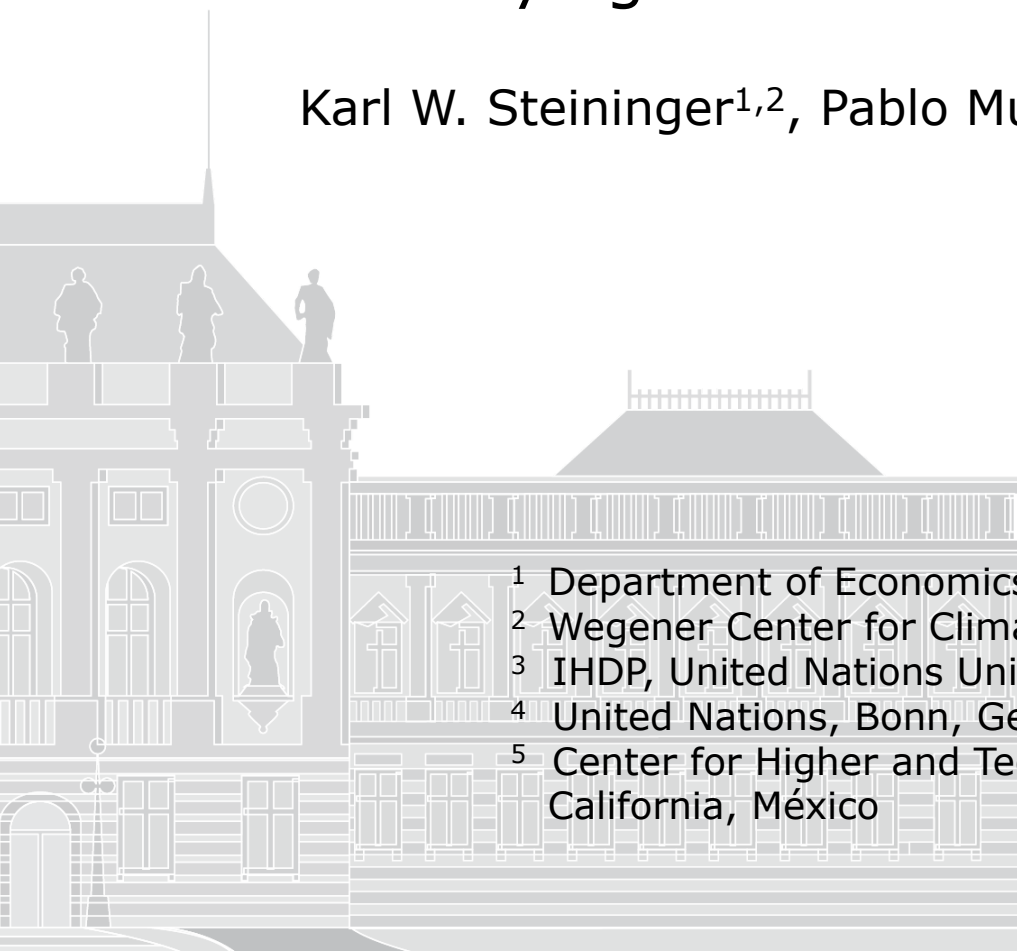


Austria 's Consumption-Based Emissions: Identifying Sectoral Origins and Destinations

Karl W. Steininger^{1,2}, Pablo Munoz^{3,4}, Erick Velázquez⁵

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- A large, light gray silhouette of the University of Graz building is positioned in the background, spanning the width of the slide. It features a central dome and several windows.
- ¹ Department of Economics, University of Graz, Austria
 - ² Wegener Center for Climate and Global Change, University of Graz
 - ³ IHDP, United Nations University, Bonn, Germany
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 - ⁵ Center for Higher and Technical Education, CETYS University, Baja California, México

Overview

- Introduction: issues in GHG accounting
- Austria 's Consumption Based Emissions
- Sectoral Origin and Destination: Hotspots
- Conclusions

Introduction

- **Supply chains in production**
 - crossing national borders
 - increasingly diversified
- **Greenhouse gas emissions allocation**
 - can be in principle allocated to each of the steps in production, or to consumption

fossil extraction

production of goods

Consumption of goods

value added

value added

value added

- different allocations to countries arise, depending on which allocation principle one follows

