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Carbon Intensity Changes in the Asian Dragons. Lessons for climate policy design.

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MAIN OBJECTIVE

To drive our attention to main drivers of carbon intensity (CO2/GDP).

To show that carbon intensity targets might be misleading for policy makers.

MOTIVATION

Developing countries usually submit intensity targets in voluntary pledges to UNFCCC. e.g. China: 40%-45% reduction on CO2 intensity w.r.t. 2005 (Copenhagen Accord).

The EU commissioned an assessment on progress toward H2020 targets that reviews whether intensity or absolute targets (or a hybrid of both) "represents a better benchmark upon which to frame a 2030 objective" (European Commission, 2014).

emission intensity targets

Some authors have advocated in favour of the adoption of emission intensity targets by developing countries (usually an upper limit on CO2 per GDP).

The survey in Marschinski and Edenhofer (2010) provide several reasons.

Emission intensity targets could facilitate the adoption of binding emission restrictions by developing countries as long as

(i) they are compatible with high economic growth,
(ii) they contribute to the reduction of cost-uncertainty of any emission commitment
(iii) they introduce the right incentives for low-carbon economic development.

Xu and Ang (2013) provide a recent survey of the empirical literature in order to identify the key elements that explain the changes in aggregate carbon intensity:

- ✓ changes in the structure of the economy
- ✓ **energy intensity**
- ✓ the fuel mix
- ✓ the carbon coefficient (carbon-to-energy ratio).

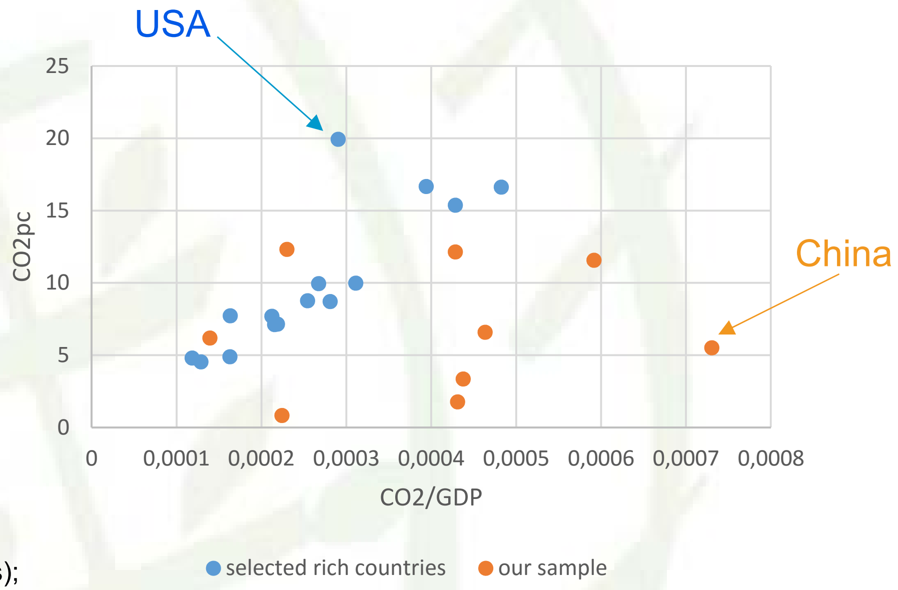
Xu and Ang (2013) concluded that energy intensity "was the main contributor to reductions in aggregate carbon intensity in most countries", both in developing and developed countries.

Our sample: China, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand (1990-2011).

CO_2 intensity[1] in selected regions

	1990	2011	Variation %	Decoupling ratio
World	0,56	0,43	-24,16	0,76
OECD	0,46	0,32	-29,45	0,71
Middle-East	0,55	0,64	16,03	1,16
Africa	0,40	0,34	-15,33	0,85
ASEAN	0,35	0,39	12,14	1,12
Asia	0,63	0,55	-12,64	0,87
North America	0,60	0,40	-33,50	0,66
Latin America	0,28	0,26	-8,75	0,98
European Union (EU-28)	**0,41**	**0,25**	**-40,53**	0,59
Our sample[2]	**1,45**	**0,68**	**-53,52**	0,46
China	**1,87**	**0,78**	**-58,07**	0,42

Source: Enerdata and own calculations.
Notes: [1] $kCO_2/\$$ in constant US$ 2005 PPP (Purchasing Power Parities);
[2] weighted mean according to 2011 population.



