Environmental Cooperation and Trade - The Impact of Heterogeneity in Environmental Damages: An Endogenous Solution

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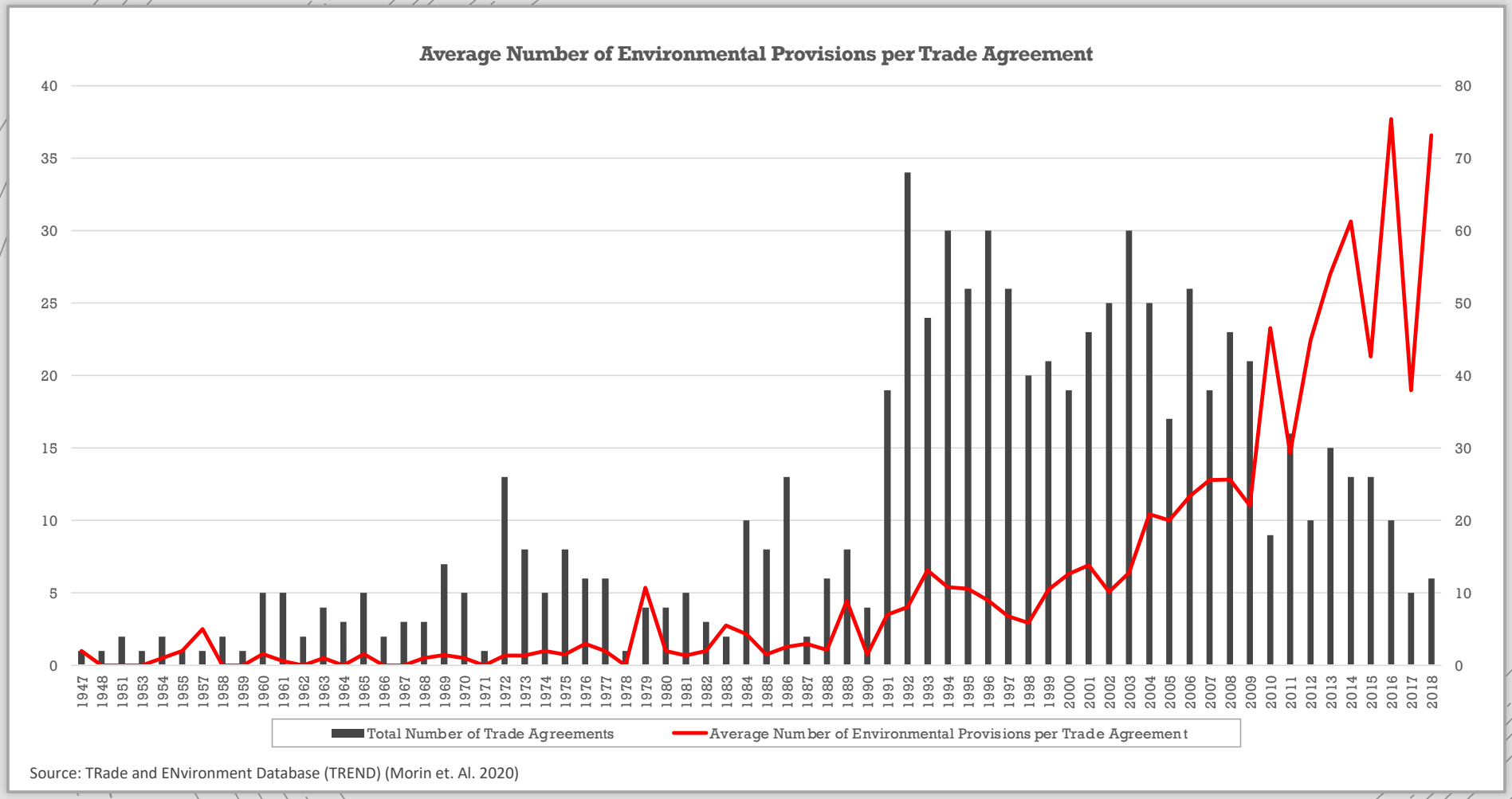


