Household and Government Adaptation to Climate Change

Chen Song

The George Washington University

August 11, 2014

Introduction

- Planned vs. Autonomous adaption (Malik and Smith 2012); Studies have examined planned adaptation (e.g., Titus et al., 1991; Fankhauser, 1995) and autonomous adaptation (Yohe et al. 1996) separately.
- This paper theoretically investigates the interaction between these two types of adaptation.
- A coastal region that is initially free of climate risk becomes susceptible to sea level rise (SLR).
  Autonomous household adaptation --- migration
  Planned government adaptation --- building a seawall
- Seawall has local public good character; the model is grounded in the local public goods literature (Flatters, Henderson and Mieszkowski, 1974; Boadway, 1982; Myers 1990).

Questions

1. How does the order of adaptation actions undertaken by the government and households affect the adaptation results?
The government acts first vs. households act first.

2. How does planned adaptation undertaken by local and central governments differ?

3. Social welfare indications

Timeline

Period 0 (Safe)	Period 1 (Safe)	Period 2 (Risky)
(Expect no risk in periods 1 & 2)	**(Expect SLR in period 2)**	**(Hazards occur)**
Local government chooses optimal local public goods expenditure.	**Adaptation actions are undertaken: i) The government acts first ii) Households act first**	**No chance for further adaptation.**

The Model

- Two regions A and B, with the same area of land $\overline{D}$, same number of households N initially. Each household inelastically supplies 1 unit of labor. The production function for each region is $F\left(N^i\right), i = A, B$.

- Utility function with amenity: $U = \theta(g)u(x, P)$;
  x: private consumption; P: local public goods expenditure.
  Period 0: θ=1 for both regions. With SLR risk in region A, $0 < \theta(g) < 1$, random variable; $0 \leq g \leq 1$: seawall height.

- The distribution of θ with larger value of g first-order stochastically dominates that with smaller value of g; $F_g(\theta;\ g) = \frac{\partial F(\theta;\, g)}{\partial g} < 0$.

Initial Equilibrium without Risk

- The local government of each region chooses public goods expenditure to maximize per capita utility.

$$\max_{x,P} u(x,P)\,, \qquad s.t.\ xN + P = f(N);$$

Samuelson condition: $\frac{Nu_P}{u_x} = 1$; the sum of the marginal rates of substitution equals the marginal rate of transformation.

- How does population affect the equilibrium utility level?

Since under population tends to cause instability of migration (Stiglitz, 1977), optimal population is rather special, I assume that both regions are over-populated, $\frac{\partial u}{\partial N} < 0$.

Local Government

i) The government acts first

In period 1, the local government in region A decides seawall height g first, and then households make migration decision.

Public goods consumption in period 1: $P_1^A = P - C(g)$

Lower expected amenity in period 2 in region A causes migration from A to B. The population is in equilibrium when

$$\hat{\theta}(g)u[x_2^A(N_1), P_2^A(N_1)] = u[x_2^B(2N - N_1), P_2^B(2N - N_1)]$$

--- Response function of migration to seawall height $N_1(g)$.

The local government in region A then chooses g to maximize the sum of per capita utility of period 1 and 2 in region A.

$$\max_g u_1^A + E(u_2^A) = u(x, P_1^A) + \hat{\theta}(g)u[x_2^A(N_1), P_2^A(N_1)];$$

Substitutes $N_1(g)$ into FOC to solve for g:

$$u_{P_1^A}C'(g) - \hat{\theta}(g)u_{N_1(g)}\frac{\partial N_1(g)}{\partial g} = \frac{\partial\hat{\theta}(g)}{\partial g}u[N_1(g)]$$

LHS: marginal social costs of increasing the seawall height.

- Direct marginal social costs from seawall construction in terms of the value of foregone marginal utility from public goods.
- Indirect marginal social costs from less migration due to higher seawall.

RHS: marginal social benefits of a higher seawall, which is higher amenity and thus higher per capita utility.

ii) Households act first

Households in region A make their migration decision first, and the local government of region A chooses seawall height g based on the observation of actual migration.

