Business Cycles & CO_2 Emissions

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26 March 2015

Green Growth and the New Industrial Revolution

Context & motivation

- We know relatively little about the relationship between fluctuations in GDP and CO_2 emissions.
- The nature of the relationship is important for
  - making sure theoretical models resemble the real world
  - carbon pricing policy instruments in practice

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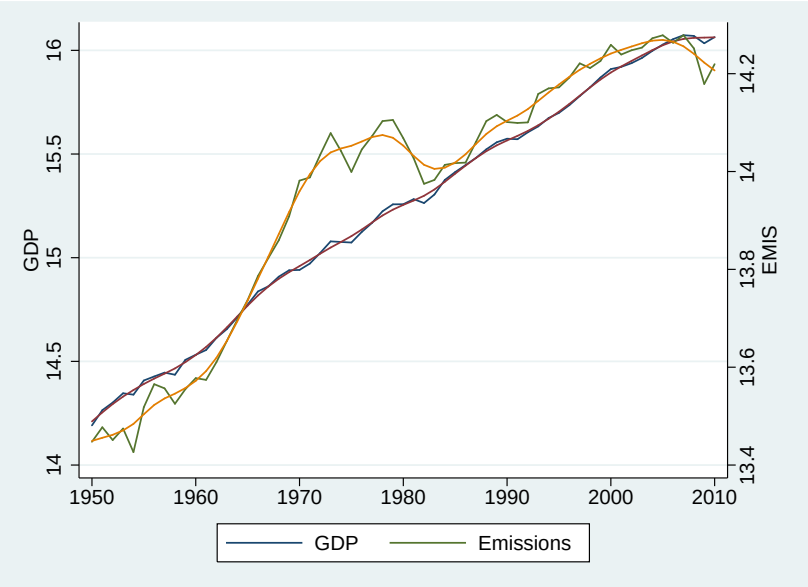
Research topic

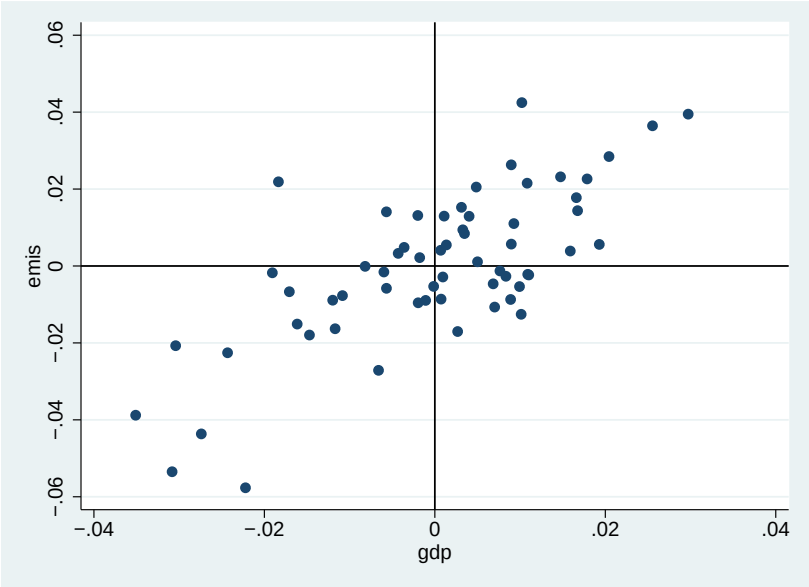
1. What are the key properties of fluctuations in GDP and CO_2 emissions in a given country?

US GDP & Emissions

Time Series & Trend Components



Cyclical Components



2. Is there a systematic relationship between these properties and GDP per capita?
(Annual data from 122 countries covering 1950-2011)

