Long-Term Growth in Developing Countries

Steven Pennings
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Contact: spennings@worldbank.org. Long Term Growth Model (LTGM) available at http://www.worldbank.org/LTGM. Disclaimer: The views expressed here are the author’s and do not necessarily reflect those of the World Bank, its Executive Directors, or the countries they represent.
Outline of the talk

This talk:
• Long Term Growth Model (LTGM): a suite of papers and tools to simulate future long-term growth in developing countries.

Part 0: Motivation and Introduction

Part 1: Long Term Growth Model (LTGM) (basic version)

Part 2: Extensions to the basic LTGM (Overview)
Why is economic growth important?

• Economic growth is a main driver of higher living standards and economic development.
  • Highly correlated with other measures like the Human Development Index (UNDP) and median incomes.
  • An absence of growth creates other problems like debt crises, unemployment, social unrest.

• Sustained and inclusive long-run growth is central to achieving the World Bank Twin Goals:
  • Ending extreme poverty (Kraay 2006)
  • Boosting shared prosperity – Incomes of the Bottom 40% (Dollar, Kleineberg and Kraay 2015)
Large countries/regions (>1bn): growth and poverty over past 30yrs

- Average GDP PC growth 1990-2020: 8% China, 4% for India, 0.8% for Sub-Saharan Africa

Source: WDI (SI.POV.DDAY).
This talk: the Long Term Growth Model (+ extensions)

• Developing countries want to grow at high rates over the next 30 years:
  • What growth rates are feasible?
  • How to achieve growth goals?

• This talk discusses Long Term Growth Model (LTGM)
  • Spreadsheet-based toolkit (and papers) to answer these questions
  • Designed for simplicity, transparency, ease-of-use and low data requirements.
  • Long-term focused (other tools like MFMOD or Oxford Model are short-term focused).

• LTGM based on the neoclassical Solow-Swan growth model
  • Savings & investment are key; also productivity (TFP), human capital, demographics, FLFP

• Extensions: TFP, Public investment, human capital (HCI), Natural Resources.
What can we learn from the LTGM about growth? Five takeaways

1. Growth performances, constraints and opportunities are *heterogeneous*.

2. Investment-led growth strategies are *unsustainable* in the long run.
   - Growth rates will fall as due to the diminishing marginal productivity of capital
   - Need to have broad-based growth – human capital, productivity, labor force participation.

3. Hard to have high investment rates without high *savings rates*.

4. Higher public investment yields only a modest boost to growth (*no miracles*)
   - Boost to growth no larger in low-income than high-income countries, and is transitory.
   - Level of public investment efficiency has *no effect* on impact on growth (if constant).

5. Fast growth usually involves fast *productivity* (TFP) growth.
   - Human capital growth important too, but less than TFP and operates with a lag.
Some examples of work using the LTGM

Used in CEMs, SCDs and other growth work all over the world (around 45 countries):

• **Sub-Saharan Africa**: Cameroon (CEM), Cape Verde (SCD), Central African Republic (CEM), Eswatini, Gabon, Guinea (SCD), Seychelles (SCD), Ghana (SCD), Malawi, South Africa, Ivory Coast, Mauritania, Niger, Zambia (SCD), Zimbabwe

• **South Asia**: Bangladesh, India, Nepal (CEM), Sri Lanka (CEM)

• **Latin America & Caribbean**: Argentina, Brazil, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Peru

• **East Asia & Pacific**: Cambodia, Korea, Laos, Malaysia, Philippines, Vietnam, Thailand

• **Europe and Central Asia**: Azerbaijan (CEM), Armenia (SCD), Bosnia, Bulgaria, Georgia (SCD), Kyrgyz Republic (SCD), Tajikistan (CEM)

• **MENA**: Egypt (CEM), Syria

• **Honduras, Panama, Peru, Zambia, Bangladesh, Malaysia, Cambodia** – Training for govt officials
LTGM developed by team as DEC-MTI partnership

co-TTLs:

Norman Loayza
Steven Pennings

Team:

- Spreadsheet & model development:
  - Jorge Guzman and Leonardo Garrido.

- Early versions: Constantino Hevia

- LTGM Extensions: Sharmila Devadas, Young Kim, Fabian Mendez, Arthur Mendes.

