1st AIEE Energy Symposium
Current and Future Challenges to Energy Security

Examining the energy rebound effect in South Africa within a BRICS countries context

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Today's discussion…

- Introduction and Motivation of the study
- Rebound effect
- Why SA and Why within the BRICS context?
- Decomposition method and data
- Empirical results
- Limitations, Challenges, Future research

Paris Agreement 2015

- Goal: limiting global warming to less than 2 degrees Celsius
- Paris agreement: consensus of the representatives of the 196 parties.
- Although a more universal agreement was reached, no detailed timetable or country-specific goals were incorporated (as done in the Kyoto Protocol)
- The most advanced economies have already included renewables in their energy mix and have planned to increase their use in order to meet their mitigation goals: But the least developed economies are also playing their part: 40% of non-G20 countries which have submitted their contribution have set specific targets in this area,

Generation sector/
Supply side only?

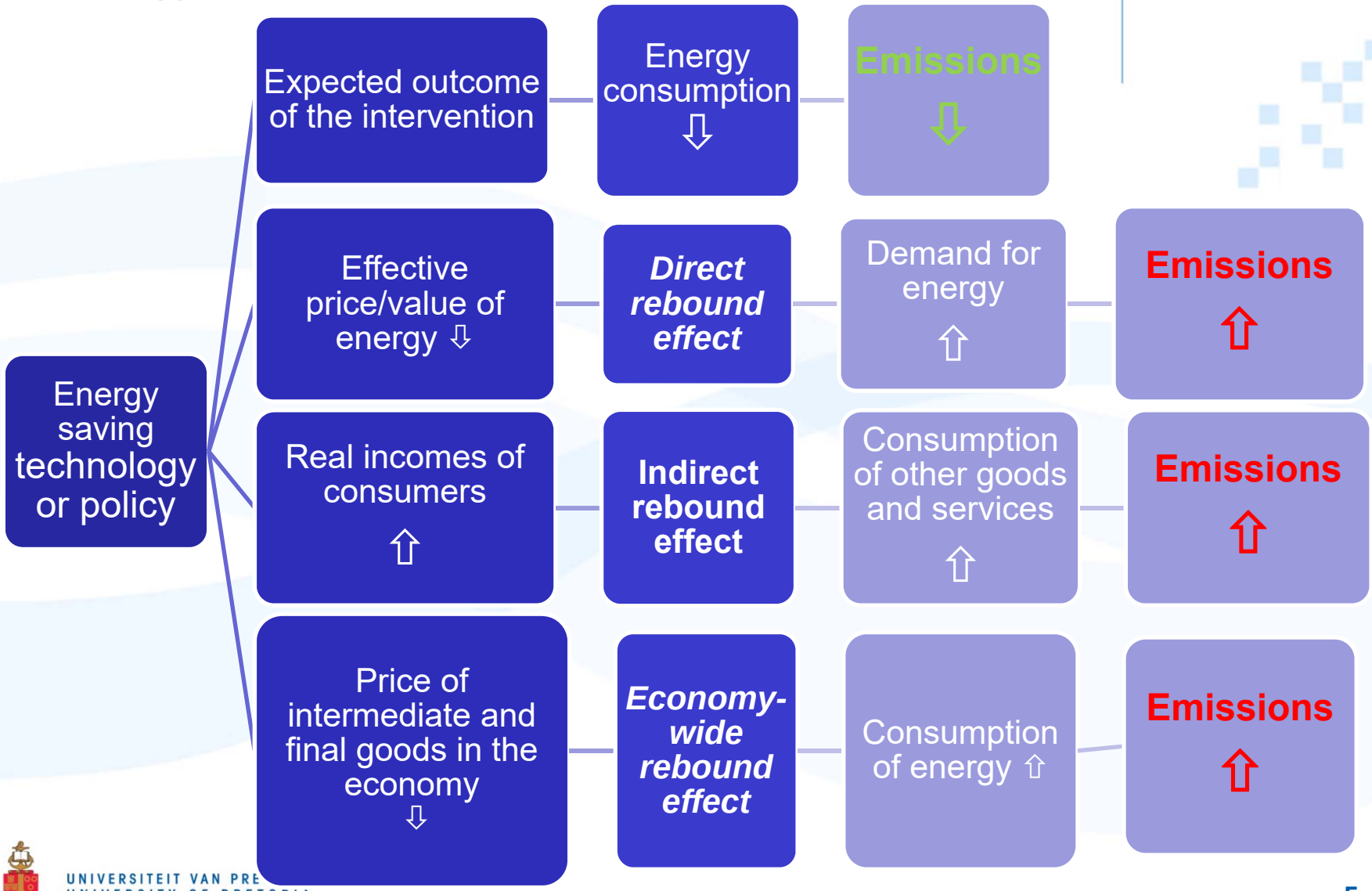
Paris Agreement 2015

- Potential areas for saving energy have been identified and countries are willing to adapt ***the most effective practices across all levels of development.***
- Many forested countries, including those which are economically least developed, have planned to ***stem – or even to reverse – deforestation trends***. Forests are natural "carbon sinks" and are also beneficial for adaptation and the preservation of biodiversity.
- ***Sectoral energy efficiency measures*** (buildings, transport, industry, etc.) have been planned by many countries.