Solving for g:

$$u_{P_1^A} C'(g) = \frac{\partial \hat{\theta}(g)}{\partial g} u[N_1(g)]$$

Compare the solutions of i) and ii): MSB are the same; MSC are higher in i), when the local government acts before households.

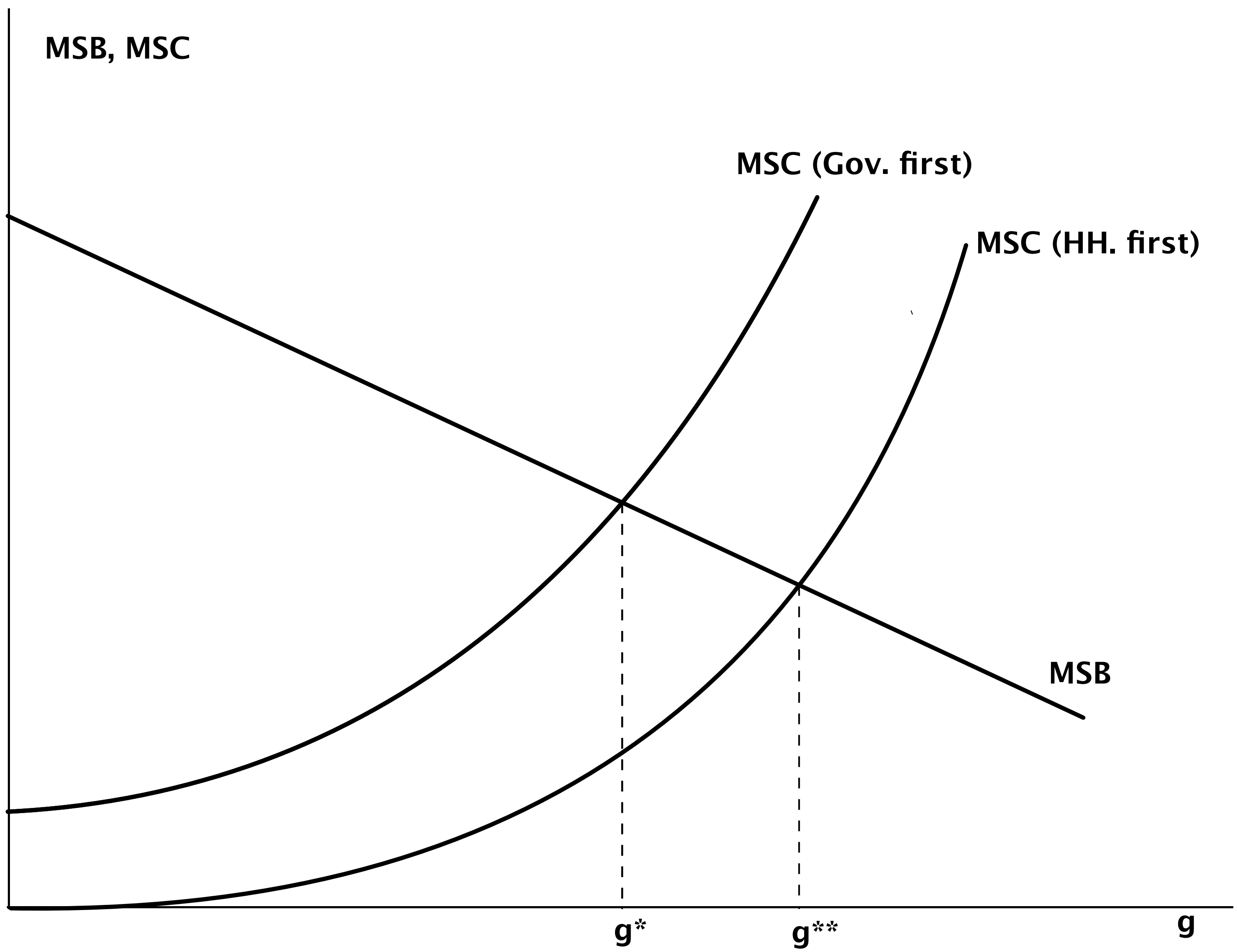

Figure 1. Local government and household adaptation

Central Government

The central government finances the costs of seawall from both regions equally. Public goods in period 1: $P_1 = P - \frac{C(g)}{2}$.

