OVERVIEW OF KEY MESSAGES: MACRO 2

Carl-Johan Dalgaard
Department of Economics
University of Copenhagen

ISSUES AND REGULARITIES

1. Time series evidence: "Kaldorian Facts" and Non-Kaldorian dynamics

2. Cross Country Evidence:

   A. International growth difference

   B. International income differences

   C. Global inequality.

TIME SERIES EVIDENCE

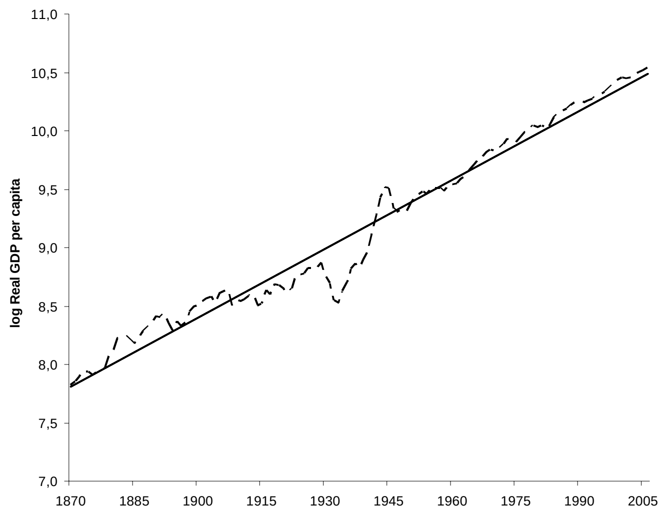

Figure 1: Log real GDP per capita in the US, 1870-2006. Data source: Johnston and Williamson (2007)

In some ways mysterious: Two world wars (total collapse of trade after no. 1; globalization again after end of 2nd), structural change (agriculture-industry-services), mass education, origin of the Welfare State (DNK); female labor participation etc.

In spite of this: constant growth at about 2% per year.

THEORETICAL PERSPECTIVE

The main way in which we can explain this "fact" is as a representation of the steady state growth path

In the Solow model (Ch. 3 and 5) we have, in the steady state, that:

$$y_t^* = \left[\left(\frac{K}{Y}\right)^*\right]^{\frac{\alpha}{1-\alpha}} A_t = \left(\frac{s}{n+\delta+g}\right)^{\frac{\alpha}{1-\alpha}} A_0 \left(1+g\right)^t \equiv y_0^* \left(1+g_y^*\right)^t$$

Hence

$$\log\left(y_t\right) = \log\left(y_0\right) + t\log\left[\left(1+g\right)\right] \approx \log\left(y_0\right) + g_y^* t$$

Hence, the "intercept" (in the figure) is given by $\left(\frac{s}{n+\delta+g}\right)^{\frac{\alpha}{1-\alpha}} A_0$, and the slope represents technological progress $g_y^* = g$.

In the *human capital* augmented model (ch. 5) the intercept also depends on the investment rate in human capital.

THEORETICAL PERSPECTIVE

In the open economy model growth in *income* per capita will also need technological change. Hence, the predictions of this model is very much like the basic Solow model.

If land enters the production function, the "Solow model" yields a slightly different result

$$y_t^* = A_0^{\frac{\beta}{1-\alpha}} \left(\frac{X}{L_0}\right)^{\frac{\kappa}{\beta+\kappa}} \left[\left(\frac{K}{Y}\right)^*\right]^{\frac{\alpha}{1-\alpha}} \left[\frac{(1+g)^{\beta/(\beta+\kappa)}}{(1+n)^{\kappa/\beta+\kappa}}\right]^t \equiv y_0 \left(1+g_y\right)^t$$

Hence, the "intercept" is *also* depends on the land-labor ratio, and the slope represents technological progress *and* population growth

$$1+g_y^* = \frac{(1+g)^{\beta/(\beta+\kappa)}}{(1+n)^{\kappa/\beta+\kappa}}$$

THEORETICAL PERSPECTIVE

In *endogenous* growth models (ch. 8) g_y is endogenously determined. In the "AK" model" $(y_t = Ak_t)$we have that

$$(k_{t+1}/k_t)^* - 1 = (y_{t+1}/y_t)^* - 1 = \frac{sA - (n+\delta)}{1+n}$$

and so

$$y_t^* = y_0^* \left(1 + \frac{sA - (n+\delta)}{1+n}\right)^t \equiv y_0 \left(1 + g_y^*\right)^t$$

Note, however, that if s (for instance) is increasing over some period in time, g (the slope in Figure 1) should be accelerating (become steeper).