Demand-side management

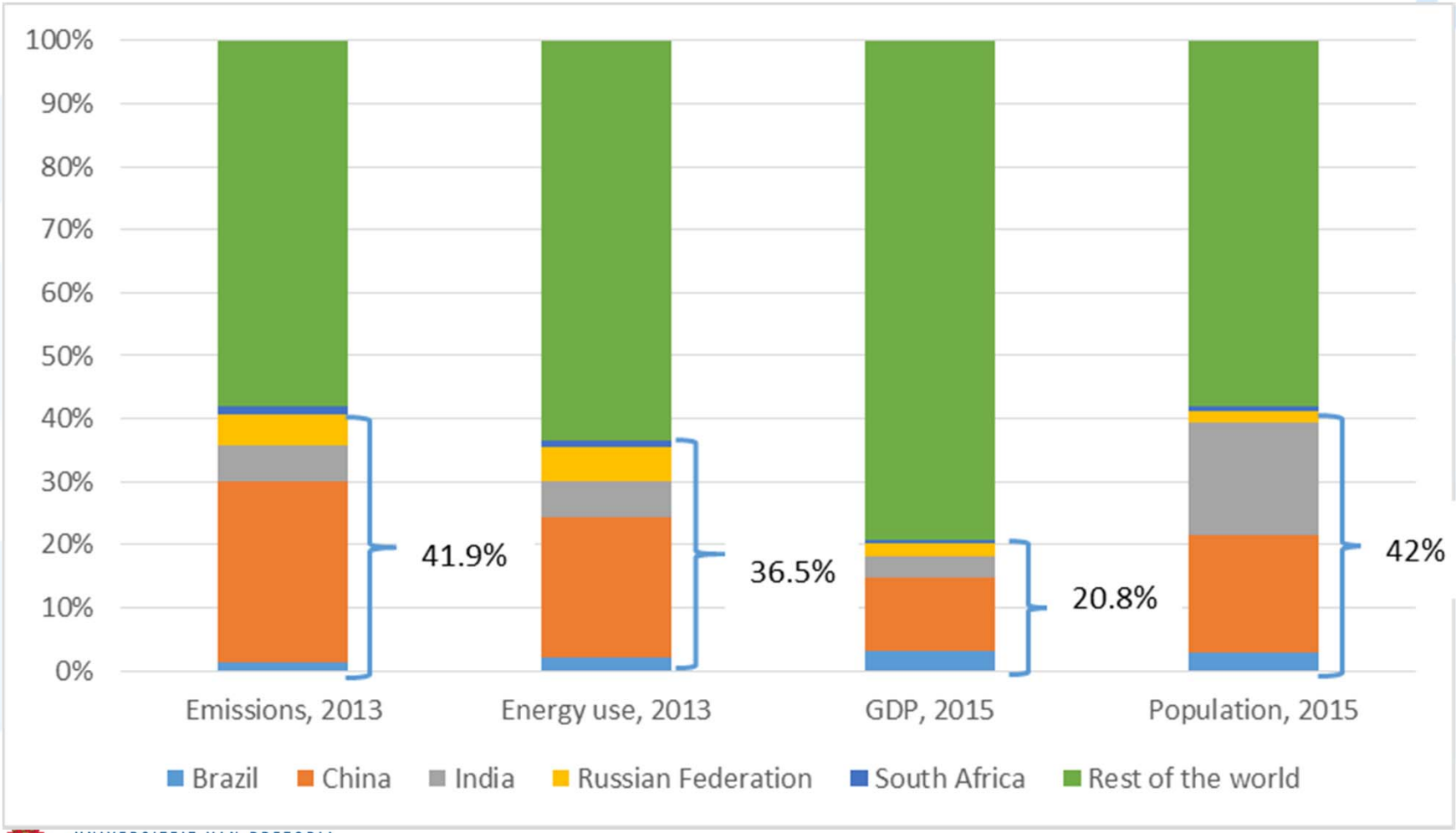
Systematic utility and government activities designed to change the amount and/or timing of customer's use of energy for the overall benefit of the society

Energy rebound effect



Greening et al. (2000)

