

Tropical Deforestation

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Why we care

① Climate change

- Direct carbon emissions
- Loss of carbon sinks

② Measurement revolution

- Satellite imagery (Donaldson & Storeygard 2016)
- Empirics (Deschenes & Meng 2018)

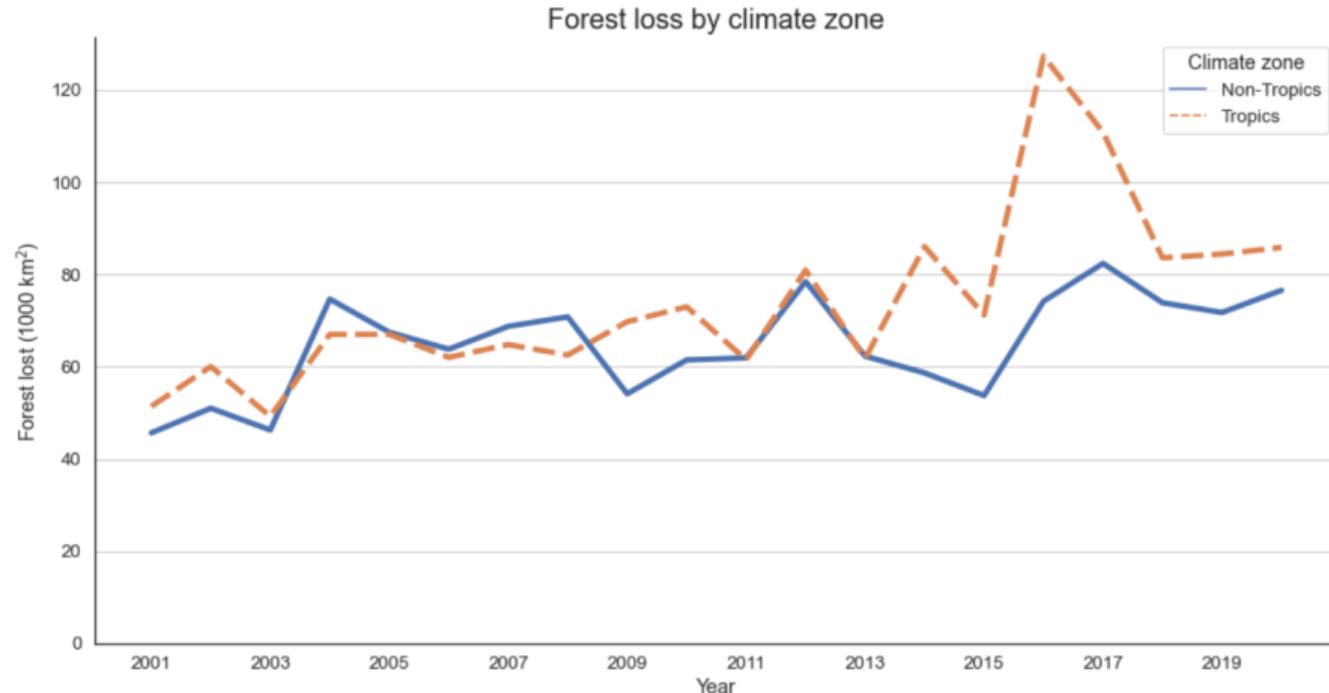
Global emissions, 1990-2019 (Gt/yr CO₂)

| Country | Total | Forest |
|---------|--------------|--------|
| China | 7.07 | -0.44 |
| USA | 5.92 | -0.38 |
| EU | 3.69 | -0.33 |

| Country | Total | Forest |
|-----------|-------|---------------|
| Brazil | 1.71 | 0.85 |
| Indonesia | 1.44 | 0.73 |
| DRC | 0.50 | 0.46 |

