

Errata for "Human Well-Being and the Natural Environment", Oxford University Press, 2001.

I have discovered several misprints, as well as a few errors that crept in during transmission from earlier papers onto the document that became the text of my recent book, *Human Well-Being and the Natural Environment* (Oxford: Oxford University Press, 2001). The mistakes will be removed from the book should it be reprinted. As it is, I am posting those misprints and errors of transmission that are substantial:

1. (page 3, first sentence of first complete paragraph): "In a moving discourse on the character of poverty at the 1991 meeting of the Pontifical Academy of Social Sciences, ...", should read, ""In a moving discourse on the character of poverty at the 2001 meeting of the Pontifical Academy of Social Sciences, ..."

2. Equation (9.6) of Chapter 9, page 150, should read:

$$\begin{aligned} \text{NNP}_t = & [\Sigma_i \{ \delta \cdot g(p_{it}) \} (p_{it} K_{it}) + \Sigma_j \{ \delta \cdot g(h_{jt}) \} (h_{jt} H_{jt}) \\ & + \Sigma_k \{ \delta \cdot g(r_{kt}) \} (r_{kt} S_{kt}) + \Sigma_m \{ \delta \cdot g(q_{mt}) \} (q_{mt} Z_{mt})], \end{aligned} \quad (9.6)$$

where  $g(x)$  is the percentage rate of change in  $x$ .

3. Proposition 2 in the Appendix (page 245) is correct, but given the example that was being developed, the arguments leading up to the proposition in Section A.5 are misleading. Section A.5 ("Project Evaluation") up to Proposition 2 (pp. 244-245) should read:

Imagine that, even though the government does not optimize the economy, it can bring about small changes to it by altering the existing resource allocation mechanism in minor ways. The perturbation in question could be small adjustments to the prevailing structure of taxes for a short while; it could be minor alterations to the existing set of property rights for a brief period; it could be a public investment project - or whatever. Call any such perturbation a policy reform.<sup>1</sup>

Consider an investment project. It can be viewed as a perturbation to the resource allocation mechanism  $\alpha$  for a "brief" period (the lifetime of the project), after which the mechanism reverts back to its earlier form. We consider projects that are small relative to the size of the economy. How should they be evaluated?

Let the project's lifetime be the period  $[0, T]$ . The project involves small quantities of manufactured capital, labour, and natural resources to produce a small additional quantity of the all-purpose commodity  $Y$ . Denote the project's output and inputs at  $t$  by the vector  $(\Delta Y_t, \Delta K_t, \Delta L_t, \Delta R_t)$ .<sup>2</sup>

The project's acceptance would perturb aggregate consumption and labour supply under  $\alpha$ . Let the perturbation at  $t$  ( $\geq 0$ ) be  $(\tilde{\Delta} C_t, \tilde{\Delta} L_t)$ . It would affect  $U_t$  by the amount  $(U_C \tilde{\Delta} C_t + U_L \tilde{\Delta} L_t)$ . However, because the perturbation includes all "general equilibrium effects", it would be tiresome if the project evaluator were required to estimate  $(\tilde{\Delta} C_t, \tilde{\Delta} L_t)$  for every project that came up for consideration.

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<sup>1</sup> Over the years, economic evaluation of policy reform in imperfect economies has been discussed by a number of economists (Meade, 1955; Dasgupta, Marglin, and Sen, 1972; Mäler, 1974; Starrett, 1988; Ahmad and Stern, 1990; Dreze and Stern, 1990; and Edwards and Keen, 1996, to name only a few). But they did not develop a formal account of intertemporal welfare economics in a reformist economy. This section of the Appendix is an attempt to fill that gap.

<sup>2</sup> If the project has been designed efficiently, we would have  $\Delta Y_t = F_K \Delta K_t + F_L \Delta L_t + F_R \Delta R_t$ . The analysis that follows in the text doesn't require the project to have been designed efficiently.