Source: TRade and ENvironment Database (TREND) (Morin et. Al. 2020)

International Environmental Cooperation

- This research examines the stability of partial and global International Environmental Agreements (IEAs) among heterogeneous trading partners.
- Strong incentives to free ride and challenges in enforcing International Environmental Agreements (IEAs) make international cooperation a difficult task.
- In the context of international trade, governments face the tradeoff between enforcing higher taxes to cooperatively reduce emissions and paying higher tariffs on exports when acting noncooperatively.
- The focus is on environmental damage heterogeneity. Countries do not suffer equally the consequences of environmental damage.

Research Objectives

1

Determine whether environmental cooperation among heterogenous countries provides environmental gains, overall welfare gains, or both

2

Identify which cooperative scenarios will emerge in a stable environmental coalition to exploit these gains

3

Capture the effect of heterogeneity in environmental damages on the stability of these environmental coalitions

Theoretical Literature Review

Environmental Cooperation and Trade

International Environmental Agreements

Theoretical Literature Review

- Heterogeneity in two-country trade models provides significant overall welfare gains (Duval and Hamilton 2002, Cheikbossian 2010, Baksi and Chaudhuri 2017, Gautier 2017).
- Heterogeneity, in pure IEAs does not increase the size of stable coalitions and can reduce the likelihood of cooperation (Hoel 1992, Barrett 1997, Finus and Rundshagen 2003, Pavlova and de Zeeuw 2013, Diamantoudi et al 2018a).
- Heterogeneity, when associated with trade linkages, such as trade sanctions, can reduce free riding incentives and increase the size of stable coalitions (Cirone and Urpelainen 2013, Nordhaus 2015, Hagen and Schneider 2017).
- Few scholars (Cavagnac and Cheikbossian 2017) have examined the stability of IEAs among heterogeneous trading partners. They found that market size heterogeneity fostered the formation of a partial rather than a global agreement.
- This paper is closest to (Cavagnac and Cheikbossian 2017). Using different stability criteria, the focus is on environmental damage rather than market size heterogeneity, in a segmented market setting with positive import tariffs rather than free trade.

