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Global Growth Projections for The Conference Board Global Economic Outlook 2017

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Abstract

This paper presents the methodology for The Conference Board Global Economic Outlook 2017 which includes growth projections for 11 major regions and individual estimates for 33 mature and 32 emerging market economies for 2017, 2017-2021, and 2022-2026. 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 information on demographic changes and work force participation rates, capital input and total factor productivity growth are econometrically estimated using a wide range of related variables during past periods. Even though the model is predominantly a supply side one, it also considers demand side elements such as savings, and socio-economic variables such as life expectancy and educational attainment. In order to account for the potential impact of trends in globalization on future economic growth, we also incorporate measures of globalization, where exports and imports – two other demand side indicators – enter as key elements. This year's outlook also includes adjustments for the impact of rapidly falling prices of information and communication technology (ICT) goods on investment and GDP. The trend growth rates that are obtained from the estimated model are adjusted for possible deviations between actual and potential output in the short run.

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*© The Conference Board, Inc. 2016. Corresponding author: Abdul A. Erumban, abdul.erumban@conferenceboard.org. We would like to thank the entire economics research team of The Conference Board for helpful comments, suggestions and data. In particular, we would like to thank Bart van Ark, Ataman Ozyildirim, Gad Levanon, Eliza Winger, Jing Sima, Yuan Gao, Ilaria Maselli, Brian Schaitkin and Harry Wu for their comments and help at various stages. All remaining errors are ours. The views expressed in this paper are those of the author(s) and do not necessarily represent those of The Conference Board.

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1. Introduction

1.1 Projecting global economic growth

Since 2008, The Conference Board publishes an annual global economic outlook, projecting GDP growth for 65 countries using growth accounting techniques.[1] The basic framework builds on the work of Dale Jorgenson and colleagues, including Jorgenson, Ho and Stiroh (2005) and Jorgenson and Vu (2009 a and b). Over the years The Conference Board extended and improved the projection methods by refining the underlying model and expanding the pool of historical data.

This paper describes the methodology and sources underlying the projections of growth of Gross Domestic Product in the 2017 edition of *The Conference Board Global Economic Outlook* (GEO). The projection methodology used in the 2017 GEO is an expanded version of the methods implemented in the 2016 edition of the outlook.[2] The predictive model in the 2016 version has been improved substantially by including more theoretically pertinent explanatory variables in the productivity and capital services equations and also by allowing for regional differences in the intercept. By including regional dummies in the model, we allow the model to capture any region specific factors, which are otherwise not captured by our global model.

The most important quantitative change in the current version compared to last year is improved estimates of information and communication technology (ICT) capital. In addition to improved estimates of underlying investment data for ICT assets—hardware, software and communication equipment—new measures of ICT prices which show a faster decline relative to official measures are used to more accurately capture the contribution of ICT to growth.[3] Since the ICT investment component of GDP is deflated using the above-mentioned alternative ICT deflators, to maintain consistency of the national income identity, a corresponding adjustment is applied to GDP deflator as well for countries with significant ICT production and trade. This revision has been applied to 10 countries, Singapore, Malaysia, Philippines, Ireland, Taiwan, South Korea, Japan, United States, Canada and China, and the net impact is an upward revision in their GDP growth rates (see section 2.3.2 for a discussion on this adjustment).

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[1] Earlier editions of the GEO included 55 countries, while since 2015 the country coverage has been expanded to include 10 additional emerging market economies.

[2] See Erumban and de Vries (2015), which builds upon Chen, V., B. Cheng, G. Levanon, A. Ozyildirim and B. van Ark (2012).

[3] See Erumban, de Vries and Inklaar (2017) for a detailed discussion on the construction of ICT investment and Byrne and Corrado (2016a, 2016b) for discussion on ICT deflators.

The projections in this paper cover the period 2017-2026, with separate projections for the medium term (2017-2021) and the long term (2022-2026). The outlook covers 65 major economies across 11 regions, including 33 mature economies (the United States, Europe, Japan and other mature economies) and 32 emerging and developing economies. Section 1.2 provides an overview of main results of the 2017 outlook. Section 2 describes how trend growth is estimated on the basis of an extrapolated growth accounting model which projects the various growth components of the production function. 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 2.1) are based on projections of employment (2017-2020) and labor force participation rates (2021-2026) from the International Labor Organization (ILO, 2015), combined with working-age population projections from the United Nations (UN, 2015). The measures on labor composition (Section 2.2) are based on projections of educational attainment by the Wittgenstein Centre for Demography and Global Human Capital (2015) and Barro-Lee (2014). Capital services and total factor productivity (Section 2.3) 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, which are presented in Section 2.4.

The projected GDP 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.[4] In the short run, however, countries deviate from their long-run path due to temporary fluctuations primarily due to business cycle 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. Section 3 describes the medium-term adjustments to the trend growth estimates obtained from the extrapolated growth accounts. Section 3 compares our GDP growth projections with those from other studies, and section 4 concludes.

[4] Our 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", as our estimates are essentially derived from past growth trends.

1.2 Overview of the main results

1.1.1 A stagnating trend

The outlook for 2017 and beyond shows a continuation of stagnant global growth (Table 1). [5] Global growth in real GDP has dropped off to 2.5 percent in 2016 – its lowest rate since the end of the global recession in 2009, and is likely to increase only marginally to 2.8 percent in 2017. Among the larger economies, the United States is expected to see somewhat faster growth of 2 percent in 2017 compared to 1.6 percent in 2016. The European growth environment remains fragile as downside risks continue to linger after the 2008/09 and 2012/13 recessions. During the last five years, Euro Area average GDP growth was just 0.5 percent. The region is expected to see a 1.4 percent growth rate in 2017, somewhat below the 1.5 percent growth in 2016.

Emerging markets are on a declining growth path, as their growth engines sputter because of declines in commodity and energy prices as the commodity super-cycle comes to an end, reversal of capital flows and the exhaustion of their catch-up potential. While growth in emerging and developing economies was quite strong immediately after the 2008/09 crisis with 5 to 8 per cent growth in 2010 and 2011, since then it has shown a declining trend in the range of 3 to 4 percent. Given the weak conditions in the global economy, and the time lag by which reforms pay off in terms of faster growth, there is little scope for emerging economies to accelerate their growth performance much in the next few years. The year 2017 is likely to end up at a growth rate of 3.6 percent average growth rate compared to 3.2 percent in 2016.

Looking beyond 2017, the global economy is likely to continue the stagnant growth at about 3.0 percent for 2017-2021 even slowing down to 2.7 percent on average between 2022-2026. Mature economies are likely to grow at 2.1 percent and 1.8 percent and emerging markets at 3.7 percent and 3.5 percent for the respective projection periods. Growth for the U.S between 2017 and 2021 is projected to be 2.2 percent, which is likely to decline marginally to 2.0 percent during 2022-2026. The long-run growth in Euro Area will decline from 1.7 percent during 2017-2021 to 1.2 percent during 2022-2026, as the declining work force and the increase in ageing of the population further add to long-run downside risks.[6] The growth slowdown in the emerging markets will be driven primarily by two largest economies in the region, China (from 3.3 percent to 2.9 percent) and India (from 5.8 percent to 5.5 percent).

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[5] For a more complete analysis of the Global Economic Outlook, visit our website to gain access to the reports associated with the 2017 outlook, which are StraightTalk for a global overview and regional reports on Europe, the US and Emerging Asia.

[6] For a comprehensive analysis of labor shortages in mature economies, see Levanon et al. (2016).

