Carbon Sensitive Productivity Growth, Climate Change and Institutions

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Motivation

- Concerns about climate change impacts and at the same time, concerns about the costs of abating emissions have made climate change an issue of central concern
- Climate change impacts occurs through affecting the productivity of resources
- Mitigation of CO_2 emissions diverts resources from the conventional usage
- Better institutions helps in better utilization of resources and supposed to improve productivity and thus lowers the impacts of climate change and cost of mitigation

Related Literature

- Efficiency and productivity measurement under strong and weak disposability of CO_2 emissions (e.g., Fare et al 1996, Murty and Kumar 2002, Kumar and Khanna 2009, Kumar and Managi 2009).
- Climate change impacts: sectoral studies, IAMs, econometric studies (e.g., Tol 2002, Deschenes and Moretti 2007, Nordhaus 2010, Dell et al. 2008)
- Cost of abatement: CGE/IAMs models (e.g., Nordhaus, 2011)
- Institutions and economic growth (e.g., Acemoglu and his colleagues 2001, 2002, 2003, 2005)

Research Questions

- Does CO_2 emissions abatement lower the growth potential?
- Does climate change affect productivity growth
- Do better institutions helps in lowering the impacts of climate change

Outline

- Basic framework and production technology
- Directional output distance function and productivity measurement
- Productivity results
- Determinants of productivity: climatic factors and institutions
- Regression results
- Summary and conclusions

The basic framework

- *y* is desirable (good) output
- *b* is undesirable (bad) output – CO_2 emissions
- *x* is the vector of inputs
- there are K countries

Technology

We model technology in terms of output sets P(x)

P(x) = {(y, b): x can produce (y, b)}

Outputs are assumed to be *weakly disposable*

$$(y,b) \in P(x) \text{ and } 0 \leq \theta \leq 1 \text{ imply } (\theta \mathrm{y}, \theta \mathrm{b}) \in \mathrm{P(x)}$$

Desirable output is *freely (or strongly) disposable*

$$(y,b) \in P(x) \text{ and } \widehat{\mathrm{y}} \leq \mathrm{y} \text{ imply } (\widehat{\mathrm{y}}, \mathrm{b}) \in \mathrm{P(x)}$$

But bad output is not (if there is environmental regulation)

'Goods' are *nulljoint* with the 'bads'

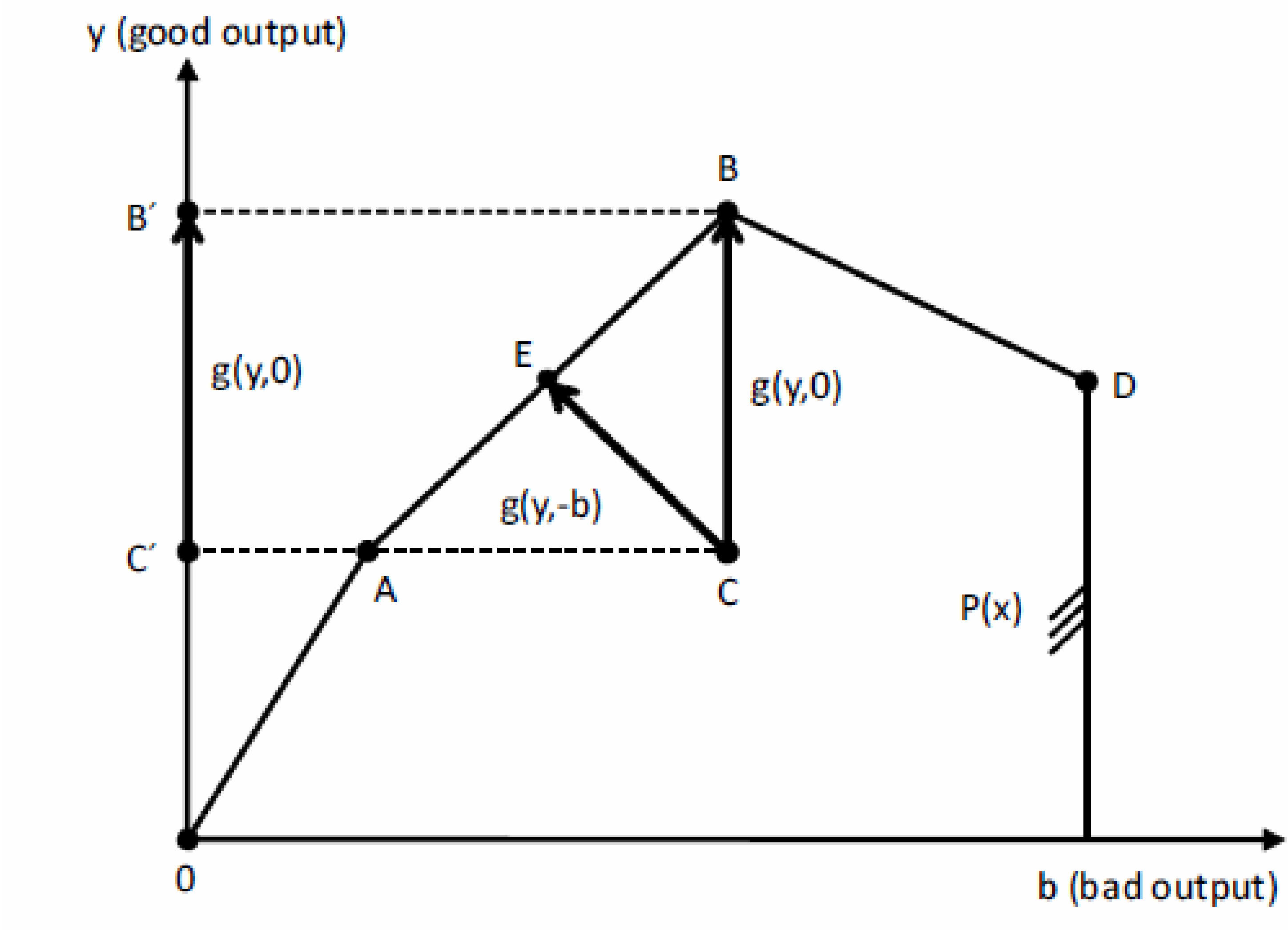
$$\textit{if } (y,b) \in P(x) \text{ and } \mathrm{b} = 0 \text{ then } \mathrm{y} = 0$$

