

Dynamic Amazonia: The EU–Mercosur Trade Agreement and Deforestation

Supplementary Information

Table S1. Details of current tariff regime and quotas for relevant agricultural products.

Commodity	Current tariff regime	Regime under FTA
Beef, fresh & chilled	12.8% + between EUR 176.80 and EUR 303.40 /100kg.	7.5% tariff for 54,450 tonnes
Beef, frozen	12.8% + between EUR 141.40 EUR and EUR 304.1 /100kg.	7.5% tariff for 44,550 tonnes
Beef - high quality fresh&frozen	In-quota tariff: 20% (10,000 tonnes Brazil, 6,376 tonnes Uruguay, 29,500 tonnes Argentina, 1,000 tonnes Paraguay	In-quota tariff: 0%
Pork - fresh & chilled	Between EUR 46.7 and EUR 86.9 / 100kg	25,000 tonnes at EUR 83 / tonne
Pork - frozen	Between EUR 46.7 and EUR 86.9 / 100kg	
Pork - processed	Between EUR 46.7 and EUR 151.2 /100kg	
Poultry - with bones	For chicken only: Between EUR 26.2 and EUR 100.8 /100kg	0% tariff for 90,000 tonnes (covers all poultry)
Poultry - boneless	For chicken only: between EUR 18.7 and EUR 102.4 / 100kg	0% tariff for 90,000 tonnes
Sugar for refining	For Brazil: 180,000 tonnes at EUR98/tonne. Other Mercosur countries: 33.9 EUR/100kg	Brazil in-quota tariff = 0, New quota for Paraguay, 10,000 at 0%. Otherwise remains as baseline.
Ethanol	Between EUR10.2 and EUR 19.2 / hectolitre	0% tariff for 450,000 tonnes, only for chemical use. 1/3 baseline tariff for 200,000 tonnes for any use (including fuel)
Oilseeds	Import tariff = 0. Argentina imposes export tariff of 18%	Tariff free, both import and export

Table S2. Descriptive statistics of variables used in the regression with source.

Variable	Obs	Mean	Std. Dev.	Min	Max	Unit
dft ¹	4,943,201	.0709959	.256818	0	1	Binary
d2unp ²	4,943,201	10.44046	10.05844	0	49.30135	x10,000m
d2pvd ³	4,943,201	16.74044	13.79114	0	73.67928	x10,000m
d2dft ⁴	4,943,201	.7691481	.8121651	0	6.110728	x10,000m
trmm ⁵	4,943,201	2.346438	.4305433	1.193647	4.382253	in meters
indg ⁶	4,943,201	.2329913	.4227368	0	1	Binary
ucei ⁷	4,943,201	.0279285	.1647679	0	1	Binary
ucfi ⁸	4,943,201	.0687538	.2530351	0	1	Binary
ucfus ⁹	4,943,201	.0729254	.2600141	0	1	Binary
soilmod ¹⁰	4,943,201	.0905796	.2870103	0	1	Binary
soilsev ¹¹	4,943,201	.5636093	.4959374	0	1	Binary
projass ¹²	4,943,201	.0452051	.2077538	0	1	Binary

Note 1: water bodies, non-forested areas, and areas deforested prior to 2001 were masked out. Therefore, these numbers do not necessarily correspond to the statistics for the Amazon as a whole.

Note 2: the estimation procedure requires a computationally intensive matrix inversion that can cause singularity issues if the variables are not properly scaled. Scaled variables were linearly transformed, which does not change the regression results.

¹ dft: accumulated deforestation from 2001-2018. Source: Mapbiomas Collection 4.1. <https://mapbiomas.org/en/download> (accessed on 18 May 2020)

² d2unp: Euclidean distance to unpaved roads. Subset of unpaved roads was created by removing the roads with attributes 'pavimentada', 'duplicada', 'planejada', and 'travessia'. The remaining segments correspond to unpaved roads. Source: Ministerio do Meio Ambiente (MMA). Geoprocessamento. URL: <http://www.mma.gov.br/governanca-ambiental/geoprocessamento>. (Accessed on Feb 21 2017).

³ d2pvd: Euclidean distance to paved roads, also from the same dataset above, selected segments with attributes 'pavimentada' or 'duplicada'.

