A macroeconomic perspective on climate change mitigation

Meeting the financing challenge

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WWWforEurope Conference

Vienna - March 13th, 2013

LIMITS FP7 Project

- Target of LIMITS: Analyze the technical, economic and political feasibility of attaining climate policies able to limit global temperature increase below 2°C;
- Model comparison exercise: run the same set of scenarios and analyze robustness of conclusions;
- Partners: FEEM, PIK, IAASA and other institutions;
- Integrated Assessment Models: WITCH, REMIND, MESSAGE, IMAGE, TIAM-ECN, GCAM and AIM-Enduse;
- LSE role: macroeconomic analysis.

Integrated Assessment Modelling

- Integrated Assessment Models (IAMs) built to study the interactions between the economic, energy and climatic systems;
- The most interesting class of IAMs from an economic perspective includes DICE/RICE, WITCH and REMIND:
  - Ramsey-type growth models;
  - Intertemporal maximization of a social welfare function;
  - Physical constraints (e.g what is the optimal emissions trajectory if we want to respect the 2°C limit?);
  - BAU vs climate policies scenarios;
  - Gross output affected by climate change damage function;
  - Highly aggregated nature of their economic modules;
  - Long-term perspective of the analysis (2100);
  - Economic growth mainly a result of exogenous productivity improvements;
  - ▸ Equations

Our research up until now

- Non modelling work on the macroeconomic implications of LIMITS simulations (finance, institutions, developing countries)
  1. Analysis and discussion of macro variables included in modelling outputs;
  2. Broader perspective on macro issues beyond LIMITS models.
- Main research question: How to finance the transition to a low carbon society?
  1. Macroeconomic implications of climate policies;
  2. Carbon tax revenues and energy investments;
  3. International financial flows;
  4. GDP and aggregate investment.
- Paper submitted to Climate Change Economics (with Massimo Tavoni).

