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)

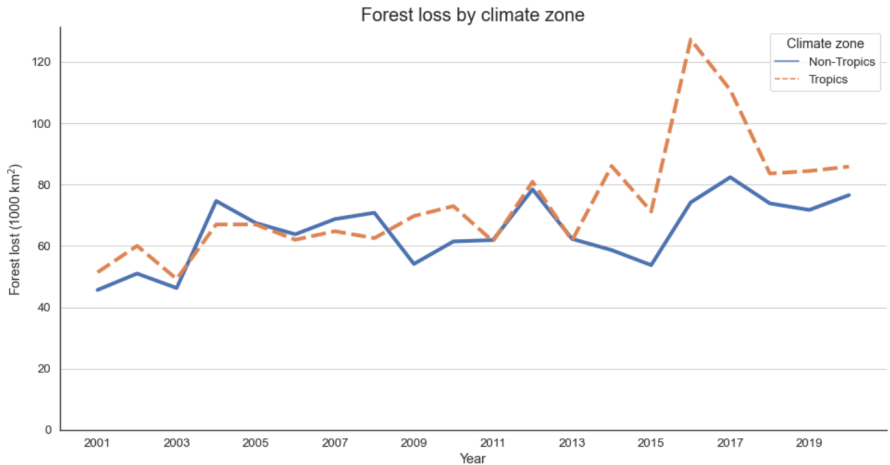
Global emissions, 1990-2019 (Gt/yr CO_2)

