DOES FREE TRADE INCREASE DEFORESTATION? EFFECTS OF REGIONAL TRADE AGREEMENTS

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J. of the Assoc. of Env. and Res. Econ. 2019

Commented by L. Hotte (2023)

THE BIG ISSUE

- Deforestation in the developing world is a major problem.
- Expansion of agricultural land is considered a big driver.
- A lot of agri output is meant for exports.
- Does trade contribute to deforestation?

MORE SPECIFICALLY HERE

- Is there more deforestation associated with the enactment of regional trade agreements (RTAs) in developing countries?
- If so, what is the role of agricultural expansion?
- The authors argue that using RTAs, instead of standard measures of trade openness, are less prone to endogeneity issues. (More about this later.)

THE CONTEXT

NB A TYPICAL STRUCTURE FOR AN EMPIRICAL PAPER

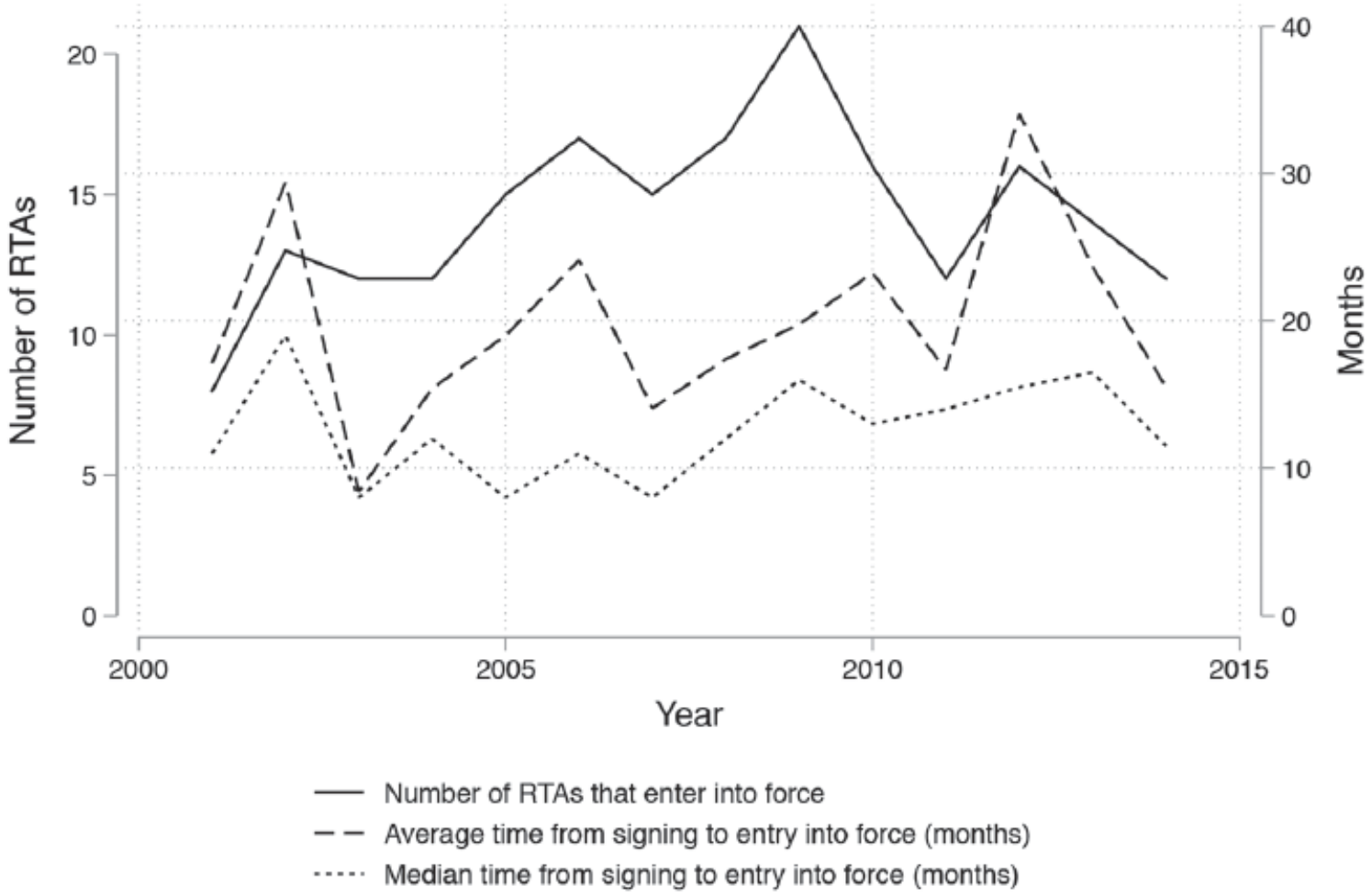
1. Issues in general terms
   - Sometimes a methodology issue (causality, etc) or new data
2. The more specific question(s)
3. Theoretical arguments
   - Anticipated effects; mechanisms
4. Context
   - Geography, period, individuals (firms, workers), socio-economic, …
5. The data
   1. Summary statistics
   2. Dependent and explanatory variables
6. Empirical strategy
7. Main results
   - Regression tables
8. Robustness checks; Sensitivity analysis
9. Conclusion