Directional Output Distance Function

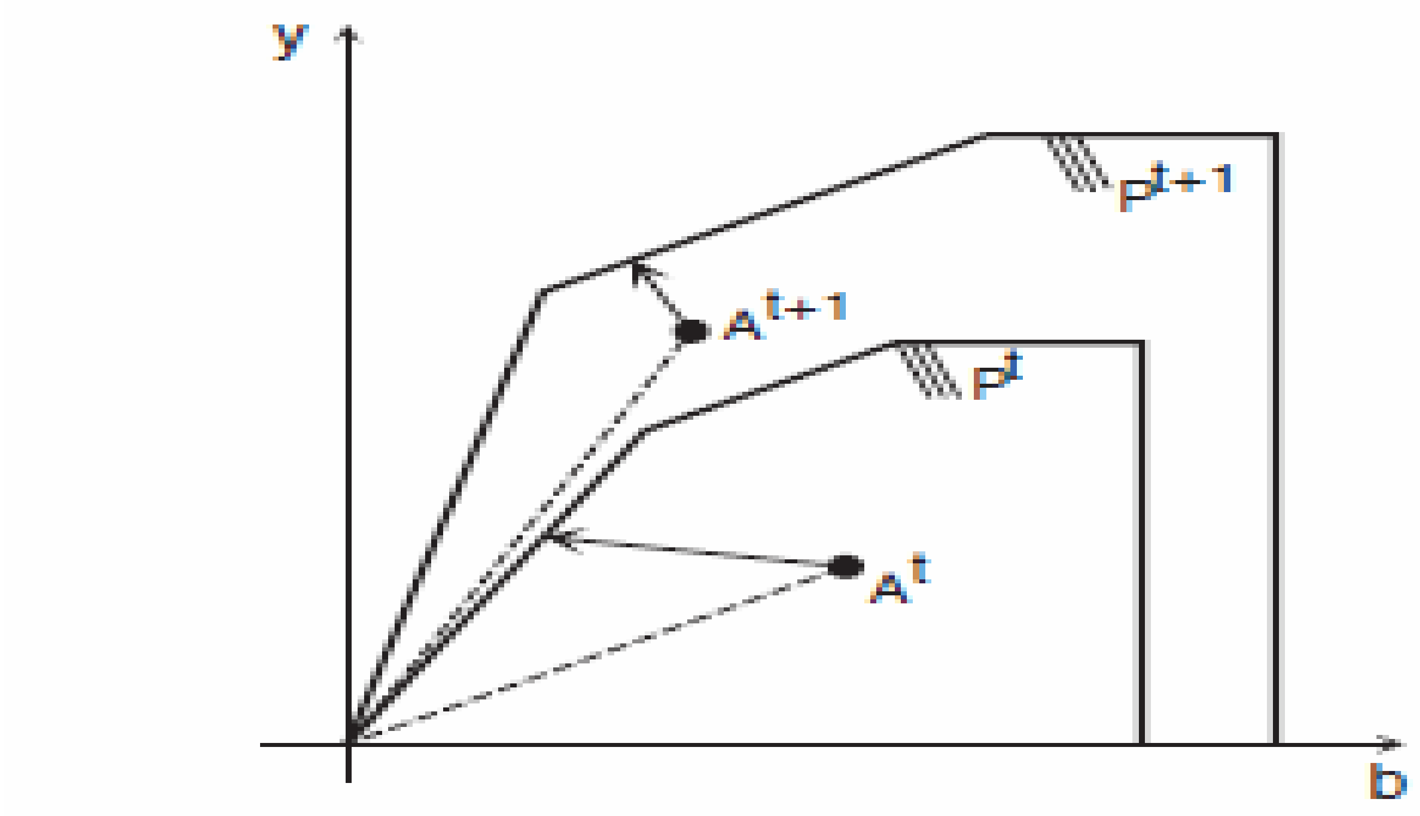
It seeks to increase the desirable outputs whilst simultaneously reducing the undesirable outputs, i.e.,

