

Climate Engineering in an Interconnected World

The Role of Tariffs

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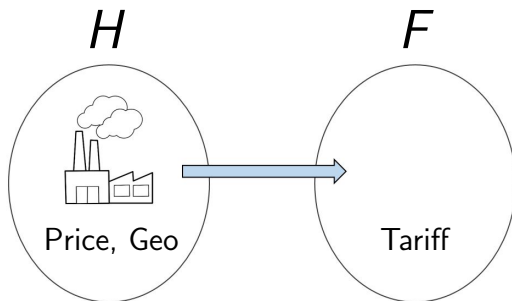
- ▶ Global CO_2 concentrations show no sign of slowing down.
- ▶ Three ways of reducing risks due to climate change: Abatement, Adaptation and Geoengineering (Heutel et al., 2016).
- ▶ Climate engineering: *The deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change.* (The Royal Society, 2009)
- ▶ Two classes:
 1. CO_2 removal (CDR).
 2. Solar Radiation Management (SRM).

Properties of SRM

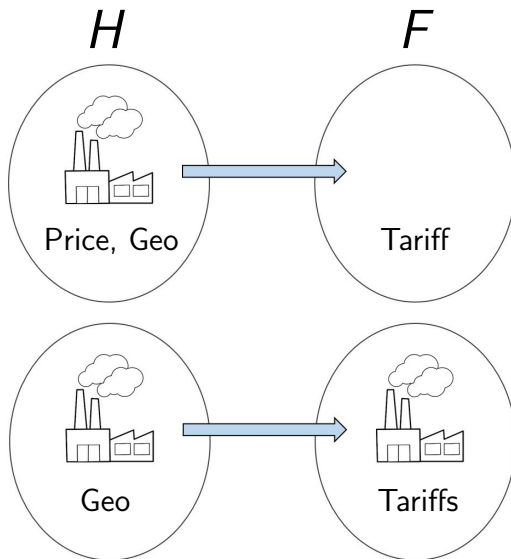
- ▶ Fast and cheap.
- ▶ Unclear whether it is captured by any of the existing international treaties.
- ▶ Governance issues (Barret, 2008). Who should decide?
- ▶ Termination effect.
- ▶ Asymmetric implementation effects (Bala et al., 2008).

What are some plausible reactions to countries negatively affected by climate engineering? What is the role of tariffs in such a model?

Effects on trade?



Effects on trade?



The model without foreign production

$$H : \max_{\substack{p_t \geq 0 \\ g_t \geq 0}} \int_0^\infty e^{-rt} \left[\underbrace{(p_t - p_t^2 - \tau_t p_t)}_{PS} - \overbrace{\frac{g_t^2}{2}}^{\text{geo costs}} - \underbrace{\frac{\alpha_H}{2} (P_t - g_t)^2}_{\text{Poll. costs}} \right] dt$$

$$F : \max_{\tau_t \geq 0} \int_0^\infty e^{-rt} \left[\underbrace{\frac{1}{2}(1 - 2p_t + p_t^2 - \tau_t^2)}_{CS+TR} - \overbrace{\beta g_t}^{\text{Ext}} \right] dt$$

s.t.

$$\dot{P}_t = q_t - \delta P_t = 1 - p_t - \tau_t - \delta P_t, \quad P_0 \geq 0.$$