- MTI coordination & support: Vinaya Swaroop

- Data analysis: Diego Barrot and Federico Fiuratti

- Feedback from dozens of country economists

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All LTGM papers and toolkits can be freely downloaded at: www.worldbank.org/LTGM
Questions we try to answer (and not answer)

• **Do** try to answer:
  • What growth rates *if* trends in growth fundamentals continue (business as usual)?
  • What growth rates are feasible?
  • How can countries boost long term growth (in terms of growth fundamentals)?

• **Not** try to answer:
  • What growth rates *will* occur? → Difficult to forecast long-run growth
  • Possible growth paths in short term? → LTGM wrong type of model (no demand side)
  • What *specific policies* will boost growth? → Country context & lack of exogenous policies
LTGM Conceptual Approach

Policies → “Solow growth fundamentals” → Growth

1. Country economists & counterparts to analyze country-specific constraints
   • Also bring in country-specific studies (e.g. firm-level TFP)

2. The LTGM conducts “future growth accounting” – *proximate* determinants
   • Use the minimum amount of theory → makes the relationship more robust.

• Modelling forces us to be explicit about assumptions, mechanism and dynamics
Outline of the rest of the talk

Part 1: Long Term Growth Model (LTGM) (basic version)

Part 2: Extensions to the basic LTGM (Overview)
1. The basic LTGM

- Model Overview
- Common results
- Using the model
- The effect of growth on poverty
- Policy application to long run growth in Cambodia
A Simple Model with 3 building blocks

1. Production Function

\[ Y_t(GDP) = A_t K_t^{1-\beta} (h_t L_t)^\beta \]

2. Capital Accumulation

\[ K_{t+1} = (1 - \delta) K_t + I_t \]

3. Demographics and Labor Market (for GDP Per Capita, \( y_t^{PC} \)):

\[ y_t^{PC} = \frac{Y_t}{N_t} = \left[ \frac{Y_t}{L_t} \right] \frac{L_t}{W_t} \frac{W_t}{N_t} = \left[ A_t k_t^{1-\beta} h_t^\beta \right] \rho_t \omega_t \]

\((A_t: \text{TFP}; K_t: \text{capital stock}; h_t: \text{human capital per worker}; L_t: \text{number of workers}; I_t: \text{investment})\)

\((W_t: \text{working-age pop}; N_t: \text{total pop}; \rho_t: \text{labor participation rate}; \omega_t: \text{working-age-pop. to pop. ratio}; k_t: \text{capital/worker})\)
Growth Drivers

\[ g_{y,t+1} \approx g_{A,t+1} + \beta (g_{h,t+1} + g_{\omega,t+1} + g_{N,t+1} + g_{\rho,t+1}) + \left[ \frac{1-\beta}{K_t/Y_t} \right] I_t - (1-\beta)\delta \]

• **Common policy message (1):** investment-led growth [by itself] is not sustainable in long run
  • K/Y increases over time because of higher rates of investment
  • Leads to a fall in \( MPK = \frac{1-\beta}{K_t/Y_t} \) (diminishing returns)
    • Each extra unit of investment adds less to growth than the previous one
    • Investment-led growth rate will fall over time

• **Policy advice:** Investment to be accompanied by other sources (e.g., human capital, TFP, LF participation) – a broad-based growth strategy.
How to fund investment?

\[
\frac{I_t}{Y_t} = \frac{S_t}{Y_t} + \frac{CAD_t}{Y_t}
\]

Investment \hspace{1cm} \text{Savings} \hspace{1cm} \text{Current account deficit}

Current Account Deficit and External Debt approximation (assuming \(\Delta NFA_t \approx 0\))

\[
\frac{CAD_t}{Y_t} \approx \frac{FDI_t}{Y_t} + \frac{D_t}{Y_t} - \frac{D_{t-1}/Y_{t-1}}{(1 + g_t^Y)}
\]

Foreign Direct Inv. \hspace{1cm} \text{Change Total External Debt}

- **Common policy message (2):** need to increase savings or attract FDI to fund investment plans
Saving and Investment
Average, 1980-2008

Source: Hevia & Loayza (2012)
Using the Basic LTGM: 3 Steps

1. **Calibration:** three variables: $\beta$ (labor share), $\delta$ (depreciation) and $K_0/Y_0$
   - Increases in $\beta$, $\delta$, $K/Y$ make fast growth more difficult. Can usually calibrate from PWT (preloaded)

2. **Baseline:** Choose future paths of growth drivers (Solow fundamentals):
   - TFP, Human Capital, Demographics (e.g. from UN) - using trends or peer countries
   - Calibrate a path for investment – based on trends, peers or constraints (Submodel 1)