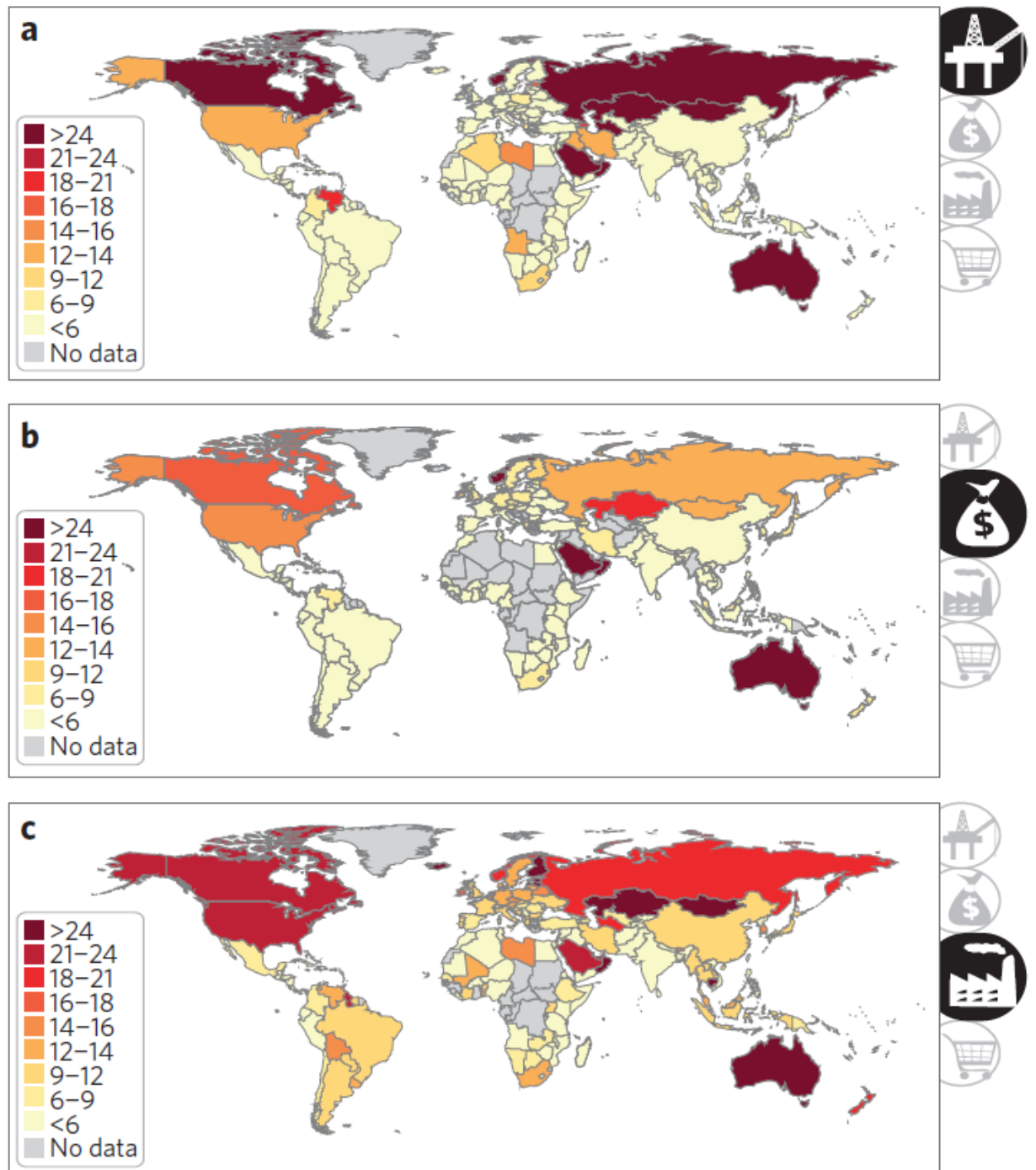
Accounting Principles

Figure 1 | Countries' emissions per capita according to different accounting principles (in the year 2011).

GHG emissions, in tonnes CO₂ or CO₂ equivalent, according to:

- (a) extraction-based
- (b) income-based
- (c) production-based
- (d) consumption-based accounting.

Source: Steining et al., *NClimate* 2016



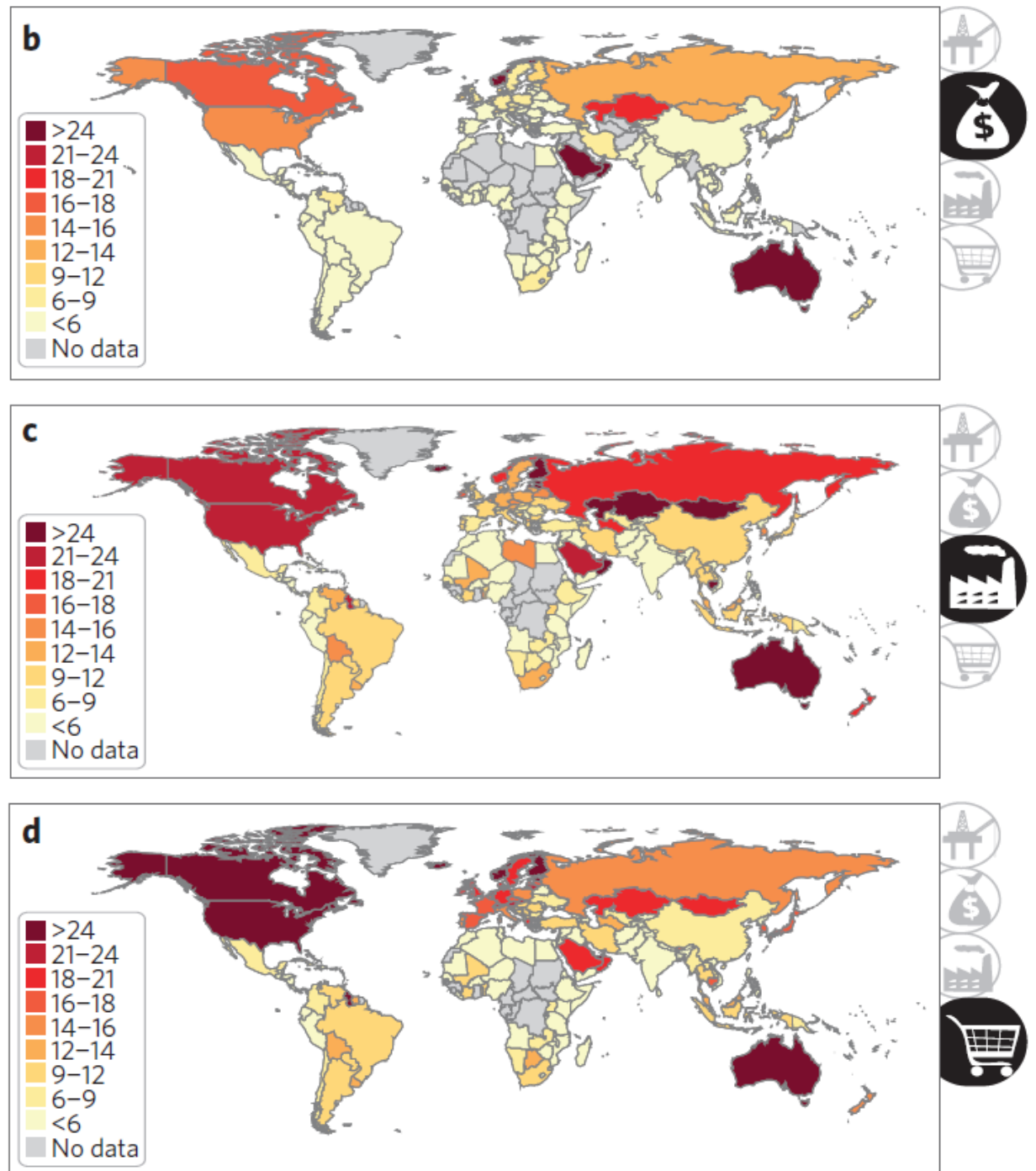
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No single accounting principle is dominating the others