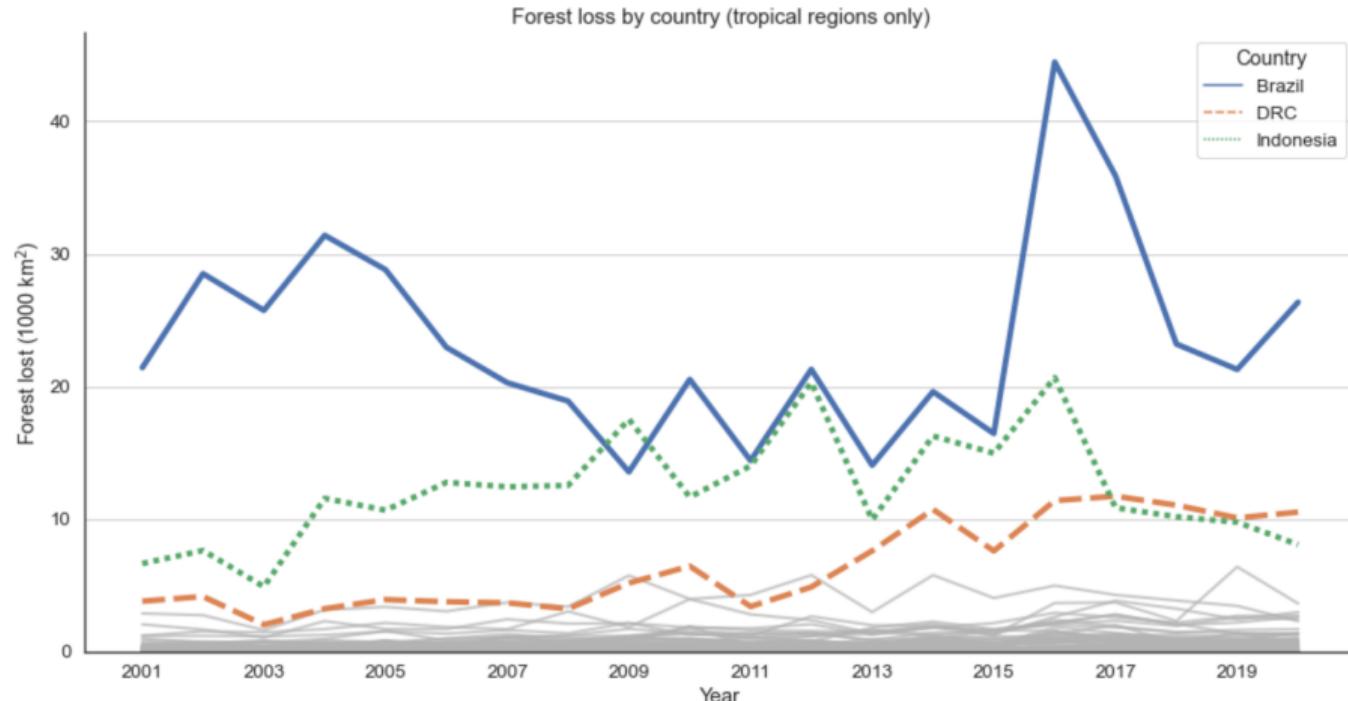
Data: Climate Watch

Tropical deforestation, 2001-2020



Data: Hansen Global Forest Change

Tropical deforesters, 2001-2020



Data: Hansen Global Forest Change

Emissions vs. production, 1990-2019 (\$1T)

| Country | Deforestation emissions | Agricultural value |
|-----------|-------------------------|--------------------|
| Brazil | 2.55 | 1.68 |
| Indonesia | 2.19 | 2.54 |
| DRC | 1.39 | 0.16 |

Data: Climate Watch, World Bank
(\$100/t SCC, agriculture/forestry/fishing value added)

Large, global externalities

- Land use change is **14%** of CO₂ emissions (Global Carbon Budget 2019)
 - Land use change is 1.5 ± 0.7 Gt/yr (2009-2018)
 - Fossil fuels are 9.5 ± 0.5 Gt/yr
- Carbon targets relative to 2010 levels (IPCC 2018)
 - 2°C: 25% decline by 2030, net zero by 2070
 - 1.5°C: 45% decline by 2030, net zero by 2050