p ... price

τ ... tariff

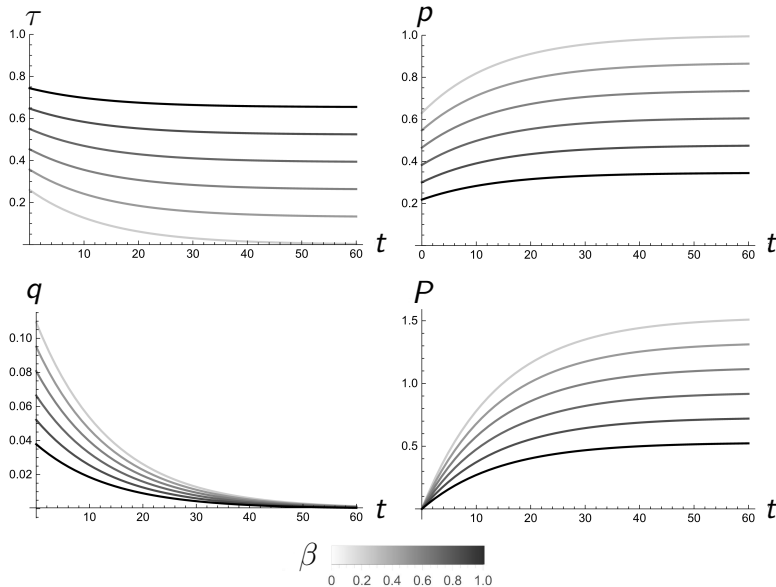
δ ... recharge rate

g ... geoengineering

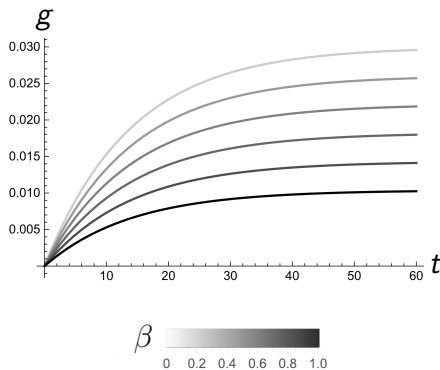
P ... Pollution

β ... coeff. of the ext. due to g

Optimal trajectories (1)



Optimal trajectories (2)



The model with foreign production (1)

- ▶ Cournot competition in the foreign market:

$$D(q^H, q^F) = 1 - q^H - q^F$$

- ▶ Profits defined by

$$\Pi_H = (1 - q^H - q^F - \tau^H)q^H,$$

$$\Pi_F = (1 - q^H - q^F - \tau^F)q^F,$$

imply the following Cournot-Nash quantities

$$q_H = \frac{1 - 2\tau^H + \tau^F}{3},$$

$$q_F = \frac{1 - 2\tau^F + \tau^H}{3}.$$

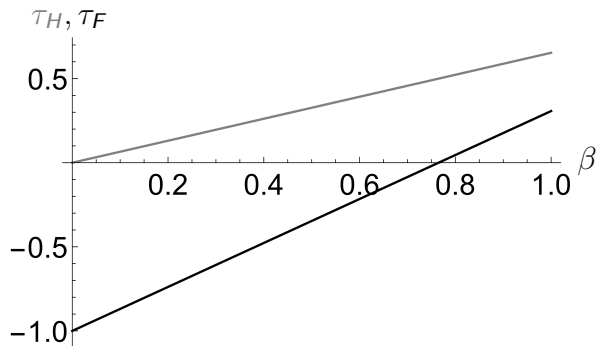
The model with foreign production (2)

$$H : \max_{g_t} \int_0^{\infty} e^{-rt} \left[(1 - q_t^H - q_t^F - \tau_t^H) q_t^H - \frac{g_t^2}{2} - \frac{\alpha}{2} (P_t - g_t)^2 \right] dt,$$

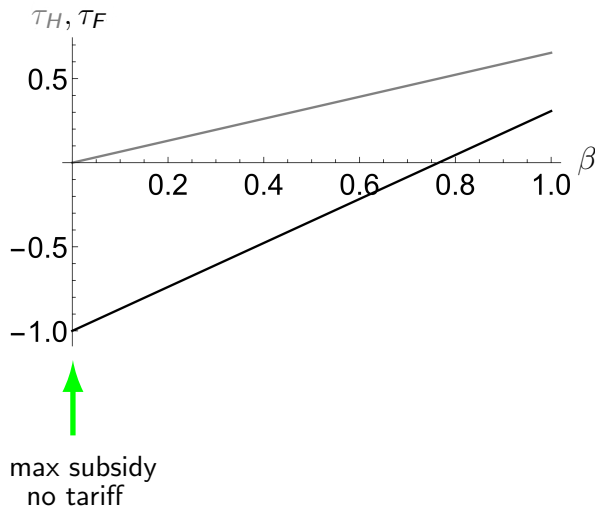
$$F : \max_{\tau_t^H, \tau_t^F} \int_0^{\infty} e^{-rt} \left[\frac{(q_t^H + q_t^F)^2}{2} + (1 - q_t^H - q_t^F - \tau_t^F) q_t^F + \tau_t^H q_t^H \right. \\ \left. + \tau_t^F q_t^F - \beta g_t \right] dt, \\ \text{s.t.}$$

$$\dot{P}_t = q_t^H + q_t^F = \frac{2 - \tau_t^H - \tau_t^F}{3}, \quad P_0 \geq 0, \\ q_t^H = \frac{1 - 2\tau_t^H + \tau_t^F}{3}, \quad q_t^F = \frac{1 - 2\tau_t^F + \tau_t^H}{3}.$$

