Week Thirteen – Social Cost of Carbon

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1 Social Cost of Carbon

The DICE model started as a modeling exercise but really took off as *the* model. Keep in mind that it relies on Negishi weights which are the inverse of marginal utility of money. Negishi weights up-weight the rich and down-weights the poor because wealthy people tend to have a lower marginal utility for money.

$$SWF = \max_{c(t)} \sum_t U(C(t), P(t))(1+\rho)^{-1} \tag{1}$$

$$U(C, P) = \frac{P(C^{1-\alpha} - 1}{1-\alpha} \tag{2}$$

$$r = \rho + \alpha g \tag{3}$$

Where C is consumption and P is population and ρ is the pure rate of social time preference, r is the discount rate. Not that **??** is the Ramsey rule, which we have seen before.
Production is written

$$Q(t) = \Omega(t)A(t)K(t)^{\gamma}P(t)^{1-\gamma} \tag{4}$$

γ is the percent change in capital wrt change in capital. K is produced capital. The population is the labor supply. This is Cobb-Douglas form which means we've assumed constant returns to scale. A is the Solow residual *aka* total factor productivity. Ω is where the climate effects enter.

$$C(t) = Q(t) - I(t) \tag{5}$$

The consumer is just production Q minus investment.

$$K(t) = (1-\delta_K)K(t-1) + I(t) \tag{6}$$

where δ_K is the depreciation of capital.

Emissions are written

$$E(t) = [1-\mu(t)]\sigma(t)Q(t) \tag{7}$$

μ is the investment in emissions reduction. σ assumes no emissions control but assumes market powers will make it so that production is less emissions-intensive.

$$M(t) = \beta E(t) + (1-\delta_M)M(t-1) \tag{8}$$

where M the stock of emissions in the atmosphere. Notice is=t works just like the capital stock.

$$F(t) = f(M(t)) \tag{9}$$

where $F(t)$ is the effect of emissions on climate.

Nordhaus then creates a damage function

$$d(t) = 0.0133(\frac{T(t)}{3})^2 Q(t) \tag{10}$$

damages don't change investment or the depreciation of capital. It does affect productivity

$$\Omega(t) = \frac{(1-b_1)\mu(t)^{b_3}}{1+d(t)} \tag{11}$$

Eli: we're over-investing in getting a damage function rather than figuring out how to have damages affect investment and depreciation.

$$\max_{C(t),\mu(t)} = \sum_t \frac{P(t)(C(t)^{1-\alpha}-1)}{1-\alpha}(\frac{1}{1+\rho})^t \tag{12}$$

Finally, we can plug loads of stuff in.

$$\Delta K = (1-\delta_K)K(t-1) + \frac{(1-b_1)\mu(t)^{b_3}}{1+d(t)} A(t-1)K(t-1)^\gamma P(t-1)^\gamma - C(t-1)P(t-1) - K(t-1) \tag{13}$$

$$\Delta M = (1-\delta_M)M(t-1) + \beta(1-\mu(t-1))\sigma(t-1)\frac{(1-b_1)\mu(t-1)^{b_2}}{1+\delta(M(t-1))} A(t-1)K(t-1)^\gamma P(t-1)^(1-\gamma) - M(t) \tag{14}$$

$$H = \frac{P(t)(C(t)^{1-\alpha}-1)}{1-\alpha}\frac{1}{1+\rho} + \lambda(t)\frac{1}{1+\rho}\Delta K + \eta(t)\frac{1}{1+\rho}\Delta M \tag{15}$$

?? is just a Hamiltonian with two stocks, K and M. He solved it using the expensive version of solver. Eli described this first DICE model as a term project on steroids.

2 EPA's "textbook" on SCC

Best methods available for calculating SCC: https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf
As of April of 2023, it was still being peer-reviewed.