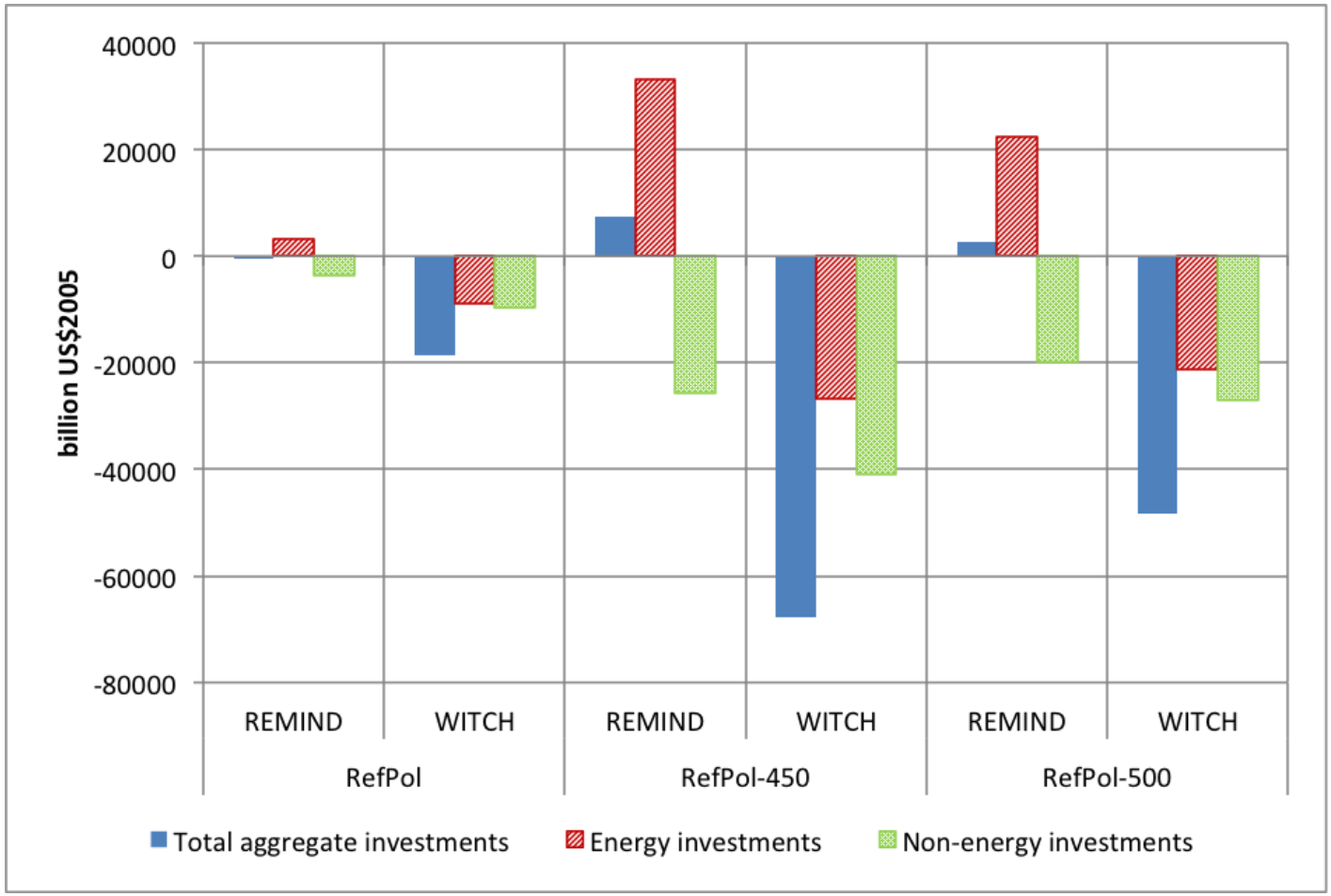
Scenarios

- 12 scenarios: 3 reference + 2 benchmark + 7 policy scenarios
- Two targets: 450ppm (2.8 W/m^2) and 500 ppm (3.2 W/m^2)
- Two scenarios with burden sharing mechanisms:
  - Equal per capita emissions;
  - Equal mitigation costs.

Scenario	Description	Forcing level target (in 2100)	Before 2020	After 2020	Burden Sharing
Base	No Policy Baseline	/	No policy		/
RefPol	Weak Policy reference case	/	Weak policy		/
StrPol	Stringent Policy reference case	/	Strong policy		/
450	2.8 W/m^2 benchmark case	2.8 W/m^2	2.8 W/m^2		/
500	3.2 W/ m^2 benchmark case	3.2 W/m^2	3.2 W/m^2		/
RefPol-450	Weak policy until 2020 then cooperation to 2.8 W/m^2	2.8 W/m^2	Weak policy	Global GHG tax	/
StrPol-450	Stringent policy until 2020 then cooperation to 2.8 W/m^2	2.8 W/m^2	Strong policy	Global GHG tax	/
RefPol-500	Weak policy until 2020 then cooperation to 3.2 W/m^2	3.2 W/m^2	Weak policy	Global GHG tax	/
StrPol-500	Stringent policy until 2020 then cooperation to 3.2 W/m^2	3.2 W/m^2	Strong policy	Global GHG tax	/
RefPol2030-450	Weak policy until 2030 then cooperation to 3.2 W/m^2	3.2 W/m^2	Weak policy (before 2030)	Global GHG tax (after 2030)	/
RefPol-450-PC	Weak policy until 2020 then cooperation to 2.8 W/m^2 with C&C burden sharing	2.8 W/m^2	Weak policy	Global GHG tax	Contraction & Convergence
RefPol-450-EE	Weak policy until 2020 then cooperation to 2.8 W/m^2 with mitigation costs burden sharing	2.8 W/m^2	Weak policy	Global GHG tax	Equal mitigation costs

