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Projecting Economic Growth for Medium- to Long-term

Using growth accounting techniques
World KLEMS Conference, Harvard University, August 10th, 2012

Introduction

- Projections of Gross Domestic Products used in *The Conference Board Global Economic Outlook*, annual release in November
- Projections for medium- (2013-2016) and long-term (2017-2025) potential GDP growth
- Covers 12 regions, including 30 advanced economies and 25 major emerging economies
- Growth accounting framework, together with regression approach to project capital services growth and total factor productivity growth
- Base, optimistic and pessimistic scenario projections based on the policy oriented variables in the regression

Other studies on medium- and long-term projection using growth accounting framework

- Jorgenson (2009): projections for input components are based on the performance of the near past
- Lee and Hong (2010): similar regression approach to estimate and project capital deepening growth and TFP growth, but covers Asian countries only
- Goldman Sachs (2007): a process of convergence in technology with the developed markets, convergence speed is determined by Growth Environment Scores (GES): a higher GES is associated with more rapid catch-up on the income levels of the rich countries
- PWC (2011): growth in capital stock is derived from assumptions on capital investment; growth in TFP is assumed to be related to the extent to which a country lags behind the technological leader (US) and so has the potential for “catch-up”.

What's new in The Conference Board approach

- Jorgensonian's growth accounting framework, which uses capital services instead of capital stock
- Simultaneous equation system to estimate and project the growth in TFP and capital services
- Scenario analysis based on the policy variables in the simultaneous equation system
- Link the medium- and long-term projection with the short-term GDP growth by cyclical adjustment (next step)
- Broad coverage: 30 advanced economies and 25 major emerging economies

Model: growth accounting framework

$$\Delta lnY = \Delta lnA + \bar{v}_L \Delta lnL + \bar{v}_L \Delta lnQ + \bar{v}_K \Delta lnK$$

- Growth accounting framework: production function decomposes output growth into changes in factor inputs
- *Y*: gross output
- *L*: labor quantity
- Q: composition of the labor force based on different education attainment
- *K*: capital services
- *A*: total factor productivity
- $\bar{v}$'s: two period average input shares in total factor income
- $\Delta \mathrm{lnX}$: growth rate of variable *X* over two studying time periods

Model: projections on labor inputs

- Labor quantity (L): working age population (age of 15-64) from International Databases of the U.S. Census Bureau
- Composition of labor force (Q):

$$\Delta lnQ_t = 1/2 \sum_i \left(v_{i,t} + v_{i,t-1}\right)\left(lnh_{i,t} - lnh_{i,t-1}\right)$$

  - ✓ v_i: share in labor compensation by labor type *i* (low, medium and high skilled workers based on education attainment)
  - ✓ h_i: share of total hours worked by labor type *i*
- Labor shares: average labor share for individual countries in 2000-2007 for the projection years

Model: growth in capital services and total factor productivity

$$\Delta \ln TFP_t = \alpha_0 + \alpha_1 \Delta \ln TFP_{t-1} + \alpha_2 lnLP_{t-1} + \alpha_3 lnlife_t + \alpha_4 open_t + \alpha_5 edu_t + \varepsilon_{1t}$$

$$Saving_t = \beta_0 + \beta_1 dep\_old_t + \beta_2 dep\_young_t + \beta_3 lnKD_{t-1} + \beta_4 open\_fin_t + \beta_5 depreciation_t + \beta_6 inflation_t + \beta_7 services_t + \varepsilon_{2t}$$

$$\Delta lnKSvc_t = \gamma_0 + \gamma_1 saving_{t-1} + \gamma_2 \Delta lnpop_t + \gamma_3 depreciation_t + \gamma_4 \Delta lnTFP_t + \gamma_5 lnKD_{t-1} + \gamma_6 open\_fin_t + \gamma_7 inflation\_s.d_t + \gamma_8 manufactuirng_t + \varepsilon_{3t}$$

