Effects of Urban Land-Use Regulations on Greenhouse Gas Emissions

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Overview

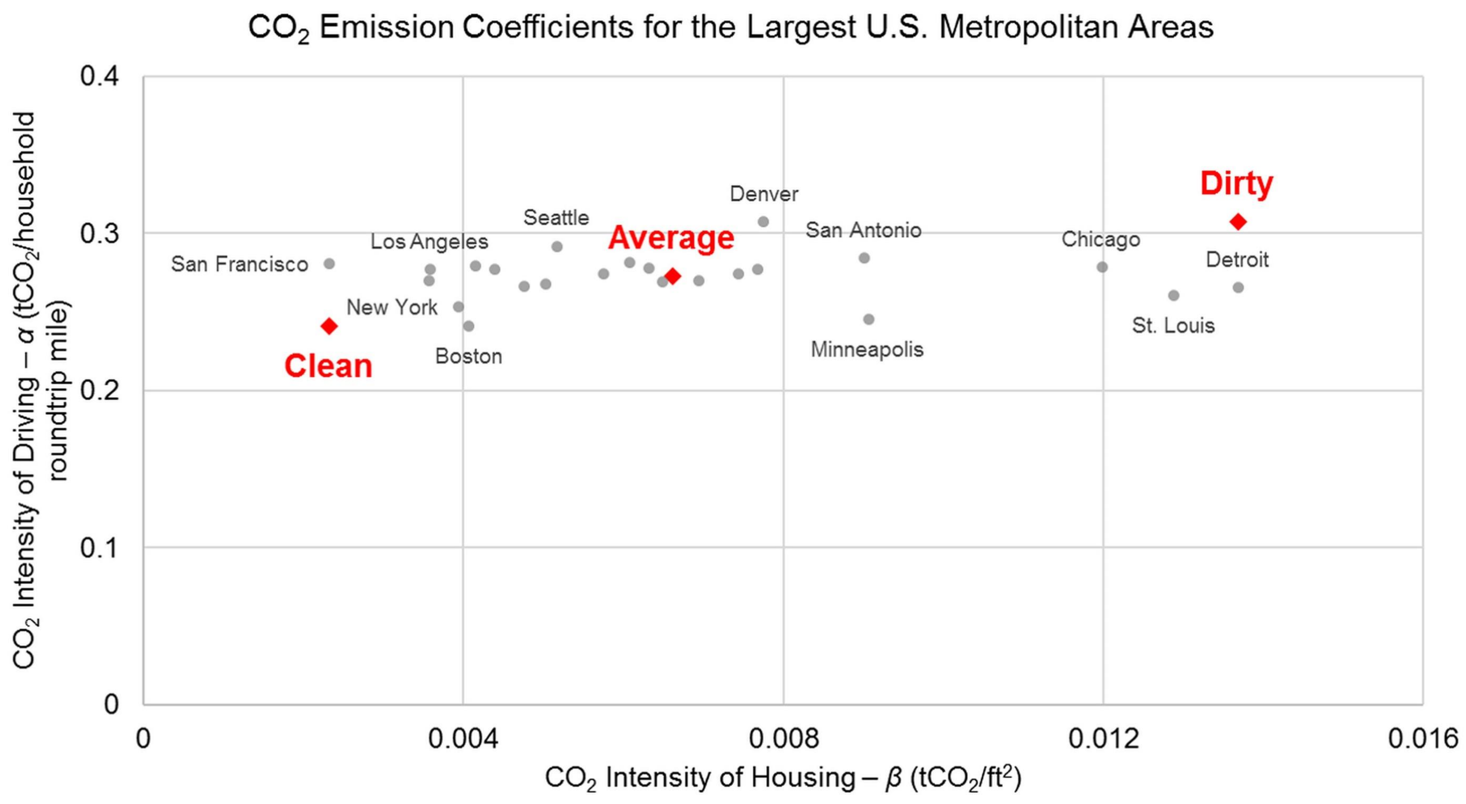
- This study is a **model-based exploration** of the **greenhouse gas (GHG) emissions** and **welfare** impacts of **urban land-use regulations**.
- Considers two types of regulation:
  1. **Floor area ratio (FAR) restriction**
  2. **Urban growth boundary (UGB)**
- Addresses three key questions:
  1. Under what circumstances will urban land-use regulations **reduce emissions**?
  2. When they do reduce emissions, what will be the **abatement cost** borne by consumers due to higher housing prices?
  3. What **factors** do these outcomes most critically depend on?