Why BRICS?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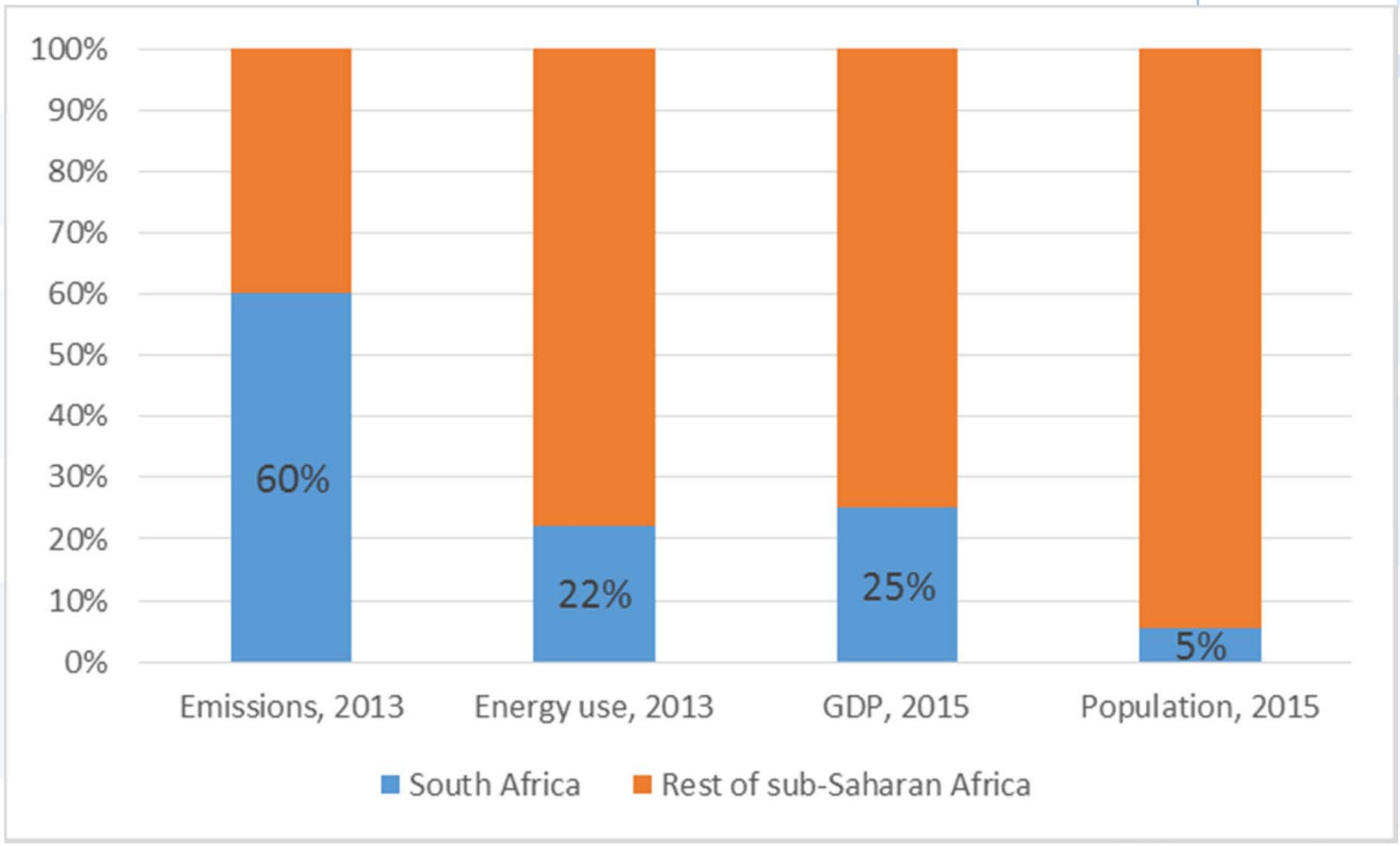
Emissions, 2013
Energy use, 2013
GDP, 2015
Population, 2015
Brazil
China
India
Russian Federation
South Africa
Rest of the world

