Assessing the impacts of fertility and retirement policies on China's carbon emissions

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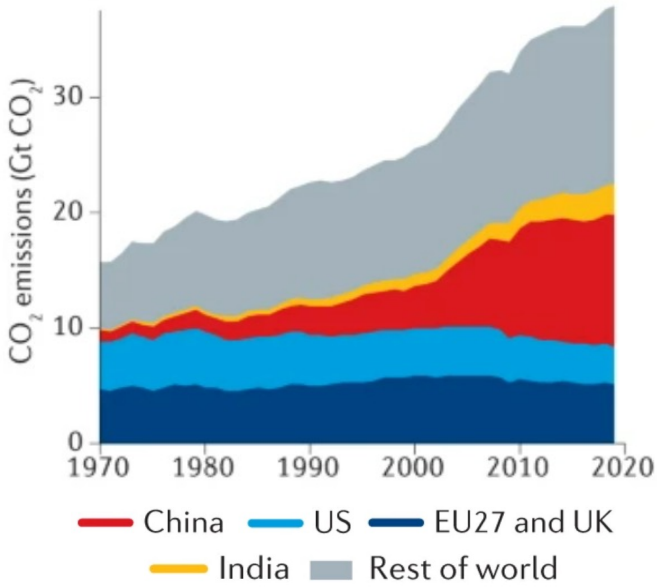
8th July 2025, Malé, Maldives

Contents

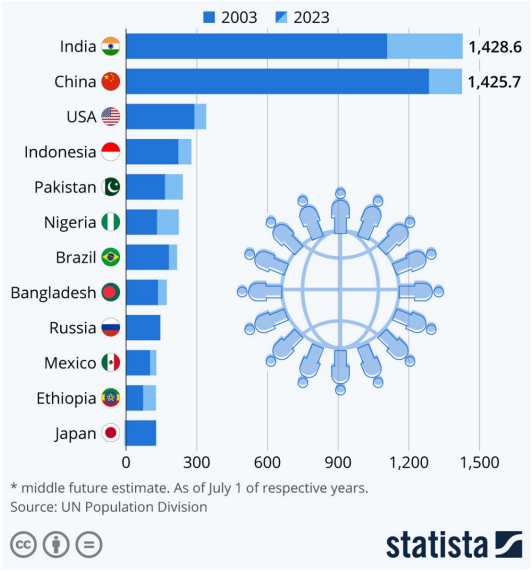
Background: climate change and aging

- Mitigating **climate change** and coping with **population aging** are both critical goals for achieving sustainable development.
- China: (1) the world's **largest carbon emitter**.
  (2) one of the **most populous countries** in the world.

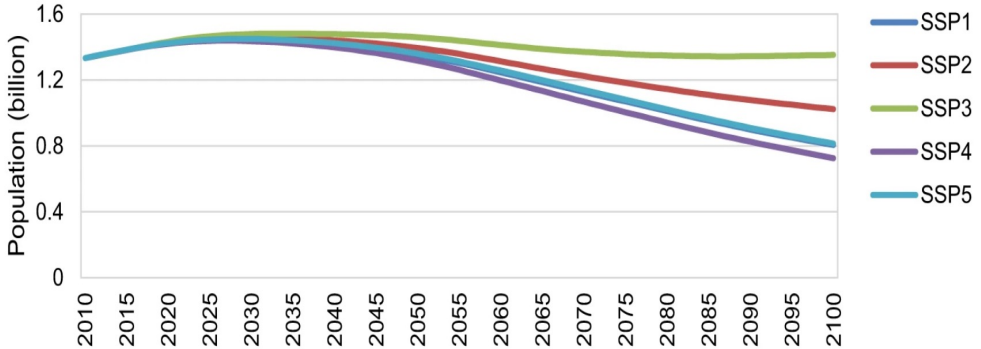
Carbon emissions by region



The most populous countries



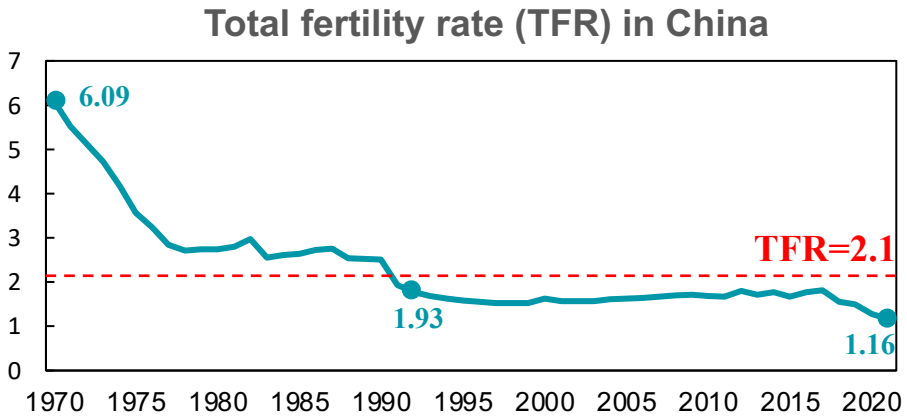
Changes in China's populations under SSPs



Liu, Z., et al. Challenges and opportunities for carbon neutrality in China. *Nat Rev Earth Environ* 3, 141–155 (2022).
Chen, Y., et al. Provincial and gridded population projection for China under shared socioeconomic pathways from 2010 to 2100. *Sci Data* 7, 83 (2020).

Background: population policies

- **Total fertility rate and population policies**



1979

One-child policy

2015

Two-child policy

2021

Three-child policy

Background: retirement age

- **Retirement age and retirement delay policy**

Lower retirement age in China


中华人民共和国中央人民政府
www.gov.cn

中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要

2021-03-13 07:16 来源：新华社

第三节 完善养老服务体系

推动养老事业和养老产业协同发展，健全基本养老服务体系，大力发展普惠型养老服务，支持家庭承担养老功能，构建居家社区机构相协调、医养康养相结合的养老服务体系。完善社区居家养老服务网络，推进公共设施适老化改造，推动专业机构服务向社区延伸，整合利用存量资源发展社区嵌入式养老。强化对失能、部分失能特困老年人的兜底保障，积极发展农村互助幸福院等互助性养老。深化公办养老机构改革，提升服务能力和水平，完善公建民营管理机制，支持培训疗养资源转型发展养老，加强对护理型民办养老机构的政策扶持，开展普惠养老城企联动专项行动。加强老年健康服务，深入推进医养康养结合。加大养老护理型人才培养力度，扩大养老机构护理型床位供给，养老机构护理型床位占比提高到55%，更好满足高龄失能失智老年人护理服务需求。逐步提升老年人福利水平，完善经济困难高龄失能老年人补贴制度和特殊困难失能留守老年人探访关爱制度。健全养老服务综合监管制度。构建养老、孝老、敬老的社会环境，强化老年人权益保障。综合考虑人均预期寿命提高、人口老龄化趋势加快、受教育年限增加、劳动力结构变化等因素，按照小步调整、弹性实施、分类推进、统筹兼顾等原则，逐步延迟法定退休年龄，促进人力资源充分利用。发展银发经济，开发适老化技术和产品，培育智慧养老等新业态。