$$\vec{D}_o(\mathbf{y}, \mathbf{b}, \mathbf{x}; g) = \sup\left\{\beta : (\mathbf{y}, \mathbf{b}) + \beta g \in P(\mathbf{x})\right\}$$

Graphical Presentation of Directional output distance function



Productivity growth, efficiency change and technical change



Productivity Change = Efficiency Change + Technical Change
(Technological Diffusion) (Innovation)

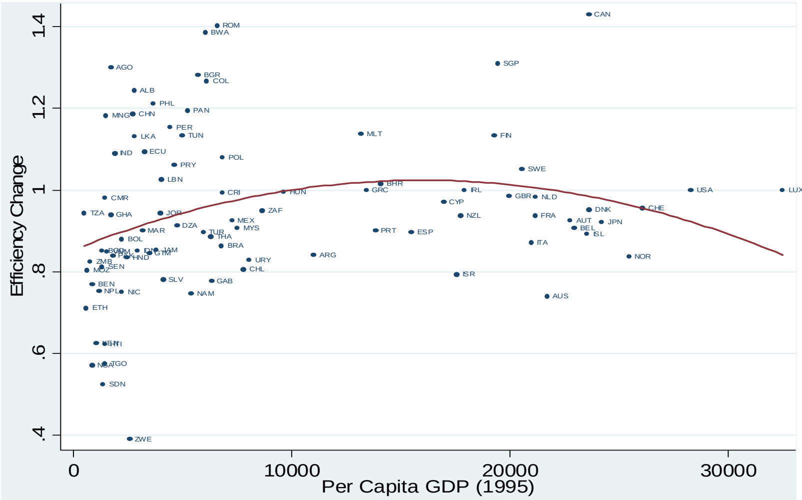
Data

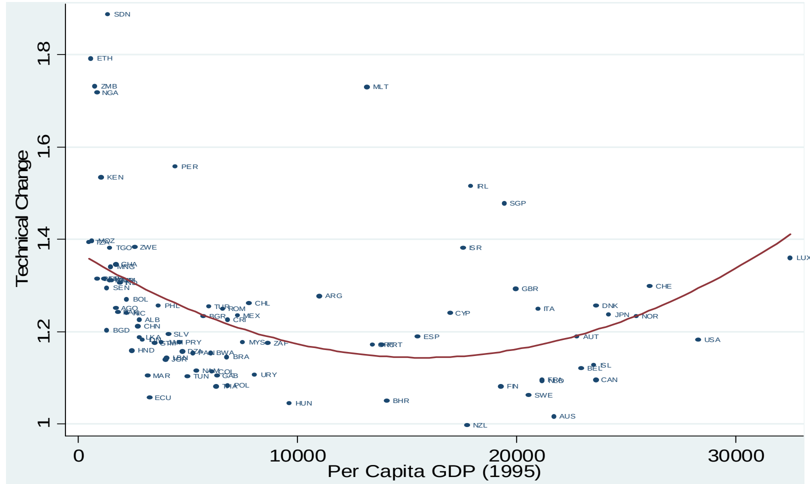
- 88 countries, 26 developed and 62 developing countries
- Time period: 1994-2008
- Desired output: GDP (in 2005 PPP)
- Undesired output: CO_2 emissions
- Inputs: labour, capital and energy consumption