- **Extraction-based**
 - Low transaction costs (fewer parties involved)
- **Income-based**
 - Global environmental stringency likely to be higher (income receiving countries with more capability to reduce emissions)
- **Production-based**
 - Scope of emissions covered (most comprehensive, e.g. also process emissions)
- **Consumption-based**
 - Addressing consumer responsibility

Literature development

- **Early conceptual (producer vs. consumer, “responsibility”):**
 - Kondo et al, Appl. Energy (1998)
 - Munksgaard & Pedersen, Energy Policy (2001)
 - Ferng, Ecol. Econ. (2003)
 - Bastianoni et al, Ecol. Econ. (2004)
 - Rodrigues et al, Ecol. Econ. (2006)
 - Lenzen et al, Ecol. Econ. (2007)
- **Quantifications of consumption-based emissions (national level):**
 - Peters & Hertwich, Clim. Change (2008)
 - Hertwich & Peters, Environ. Sci. & Technol. (2009)
 - Peters, Carbon Managem. (2010)
 - Munoz & Steininger, Ecol. Econ. (2010)
 - Davis & Caldeira, Proc. Natl Acad. Sci. USA (2010)

Literature development

- **Further accounting approaches (extraction-based, income-based):**

Davis et al, Proc. Natl Acad. Sci. USA (2011)

Lenzen & Murray, Ecol. Econ. (2010)

Marques et al, Ecol. Econ. (2012)

Policy implications?

- border carbon adjustment

- broader instrument set?

prerequisite: identifying hotspots

Method:

Multi-Regional Input Output (MRIO)



Data

- Economic: Global Trade Analysis Project (GTAP)
- GTAP v9 relates to 2011 (and 2007), 140 regions
- GTAP v8 relates to 2007
- GTAP v7 relates to 2004, 113 regions
- GTAP v6 relates to 2001
- GTAP v5 relates to 1997, 66 regions
- 57 industries per region

- Exiopol: 163 sectors; latest base year available: 2007

- CO₂ emissions: IEA energy statistics (fuel combustion)
 - process emissions (UNFCCC)