   → Generates “business as usual” baseline path for Growth, GDPPC, and poverty

3. **Scenarios:** Change growth drivers (TFP, HC, Inv etc) to see how growth and poverty respond

Other exercises:
- Start with a growth/poverty target, and calculate required investment to reach (Submodel 2)
- Start with a savings/debt constraint (rather than investment) and calculate growth (Submodel 3)
Growth and Poverty

• Policymakers want to know how growth will affect poverty rates:
  • Usually complicated as need microdata on whole income distribution for all countries

• LTGM uses log-normal approx. of income distribution, requires only 2 data points:
  • Initial poverty rate and Gini coeff. inequality
  • Lopez & Serven (2006) – “well approximated”

• If unchanged Gini, 5% growth increases all incomes by 5% - distribution shift right

• Larger effect of growth on poverty if
  • More people near poverty line
  • More equal income distribution (lower Gini)


- **Context:** GDPPC growing strongly (≈5%) surrounded by countries with robust growth.

- **Goals:** Cambodian govt had ambitious growth goals (relative to ≈ $1200 in 2017):
  - Upper Middle Income (≈$4000pc) by 2030.
  - High income country (≈$12000pc) by 2050.

- What rates of growth under current trends ("business as usual")?

- **Calibrated:** Solow fundamentals to historical averages e.g. Inv/GDP 20-22% (also TFP, HC etc)

- **LTGM Simulation:** baseline growth is rapid, but falls short of ambitious growth targets.

What growth rates are feasible? How to achieve growth goals?

- Human Capital & TFP growth already fast in baseline
  - Maintaining that pace already challenging

- But some peer countries had higher investment:
  - “Investing like Korea” scenario → 33% Inv/GDP (v. ambitious)
  - “Investing like Malaysia” scenario → 28% Inv/GDP

- Challenges:
  1. High investment can become less effective over time at boosting growth (lower MPK, higher [marginal] ICOR)
  2. How fund investment? Peer countries have much higher savings rates (Cambodia S/Y≈10%).
  3. High investment can overheat economy.
Scenario results and Policy Options

- 2030 target difficult to reach, even with the most optimistic assumptions
  - Suggest less ambitious 2030 target.
  - Focus on sustaining growth and avoiding imbalances

- 2050 target is possible, but only with much higher long run investment and savings.
  - Reforms to encourage financial sector development and improving business environment

**FIGURE S17: Cambodia GNI PC Level**
(with Korean investment rates from 2030)

Part 2. Extensions to the basic LTGM (overview)

2.1 TFP Extension

\[ Y_t(GDP) = A_t K_t^{1-\beta} (h_t L_t)^{\beta} \]

2.2 Public Capital

\[ Y_t(GDP) = A_t K_t^{1-\beta} (h_t L_t)^{\beta} \]

2.3 Human Capital

\[ Y_t(GDP) = A_t K_t^{1-\beta} (h_t L_t)^{\beta} \]

2.4 Natural Resources

\[ Y_t(GDP) = A_t K_{0,t}^{1-\beta} (h_t L_t)^{\beta} + p_t^{oil} Q_t^{oil} \]
2.1 LTGM-TFP (Kim & Loayza 2019)

- Literature review on the determinants of TFP
- Form TFP determinant index \((\text{Index}_{c,t})\)
  - Principal components of data in 5 areas
- Run cross-country regression:
  - Connect *determinant index* to TFP growth:

\[
\text{Ave. TFP growth}_{c,t,t-5} = \beta_1 \ln(\text{Index}_{c,t-5}) + \beta_2 \ln(\text{TFP level})_{c,t-5} + \delta_t + \theta_c
\]

- Higher index \(\rightarrow\) faster TFP growth \((\hat{\beta}_1 = 0.05^{***})\)
Example: increasing determinant index to regional leader

- **Scenario:** increase determinant index to the regional leader over 15 years.

- **Result:** Substantial TFP Growth by t+15:
  - 2-2.5% in EAP & SSA

- **Growth:** TFP growth path → main LTGM
  - SR: boost GDP growth one-for-one
  - LR: 1.5-2 times (incl. effect via K)

**Region** | **Highest Index in 2014**
--- | ---
East Asia & Pacific (EAP) | South Korea
Europe & Central Asia (ECA) | Czech Republic
Latin America & Caribbean (LAC) | Chile
Middle East & North Africa (MENA) | United Arab Emirates
South Asia (SAR) | India
Sub-Saharan Africa (SSA) | South Africa

Source: Kim and Loayza (2019)
2.2 LTGM-Public Capital (Devadas & Pennings 2018)

- Public capital ("essential infrastructure") thought to boost productivity of other factors.