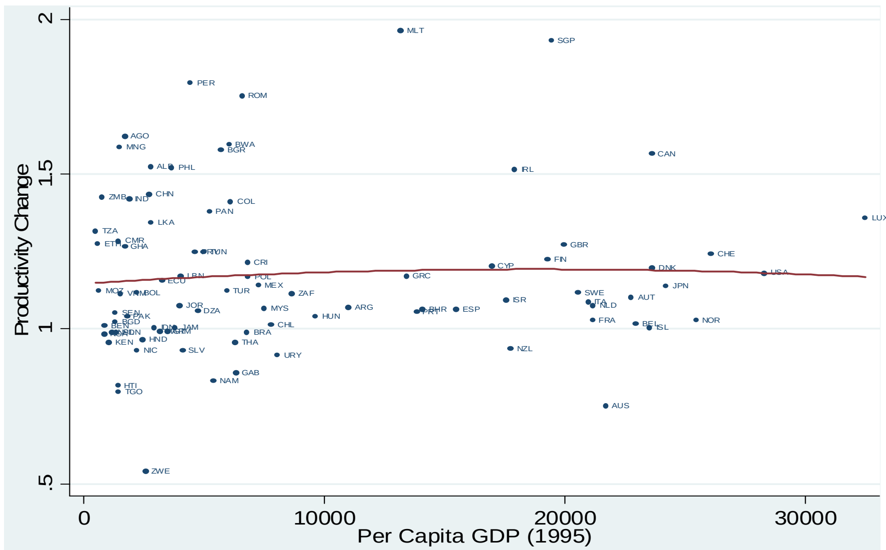
Descriptive Statistics of Various Measures of Productivity in 2008 over 1994

	Developed Countries				Developing Countries			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
$EFFCH_S$	0.98	0.15	0.74	1.43	0.92	0.21	0.39	1.40
TC_S	1.22	0.17	1.00	1.73	1.26	0.18	1.04	1.89
PC_S	1.20	0.28	0.75	1.97	1.15	0.25	0.54	1.80
$EFFCH_W$	1.00	0.13	0.75	1.43	1.05	0.11	0.75	1.42
TC_W	1.22	0.15	1.02	1.69	1.06	0.17	0.90	1.83
PC_W	1.22	0.24	0.76	1.91	1.11	0.20	0.80	1.76
ENVEFF	0.96	0.06	0.77	1.00	0.66	0.24	0.12	1.00

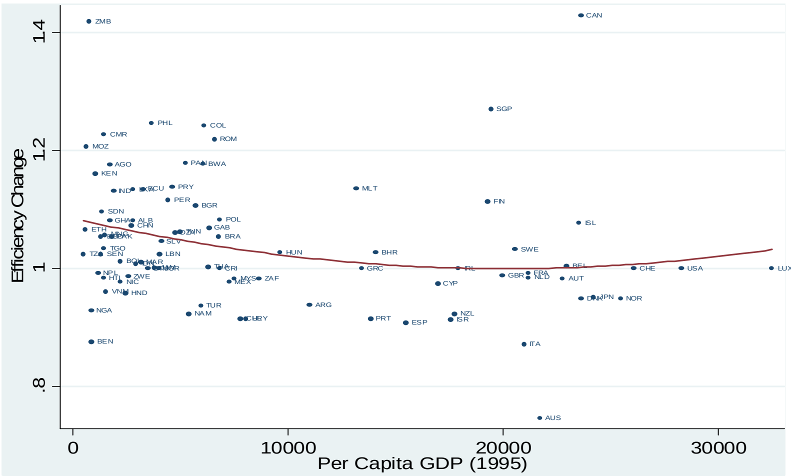
Income and productivity change under strong disposability of CO_2 emissions