It has, in the OECD, while growth has not accelerated... critique.

The learning-by-doing model might also suggest L matters to the size of g_y^*; scale effects.

THEORETICAL PERSPECTIVE

In the *semi-endogenous* growth model (ch. 8)

$$y_t^* = \left(\frac{s}{g_A^* + \delta}\right)^{\frac{\alpha + \frac{\phi}{1-\phi}}{1-\alpha}} L_0^{\frac{\phi}{1-\phi}} \left(1 + g_y^*\right)^t \equiv y_0 \left(1 + g_y^*\right)^t$$

where $1 + g_y^* \equiv (1+n)^{\frac{\phi}{1-\phi}}$. Hence, this model would suggest the *level* of population matters to the "intercept", whereas the growth rate of the labor force matters to the growth rate of output.

However: Evidence does not seem to support a positive association between g_y and n; rather a negative one.

KALDOR'S LIST OF FACTS

(1) No tendency for GDP per capita growth to decline, constant growth.

(2) Constant relative shares (wL/Y, rK/Y).

(3) Constant r.

THEORY

In general we have assumed $y_t = A_t f\left(\tilde{k}_t\right)$. Competitive markets imply

$$r = f'\left(\tilde{k}_t\right),\ w_t = A_t\left[f\left(\tilde{k}_t\right) - f'\left(\tilde{k}_t\right)\tilde{k}\right]$$

In steady state $\tilde{k}_t = \tilde{k}_{t+1} = \tilde{k}^*$. If so, r is constant. Moreover, $rK/Y = f'\left(\tilde{k}^*\right)\tilde{k}^*/f\left(\tilde{k}^*\right)$. Hence relative share are also constant *in the steady state. If* f is Cobb-Douglas ...

NON-KALDORIAN DYNAMICS

Currently poor countries rarely display the same sort of "persistency" in growth performance.

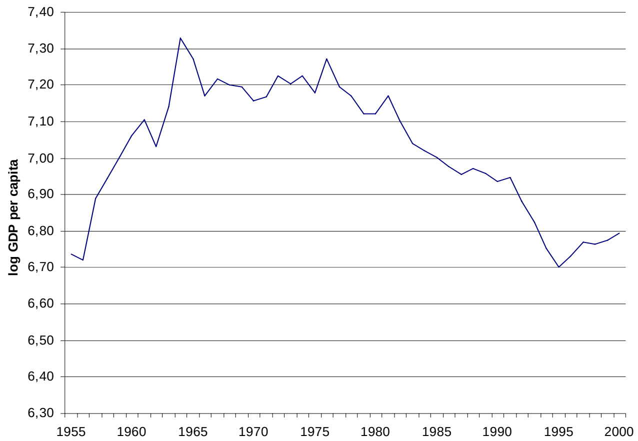

Figure 2: Growth of GDP per capita in Zambia 1955-2000 - No so Kaldorian. Data: Penn World Tables Mark 6.1.

Judged from time series evidence such as this (see also the textbook for other illustrations) it is safe to conclude that growth rates are *not* "relatively constant" over time, in poor places. We want to understand why Kaldor might be right in some places, and not in other places.

THEORY: NON-KALDORIAN DYNAMICS

In general our models are consistent with Kaldor's stylized facts, *in the steady state.* Outside the steady state we do not have (in general) constant relative shares; the real rate of return and the growth rate (in per capita GDP) are not constant either.

Outside the steady state (in the Solow model), we have (approximately)

$$g_k \approx g + \lambda \log\left(\tilde{k}^*/\tilde{k}_0\right),$$

where λ is the rate of convergence.

Hence, as $\tilde{k}$ adjusts, the growth rate declines (in absolute value), and r_t as well as $r_t k_t / y_t$ changes (in general).