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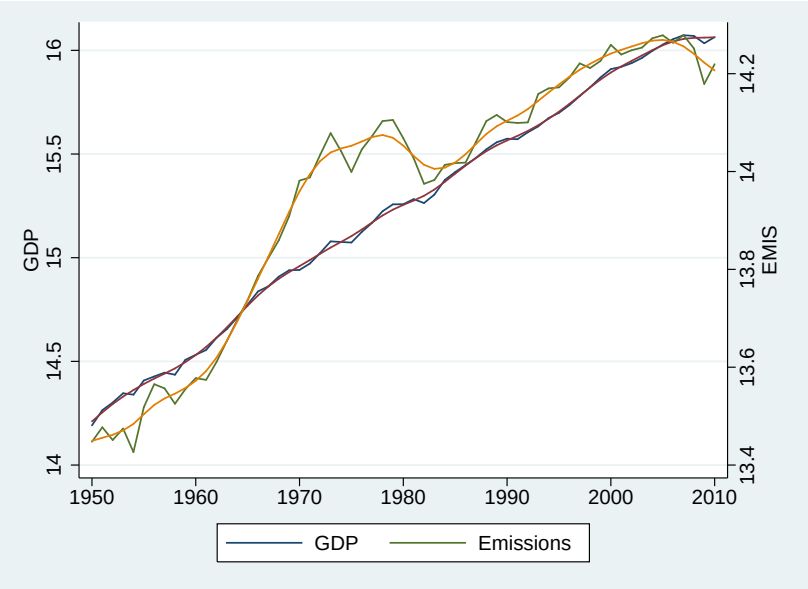

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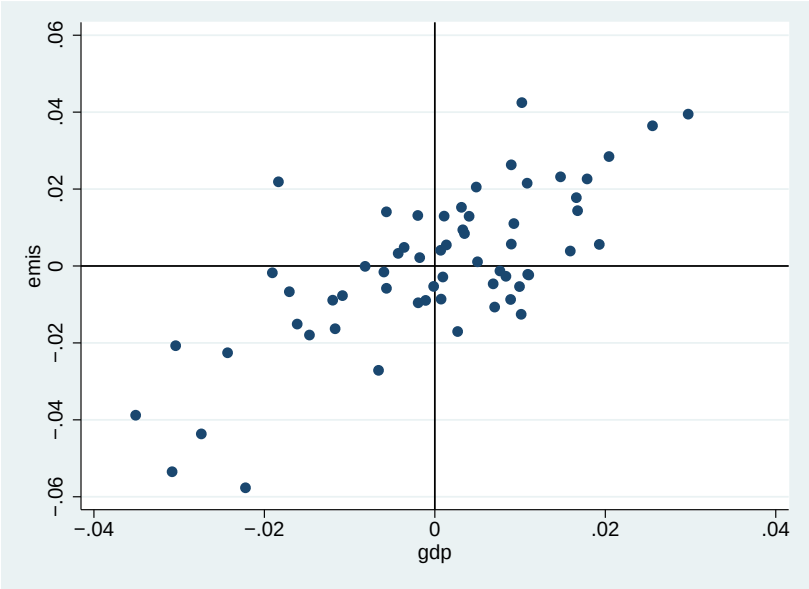

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Business cycle properties of emissions

FACT 1: Emissions are procyclical in a typical country.

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FACT 2: Procyclicality of emissions is greater in countries with higher GDP per capita.

Table Figure

FACT 3: Emissions are cyclically more volatile than GDP in a typical country.

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FACT 4: Cyclical volatility of emissions is greater in countries with lower GDP per capita.