Asian Dragons show the fastest decoupling trend coupled with some of the highest carbon intensity in World but low CO_2 per capita.

Selected rich countries: Austria, Australia, Canada, Switzerland, Germany, Denmark, Finland, France, UK, Japan, Luxembourg, Netherlands, Norway, Sweden, United States.

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IEA (2013): “the center of gravity of the global energy system is shifting towards Asia”.

That “centrality” of Asian Dragons for the global energy system is motivated by their strong rise in per capita GDP during the last decades.

What are the primary sources of the Asian Miracle?

Two basic explanations rooted in the decomposition of economic growth sources:

- ✓ the “intensive” and
- ✓ the “extensive”
- ✓ … GDP growth assumptions (Sickles and Cigerli, 2009) .

Our main hypothesis is that the nature of economic growth has a major effect on carbon intensity trends that deserves some attention.

We will try to capture those elements by making use of labour market variables because it is “a useful way of viewing growth in GDP per capita” OECD (2003).

Accordingly, GDP per capita growth can be broken down into:

- ➢ growth in labour productivity and
- ➢ changes in the extent of labour utilisation.

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The Data and Methodology

Our sample: a balanced panel for 8 south east emerging countries for the period 1990 to 2011. {China, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand}

We perform a fixed effect econometric regression of carbon intensity on several variables:

- The goal is to pay special attention to the main sources of GDP growth and their impacts on carbon intensity:
  - ✓ whether GDP growth was driven by “intensive” (higher labour productivity)
  - ✓ or “extensive” growth (more employment rates).
- Additional control variables have been included following our literature survey: urbanization rates, energy prices, carbon intensity of electricity generation (which is conditioned by the electricity generation mix and therefore natural resources endowment which is a national idiosyncratic characteristic), industrial energy intensity per worker, industrial share in GDP, per capital households energy consumption.
- Year dummies and individual country trends have been included.

Econometric Results for CO_2/GDP

	Lineal		Quadratic	
Productivity	**-0.892*****	**-1.020****	**-1.451*****	**-1.987*****
Global Employment rate	-0.096	-0.540*	-0.106	-0.213
Industrial energy consumption per worker	**0.485*****	**0.294**	**0.539*****	**0.241****
Residential energy consumption per capita	0.059	0.008	0.135	0.658
Energy carbon factor	**1.186*****		**1.352*****	
Spot price of Dubai		-0.065		**-0.114*****
Urbanization rate		0.894		0.326
Electricity carbon factor		**0.263***		**0.347****
Industrialization rate		-0.077		0.081
Productivity (squared)			0.100*	**0.196****
Ind. energy cons. per worker (squared)			0.095***	-0.013
Resid. energy cons. per capita (squared)			0.039	0.215
Constant	0.733	-0.695	0.375	0.756
Observation	176	176	176	176
Adjusted R2 (within model)	**0.93**	**0.86**	**0.96**	**0.88**
[a] Year dummies significance (F-test)	0.80	2.04	12.55***	4.60***
[b] Country trends significance (F-test)	14119.18***	90.13***	118.15***	414.38***

Legend: * p<.1; **p<.05; *** **p<.01**. Note: all variables expressed in logarithms. Year dummies and country trends included. [a] F test statistics with corresponding p-value in parentheses for the joint significance of the country-trends. [b] F test statistics with corresponding p-value in parentheses for the joint significance

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Econometric Results as a Factorial Decomposition Index

Country	Changes in carbon intensity	CE	E_{pc} [a]	E_{pw} [b]	$prod_L^{-1}$	ER^{-1}	others
China	-1.13	0,61	0,01	1,18	-1,51	-0,01	-1,42
Indonesia	0.06	0,22	0,00	0,14	-0,16	0,00	-0,14
Korea	-0.06	0,09	0,01	0,18	-0,24	-0,01	-0,10
Malaysia	0.08	0,14	0,01	0,07	-0,16	0,00	0,02
Philippines	-0.02	0,19	-0,01	-0,02	-0,05	0,00	-0,13
Singapore	-0.15	-0,23	0,01	0,54	-0,15	-0,01	-0,31
Thailand	0.09	0,10	0,00	0,18	-0,15	0,00	-0,05
Taiwan	-0.1	0,21	0,02	0,15	-0,34	-0,01	-0,13

Source: own calculations.
Notes: [a] Residential energy consumption per capita;
[b] Industrial energy consumption per worker.