CROSS-COUNTRY EVIDENCE

A. GROWTH DIFFERENCES

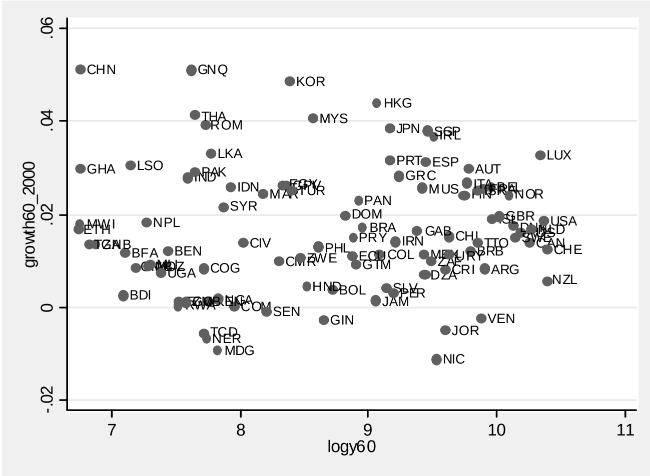

Figure 3: Growth in GDP per worker 1960-2000 vs. log GDP per worker 1960, 97 countries. Data source: Penn World Tables 6.2

Note: Some countries have been shrinking, on average, for 40 years! Large growth differences: Up to 7 percent per year!

Note also: Initially poor are not "outgrowing" initially rich; similar to "Gibrat's Law of Proportionate Effect" (firm's).

A. GROWTH DIFFERENCES

If we focus attention ot countries that are "similar", another picture emerges

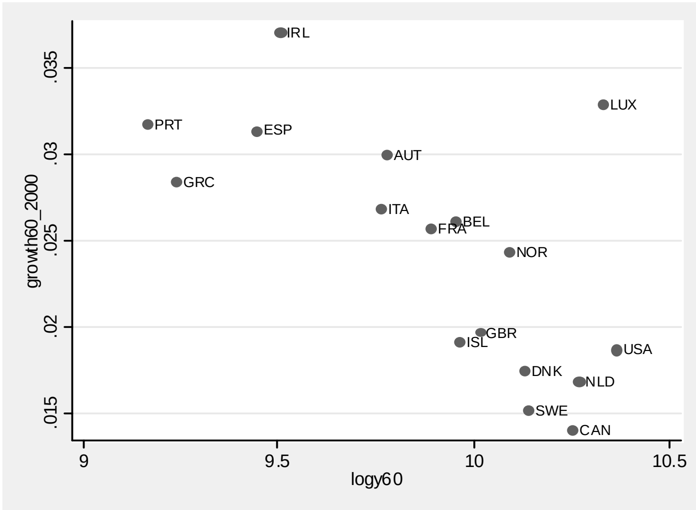

Figure 4: Growth in GDP per worker 1960-2000, 17 original OECD member countries. Data source: Penn World Tables 6.2 .

A. GROWTH DIFFERENCES

Also true if we look at the poorest countries ...

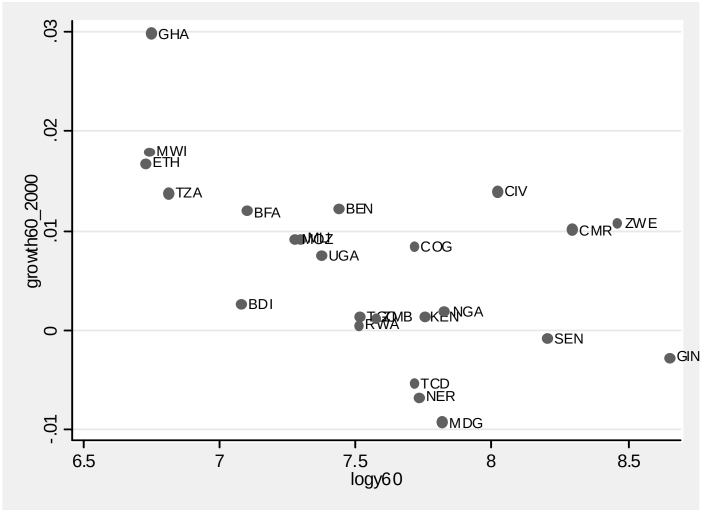

Figure 5: Growth in GDP per worker, 1960-2000: 24 tropical sub-saharan African countries. Data sourve: Penn World Tables 6.2

Our theories better explain *why*.

THEORY: SYSTEMATIC VARIATIONS

Consider the law of motion (approximation) for the Solow model

$$g_k \approx g + \lambda \log\left(\tilde{k}^* / \tilde{k}_0\right)$$

This can be viewed as a linear equation (i index for country)

$$g_{ki} = g + \lambda \log\left(\tilde{k}_i\right)^* - \lambda \log\left(\tilde{k}_{i0}\right)$$

If we are considering similar countries we have $\log\left(\tilde{k}_i\right)^* \approx \log\left(\tilde{k}\right)^*$ for all i. Then

$$g_{ki} = a - b \log\left(\tilde{k}_{i0}\right),\ a \equiv g + \lambda \log\left(\tilde{k}\right)^*, b = \lambda < 0$$

and we would *expect* a clear *negative* link between g_{ki} and (log) initial capital $\tilde{k}_{i0}$ (or GDP per capita).