Table Figure a Figure b

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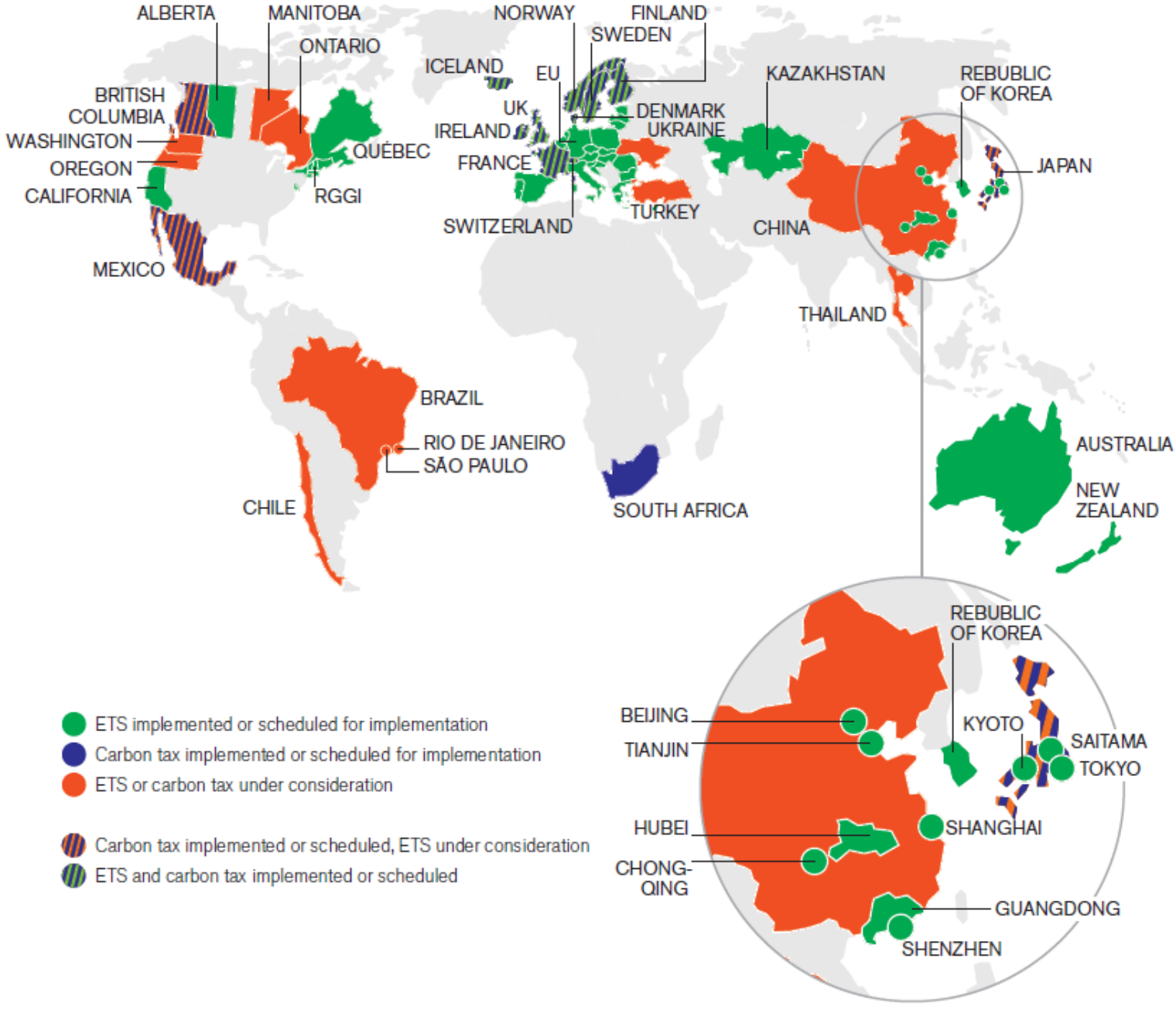

Source: World Bank (2014)

What are the facts good for?

- Implications for fixed instruments:
  - Carbon tax $\Longrightarrow$ emissions uncertainty
  - Emissions trading system $\Longrightarrow$ cost uncertainty
- Improving instrument performance
  - Indexed regulation

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How to price carbon in good times...and bad!

Two broad policy implications:

1) Making the stringency of regulation responsive to economic fluctuations can decrease overall burden of regulation.

2) Whatever instrument is chosen to price carbon, it should apply to as large a group of emitters as possible.

- Linking previously independent ETSs can mimic responsive regulation and lead to overall gains.
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Conclusions

- Business cycle properties of emissions differ across countries.
- Climate change policy design and performance can be improved by conditioning policy on
  - business cycle fluctuations
  - cross-country differences in business cycle properties of emissions
  - other country characteristics

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Table: Cyclicality of emissions

	Mean	Std. Dev.	Min	Max	Sample
$\bar{\rho}_{ey}$	0.297^{***}	0.244	-0.305	0.824	Full (N=122)
$\bar{\rho}_{ey}$	0.260^{***}	0.229	-0.305	0.725	Restricted (N=89)

Notes:

A bar over a variable indicates a sample mean. The null hypothesis that $\bar{\rho}_{ey}$ is equal to zero tested against a two-sided alternative in each case, where * implies p<0.10, ** implies p<0.05, and *** implies p<0.01.

Table: Cyclicality of emissions across countries

	Value	**Sample**
$\rho(\rho_{ey}, GDPpc_{2009})$	0.327^{***}	Full (N=122)
$\rho(\rho_{ey}, GDPpc_{2009})$	0.359^{***}	Restricted (N=89)

Notes:

The null hypothesis that $\rho(\rho_{ey}, GDPpc_{2009})$ is equal to zero tested against a two-sided alternative in each case, where * implies p<0.10, ** implies p<0.05, and *** implies p<0.01.