Literature Review

- More **compact urban forms** are associated with lower GHG emissions (Grubler et al., 2012).
  - In **transportation**, higher population densities tend to shorten commutes and enable public transit (Kennedy et al., 2011; Lohrey and Creutzig, 2016; Marshall, 2008).
  - In the **residential sector**, homes in denser cities are typically smaller and more likely to be part of multifamily buildings, which use energy more efficiently (Ewing and Rong, 2008; Kennedy et al., 2011).
- Efforts to **limit urban sprawl** could potentially make significant contributions to mitigating climate change (Hankey and Marshall, 2010; Marshall, 2008; Stone et al., 2009).
- However, land-use regulations often **raise real estate prices**, thus **shifting development** to relatively cheaper places that could have higher GHG emission intensities.
- "*Land-use restrictions, often allegedly implemented for environmental reasons, may be having the ironic effect of moving development from low emissions places, like California, to high emissions places, like Texas ... It is certainly possible that land-use restrictions are actually pushing people away from lower emission areas into higher emission areas. This topic seems to merit future research*." (Glaeser and Kahn, 2010)

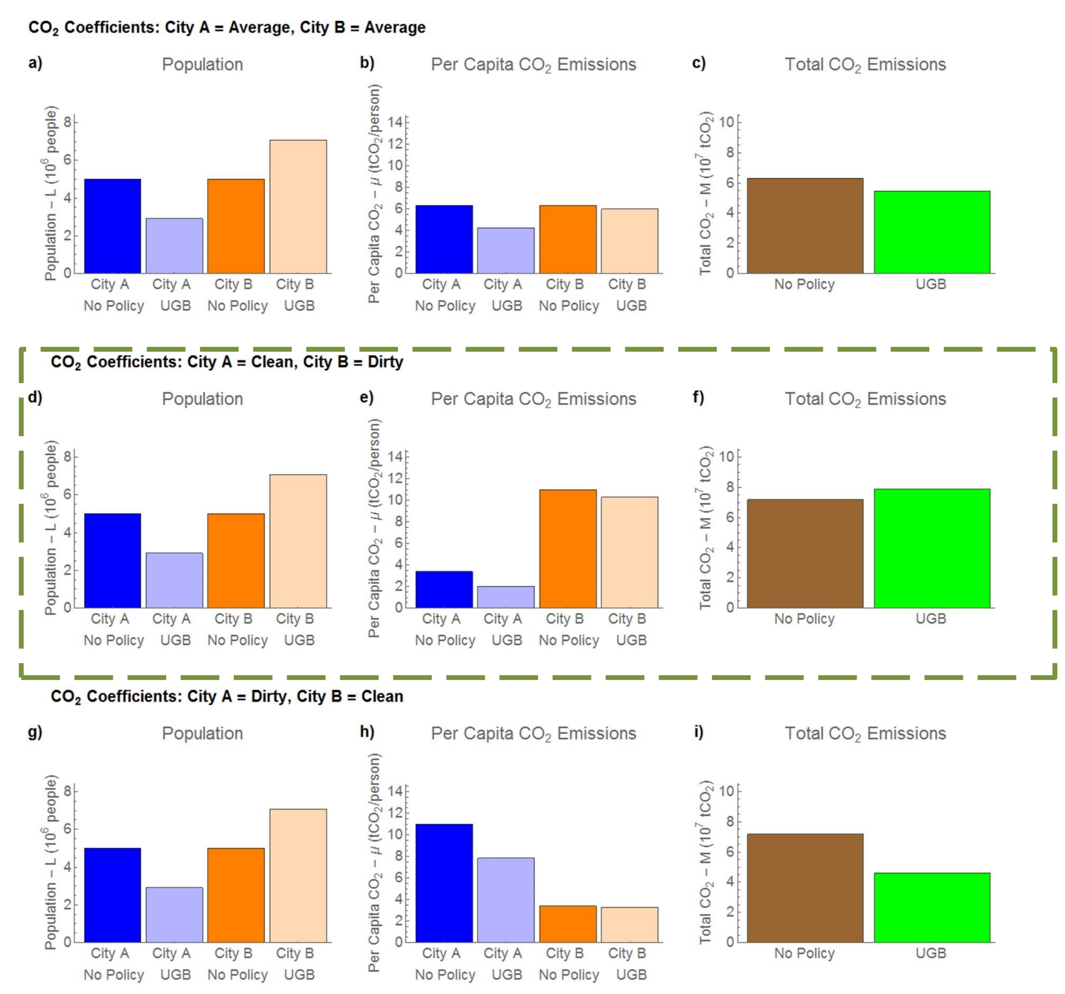
Methodology

- Extend the well-known **monocentric city model** (Alonso, 1964; Mills, 1967, 1972; Muth, 1969) to a context with **two cities** and regulation-induced, **inter-city migration**.
- The **urban spatial structure equilibrium** endogenously adjusts to the implementation of a land-use regulation, both within each city and across the two of them.
- For each resulting urban equilibrium, compute total and per-capita GHG emissions produced by transportation and housing.
- In cases where a regulation reduces emissions, estimate the GHG abatement cost by converting the change in household utility to monetary terms using **compensating and equivalent variation**.