Table 1: Projected GDP growth by region, 2016, 2017, 2017-2021, 2022-2026 (%)

	2016	2017	2017-2021	2022-2026
United States	1.6	2.0	2.2	2.0
Europe*	1.6	1.4	1.7	1.3
Of which: Euro Area	1.5	1.4	1.7	1.2
Japan	0.9	0.6	1.2	0.8
Other Mature**	3.0	3.0	3.4	2.8
MATURE ECONOMIES	1.7	1.8	2.1	1.8
China	3.9	3.8	3.3	2.9
India	6.8	6.5	5.8	5.5
Other Developing Asia	5.1	5.0	5.0	4.5
Latin America	-1.3	1.2	2.6	2.7
Of which: Brazil	-3.8	0.0	1.9	2.3
Of which: Mexico	2.4	2.6	4.0	3.8
Middle East & North Africa	3.7	2.7	3.3	3.3
Sub-Saharan Africa	1.7	2.3	4.8	5.1
Russia, Central Asia and Southeast Europe***	0.0	2.0	1.6	1.0
EMERGING MARKETS AND DEVELOPING ECONOMIES	3.2	3.6	3.7	3.5
WORLD	2.5	2.8	3.0	2.7

Notes: GDP growth is revised upward to reflect faster declines in alternative ICT prices for 10 countries with significant ICT production and trade, including Singapore, Malaysia, Philippines, Ireland, Taiwan, South Korea, Japan, the United States, Canada, and China; Growth rates for China reflect The Conference Board's own estimates; Projections are based on trend growth estimates, which – for the period 2017-2021 – are adjusted for remaining output gaps; Europe includes European Union -28 as well as Switzerland, Iceland and Norway; Other mature economies are Australia, Canada, Israel, Hong Kong, South Korea, New Zealand, Singapore, and Taiwan; Russia, Central Asia, and Southeast Europe include projections for Russia, Kazakhstan, Turkmenistan, Uzbekistan, Belarus, and Turkey.
Source: The Conference Board Global Economic Outlook 2017.

1.1.2 Alternative GDP growth rates for China

An important feature of the The Conference Board Global Economic Outlook is that it uses alternative GDP figures for China. Based on Wu (2014), growth rates of Chinese industrial GDP are adjusted for misreporting bias and non-material services GDP are adjusted for biases in price deflators.[7] These adjustments suggest that, even though the Chinese economy has been growing slower than the official numbers for a longer period of time, the gap between official and alternate series has widened in the recent years. China's economy grew much slower than the official estimates suggest in the recent years. During the last five years, our estimates suggest an

[7] For a detailed discussion on this adjustment, see Wu (2014) and for frequently asked questions on the China adjustment see China GDP FAQ. The series have been updated by Wu in the Spring of 2016.

average growth of 5.3 percent which is substantially lower than the official estimate of 7.4 percent. In 2016, we project China to see an average growth of 3.8 percent, which is indeed lower than the official target range of 6.5 to 7 percent. In the medium term (2017-2021) the model suggests a growth of 3.3 percent, slowing down to 2.9 percent between 2022-2026. The change in China's growth estimates has important implications for our assessment of the growth rate of the global economy in general and that of the emerging markets in particular. It reduces global growth of the last five years by about 0.2 percentage point on average, and by 0.5 percentage point for 2016. For emerging markets as a whole, The China GDP growth adjustment reduces the growth rate of emerging markets' GDP by about 0.4 percent on average during the last five years.

2. Medium- and long term projections for 2017-2021 and 2022-2026

2.1 The growth accounting framework

The medium- and long-term projections which form the basis of The Conference Board Global Economic Outlook are based on the growth accounting framework as developed in Jorgenson, Gollop and Fraumeni (1987) and more recently in Jorgenson, Ho and Stiroh (2005) and Jorgenson and Vu (2009b). The growth accounting methodology is based on 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:

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

Where Y is gross domestic product, L is labor quantity, Q is the composition of the labor force based on educational attainment, K is capital services, A is total factor productivity. 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:

$$\Delta lnY_t = \Delta lnA_t + \bar{v}_{L,t}\Delta lnL_t + \bar{v}_{L,t}\Delta lnQ_t + \bar{v}_{K,t}\Delta lnK_t \tag{2}$$

In the above equation, growth of output in a given year t ($\Delta ln\mathrm{Y}_t$) is decomposed into the contributions of total factor productivity growth ($\Delta ln\mathrm{A}_t$), labor ($\Delta ln\mathrm{L}_t$), labor composition

($\Delta ln\text{Q}_t$) and capital services ($\Delta ln\text{K}_t$).[8] 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 Gross Domestic Product averaged over the last two years:

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

and

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

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 (wage rate), P_K the price of capital (rental price) and P_y the price of output. Under the assumption of constant returns to scale, the cost shares of labor and capital sums 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 requires projections of each individual input component and TFP growth on the right hand side of equation (2). Our projection covers the medium term period (2017-2021) and a longer term period (2022-2026) for 33 mature economies and 32 major emerging economies.

2.2 Measuring the growth of labor input

2.2.1 Growth of labor quantity

The growth in labor quantity for our projection periods are based on projections of employment (2017-2020) and labor force participation rates (2021-2026) sourced from the ILO (2015) and the growth of the working-age population from the UN (2015).[9] While population growth can be projected with a certain degree of accuracy, predictions on labor force participation have a greater degree of uncertainty as they are affected by unpredictable factors such as policy changes like retirement plans, cultural changes, such as preferences for work vs. leisure, as well as cyclical fluctuations.

Mature economies in general are expected to see tight labor markets in the coming decade, as looming labor shortage in these economies are likely to exert wage pressures. While several of the mature economies will see a shrinking working-age population, others are expected to see only a negligible increase (see table 2). The United States will see a 0.5 percent

[8] In this paper, all growth rates are calculated as the difference in the log of the levels of each variable unless otherwise specified.
[9] The range of ages used in defining working-age population often differs from country to country. However, to be consistent across countries, we use the most common definition of population of age 15 to 64.

annual average growth rate of its employed population during the next five years, which is the fastest growth rate among the larger mature economies. Employment growth in a number of European economies, as well as in Japan, is already projected to become negative between 2017 and 2021, putting downward pressure on output growth.

Among the emerging economies, China and Russia are part of a group of countries that are expected to witness a contraction of their labor force, and a consequent decline in employment, during 2017-2021 (see table 2). China, where economic growth has thus far been fueled by cheap and abundant labor, will see its employment growth decline at a faster rate (-0.5) between 2022 and 2026. Thailand and Belarus are also likely to join this group of countries with declining demographic dividend in the longer term. India, on the other hand, still enjoys a demographic dividend, registering 1.7 percent annual growth in its projected employment during 2017-2021, with a marginal decline to 1.4 percent during 2022-2026. However, translating India's demographic dividend into economic growth is constrained by a severe lack of skills and education of its workforce (Das et al, 2016). Several other Asian economies are also likely to witness similar skill challenges in the coming years (Levanon et al, 2016). Most other emerging market economies still have demographic dividends as their labor force continues to grow though the pace of growth will slow in the long term, with the possible exception of sub-Saharan Africa.

2.2.2 Growth of labor composition

To measure labor's effective contribution to output growth, an adjustment for changes in the composition of the labor force in terms of different skill-levels is needed in addition to the change in labor quantity (section 2.2.1). The change of labor composition is constructed on the basis of weighted measures of different skill-level groups (low, medium and high skilled workers based on educational attainment) in the labor force:

$$\Delta lnQ_t = 0.5 * \sum_i (v_{i,t} + v_{i,t-1})(lnh_{i,t} - lnh_{i,t-1}) \quad (5)$$

where v_i is the compensation share of i^{th} labor type (where i=low, medium and high skilled) in total labor compensation and h_i is the share of i^{th} labor type in total hours worked. For a detailed methodology describing the construction of the labor composition data, please refer to Bonthuis (2011).

The projection data used in equation (5) are based on projections of population by level of educational attainment by the Wittgenstein Centre for Demography and Global Human Capital (2015) and Barro-Lee (2014). In general, labor composition is relatively stable over time. Consequently, the direct contribution from the growth of labor composition to total output growth is quite small. However, a well-educated labor force can improve productivity by enabling better utilization of equipment, adoption of advanced technologies, and improvement of production processes, thereby contributing to output growth via an additional channel. There is also a likely complementarity with investment in intangible capital, such as R&D and organizational changes, which will also enhance productivity (Corrado, Haskel and Jona-Lasinio, 2014).

2.2.3 The share of labor income in GDP

In order to measure the contribution of labor quantity, labor composition and capital services to GDP growth using the growth accounting model, relative weights of labor and capital are required. Under neoclassical assumptions, these weights can be approximated by compensation shares of labor and capital in total nominal GDP. Since capital incomes are unobservable, they can be obtained as a residual after subtracting labor incomes from GDP, which is data that is however typically not directly available for most countries.