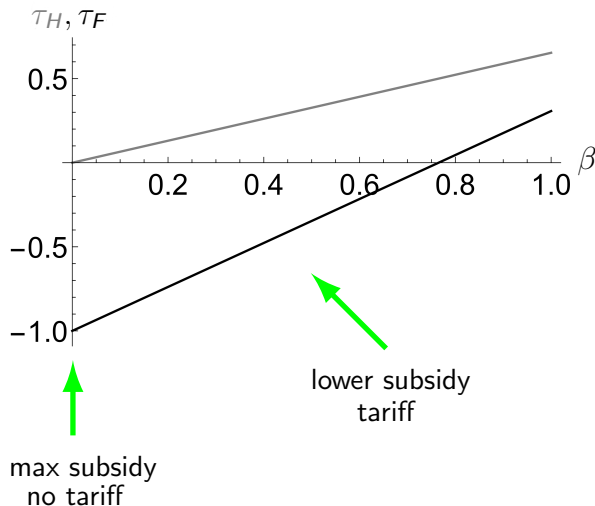
Results



Results



Results



Conclusion

- ▶ Extension of some mitigation results to the domain of trade relationships.
- ▶ Trade patterns can be affected by climate engineering activities.
- ▶ Incentives to implement and increase tariffs have been established in all setups. $\tau \uparrow \rightarrow p \uparrow \rightarrow q \downarrow \rightarrow P \downarrow \rightarrow g \downarrow$.
- ▶ An isolated analysis of abatement does not paint the full picture when countries have linked production and consumption patterns.

Thank You!

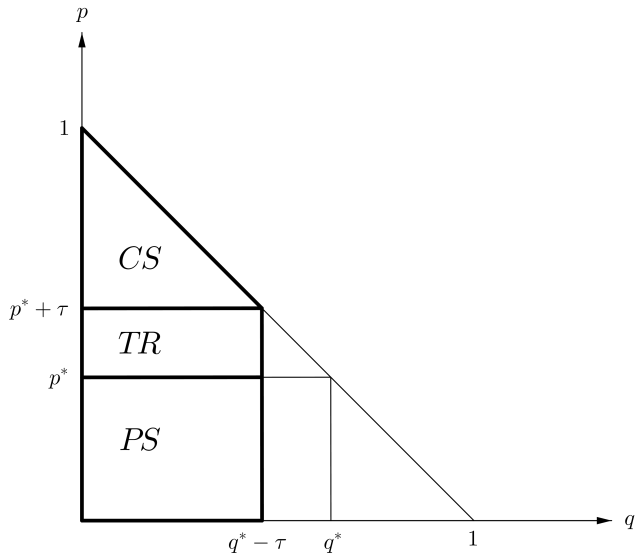


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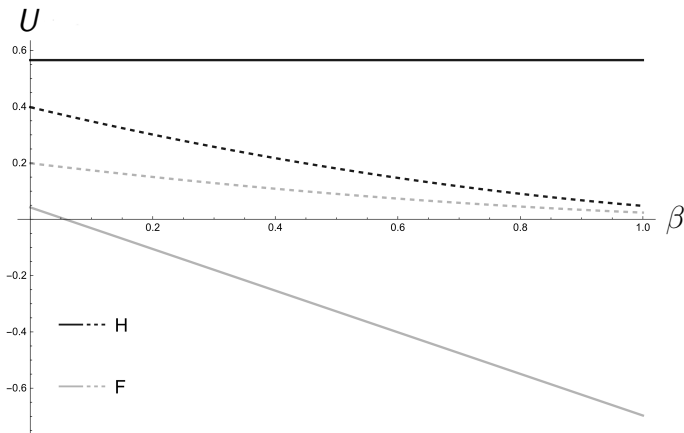
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Utilities



Total payoffs for both countries under a tariff-free (solid) and a tariff regime (dashed).