Results

Development over time

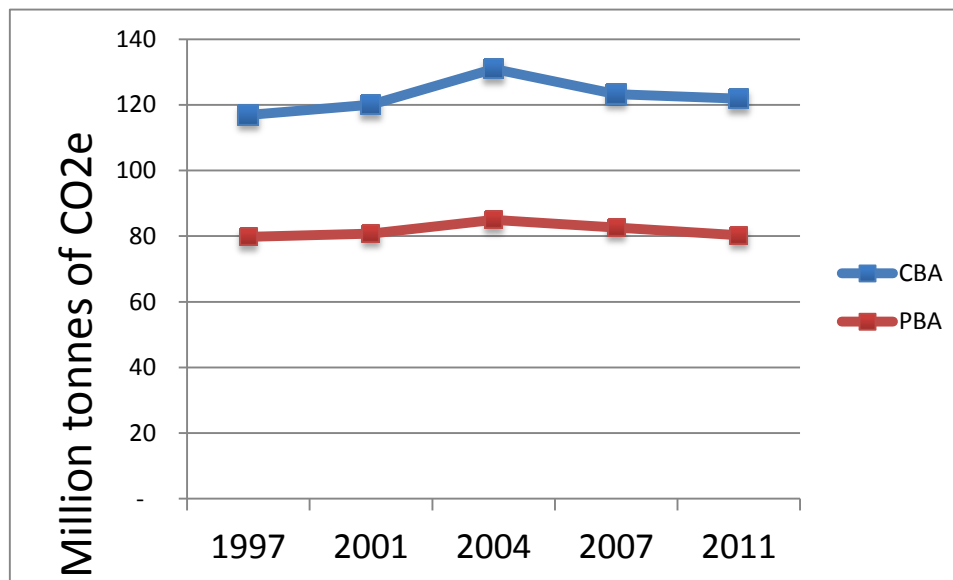
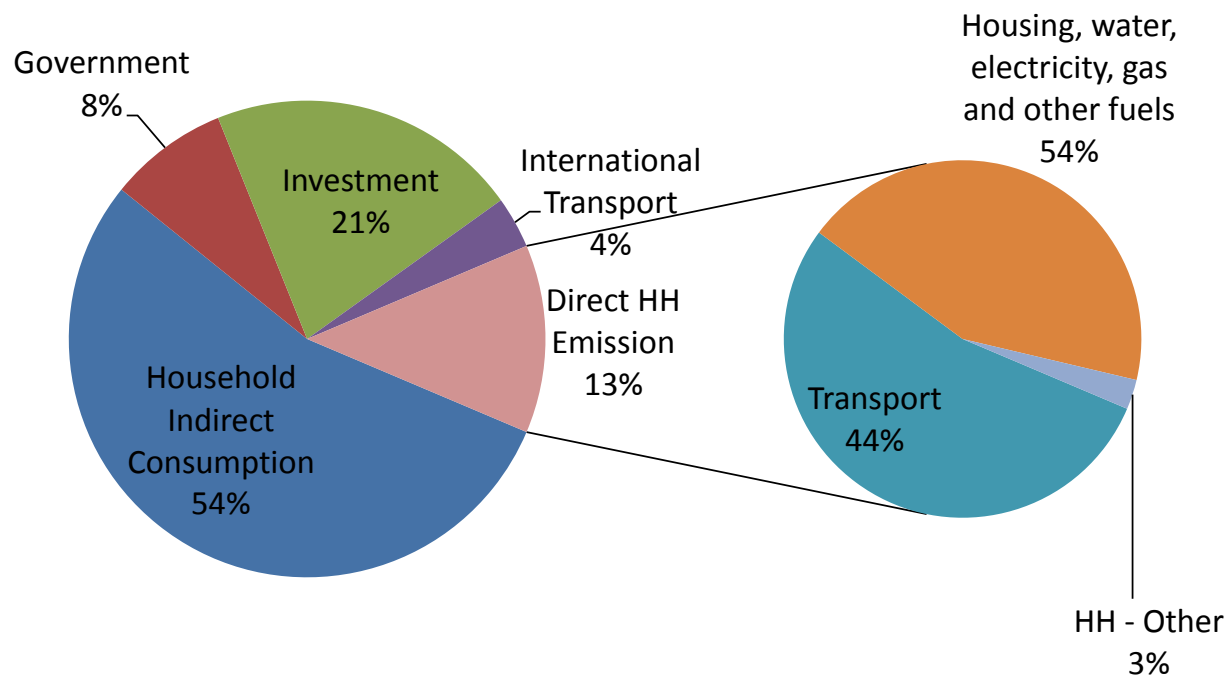


Figure 2: Austria's CO₂e from a consumption-based accounting (CBA) and production-based accounting (PBA) perspective

- strong divergence in Austria (CBA about 50% higher than PBA)
- divergence CBA-PBA stable so far

Results

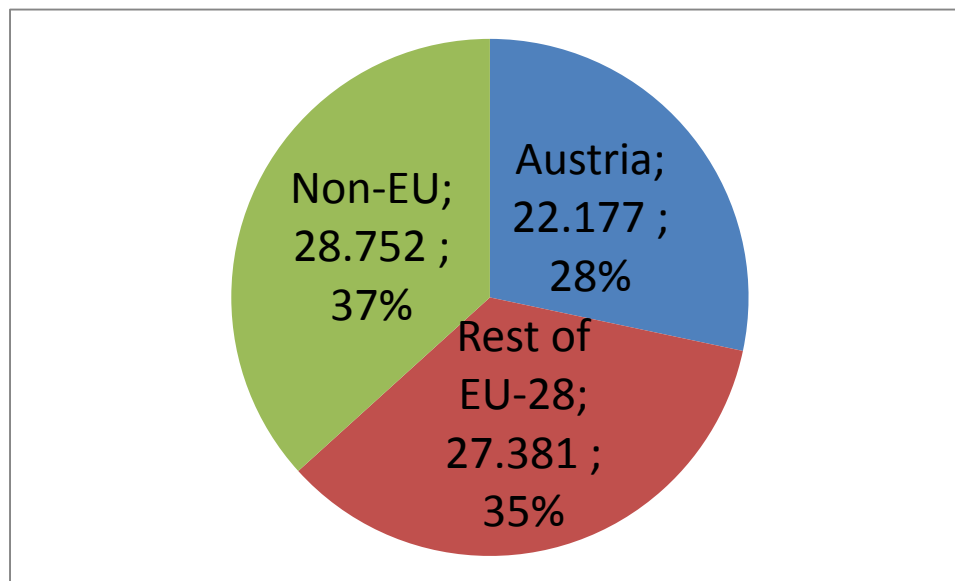
Shares of consumption-based emissions across agents