2021
Call for raising the retirement age


中华人民共和国中央人民政府
www.gov.cn

全国人民代表大会常务委员会关于实施渐进式延迟法定退休年龄的决定

2024-09-13 17:17 来源：新华社

新华社北京9月13日电

全国人民代表大会常务委员会关于实施渐进式延迟法定退休年龄的决定

（2024年9月13日第十四届全国人民代表大会常务委员会第十一次会议通过）

为了深入贯彻落实党中央关于渐进式延迟法定退休年龄的决策部署，适应我国人口发展新形势，充分开发利用人力资源，根据宪法，第十四届全国人民代表大会常务委员会第十一次会议决定：

一、同步启动延迟男、女职工的法定退休年龄，用十五年时间，逐步将男职工的法定退休年龄从原六十周岁延迟至六十三周岁，将女职工的法定退休年龄从原五十周岁、五十五周岁分别延迟至五十五周岁、五十八周岁。

二、实施渐进式延迟法定退休年龄坚持小步调整、弹性实施、分类推进、统筹兼顾的原则。

三、各级人民政府应当积极应对人口老龄化，鼓励和支持劳动者就业创业，切实保障劳动者权益，协调推进养老托育等相关工作。

四、批准《国务院关于渐进式延迟法定退休年龄的办法》。国务院根据实际需要，可以对落实本办法进行补充和细化。

五、本决定自2025年1月1日起施行。第五届全国人民代表大会常务委员会第二次会议批准的《国务院关于安置老弱病残干部的暂行办法》和《国务院关于工人退休、退职的暂行办法》由有关退休年龄的规定不再施行。

2024
Decide to raise the retirement age

Background

- **Literature review**

Research gap:

No studies have assessed the impacts of **policies that address population aging**—including **fertility** and **retirement** policies—on carbon footprints.

This study:

- ✓ Investigates **age-based household carbon footprints** in China and its provinces by compiling a global multiregional input–output (MRIO) table and employing a large-scale household survey;
- ✓ Estimates the **age and sex distribution of the population** in China and its provinces up to 2060 under different fertility and retirement policies by using a cohort-component method;
- ✓ Assesses the **impacts of fertility and retirement policies** on household carbon footprints.

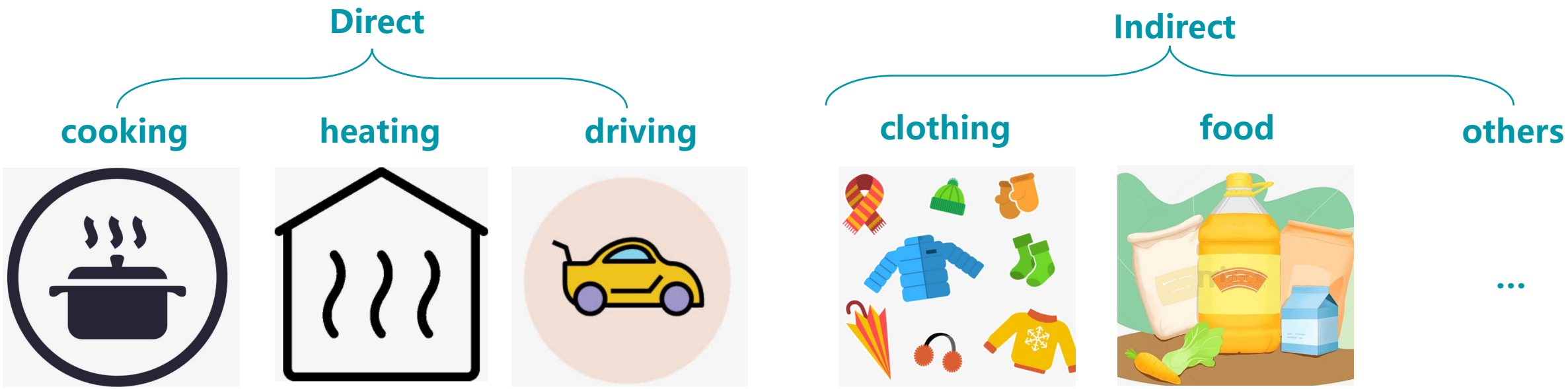
Contents

Methods

- **Household carbon footprint and MRIO analysis**

Household carbon footprints come from household consumption activities, including

- **direct carbon footprints**: direct energy use, for example, during cooking, heating and driving;
- **indirect carbon footprints**: the consumption of goods and services which are produced by using energy as intermediate inputs.



Methods

- **Household carbon footprint and MRIO analysis**

Direct household carbon footprint are calculated based on the China Emission Accounts and Datasets (CEADs);

Indirect household carbon footprints are calculated based on input-output analysis as follows:

$$\begin{pmatrix} \mathbf{x}^1 \\ \mathbf{x}^2 \\ \vdots \\ \mathbf{x}^r \end{pmatrix} = \begin{pmatrix} \mathbf{A}^{1,1} & \mathbf{A}^{1,2} & \cdots & \mathbf{A}^{1,s} \\ \mathbf{A}^{2,1} & \mathbf{A}^{2,2} & \cdots & \mathbf{A}^{2,s} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}^{r,1} & \mathbf{A}^{r,2} & \cdots & \mathbf{A}^{r,s} \end{pmatrix} \begin{pmatrix} \mathbf{x}^1 \\ \mathbf{x}^2 \\ \vdots \\ \mathbf{x}^r \end{pmatrix} + \begin{pmatrix} \sum_s \sum_t \mathbf{y}_t^{1,s} \\ \sum_s \sum_t \mathbf{y}_t^{2,s} \\ \vdots \\ \sum_s \sum_t \mathbf{y}_t^{r,s} \end{pmatrix} \quad (1)$$

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y} \quad (2)$$

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \quad (3)$$

$$\mathbf{e} = \mathbf{f}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}} \quad (4)$$