Historical data on observed labor income shares, including estimates of compensation to self-employed workers, are taken from The Conference Board Total Economy Database. Our data shows a decline in the labor share in many advanced economies over a long span of time, which contrasts Gollin's (2002) assumption of relatively constant labor income shares across time and countries. For instance the labor income share in GDP in the United States has declined from 64 percent in 1970 to 59 percent in 2015. We find that, compared to mature economies, labor shares are lower in emerging economies because capital is scarcer and more expensive while labor is cheaper. During the period 2006-2015, the average labor share in emerging economies including Mexico, Thailand, China, India and Indonesia, varies from 30 to 52 percent while the variation in mature economies such as Switzerland, France, Germany, Denmark, United States, and the United Kingdom, is between 57 to 74 percent. For the projection period, we assume a constant labor share based on the last year of data.

Table 2: Growth of labor quantity and labor composition and the labor share, 2017-2021, 2022-2026

Country	Region	Growth of labor quantity (% change) 2017-2021	2022-2026	Growth of labor composition (% change) 2017-2026	Labor share (%) 2017-2026
MATURE ECONOMIES					
United States	United States	0.5	0.2	0.3	57
Austria	Europe	0.1	-0.6	0.3	58
Belgium	Europe	0.4	-0.2	0.5	66
Cyprus	Europe	1.7	0.5	0.5	49
Czech Republic	Europe	-0.2	-0.4	0.2	49
Denmark	Europe	0.6	0.2	0.2	58
Finland	Europe	0.0	-0.1	0.5	59
France	Europe	0.4	0.1	0.4	61
Germany	Europe	-0.2	-0.9	0.1	60
Greece	Europe	1.4	-0.5	0.8	52
Hungary	Europe	-0.1	-0.4	0.5	50
Iceland	Europe	0.9	0.3	0.2	64
Ireland	Europe	1.0	0.6	0.3	51
Italy	Europe	0.2	-0.6	0.2	58
Luxembourg	Europe	1.2	0.7	0.5	55
Malta	Europe	0.8	0.0	0.0	53
Netherlands	Europe	0.4	-0.3	0.2	65
Norway	Europe	0.8	0.5	0.3	50
Poland	Europe	-0.4	-0.7	0.3	47
Portugal	Europe	0.0	-0.7	0.9	52
Spain	Europe	0.8	-0.6	0.5	56
Sweden	Europe	0.7	0.3	0.2	51
Switzerland	Europe	0.5	-0.1	0.2	74
United Kingdom	Europe	0.4	0.1	0.4	59
Japan	Japan	-0.5	-0.6	0.4	56
Australia	Other Mature	1.0	0.8	0.3	51
Canada	Other Mature	0.4	0.1	0.4	56
Hong Kong	Other Mature	-0.5	-1.0	0.2	53
Israel	Other Mature	1.4	1.4	0.0	51
New Zealand	Other Mature	0.8	0.3	0.5	52
Singapore	Other Mature	1.1	-0.1	0.9	41
South Korea	Other Mature	0.4	-0.7	0.7	60
Taiwan	Other Mature	-0.2	-1.1	0.2	53

Country	Region	Growth of labor quantity (% change)		Growth of labor composition (% change)	Labor share (%)
		2017-2021	2022-2026	2017-2026	2017-2026
EMERGING AND DEVELOPING ECONOMIES					
China	China	-0.1	-0.5	0.3	52
India	India	1.7	1.4	0.3	41
Indonesia	Other Developing Asia	1.4	0.9	0.3	46
Malaysia	Other Developing Asia	1.7	1.1	0.4	43
Pakistan	Other Developing Asia	2.4	2.3	0.3	50
Philippines	Other Developing Asia	2.1	1.6	0.4	38
Thailand	Other Developing Asia	0.1	-0.5	0.7	41
Vietnam	Other Developing Asia	0.8	0.4	0.2	50
Argentina	Latin America	1.2	1.1	0.3	38
Brazil	Latin America	1.0	0.6	0.3	50
Chile	Latin America	1.0	0.7	0.4	54
Colombia	Latin America	1.4	0.7	0.5	42
Mexico	Latin America	1.7	1.3	0.3	30
Venezuela	Latin America	1.4	1.2	0.3	37
Algeria	Middle East & Northern Africa	1.6	0.9	-0.1	50
Egypt	Middle East & Northern Africa	2.2	1.8	0.5	40
Iran	Middle East & Northern Africa	1.1	0.7	0.4	26
Morocco	Middle East & Northern Africa	1.2	0.9	0.4	49
Saudi Arabia	Middle East & Northern Africa	1.4	1.1	0.0	28
United Arab Emirates	Middle East & Northern Africa	1.1	0.4	0.0	50
Ethiopia	Sub-Saharan Africa	3.4	3.0	0.1	50
Ghana	Sub-Saharan Africa	2.5	2.4	0.1	50
Kenya	Sub-Saharan Africa	3.0	3.1	0.2	64
Nigeria	Sub-Saharan Africa	2.9	3.1	0.2	45
South Africa	Sub-Saharan Africa	1.7	1.1	0.6	48
Tanzania	Sub-Saharan Africa	3.2	3.3	0.1	36
Belarus	Russia, Central Asia and Southeast Europe	-1.2	-1.2	0.0	59
Kazakhstan	Russia, Central Asia and Southeast Europe	0.3	0.2	0.4	38
Russian Federation	Russia, Central Asia and Southeast Europe	-0.8	-0.9	0.0	55
Turkey	Russia, Central Asia and Southeast Europe	1.2	0.8	0.3	33
Turkmenistan	Russia, Central Asia and Southeast Europe	1.4	1.0	0.0	50
Uzbekistan	Russia, Central Asia and Southeast Europe	1.2	1.0	0.0	50

Notes: The growth rates in labor quantity are based on labor force participation rate projections from the ILO and the growth of the working-age population from the United Nations ('2015 Revision of World Population Prospects'). The labor composition projections are mainly based on the projection of population by level of educational attainment by the Wittgenstein Centre for Demography and Global Human Capital (2015) and Barro-Lee (2014).
Source: The Conference Board Global Economic Outlook, 2017

2.3 Measuring the growth of capital services and Total Factor Productivity

2.3.1 Estimating TFP, the savings rate and capital services

Compared to the projections for labor inputs, the development of capital services and Total Factor Productivity (TFP) are subject to a higher degree of uncertainty. The growth contributions are estimated by a system of equations in which uses explanatory variables—both economic and institutional—as suggested by the literature. We estimate three endogenous variables: TFP growth, the savings rate, and capital services growth. It is important to include the savings rate, 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.

In this year's edition of the GEO model we include the real exchange rate in the saving and TFPG equations (see discussion in the next section). In addition, considering the potential role of investment in digital assets on productivity, we include ICT capital deepening in the previous period as an explanatory variable to the TFPG equation (equation 6). We expect ICT capital deepening to have a positive impact on TFPG, as it enhances the quality of capital (see table 3).

The three equations are specified as follows:

$$\Delta \ln TFP_t = \alpha_0 + \alpha_1 \Delta \ln TFP_{t-1} + \alpha_2 lnLP_{t-1}^{US} + \alpha_3 lnCORRUPT_t + \alpha_4 R\&D_t + \alpha_5 HDI_t + \alpha_6 ln\, ICTdeep_{t-1} + \alpha_7 R\_EXR_t + \sum_{i=1}^{n} \alpha_{i+7} R\_DUMMY_i + \varepsilon_{1t} \quad (6)$$

$$SAVING_t = \beta_0 + \beta_1 DEP_t + \beta_2 P\_GDP_{t-1} + \beta_3 \Delta lnGDP_{t-1} + \beta_4 SERVICE_t + \beta_5 R\_EXR_t + \sum_{i=1}^{n} \beta_{i+5} R\_DUMMY_i + \varepsilon_{2t} \quad (7)$$

$$\Delta lnKSERV_t = \gamma_0 + \gamma_1 SAVING_t + \gamma_2 DPN\_RATE_t + \gamma_3 lnKD_{t-1} + \gamma_4 WAGE_t + \gamma_5 ENERGY_t + \gamma_6 SD.INFL_t + \gamma_7 ECO\_GLOB_t + \gamma_8 INTEREST_t + \sum_{i=1}^{n} \gamma_{i+8} R\_DUMMY_i + \varepsilon_{3t} \quad (8)$$

where ΔlnX denotes the log growth rate of variable X over period t and $t-1$, lnX indicates the log level of the variable X. The definition of the variables and the data sources are listed in table 3 below.