Table: Volatility of emissions

	Mean	Std. Dev.	Min	Max	Sample
$\bar{\sigma}_e$	0.078	0.064	0.018	0.358	
$\bar{\sigma}_y$	0.029	0.018	0.006	0.109	Full (N=122)
$\bar{\sigma}_{rel}$	3.040^{***}	2.492	0.701	17.221	
$\bar{\sigma}_e$	0.068	0.051	0.018	0.285	
$\bar{\sigma}_y$	0.023	0.011	0.009	0.081	Restricted (N=89)
$\bar{\sigma}_{rel}$	3.082^{***}	2.197	1.019	15.258	

Notes:

A bar over a variable indicates a sample mean. In the last row of each panel the null hypothesis that $\bar{\sigma}_{rel} = 1$ is tested against the alternative that $\bar{\sigma}_{rel} > 1$, where * implies p<0.10, ** implies p<0.05, and *** implies p<0.01.

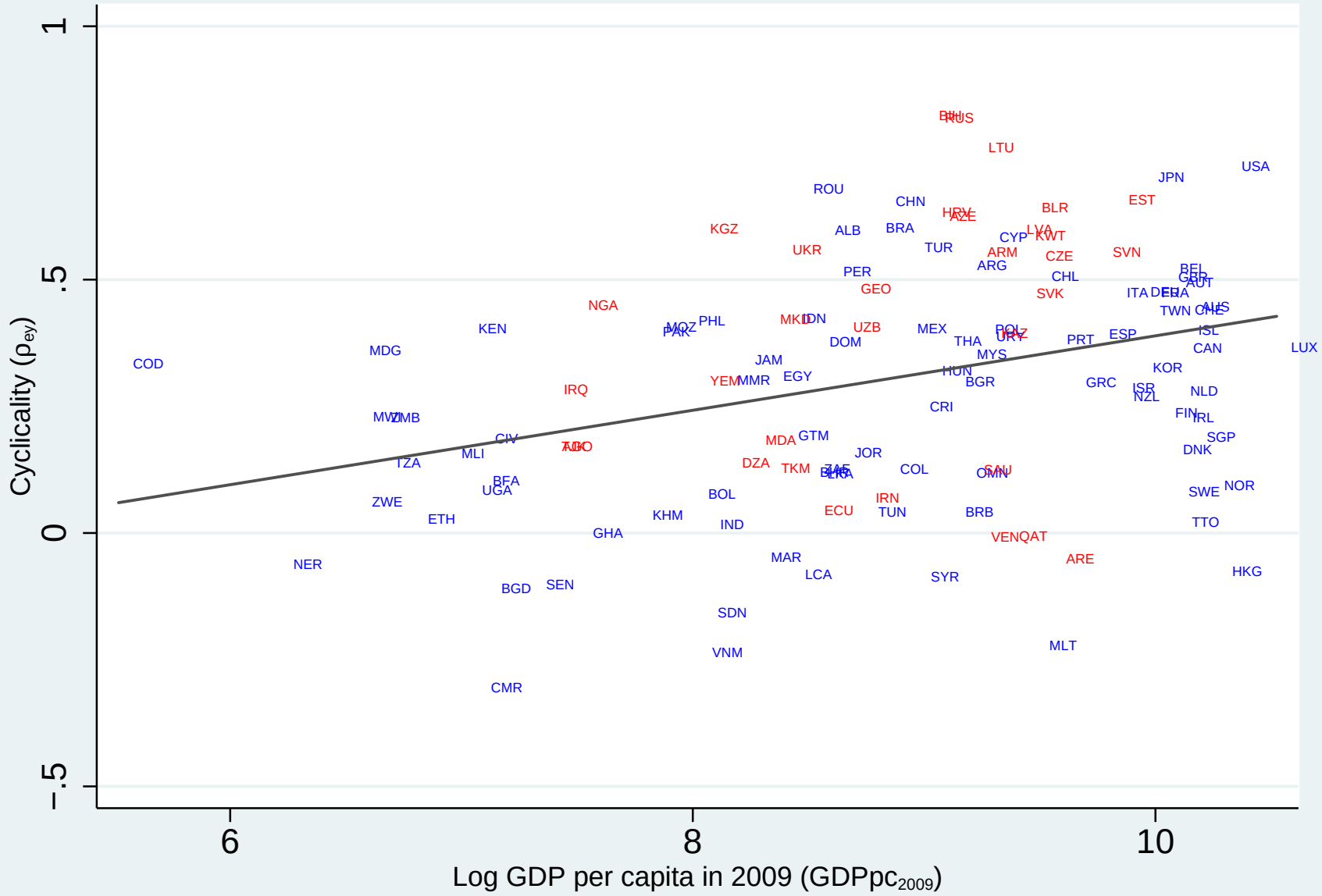
Table: Volatility of emissions across countries