Methods

- **Theil index**

We use the Theil index to measure **how unevenly household carbon footprints are distributed across age groups**. The Theil index ranges from zero to one, with a higher value indicating greater inequality of distribution across age groups. The Theil index is calculated by the following:

$$T = \sum_q d_q \ln\left(\frac{d_q}{w_q}\right) \quad (13)$$

$$d_q = \frac{\mathrm{ce}_q}{\sum_q \mathrm{ce}_q} \quad (14)$$

$$w_q = \frac{P_q}{\sum_q P_q} \quad (15)$$

T – Theil index
d – the share of household carbon footprint
w – the share of population
ce – household carbon footprint
p – population
q – age

Methods

- **Projection**

$$\mathbf{e}_{l,q,n}^{s,v} = \mathbf{f}_{l,n}^{s}(\mathbf{I}-\mathbf{A})^{-1}\hat{\mathbf{y}}_{l,q,n}^{s,v} \quad (16)$$

Carbon intensity **Household consumption**

e – household carbon footprint
f – carbon intensity
$(I-A)^{-1}$ – Leontief inverse matrix
y – Household consumption
s – region
v – policy scenario
l – expenditure category
q – age
n – year

✓ **Carbon intensity** is modelled following *the China's Long-Term Low-Carbon Development Strategies and Pathways: Comprehensive Report*.

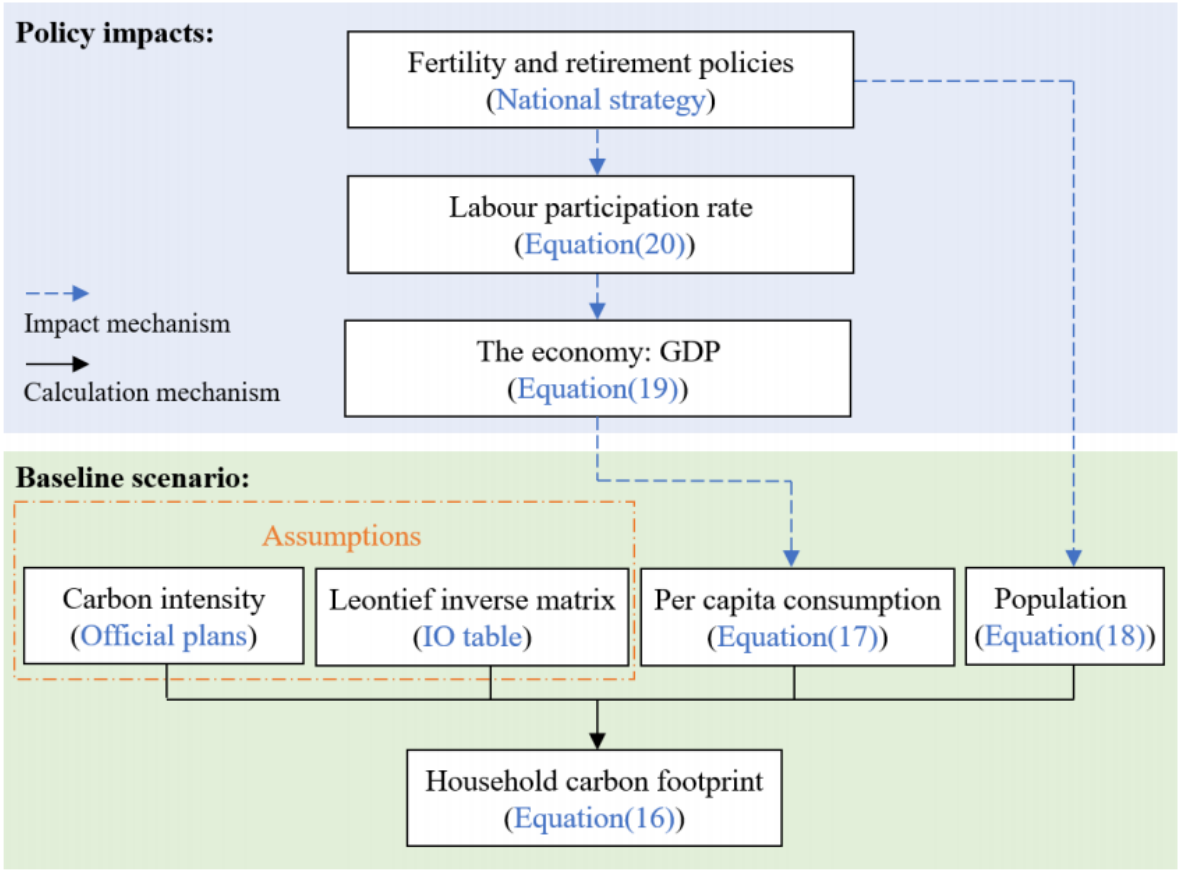
✓ **Household consumption** is calculated by multiplying per capita household consumption with population. Income is projected based on the long-term GDP forecast under the SSP2 scenario (Shared Socioeconomic Pathway Middle of the Road scenario).

$$\log(y_{q,l}) = a_{q,l} + b_{q,l}\log(m_q) \quad (17)$$

y – per capita consumption m – per capita income
b – income elasticity of consumption

Methods

- **The impacts of fertility and retirement policies**



The fertility and retirement policies affect the

- **population** (in terms of size and structure)