The Model

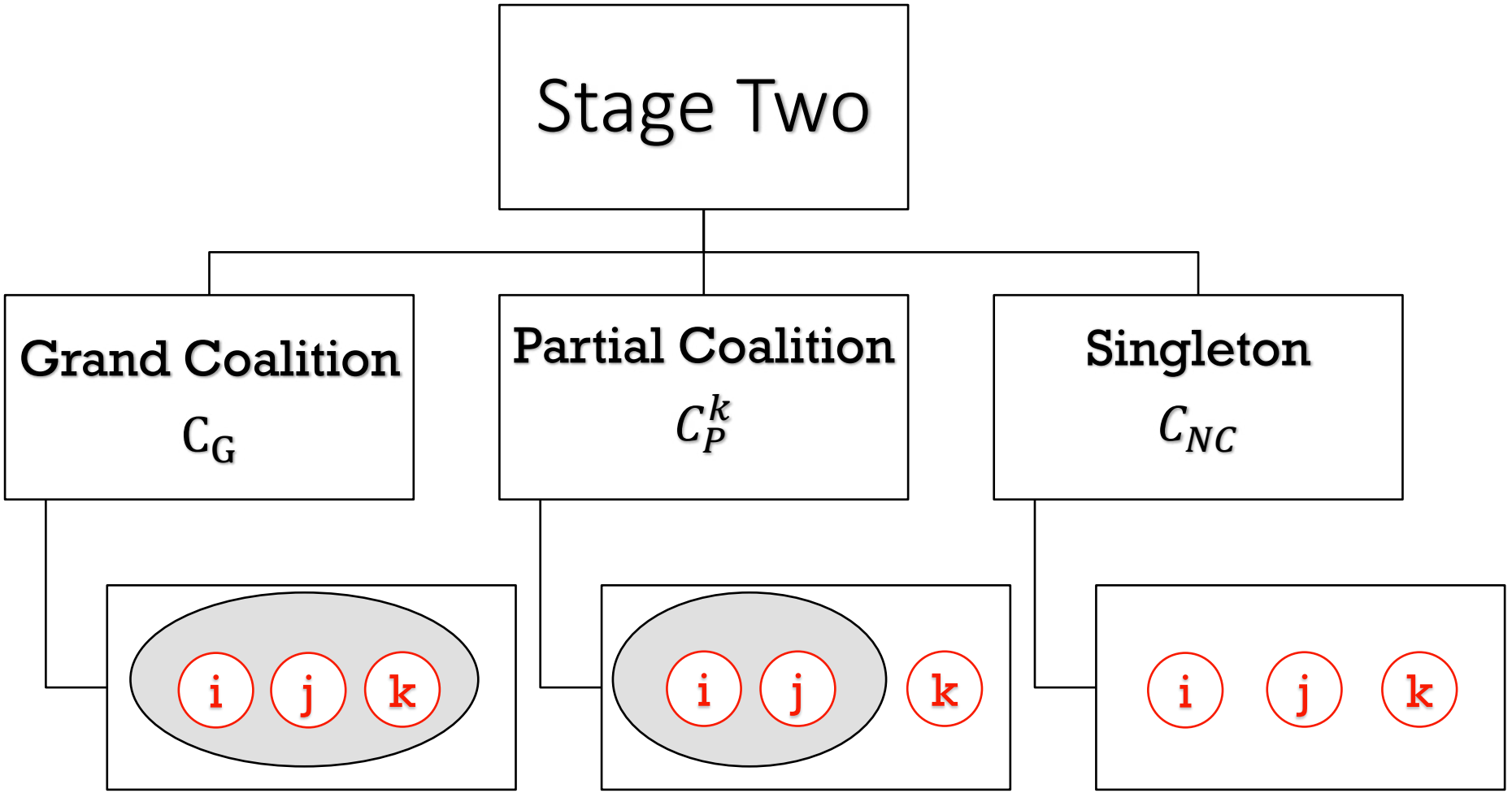
- There are 3 countries N = $\{i, j, k\}$, each with different environmental damage parameters, where $\beta_i > \beta_j > \beta_k$
- Each country has one firm, producing an emission-intensive homogenous product.
- Total production of the firm located in country i: $X_i = \left(x_{ii} + x_{ij} + x_{ik}\right)$
- The production process generates transboundary pollution (CO2). Every unit produced generates one unit of global emissions.
- The firm's choice variable is production (emissions).
- Firms compete à la Cournot in a segmented market.
- Firms face linear market-specific demands $\mathrm{Q_i} = (\alpha - \mathrm{P_i})$, where $\mathrm{Q_i}$ is the total consumption of the good in country i, and α is the maximal marginal utility derived from its consumption.

The Model

- For simplification, it is assumed that the marginal cost of production is equal to zero. Each firm can export to the other two markets at no shipping costs.
- Pollution generates environmental damage in each country: $D_i(X) = \beta_i (X_i + X_j + X_k)$
- β_i = marginal environmental damage in country i caused by aggregate production.
- Each country uses import tariffs as a trade policy tool to protect local production.
- $\tau_{i,j}$ = tariff imposed by country i on imports from country j - **Optimal Unrestricted Tariffs**
- Each government uses a per unit production (emissions) tax rate t_i as an environmental policy tool, imposed by the government in country i on the local firm.
- There are no transfer payments between countries and fiscal revenues remain in the country of origin.