Table 3: Definition of variables, expected signs, and data sources

Independent Variables	TFP	Saving	Capital Services	Description	Data sources
$\Delta \ln TFP_{t-1}$	+			Total factor productivity growth in the previous period	Total Economy Database and Projection from TFPG equation
$lnLP^{US}_{t-1}$	-			Log of level labor productivity relative to the United States in the previous period	Total Economy Database
$CORRUPT_t$	-			Change in corruption	World Bank, Worldwide Governance Indicators; Transparency International
$R\&D_t$	+			Growth rate of real R&D spending	OECD, UNESCO, Eurostat
HDI	+			Geometric average of average years of schooling and life expectancy at birth	Schooling: Wittgenstein (2015), Barro-Lee (2014); Life expectancy: UN Population Division (2015), except for Taiwan, which are from Taiwan National development council
$ln\ ICTdeep_{t-1}$	-			Log level of ICT capital deepening in the previous period	Total Economy Database, data for the last projection period are imputed using the changes in projected capital services values.
R_EXR_t	-	-		Real exchange rates, obtained as market exchange rate (i.e. $/national currency) × (national consumer price deflator / US consumer price deflator)	IMF, World Economic Outlook; UN National Account Statistics
DEP_t		-		Total (sum of old and young) dependency ratios	UN Population Division (2015)
$SERVICE_t$		-		Service share in GDP	UN National Account Statistics; World Bank World Development Indicators
lnP_GDP_{t-1}		+		Log of per capita GDP	Total Economy Database
$\Delta lnGDP_{t-1}$		+	+	GDP growth in the previous period	Total Economy Database
$\Delta lnTFP_t$			+/-	Total factor productivity growth	Total Economy Database and Projection from TFPG equation
$SAVING_t$			+	Saving rate	UN National Account Statistics; World Bank World Development Indicators and Projection from Saving equation
DPN_RATE_t			+	Depreciation rate	Total Economy Database*
$SD.INFL_t$			+	Standard deviation of inflation rate	IMF, World Economic Outlook;
$WAGE_t$			+	Growth rate of wages	Implicit Wage rates from Total Economy Database
$ENERGY_t$			+	Growth rate of energy use	International Energy Statistics
$lnKD_{t-1}$			-	Log of capital deepening in the previous period	Total Economy Database
$NTEREST_t$			-	Nominal interest rate	IMF, International Financial Statistics; OECD statistics
ECO_GLOB_t			+	Index of economic globalization which measures trends flows of trade, FDI, income payments and restrictions on international flows.	KOF Swiss Economic Institute Globalization Index data
R_DUMMY	+/-	+/-	+/-	Region dummies	1 if a country belongs to a given region, and 0 otherwise

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

The above three equations constitute a simultaneous equation system which is estimated using three-stage least squares. We use this approach, because some of the explanatory variables are the dependent variables of other equations in the system. Therefore the three error terms are expected to be correlated, thus generalized least squares should be used to account for the correlation among the error terms across equations. We implement the regressions on our sample of 33 mature economies and 32 major emerging economies from 1972 to 2016. We divide the 45 years into seven time periods (see table 4) in such a way that the initial and end years do not coincide with recession years.[10] All annual variables from the data sources are averaged for each defined period.

Table 4: Period averages used in estimating the equations

Number	Years included
Historical periods	
1	1972-1978
2	1979-1986
3	1987-1992
4	1993-1998
5	1999-2005
6	2006-2010
7	2011-2016
Projection periods	
8	2017-2021
9	2022-2026

2.3.2 Correcting for the bias in official ICT price statistics

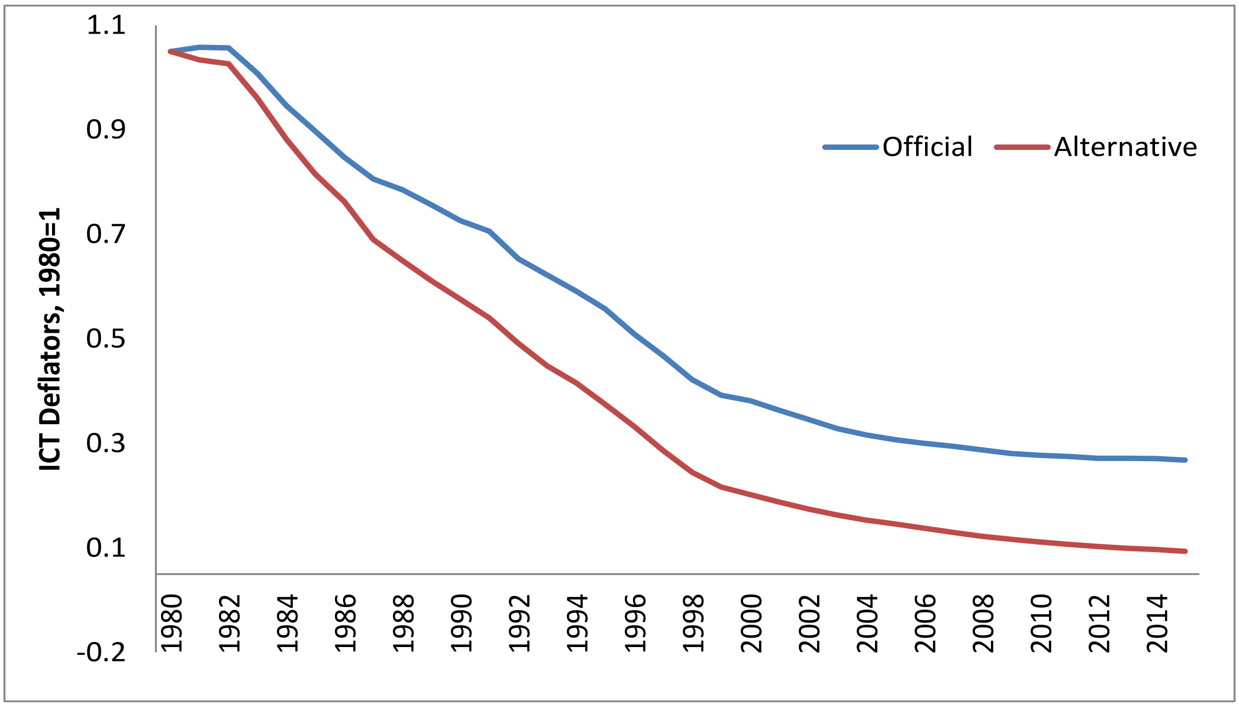
The underlying historical data for estimating equations 6 to 8 are taken from The Conference Board Total Economy Database (TED). The TED provides time series data for 123 countries on the growth rates of capital services—broken down into ICT and non-ICT capital services—and Total Factor Productivity growth. A major improvement to the current version of the TED, which is important in improving the quality of our model projections, is better estimates of ICT investment.[11]

Our approach to measure ICT investment is documented in detail in de Vries and Erumban (2016) and Erumban, Inklaar and de Vries (2017). In addition to the improved investment series, we also use alternative ICT price deflators, to capture the ICT price declines

[10] Recession years vary across countries. However, we choose divisions based on U.S. recession years as determined by the National Bureau of Economics Business Cycle Dating Committee because the U.S. is the largest economy throughout the period under study.
[11] For more information, visit the Total Economy Database website.

more accurately. It has been argued that the official ICT price deflators in the United States fail to capture the rapid declines in ICT prices (Byrne and Corrado, 2016a, 2016b). Byrne and Corrado have developed alternative ICT deflators, which are arguably superior to the official series. Figure 1 depicts the official price deflators for aggregate ICT assets in the United States, along with the alternative deflator series developed by Byrne and Corrado.[12] It is quite evident that the alternative series drop significantly faster than the official series.