REGIONAL TRADE AGREEMENT TYPES

- free trade agreements: tariffs reductions within group but own tariffs outside group.
- customs unions: unified external tariffs
- partial scope agreements: limited scope of goods with low tariffs
- economic integration agreements: FTA covers trade in services

RTA PROCESS

- two stages: negotiation + ratification
- lots of uncertainty and delays about time of actual enactment
- Authors argue that " the timing of enactment provide plausibly exogenous variation in trade policy we leverage to study deforestation."
- Authors say that this is the main innovation in this paper. Contribution is more methodological as the same question has been studied before.
- Other typically used "measures of trade may be driven by unobserved changes in local governance, political institutions, agricultural subsidies, and other factors that have also been shown to affect deforestation."


Number of RTAs
0
5
10
15
20
Months
0
10
20
30
40
2000
2005
2010
2015
Year
Number of RTAs that enter into force
Average time from signing to entry into force (months)
Median time from signing to entry into force (months)

THEORY

LINKS BETWEEN TRADE AND DEFORESTATION

Authors discuss three main mechanisms:

1. Agricultural markets
2. Forest product markets
3. Incidental deforestation

AGRICULTURAL MARKETS

Authors propose four mechanisms associated with how trade liberalization affects agri markets:

1. Change in relative value of agricultural land leads to "extensification" of agri production, leading to conversion from forestland to agriculture.
2. Lower cost of imported agri inputs leads to "intensification". Ambiguous net impact on deforestation as it could lead to higher rents on agri land.
3. Lower cost of imported forest-clearing capital. The "cheaper chain saw hypothesis".
4. Demand-induced effects. Higher income and population growth may cause more deforestation.