The Model – 3 Stage Static Coalition Game

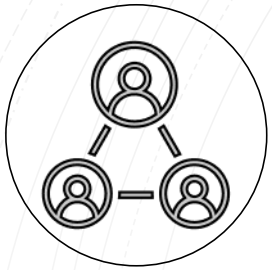
STAGE 3	Each firm chooses noncooperatively the output rate by maximizing the firms' profits.
STAGE 2	Each coalition sets a uniform emission tax and import tariff rate by maximizing the coalition's welfare.
STAGE 1	The stability of each coalition structure is analyzed.


Stage Two
Grand Coalition
C_G
Partial Coalition
C_P^k
Singleton
C_{NC}
i
j
k
i
j
k
i
j
k

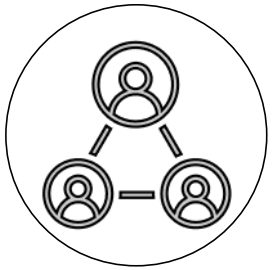
Stage Two – The Grand Coalition C_G

- Countries collectively decide on a uniform emissions tax and an import tariff that maximize the joint welfare of all three countries, $\max_{t_G} W(C_G) = \max_{t_G} \sum_i W_i(C_G)$
- $t_i(C_G) = t_j\ (C_G) = t_k\ (C_G) = t_G(C_G)$
- $\tau_{i,j}(C_G) = \tau_{i,k}(C_G) = \tau_{j,i}(C_G) = \tau_{j,k}(C_G) = \tau_{k,i}(C_G) = \tau_{k,j}(C_G) = \tau_G(C_G)$.
- Equilibrium tax rate $t_G^*(C_G) = \frac{1}{3}(4\sum_i \beta_i - \alpha - 2\tau_G)$
- Aggregate emissions $\sum_i X_i\ (C_G) = \sum_i Q_i\ (C_G) = 3(\alpha - \sum_i \beta_i)$
- Individual country welfare $W_i(C_G) = \frac{1}{2}(\alpha - \sum_i \beta_i)(\alpha + \sum_i \beta_i - 6\beta_i)$
- Total welfare $W(C_G) = \sum_i W_i(C_G) = \frac{3}{2}(\alpha - \sum_i \beta_i)^2 > 0$