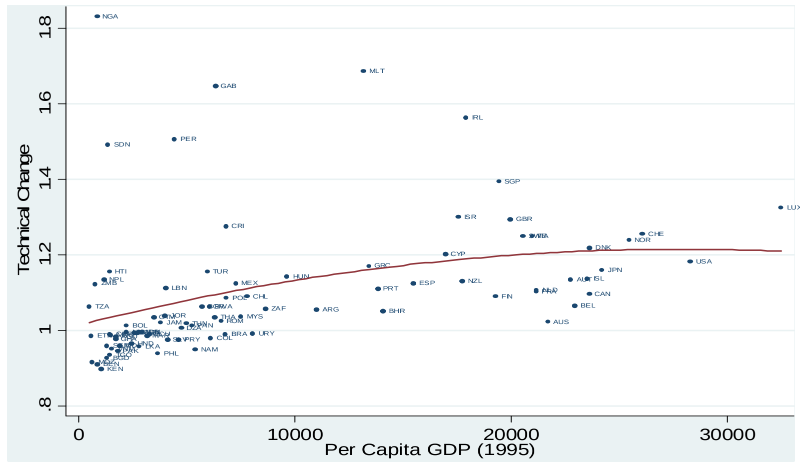


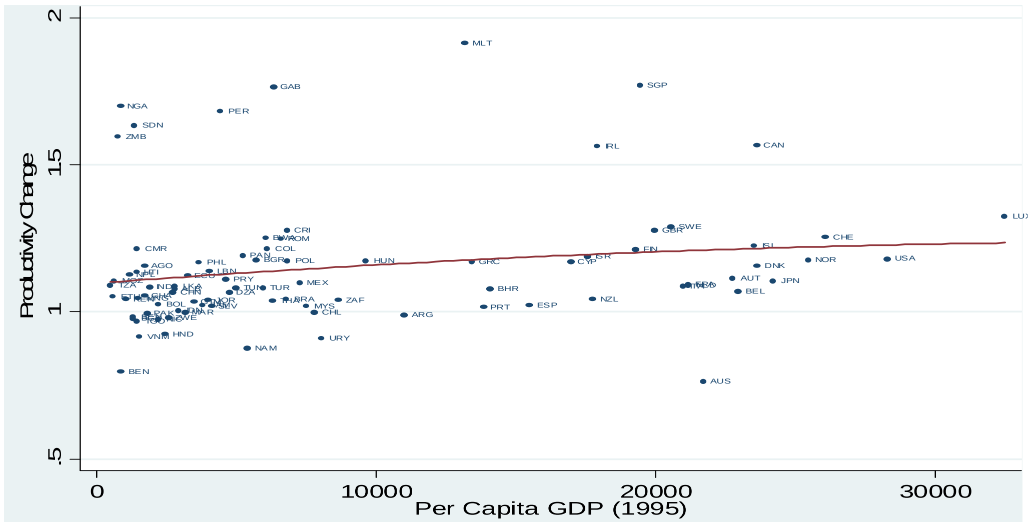




Income and productivity change under weak disposability of CO_2 emissions



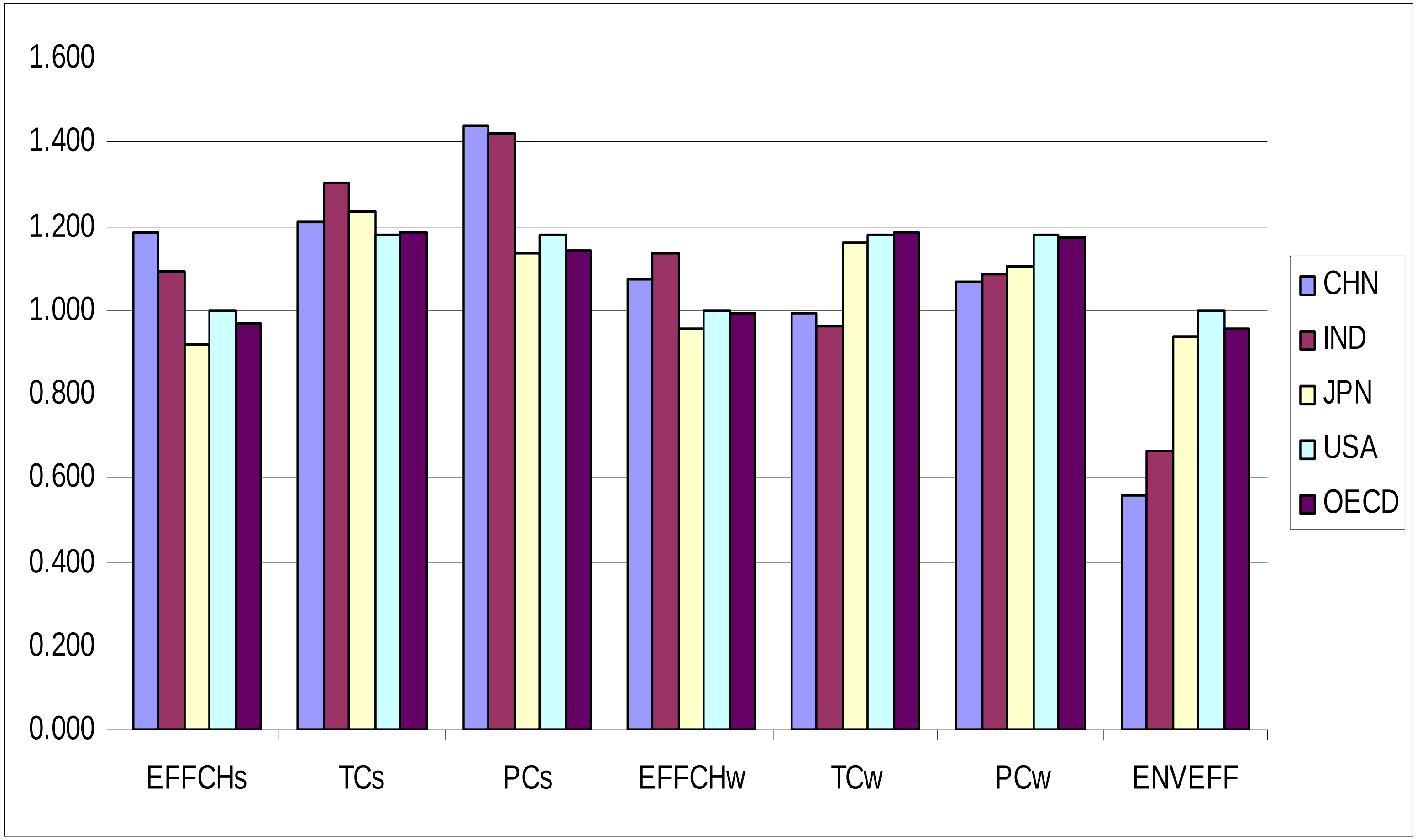




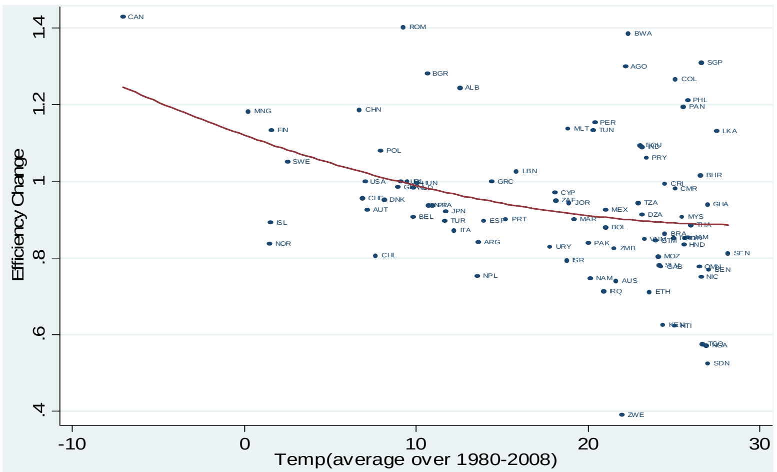
Productivity Change results

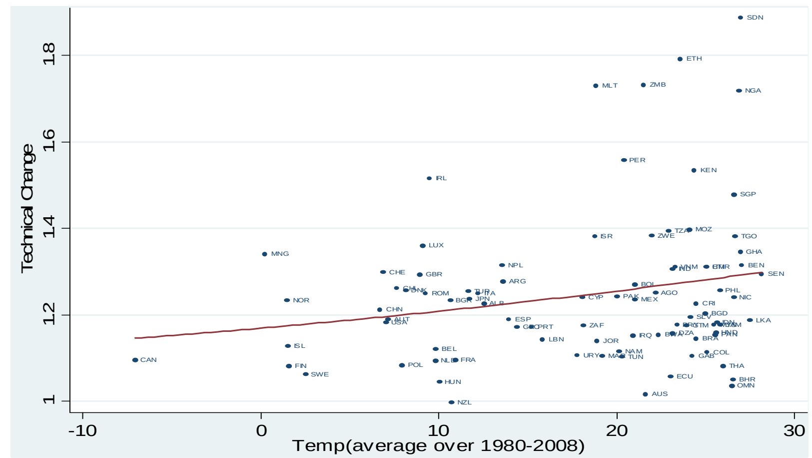
- Productivity growth happened both in developed and developing countries both under strong disposability and weak disposability of CO_2 emissions.
- In developed countries, there is no efficiency improvement and growth in productivity is led by innovations.
- In developing countries growth in productivity is led by innovations under strong disposability but under weak disposability, it is function of both innovations and diffusion of technologies.
- Restrictions on the disposal of CO_2 emissions is costly both in developed and developing countries, but it impacts much the growth potential of developing countries, though it is cheap to reduce emissions in these countries

