



DEVELOPING ECOLOGICAL MACROECONOMIC ANALYSIS

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Introduction

- Extend post Keynesian/Kaleckian analysis to incorporate ecological concerns and constraints
- Bring into ecological economics a monetary and demand-led macroeconomic analysis

Inputs and resource use

- Physical (or manufactured) capital
- Labour resource
- Use of environmental resources expressed in terms of the ecological footprint
- Fixed factor proportions production function
- There is no direct substitutability among inputs identified ('strong sustainability' hypothesis)
- Input-output relationship unaffected by relative prices, but changes over time through technological change and sectoral shifts

Input-output relations

- $Y_c = K/v$ where v is the capital-capacity output ratio
- $Y = uK/v = a.q.h.E$ where E is employment, h hours worked, q productivity and a treated as constant
- Augmented labour resource is $N = q.h.p.F$ where q is productivity with its rate of change dependent on demand, h hours worked, p is the participation rate, and F the working age population

Ecological footprint

- The ecological footprint (EFP) is taken to depend on both the level and cumulative level of actual output Y , and research and development (R&D).
- $EFP = f(Y, CumY, R\&D)$, where $f_Y > 0$, $f_{CumY} > 0$, $f_{R\&D} < 0$

Three growth of output paths

- Demand-led rate of growth of output (taken to be the one achieved) based on investment and growth of capital stock ($g_k(t)$)
- Growth of augmented labour resource, and the growth of output which would result if labour use grew in line with labour resource ($g_n(t)$)
- The growth of the ecological footprint dependent of growth of output; a sustainable ecological footprint implies an environmentally constrained growth of output.
- With no direct substitutability among inputs, no reason to think these three growth paths consistent.

Investment

- Investment equation:
- Desired investment is variant on Kaleckian investment function
- (1) $\frac{I^d}{Y^c} = [\alpha(u - u^*) + \delta\Delta u + \beta m + \mu + \tau]$
- Capacity output Y^c u capacity utilisation; m profit share; μ animal spirits; τ research and development expenditure

Investment

- Effective investment
- (2) $\frac{I^e}{Y_C} = \gamma [\alpha(u - u^*) + \delta \Delta u + \beta m + \mu - s_p m u] + \tau + s_p m u$
- Where distinction made between funding from prior retained earnings (last term), and from borrowing with a portion γ of loan requests granted, and all research and development internally funded.

Savings

- Differential savings out of wages and profits

$$\begin{aligned} \bullet \frac{S}{Y^c} &= \frac{s_w W + s_p P}{Y^c} = \frac{s_w W + s_p P}{Y} \frac{Y}{Y^c} = \left(s_w \frac{W}{Y} + s_p \frac{P}{Y} \right) u = \\ & [s_w (1 - m) + s_p m] u = s \cdot u \end{aligned}$$

- Capacity utilisation:

- (5) $u = \frac{\beta m + \delta \Delta u + \mu - \gamma \alpha u^* + \tau / \gamma}{\gamma s_p m + s_w (1 - m) - \gamma \alpha}$

- Growth of capital stock

- (6) $g_K = \frac{s[\beta m + \delta \Delta u + \mu - \gamma \alpha u^* + \tau / \gamma]}{v[\gamma s_p m + s_w (1 - m) - \gamma \alpha]}$

Growth of labour force

- The growth of the augmented labour resource force is given by:
- (9) $g_N(t) = g_q(t) + g_h(t) + g_p(t) + g_F(t)$
- the growth of productivity is taken to depend on growth of output ('learning by doing'); and other terms similarly could be taken to depend on growth of output

Ecological footprint

- The rate of growth of the ecological footprint is given by:
- $EFP = f(Y, CumY, R\&D)$, where $f_Y > 0$, $f_{CumY} > 0$, $f_{R\&D} < 0$
- It is taken that there is a sustainable rate of growth of ecological footprint', to which corresponds a sustainable rate of growth of output.