Figure 1: ICT price deflators – official vs. alternative, United States (1980=1)



Note: The aggregate ICT deflators are obtained using weighted growth rate of individual assets—hardware, software and communication equipment—with the weights being their nominal share in total ICT investment.
Sources: Bureau of Economic Analysis, Byrne and Corrado (2016a, 2016b)

In our analysis we make use of these alternative ICT price deflators, which are available separately for hardware, software and communication equipment. The direct impact of this shift is that measured real investment will be larger than what is officially reported, and therefore, the contribution of ICT capital—and hence that of the overall capital services—to GDP growth will be larger. For non-US countries we use harmonized ICT price deflators, as suggested by Schreyer (2002), by adjusting the US ICT prices for domestic inflation rates.[13] However, as we

[12] The aggregate ICT deflators are obtained using weighted growth rate of individual assets – hardware, software and communication equipment – with the weights being their nominal share in total ICT investment. The magnitude of price decline varies significantly across these three asset types.
[13] More precisely, we define the ICT price change in country i as the $\Delta \ln P_i^{ICT} = \Delta \ln P_i^{nICT} + \Delta \ln P_{US}^{ICT} - \Delta \ln P_{US}^{nICT}$, where P_i^{ICT} and P_i^{nICT} are respectively the price of ICT and non-ICT in country i, and P_{US}^{ICT} and P_{US}^{nICT} are the price of ICT and non-ICT in the United States.

make a correction for ICT investment prices, and thereby alter one component of the national income identity (i.e. GDP = C + I + X – M, where C is consumption, I is investment, X is exports and M is imports), a proportional correction to GDP needs to be made as well. The impact of the ICT price adjustment on GDP in ICT importing countries will be *minimal*, as the net impact of the investment correction will be cancelled out when imports of ICT are subtracted from GDP.[14] Given that most economies are ICT importers rather than producers or exporters, we only correct GDP for those countries which are large producers and exporters of ICT goods, including Singapore, Malaysia, Philippines, Ireland, Taiwan, South Korea, Japan, United States, Canada and China.

The adjusted GDP deflator, which reflects alternative ICT prices, is constructed as follows:

$$\Delta \ln \mathrm{P}_{GDP}^{adj} = (\mathrm{i}+\mathrm{x}-\mathrm{m})\Delta \ln P_{ICT} + [1-(\mathrm{i}+\mathrm{x}-\mathrm{m})]\Delta \ln \mathrm{P}_{GDP}^{na} \quad (9)$$

where $\Delta \ln \mathrm{P}_{GDP}^{adj}$ is the change in the log of the ICT prices adjusted GDP price deflator, $\Delta \ln P_{ICT}$ is change in the log of the ICT investment deflator (obtained from Byrne and Corrado, 2016a, 2016b) for the United States, and harmonized deflators for other countries, and $\Delta \ln \mathrm{P}_{GDP}^{na}$ is the national accounts official unadjusted GDP deflator. The Tornquist weight $\mathrm{i}+\mathrm{x}-\mathrm{m}$ consists of the share of investment (i), export (x) and import (m) in ICT assets in nominal GDP. Real GDP in the above-mentioned countries are obtained using this adjusted GDP deflator, and the resulting GDP growth rates are higher than the official GDP growth rates (see table 5).

[14] Note that the impact to be fully zero, we have to assume a country is importing all ICT goods, and does not produce anything, and all imports are absorbed in investment. In such case no adjustment to GDP is essential, because the country's GDP consists only non-ICT goods.

Table 5: Comparison of original GDP growth rates and adjusted GDP growth rates

Country	*Version*	1995-2000	2001-2006	2007-2013	2014	2015
Canada	Adjusted	4.5	3.4	2.0	3.1	1.4
	Original	3.8	2.6	1.5	2.4	1.0
China	Adjusted	6.6	9.8	8.7	6.2	4.2
	Original	6.3	9.2	7.6	5.6	3.8
Ireland	Adjusted	12.6	7.6	0.6	5.7	8.5
	Original	10.0	5.4	0.3	5.2	7.8
Japan	Adjusted	1.8	1.6	0.6	0.2	1.0
	Original	1.0	1.3	0.4	0.0	0.6
Malaysia	Adjusted	8.9	8.0	6.5	7.0	7.2
	Original	5.6	4.9	4.6	6.0	5.0
Philippines	Adjusted	5.7	6.2	6.1	6.8	7.2
	Original	3.8	4.7	5.3	6.1	5.9
Singapore	Adjusted	12.2	11.3	9.2	4.5	6.8
	Original	5.9	5.5	5.5	2.9	2.0
South Korea	Adjusted	7.7	6.3	4.6	4.2	4.6
	Original	6.0	4.8	3.5	3.3	2.6
Taiwan	Adjusted	7.0	5.1	4.1	4.1	1.1
	Original	5.4	3.9	3.4	3.8	0.7
United States	Adjusted	4.5	2.9	1.1	2.6	2.8
	Original	4.0	2.6	0.9	2.4	2.6

Notes: Growth rates are presented as percent changes; The adjusted growth rates correspond to the Total Economy Database (Adjusted version) and the original growth rates correspond to the Total Economy Database (Original version); Chinese data is from Wu (2014), revised and updated.
Source: The Conference Board Global Economic Outlook, 2017.

We recognize that this correction is not a perfect adjustment, because, it does not account for the ICT consumption (C) part of GDP, and ideally the last term on the right hand side of equation 9 should therefore be the GDP deflator for the non-ICT part of GDP only. But for now we assume that the impact of ICT prices on the official GDP deflator is small, so that the changes in the GDP deflator are proportional to changes in the non-ICT deflator. Another rather strict assumption in the current adjustment is that ICT price changes are the same for investment, exports and imports, which may not hold but we have been unable to check due to data limitations.

2.3.3 Estimation results of the simultaneous equations

Table 6 reports the results of the simultaneous equation system using the three-stage least squares estimation. The results are largely consistent with theoretical expectations. Specifically, the relative level of the labor productivity variable in the TFP growth equation and the lagged capital deepening variable in the capital services growth equation are specified to test the convergence hypothesis.[15] 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.

In the TFP growth equation, the coefficient of the geometric average of life expectancy and average years of schooling is significantly positive. This indicator represents a country's human development, which reflects both 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. 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; our results yield a significant positive effect of real R&D growth rates on TFPG. Corrupt economies are prone to misallocation of resources, as investment decisions can be heavily influenced by wasteful rent seeking and a distorted bureaucracy.[16] Lack of transparency and accountability can not only lead to irresponsible investments resulting in misallocation of capital, but can also strangle innovation, and, therefore, corruption is expected to impact productivity negatively. Our results, while it yields a negative coefficient for corruption, do not suggest a significant negative impact of corruption on productivity growth.[17]

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[15] Ideally, we want to use the TFP and capital services level of the initial year to test convergence. Since we do not have the level data for TFP and capital services for all countries, labor productivity and capital deepening levels are used instead in the specification.

[16] Mauro (1995), among others, show a negative impact of corruption on investment/GDP ratio.

[17] 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.

Table 6: Estimation results of simultaneous equations

Independent Variables	TFP growth		Savings rate		Capital services growth	
$\Delta \ln TFP_{t-1}$	0.212	***				
	(5.66)					
$lnLP_{t-1}^{US}$	-0.933	***				
	(-5.24)					
$CORRUPT_t$	-0.257					
	(-0.09)					
$R\&D_t$	0.00737	*				
	(1.96)					
HDI	1.518	***				
	(3.04)					
$\ln ICTdeep_{t-1}$	0.0776					
	(1.18)					
R_EXR_t	-0.00646		-0.505	***		
	(-0.16)		(-3.05)			
DEP_t			-0.103	***		
			(-3.36)			
$SERVICE_t$			-0.297	***		
			(-6.43)			
lnP_GDP_{t-1}			7.723	***		
			(10.34)			
$\Delta lnGDP_{t-1}$			1.326	***		
			(10.95)			
$SAVING_t$					0.128	***
					(5.38)	
DPN_RATE_t					-0.0674	
					(-0.54)	
$SD.INFL_t$					-0.0872	
					(-0.70)	
$WAGE_t$					0.347	***
					(10.41)	
$ENERGY_t$					0.211	***
					(6.78)	
$lnKD_{t-1}$					-1.18	***
					(-5.91)	
$INTEREST$					-0.00175	
					(-0.84)	
ECO_GLOB					0.945	**
					(2.41)	
Constant	-4.731	***	50.47	***	2.963	
	(-2.75)		(10.48)		(1.55)	
R-squared	0.229		0.557		0.586	
Regional Dummies	YES		YES		YES	

Notes: The system of equations is estimated by the 3SLS (three-stage least squares) method; Number of observations: 308.
* significant at 10%; ** significant at 5%; *** significant at 1%.