$$P(N) = P(0) + B(0,N) - D(0,N) + G(0,N) \quad (18)$$

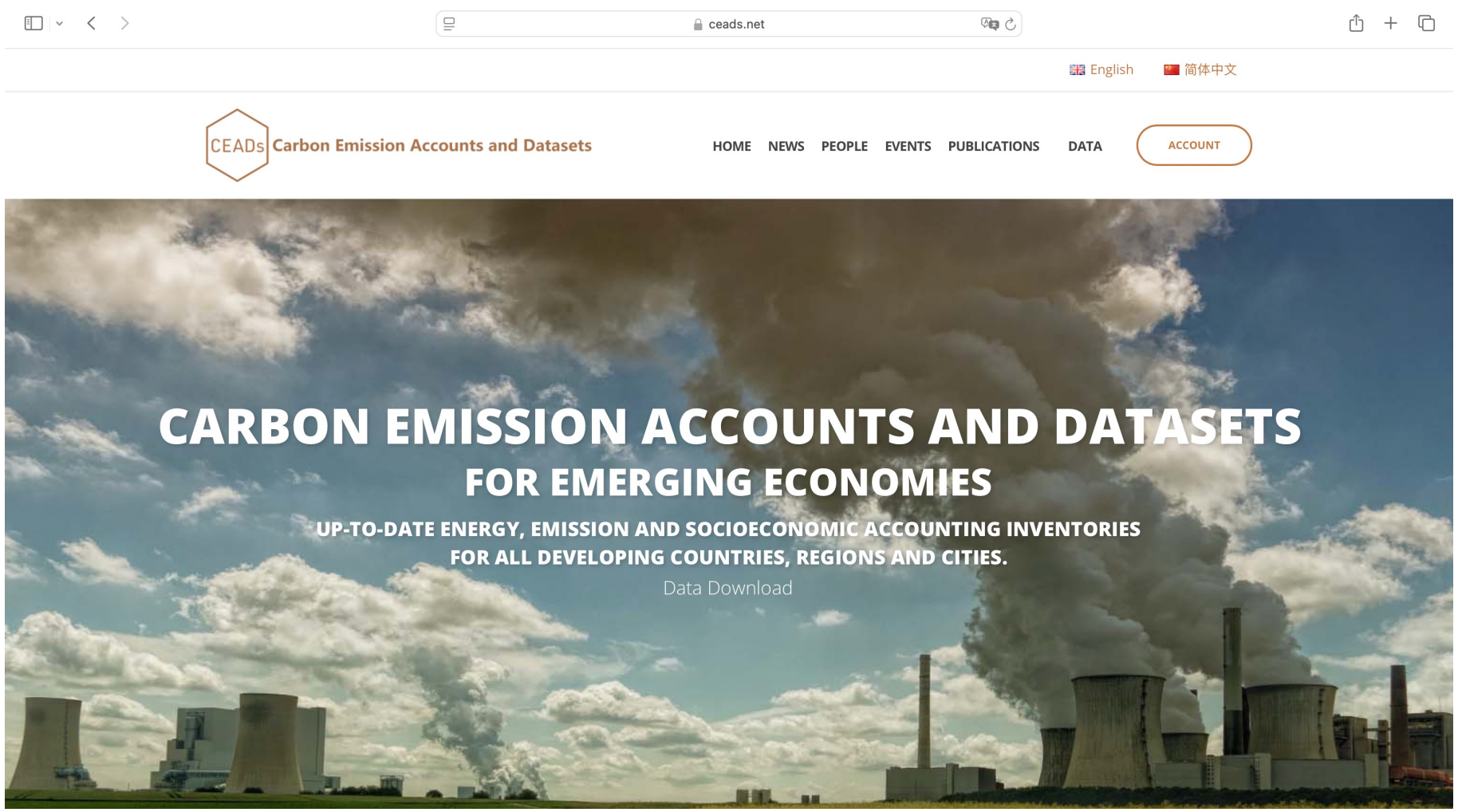
- **economy** (in terms of GDP and household income)

$$\Delta GDP_n^{s,v} = \sum_q \sum_g \Delta labourrate_{q,g,n}^{s,v} \times ratio^s \quad (19)$$

$$labourrate_{q,g}^s = \beta_0 + \beta_1 D(age_{q,g}^s) + \beta_2 age_{q,g}^s + \varepsilon_{q,g}^s \quad (20)$$

Methods

- **Data Source**: China Emission Accounts and Datasets (CEADs, http://www.ceads.net/)



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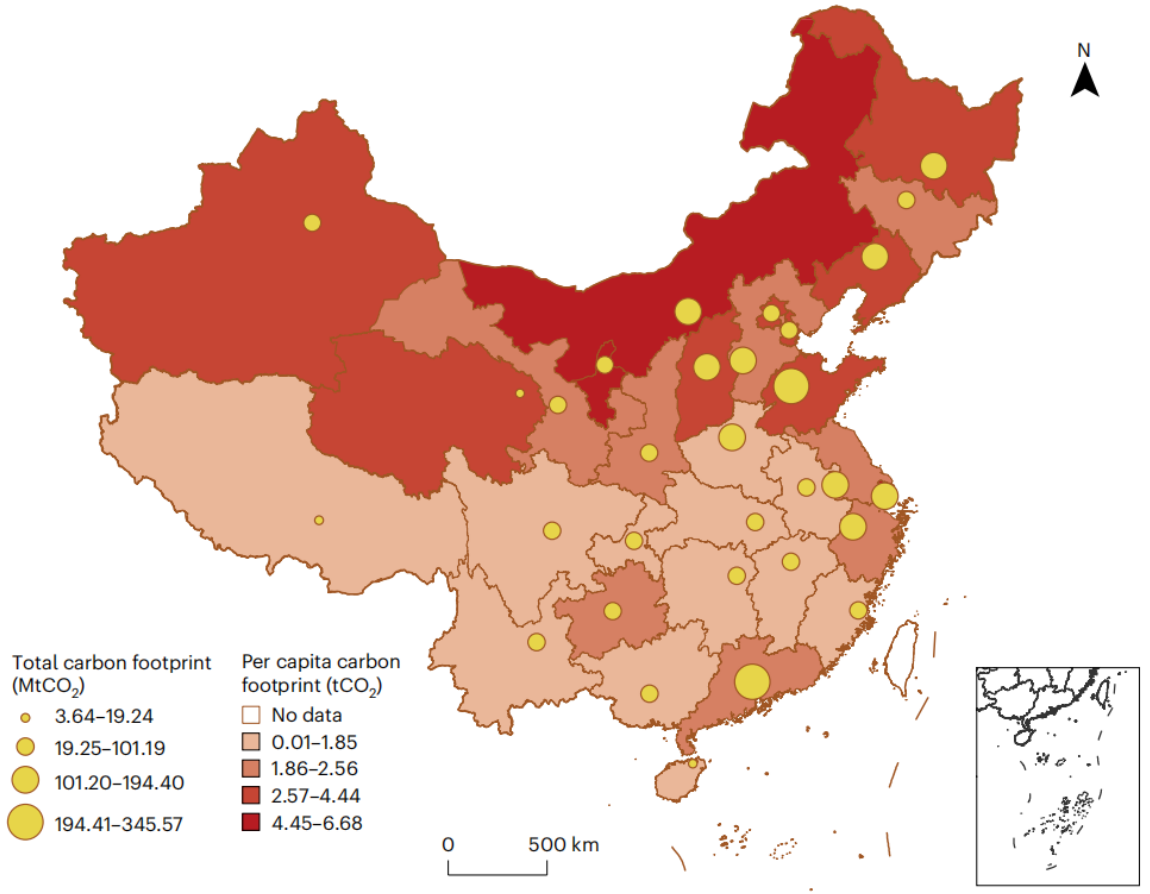
Results and Discussions

- **Household carbon footprints**
  - **Carbon footprint (2017)**
    - ✓ Total: eastern provinces ↑ (with larger populations)
    - ✓ Per capita:

      northwestern provinces ↑ (with higher carbon intensity)

      eastern provinces ↑ (with higher household consumption)



