SUSTAINABILITY ECONOMICS RESEARCH IN THE FENNER SCHOOL

Note for Nick Hanley's IDEC8053 Environ. Econ. students, Semester 1, 2012

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This is to tell you about my research areas, in case you might be interested in doing a PhD (in Economics or Environment, two PhD fields with very different coursework requirements) under my supervision. Since you'd be somewhat isolated intellectually as a sustainability economics researcher in Fenner, you could well remain in the Crawford building while being supervised by me (and probably another Crawford academic). Email me if you're interested, or ask Nick if you and enough others want me to give a (non-assessable) lecture at your usual time, 2pm Friday, on 1 June (last day of semester).

My past research (for more details, see my website)

- General surveys of "society-wide" (national or global) sustainability concepts and measures (weak and strong); economic theory of measuring the sustainability of well-being (utility), especially Genuine Saving (GS, a.k.a. net investment); empirical applications, especially the World Bank's Adjusted Net Saving realisation of GS. [Topics broadly covered by Ch. 2 of the Hanley et al. textbook]
- Theory and political economy of taxes vs. tradable permits for pollution control, with emphasis on both long-run efficiency and politics of property rights; applications mainly to climate policy. [Topics covered in Ch. 5 in Hanley et al. Various aspects of this are possible and interesting for PhD research.]

Future research interest - global sustainability modelling

My long-term future interest is in exploring empirical models (probably with no analytic solution) of a possible limit to growth (of global average consumption and/or utility per person) that might be met before the end of the century. Such limit might be caused by a combination of (a) high energy costs (from oil/gas depletion and geophysical limits on renewables), (b) high costs (both thermodynamic and political) of rapid falls in energy intensity, (c) high (but very uncertain) costs from catastrophic climate change if coal-burning (instead of shift to renewables + fall in energy intensity) continues to grow.

One part of this research could be to estimate, using Input-Output tables and/or data from empirical models of Inducted Technical Change, the minimum amount of energy input needed per real $ of global GDP by e.g. 2100, or maybe ever. (Such a "minimum ever" exists in CES production functions with substitution elasticity $\sigma < 1$, but not if $\sigma = 1$, i.e. Cobb-Douglas production.)

Future research interest - using sustainability prices in a global sustainability measure

This research would be mainly theoretical at first, but is closely connected to, and might have some applications for, global sustainability modelling. See the next page for more details, which also explain remarks in Hanley et al. textbook just after Table 2.2 on p34.

CAN ONE FIND SUSTAINABILITY PRICES FOR NONRENEWABLE RESOURCES?

Note by Jack Pezzey, Fenner School, ANU on 21/2/12

The simplest theoretical case to consider

Consider the Dasgupta-Heal-Solow model of PV-optimal growth starting at time 0 from manufactured capital stock $K(0) = K_0$ and nonrenewable resource stock $S(0) = S_0$, with Cobb-Douglas production using as inputs fixed technology A_0 (i.e. no technical progress), capital stock K and nonrenewable resource flow R, and divided between consumption C and investment $\dot{K}$ (where K, S, C and R are functions of time t, and $\dot{K} \equiv dK/dt$, $\dot{S} \equiv dS/dt$):

$$F(K,R) = A_0 K^{\alpha} R^{\beta} = C + \dot{K}, \quad 0 < \beta < \alpha < \alpha+\beta \leq 1; \quad R = -\dot{S}.$$

The PV-optimal paths of capital stock $K^*(t)$ and resource stock $S^*(t)$ come from choosing consumption flow $C^*(t)$ and resource flow $R^*(t)$ to maximise present-value (PV) of utility, or

$$\text{(intertemporal) welfare} := \int_0^{\infty} U(C) e^{-\rho t} dt, \quad \rho > 0, \text{ constant}; \quad U_C(C) > 0, \quad U_{CC}(C) < 0$$

Dasgupta and Heal (1974) showed that under typical conditions, optimal consumption $C^*(t)$ is then single-peaked, that is, it rises to a peak, and then keeps falling towards zero: an unsustainable development, by any definition. Now from Pezzey (2004, Prop. 3), during a finite time period, a positive PV-optimal Genuine Saving (GS, = "net investment" there, or Adjusted Net Saving in World Bank 2011) gives a false indication of sustainability, in that

$$GS^*(t) := \dot{K}^*(t) - F_R^*(t) R^*(t) > 0 \quad \text{for any } t \text{ during that time period,}$$

yet during the same period consumption is unsustainable, in the precise sense that

$$C^*(t) > C^m[K^*(t), S^*(t)] := (1-\beta) \{A_0 [K^*(t)]^{\alpha-\beta} (\alpha-\beta)^{\beta} [S^*(t)]^{\beta}\}^{1/(1-\beta)}.$$

This $C^m[.]$ is Solow's (1974) formula for maximum sustainable consumption, starting from any time t (not just time 0) on the PV-optimal path. Intuitively, the PV-optimal resource price F_R^* (= $\beta F^*/R^*$) "doesn't care" about sustainability (which has no direct connection with PV-optimality), and is too low to make GS an exact (2-sided) measure of sustainability.

So a key question, unanswered even for this simple, much-studied economy is:

Can we find any formula, even an approximate one, for calculating the *sustainability price of the resource flow*, $F_R^m(t)$, so that $GS^m(t)$ is a exact, 2-sided measure of sustainability, i.e.

$$GS^m(t) := \dot{K}^*(t) - F_R^m(t) R^*(t) \gtrless 0 \quad \Leftrightarrow \quad C^*(t) \lessgtr C^m[K^*(t), S^*(t)] \quad \text{for any time } t \text{ ?}$$

Possible empirical applications

This is not just a theoretical exercise. Current market prices for fossil fuels may be far too low for the World Bank's GS to be a good sustainability measure. The same is true for CO_2 emission prices calculated from PV-optimal climate-economy models like DICE (Nordhaus 2008). Using sustainability prices instead could greatly lower the value of global GS, making it much less reassuring about global sustainability, and shake up the "limits to growth" debate.

References:

Dasgupta, Partha S. and Geoffrey M. Heal (1974). "The optimal depletion of exhaustible resources." *Review of Economic Studies*, 41, Symposium on the Economics of Exhaustible Resources, 3-28.

Nordhaus, William (2008). *A Question of Balance*. Yale University Press.

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Solow, Robert M. (1974a). "Intergenerational equity and exhaustible resources." *Review of Economic Studies*, 41, Symposium on the Economics of Exhaustible Resources, 29-45.

World Bank (2011). *The Changing Wealth of Nations*. Washington D.C.: World Bank.