In the savings equation (equation 7), the dependency ratio has a negative effect on the savings 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 savings rate probably results from the larger presence of government funded social services, education and health care, causing people to have less precautionary savings. The savings rate is positively influenced by the overall growth of real GDP and the level of per capita income.

In previous versions of the GEO model, we included the real exchange rate as a determinant of capital services.[18] However, as we acknowledged, the impact of exchange rates on investment, and thereby capital service growth, is less clear in theory. When a country's currency appreciates (i.e. the exchange rate expressed as domestic currency per unit of foreign currency decreases), the resulting substitution of demand for domestic goods by imported goods and the declining exports could depress marginal return over capital..[19] However, an appreciating currency makes imports cheaper, allowing increased use of imported intermediate and capital goods. The overall effect of exchange rates on investment depends upon which effect dominates, and thus remains an empirical question (see Harchaoui, Tarkhani, and Yuen, 2005). We measure the real exchange rate as:

$$RealXR = \left(\frac{P_d}{P_f}\right)\left(\frac{1}{e}\right) \tag{10}$$

where P_d and P_f are the price levels in domestic and foreign 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 an appreciation of the currency, and a decline is depreciation, both corrected for inflation. The real exchange rate explains to what extent more or less goods and services can be purchased abroad (after conversion into a foreign currency) than in the domestic market for a given amount.

In the current version of the model, we moved the real exchange rate from the capital to the savings and TFP equations. An appreciation of the real exchange rate shifts production from traded to non-traded goods, as domestic goods become dearer for foreign consumers, and

[18] See Erumban and de Vries (2015)
[19] Throughout this paper, exchange rates are expressed as domestic currency per US$, for instance the exchange rate between the Euro and the $ is Euro per unit of US $ *(e = €/$)*.A decrease in *e* reflects an appreciation of € and an increase reflects depreciation.

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 savings, as it tends to reduce saving and thus depress growth by hampering capital accumulation.

We find that the effective exchange rate has a negative and significant impact on savings rates, and an insignificant, though negative, impact on TFP growth. This is consistent with the theoretical prediction that real appreciation (depreciation) of a currency would lead to a decline (increase) in savings and thereby lower capital service growth. Since the appreciated currency makes imports cheaper driving consumer demand, domestic saving propensity will decline leading to a decline in investment and capital services.

In the capital services growth equation (equation 8), the savings rate have a positive impact. The standard deviation of inflation is used as a proxy for the stability of the macroeconomic environment. Even though it has the expected negative sign - unstable macroeconomic conditions may deter investment and consequently growth in capital services – it is not significant. Two other major indicators that affect capital service growth rates are the wage rate and the growth rate of energy use. As labor costs rise, demand for capital is likely to increase due to possible substitution effects. 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– has a negative, but insignificant 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.

2.4 Trend growth projections

2.4.1 The exogenous variables underlying the projections

As explained above, equations (6) – (8) are estimated using period averages in the actual data from periods 1 to 7 (see table 4). The estimated coefficients are then used to derive projections for TFP and capital services growth. Projecting TFP and capital services growth for both the medium-term (2017-2021, period 8) and the long-term (2022-2026, period 9), necessitates all the exogenous variables in the system, which can be divided into three categories.

The first category includes variables whose values of medium- and long-term are available: old and youth dependency ratios, as well as growth of the employed population, sourced from the UN and ILO datasets.

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 9 value of the first two lagged variables are obtained using the projected value of period 8. The lagged labor productivity level in period 9 is calculated through labor productivity growth, which is obtained from the difference between GDP growth and employment growth. GDP growth in period 8 is obtained using projected capital services and TFP growth as explained above. The lagged capital deepening in period 8 is calculated based on the projected growth of capital services in period 8 and the projected growth of the employed population.

The third category includes contemporary variables whose period 8 and 9 values are subject to judgment: inflation, standard deviation of inflation, services share in total value added, life expectancy, education attainment, corruption, R&D spending, wage rate, energy growth, globalization, interest rates and exchange rates. The share of the services sector reflects the structure of the economy; inflation rate and the standard deviation of inflation characterize the macro condition. For period 8, we use inflation and exchange rate projections from the IMF World Economic Outlook, which are kept constant for period 9. Life expectancy and educational attainment are considered policy oriented variables, whose values are subject to change depending on a country's economic condition and development strategy. Projections on educational attainment are obtained from Wittgenstein Datacenter (2015) and Barro-Lee (2014). Projections of life expectancy at birth are obtained from the United Nations. Corruption, an institutional variable, is assumed to remain constant, so that it mainly captures cross section effects while projecting forward. Growth rates of R&D spending, a major innovation influencing indicator, wage rates, energy use, globalization and interest rates are also assumed for the projection periods are taken from period.

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.[20] 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 level 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.

2.4.2 Results: GDP growth projections and its components

Table 7 lists GDP projections and its components for periods 8 (2017-2021) and 9 (2022-2026) for all 65 economies as well as the average GDP growth rates over the period 2012-2016 which are included for comparison purposes. The GEO portal on the Conference Board website provides a detailed analysis of the results and what it means for the business environment, including reports for the United States, Europe and Asia Pacific.[21]

Table 7: GDP growth projections and its components (%), 2017-2021, 2022-2026

Country	Average growth 2012-2016	Average annual growth 2017-2021 (trend growth projection adjusted for output gaps)					Average annual growth 2022-2026 (trend growth projection)				
		GDP	L	LQ	K	TFP	GDP	L	LQ	K	TFP
MATURE ECONOMIES											
United States	2.0	2.2	0.3	0.2	1.3	0.5	2.0	0.1	0.2	1.2	0.5
Austria	0.7	2.2	0.0	0.2	0.8	1.1	1.8	-0.3	0.2	0.8	1.1
Belgium	0.8	1.9	0.3	0.3	0.4	0.9	1.7	-0.1	0.4	0.4	1.1
Cyprus	-1.6	2.9	0.8	0.2	0.8	1.0	2.5	0.2	0.3	1.1	0.9
Czech Republic	1.4	0.8	-0.1	0.1	0.7	0.1	0.6	-0.2	0.1	0.6	0.0
Denmark	0.6	1.8	0.3	0.1	1.1	0.2	1.6	0.1	0.2	1.1	0.2
Finland	-0.3	2.2	0.0	0.3	0.6	1.3	2.0	-0.1	0.4	0.6	1.1
France	0.6	2.0	0.3	0.2	0.5	0.9	1.6	0.1	0.2	0.5	0.7
Germany	1.1	1.5	-0.1	0.1	0.9	0.7	1.2	-0.6	0.1	0.8	0.8
Greece	-2.1	2.6	0.8	0.4	-0.3	1.7	1.0	-0.2	0.4	0.1	0.7
Hungary	1.7	1.1	0.0	0.2	0.2	0.7	0.8	-0.2	0.3	0.2	0.6

[20] 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

[21] Please visit our Global Economic Outlook website for more analysis.