- Largest fraction: Household indirect emissions
- Investment demand ranks second

Results

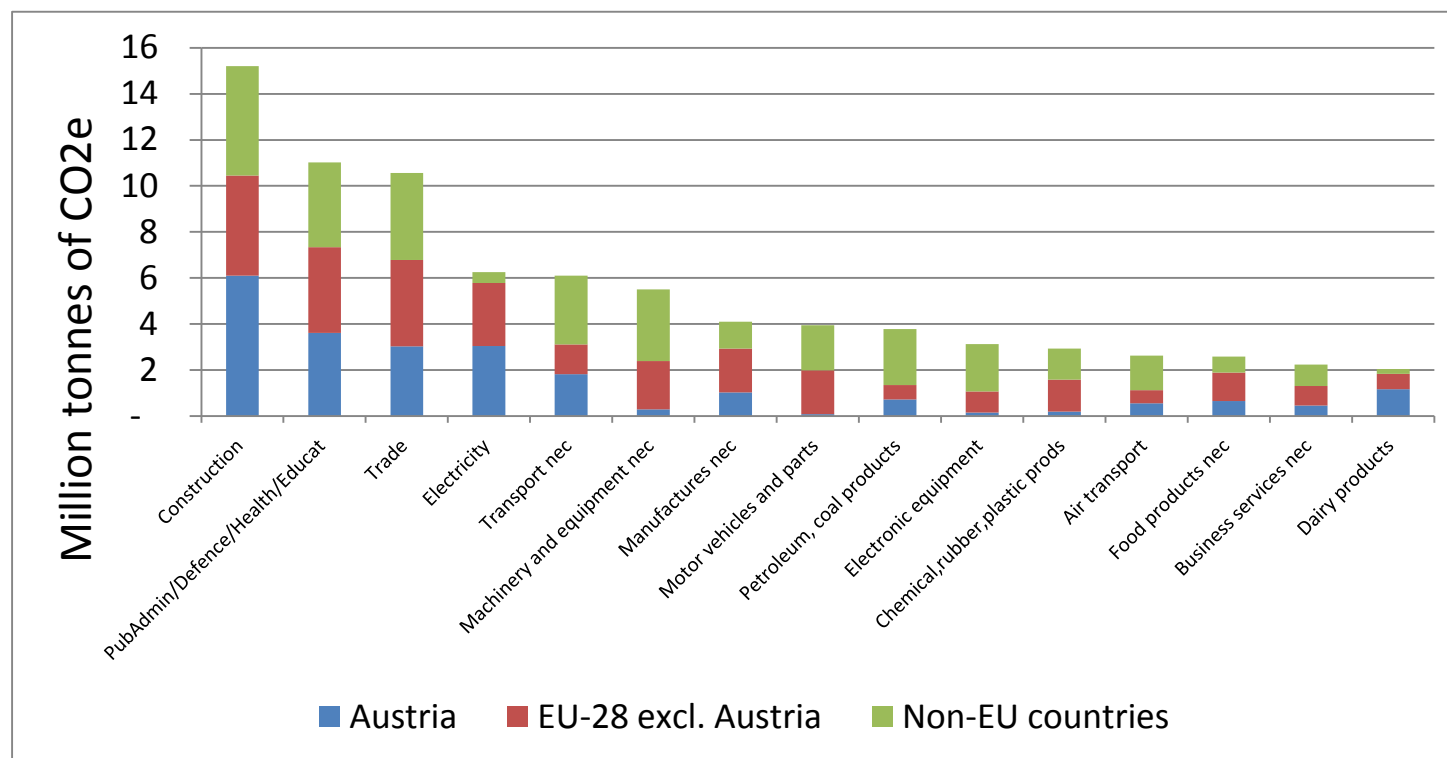
Consumption-based emissions by regional origin



- Roughly a third originating in each Austria – Rest of EU – Non-EU
- Largest fraction: Non-EU countries