Results and Discussions

- **Household carbon footprints**

➢ **Age-based carbon footprint (2017)**

✓ Age:

young> middle-aged > old (Contrast to patterns in developed countries)

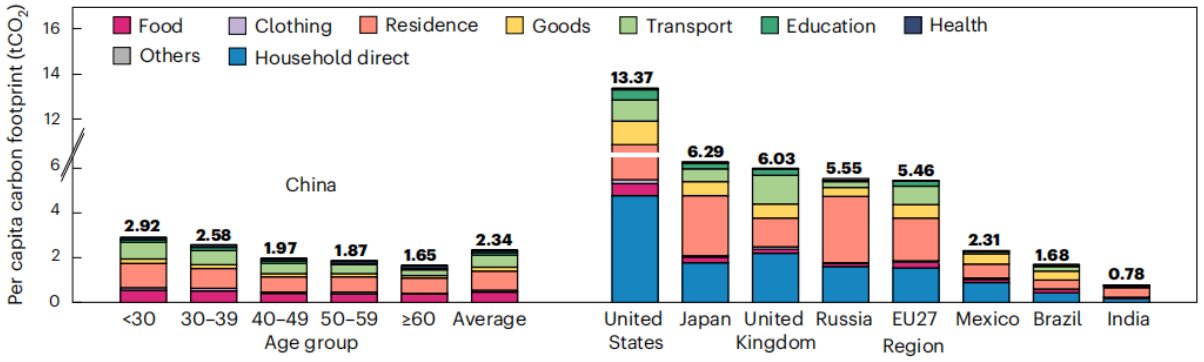
✓ Expenditure categories:

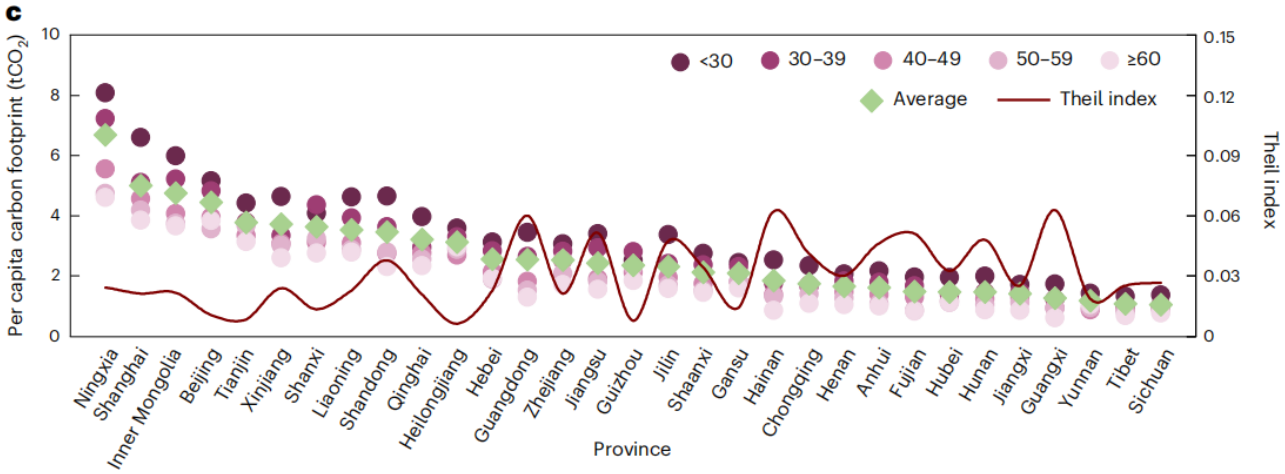
Residence, transport, and food → top three contributors

Clothing, goods and transport → decrease gradually with age

Health → increases gradually with age

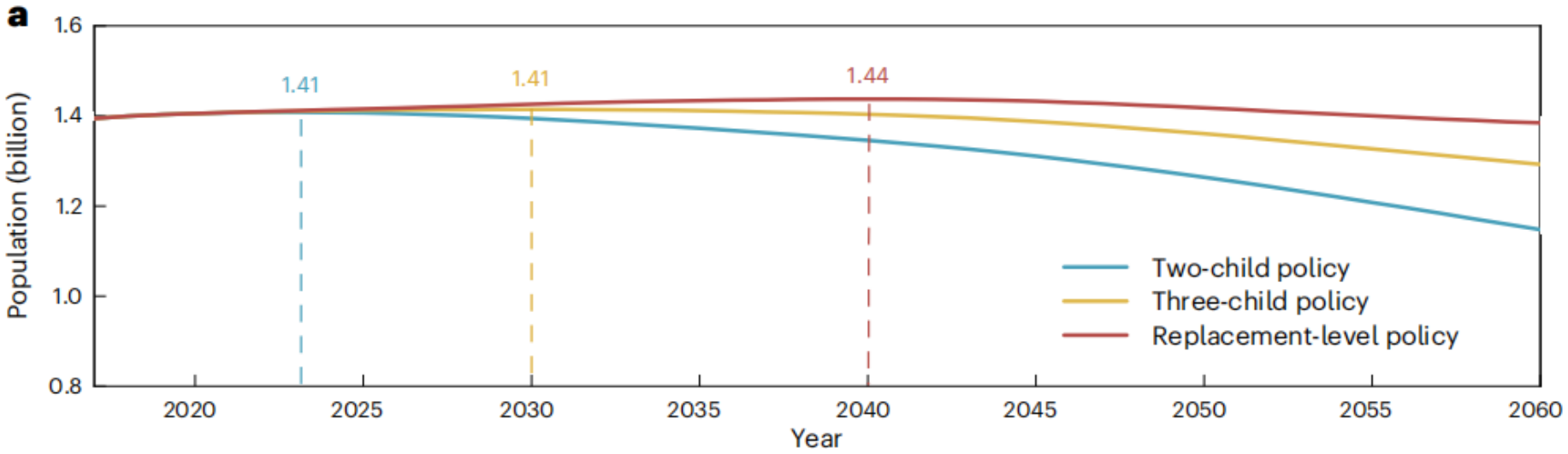
Education → increases until 30s to 40s, after which it decreases





Results and Discussions

- **Fertility and retirement policies**
  - **Peak year**
    - ✓ two-child policy: 2023
    - ✓ three-child policy: 2030
    - ✓ replacement-level policy: 2040
  - **Population size (2060)**
    - ✓ two-child policy: 1.15 billion
    - ✓ three-child policy: 1.30 billion
    - ✓ replacement-level policy: 1.39 billion