Energy carbonization (CE)
Household energy per capita (E_{pc})
Energy per worker (E_{pw})
Labour productivity ($prod_L^{-1}$)
Employment (ER^{-1})

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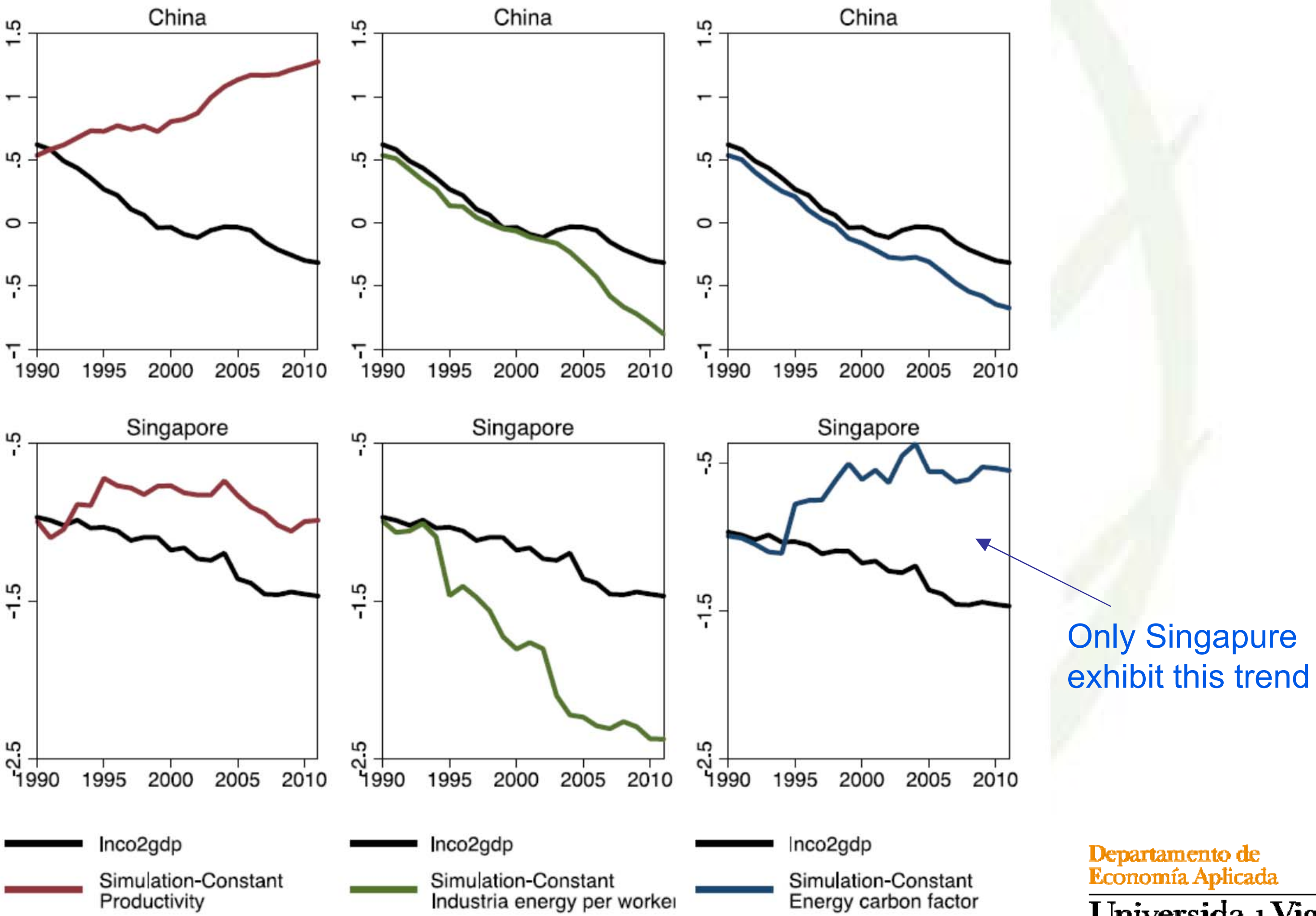
“What-if” analysis for China and Singapore.