The central government's objective is to maximize expected total utility of both regions for period 1 and period 2.

i) The government acts first

ii) Households act first

Compare the solutions of i) and ii): MSB are the same; MSC are lower in i), when the central government acts before households.

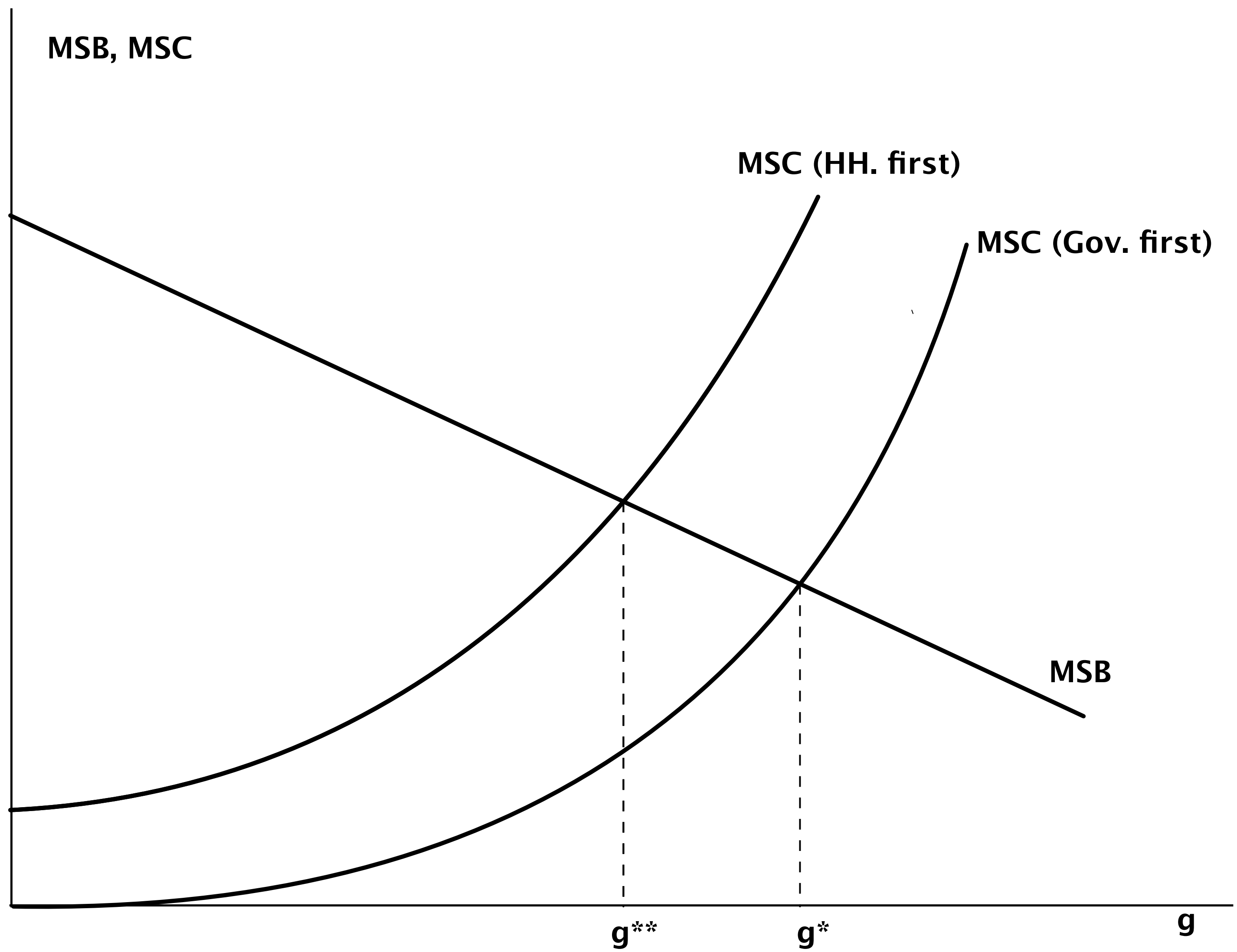

Figure 2. Central government and household adaptation

Local vs. Central government

1) The government acts first

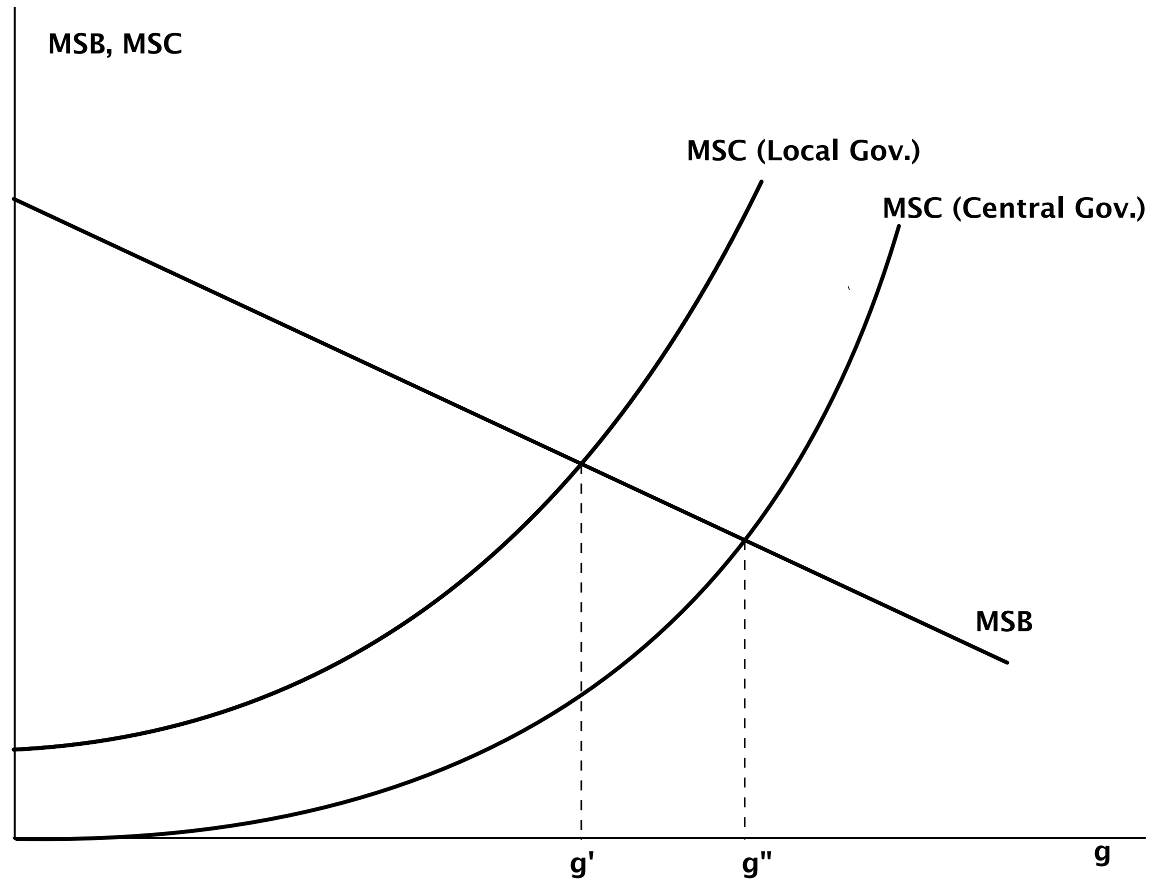

Figure 3. Local government and central government adaptation

2) Households act first: ambiguous, depends on N_1, $C(g)$.

Conclusion

- If the local government in the risky region is in charge of building a seawall, the seawall height is lower when the local government acts first.

  If the central government is in charge of building a seawall, the seawall height is lower when households act first.

- Given that the government acts before households, the local government would build a lower seawall than the central government.

  Given that households act first, the result is ambiguous.

Next step…

Conduct a simulation to compute utility for each case and find out which case yields the highest utility level regarding the risky region solely and both regions as well.