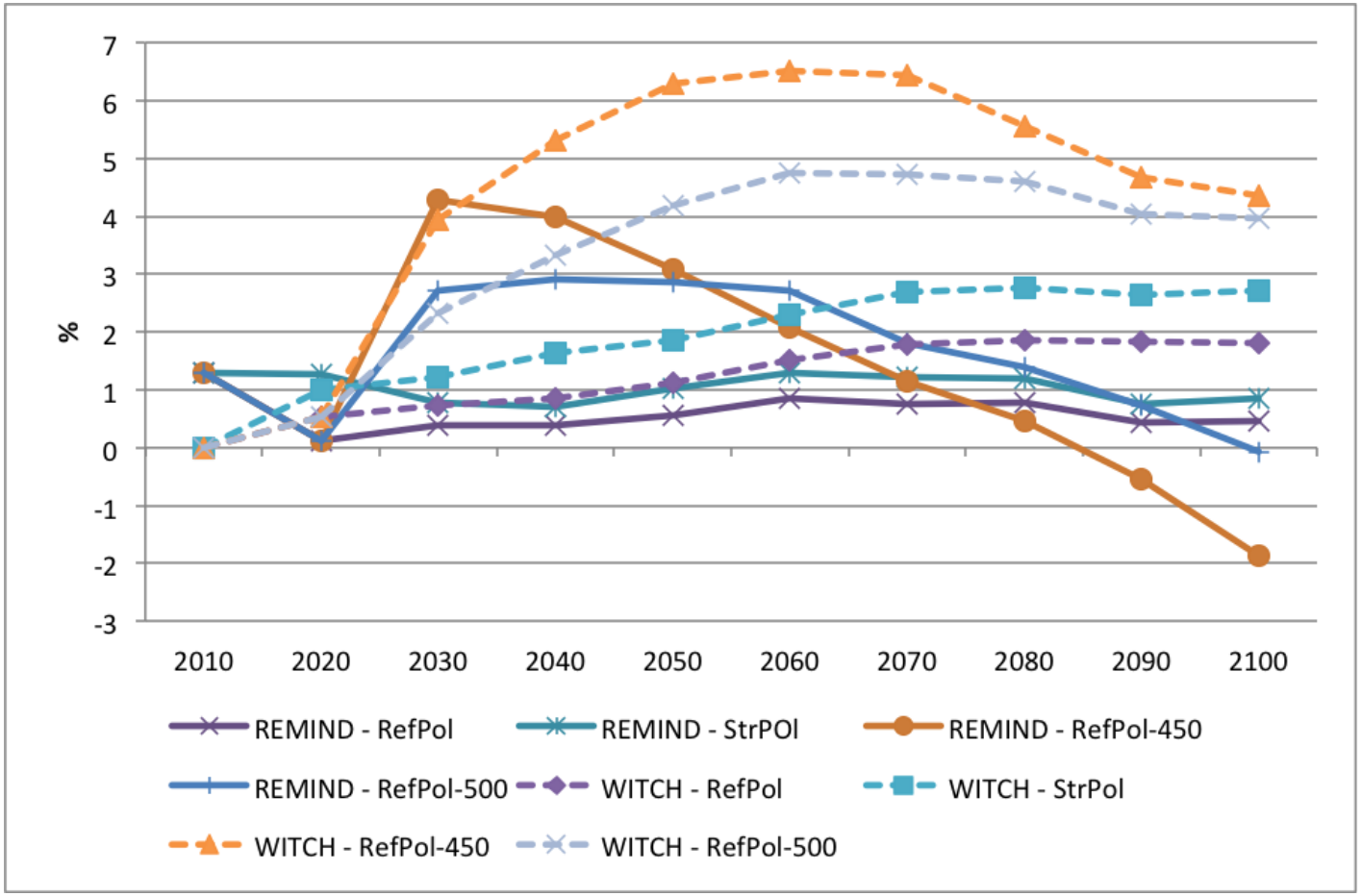
Composition of investments

Cumulated investments 2010-50 (difference w.r.t. Base)