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

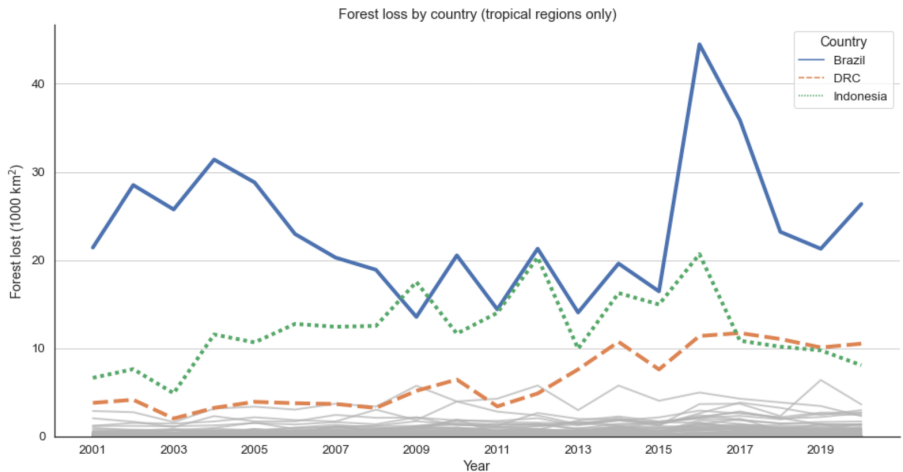
Data: Climate Watch

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

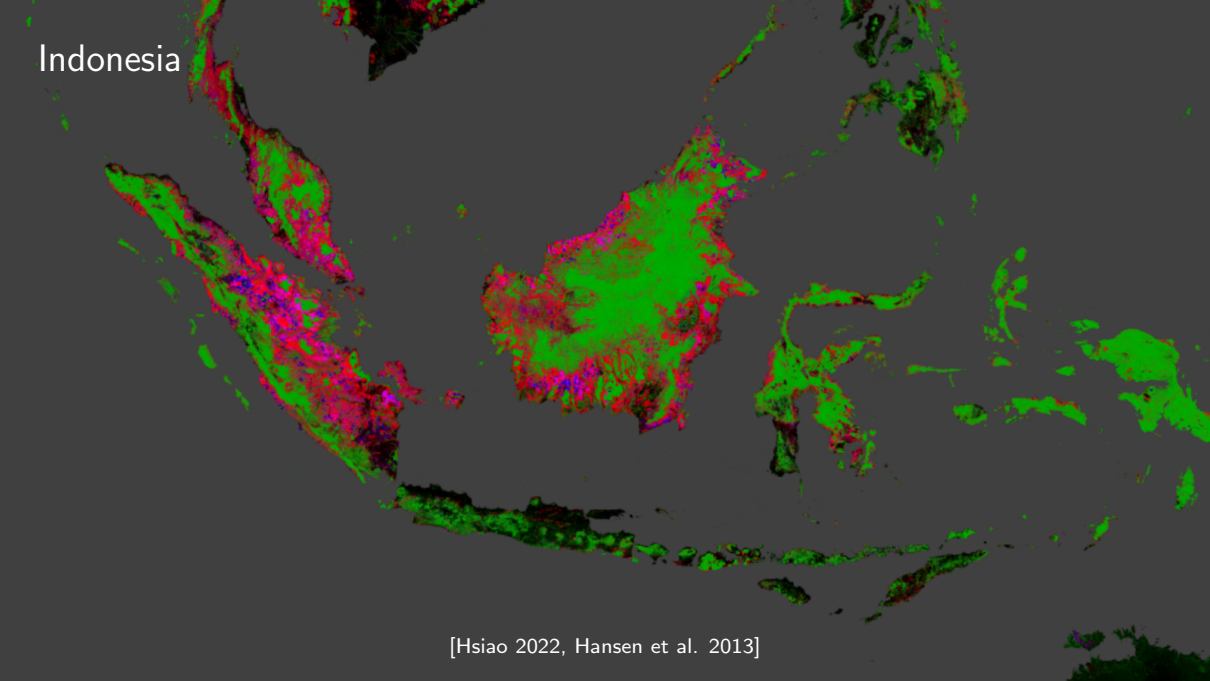
Data: Climate Watch, World Bank
($100/t SCC, agriculture/forestry/fishing value added)

Large, global externalities

- Land use change is **14%** of CO_2 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



[Hsiao 2022, Hansen et al. 2013]

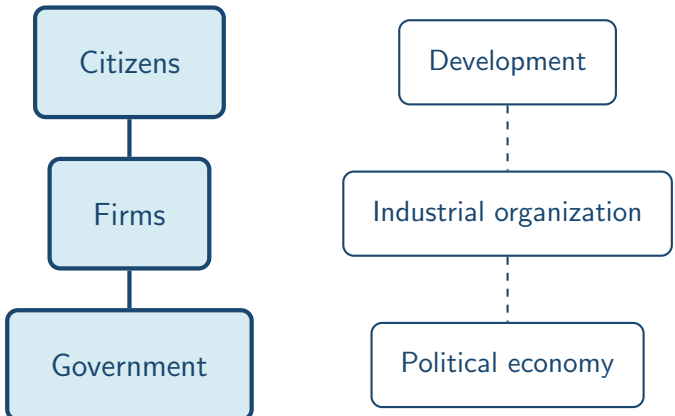

Sungai Trus
Sungai Trus

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-Iino 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

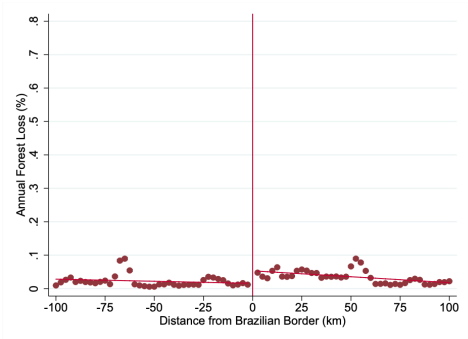
  [Nordhaus 2015, Böhringer et al. 2016, Farrokhi & Lashkaripour 2021]