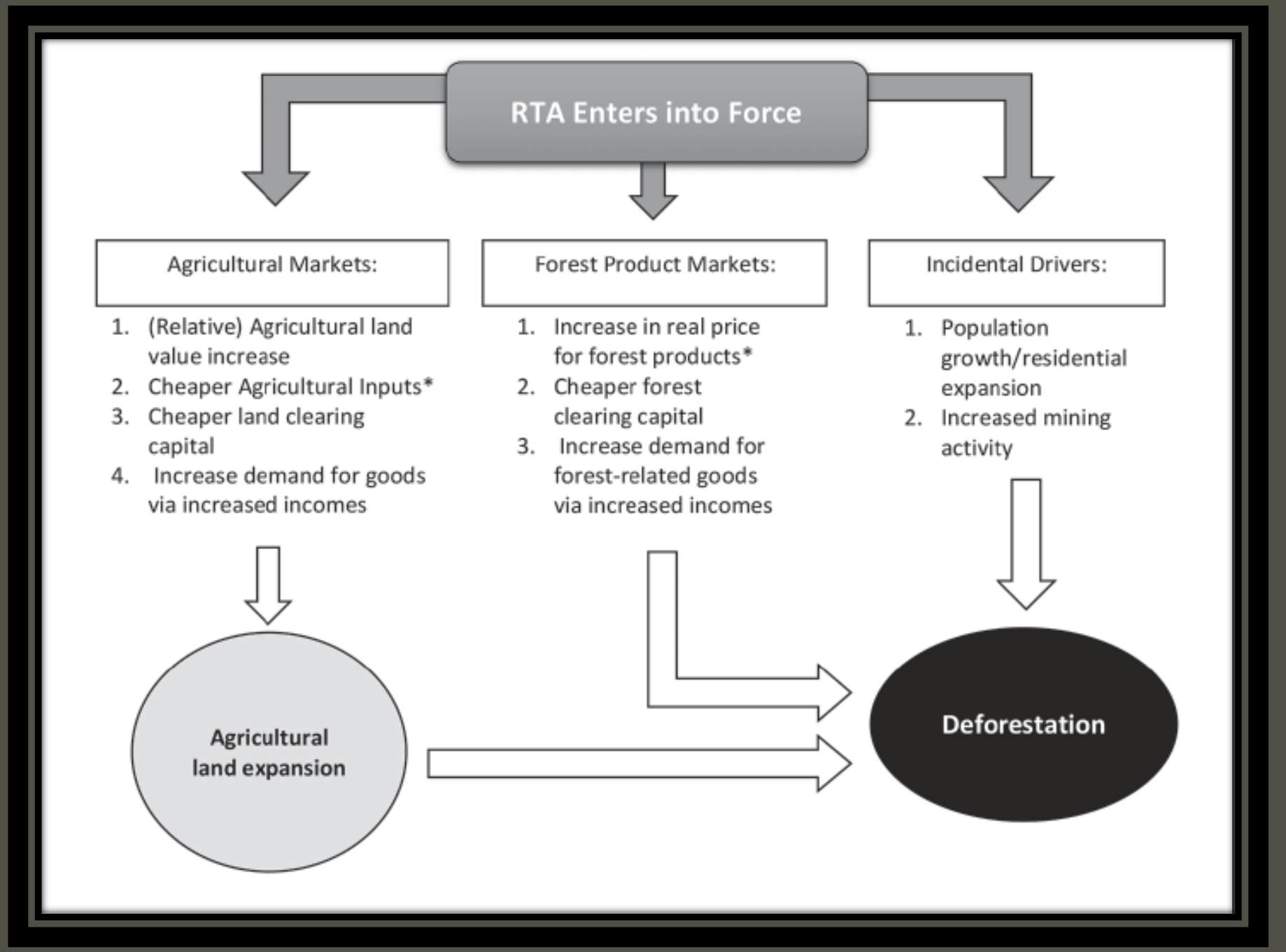
FOREST PRODUCT MARKETS

- Direct demand for forest products from new trade partners may increase deforestation.

INCIDENTAL DEFORESTATION

Local economic development leads to increased demand from deforested land:

1. Development of residential frontier
2. Increased mining activities


RTA Enters into Force
Agricultural Markets:
1. (Relative) Agricultural land value increase
2. Cheaper Agricultural Inputs*
3. Cheaper land clearing capital
4. Increase demand for goods via increased incomes
Forest Product Markets:
1. Increase in real price for forest products*
2. Cheaper forest clearing capital
3. Increase demand for forest-related goods via increased incomes
Incidental Drivers:
1. Population growth/residential expansion
2. Increased mining activity
Agricultural land expansion
Deforestation

DATA

OUTCOME VARIABLES

- High-resolution satellite images for deforestation.
- Compares pixels of foret cover between years and calculates losses over time.
- Most previous studies used FAO data, which is said to be highly inaccurate. Based of countries' reports etc.
- 5 dependent variables (to inform mechanism):
  1. deforestation
  2. agri area growth
  3. agri output
  4. forest product output
  5. agri yields

TRADE OPENNESS DATA

- Uses the WTO definition of RTAs.
- Dummy variable equal to 1 for country i at year t if RTA "came into force" (enactment).

