CEE Growth & Development

UPCES
Lecture 13

Fall Semester, 2014

- Cobb-Douglas Production Function

$$Y_t = A K_t^{\alpha} L_t^{1-\alpha}$$

- Fundamental Law of Motion

$$\Delta K_t = s \cdot Y_t - \delta \cdot K_t$$

- Steady state

  1. $L_{t+1} = L_t$: GDP and GDPpc are in steady state

$$\frac{\Delta Y_t}{Y_t} = \frac{\Delta y_t}{y_t} = 0 \left[= \frac{\Delta L_t}{L_t} \right]$$

Cobb-Douglas Production Function

$$Y_t = AK_t^\alpha \left(hL_t\right)^{1-\alpha}$$

- Factors of production
  - capital
  - labour
  - human capital

$$\underbrace{Y_t}_{output} = \overbrace{A}^{productivity} \bullet \underbrace{K_t^\alpha \left(hL_t\right)^{1-\alpha}}_{factors\ of\ productin}$$

Definitions

Productivity is the effectiveness with which factors of production are converted into output.

Development accounting

- Productivity

$$A_t = \frac{Y_t}{K_t^\alpha \left(hL_t\right)^{1-\alpha}}$$

Development accounting

- Productivity

$$A_t = \frac{Y_t}{K_t^{\alpha} (hL_t)^{1-\alpha}}$$

- Ratio of productivity

$$\frac{A_t^{MD}}{A_t^{US}} = \frac{\dfrac{Y_t^{MD}}{\left(K_t^{MD}\right)^{\alpha} \left(h^{MD} L_t^{MD}\right)^{1-\alpha}}}{\dfrac{Y_t^{US}}{\left(K_t^{US}\right)^{\alpha} \left(h^{US} L_t^{US}\right)^{1-\alpha}}}$$

Growth accounting

- Production

$$
\begin{aligned}
Y_t &= A_t K_t^{\alpha} \left(h_t L_t \right)^{1-\alpha} \\
y_t &= A_t k_t^{\alpha} h_t^{1-\alpha}
\end{aligned}
$$

Growth accounting

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- in log

$$\ln y_t = \ln A_t + \alpha \ln k_t + (1-\alpha) \ln h_t$$

Growth accounting

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Y_t &= A_t K_t^{\alpha} \left(h_t L_t \right)^{1-\alpha} \\
y_t &= A_t k_t^{\alpha} h_t^{1-\alpha}
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- in log

$$
\ln y_t = \ln A_t + \alpha \ln k_t + (1 - \alpha) \ln h_t
$$

- growth rate (i.e. derivative of log)

$$
\frac{\dot{y}}{y} = \frac{\dot{A}}{A} + \alpha \frac{\dot{k}}{k} + (1 - \alpha) \frac{\dot{h}}{h}
$$

$$
\begin{aligned}
\textit{Total Growth} &= \textit{Productivity Growth} + \textit{Factor Growth} \\
\textit{Total Growth} &= \textit{Intensive Growth} + \textit{Extensive Growth}
\end{aligned}
$$