Country	Average growth 2012-2016	Average annual growth 2017-2021 (trend growth projection adjusted for output gaps)					Average annual growth 2022-2026 (trend growth projection)				
		GDP	L	LQ	K	TFP	GDP	L	LQ	K	TFP
Iceland	3.1	0.9	0.6	0.1	0.5	-0.2	0.6	0.2	0.1	0.4	-0.1
Ireland	3.9	3.1	0.5	0.2	1.4	1.1	3.0	0.3	0.2	1.3	1.2
Italy	-0.7	1.1	0.1	0.1	0.3	0.5	0.2	-0.4	0.1	0.4	0.1
Luxembourg	3.2	2.8	0.6	0.3	1.2	0.7	2.8	0.4	0.3	1.1	1.0
Malta	4.2	1.4	0.4	0.0	0.2	0.8	0.9	0.0	0.0	0.1	0.9
Netherlands	0.6	2.1	0.3	0.2	0.6	1.1	1.7	-0.2	0.2	0.6	1.1
Norway	1.6	2.6	0.4	0.2	1.7	0.3	2.4	0.2	0.2	1.7	0.3
Poland	2.5	1.9	-0.2	0.1	1.0	0.9	1.3	-0.3	0.1	0.9	0.7
Portugal	-0.3	1.9	0.0	0.5	0.5	0.9	1.3	-0.3	0.5	0.6	0.5
Spain	0.5	1.6	0.4	0.3	0.4	0.4	0.5	-0.3	0.3	0.5	0.1
Sweden	2.1	1.7	0.3	0.1	1.5	-0.2	2.1	0.2	0.1	1.5	0.4
Switzerland	1.4	1.9	0.3	0.1	0.9	0.6	1.0	0.0	0.1	0.8	0.1
United Kingdom	2.0	1.5	0.2	0.2	0.7	0.3	1.4	0.1	0.3	0.6	0.3
Japan	0.8	1.2	-0.3	0.2	0.9	0.4	0.8	-0.3	0.2	0.8	0.1
Australia	2.7	3.0	0.5	0.2	1.7	0.6	2.8	0.4	0.2	1.7	0.5
Canada	1.8	3.0	0.2	0.2	1.9	0.6	2.7	0.1	0.2	1.8	0.5
Hong Kong	2.2	1.8	-0.2	0.1	1.4	0.5	1.4	-0.5	0.1	1.2	0.5
Israel	2.8	3.8	0.7	0.0	1.9	1.2	3.7	0.7	0.0	1.9	1.0
New Zealand	2.8	3.0	0.4	0.2	1.9	0.4	2.9	0.2	0.3	1.9	0.5
Singapore	2.9	4.5	0.5	0.4	3.1	0.6	3.5	-0.1	0.4	2.7	0.3
South Korea	2.7	4.4	0.2	0.4	2.1	1.6	3.3	-0.4	0.5	2.0	1.2
Taiwan	1.9	2.7	-0.1	0.1	2.0	0.8	2.0	-0.6	0.1	1.9	0.7
EMERGING AND DEVELOPING ECONOMIES											
China	4.7	3.3	-0.1	0.2	3.0	0.2	2.9	-0.2	0.2	2.7	0.2
India	6.4	5.8	0.7	0.1	4.1	0.9	5.5	0.6	0.1	4.0	0.7
Indonesia	5.3	5.1	0.7	0.1	3.1	1.1	4.5	0.4	0.2	3.0	0.9
Malaysia	5.0	4.3	0.7	0.2	2.9	0.5	3.6	0.5	0.2	2.7	0.3
Pakistan	4.6	4.5	1.2	0.1	2.1	1.0	4.0	1.1	0.1	2.1	0.6
Philippines	6.4	6.1	0.8	0.2	3.4	1.6	5.5	0.6	0.2	3.3	1.3
Thailand	3.3	4.2	0.0	0.3	2.8	1.1	3.6	-0.2	0.3	2.8	0.7
Vietnam	5.9	6.7	0.4	0.1	4.0	2.1	6.1	0.2	0.1	3.9	1.8
Argentina	0.3	1.7	0.5	0.1	1.7	-0.6	1.9	0.4	0.1	1.7	-0.3
Brazil	-0.6	1.9	0.5	0.2	1.2	0.1	2.3	0.3	0.2	1.3	0.6
Chile	3.0	3.3	0.5	0.2	1.9	0.5	2.4	0.4	0.2	1.8	0.0
Colombia	3.7	3.4	0.6	0.2	2.3	0.3	3.1	0.3	0.2	2.2	0.4
Mexico	2.5	4.0	0.5	0.1	2.6	0.8	3.8	0.4	0.1	2.6	0.6
Venezuela	-2.4	-0.6	0.5	0.1	0.2	-1.4	-0.1	0.4	0.1	0.1	-0.8
Algeria	3.4	2.5	0.8	0.0	1.7	0.0	2.2	0.5	0.0	1.6	0.0

Country	Average growth 2012-2016	Average annual growth 2017-2021 (trend growth projection adjusted for output gaps)					Average annual growth 2022-2026 (trend growth projection)				
		GDP	L	LQ	K	TFP	GDP	L	LQ	K	TFP
Egypt	2.7	3.3	0.9	0.2	2.4	-0.2	3.5	0.7	0.2	2.4	0.1
Iran	1.6	3.7	0.3	0.1	3.2	0.1	4.0	0.2	0.1	3.6	0.2
Morocco	3.3	2.2	0.6	0.2	0.9	0.5	2.1	0.4	0.2	0.7	0.7
Saudi Arabia	3.2	3.4	0.4	0.0	3.9	-0.9	3.3	0.3	0.0	3.7	-0.6
United Arab Emirates	4.3	3.1	0.5	0.0	3.1	-0.5	2.3	0.2	0.0	2.8	-0.6
Ethiopia	9.2	7.3	1.7	0.0	3.9	1.5	7.6	1.5	0.0	3.7	2.2
Ghana	5.9	5.3	1.3	0.0	2.6	1.3	5.1	1.2	0.0	2.4	1.4
Kenya	5.4	5.6	1.9	0.1	1.7	1.8	5.9	2.0	0.1	1.7	2.0
Nigeria	3.9	5.6	1.3	0.1	3.3	0.8	5.8	1.4	0.1	3.4	0.8
South Africa	1.5	1.7	0.8	0.3	0.9	-0.4	1.6	0.5	0.4	0.9	-0.2
Tanzania	6.7	8.5	1.2	0.0	5.3	1.8	8.9	1.2	0.0	5.4	2.0
Belarus	-0.5	0.0	-0.7	0.0	1.0	-0.2	0.2	-0.7	0.0	0.8	0.1
Kazakhstan	3.3	1.7	0.1	0.2	1.3	0.1	1.1	0.1	0.2	1.0	-0.2
Russian Federation	0.1	0.7	-0.5	0.0	0.1	1.0	0.2	-0.5	0.0	0.0	0.7
Turkey	3.0	3.3	0.4	0.1	2.2	0.6	2.1	0.3	0.1	2.0	-0.2
Turkmenistan	8.9	4.3	0.7	0.0	2.9	0.6	3.2	0.5	0.0	2.5	0.2
Uzbekistan	7.2	4.6	0.6	0.0	2.2	1.7	3.8	0.5	0.0	2.0	1.3

Notes: L denotes labor quantity; LQ denotes labor quality; K denotes capital; The projected medium-term growth rates for some countries in this table are adjusted for 2017-2021 taking into account the output gap in 2016 (see table 7).
Source: The Conference Board Global Economic Outlook 2017.

2.4.3 Adjusting trend growth rates for output gaps

The projected GDP growth rates based on the growth accounting framework are to be interpreted as the trend growth rates of an economy. Trends are important for projecting future growth because they depict how an economy develops on the basis of its growth potential which is determined by the available labor force, capacity in capital and technology base. 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 primarily, in particular their business cycle dynamics. Occasionally, shocks can also occur which have a deep impact on the structure of the economy beyond the business cycle 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. In order to come up with annual estimates between 2016 and 2020, we therefore made use of estimates of existing output gaps in individual economies. We make a distinction between average projected growth (trend growth) between 2016 and 2020 and the potential growth rate of the economy averaged over those years. In the long run these two measures 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 (2015) output gap by a given year in the future. For instance, in the case of United States, we assume a less than half a percent output gap in 2016, and we also assume that the U.S will close this output gap by 2018. Taking the model projection for potential output growth from 2017-2021, which is 2.1 percent per year on average, we obtain 2.2 percent average annual growth rate for the period 2017-2021, which is required to close the output gap in 2018. Table 8 below provides an overview of the output gap assumptions that feed into our model. Annual growth for 2017 and 2018 are linearly interpolated using 2016 growth and trend growth of period 2017-2021. As our trend GDP growth is derived via a growth accounting approach, we also adjust the TFP when the actual projected GDP is modified by the aforementioned method. Specifically, we attribute all the output gain over and above the trend growth due to output gap adjustment to TFPG. In the long-run (2022-2026), we assume actual GDP growth coincides with the trend GDP growth.