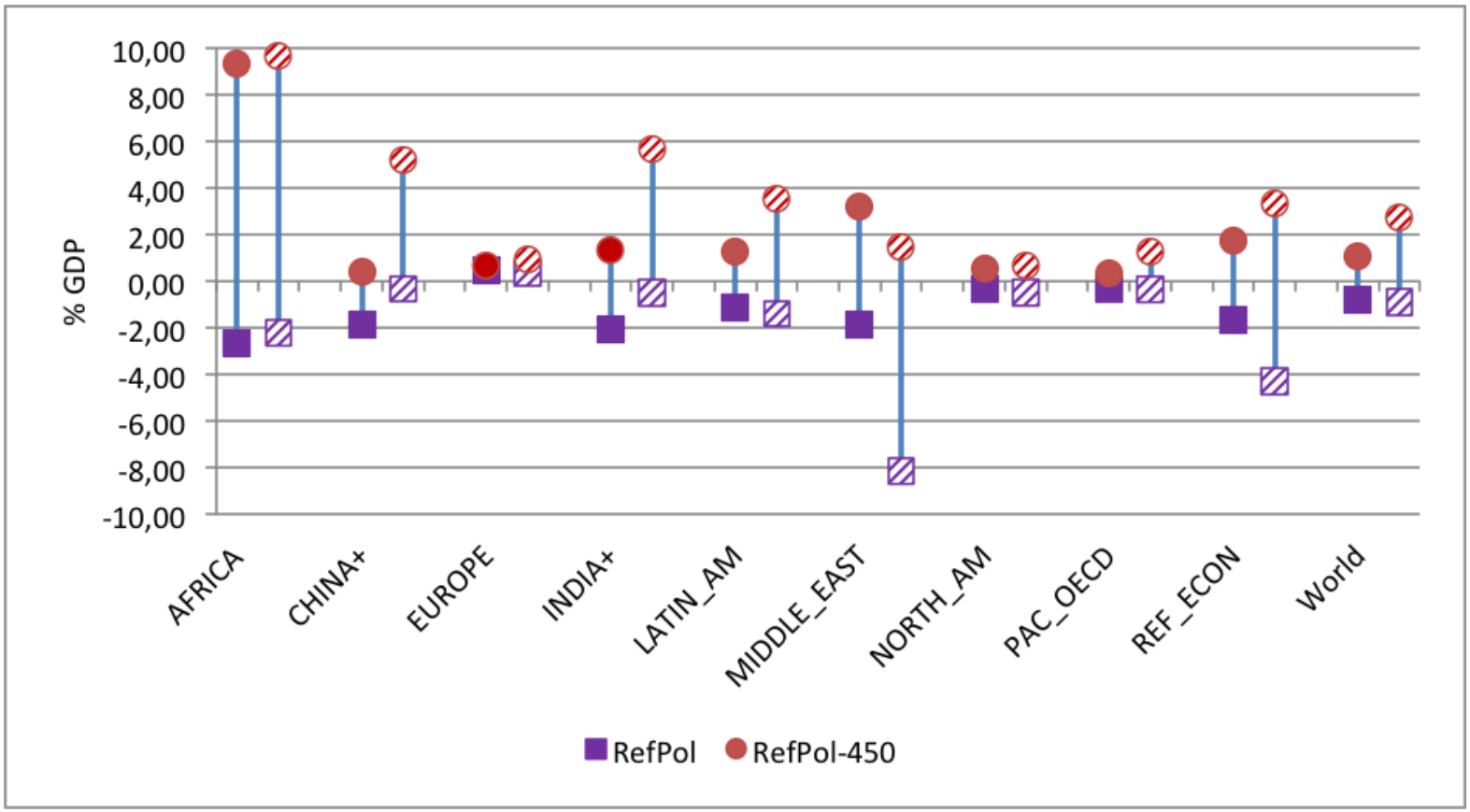
Fiscal revenues from carbon taxation

Carbon tax revenues (as % of GDP)