Simulation Results – Stable Coalition Structures



$$\beta_i = \beta_j = \beta_k$$



$$\beta_i > \beta_j = \beta_k$$

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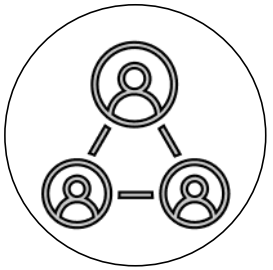
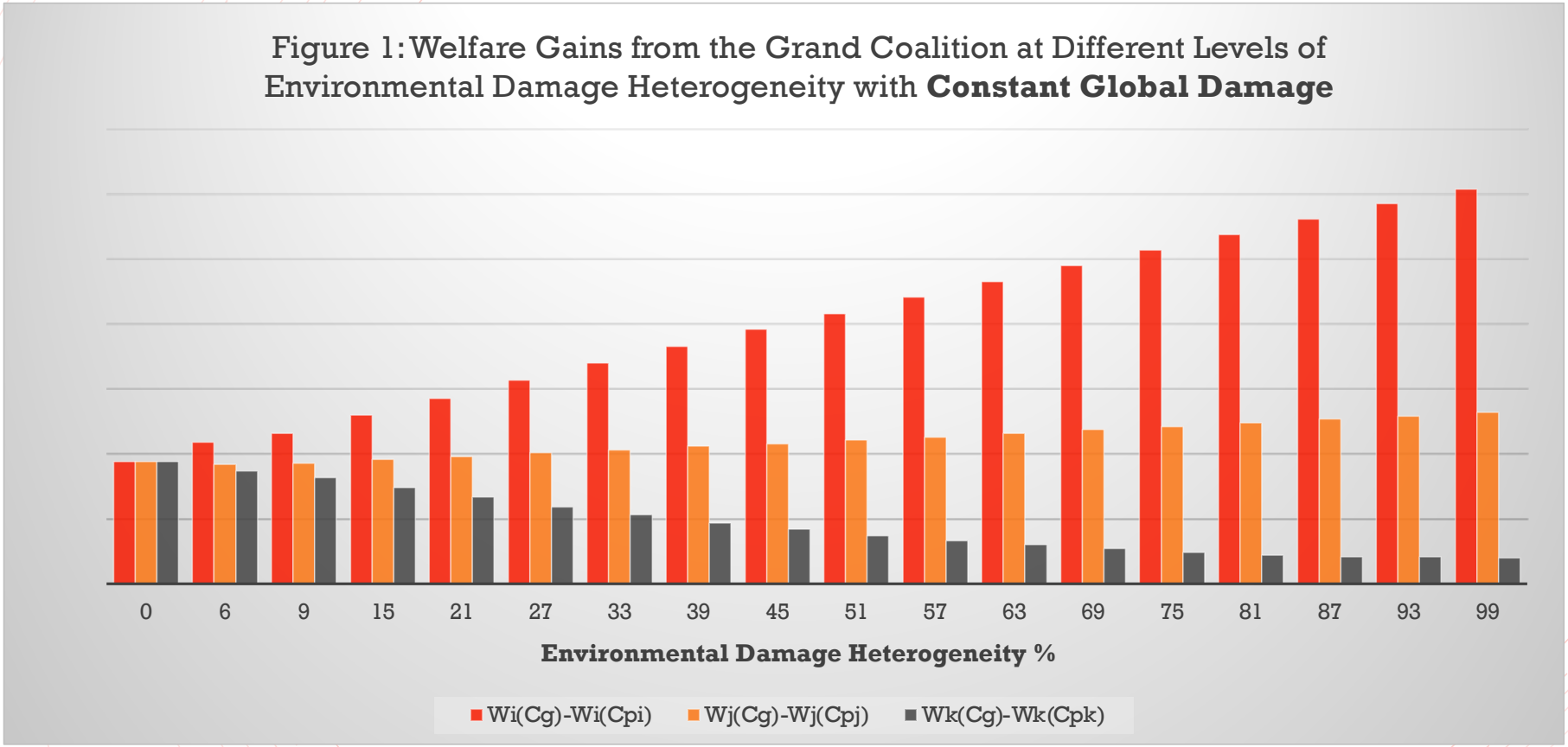