In samples where countries are very different, $\log\left(\tilde{k}_i\right)^* \neq \log\left(\tilde{k}\right)^*$ for all i, the same negative association should *not* (necessarily) arise, unless we take the differences in $\log\left(\tilde{k}_i\right)^*$ into account (i.e., s, n and so on).

To fully control for $\log\left(\tilde{k}_i\right)^*$ the basic Solow model suggests s_K and n. The augmented Solow model would suggest we also need s_H. The Solow model with land would suggest X/L_0 should enter as well, and semi-endogenous growth theory would suggest L_0 should enter.

The AK endogenous growth model is NOT consistent with this evidence. However an “asymptotic version" can be.

THEORY: GROWTH DIFFERENCES

Neoclassical growth theory (Ch. 3,4,5,6, (7..see below)**)** offers transitional dynamics. Basically we have

$$g_y \approx g + \lambda \log\left(\tilde{y}^*/\tilde{y}_0\right)$$

growth differences in g are not attractive; hence the "story" is that countries differ in terms of their distance to steady state

$$\log\left(\tilde{y}^*/\tilde{y}_0\right)$$

This is a meaningful story, as the model suggests λ is fairly low, implying lengthy transitions. Takes at least 17 years (under plausible parameter values to reach steady state)

THEORY: GROWTH DIFFERENCES

The drawback of this "story" is that every country with less than g percent growth (say, 2%) per year, are converging from above

Given the growth record, this turns out to be *systematically* the poorest countries

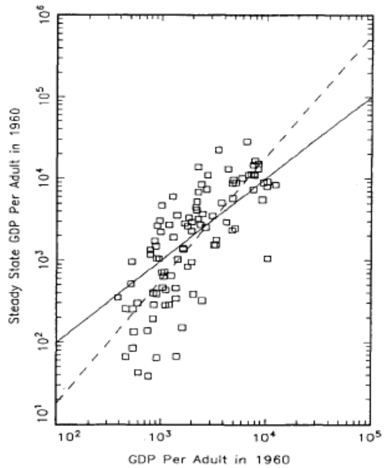

Fig. 1. Current vs. steady-state positions, 98 countries. Data from Mankiw et al. (1992).

Figure 6: Source: Cho and Graham, 1996. Note; The bold faced line is a 45 degree line.

THEORY: GROWTH DIFFERENCES

The one exception is the neoclassical growth model with *natural resources* (Ch 7)!

Here the long-run growth rate is *not* the same: countries with faster population growth will grow more slowly in transition *and* in the steady state (cf Above)

An alternative account is endogenous growth theory. Here the long-run growth rate is endogenous (so we can do without "g"). **D**ifferences in s (e.g.) will generate difference in growth. *Policy* can affect s (cf. Ch. 16 on consumption: higher taxes can lower s, for instance). Has its drawbacks (cf time series evidence)

Semi-endogenous growth: transitional dynamics. Steady state growth$\propto$ n. Little evidence that $n \uparrow \Rightarrow g_y \uparrow$

B. INCOME DIFFERENCES

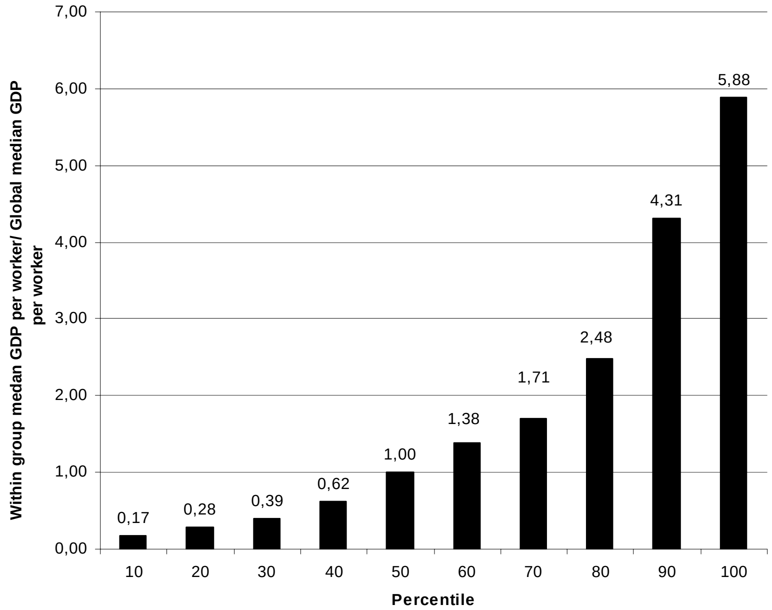

Figure 7: The numbers refer to the year 2000 and are PPP corrected. Source: World Development Indicators CD-rom 2004.