Measurement revolution

- Rich satellite data capturing deforestation
 - Over time and space
 - Including vegetation type and density
- For researchers
 - Within-country studies (not just cross-country)
 - Better measurement of externalities
- For regulators
 - Real-time monitoring technology
 - Including for global agencies

Indonesia

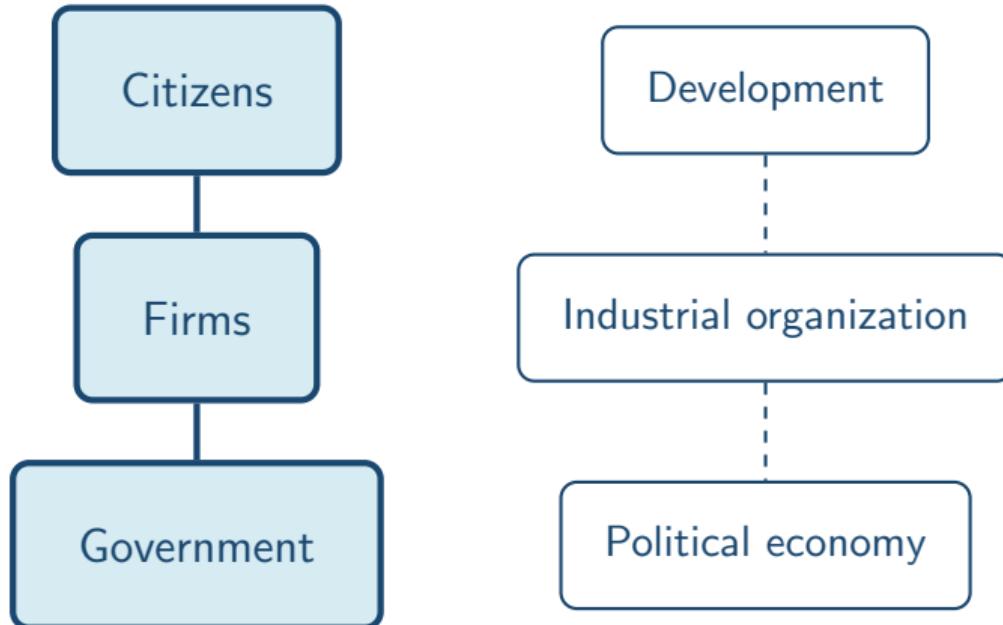
[Hsiao 2022, Hansen et al. 2013]

Outline

- ① What we know
- ② What is missing
- ③ What to do

What we know

An extraction equilibrium



Economic development drives deforestation

- Land use change for agriculture
 - Rather than for extracting resources like timber and minerals
 - Recurring revenue from exporting to world markets

[Roberts & Schlenker 2013, Scott 2013, Costinot et al. 2016, Sotelo 2020]

- Importance of poverty reduction
 - Industrial policy targeting agricultural production
 - Assets for individuals during lean times

[Jack & Jayachandran 2017, Jayachandran et al. 2017, Edwards 2019, Edwards et al. 2020, Jack et al. 2022]

Industrial organization and firm incentives affect regulation

- Industrial agricultural by large firms
 - Rather than small-scale production by individuals
 - Market structure determines profits of farmers vs. processors

[Bergquist & Dinerstein 2020, Chatterjee 2022, Dhingra & Tenreyro 2022, Domínguez-lino 2022, Méndez & Van Patten 2022, Rubens 2022, Zavala 2022]

- Firm behavior matters for the impacts of regulation
 - Want detailed firm-level modeling and microdata
 - Discrete choice over deforestation activities
 - Estimated elasticities differ with static vs. dynamic estimation

[Scott 2013, Souza-Rodrigues 2019, Assunção et al. 2021, Araujo et al. 2022, Hsiao 2022]

Political economy constrains regulation

- Winners vs. losers + implications for regulation
 - Local benefits, but global costs
 - Local voters, firms, and governments are aligned
 - Need transfers to address distributional effects