- Simultaneous equation system estimated using 3SLS
- 30 advanced economies and 25 major emerging economies from 1972 to 2007
- Six time periods: 1972-1978, 1979-1983, 1984-1989, 1990-1994, 1995-1999, and 2000-2007
- Annual variables are averaged for each defined period

Definition of variables and data sources

Variable Name	Definition	Data Source
$\Delta lnTFP_{t-1}$	log growth of TFP in period t-1	Total Economy Database, The Conference Board
$\Delta lnTFP_t$	log growth of TFP in period t	Total Economy Database, The Conference Board
$ln(LP_{t-1})$	log level of labor productivity (output and employment ratio) in period t-1	Total Economy Database, The Conference Board
ln(life$_t$)	log level of life expectancy at birth in period t	World Development Indicators, World Bank
open$_t$	trade openness at current price in period t (share of import and export among GDP)	Penn World Table 7.0
edu$_t$	educational attainment for population aged 25 and over in period 6	Barro-Lee data
Old Dependency$_t$	old age dependency ratio in period t, (population above 64 over working age population)	International Data Base, US Census Bureau
Young Dependency$_t$	youth age dependency ratio in period t, (population below 15 over working age population)	International Data Base, US Census Bureau
$ln(KD_{t-1})$	log level of the average capital deepening (capital stock-employment ratio) in last two years of the previous peirod	Total Economy Database, The Conference Board
Depreciation$_t$	weighted depreciation rate across 6 asset types in period t	Author's own calculation
open_fin$_t$	financial openness in period t	Chinn-Ito Index
Inflation$_t$	inflation rate in period t (average consumer prices, percent change, standardized)	World Economic Outlook Database, IMF
Inflation_s.d$_t$	standard deviation of inflation rate in period t	World Economic Outlook Database, IMF
Saving$_{t-1}$	saving's rate in period t (100 - consumption share of PPP converted GDP per capita at current prices)	Penn World Table 7.0
$\Delta lnpop_t$	log growth of working age population in period t	International Data Base, US Census Bureau
Manufacturing$_t$	manufacturing share in period t, value added as percentage of GDP	World Development Indicators, World Bank
Services$_t$	services share in period t, value added as percentage of GDP	World Development Indicators, World Bank

Estimation results of simultaneous equations system: TFP growth

TFP Growth	
$\Delta \ln TFP_{t-1}$	0.0861 (1.56)
$\ln(LP_{t-1})$	-1.163*** (-5.98)
$\ln(life_t)$	5.137*** (2.74)
$open_t$	0.00732*** (4.11)
edu_t	0.197*** (3.14)
constant	-11.51 (-1.58)

Interpretations

- Lagged labor productivity: convergence
- Life expectancy: better health condition
- Education: better knowledge and skills
- Trade openness: specialization

Estimation results of simultaneous equations system: savings rate

Savings	
Old Dependency$_t$	**-0.846*** (-7.01)**
Young Dependency$_t$	**-0.170*** (-3.67)**
ln(KD$_{t-1}$)	**4.732*** (7.08)**
Depreciation$_t$	**2.575*** (4.36)**
open_fin$_t$	**1.244*** (3.05)**
Inflation$_t$	**-1.807*** (-2.91)**
Services$_t$	**-0.615*** (-9.12)**
Constant	**15.32* (1.82)**

Interpretations

- Dependency ratio: old and young cohorts are major consumers of education and health care
- Financial openness: better financial instruments to invest
- Inflation: depreciates money value
- Services: government funded social services, education and health care

Estimation results of simultaneous equations system: capital services growth

Capital Services Growth	
$\ln(KD_{t-1})$	-1.033*** (-6.01)
$Depreciation_t$	0.218 (1.30)
$open\_fin_t$	0.247** (2.23)
$\Delta lnTFP_t$	0.284* (1.88)
$Saving_{t-1}$	0.0462*** (2.71)
$\Delta lnpop_t$	0.301* (1.67)
$Inflation\_s.d_t$	-0.00284*** (-2.73)
$Manufacturing_t$	0.0889*** (3.21)
Constant	10.30*** (4.76)