- Modify production function for infrastructure services $S_t$ provided by public capital $K_t^G$:

$$Y_t = A_t S_t (K_t^P)^{1-\beta} \phi (h_t L_t)^\beta \quad \text{where} \quad S_t = [\theta_t K_t^G]^\phi$$

- Allows for lower "efficiency" ($\theta_t < 1$) of public investment (corruption etc)

- Level of efficiency $\theta < 1$ has no effect on impact of public inv. on growth (Berg et al 2015)

$$g_{Y,t+1} \approx \cdots + \left[ \frac{\phi}{\theta_t K_t^G / Y_t} \right] \theta_t^N I_t^G \frac{\theta_t N I_t^G}{Y_t}$$

Greater need for $K_G : \theta < 1$ increases $MPK_G$
LTGM-Public Capital: Main Findings

- Permanent ↑public investment provides **modest** boost to growth.
  - ↑0.15-0.2ppt in short run (excluding multiplier effects).
- Boost to growth is **temporary** (falling MPK for public capital)
  - 0.05-0.1ppt after 30 years
- Helpful, but not a growth miracle
- No larger effect if **low income**
  - Effect size depends on $K_t^G/Y$, not shortage of public K.
- Heterogeneous effects: LTGM-PC toolkit for individual countries

**Effect of Public Investment on Growth**

1ppt GDP permanent increase in public investment

Source: Devadas and Pennings (2018), Graph 3, Congestion ($\phi = 0.17$) specification.
2.3 LTGM-Human Capital (beta version) \[ Y_t(GDP) = A_t K_t^{1-\beta} (h_t L_t)\beta \]

- \(h_t\) is the productivity of average worker (relative to unskilled) due to human capital
  - Basic LTGM only based only on their years of schooling (Mincer return)

LTGM-Human capital makes two changes:

1. Broader HC definitions based on the WB Human Capital Index (HCI)
   - Learning-Adjusted Years of Schooling (includes quality) + health measures

2. Trace human capital over time by population cohorts (as in Collin and Weil 2018)
   - Reforms affecting today’s children, who are not in labor force
   - Delayed effect on \(h_t\) and GDP growth in when then those children join the workforce.
Malaysia example: \( \uparrow \) Education quality & health to HI median

Common result: Education quality has largest effect on growth and health has smallest

2.4 LTGM-Natural Resource Extension (beta version)

- LTGM-NR adds commodity sector (e.g. Oil, but could also be copper, gold etc)

\[ Y_t(GDP) = A_t K_{0,t}^{1-\beta} (h_t L_t)^{\beta} + p_{t}^{oil} Q_{t}^{oil} \]

- Commodity production \( Q_{t}^{oil} \) depends on oil capital stock and oil reserves

- Govt taxes oil production → invest revenues, spend them or save them abroad (fiscal rule)

- LTGM-NR finding (1): commodity price shocks have no direct effect on real potential GDP (only have indirect effect, mostly through fiscal policy).
  - Constant export prices (Kehoe & Ruhl 2008) (models does not consider demand side)

- LTGM-NR finding (2): fiscal rules that invest revenues have fastest growth (Hartwick Rule)
Conclusions

• Growth in developing countries → living standards and World Bank twin goals

• LTGM: simple & transparent toolkit to simulate future growth paths
  • Based on neoclassical Solow-Swan Model
  • Investment, savings, TFP growth, human capital, demographics etc

• Many extensions (TFP, Public capital, HC, Natural Resources)

• Future work: incorporating climate change
Key Takeaways

Five common findings when applying the Long Term Growth Model:

1. Heterogeneity in terms of quantitative impacts
2. Investment-led growth not sustainable in long run $\rightarrow$ broad-based strategy
3. Hard to have high investment without high savings
4. Public investment usually doesn’t generate a growth miracle (but is helpful)
5. Fast TFP growth usually needed (human capital helps, but operates with a delay)
Questions and Comments

• LTGM papers and toolkits can be freely downloaded at: www.worldbank.org/LTGM

• Contact about LTGM: spennings@worldbank.org
References


• Kehoe, T. and K. Ruhl. 2008. “Are shocks to the terms of trade shocks to productivity?” RED, 11(4): 804-819,

References (continued)