[Harstad 2012/2016, Harstad & Mideksa 2017, Harstad 2022]

- Infeasibility of first-best regulation
 - Corruption, electoral incentives, administrative constraints
 - Ill-defined property rights complicate Coasian bargaining

[Burgess et al. 2012, Balboni et al. 2021, Morjaria 2021, Dahis & Bragança 2022]

Trade policy can implement regulation

- Environmental regulation by trade policy
 - Direct regulation faces issues of sovereignty
 - Indirect regulation sidesteps local government

[Copeland & Taylor 1994, Antweiler et al. 2001, Kortum & Weisbach 2017, Shapiro 2021, Harstad 2022, Hsiao 2022]

- International coordination for international problem
 - Climate clubs to incentivize participation

[Nordhaus 2015, Böhringer et al. 2016, Farrokhi & Lashkaripour 2021]

Brazil

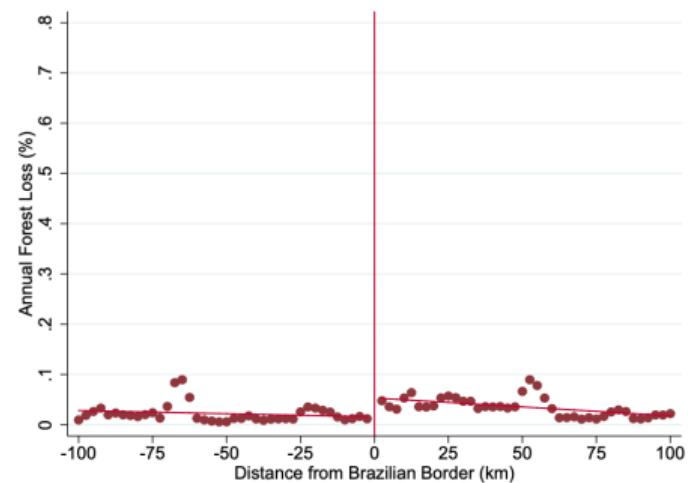


[Burgess et al. 2019, Hansen et al. 2013]

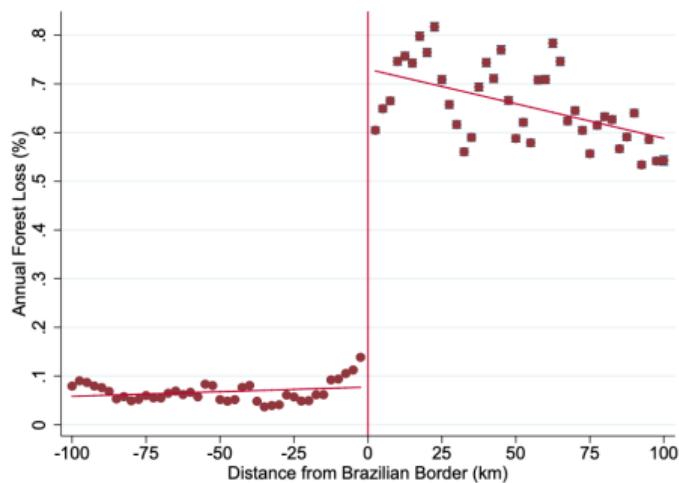
Brazilian forest loss

2001-2005

Protected areas



Non-protected areas

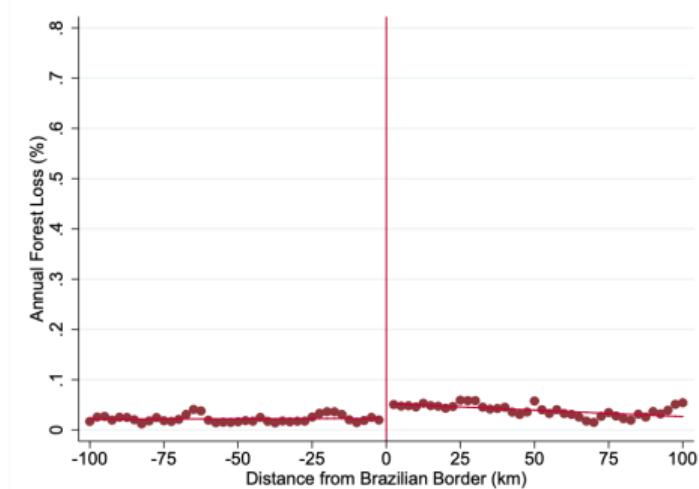


[Burgess et al. 2019]