⁴ d2dft: Euclidean distance to previously deforestation up to base year of 2000. Source: same as dft.

⁵ trmm: Annual mean precipitation, calculated using TRMM data from 1999-2018 using simple raster algebra. Source: NASA. <ftp://disc3.nascom.nasa.gov> (Accessed on Nov 04 2019).

⁶ indg: Indigenous lands included all demarcated lands but not 'em estudo' or 'planejamento'. Source: MMA.

^{7,8} ucei, ucfi: Conservation units at state and federal levels, integral protection. Source: MMA.

⁹ ucfus: Federal conservation units, sustainable use. Source: MMA.

^{10,11} soilmod, soilsev: Soil types: moderate restrictions to agriculture (category 2), severe restrictions (category 3), and omitted variable is very severe restrictions. Source: Harmonized World Soil Database v1.2, FAO. Accessed on October 10 2015.

¹² projass: Settlement projects included polygons with attributes 'projeto de assentamento', 'projeto integrado de colonização', and 'projeto agroextrativista'. Source: INCRA. URL: <https://acervofundiario.incra.gov.br/acervo/acv.php> (Accessed on: May 19 2020).

Table S3. EU imports of pork and poultry by exporting region for all examined scenarios (in million USD).

Region	Base	S11	S12	S13	S21	S22	S23
US	370	366	366	366	364	364	364
EU	33,525	32,950	32,950	32,950	32,792	32,792	32,792
Brazil	1,619	1,649	1,649	1,649	1,660	1,659	1,659
China	318	314	314	314	313	313	313
OCSA	431	1,351	1,351	1,351	1,604	1,604	1,604
Other	2,093	2,067	2,067	2,067	2,058	2,058	2,058
Total	38,357	38,696	38,696	38,696	38,791	38,791	38,791

Table S4. Impacts of the EMTA on harvested area by region (in hectares).

Scenarios	Crops	EU	Brazil	OCSA	Others	Total
S11	Soybeans	-5,238	54,642	46,358	-40,740	55,023
	Other oilseeds	-16,481	868	-8,359	-18,309	-42,281
	Sugar crops	-1,497	109,884	4,489	-1,766	111,110
	Other crops	8,319	44,976	-33,782	48,656	68,170
	Total	-14,896	210,369	8,707	-12,158	192,022
S12	Soybeans	-5,274	64,070	45,632	-43,985	60,444
	Other oilseeds	-17,423	1,108	-8,483	-20,831	-45,628
	Sugar crops	-1,484	109,452	4,515	-1,634	110,850
	Other crops	8,682	51,999	-33,293	49,431	76,818
	Total	-15,498	226,629	8,372	-17,018	202,484
S13	Soybeans	-5,277	64,812	45,560	-44,316	60,779
	Other oilseeds	-17,520	1,122	-8,496	-21,090	-45,983
	Sugar crops	-1,483	109,359	4,518	-1,621	110,774
	Other crops	8,717	52,319	-33,245	49,434	77,225
	Total	-15,563	227,612	8,338	-17,592	202,795
S21	Soybeans	-41,416	8,042	96,726	-58,107	5,245
	Other oilseeds	-1,169	-604	-15,795	-1,343	-18,911
	Sugar crops	-8,721	336,912	27,756	-7,032	348,915
	Other crops	29,974	37,260	-89,445	60,745	38,534
	Total	-21,332	381,610	19,242	-5,737	373,783

S22	Soybeans	-41,621	30,684	94,588	-67,529	16,122
	Other oilseeds	-2,948	-248	-15,968	-6,196	-25,360
	Sugar crops	-8,702	337,078	27,813	-6,902	349,287
	Other crops	30,775	47,204	-87,904	65,209	55,284
	Total	-22,496	414,718	18,529	-15,418	395,333
S23	Soybeans	-41,643	32,676	94,362	-68,518	16,878
	Other oilseeds	-3,133	-228	-15,987	-6,664	-26,012
	Sugar crops	-8,700	337,027	27,819	-6,889	349,256
	Other crops	30,861	47,562	-87,745	65,555	56,232
	Total	-22,614	417,037	18,448	-16,517	396,354

Table S5. Impacts of the EMTA on land cover by region (in hectares).