Table 8: Output gap assumptions for medium term projections

Country	Output gap in 2016	Source	Year in which output gap closes	Model projected potential growth 2017-2021	Forecast growth rate 2017-2021	Difference
Australia	1.2	IMF	2021	2.8	3.0	0.3
Austria	0.8	IMF	2021	2.0	2.2	0.2
Belgium	0.7	IMF	2021	1.8	1.9	0.1
Canada	1.1	IMF	2021	2.8	3.0	0.2
Chile	2.9	OECD	2021	2.7	3.3	0.6
Cyprus	1.8	IMF	2021	2.5	2.9	0.4
Czech Republic	0.4	OECD	2021	0.8	0.8	0.1
Denmark	0.6	IMF	2021	1.7	1.8	0.1
Finland	2.4	IMF	2021	1.7	2.2	0.5
France	1.8	IMF	2021	1.6	2.0	0.4
Germany	-0.4	IMF	2021	1.6	1.5	-0.1
Greece	6.5	IMF	2021	1.2	2.6	1.4
Hungary	0.5	OECD	2021	1.0	1.1	0.1
Iceland	-1.3	OECD	2021	1.2	0.9	-0.3
Ireland	-0.6	IMF	2021	3.2	3.1	-0.1
Israel	1.2	OECD	2021	3.5	3.8	0.2
Italy	2.5	IMF	2021	0.5	1.1	0.5

Country	Output gap in 2016	Source	Year in which output gap closes	Model projected potential growth 2017-2021	Forecast growth rate 2017-2021	Difference
Japan	1.5	IMF	2021	0.9	1.2	0.3
Luxembourg	-0.5	IMF	2021	2.9	2.8	-0.1
Malta	-1.2	IMF	2021	1.7	1.4	-0.2
Mexico	1.2	OECD	2021	3.8	4.0	0.2
Netherlands	1.0	IMF	2021	1.9	2.1	0.2
New Zealand	0.0	IMF	2021	3.0	3.0	0.0
Norway	1.0	IMF	2021	2.4	2.6	0.2
Poland	1.2	OECD	2021	1.7	1.9	0.2
Portugal	2.9	OECD	2021	1.3	1.9	0.6
Russian Federation	1.5	Own estimate	2021	0.3	0.7	0.3
South Korea	1.5	IMF	2021	4.1	4.4	0.3
Spain	1.9	IMF	2021	1.2	1.6	0.4
Sweden	-2.8	IMF	2021	2.3	1.7	-0.6
Switzerland	2.4	OECD	2021	1.4	1.9	0.5
Turkey	4.0	OECD	2021	2.4	3.3	0.8
United Kingdom	0.1	IMF	2018	1.5	1.5	0.0
United States	0.5	IMF	2018	2.1	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 2017; IMF World Economic Outlook October 2016; OECD Economic Outlook July 2016.

3. Comparison of GDP projections with other studies

A number of researchers have attempted projecting global economic growth (e.g. Jorgenson and Vu, 2013; Lee and Hong, 2010; Fogel, 2007; Wilson et.al., 2011, among others). However, not all these projections are updated on an annual basis, and, therefore, often do not reflect the most up to date information and dynamics of the global economy. A few organizations such as International Monetary Fund in its World Economic Outlook (IMF), the Economist Intelligence Unit (EIU) and PricewaterhouseCoopers (PWC) publically provide up to date projections for the medium to longer term. In this section we compare the methodology and results from The Conference Board's growth projections with some of these studies.

As mentioned, our projection model is based on Jorgenson's growth accounting framework. However, Jorgenson and Vu (2013)'s projections for all input components are based on the performance of the near past, while in our methodology this only holds for the inputs capital services and TFP growth. Our methodology is closely akin to Lee and Hong (2010), in terms of both the growth accounting framework as well as the regression approach to estimate and project input factors. However, their work only covers Asian countries while ours includes 33 mature economies and 32 emerging markets.

IMF projections presented in their World Economic Outlook are based on a 'bottom-up' approach, where the individual country projections produced by respective country teams are aggregated through a series of iterations. Therefore, the methodology can vary from country to country and between different series. The Economist seems to be doing something similar, where country models are adjusted according to 'expert judgement'. Unfortunately, none of these organizations provide very detailed descriptions of the methodology used.[22]

Table 9: Comparison of projections of medium-term GDP growth from difference sources

	GEO Nov. 2016	IMF Oct. 2016	EIU Nov. 2016	PWC Oct. 2016
	2017-2021	**2017-2021**	**2017-2020**	**2018-2022**
United States	2.2	1.9	1.9	2.3
Japan	1.2	0.5	0.3	0.8
Germany	1.5	1.3	1.4	1.4
France	2.0	1.7	1.2	1.6
Italy	1.1	0.9	0.7	1.2
United Kingdom	1.5	1.7	1.0	2.1
China	3.3	6.0	5.0	5.7
India	5.8	7.8	7.4	6.5
Brazil	1.9	1.6	1.7	3.0
Russia	0.7	1.4	1.2	1.5
MATURE ECONOMIES	**2.1**	**1.8**	**1.7**	
EMERGING MARKETS	**3.7**	**4.9**	**4.4**	
WORLD	**3.0**	**3.6**	**3.2**	**3.4**

Sources: The Conference Board Global Economic Outlook 2017; International Monetary Fund (IMF) - World Economic Outlook Database, October 2016; PricewaterhouseCoopers (PWC), Global Economy Watch- Economic Projections, October 2016; The Economist Intelligence Unit, November 2016.

Table 9 compares our medium-term projections with those of the IMF, EIU and PWC, which should be comparable even though the projection periods are not entirely the same. It seems that our projections for global growth are the lowest with 3.0 percent, the difference with the IMF is even 0.6 percentage points. Different projections for China are the main reason behind this,

[22] For a brief description of the methodology used by the IMF, see http://www.imf.org/external/pubs/ft/weo/faq.htm#q1g; for the EIU projections, see http://graphics.eiu.com/data_services/contentguide/eeiumacr.htm; PWC projections are made available at http://www.pwc.com/gx/en/issues/economy/global-economy-watch/projections.html, but no methodologival description are available in the public domain..

which are significantly lower in our GEO—as our model uses alternative, lower, estimates for Chinese GDP growth, though projections from the Economist are also clearly below the IMF and PWC. There seems to be more consensus on forecasts for India, another major emerging market, though again our projections are the lowest. Still, in all projections it is clear that India will overtake China in terms of economic growth in the coming five years.

While our model projects slower growth for emerging markets compared to the other studies under review here, the opposite is true for mature economies. The GEO model produces higher GDP growth projections for almost all major advanced economies, and the difference is greatest with the projections from the EIU. Especially for a country like Japan, there seems to be no consensus with the GEO estimates being at the high end of the spectrum. The same is true for the UK, where the EIU expects the biggest negative impact from Brexit, though here our projections are somewhere in between. Projections for the United States are relative similar across the different studies and show growth of around 2 percent, slightly above its current pace.

4. 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 and 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, makes it possible to be more explicit about understanding the sources of growth and the drivers of change over time.

Our projections of GDP growth may be seen as relatively low compared with other studies. Much of this difference is visible in the emerging markets, of which our alternate estimate for China contributes a major part of the overall decline, as we maintain that official Chinese GDP growth rates are overstated. However, over a time span as long as the one we have used, there will likely be deviations in both directions. Despite the transparency and comparability of our approach, the disadvantage is that there is no simple framework that can take into account all the country specific factors and potential shocks in the future. That said, our goal is not to provide an explicit forecast in the sense of the precise point forecasts on growth, but rather to provide a reasonable way of benchmarking trend growth across a large group of economies.

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