparency International–Corruption Perceptions Index, http://www.transparency.org/

UNESCO Statistics on Research and Development, http://www.uis.unesco.org/ScienceTechnology/Pages/research-and-development-statistics.aspx

United Nations National Account Statistics, https://unstats.un.org/unsd/snaama/Introduction.asp

United Nations, Department of Economic and Social Affairs, World Population Prospects: The 2017 Revision, http://esa.un.org/unpd/wpp/index.htm

Wittgenstein Centre for Demography and Global Human Capital. Wittgenstein Centre Data Explorer Version 1.2, www.wittgensteincentre.org/dataexplorer