Scenarios	Land Types	EU	Brazil	OCSA	Others	Total
S11	Forest	3,120	-55,728	-66,504	9,680	-109,432
	Pasture	-148	12,928	58,592	-5,760	65,612
	Cropland	-2,972	42,800	7,912	-3,920	43,820
S12	Forest	3,184	-78,352	-66,712	10,304	-131,576
	Pasture	-80	14,192	59,136	-4,960	68,288
	Cropland	-3,104	64,160	7,576	-5,344	63,288
S13	Forest	3,184	-110,752	-66,752	10,368	-163,952
	Pasture	-68	-35,056	59,216	-4,944	19,148
	Cropland	-3,116	145,808	7,536	-5,424	144,804
S21	Forest	5,424	-83,584	-86,840	10,928	-154,072
	Pasture	-1,164	6,192	69,056	-9,360	64,724
	Cropland	-4,260	77,392	17,784	-1,568	89,348
S22	Forest	5,520	-112,544	-87,456	11,936	-182,544
	Pasture	-1,052	-4,416	70,352	-7,360	57,524
	Cropland	-4,468	116,960	17,104	-4,576	125,020
S23	Forest	5,552	-172,960	-87,552	11,984	-242,976
	Pasture	-1,032	-93,920	70,496	-7,088	-31,544
	Cropland	-4,520	266,880	17,056	-4,896	274,520

Table S6. Percent change in EU imports of Ethanol from Brazil (percentage change).

Scheme 11.	S11	S12	S13	S21	S22	S23
% change	6.45	6.47	6.47	10.40	10.46	10.47

Table S7. Bayesian spatial probit regression analysis results (n= 4,943,201).

Variable	Coefficient	Std Deviation	p-value
const	0.0864	0.1758	0.382
d2unp	-0.0473	0.0034	0.000
d2pvd	-0.0118	0.0017	0.000
d2dft	0.1884	0.0369	0.000
trmm	-0.9134	0.0681	0.000
indg	-1.1580	0.0278	0.000
ucei	-1.1795	0.0323	0.000
ucfi	-1.1935	0.0179	0.000
ucfus	-0.7328	0.0171	0.000
soilmod	0.2146	0.0076	0.000
soilsev	0.1810	0.0059	0.000
projass	0.6964	0.0090	0.000

Table S8. Cross-tabulation of predicted vs. actual deforestation on a pixel-by-pixel basis.

		Predicted		
		Forest	Deforested	All
Actual	Forest	4,402,347	189,907	4,592,254
	Deforested	189,907	161,040	350,947
	All	4,592,254	350,947	4,943,201

Table S9. Cross-tabulation of predicted vs. actual deforestation Hagen's two-way fuzzy similarity index.

		Predicted	
		Forest	Deforested
Actual	Forest	1.000	0.342
	Deforested	0.153	1.000

Overall mean = 0.942

Table S10. Indigenous and conservation areas within 5 km from hotspots of deforestation.

NAME	CATEGORY	LEVEL	YEAR CREATED
Karipuna	Indigenous	Federal	1999
Badjonkore	Indigenous	Federal	2004
Kayapó	Indigenous	Federal	1989
Parakana	Indigenous	Federal	1989
Maraiwatsede	Indigenous	Federal	1999
Urubu Branco	Indigenous	Federal	1999
Batelao	Indigenous	Federal	2007
Apyterewa	Indigenous	Federal	2008
Trincheira Bacaja	Indigenous	Federal	1998
Alto Rio Guamá	Indigenous	Federal	1994
Manoki	Indigenous	Federal	2008
Cachoeira Seca	Indigenous	Federal	2009
Parque Nacional Dos Campos Amazônicos	Park	Federal	2006
Reserva Biológica Nascentes Serra Do Cachimbo	Biological Reserve	Federal	2005
Reserva Biológica Do Tapirapé	Biological Reserve	Federal	1989
Parque Estadual De Guajará-Mirim	Park	Estadual	1990
Parque Estadual De Corumbiara	Park	Estadual	1990
Floresta Nacional De Itacaiunas	National Forest	Federal	1998
Floresta Nacional De Tapirapé-Aquiri	National Forest	Federal	1989
Floresta Nacional De Bom Futuro	National Forest	Federal	1988
Floresta Nacional Do Jamanxim	National Forest	Federal	2006