	Value	**Sample**
$\rho(\sigma_e, GDPpc_{2009})$	-0.220^{**}	Full (N=122)
$\rho(\sigma_e, GDPpc_{2009})$	-0.316^{***}	Restricted (N=89)
$\rho(\sigma_{rel}, GDPpc_{2009})$	-0.203^{**}	Full (N=122)
$\rho(\sigma_{rel}, GDPpc_{2009})$	-0.235^{**}	Restricted (N=89)

Notes:

The null hypothesis that a given correlation coefficient is equal to zero is tested against a two-sided alternative in each case, where * implies p<0.10, ** implies p<0.05, and *** implies p<0.01.

Figure: Procyclicality of emissions increases with GDP per capita (Fact 2)



Note: 3−letter country codes in red denote members of the full but not the restricted sample. Regression line drawn for the full sample.

Figure: Volatility of emissions decreases with GDP per capita (Fact 4)

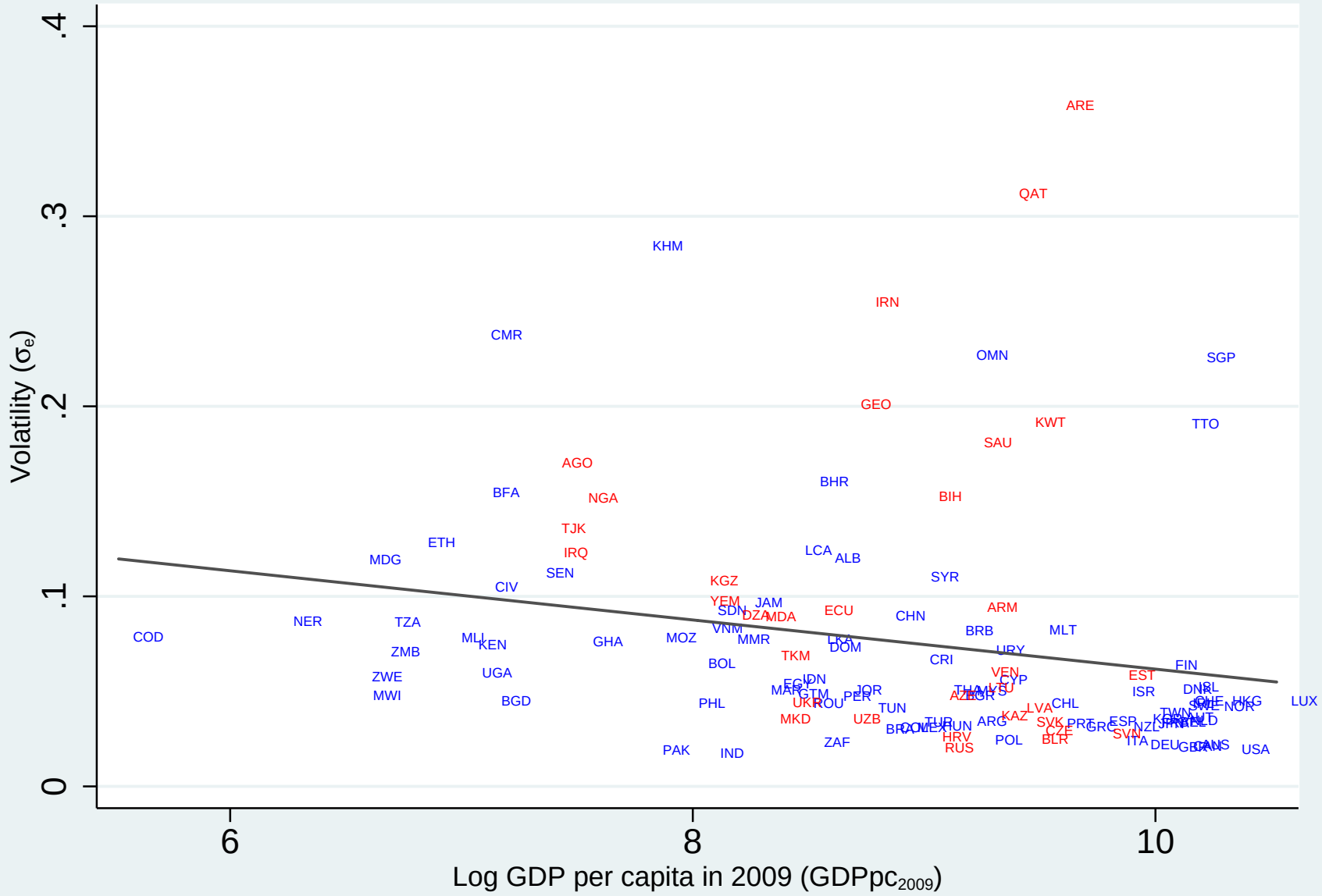


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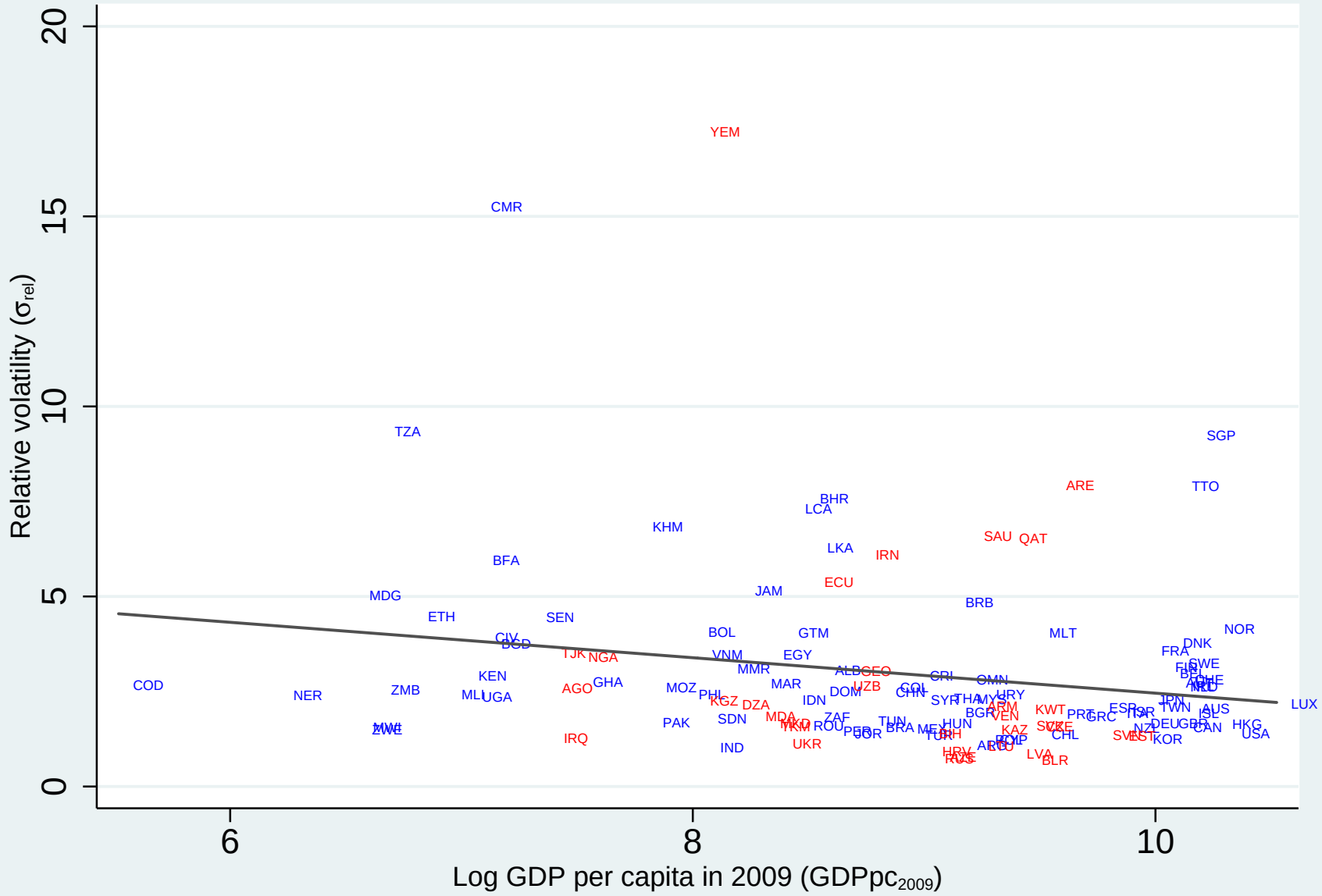
Figure: Relative volatility of emissions decreases with GDP per capita (Fact 4)



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