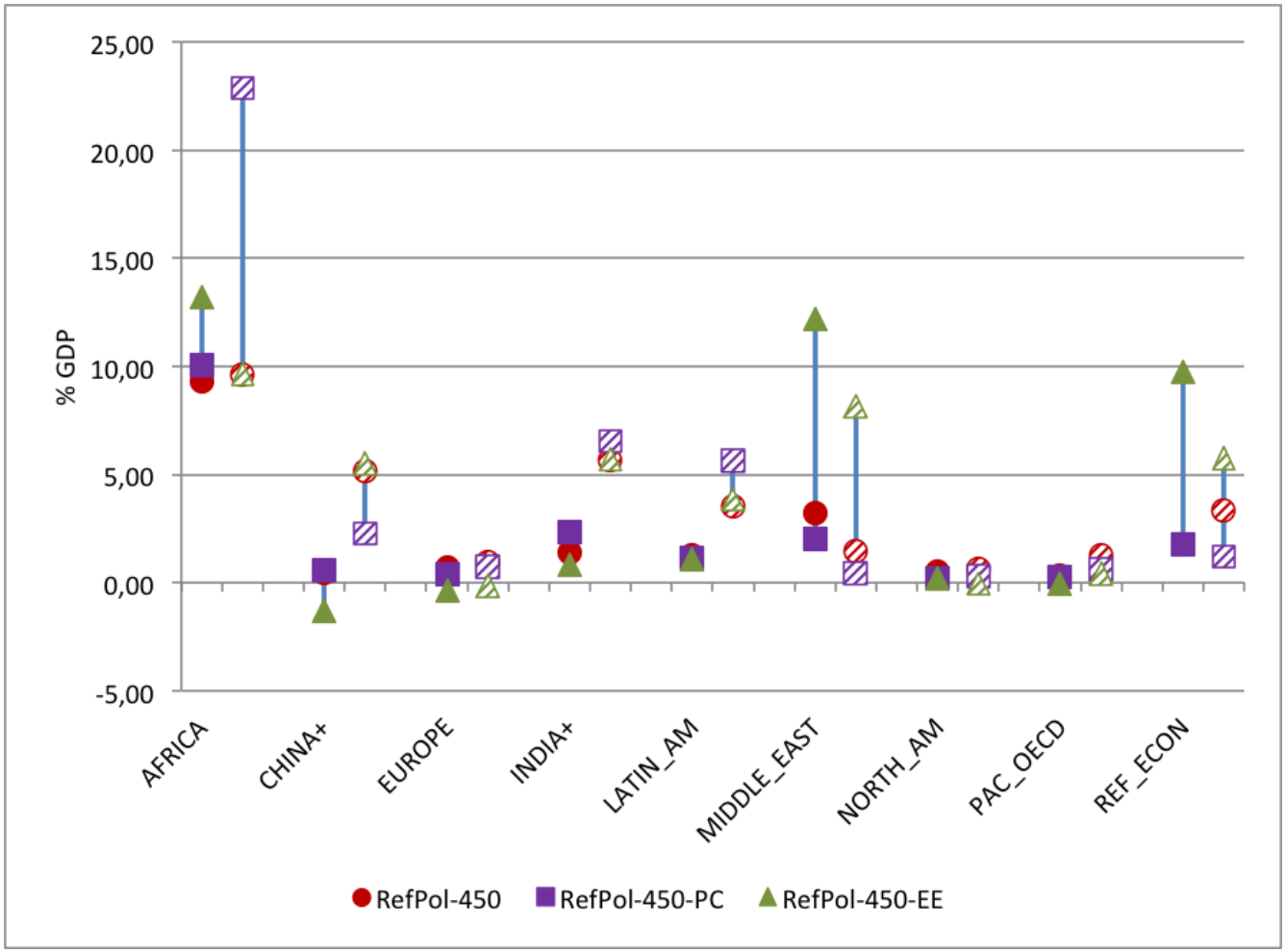
Are carbon revenues enough to finance investments?

