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The Greenness of Pakistani Cities:
Urban Growth and Household Carbon Emissions

Syed Hasan* and Wendong Zhang**

*: Department of Economics
Lahore University of Management Sciences
Syed.hasan@lums.edu.pk

**: Department of Economics
Iowa State University, Ames, IA, 50010, USA.
wdzhang@iastate.edu

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The Greenness of Pakistani Cities: Urban Growth and Household Carbon Emissions

Syed Hasan* and Wendong Zhang**

*: Department of Economics, Lahore University of Management Sciences, Pakistan; **: Department of Economics, Iowa State University

Objective

Urban growth on unsustainable trajectory, may lead to substantial environmental problems such as air pollution and sharp rise in greenhouse gas (GHG) emissions. This issue is significant for developing countries which often lack adequate and cost-efficient abatement technologies and conducive economic and political institutions.

Previous literature: Linkages between urban growth and climate change impacts have been recently examined for cities in the US (Glaeser and Kahn 2010), China (Zheng et al. 2011), and India (Ahmad et al. 2015) using household-level data.

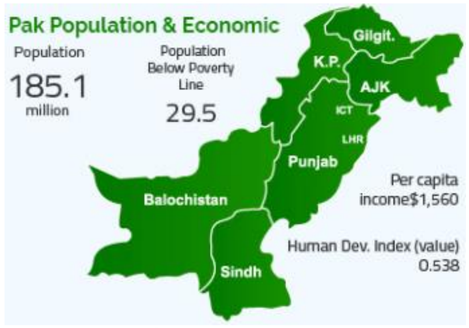
Literature Gap: previous studies rely on one single year's household survey data, thereby providing a snapshot of GHG emissions across cities.

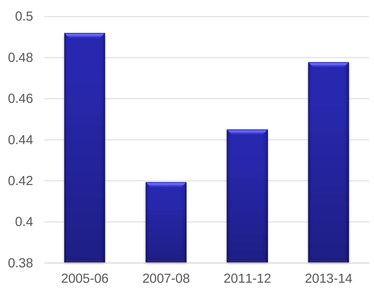
The primary objective of this project is, for the first time and using household level data from multiple years of surveys, to quantify the impacts of urbanization and city growth in Pakistan on greenhouse gas emissions and its changes over time.

We use multiple year data to explain how urban growth affect carbon emissions: for example, how changes in industry composition, demographic shifts and implementation of green city policies resulted in different trajectories in GHG emissions.

Why Pakistan?

Per-capita Pakistani CO_2 Emissions in Metric Tons 2005-2014





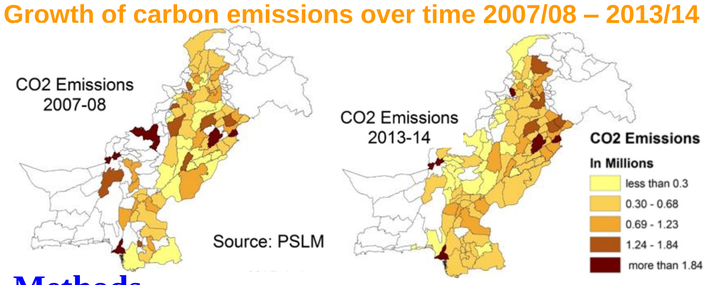
Being the 6th most populated country in the world, Pakistan has the highest population growth rate among all South Asian countries where city dwellers constitute 38% of the population, with estimates that half of the country's population will be living in urban areas by 2025 (World Bank 2016).

Data - Pakistan Social & Living Standards Measurement (PSLM) micro-level data 2005/06; 2007/08; 2011/12; 2013/14

- **Coverage**: The survey is conducted in alternate years and covers all urban areas in Pakistan and roughly 40 % of all households that live in cities.
- **Characteristics**: demographic characteristics, household income, and **energy consumption, assets and expenditures -** private car ownership, cooking fuel, lighting fuel, insulation material, transportation mode, as well as household expenditure on fuel & lighting, and transportation.

