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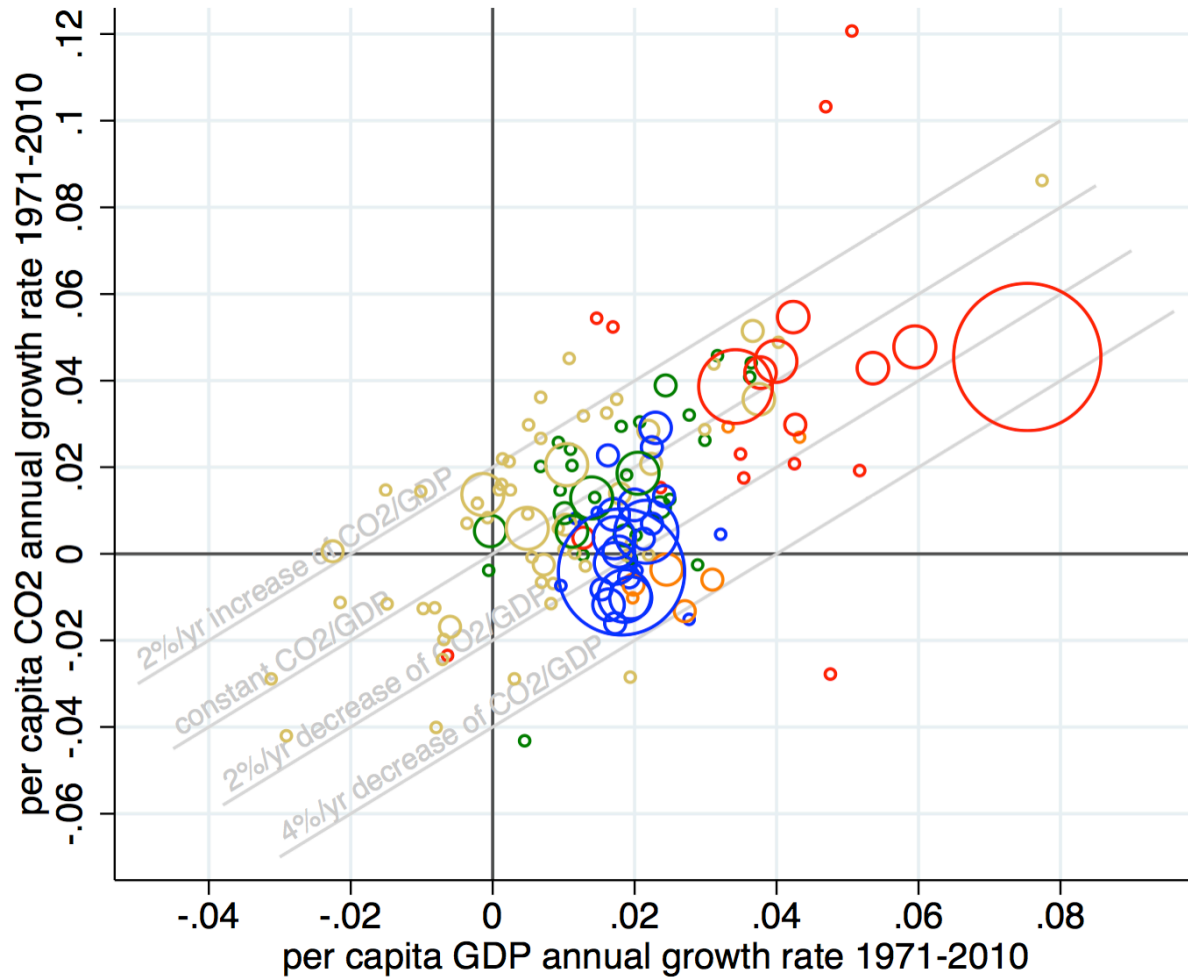
Rethinking the Emissions-Income Relationship in Terms of Growth Rates