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

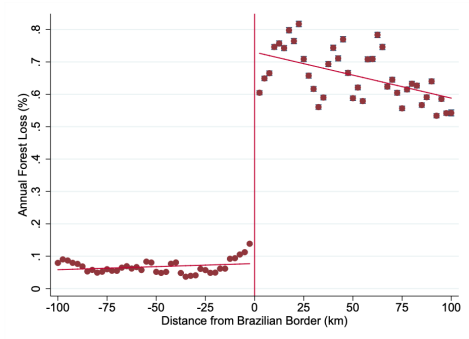
Brazilian forest loss

2001-2005

Protected areas



Non-protected areas

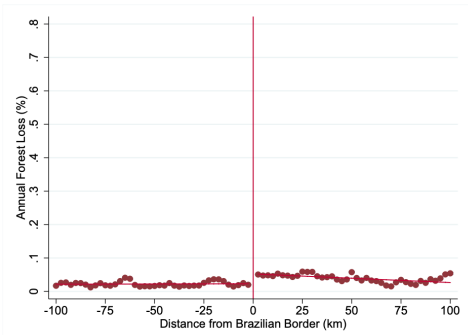


[Burgess et al. 2019]

Brazilian forest loss

2006-2013

Protected areas



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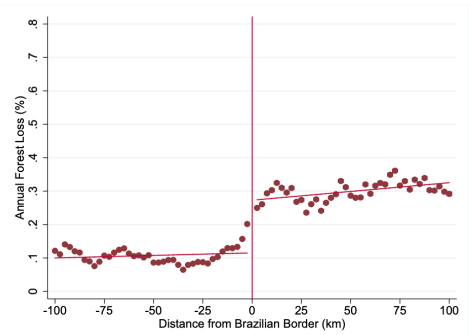
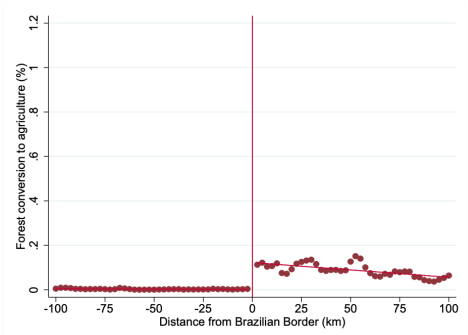


[Burgess et al. 2019]

Brazilian agriculture

2001-2005

Protected areas



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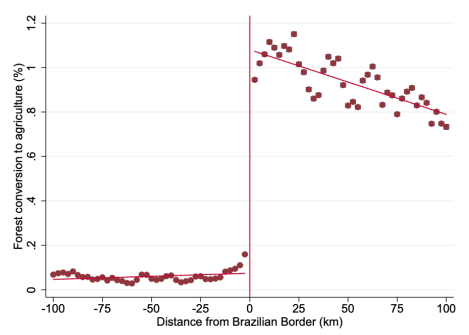

[Burgess et al. 2019]

Brazilian agriculture

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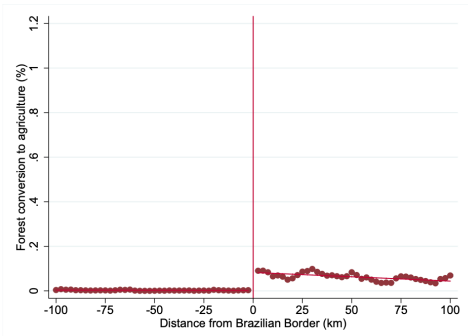

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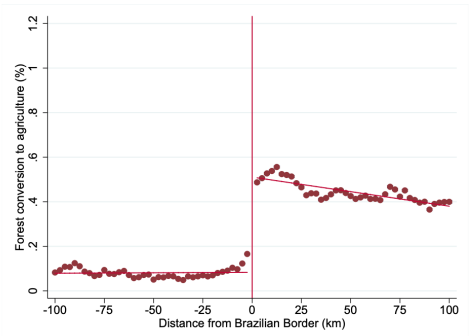


[Burgess et al. 2019]