OTHER DATA

- NB Distinguish variables of interest, control, dependent, explanatory.
- From FAO: agri land area; agri output; forest product output; yields; agri trade

- Sovereign nations only.
- 189 nations
- 2001 to 2012.
- Sample size may vary depending on availability of variables.
- Summary stats taken from online appendix.

Table 1: Summary Statistics

	Mean	Median	SD	Min	Max	No Obs
Baseline Forest Area (km^2)	253433.3	27443.69	884673.9	0	8833904	2268
Forest Loss (km^2)	997.65	52.15	4030.074	0	58995.42	2268
Ag Land Area (km^2)	254231.4	39462.3	668879.2	4	5199150	2256
Annual Ag Output (1000's tons)	83492.52	12970.57	310691.1	.378	3876270	2244
Ag Area Harvested (km^2)	13321.08	2459.401	40480.06	.605	372950.2	2232
Annual Forest Output (1,000's m^3)	2.53e+07	5506250	7.34e+07	0	6.95e+08	2164
Food Exports (1,000s USD)	4514315	427488.5	1.24e+07	0	1.45e+08	2196
Food Imports (1,000s USD)	4612722	806513	1.15e+07	1250	1.10e+08	2208
Tractor Imports	5381.785	624	17587.58	1	247557	1412

EMPIRICAL STRATEGY

(identification strategy)

(econometric approach)

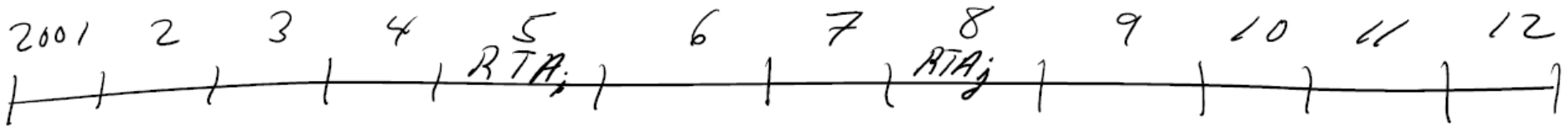
MODEL AND ESTIMATION METHOD

$$y_{it} = \delta_{LR-}\mathbf{1}[\mathrm{RTA}_{(<-k),it}] + \sum_{\substack{s=-k,\\ s\neq -1}}^{k} \delta_s \mathbf{1}[\mathrm{RTA}_{s,it}] + \delta_{LR+}\mathbf{1}[\mathrm{RTA}_{(>k),it}] + \alpha_i + \gamma_t + \varepsilon_{it},$$

- "we leverage the uncertainty in timing of enactment of RTAs as plausibly exogenous variation in trade policy"
- Event study methodology
- Country and year fixed effects
- Use of dummy variables only
- Yearly leads and lags
- Long term leads and lags
- (about model vs estimation method, see Wooldridge 19.5c – chap 19 on "Carrying out an empirical project")

SUPPOSE: i = NICA, RTA enacted in 2005, $k = 3$:

j = SEN, RTA enacted in 2008



$$y_{NICA,2007} = \delta_2 + \alpha_{NICA} + \gamma_{2007}$$

$$y_{NICA,2010} = \delta_{LR+} + \alpha_{NICA} + \gamma_{2010}$$

$$y_{SEN,2007} = \alpha_{SEN} + \gamma_{2007}$$

$$(\delta_{-1} \equiv 0)$$

$$y_{NICA,2005} = \delta_0 + \alpha_{NICA} + \gamma_{2005}$$

$$y_{NICA,2002} = \delta_{-3} + \alpha_{NICA} + \gamma_{2002}$$

$$y_{NICA,2001} = \delta_{LR-} + \alpha_{NICA} + \gamma_{2001}$$

$$y_{SEN,2010} = \delta_2 + \alpha_{SEN} + \gamma_{2010}$$

RESULTS

Table 1. Effects of RTA Enactment on Deforestation and Agricultural Area Growth

	Deforestation		Ag Area Growth	
	Coefficient	Cumulative Effect	Coefficient	Cumulative Effect
RTA_{LR-}	−.018		.0030	
	(.042)		(.0036)	
RTA_{t-3}	.015		−.0034	
	(.029)		(.0035)	
RTA_{t-2}	−.007		−.0013	
	(.029)		(.0020)	
RTA_{t-1}	. . .		. . .	
RTA_{t}	.078***	.078***	.0004	.0004
	(.029)	(.029)	(.0023)	(.0023)
RTA_{t+1}	.056*	.134***	.0050**	.0055*
	(.030)	(.047)	(.0022)	(.0029)
RTA_{t+2}	.076**	.210***	.0032	.0087*
	(.031)	(.060)	(.0025)	(.0046)
RTA_{t+3}	.049*	.258***	−.0003	.0084
	(.028)	(.073)	(.0021)	(.0053)
RTA_{LR+}	.035	.293***	.0002	.0086
	(.048)	(.091)	(.0028)	(.0061)
Observations	2,268		2,256	
R^2	.009		.004	
Wald (leads)	.561		2.009	
Mean	998	258†	−.001	2,137†
Median	52	13†	.000	332†

INTERPRETATION OF TABLE 1

- NB statistical significance vs economic significance (magnitude)
- yearly v. cumulative
- Interpretation of numbers is often tricky
  - (review table 2.3 in Wooldridge)
- After 3 years since RTA, deforestation is 26% larger compared to no RTA.
- Coefs on ag area growth are not very significant (no significance after 3 years)
- The following comment is not very scientific (objective): "While the 3-year cumulative effect of 0.8 percentage points is not statistically differentiable from zero, it corresponds to roughly 2,137 km2 calculated at the mean agricultural area over the full sample."

MECHANISMS

Table 3. Effects of RTA Enactment: Deforestation

	Dependent Variable: Deforestation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RTA cumulative	.230***	.220***	.219***	.218***	.190***	.214***	.218***	.230***
	(.074)	(.073)	(.074)	(.074)	(.073)	(.075)	(.074)	(.080)
Per capita GDP	−1.065	−.703	.803	.955	1.823	.518	.955	.725
	(.894)	(.924)	(1.531)	(1.583)	(1.600)	(1.612)	(1.583)	(1.650)
(Per capita GDP)^2	.041	.018	.024	.023	−.035	.013	.023	.107*
	(.049)	(.051)	(.051)	(.056)	(.057)	(.057)	(.056)	(.056)
Per capita GDP (lag)	.463	.413	−1.188	−1.325	−1.206	−.750	−1.325	−1.967
	(.300)	(.316)	(1.427)	(1.494)	(1.508)	(1.500)	(1.494)	(1.670)
Population		−.441**	−.392*	−.372	−.230	−.461*	−.372	.483**
		(.222)	(.232)	(.241)	(.253)	(.262)	(.241)	(.197)
GDP growth			−1.624	−1.799	−1.710	−1.262	−1.799	−2.929*
			(1.461)	(1.552)	(1.572)	(1.556)	(1.552)	(1.700)
Openness				.086	.067	.081	.086	.144
				(.084)	(.082)	(.082)	(.084)	(.090)
Corruption								.174*
								(.101)
Accountability								.197**
								(.093)
Rule of law								.030
								(.107)
Regulatory								−.148
								(.098)
Stability								.055
								(.061)
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y				Y
Year × developed FE					Y			
Year × tropics FE						Y		
Year × exporter FE							Y	
Observations	2,196	2,196	2,196	2,097	2,097	2,097	2,097	2,084
R^2	.011	.013	.013	.015	.149	.133	.120	.075