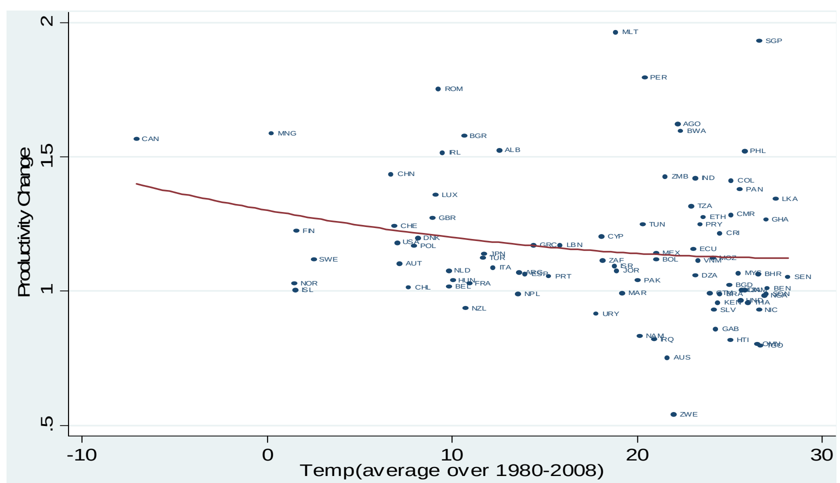
Productivity change in major economies



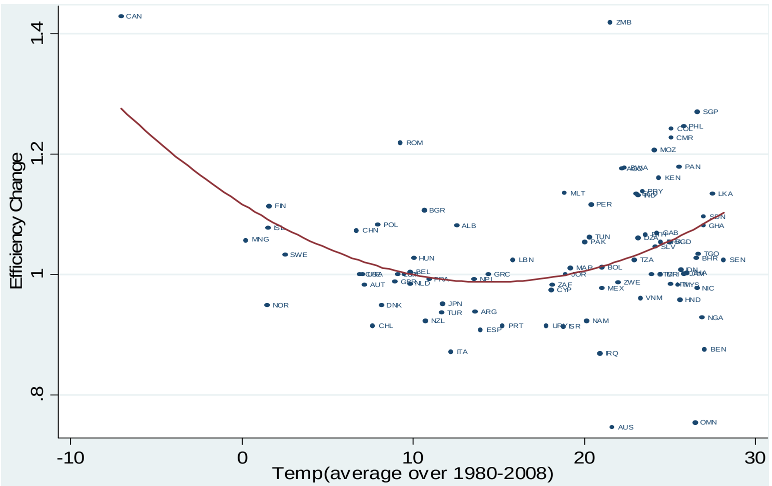
Temperature and productivity change under strong disposability of CO_2 emissions