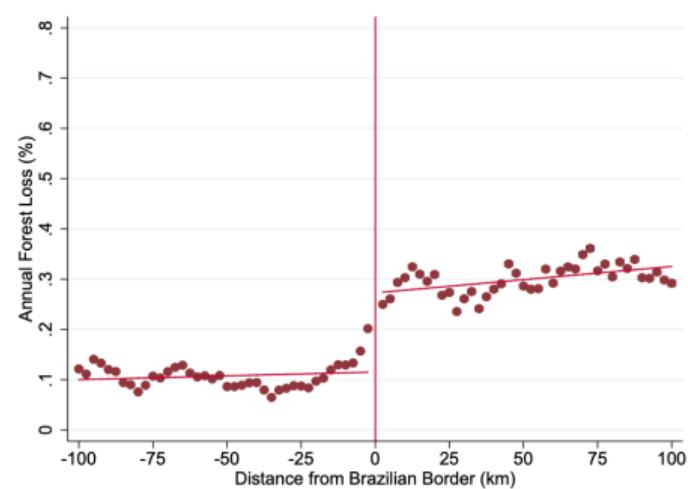
Brazilian forest loss

2006-2013

Protected areas



Non-protected areas

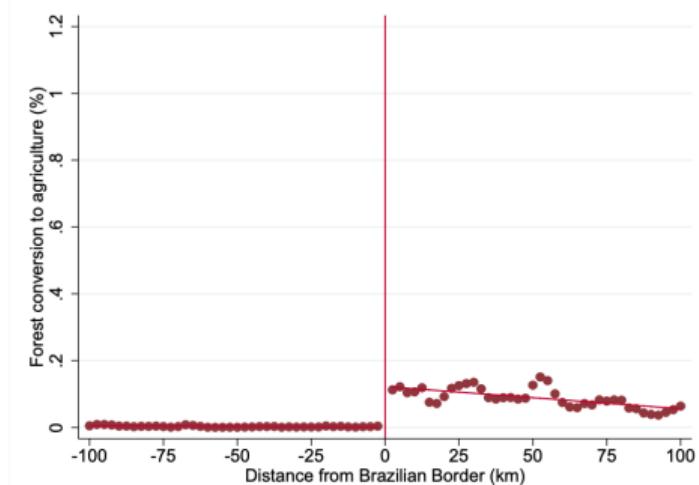


[Burgess et al. 2019]