Why SA?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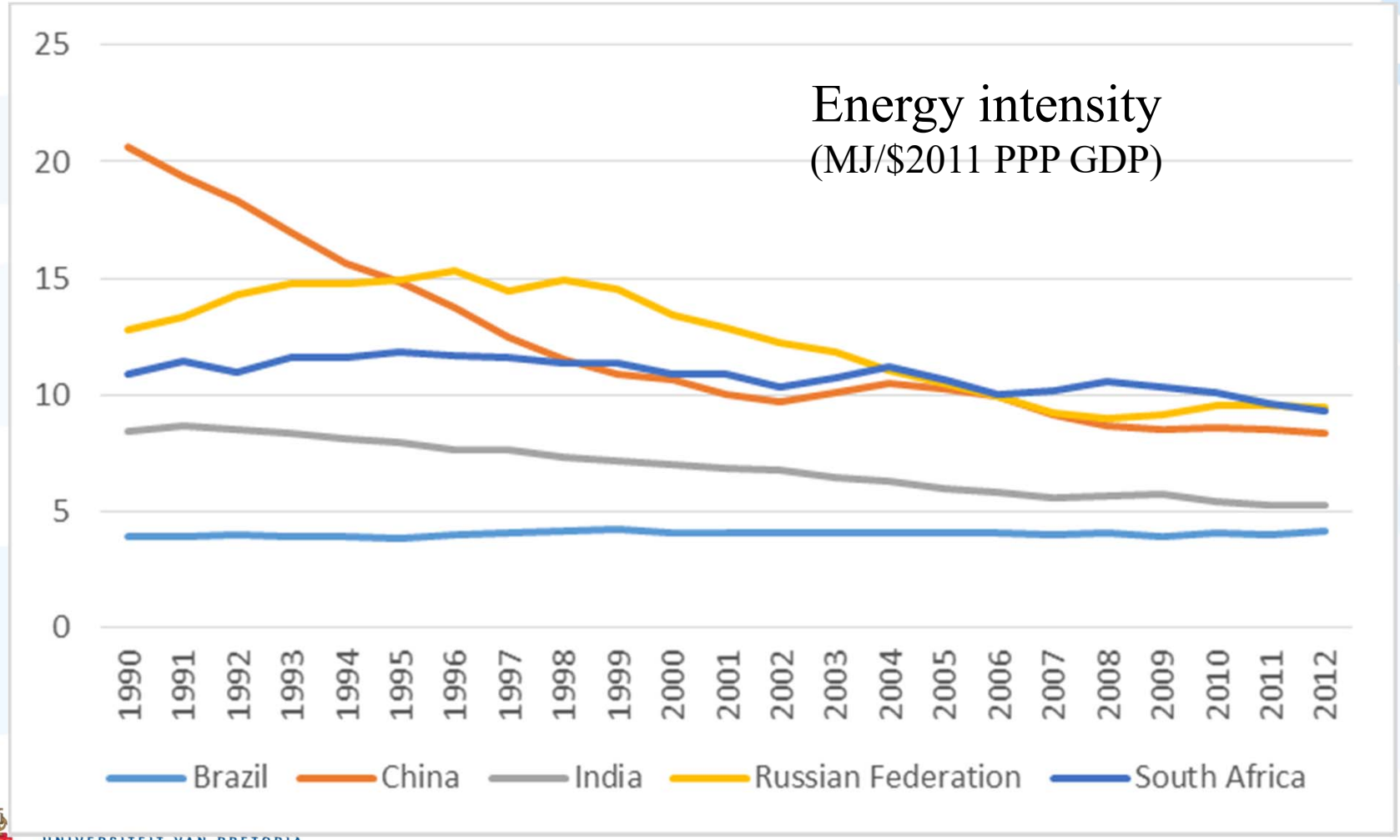
Emissions, 2013
Energy use, 2013
GDP, 2015
Population, 2015
South Africa
Rest of sub-Saharan Africa

Why SA within the BRICS group?



Decomposition technique

- Decomposition techniques have been used extensively in the energy literature to decouple the effects of various factors on the evolution of emissions (Ang and Choi, 1997; Bhattacharyya et al. 2010; Hammond and Norman, 2011; Kumbaroglu, 2011; Sheinbaum et al., 2011; Wang et al, 2011; Zhao et al, 2010b; Cansino et al., 2015; Shao et al. 2016; Sumabat et al., 2016; Xu et al., 2016).
- Example
- The paper of Shao et al. (2016) employed the specific LMDI model to disaggregate China's emissions into factors such production of the economy and the intensity of energy use.
  - Among their results, they showed that ***the impact of energy intensity towards cutting emissions was less than expected due to the rebound effect.***

Theoretical framework

Changes in CO_2 emissions are decomposed into five factors:

1. the carbon intensity of energy use (CIt),
2. energy intensity of real GDP (EIt),
3. contribution of the economy to the rest of the world (OutputShare),
4. GDP per capita (OutputCap) and
5. Population (Population).

Decomposition technique

The decomposition identity looks as follows:

$$C02_i = \sum \frac{C0_{2,i}}{Energy\ consumption_i} \frac{Energy\ Consumption_i}{GDP_i} \frac{Output_i}{Output} \frac{Output}{populatio}$$

$$= \sum carbon\ intensity\ x\ energy\ intensity\ x\ size\ of\ the\ economy\ x\ ouptut\ per\ capita\ x\ population$$

- Hence, changes in emissions are equal to the sum in changes of each of all the drivers.