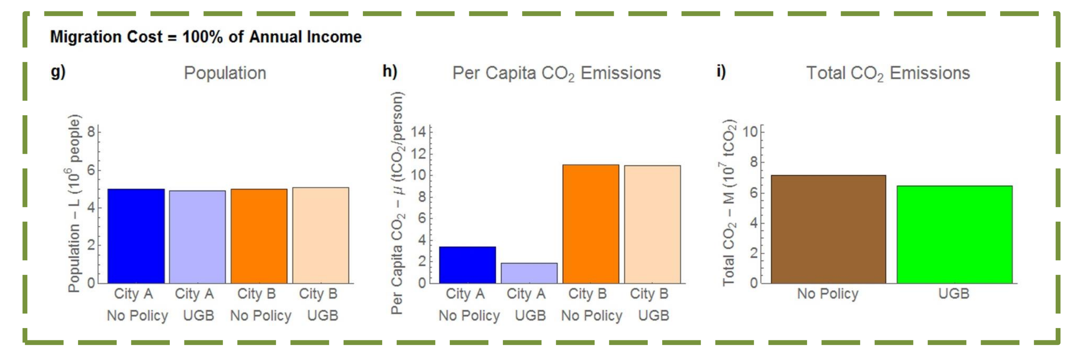


Results

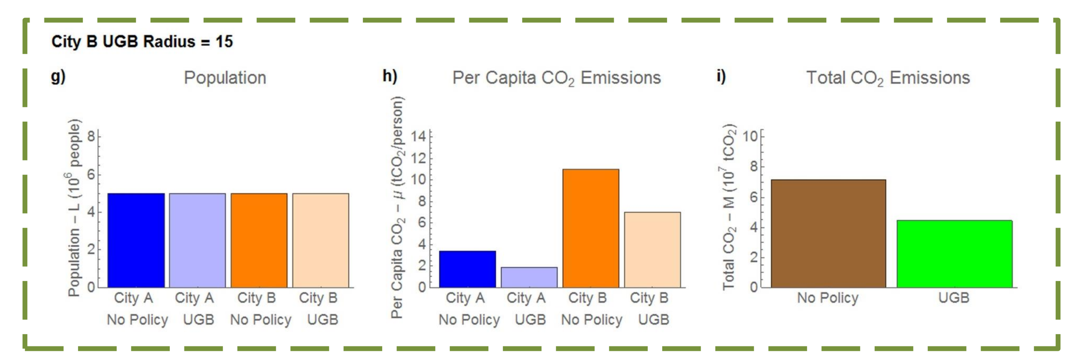
- A **UGB can increase emissions** if it is implemented in a relatively clean city and induces inter-city migration to a relatively dirty city.
- This occurs even though per-capita emissions decline in both cities.



- This outcome is less likely to occur if **migration is more costly**.



- Land-use regulation is more likely to reduce emissions if it is **universal**, rather than implemented in select cities.

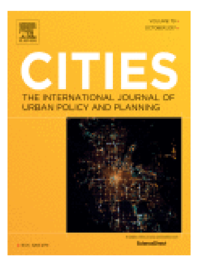


- Even when UGBs reduce GHG emissions, they carry **high abatement costs** because consumers suffer from higher housing prices.

City A CO_2 coefficients	City B CO_2 coefficients	Model variation	CO_2 abatement cost ($/t$CO_2$)
Average	Average	Basic model	1127–1233
Clean	Dirty	Basic model	(1348–1474)
Dirty	Clean	Basic model	365–399
Average	Average	Costly migration (50%)	1072–1187
Clean	Dirty	Costly migration (50%)	72,273–79,999
Dirty	Clean	Costly migration (50%)	483–535
Average	Average	Multiple trans. modes (10,20)	1036–1133
Clean	Dirty	Multiple trans. modes (10,20)	(1542–1686)
Dirty	Clean	Multiple trans. modes (10,20)	357–390
Average	Average	Regulation in both cities (30)	869–1019
Clean	Dirty	Regulation in both cities (30)	2372–2783
Dirty	Clean	Regulation in both cities (30)	467–548

Conclusions

- Cities with relatively low GHG emission intensities should be **cautious about using smart growth regulations for climate change mitigation**, since this approach can actually increase emissions by shifting development to more emission-intensive places.
- Even when they do reduce total emissions, smart growth controls are an **expensive** way of doing it. Based on most social cost of carbon estimates, climate change mitigation benefits only **justify a small fraction of the costs** they impose via higher housing prices.



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