Moving from median in the top group to median of lowest group: Difference on a scale of 1:35. Our theories should motivate such differences quantitatively.

B. THEORY

The basic Solow model has problems accounting for such vast differences. Two identical countries, except for s

$$\frac{y_1^*}{y_2^*} = \left(\frac{s_1}{s_2}\right)^{\frac{\alpha}{1-\alpha}}$$

as $\frac{s_1}{s_2}$ is at most 1:4, $\frac{\alpha}{1-\alpha} = 1/2$ if $\alpha = 1/3$. This result is *not* changed if we look at the open economy (again, focusing on *income* differences).

However, adding human capital improves the explanatory power of physical capital investments:

$$\frac{y_1^*}{y_2^*} = \left(\frac{s_1}{s_2}\right)^{\frac{\alpha}{1-\alpha-\beta}}$$

since $\alpha \approx \beta \approx 1/3$, $\frac{\alpha}{1-\alpha-\beta} \approx 1$. Reason: Capital-Skill complementarity. In addition: Human capital levels differ.

B. THEORY

Drawback: Probably *overestimating* the importance of human capital (i.e, putting $\beta = 1/3$)

Alternative: Include technology diffusion, so that *levels of A differ*. Evidence suggests levels of A differ across countries. Likely reason: differences in technological sophistication (... as well as other things: efficiency etc)

A reasonable diffusion model will also generate growth differences in technology, in transition. That is, a structure like

$$A_{t+1}^{w} = (1+g)\, A_t^{w}$$

$$T_{t+1} - T_t = \omega \cdot \left(A_t^{w} - T_t\right), \; \omega < 1.$$

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C. CONVERGENCE AND INEQUALITY

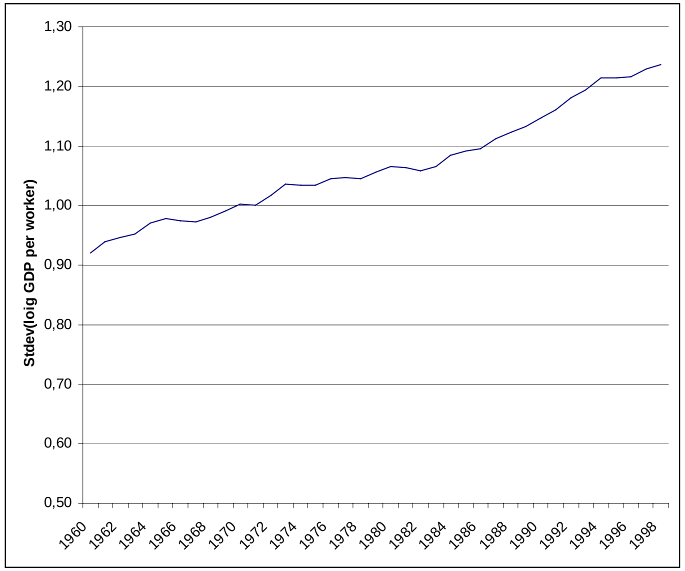

Figure 8: Evolution of Standard deviation of log GDP per worker, 1960-1998. Data: Penn World Tables 6.1.

You tend to find increasing inequality.

C. THEORY

Neoclassical growth theories (Ch. 3-7) predict conditional convergence. Hence, neoclassical growth theory does not suggest income differences across countries will be equalized, unless countries converge in structure (s,n etc)

Even if countries are similar (but hit by shocks) inequality (appropriately measured) may not decline. The fact that there is a negative link between growth and initial levels $\nrightarrow$ Declining inequality (cf. "Galton's fallacy)

Another viable hypothesis: Club Convergence. E.g. the subsistence story, or, endogenous fertility (exercises)

In endogenous growth theory countries with similar characteristics will converge in growth rates, but not in levels.