Econometric examples

Growth Accounting Results for Central and Eastern European Countries, 1970-1997

		Output growth	TFP growth	Factor growth			Output growth	TFP growth	Factor growth
Bulgaria	Avg. 1971-97	1.1	0.8	0.3	Poland	Avg. 1971-97	2.7	0.9	1.8
	Avg. 1971-80	6.9	4.6	2.3		Avg. 1971-80	5.9	2.7	3.2
	Avg. 1981-90	1.9	2.1	-0.2		Avg. 1981-90	0	-0.3	0.3
	Avg. 1991-97	-8.8	-6.2	-2.6		Avg. 1991-97	1.8	0.1	1.7
Croatia	Avg. 1971-95	1.1	1.1	0	Romania	Avg. 1971-97	3.1	1.9	1.2
	Avg. 1971-80	5.7	3.3	2.4		Avg. 1971-80	9.4	5.6	3.8
	Avg. 1981-90	-0.8	0.9	-1.7		Avg. 1981-90	0.4	1.3	-0.9
	Avg. 1991-95	-4.2	-3.2	-1.0		Avg. 1991-97	-2.4	-2.4	0
Czech R.	Avg. 1971-97	0.5	-0.6	1.1	Slovak R.	Avg. 1971-97	2.1	0.8	1.3
	Avg. 1971-80	3.4	1.7	1.7		Avg. 1971-80	5.1	2.9	2.2
	Avg. 1981-90	0.8	0.2	0.6		Avg. 1981-90	1.5	0.8	0.7
	Avg. 1991-97	-4.2	-5.1	0.9		Avg. 1991-97	-1.6	-2.3	0.7
Hungary	Avg. 1971-96	2.8	2.4	0.4	Slovenia	Avg. 1971-95	3.7	2.6	1.1
	Avg. 1971-80	4.9	3.2	1.7		Avg. 1971-80	5.7	2.7	3.0
	Avg. 1981-90	1.1	2.1	-1.0		Avg. 1981-90	-0.9	-0.3	-0.6
	Avg. 1991-96	1.9	1.6	0.3		Avg. 1991-95	8.9	7.9	1.0

Source: Campos & Coricelli (2002)

Econometric examples

Growth Accounting Results for Former Soviet Union Countries, 1970-1997

		Output growth	TFP growth	Factor growth				Output growth	TFP growth	Factor growth
Armenia	Avg. 1971-97	0.9	-0.8	1.7	Latvia	Avg. 1971-97		-0.1	-0.4	0.3
	Avg. 1971-80	6.4	2.3	4.0		Avg. 1971-80		3.6	1.4	2.2
	Avg. 1981-90	1.6	-0.6	2.2		Avg. 1981-90		2.3	1.3	1.0
	Avg. 1991-97	-7.9	-5.6	-2.2		Avg. 1991-97		-8.6	-5.3	-3.4
Azerbaijan	Avg. 1971-97	-0.6	-2.9	2.3	Lithuania	Avg. 1971-97		0.8	-0.3	1.1
	Avg. 1971-80	6.1	2.6	3.5		Avg. 1971-80		2.8	0.0	2.8
	Avg. 1981-90	0.1	-2.3	2.4		Avg. 1981-90		3.7	2.3	1.4
	Avg. 1991-97	-11.5	-11.8	0.4		Avg. 1991-97		-6.3	-4.5	-1.8
Belarus	Avg. 1971-97	2.0	0.5	1.5	Moldova	Avg. 1971-97		-1.6	-2.5	0.9
	Avg. 1971-80	5.5	2.2	3.3		Avg. 1971-80		3.7	0.6	3.0
	Avg. 1981-90	3.1	1.5	1.6		Avg. 1981-90		2.1	0.9	1.2
	Avg. 1991-97	-4.5	-3.3	-1.2		Avg. 1991-97		-14.4	-11.9	-2.5
Estonia	Avg. 1971-97	1.1	0.2	0.9	Russia	Avg. 1971-97		0.1	-1.0	1.1
	Avg. 1971-80	3.8	1.4	2.4		Avg. 1971-80		3.9	1.1	2.8
	Avg. 1981-90	1.6	0.5	1.0		Avg. 1981-90		1.3	-0.3	1.6
	Avg. 1991-97	-3.4	-2.2	-1.2		Avg. 1991-97		-7.0	-5.4	-1.6
Georgia	Avg. 1971-97	-2.0	-2.8	0.8	Ukraine	Avg. 1971-97		-1.6	-2.4	0.8
	Avg. 1971-80	5.3	2.7	2.6		Avg. 1971-80		2.9	0.6	2.2
	Avg. 1981-90	0.0	-1.6	1.6		Avg. 1981-90		1.6	0.7	0.9
	Avg. 1991-97	-15.0	-12.2	-2.9		Avg. 1991-97		-12.5	-11.2	-1.3