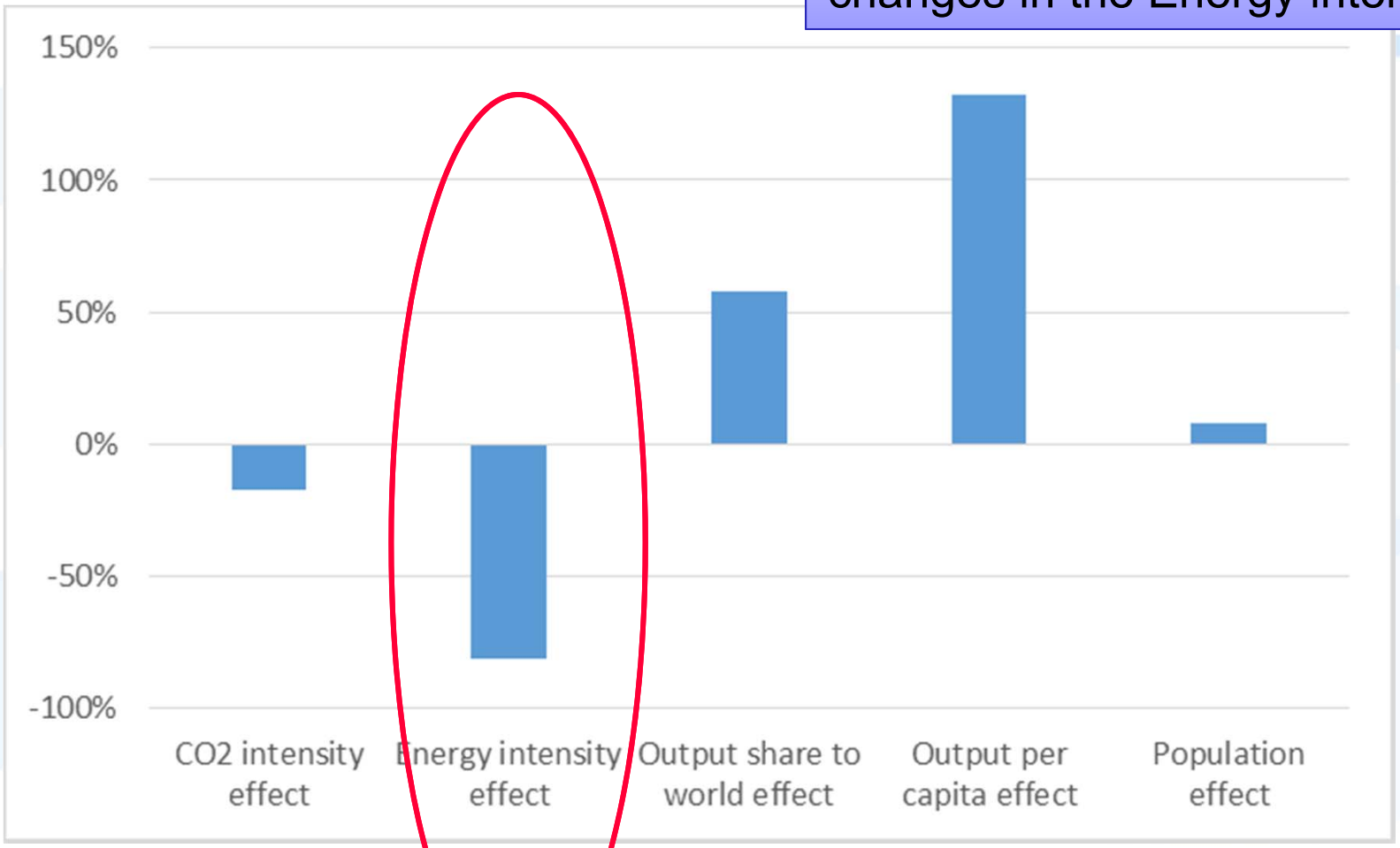
- The logarithmic scheme (weight) used here is adopted from Zhao, Ma and Hong (2010) where $w_{it} = \ln (CO_{2it}/CO_{2i0}) = (CO_{2it} - C0_{2i0})/\ln(CO_{2it}/CO_{2i0})$.

Data of the analysis

- The energy and emissions data are retrieved from the BP Statistical Review 2016 dataset .
- The economic and population data from the World Development Indicators of the World Bank for the BRICS countries (Brazil, Russia, India, China, South Africa) for the period 1990 to 2014.