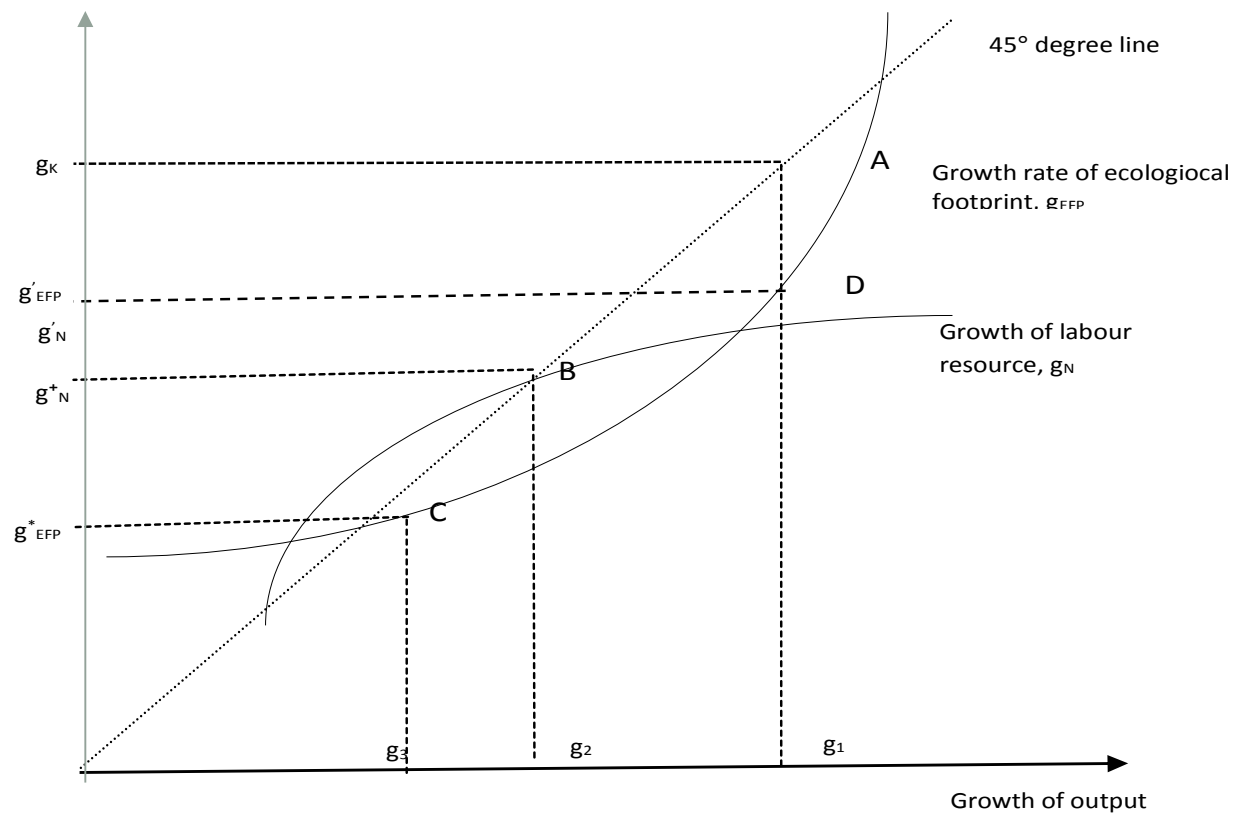
Size of economy

- Capital stock, ecological footprint (and other variables of interest) built up from successive one-period growth rates.
- No presumption that those growth rates are 'pre-determined'

Two asides

- The basic model to be modified for budget position; and not surprisingly budget deficit plays similar role to autonomous component of investment in the determination of capacity utilisation;
- A form of 'Cambridge equation' emerges linking rate of profit with rate of growth, with clear implications for impact of slower growth on rate of profit (unless off set by budget deficit).

Three growth rates



Implications

- Three conceptual growth rates identified, under the view that there is a lack of forces which would bring the growth rates into line.
- The adjustment between the demand-led and the supply-led growth rates is an old question which still remains unresolved though there are adjustment mechanisms, notably demand-pull growth of effective labour force and changes in investment behaviour
- The sustainable growth rate does not form an immediate constraint on demand-led growth rate.

Feedback effects

- Ecological footprint makes production 'more difficult', reflected in a rising capital-output ratio $v = v$ (EFP)
- Also EFP has an adverse effect on labour productivity growth
- Malthusian effects, e.g. food failures, and effects on population growth
- The role of 'social conventions' and 'animal spirits'

Resumé

- (i) for the growth of the capital stock
- (12)
$$g_K(t) = \frac{s[\beta m + \delta \Delta u + \mu - \gamma \alpha u^* + \tau/\gamma]}{v(EFP)[\gamma s_p m + s_w(1-m) - \gamma \alpha]}$$
- (ii) for the growth of the labour resource
- (13)
$$g_N(t) = g_q(t, g_Y) + g_h(t, sc) + g_p(t, sc) + g_F(t, EFP)$$
- (iii) for growth of ecological footprint
- (14)
$$g_{EFP} = \frac{Y}{f} f_Y g_Y + \frac{f_{CumY}}{f} Y + \frac{f_{R\&D}}{f} \frac{dR\&D}{dt}$$
- Where R & D expenditure is given by τY^c



Next task

- Simulation of this model

Policy Implications of general approach

- Lack of self-adjusting market forces – at least via relative prices
- Investment and finance
- Investment and ‘animal spirits’
- Labour force growth and the role of social norms and conventions
- ‘Market mechanisms’ could come into play via ‘animal spirits’ responding to environmental concerns, and through Malthusian type effects