Results and Discussions

- **Fertility and retirement policies**

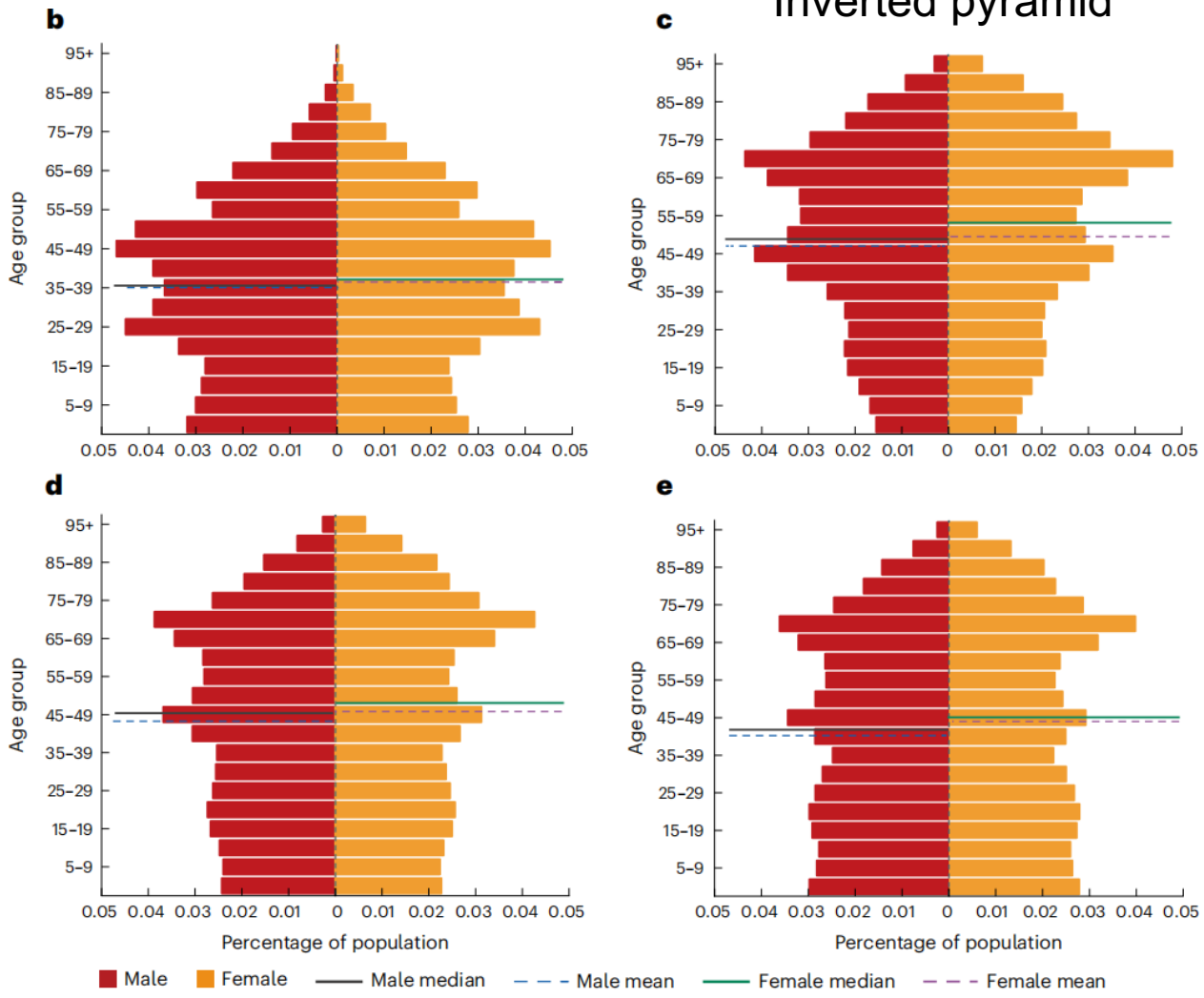
  - **Impacts on population**
    - ✓ **Proportion of older people (≥60) (2060)**