Regional domestic fiscal self-reliance



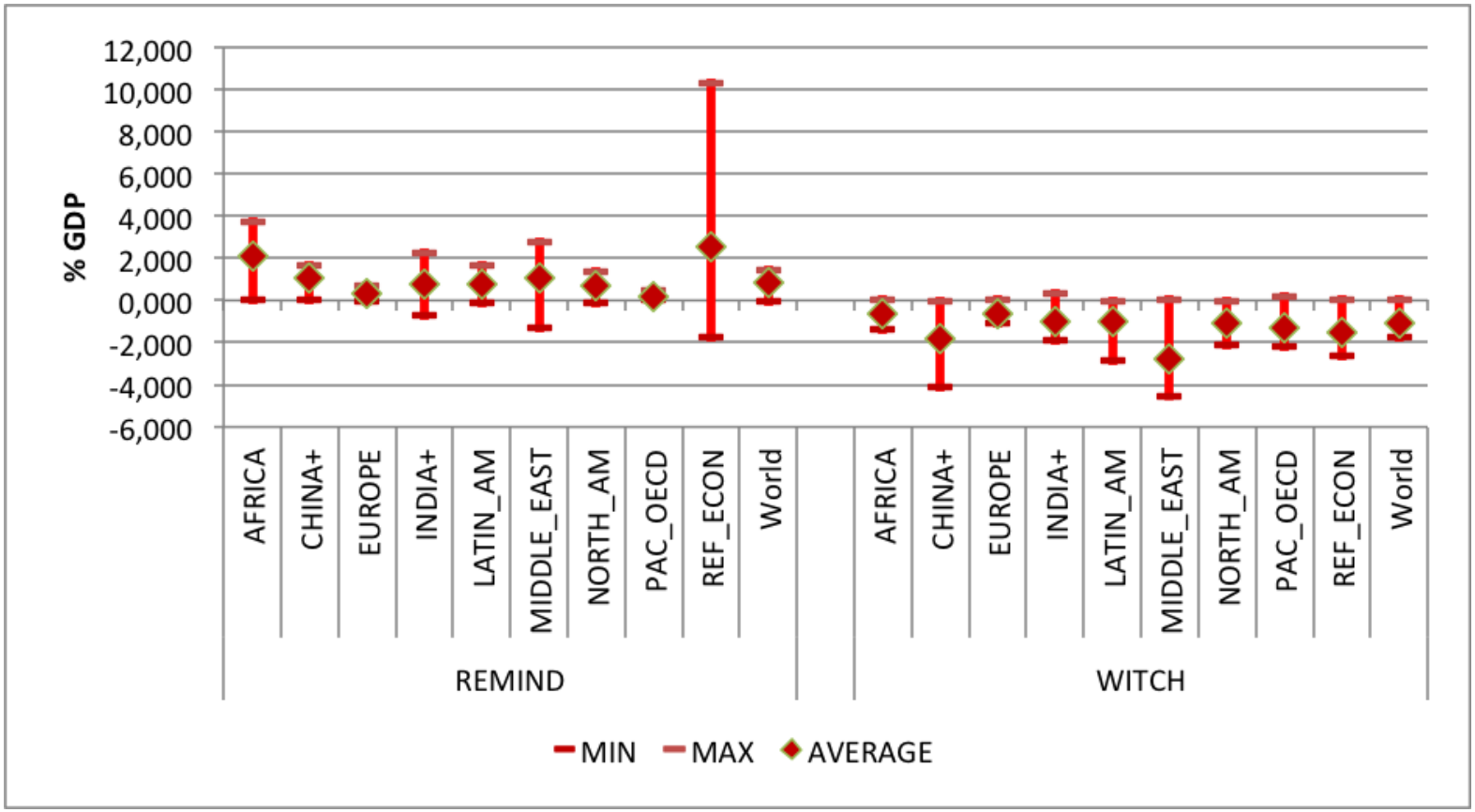
The role of emissions permits trade

Fiscal self-reliance and international financial flows



Respecting 2° is feasible

Incremental aggregate investments in RefPol-450



Next steps

- Expand the analysis to include more models and regions;
- Policy oriented analysis (LIMITS deliverables):
  - Financing mechanisms required to raise and manage the economic resources needed to achieve 2°C;
  - Institutional needs for dealing with policies and financing;
  - Implications of climate mitigation for economic development;
- Start our own modelling effort:
  - Small-scale modelling focused on the economic side of climate change mitigation;
  - Expand to novel areas: finance flows, current account balances, employment and labour frictions;
  - Discussion of IAMs and their growth theory;
- Alternative methodological choices?

Thank you!

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LIMITS

Welfare and production function

- Instantaneous welfare is a logarithmic function of per capita consumption:

$$U_t = L_t \ln\left(\frac{C_t}{L_t}\right)$$

- Maximization problem is then:

$$Max \quad W = \sum_r \sum_{t=0}^{\infty} \beta^t U_{r,t}$$

- Production function:

$$Q_t = A_t[\beta(K_t^{1-\alpha} * L_t^{\alpha})^{\rho} + (1-\beta) * ES_t^{\rho}]^{1/\rho}$$

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Emissions and output

- Damage function:

$$\Omega_t = \frac{1}{1 + \psi_1 T_t + \psi_2 T_t^2}$$

- Emissions:

$$E_t = \sigma_t [1 - \mu_t] Q_t$$

- Abatement costs function:

$$B_t = Q_t (b_1 \mu_t^{b_2})$$

- Net output:

$$Y_t = Q_t \frac{1 - b_1 \mu_t^{b_2}}{1 + \psi_1 T_t + \psi_2 T_t^2}$$

- Distribution of output

$$Y_t = C_t + I_t + ...$$

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