MECHANISM

- GDP-related controls: effect of RTA is not just through increased demand
- Governance controls: effect of RTA is not driven by changes in governance
  - What about an interaction term? (theory)

Table 4. Effects of RTA Enactment on Production

	Forest Output		Ag Harvest Area		Ag Harvest Weight	
	Coef	Cumul	Coef	Cumul	Coef	Cumul
RTA_{LR-}	.050		.018		.041	
	(.055)		(.017)		(.025)	
RTA_{t-3}	.033		−.014		−.006	
	(.035)		(.009)		(.012)	
RTA_{t-2}	−.052		−.005		−.004	
	(.034)		(.009)		(.011)	
RTA_{t-1}	. . .		. . .		. . .	
RTA_{t}	−.015	−.015	−.004	−.004	−.003	−.003
	(.017)	(.017)	(.008)	(.008)	(.011)	(.011)
RTA_{t+1}	.002	−.013	−.004	−.008	−.005	−.008
	(.022)	(.036)	(.009)	(.016)	(.011)	(.018)
RTA_{t+2}	.018	.005	.011	.003	.003	−.005
	(.020)	(.051)	(.009)	(.023)	(.012)	(.027)
RTA_{t+3}	−.049	−.044	.012	.014	.030**	.025
	(.033)	(.058)	(.011)	(.031)	(.013)	(.035)
RTA_{LR+}	−.102	−.146	.042**	.056	.045	.070
	(.085)	(.120)	(.020)	(.041)	(.028)	(.050)
Observations	2,033		2,079		2,079	2,200
R^2	.028		.068		.101	
Wald (leads)	3.485		6.637*		6.159	
Mean	26,262	−1,152[†]	140,285	2,017[‡]	89,228	2,213[§]
Median	5,690	−250[§]	26,341	379[‡]	14,018	348[§]

MECHANISM

- forest output: Effect does not appear to be about forest products
- agricultural expansion: some evidence that it is about agricultural expansion

Table 5. Effects of RTA Enactment: Subsample Analysis

	Developed		Developing			
			Tropical		Nontropical	
	Def	Ag	Def	Ag	Def	Ag
RTA_{LR-}	.109	.0077	.074	.0047	−.348***	.0021
	(.148)	(.0057)	(.053)	(.0049)	(.102)	(.0048)
RTA_{t-3}	−.025	.0046	.116**	−.0084	−.101	.0006
	(.069)	(.0042)	(.048)	(.0061)	(.062)	(.0037)
RTA_{t-2}	.022	.0037	.024	.0004	−.038	.0045
	(.062)	(.0072)	(.039)	(.0023)	(.081)	(.0041)
RTA_{t-1}	. . .	. . .	. . .	. . .	. . .	. . .
RTA_{t}	.094	−.0034	.114***	−.0007	−.026	.0003
	(.074)	(.0093)	(.041)	(.0021)	(.058)	(.0034)
RTA_{t+1}	−.007	−.0067	.136***	.0074***	−.07	.0012
	(.069)	(.0077)	(.043)	(.0027)	(.05)	(.0035)
RTA_{t+2}	−.048	.0004	.137***	.0048**	.016	−.0005
	(.058)	(.0088)	(.041)	(.0023)	(.061)	(.0026)
RTA_{t+3}	−.06	−.0007	.091**	−.0018	.017	−.0037
	(.064)	(.006)	(.039)	(.0027)	(.053)	(.004)
RTA_{LR+}	−.193	.013	.061	−.0043	.194	.0065
	(.123)	(.0132)	(.059)	(.0029)	(.144)	(.0045)
Wald (leads)	.847	4.327	7.021*	2.487	14.67***	1.253
Mean	1,601	−.0051	893	.0012	775	−.0022
Median	142	−.0026	73	.0000	7	.0000

MECHANISM (SUBSAMPLES)

- Main results appear to be driven by developing tropical countries
  - Why not use interaction terms?
  - Maybe it is about governance?

CONCLUSION/DISCUSSION

- Results about agricultural expansion seems robust.
- Role of governance has not been ruled out.