$$\beta_i > \beta_j > \beta_k$$

Simulation Results – The Grand Coalition Stability Condition



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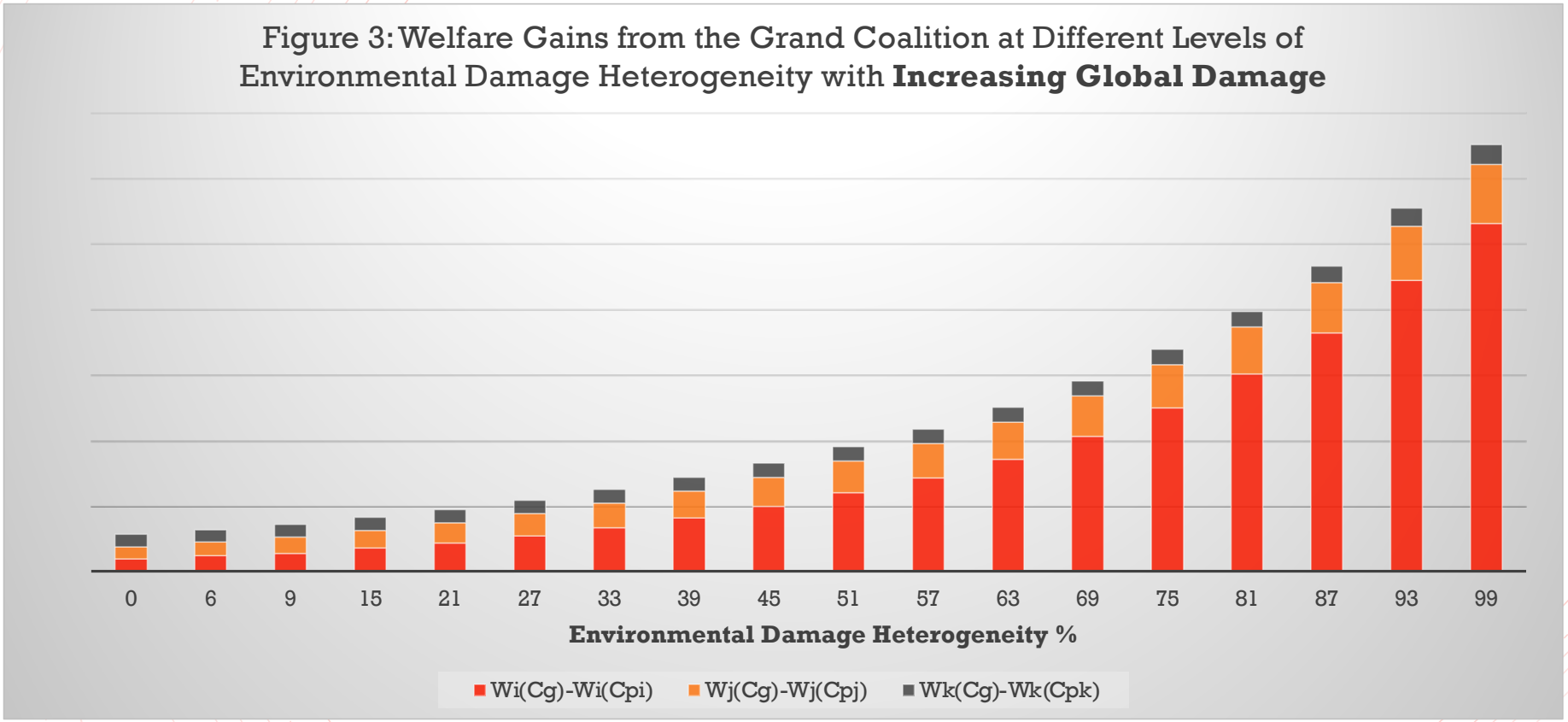

Conclusion

- The grand coalition is stable at various levels of environmental damage heterogeneity.
- At higher levels of heterogeneity, the stability of the grand coalition can be reinforced by a larger market size.
- At sufficiently low market sizes, the grand coalition provides environmental gains and overall welfare gains.
- At sufficiently larger market sizes, the grand coalition provides only collective welfare gains, mainly higher profits for the monopoly firms.

Policy Implications

Implementing modest trade penalties on countries that opt out of participation can be a valuable strategy to foster a stable global environmental agreement despite countries' heterogeneity

The coordination of environmental and trade policies can be a valuable strategy to reduce global emissions in sufficiently small markets despite differences in environmental damage

Contribution to the Literature

The use positive tariffs on imports in a segmented market as opposed to a free trade setting, reduces the outsider's free riding incentives and reinforces the stability of the grand coalition

Thank you!

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Insights into the Grand Coalition Stability: Welfare Equation

$$W_i(C) = CS_i - D_i + \pi_i + TR_i + ER_i$$

$$W_i(C) = \left[\frac{1}{2}Q_i^2 - \boldsymbol{\beta_i}\left(\boldsymbol{X_i} + \boldsymbol{X_j} + \boldsymbol{X_k}\right)\right] + \left[\tau_{i,j}x_{ji} + \tau_{i,k}x_{ki}\right]$$

$$+\left[(\alpha - Q_i)x_{ii} + \left(\alpha - Q_j - \tau_{j,i}\right)x_{ij} + \left(\alpha - Q_k - \tau_{k,i}\right)x_{ik}\right]$$