Results

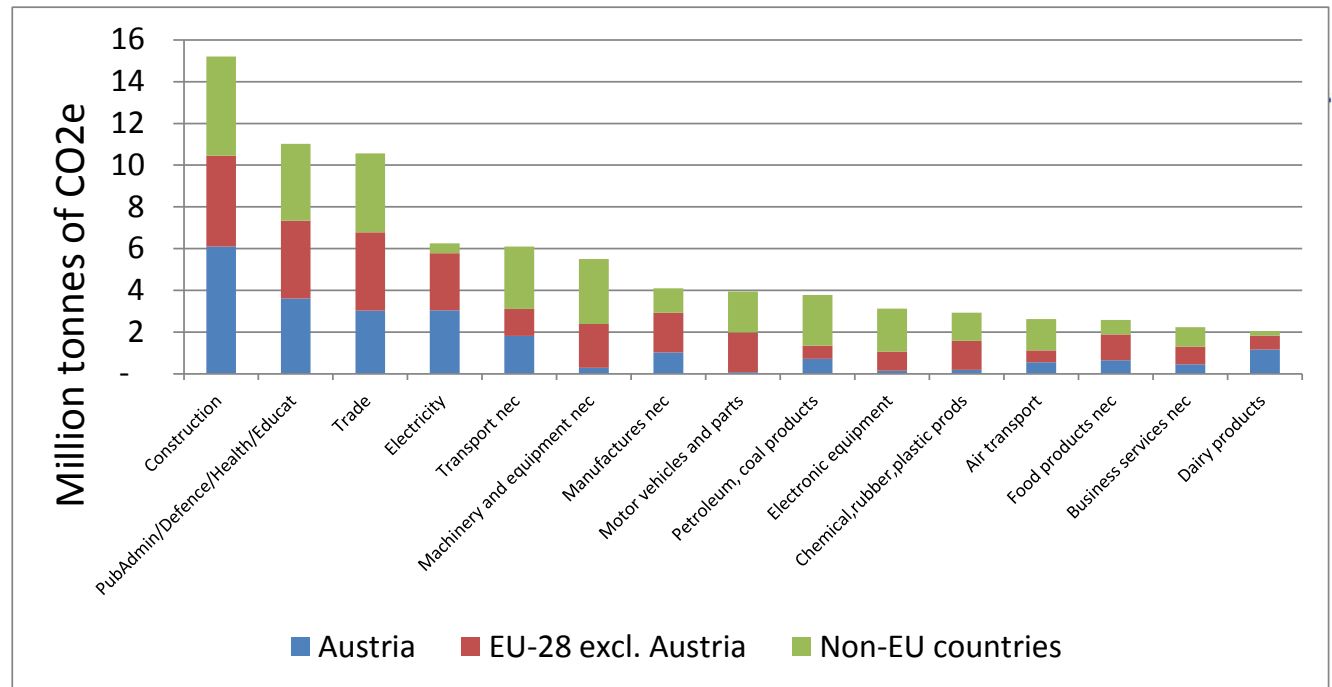
By sector of demand and region of origin of emission



- Three highly relevant sectors: construction, public, trade
- Significant share originating in non-EU countries

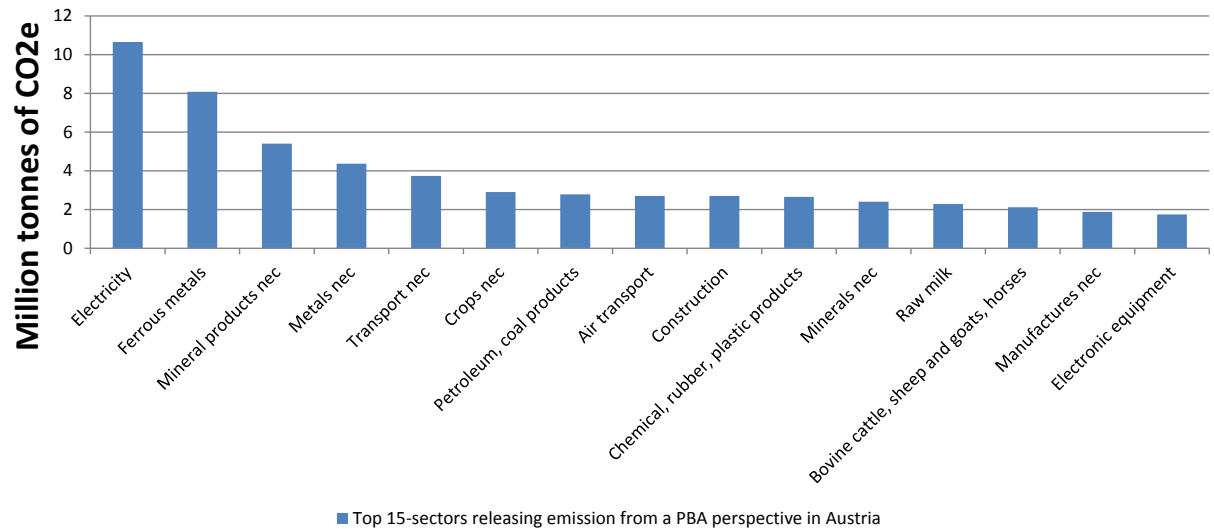
Results

CBA



versus

PBA

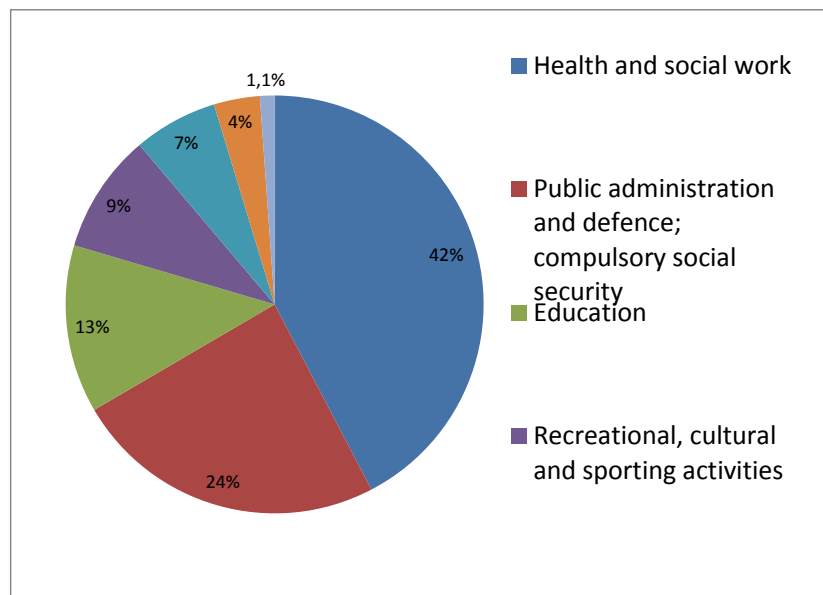


- The focus is on very different sectors; domestically relevant sectors: large exports