David Stern

Crawford School of Public Policy

AARES Annual Conference 2014, Port Macquarie, 6th February

Carbon Emissions & Economic Growth





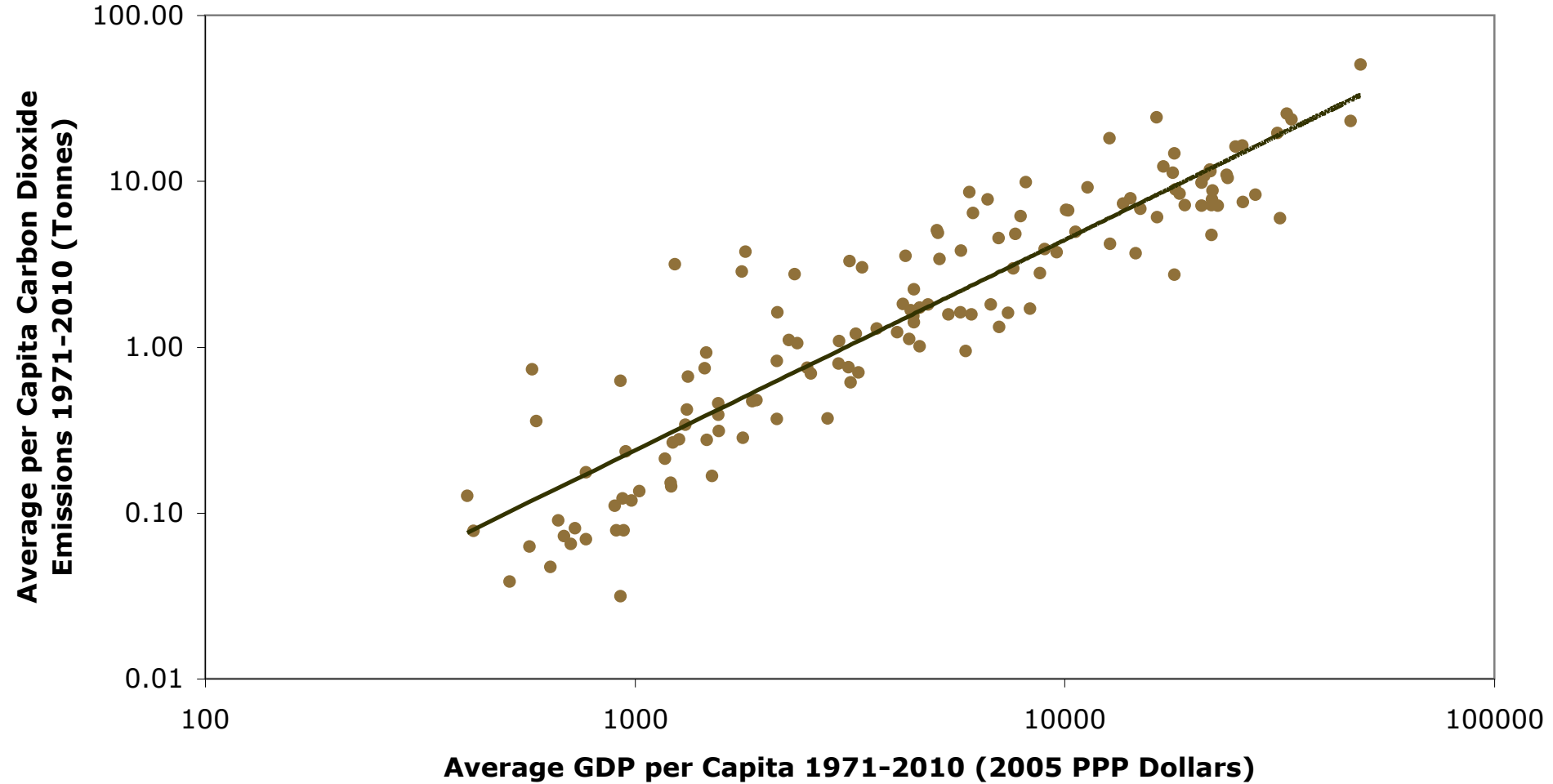
Alternative Models:

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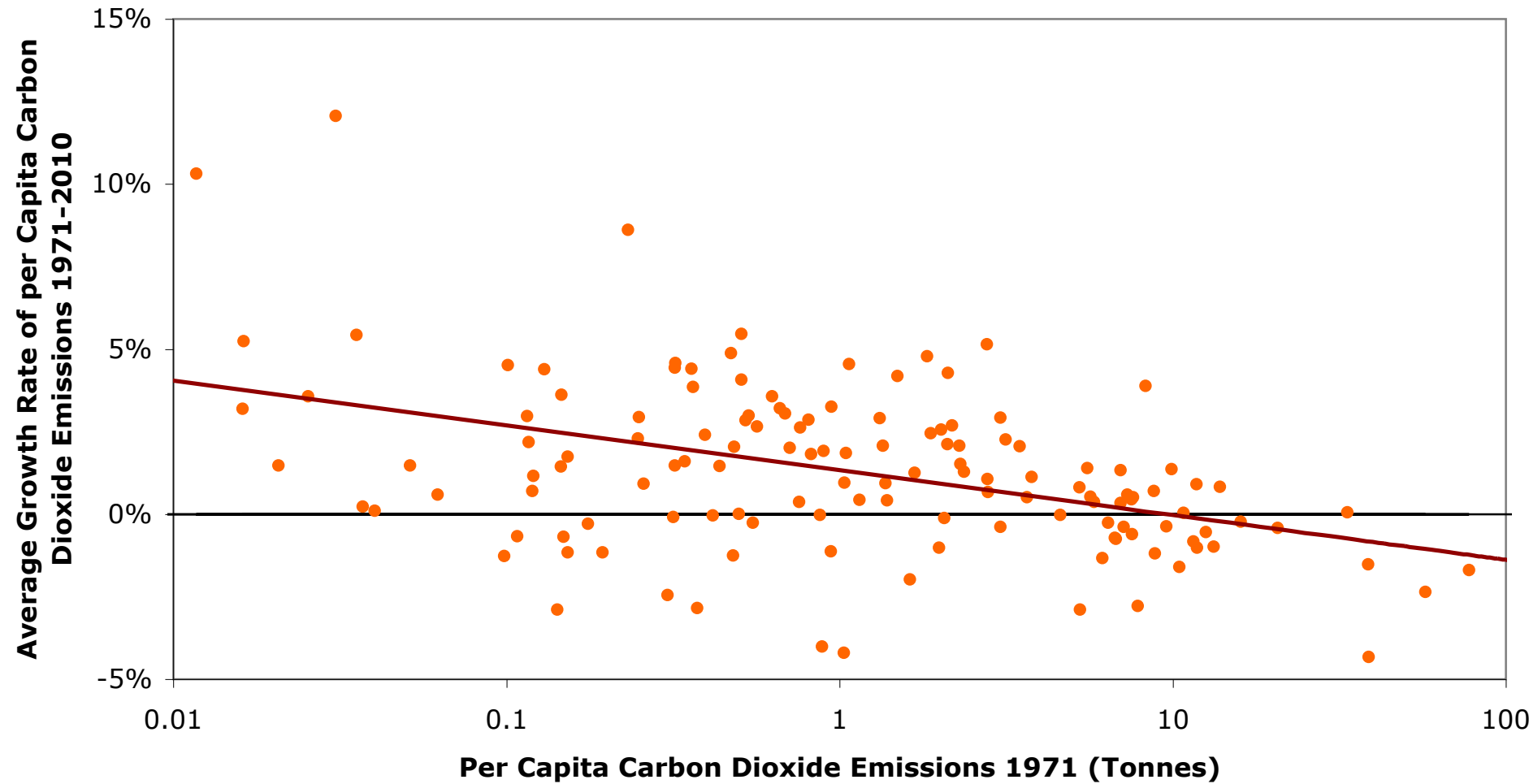
Environmental Kuznets Curve