Interpretations

- Lagged capital deepening: convergence
- Financial openness: easy access to investment capital
- TFP: higher efficiency
- Savings: available capital for investment
- S.D. of inflation: unstable macro condition deters investment
- Manufacturing: most capital intensive

Projections of capital services growth and TFP growth

- Simultaneous equation system is estimated using the actual data from periods 1 to 6. The estimated coefficients are then used to derive projections for period 7 (2008-16) and period 8 (2017-25)
- Exogenous variables can be grouped into three categories
  - ✓ Future values are given: old and young dependency ratio, growth in working age population (IDB of US Census Bureau)
  - ✓ Lagged variables: TFP growth, savings rate, labor productivity and capital deepening. Values for period 8 are calculated based on the projection of period 7.
  - ✓ Contemporaneous variables
    - inflation, s.d. of inflation, manufacturing and services share in total value added
    - Policy variables: life expectancy, trade and financial openness, education attainment

Projections of capital services growth and TFP growth, base, optimistic and pessimistic scenarios

- Inflation, s.d. of inflation, manufacturing and services share in total value added: use period 6's values for period 7 & 8
- Base scenario: four policy oriented variables (life expectancy, trade and financial openness, education attainment) are kept the same as their period 6 value for period 7 & 8
- Optimistic scenario: improve the four policy oriented variables in period 7 & 8 by adding three standard deviation onto its period 6 value
- Pessimistic scenario: four policy oriented variables decrease by three standard deviation from their respective period 6 value in period 7 and 8

Projection on GDP growth and its components for major countries, base scenario (%)

	Average growth 96-07	Average annual growth 2008 - 2016 (projection)					Average annual growth 2017 - 2025 (projection)				
		GDP	Labor Quantity	Labor Composition	Capital Services	TFP	GDP	Labor Quantity	Labor Composition	Capital Services	TFP
U.S.	3.0	2.1	0.3	0.2	1.1	0.6	1.9	0.2	0.1	1.1	0.4
France	2.2	1.1	0.1	0.2	0.6	0.3	0.9	0.0	0.2	0.5	0.2
Germany	1.6	2.2	-0.2	0.1	1.3	1.0	1.3	-0.5	0.1	1.0	0.8
Italy	1.5	1.7	0.2	0.1	1.3	0.2	1.2	-0.1	0.1	1.0	0.2
U.K.	2.9	1.3	0.2	0.1	0.8	0.2	1.1	0.1	0.1	0.8	0.0
Japan	1.4	1.8	-0.6	0.1	1.3	0.9	1.3	-0.4	0.2	0.9	0.6
China	9.1	6.5	0.2	0.1	3.8	2.5	4.3	-0.1	0.1	2.8	1.5
India	6.8	4.8	0.9	0.2	2.8	1.0	3.6	0.6	0.2	2.3	0.5
Brazil	2.9	3.5	0.5	0.2	2.2	0.6	3.1	0.4	0.1	2.1	0.5
Russia	4.0	2.8	-0.3	0.1	1.4	1.6	1.2	-0.5	0.1	0.9	0.7

Comparison of Projections of GDP growth among difference sources

	TCB, base scenario		Jorgenson	Lee and Hong	Fogel	Goldman Sachs			PWC	IMF
	2013-2016	2017-2025	2006-2016	2011-30	2000-2040	2006-2015	2015-2020	2020-2025	2009-50	2013-2017
France	1.1	0.9	1.3			1.8	1.8	1.7	1.7	1.7
Germany	2.2	1.4	1.2			1.7	1.1	0.6	1.3	1.3
Italy	1.7	1.2	0.3			1.5	1.4	0.9	1.4	0.7
Japan	1.8	1.3	0.9		1.1	1.3	1.5	1.3	1	1.4
U.K.	1.3	1.1	1.7			2.3	1.8	1.4	2.3	2.5
U.S.	2.2	1.9	3		3.8	2.3	2.1	2.2	2.4	3.1
Brazil	3.6	3.1	1.2			3.9	3.8	3.7	4.4	4.1
China	6.8	4.4	8.6	5.5	8.4	7.7	5.4	4.6	5.9	8.7
India	4.9	3.7	6.1	4.5	7.1	6.6	5.9	5.9	8.1	7.7
Russia	2.8	1.2	4.3			4.3	3.2	3.1	4	3.9
Advanced	2.1	1.7								
Emerging	5.1	3.6								
World	3.6	2.7	3.3		5					3.7