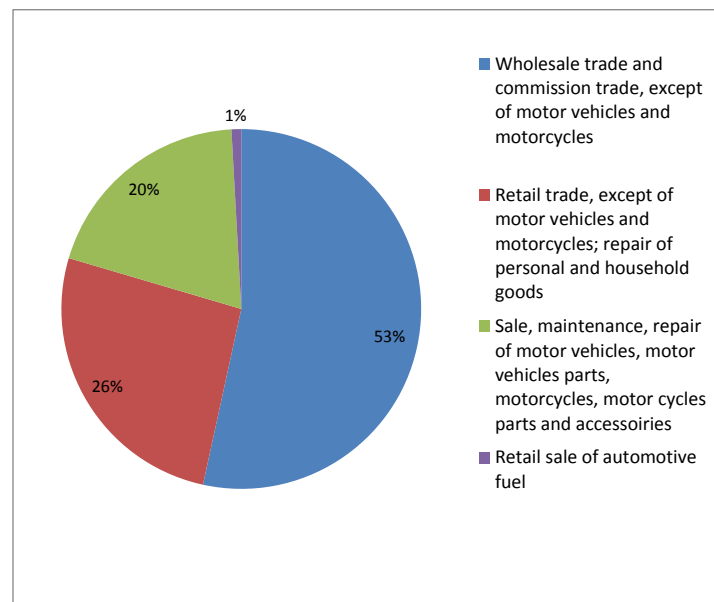
Results

Break down (shares of emissions triggered) within GTAP sectors, using Exiopol database (base year 2007)

(a) Public Administration



(b) Trade

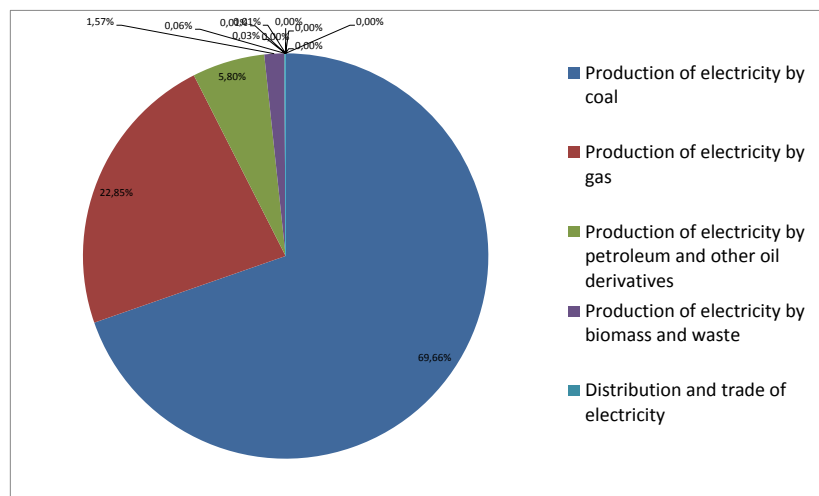


- Public Admin: largest fraction by „health and social work“
- Trade is emission dominated by wholesale trade

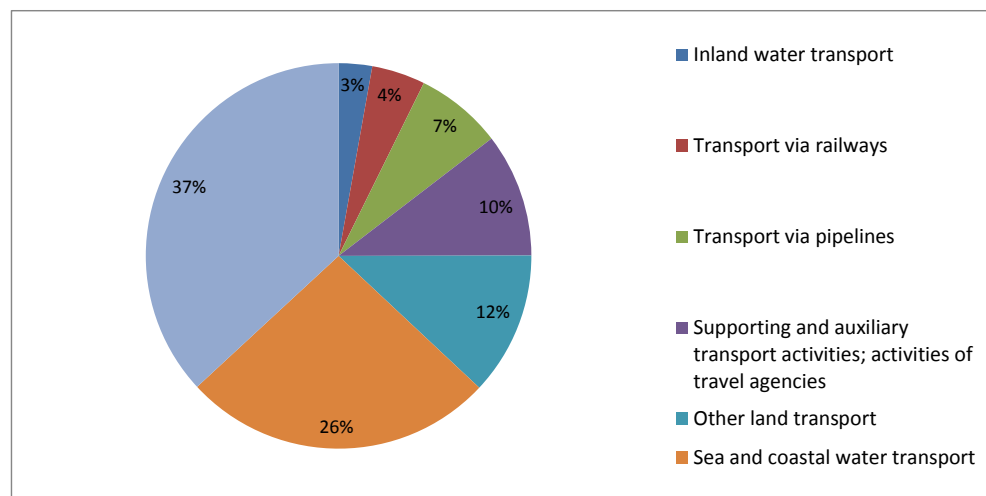
Results

Break down (shares of emissions triggered) in the two sectors globally most affected by Austrian consumption using Exiopol database (base year 2007)