Source: Campos & Coricelli (2002)

Econometric examples

Figure 4. Sources of Growth in Transition Economies, 1996–2006
(In percentage points of GDP)
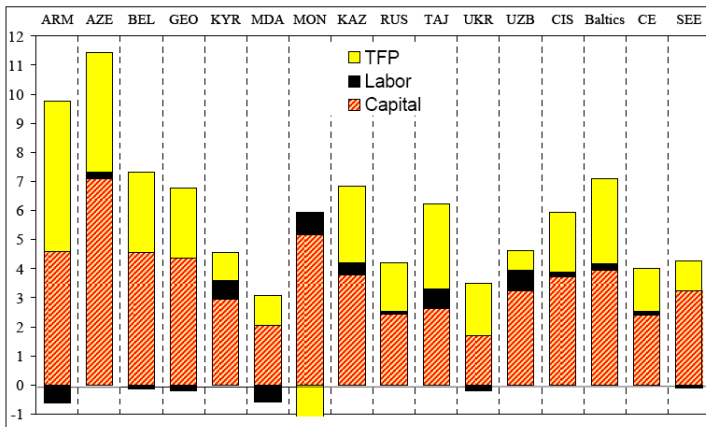
Source: Iradian, G. (2007). Rapid Growth in Transition Economies: Growth Accounting Approach. IMF WP164. p.16.

Productivity

$$Y_t = A_t K_t^{\alpha} \left(h_t L_t \right)^{1-\alpha}$$

$$\underbrace{Y_t}_{output} = \overbrace{A_t}^{productivity} \quad \bullet \quad \underbrace{K_t^{\alpha} \left(h_t L_t \right)^{1-\alpha}}_{factors\ of\ productin}$$

Measurement

$$A_t = \frac{Y_t}{K_t^{\alpha} \left(h_t L_t \right)^{1-\alpha}}$$

> **Definition**
>
> Productivity is the effectiveness with which factors of production are converted into output.

$$A_t = T_t \times E_t$$

Technology under Communism

Efficiency

Definition

Efficiency is avoiding a waste of time, effort, or resources

- Types of inefficiency
  - Idle resources
    - unemployment, overeducation, and the like

Efficiency

> **Definition**
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        - unemployment, overeducation, etc.
    - unproductive activities
        - (civil) wars, robbery, 'krysha', rent-seeking and kleptocracy

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        - (civil) wars, robbery, 'krysha', rent-seeking and kleptocracy
    - Misallocation of Factors

Efficiency

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- Types of inefficiency
    - Idle resources
        - unemployment, overeducation, and the like
    - unproductive activities
        - (civil) wars, robbery, rent-seeking and kleptocracy
    - Misallocation of Factors
    - Technology Blocking and Luddites
        - Creative destruction
    - Missing markets
        - e.g. financial
    - Tacit knowledge
    - Institutional inefficiencies

Technological growth

$$
\begin{aligned}
Y &= K^{\alpha} (AL)^{1-\alpha} \\
\dot{K} &= sY - \delta K \\
\frac{\dot{L}}{L} &= n, \frac{\dot{A}}{A} = g
\end{aligned}
$$

Innovation and imitation

$$A_{t+1} - A_t = u_n (\gamma - 1) A_t + u_m \left(\breve{A}_t - A_t \right)$$

$$g_t = \frac{A_{t+1} - A_t}{A_t} = u_n (\gamma - 1) + u_m (a_t - 1)$$

- innovation ferquency, u_n
- innovation jump, γ
- imitation frequency, u_m
- technological frontier, $\breve{A}_t$
- measure of 'backwardness', a_t

Innovation and imitation

- Innovation:
    - R&D, paying for R&D, Patents, 'Creative destruction'
- Imitation: Trickle up and down, Catching up & Leapfrogging