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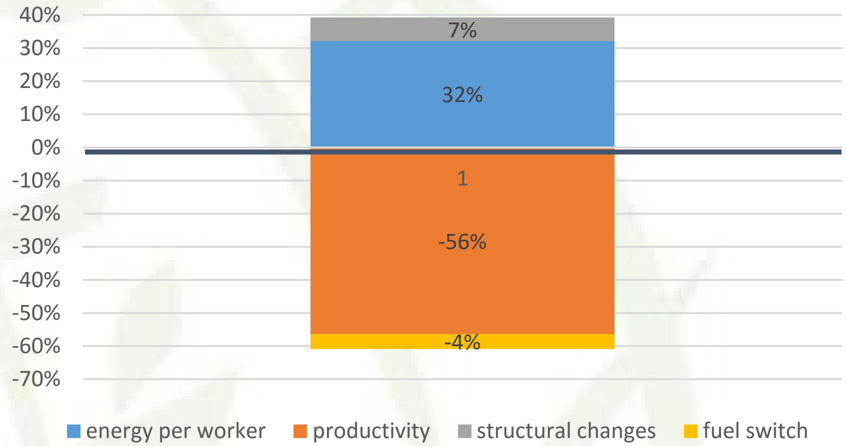
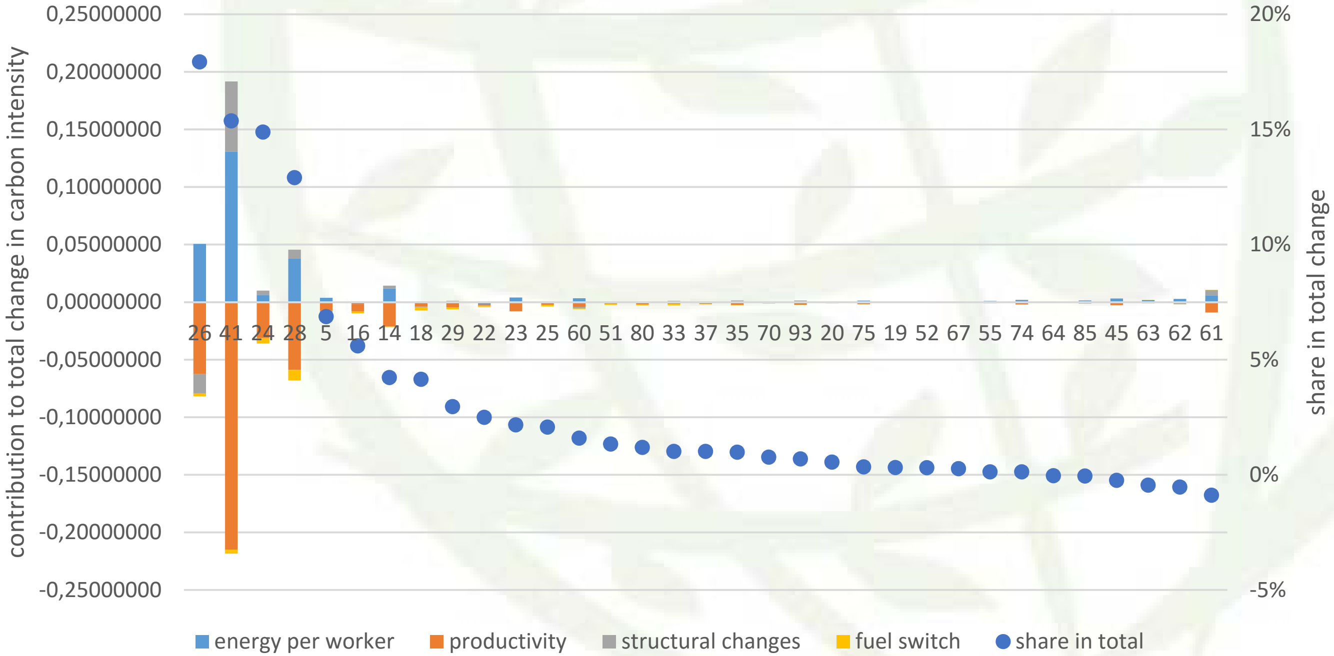
Chinese Carbon Intensity changes

Some researches believe that those productivity impacts on carbon intensity result from structural changes in the economy, e.g. GDP shifts from heavy industry to services.