Accounting prices are useful because they enable the evaluator to estimate  $(\tilde{\Delta}C_t, \tilde{\Delta}L_t)$  indirectly. Now, it is most unlikely that consumption and investment have the same accounting price in an imperfect economy. So we decompose  $\Delta Y_t$  into two components: changes in consumption and in investments in manufactured capital. Denote them as  $\Delta C_t$  and  $\Delta(dK_t/dt)$ , respectively.<sup>3</sup>

$U$  is the unit of account.<sup>4</sup> Let  $w_t$  denote the accounting wage rate. How should we measure it? If we knew  $\alpha$ , we would be able to estimate  $\tilde{\Delta}L_t/\Delta L_t$ . Now,  $w_t = -(\tilde{\Delta}L_t/\Delta L_t)U_L$ . So,  $w_t = -U_L$  if  $\tilde{\Delta}L_t = \Delta L_t$ , and  $w_t = 0$  if  $\tilde{\Delta}L_t = 0$ . In "labour-surplus economies" one would typically find  $0 < -(w_t/U_L) < 1$  (Dasgupta, Marglin, and Sen, 1972; Little and Mirrlees, 1974). Next, let  $\hat{q}_t$  be the accounting price of the flow of resources into the project and  $\lambda_t$  the social cost of borrowing manufactured capital (i.e.,  $\lambda_t = \delta - [dp_t/dt]/p_t$ ).<sup>5</sup>

It follows that:

$$\int_0^\infty [U_C \tilde{\Delta}C_\tau + U_L \tilde{\Delta}L_\tau] d\tau = \int_0^T [U_C \Delta C_\tau + p_\tau \Delta(dK_\tau/dt) - w_\tau \Delta L_\tau - \rho_\tau p_\tau \Delta K_\tau - \hat{q}_\tau \Delta R_\tau] e^{-\delta\tau} d\tau. \quad (\text{A.13})$$

But  $\int_0^\infty [U_C \tilde{\Delta}C_\tau + U_L \tilde{\Delta}L_\tau] d\tau = \Delta V_0$ , the change in social welfare if the project, starting at  $t = 0$ , were accepted. And the right-hand-side (RHS) of equation (A.13) is the present discounted value of the project's flow of social profit. We therefore have,

$$\Delta V_0 = \int_0^T [U_C \Delta C_\tau + p_\tau \Delta(dK_\tau/dt) - w_\tau \Delta L_\tau - \rho_\tau p_\tau \Delta K_\tau - \hat{q}_\tau \Delta R_\tau] e^{-\delta\tau} d\tau. \quad (\text{A.14})$$

Equation (A.14) yields the well-known criterion for project evaluation:

Proposition 2: A project should be accepted if and only if the present discounted value of its social profits is positive.

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<sup>3</sup> The arguments in the text develop the theory of social cost-benefit analysis in Dasgupta, Marglin, and Sen (1972).

<sup>4</sup> Dasgupta, Marglin, and Sen (1972) and Little and Mirrlees (1974), respectively, developed their accounts of social cost-benefit analysis with consumption and government income as numeraire. Which numeraire one chooses is, ultimately, not a matter of principle, but a matter of practical convenience.

<sup>5</sup> The following is how  $\hat{q}_t$  should in principle be estimated: Suppose other things being the same,  $\Delta R_t$  is removed from the economy as it progresses under  $\alpha$ . Let the removal cause displacements  $\hat{\Delta}C_t$ ,  $\hat{\Delta}(dK_t/dt)$ ,  $\hat{\Delta}L_t$ ,  $\hat{\Delta}(dS_t/dt)$  in consumption, net capital accumulation, labour supply, and net growth in the natural-resource base, respectively. We then have:

$$\hat{q}_t \Delta R_t = U_C \hat{\Delta}C_t + U_L \hat{\Delta}L_t + p_t \hat{\Delta}(dK_t/dt) + q_t \hat{\Delta}(dS_t/dt).$$

In practice,  $\hat{q}_t$  could be estimated from the willingness-to-pay for a unit of the resource in production, through the use, for example, of contingent-valuation techniques (Freeman, 1993). Notice that if manufactured capital were to depreciate at a constant rate, say  $\gamma$ , the social cost of borrowing capital would be  $\lambda_t = \delta + \gamma - [dp_t/dt]/p_t$ .

At a full-optimum, we would have  $p_t \partial F / \partial K_t = q_t = \hat{q}_t$ ,  $U_C = p_t$ , and  $U_L = w_t$ .