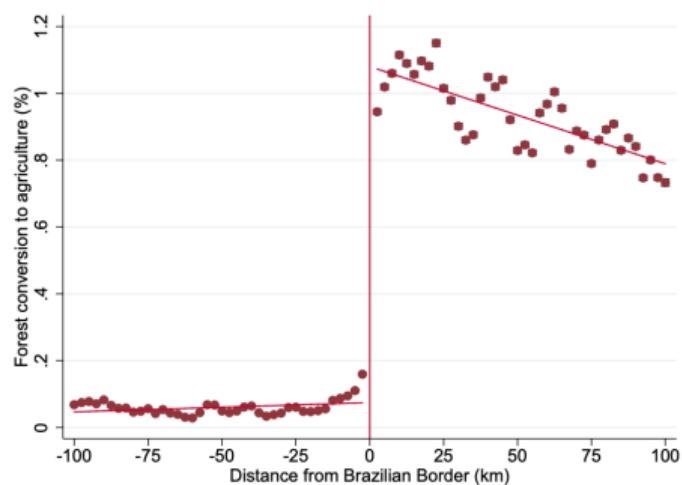
Brazilian agriculture

2001-2005

Protected areas



Non-protected areas

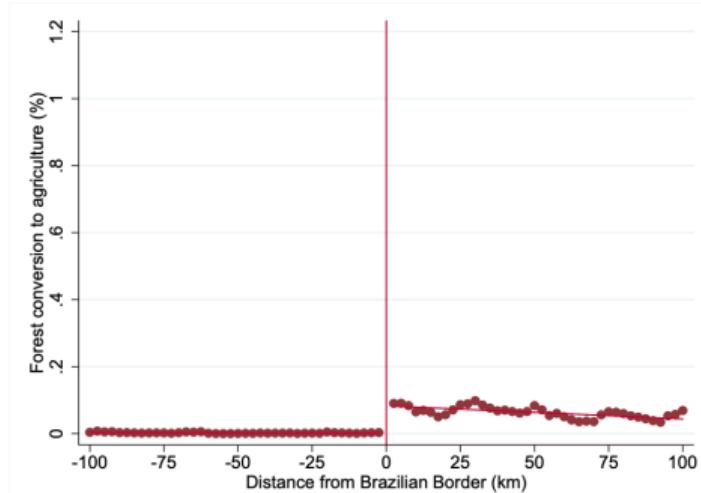


[Burgess et al. 2019]

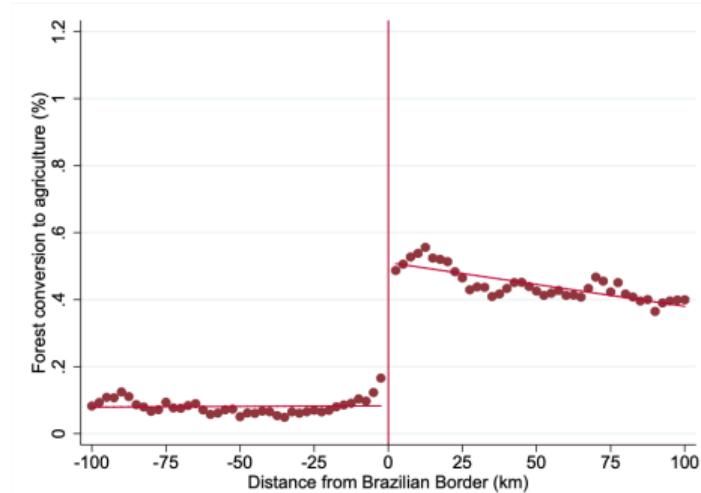
Brazilian agriculture

2006-2013

Protected areas



Non-protected areas



[Burgess et al. 2019]

What is missing

Development

- Weak local institutions
 - Property rights, corruption, and administrative capacity
- Agricultural industrial policy
 - Transition to non-resource-based economy, funded by forest
 - Urbanization, migration, and spatial path dependence in GE

- Missing data: Who is cutting?
 - Firm boundaries, customers, legality, revenues, and costs
 - Incentives for firms to monitor supply chains
- Market structure
 - More on intermediaries, but less on global supply chains

Political economy

- Political incentives
 - Regulatory resistance with votes, lobbying, and bribes
 - Political rotation generates dynamics
- Politically feasible regulation
 - Winners vs. losers, sticks vs. carrots, national vs. local