A closer look to 32 sector disaggregated data for China show us this is not the case.





26: other Non Metallic Mineral

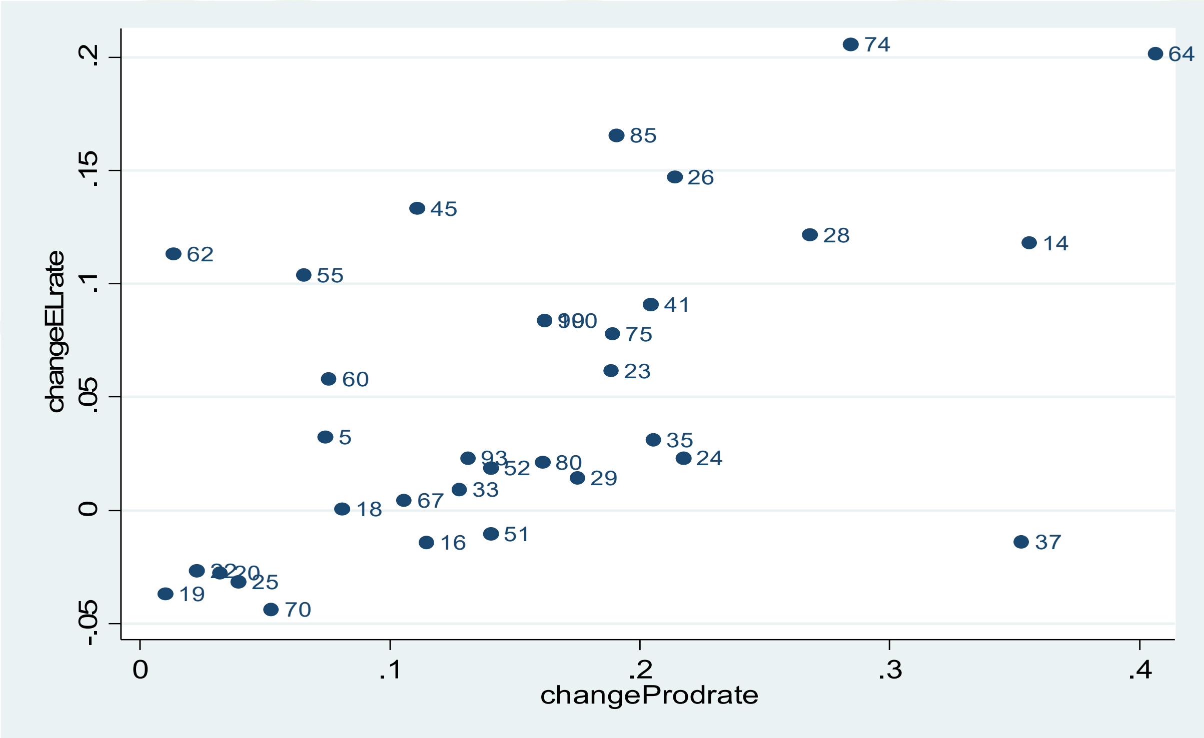
41: Electricity & Gas

24: Chemicals

28: Basic Metals

Chinese Carbon Intensity changes

What we see is a general growth in the Energy-to-Labour ratio that is strongly correlated with a raise in Labour Productivity.



Perhaps what we are witnessing is an economic development based on investment processes producing more capital-intensive sectors providing a simultaneous increase in productivity and energy consumption.

Lessons from Asian Dragons

- Labour productivity is the main factor responsible for major carbon intensity reductions.
- Household energy per capita and industrial energy per worker contributed in the opposite direction.
- The "intensive nature" of economic growth in Asian Dragons distort the value of carbon intensity as a proper indicator for efficiency improvements and climate change contributions by countries.
- The major policy message from this piece of research are the following:
  - ✓ National targets grounded on carbon intensity may be misleading for climate action.
  - ✓ Countries experiencing great productivity gains may reap significant improvements on carbon intensity without significant achievements in terms of energy and carbon efficiency.

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thanks for your attention

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