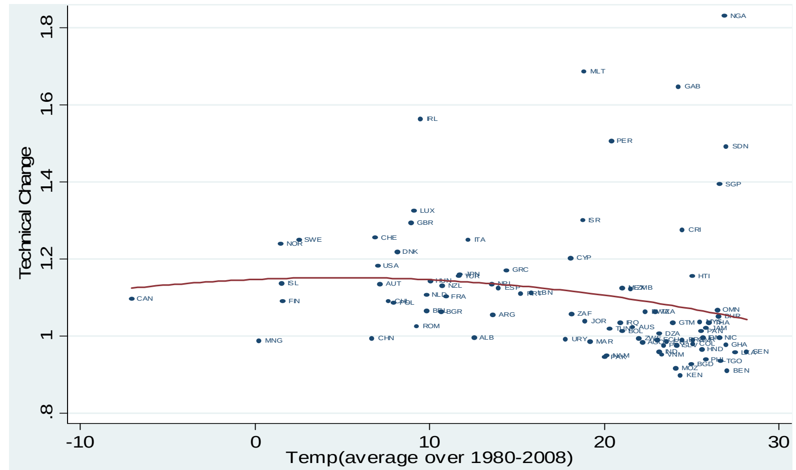


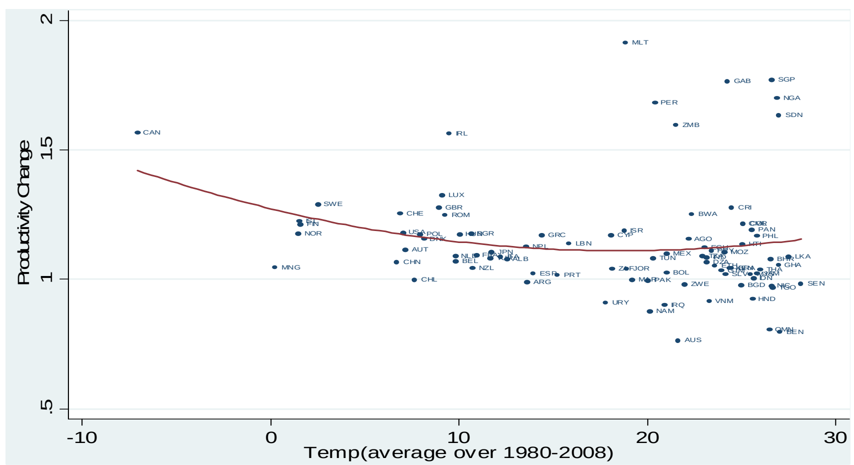




Temperature and productivity change under weak disposability of CO_2 emissions







Productivity Growth and Climate Change

- Negative relationship between temperature and productivity change under both scenarios
- Under strong disposability, the increase in temperature levels lowers the technological adoption which is not compensated by the innovations.
- When the CO_2 emissions disposal is restricted, innovations becomes costly though it is possible that at some higher temperature levels the adoption may improve

Determinants of Productivity and its components

- Cumulative Productivity (CP) and both of its components are regressed on the initial level of productivity/efficiency, level of temperature, soil quality, AVEXPR and SDFORMALISM index
- Regressions are run for all the sample countries, and separately for developed and developing countries
- Relationship between CP or its components and initial levels of productivity/efficiency shows convergence/ divergence across countries.
- +ve relation between CP and initial productivity shows divergence across countries
- -ve relation between CP components and initial inefficiency indicates divergence across countries

- Climate change is expected to lowers the productivity growth, i.e., a negative relationship between PC and temperature
- Better property rights are expected to positively influence the growth of productivity, i.e., a positive association between PC and AVEXPR
- More complex is the system, less productivity growth is expected, i.e., a negative relationship between SDFORMALISM and PC

Descriptive Statistics of Variables used in Regressions

	Developed Countries					Developing Countrie				
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Soil Quality	26	48.50	34.07	0	139.7	62	79.37	40.9	12.9	182.7
Temperature	26	10.36	7.20	-7.08	26.6	62	21.10	6.23	0.24	28.2
AVEXPR	25	9.48	0.67	7.23	10	57	6.55	1.28	1.64	9
SDFORMALISM	26	3.09	0.80	1.58	5.25	53	4.08	1.01	1.68	5.91

Regression Results: Productivity Change

- A +ve association is found between CP and its initial level which helps in explaining the growing inequality between countries. Divergence is happening even with in the developing countries under both the scenarios
- Soil quality levels impacts productivity growth in developed countries whereas the temperature levels affects in developing countries
- A -ve association between temperature level and CP level for the sample of developing countries under strong disposability indicates that climate change impacts are more pronounced in the developing countries.
- Better property rights and less complex systems helps in increasing the productivity level in developed countries under both the scenarios.

Regression Results: Efficiency Change

- Under strong disposability, neither divergence nor convergence is observed in either of the group.
- However, if the disposal of emissions is restricted then there is convergence in technological adoption across countries and within the groups of developed and developing countries.
- When the disposal of CO_2 emissions is free, the temperature increases lower the technological diffusion in developing countries, but better property rights helps in lowering the impact of climate change and spread the diffusion
- Soil quality is not related to technological diffusion

- Less complex systems improves the diffusion in developed countries
- The process of the diffusion is negatively affected in developed countries due to climate change under weak disposability of the emissions
- But better property rights in developed countries helps in improving the process of technological diffusion

Regression Results: Innovations

- Under strong disposability there is divergence in innovation in developed countries but convergence in developing countries
- But if the disposal is made costly, divergence in innovation is common in both the groups
- Better property rights helps in improving the innovations in developed countries under weak disposability and in developing countries under strong disposability
- However, innovations are not related to temperature changes under either of the scenarios

Summary and Conclusions

- Productivity growth is happening, and the divergence in productivity growth helps in explaining the growing inequalities across countries.
- Though there is higher potential in reducing CO_2 emissions in developing countries at lower cost, but the costly disposable of the emissions lowers the growth potential of these countries.
- Climate change lower the productivity growth in developing counties through lowering the process of technological adoption
- Better property rights and governance systems results in higher productivity .
- Under strong disposability, better property rights helps in lowering the impacts on climate change on developing countries through improving the process of technological adoption.

Thank you !

Welcome to Comments and feedback

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