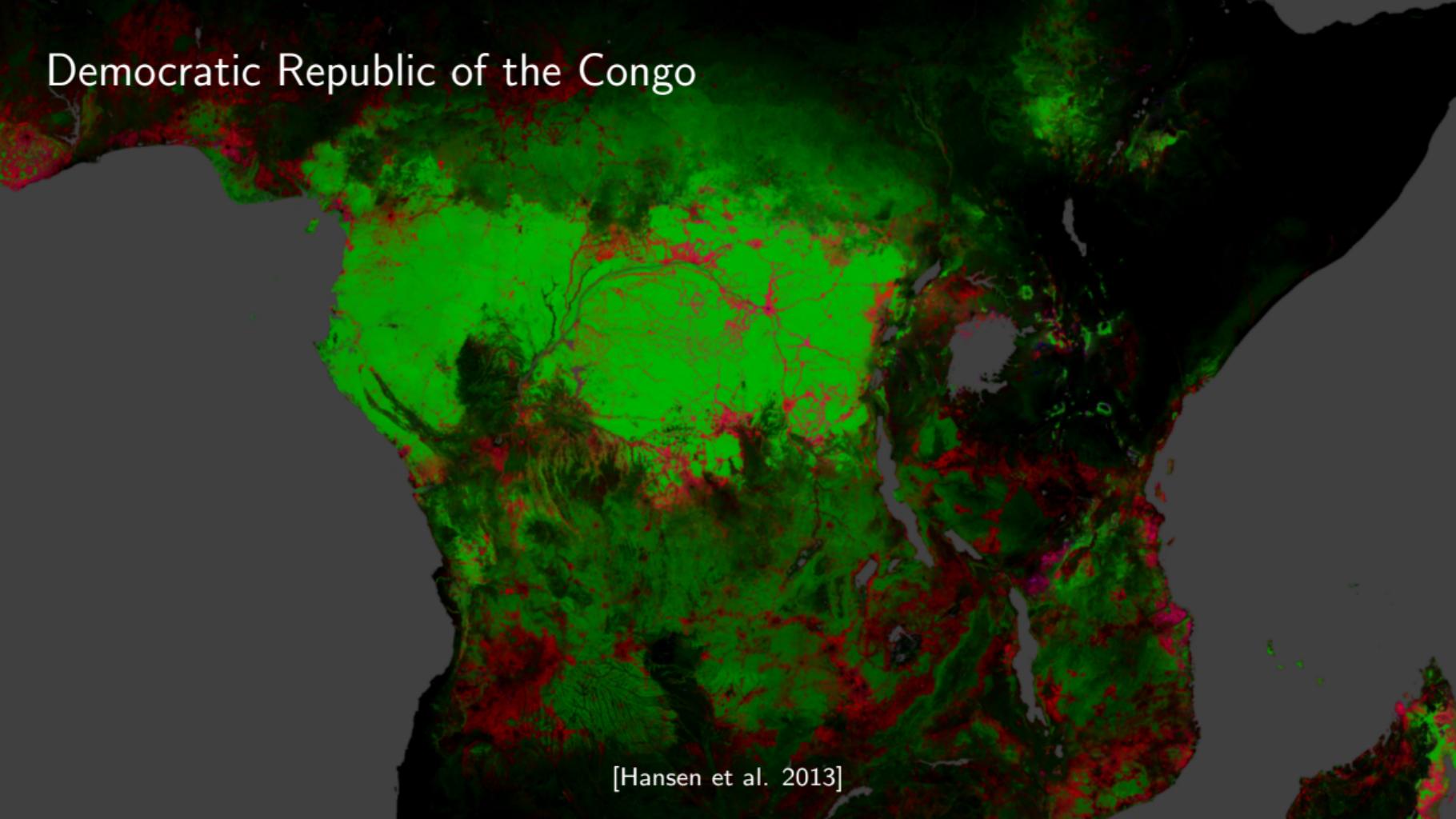
Trade

- Gains from trade
 - Offset/carbon markets, climate finance, and REDD+
- Regulation via trade
 - Trade policy, climate clubs, and border adjustment taxes

Other

- New data and models from science
 - Agronomy and land use change
 - Ecology and biodiversity
 - Hydrology and tipping toward desertification
 - Aerodynamics and particulates from burning
- New regions of focus
 - Congo, Papua, central Amazon

