The Role of Macroeconomics in Evaluating Climate Abatement Policies

Rajnish Mehra
Arizona State University
Luxembourg School of Finance
and
NBER

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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} is 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 α were 1 then

$$\frac{PL_{HG}}{PL_{LG}} = 1$$

- Note the household welfare is higher in the higher growth economy irrespective of α.

- 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 μ_x is the growth rate of consumption

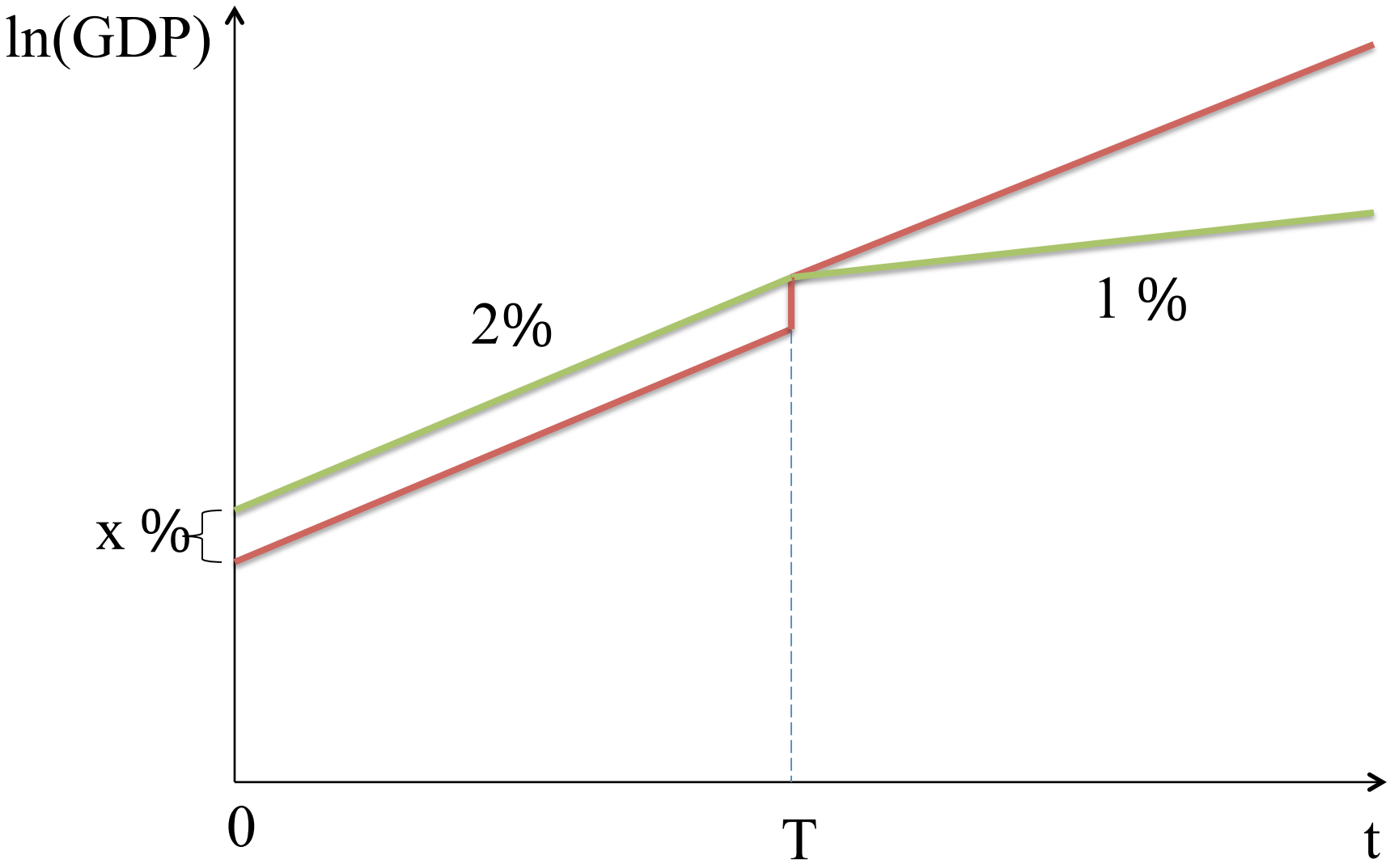
- With $\alpha = 2$, in the high growth economy the discount rate is 4.1% while in the low growth economy it is 2.1%.

- 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.


ln(GDP)
2%
1 %
x %
0
T
t

PV with abatement/PV without abatement

$\alpha = 1,\ \beta = 0.999$

	X=1%	X=2%	X=3%
T=50	1.00894	1.00846	1.00798
T=100	1.00803	1.00708	1.00614
T=150	1.00716	1.00578	1.0044
T=∞	0.9900	0.9800	0.9700

Welfare with abatement/Welfare without abatement

$\alpha = 1,\ \beta = 0.999$

	X=1%	X=2%	X=3%
T=50	1.89838	1.89833	1.89829
T=100	1.81861	1.81852	1.81843
T=150	1.74871	1.74859	1.74846
T=∞	0.99949	0.99898	0.99846

PV with abatement/PV without abatement

$\alpha = 3,\ \beta = 0.999$

	X=1%	X=2%	X=3%
T=50	0.87727	0.86966	0.86204
T=100	0.97256	0.96293	0.9533
T=150	0.98753	0.97758	0.96764
T=∞	0.9900	0.9800	0.9700

Welfare with abatement/Welfare without abatement

$\alpha = 3,\ \beta = 0.999$

	X=1%	X=2%	X=3%
T=50	1.00263	1.00211	1.00158
T=100	0.99991	0.99939	0.99886
T=150	0.99955	0.99903	0.9985
T=∞	0.9995	0.99898	0.99845

Household Heterogeneity

- The unfortunate reality is that 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:

$$u(c_t, \overline{c}) = \frac{\left(c_t - \overline{c}\right)^{1-\alpha} - 1}{1-\alpha}$$

where $\overline{c}$ is the subsistence level of consumption.

- Under these circumstances the relative risk aversion is

$$\frac{-c_t u_{11}(c_t)}{u_1(c_t)} = \frac{\alpha}{\left(1 - \overline{c}/c_t\right)}.$$

- 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 ≈ 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 α 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).