Data and Study Region

Growth of carbon emissions over time 2007/08 – 2013/14



Methods

We follow Glaeser and Kahn (2010) & Zheng et al. (2010)

- **Step 1: predict energy consumption for each district and each energy type using household level data**
  - ✓ Heckman selection model
  - ✓ electricity, natural gas, petrol, firewood, charcoal, dung cake, kerosene oil; transportation fuel
- **Step 2: convert predicted energy consumption for standardized household to carbon emission**

  emissions = a1* electricity + a2 * cooking/lighting fuel + a3* transportation
  - ✓ emission conversion factors from FAO
  - ✓ aggregated carbon emissions by city, energy type, year using survey weights
- **Step 3: use district-level panel data to explain cross-city differences in household carbon emissions**
  - ✓ Socioeconomic: average household size, income, % new rural migrants, % GDP from industries; population growth
  - ✓ Geographic: July/Jan temp, distance to coast, proximity to China & India & inter-country growth pathway, total land area

Policy Implications and Future Work

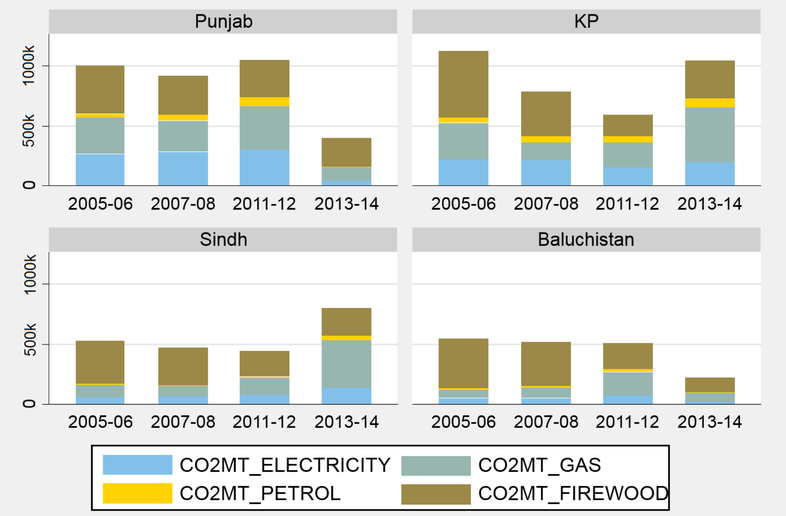
- **Evaluate impacts of discrete policy changes**
  - ✓ Energy deficit 2008-2015 in electricity and natural gas, more significant in rural areas → increase in biofuel and firewood use in rural areas
  - ✓ 2012 environment protection responsibility decentralized to cities to promote greener policies
- **Policy evaluation using district-level panel data**
  - ✓ Regress changes in predicted carbon emissions over time on various city-level characteristics
  - ✓ Could evaluate changes in % GDP from fossil-fuel consuming industries, policies that promote public transit
  - ✓ Also analyze distributional impacts of urbanization and climate change: rural migrants sorting into high-emission cities? Does smaller, lower-income cities emit more?

Results

How carbon emissions vary by household characteristics?

VARIABLES	Electricity	Natural Gas	Petrol	Fire wood	Kerosene oil	Char-coal	Dung cake
Log(Age)	0.303***	0.130***	-0.0395	0.107***	0.0720***	-0.211	0.0995***
Log(income)	0.180***	0.207***	1.007***	-0.071***	0.0618***	0.173	0.163***
Log(hhsize)	0.146***	0.183***	-0.231***	0.504***	0.174***	0.455	0.0774***
Log(MaxTemp)	-5.890***	4.115***	5.393***	0.192	-0.513*	-8.835	-3.594***
Constant	25.32***	-11.25***	-26.61***	6.470***	4.516***	38.50	18.79***
Observations	52,853	22,426	15,414	30,230	9,361	44	13,081
R-squared	0.117	0.171	0.300	0.107	0.039	0.175	0.049

Predicted Carbon Emissions by Province and Energy Types



Graphs by province

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