Democratic Republic of the Congo



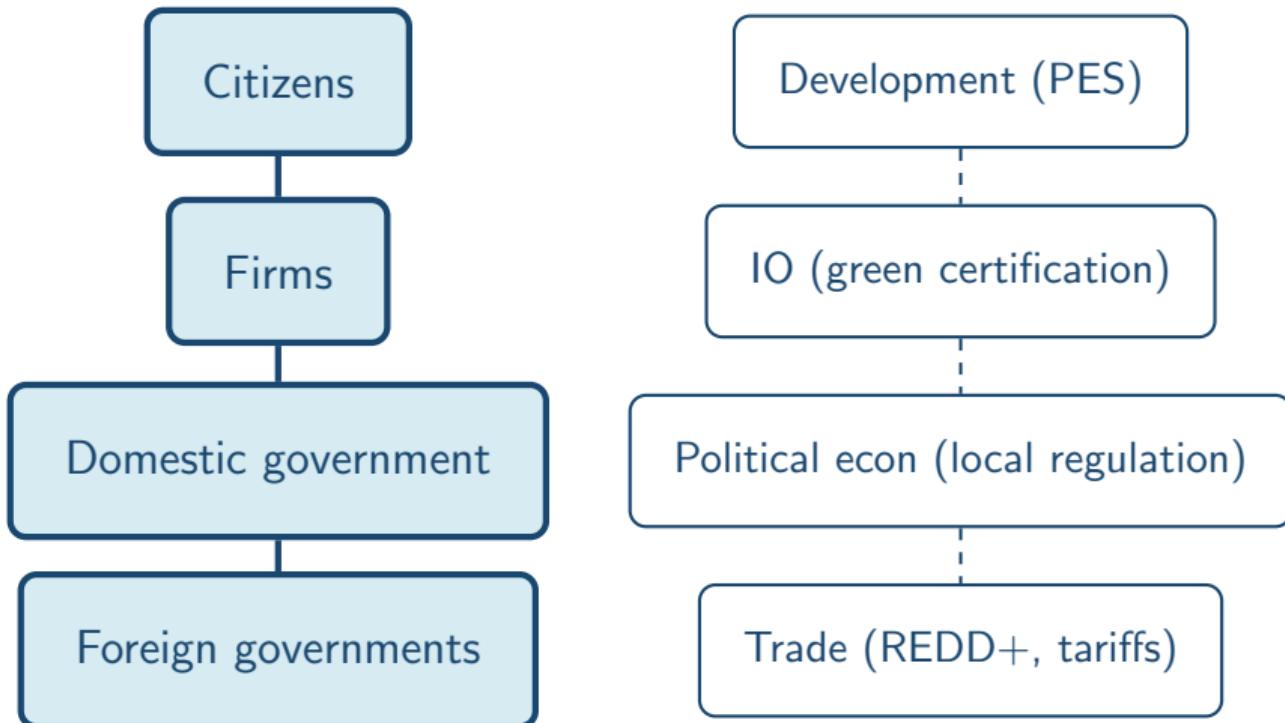
[Hansen et al. 2013]

Congo rainforest

- Second largest in the world
 - Absorbs 4% of global CO₂ emissions annually
- Congo Basin
 - Six countries and 75 million people
 - Deforestation from small-scale, illegal charcoal and mining

What to do

Moving toward a conservation equilibrium



Existing policies

- Local
 - Quantity regulation: protected regions, moratoria, quotas
 - Satellite monitoring
- Global
 - Paying landowners (PES)
 - Paying governments (REDD+)
 - Targeting demand (import tariffs, green certification)
- **Have these policies worked?**
 - What have they taught us?

New policies

- Scaling up
 - PES works individually, but may not at scale
 - Challenges of attribution, enforcement, and cost
- Price regulation
 - Direct taxation vs. carbon markets
 - Accounting for emissions heterogeneity
- **Can we propose new classes of policies?**
 - And evaluate them empirically?

We need a big push

- In economics
 - Taking seriously development and political economy concerns
 - Drawing on frontier methods from IO and trade
- In policy
 - Coordinated international action for an international problem
 - Compensation for domestic actors and building enforcement capacity