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

IO

- 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

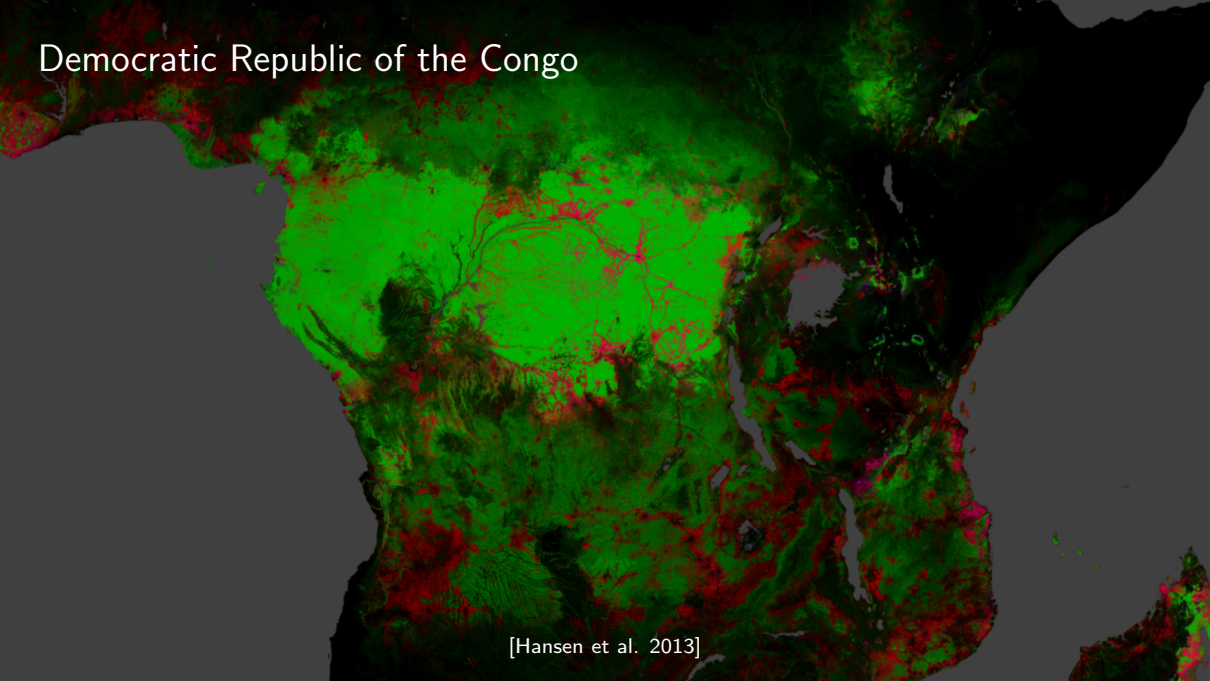
- Political incentives
  - Regulatory resistance with votes, lobbying, and bribes
  - Political rotation generates dynamics
- Politically feasible regulation
  - Winners vs. losers, sticks vs. carrots, national vs. local

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

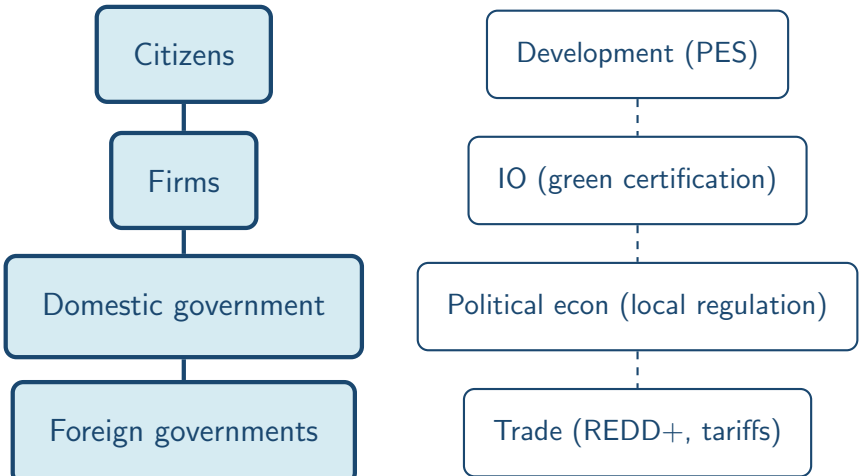

Democratic Republic of the Congo
[Hansen et al. 2013]

Congo rainforest

- Second largest in the world
  - Absorbs 4% of global CO_2 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