TCB projections are converted from log growth to percentage growth for comparison purpose

Projected GDP growth in three scenarios by region (%)

	Base Scenario		Optimistic Scenario		Pessimistic Scenario	
	2013-2016	2017-2025	2013-2016	2017-2025	2013-2016	2017-2025
United States	2.1	1.9	2.4	2.1	1.9	1.7
EU-15*	1.8	1.4	2.4	1.9	1.3	0.9
Japan	1.8	1.3	2.1	1.6	1.4	0.9
Other Advanced**	3.0	2.0	3.7	2.7	2.4	1.4
Advanced	2.1	1.7	2.5	2.1	1.7	1.3
China	6.5	4.3	7.1	4.8	6.0	3.7
India	4.8	3.6	5.4	4.2	4.3	3.1
Other Developing Asia	5.6	4.6	6.2	5.1	5.0	4.0
Latin America	3.6	3.0	4.3	3.8	2.8	2.3
Middle East	3.5	2.4	4.3	3.3	2.6	1.6
Africa	3.8	3.4	4.6	4.2	3.0	2.5
Central & Eastern Europe	2.4	1.6	3.0	2.2	1.8	1.0
Russia and Other CIS***	2.8	1.2	3.5	1.9	2.1	0.5
Emerging and Developing Economies	5.0	3.6	5.6	4.2	4.4	3.0
World	3.5	2.7	4.0	3.2	3.0	2.1

**EU-15 refers to states that joined the European Union before 2004.*
***Other advanced economies include Canada, Switzerland, Norway, Israel, Iceland, Cyprus, Korea, Australia, Taiwan, Hong Kong, Singapore, New Zealand and Malta.*
****CIS is Commonwealth of Independent States which includes all former republics of the Soviet Union, excluding the Baltic States.*

Key findings on GDP projections, I

- Recession caused advanced economies to grow below their projected trend growth between 2008 – 2016
- US is projected to outperform Europe in 2013-2016 by a small margin (2.1% vs. 1.8% respectively)
- Overall GDP growth for advanced economies will slow from 2.1% to 1.7% from 2008-2016 period to 2017-2025 period
- During the past four years, emerging and developing economies have grown beyond their growth trend of 2008-2016. Such high growth rate is unlikely to continue for long
- China and India will begin to show signs of maturing beyond 2012, their trend growth will begin to slow from 2013-2016 to 2017-2025 (from 6.5% to 4.3% in China and 4.8% to 3.6% in India.)

Key findings on GDP projections, II

- Emerging economies' growth will slow to 3.6 percent on average from 5.0 percent from 2013-2016 to 2017-2025
- Global growth of GDP is projected to grow at 3.5 percent from 2013-2016, and then show a further slowdown to 2.7 percent from 2017-2025
- In the optimistic scenario, favorable policies will add half of the percentage point to the world GDP growth for both periods (4% and 3.2%for 2013-2016 to 2017-2025 respectively). Emerging and developing economies will benefit more than advanced ones
- In the pessimistic scenario, world GDP will grow at an average of 3 percent for the next 4 years and further decrease to a mere 2.1 percent on average between 2017 to 2025

Conclusion and next steps

- The growth accounting framework provides a good starting point for projecting output growth in the medium and long term
- The different methods are strongly dependent on the approach to estimate capital and TFP growth rates
- Cyclical adjustments are needed to bridge the short-term and medium- and long-term trend growth, and to adjust the deviation of the actual GDP growth influenced by shocks and the convergence path to its long-term trend growth