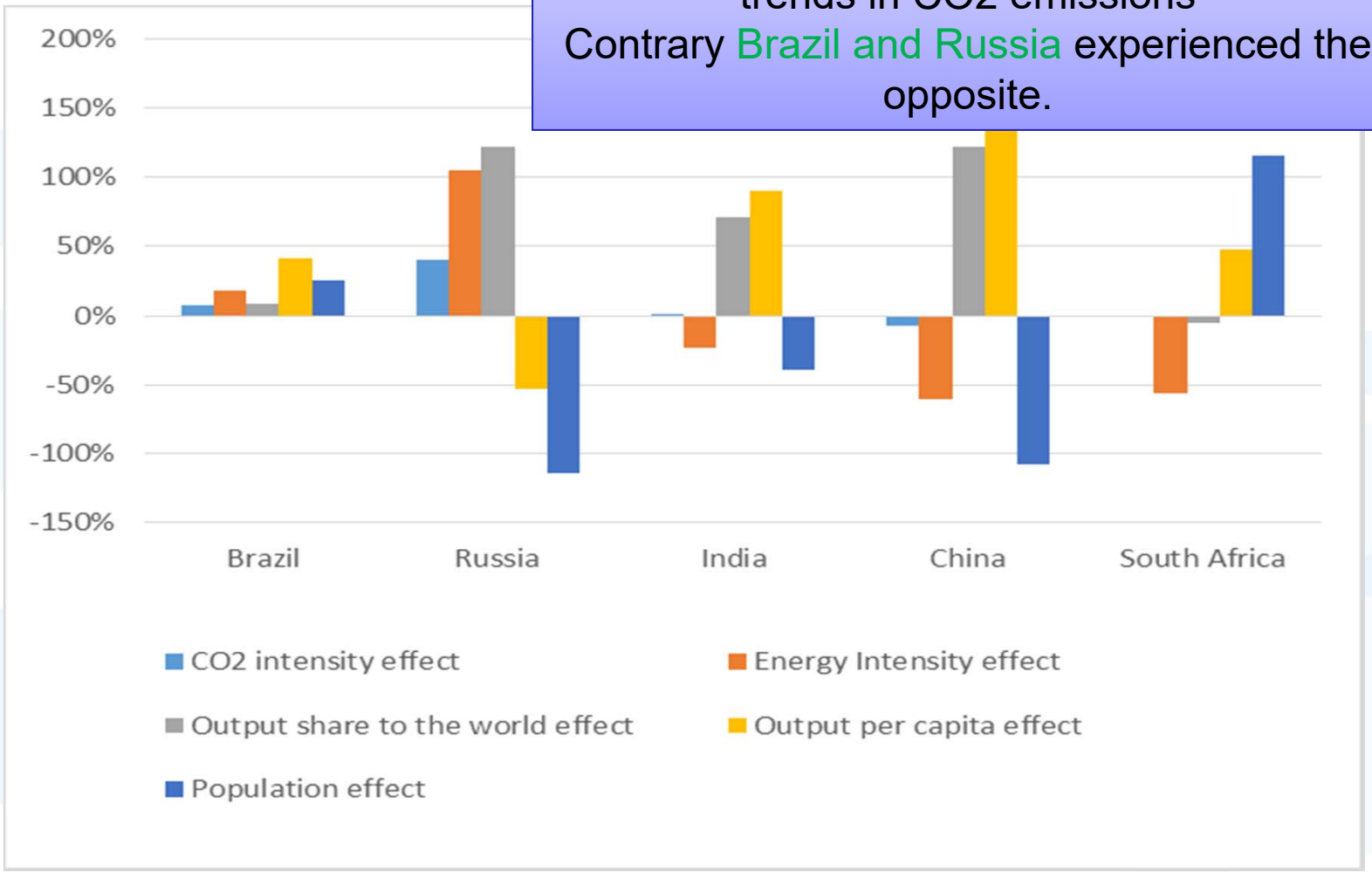
Results: Decomposition 1990-2014

In decomposition language: CO_2 emissions would have been higher if it was not for changes in the Energy intensity