(a) Electricity



(b) Transport



- Electricity: 70% from elec by coal, 23% by gas
- Transport: 37% air transport, 26% sea and coastal water transport

Conclusions

Analysis of emission profile of Austria from a consumption-perspective, because:

- increasing spatial separation between production and consumption
- divergency of climate policy efforts (NDCs in Paris Agreement)

Results:

- consumption-based emissions are about **50% larger** than those reported conventionally (production-based)
- demand **sectors responsible** for CBA emissions **somewhat different** than PBA ones

Conclusions

Results cont´d:

- suggests a different sectoral focus in policy: **Construction, Public administration and Trade** (sum to **31% of total CBA**)
- from production perspective these sectors account for only less than **8%** of Austrian emissions
- **more than one third** of Austrian CBA emissions occur **outside EU-28 borders**
- the single most relevant sector abroad: **electricity**
- for the above top-3-emission sectors the share of implicit electricity emissions is **roughly a third** in overall embodied emissions

Conclusions

Results cont´d:

- climate policy in an NDC setting (Paris) **needs to focus on further demand sectors**
- two of the top-three sectors: **Public administration and Trade**
- In Public Admin: "Health and Social works"
- In Trade: "Wholesale trade"
 - responsible for the dominant shares of emissions
- **in which sectors** across the globe **are emissions implicitly triggered by Austrian demand?**
 - Electricity, Transport are the top two
 - Electricity from coal dominating the former (70%)
 - Air transport (37%) most relevant in Transport

Conclusions

Results cont´d:

- Decarbonisation of electricity sector has been identified an early option in mitigation scenarios

Rogelj. Et al. (2015) identify the pace of decarbonization of electricity sector for both a 2⁰C and a 1.5⁰C objective:

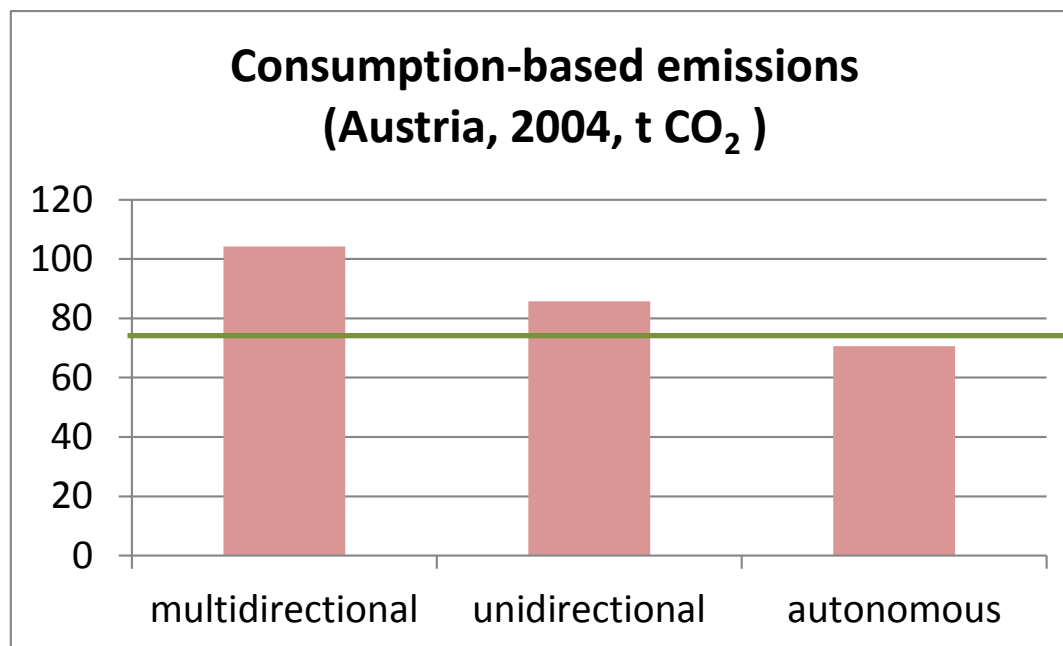
“The first step in a comprehensive transformation of the energy system is a decarbonization of the electricity system. Both 1.5 °C and likely 2 °C scenarios in our set **emit almost zero carbon emissions from electricity by 2050**. This transformation is achieved more quickly in 1.5 °C scenarios though, with median CO₂ emissions from electricity in 1.5 °C scenarios being already about 35% (55%) lower in 2030 than in likely (medium) 2 °C scenarios. Freely emitting fossil-based electricity generation is thus phased out earlier, and carbon-free technologies are ramped up at a faster pace. By 2030, the median share of low-carbon technologies, that is, renewables, nuclear and CCS, in electricity generation is already more than 10% higher in 1.5 °C-consistent scenarios compared with likely 2 °C scenarios.” (Rogelj et al., 2015: 523)

Conclusions

Results cont´d:

- consumption-based policy **addressing electricity emissions abroad** is among the most relevant and early options
- as electricity turned out to be the single by far most important sector that Austrian consumption based emissions originate from
- **share of trade-embodied emissions** in Austrian consumption-based emissions **is likely to decline** – as world is likely to focus on such early options first

Discussion: uncertainty



International agreement on accounting guidelines asked for – satellite accounts

[Steininger et al., *Nature Clim. Change*, 2016]

Project INNOVATE:



(1) identifying hotspots

(2) development of policy instruments

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