      two-child policy: 42%

      three-child policy: 37%

      replacement-level policy: 35%

Inverted pyramid



Results and Discussions

- **Fertility and retirement policies**

➢ **Impacts on carbon footprint**

✓ **Total carbon footprints (2060)**

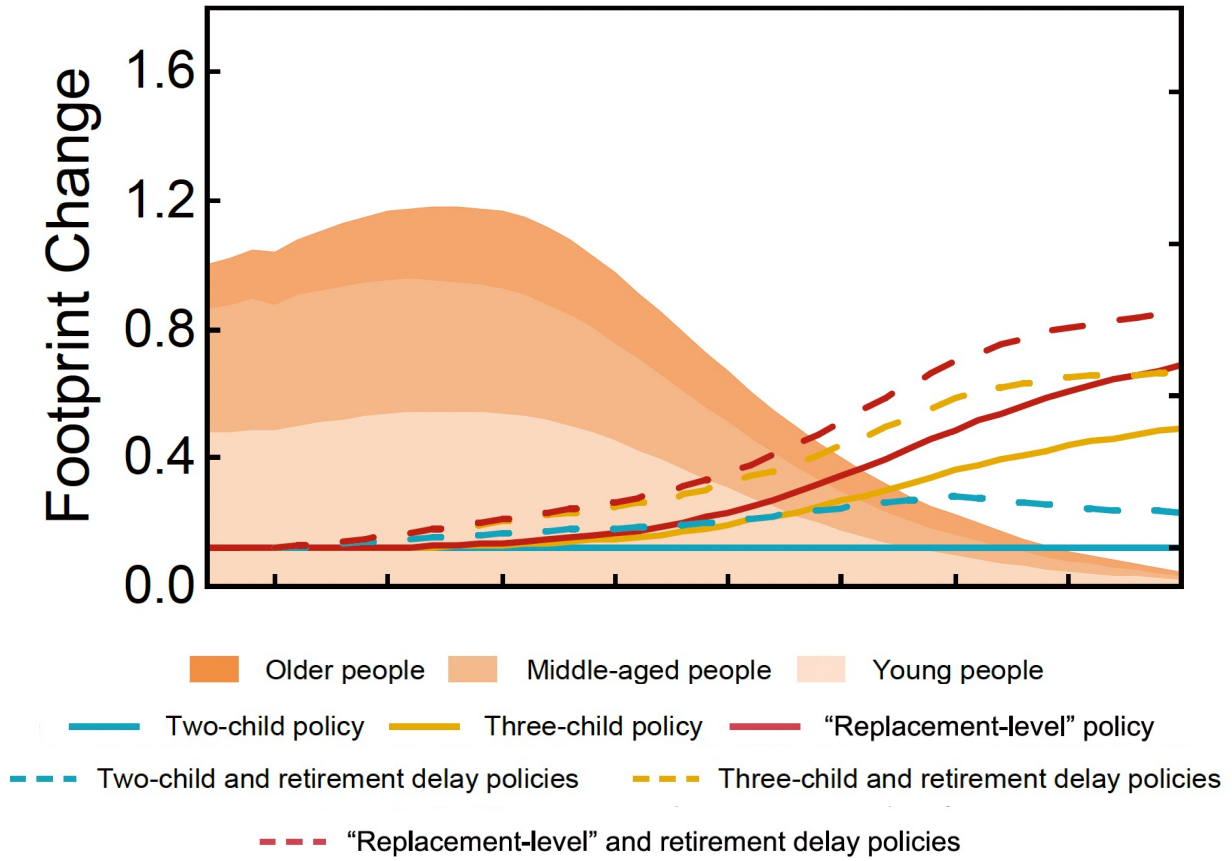
fertility policies: 21-35% ↑

retirement policy: ~3% ↑

✓ **Per capita carbon footprints (2060)**

fertility policies: 8-12% ↑

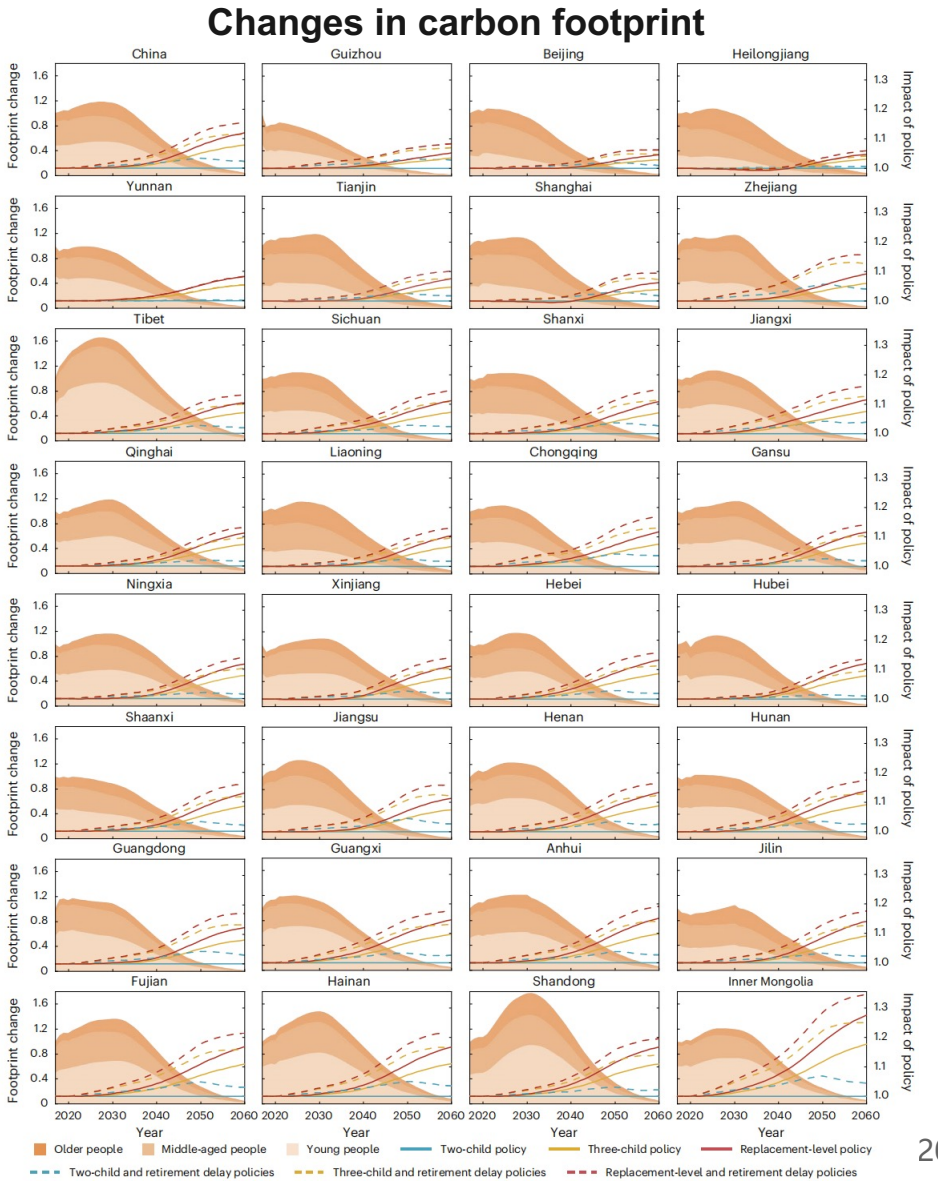
retirement policy: ~3% ↑



Results and Discussions

- **Fertility and retirement policies**

  - **Regional impacts vary**: the provinces with higher Theil index are more sensitive to changes in fertility policies (in terms of larger changes in per capita carbon footprints).
  - In **Inner Mongolia**, which has the highest Theil index in 2060, changing fertility policies are projected to increase its average per capita carbon footprint by 18-28%.
  - In **Guizhou**, which has the lowest Theil index in 2060, changing fertility policies are projected to increase its average per capita carbon footprint by only 4-5% .