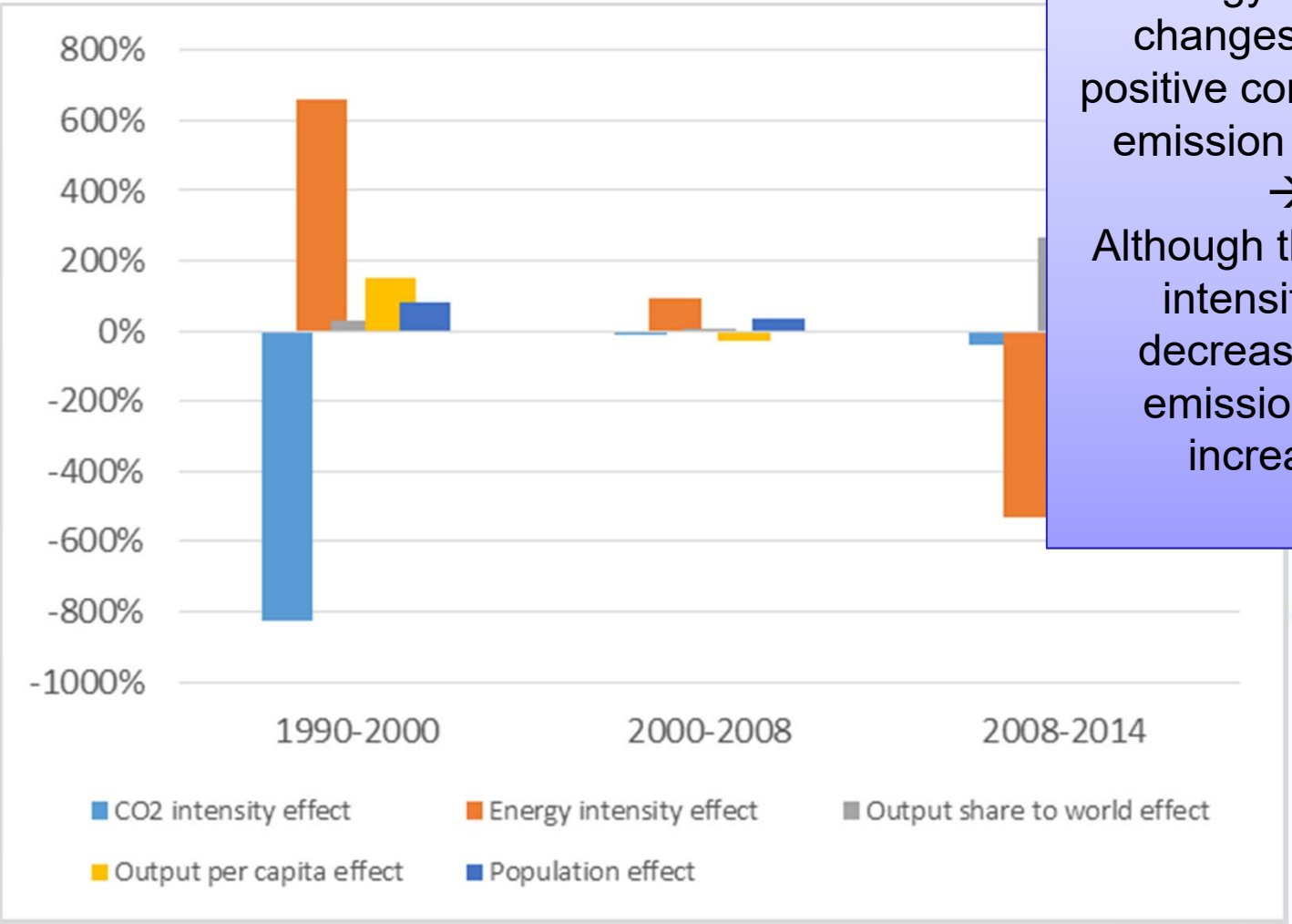


Results: Decomposition

Let's focus on the orange column:
South Africa, India, China: Energy intensity changes are a negative contributor to the trends in CO2 emissions
Contrary Brazil and Russia experienced the opposite.



Results: South Africa: Decomposition in three periods



From 1990 to 2008 energy intensity changes were a positive contributor to emission changes

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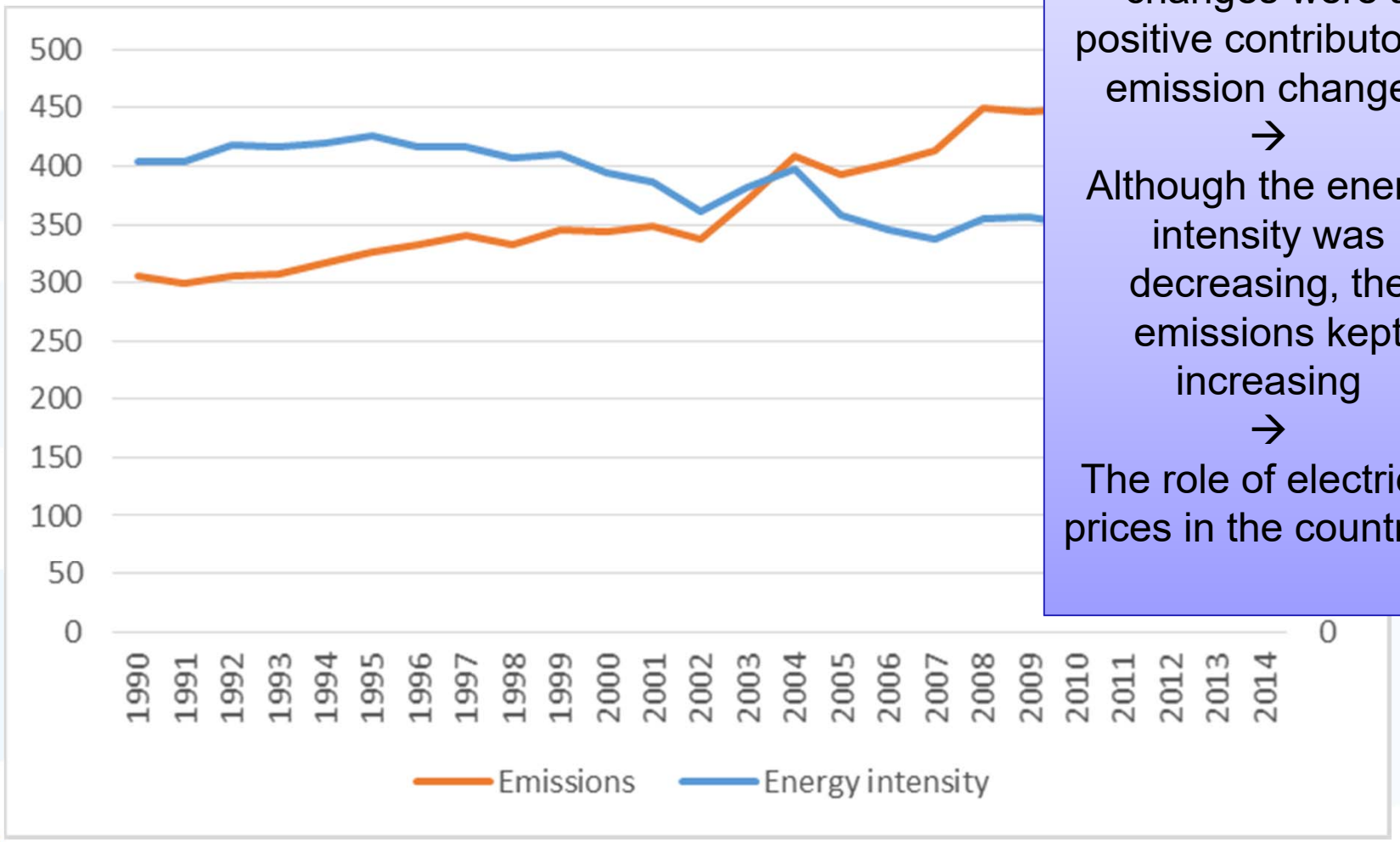
Although the energy intensity was decreasing, the emissions kept increasing

