The Role of Macroeconomics in Evaluating Climate Abatement Policies

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Pricing Climate Risk: Refocusing the Climate Policy Debate
April 12, 2013
Introduction
A crucial input in the social choice problem of climate abatement is the social discount factor.

This is well defined for households with common homothetic preferences.

However, as is well known, a social welfare function cannot be constructed in general if household preferences are heterogeneous.
In this presentation:

a) I illustrate that even in a homogenous agent economy, using social discount rates for evaluating alternative abatement policies may not be welfare enhancing.

b) Use the framework to evaluate a class of abatement policies.

c) Propose some extensions to incorporate heterogeneity in households.
A Motivating Example
Consider two Lucas endowment economies, identical in every respect except that one has a growth rate of consumption of 2% while other has a growth rate of 1%. There is no uncertainty.

There is a single infinitely lived household with CRRA preferences in each economy. Each household’s elasticity of intertemporal substitution is 0.5 ($\alpha = 2$) and its is $\beta = 0.999$.

Consumption levels are 1 in both economies at time 1. Land is the only asset in the economy. It entitles the owner to the entire consumption stream.
In this economy the time $t$ price $p_t$ of an asset with payoffs 
\[ \{y_s\}_{s=T+1}^{\infty} \] is:

\[ p_t = \sum_{s=t+1}^{\infty} \beta^{s-t} \frac{u'(c_s)}{u'(c_t)} y_s \]

The discount factor is a sequence:

\[ \{\beta^{s-t} u'(c_s) / u'(c_t)\}_{s=T+1}^{\infty} \]

An equilibrium in this economy can exist even if $\beta \geq 1$. 
We use the pricing relation above to price land in this economy.

Let $PL_{HG}$ be the price of land in the high growth economy.

Let $PL_{LG}$ be the price of land in the low growth economy.

What is the relative valuation of the land in the two economies in today’s consumption equivalent?

$$\frac{PL_{HG}}{PL_{LG}} = ?$$
The answer is:

\[
\frac{PL_{HG}}{PL_{LG}} \approx 0.5
\]

If household \( \alpha \) were 1 then

\[
\frac{PL_{HG}}{PL_{LG}} = 1
\]

Note the household welfare is higher in the higher growth economy irrespective of \( \alpha \).
The discount rate changes when the growth rate changes.

For CRRA preferences, the discount rate is given by:

\[ r = -\ln \beta + \alpha \mu_x \]

where \( \mu_x \) is the growth rate of consumption.

With \( \alpha = 2 \), in the high growth economy the discount rate is 4.1% while in the low growth economy it is 2.1%.

The value of an asset is not a good measure of the welfare consequences of the policies.
Evaluation of an GHG Abatement Policy
Consider a world with no intervention. Per capita consumption grows at 2% for $T$ years ($T = 50, 100, 150$) and thereafter grows at 1% in perpetuity.

Consider an abatement policy that reduces per capita consumption by $x\%$ ($x = 1, 2, 3$) for $T$ years but the growth rate remains constant at 2% indefinitely.
PV with abatement/PV without abatement

\[ \alpha = 1, \quad \beta = 0.999 \]

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Welfare with abatement/Welfare without abatement

\[ \alpha = 1, \quad \beta = 0.999 \]

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### PV with abatement/PV without abatement

\[ \alpha = 3, \quad \beta = 0.999 \]

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### Welfare with abatement/Welfare without abatement

\[ \alpha = 3, \quad \beta = 0.999 \]

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Household Heterogeneity
The unfortunate reality is that large parts of the population in India, China and sub-Saharan Africa live at or near subsistence levels of consumption.

This group accounts for about a third of global households and their willingness to substitute consumption over time is arguably different from households living in developed economies.

Lending rates for this subset of households are likely to be much higher than those implied by capital market data.
To illustrate this, consider a preference function of the form:

\[ u(c_t, \bar{c}) = \frac{\left( c_t - \bar{c} \right)^{1-\alpha} - 1}{1 - \alpha} \]

where \( \bar{c} \) is the subsistence level of consumption.

Under these circumstances the relative risk aversion is

\[ \frac{-c_t u_{11}(c_t)}{u_1(c_t)} = \frac{\alpha}{1 - \bar{c}/c_t}. \]
Poor households are likely to have consumption levels closer to subsistence levels than rich households.

For example, if $\alpha = 2$ and $\frac{\overline{c}}{c_t} \approx .9$ then the effective CRRA $\approx 20!$

The household’s effective (or local) CRRA in this case becomes very large.
How does one deal with household heterogeneity?

Economists can evaluate the impact of a policy on the welfare of each heterogeneous class of agents.

Weighing the interests of different classes is an ethical issue and in general is outside the scope of economics.
If the heterogeneous households have preferences that satisfy the conditions for aggregation, then a representative agent can be constructed in a manner that is independent of the underlying heterogeneous agent economy’s initial wealth distribution.

Although aggregation permits the use of the representative agent for welfare comparisons, it substantially narrows the choice of utility functions.
Unfortunately there is no general closed form representation that relates the heterogeneity in $\alpha$ at the household level to the curvature of the representative agent.

Attempts at such a construction for two agent economies include Dumas (1989), Garleanu and Panageas (2012) and Hara and Kuzmics (2004).