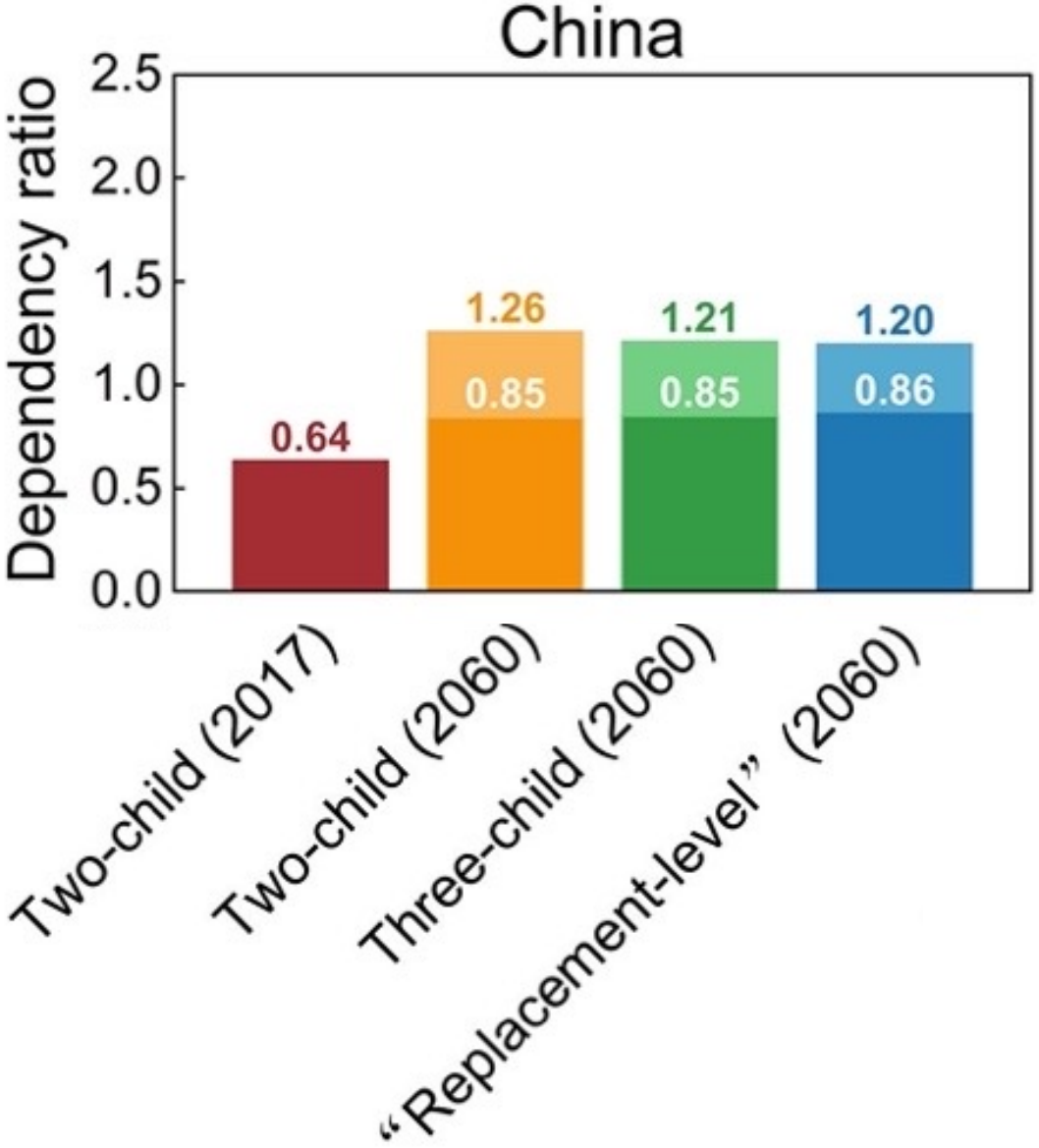
Results and Discussions

- **Fertility and retirement policies**

  - **Impacts on dependency ratio**
    - ✓ **Dependency ratio (2017)**: 0.64
    - ✓ **Dependency ratio (2060)**

      fertility policies: 4-5% ↓

      retirement policy: 28-33% ↓



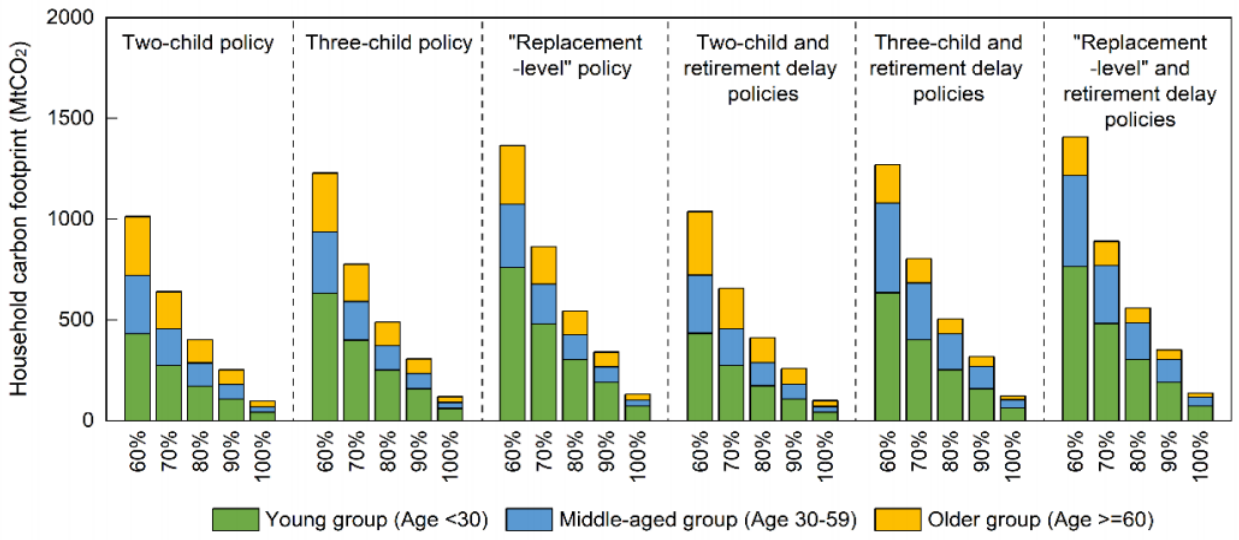
Results and Discussions

- **Scenarios of climate targets**

What might happen if climate target (carbon neutrality) is not reached?

We assume that China achieves a 60%, 70%, 80%, 90% or even 100% reduction in carbon intensity.

Household carbon footprint by age group in 2060 under different mitigation targets



- More optimistic target -> fewer carbon footprint
- More optimistic target -> less policy impact

Our major findings regarding household carbon footprints and the impacts of fertility and retirement policies do not change very much. This verifies the accuracy of our estimates, which might rely little on the climate target.

Contents

Conclusions

- **Main findings:**
  - **Younger people** in China tend to have higher household carbon footprints due to greater income and consumption.
  - Relaxing fertility policies and delaying retirement age are projected to **increase household carbon footprints** in China, most of which come from the fertility side.
  - The impacts of the policy changes seem to be greater in regions where **disparities in income and consumption** among different age groups are larger.
  - The result provides evidence of **interactions** between the policies targeting population aging and climate change, highlighting the importance of synergizing these two types of policies.

Conclusions

- **Policy recommendations:**
  - Promoting greener consumption and sustainable lifestyles, particularly among **young people**, is an effective measure to reduce household carbon footprints in China.
  - Reducing **income and consumption disparities** between age groups could alleviate the impacts of fertility and retirement policies on household carbon footprints.
  - **Delaying retirement** can considerably lower **dependency ratios**, although it may increase household carbon footprints.
  - Policymakers need to consider the **synergy** between policies addressing population aging and those addressing climate change.

Thanks.

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