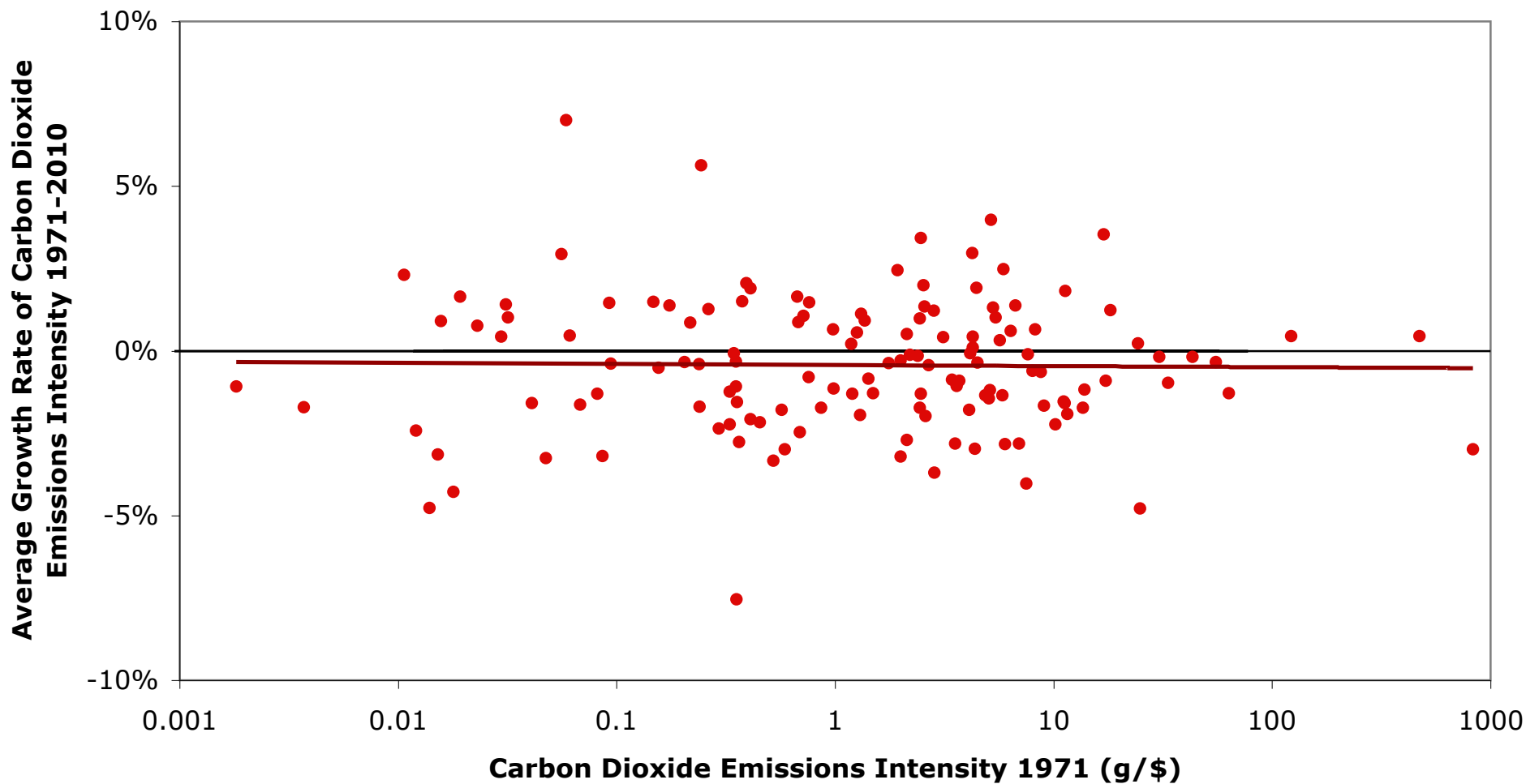
Alternative Models:

- IPAT / Kaya Identity
- Environmental Kuznets Curve
- (Empirical) Green Solow / Convergence

Convergence: Emissions per Capita



Convergence: Emissions Intensity



Econometric Models:

- Growth Rates Model:

$$\hat{E}_i = \alpha + \beta \hat{G}_i + \varepsilon_i$$



Growth Rates Approach: Theory

- Growth rates eliminate unit root problem (Wagner, 2008)

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- Growth rates eliminate unit root problem (Wagner, 2008)
- Also eliminate omitted variables in levels – problem with between estimator (Stern, 2010)
- But first differences focus on short-run dynamics – so LR growth rates
- LR growth rates identify time effects (Vollebergh *et al.*, 2009)

Econometric Models:

- Growth Rates Model:

$$\hat{E}_i = \alpha + \beta \hat{G}_i + \varepsilon_i$$

- Environmental Kuznets Curve:

$$\hat{E}_i = \alpha + (\beta_1 + \beta_2 \ln G_i) \hat{G}_i + \varepsilon_i$$

Econometric Models:

- Long-form Green Solow:

$$\hat{E}_i = \phi_0 + \phi_1 \ln E_{i0} + \phi_2 \ln s_i + \phi_3 \ln(n_i + 0.05) + \varepsilon_i$$

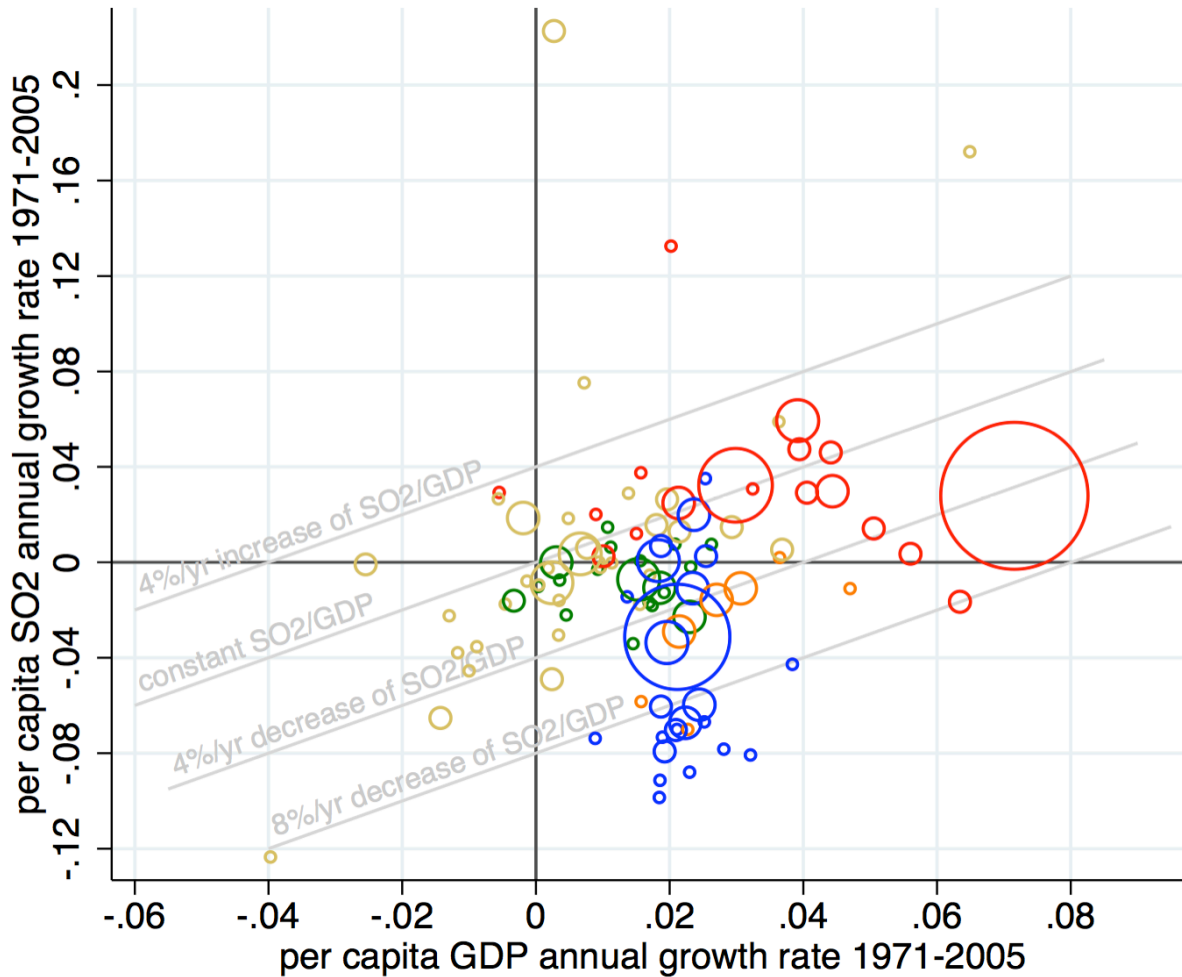
- Combined Model:

$$\hat{E}_i = \alpha + (\beta_1 + \beta_2 \ln G_i) \hat{G}_i + \gamma \ln G_i + \delta \ln(E_{i0} / G_{i0}) + \varepsilon_i$$

Data:

- CDIAC emissions: 136 countries, 1971-2010
- Penn World Table 8.0
- Smith et al. 2011 sulfur data: 103 countries, 1971-2005
- Also use IEA carbon emissions: 99 countries

Sulfur Emissions & Economic Growth



Results: Carbon Dioxide

	Growth Rates Model	EKC	Combined Model
Constant	-0.0015 (0.0021)	0.0002 (0.0022)	-0.0004 (0.0017)
\hat{G}_i	0.8338*** (0.1171)	0.8113*** (0.1103)	0.8351*** 0.0774)
$\ln G_i$			0.0033** (0.0014)
$\hat{G}_i \ln G_i$		-0.2601*** (0.0675)	-0.2049*** (0.0603)
$\ln(E_{i0}/G_{i0})$			-0.0136*** (0.0017)
EKC turning point		\$100k (\$93k)	\$260k (\$365k)
\overline{R}^2	0.3460	0.4165	0.6700

Results: Sulfur Dioxide

	Growth Rates Model	EKC	Combined Model
Constant	-0.0181** (0.0071)	-0.0139** (0.0058)	-0.0180*** (0.0044)
\hat{G}_i	0.6571** (0.3151)	0.6506** (0.2732)	0.7734*** (0.1644)
$\ln G_i$			-0.0030 (0.0028)
$\hat{G}_i \ln G_i$		-0.8909*** (0.1651)	-0.4598*** (0.1093)
$\ln(E_{i0}/G_{i0})$			-0.0231*** (0.0049)
EKC turning point		\$11.2k (\$3.5k)	\$29.1k (\$16.4k)
\overline{R}^2	0.0465	0.2556	0.5807

Results: Green Solow Model

	Carbon Dioxide		Sulfur Dioxide	
	Short Form	Long Form	Short Form	Long Form
Constant	0.0128*** (0.0019)	0.0128*** (0.0018)	-0.0067* (0.0036)	-0.0067** (0.0033)
$\ln E_{i0}$	-0.0059*** (0.0012)	-0.0084*** (0.0013)	-0.0181*** (0.0031)	-0.0187*** (0.0031)
$\ln s_i$		0.0203*** (0.0057)		0.0402*** (0.0111)
$\ln(n_i + 0.05)$		-0.0298** (0.0116)		0.0554** (0.0267)
\overline{R}^2	0.1872	0.3087	0.4388	0.5287

Conclusions:

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- Effect of growth on emissions is strongly positive
- EKC explains more than GSM for CO₂ *vice versa* for SO₂
- Combined model superior for both CO₂ and SO₂
- Time effects important for SO₂



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IEA Carbon & Economic Growth