Energy intensity vs CO2 emissions in South A



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Although the energy intensity was decreasing, the emissions kept increasing

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The role of electricity prices in the country!!!!

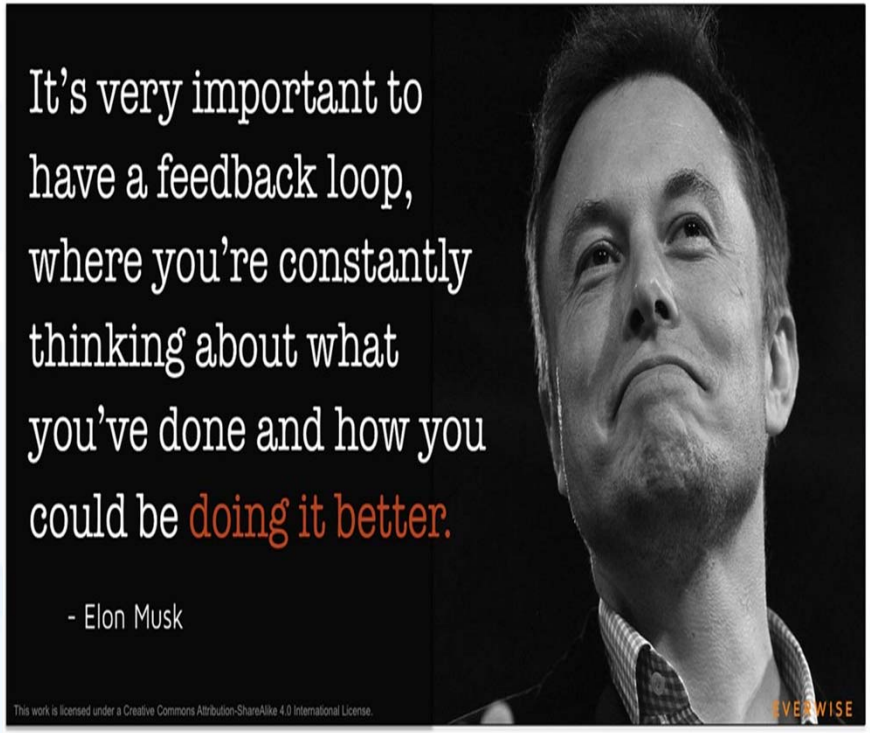
Limitations leading to future research

- *Not precise estimation of the effect:*
  Establishing the **exact size** of this direct effect will assist the policy makers of the country with their expectations of the outcomes from environmental and energy policies and implementation of technologies with regards to emission reduction.

- *Different energy mixes:*
  The different choices in the **energy mixes** between the BRICS countries (i.e. South Africa higher dependence on coal then Russia) both from the supply but also the consumption of energy might have driven the results. More research to be done taking the energy contribution of various fuels for each country.

- *Sectoral and technology rebound effect:*
  Economic sectors vary differently in various implementations of energy efficiency technologies. Not captured in this study. A study at **sectoral level and possibly on various technologies** within South Africa and in comparison with BRICS will assist in further policy decisions.

Thank you for your attention!



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