Supplement to "Food for fuel: The effect of the US biofuel mandate on poverty in India"

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Appendix: Tables

Table A1. Parameters for crop production cost.

	Rice		Wheat		Sugar		Corn		Other Crops	
	η_1^r	η_2^r	η_1^r	η_2^r	η_1^r	η_2^r	η_1^r	η_2^r	η_1^r	η_2^r
US	1.15	1.50	1.15	1.50	1.20	1.55	1.15	1.50	1.20	1.55
India	1.55	1.80	1.55	1.80	1.45	1.70	1.55	1.80	1.45	1.70
ROW	1.50	1.75	1.50	1.75	1.35	1.65	1.50	1.75	1.35	1.65

Note: *Source*: GTAP 5 (1997).

Table A2. Parameters for the cost of land conversion.

	ψ_1^r	ψ_2^r
US	430	431
India	200	200
ROW	56	106

Note: *Source*: Gouel and Hertel (2006).

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TABLE A3. Cost and yield data for corn ethanol.

	US	India	ROW
Representative crop	Corn	Sugarcane	Sugarcane
Share	(93%)	(82%)	(63%)
Unit cost ($/gallon)	0.73	1.06	0.63
	Energy yield by land quality (gallons/ha)		
High	876	1200	1463
Medium	681	912	1254
Low	487	790	1115

Note: Share denotes production of representative crop in regional biofuel production. The representative crop for ROW is sugarcane since Brazil is the dominant producer with 47% of ROW production in 2012. Unit costs of production are taken from IEA-ETSAP (2013), OECD/IEA (2011), and Ravindranath, Sita Lakshmi, Manuvie, and Balachandra (2011).

TABLE A4. Parameters for supply of transport fuel.

	US	India	ROW
Transport fuel supply q_e^r (MJ)	16,400	688	23,150
Gasoline supply q_g^r (MJ)	15,840	540	22,000
Biofuels supply q_{bf}^r (MJ)	800	40	1040
Share of gasoline μ_g^r	0.90	0.95	0.95
Elasticity of substitution ξ^r	2	2	2
Constant λ^r	1.22	1.37	1.14

Note: MJ: MegaJoules; production of transport fuel (q_e^r) equals consumption since transport fuel is not traded; supply of biofuels (q_{bf}^r) and gasoline (q_g^r) are from EIA (2014); the share of gasoline is calculated as the ratio of gasoline (q_g^r) to transport fuel supply (q_e^r); elasticities of substitution are from Hertel, Tyner, and Birur (2010).

TABLE A5. Parameters for extraction cost of crude oil.

	ϕ_1	ϕ_2	ϕ_3
World Reserves (Billion Gallons)		$/Gallon	
35,427	1.18	7.76	15

Note: *Source*: Oil reserves (British Petroleum (2013) and IEA (2014)); Cost parameters ϕ_1, ϕ_2, and ϕ_3 are from Chakravorty, Magne, and Moreaux (2012).

TABLE A6. Demand parameters by region and commodity (base year 2012).

	US	India	ROW
Population (Billion)	0.31	1.22	5.36
GDP per capita ($)	43,210	3295	10,714
		Rice	
Consumption per capita (kg)	8	70	53
Price ($/ton)	450	450	450
Price elasticity	−0.15	−0.35	−0.20
Income elasticity	0.15	0.57	0.65
Constant A_i^r	0.004	0.005	0.0004
		Wheat	
Consumption per capita (kg)	80	60	65
Price ($/ton)	250	250	250
Price elasticity	−0.15	−0.35	−0.20
Income elasticity	0.15	0.57	0.65
Constant A_i^r	0.036	0.004	0.0004
		Sugar	
Consumption per capita (kg)	60	23	22
Price ($/ton)	450	450	450
Price elasticity	−0.23	−0.57	−0.25
Income elasticity	0.41	0.71	0.71
Constant A_i^r	0.003	0.0005	0.0002
		Meat	
Consumption per capita (kg)	375	75	70
Price ($/ton)	1960	1960	1960
Price elasticity	−0.28	−0.37	−0.30
Income elasticity	0.43	0.97	0.77
Constant A_i^r	0.032	0.00048	0.00054
		Corn	
Consumption per capita (kg)	12	6	21
Price ($/ton)	250	250	250
Price elasticity	−0.15	−0.35	−0.20
Income elasticity	0.15	0.57	0.65
Constant A_i^r	0.005	0.0004	0.00015
		Other food	
Consumption per capita (kg)	119	80	116
Price ($/ton)	280	280	280
Price elasticity	−0.28	−0.53	−0.30
Income elasticity	0.41	0.71	0.71
Constant A_i^r	0.007	0.0067	0.0009
		Transport fuel	
Consumption per capita (VMT)	9250	69	752
Price ($/VMT)	0.14	0.23	0.23
Price elasticity	−0.50	−0.21	−0.78
Income Elasticity	0.94	1.30	1.20
Constant A_i^r	0.003	0.001	0.003

Note: *Sources*: Consumption figures for food commodities are from FAO (2016); transport fuel: EIA (2014); prices: World Bank (2015); own-price and income elasticities for transport fuel: Parry and Small (2005), and Dimaranan, McDougall, and Hertel (2007); price and income elasticities for food commodities (US) are from Dimaranan, McDougall, and Hertel (2007), Regmi, Deepak, Seale, and Bernstein (2001), Regmi and Seale (2011), Muhammad et al. (2010); price elasticities for food commodities (ROW): Roberts and Schlenker (2013) and from Dimaranan, McDougall, and Hertel (2007); income elasticities for food commodities (ROW): Dimaranan, McDougall, and Hertel (2007); price and income elasticities for food commodities (India): Paul (2011), Dimaranan, McDougall, and Hertel (2007), Regmi et al. (2001), Regmi and Seale (2011); population figures: United Nations Population Division UNDP (2015); and per capita income: EIA (2015).

TABLE A7. Model validation: consumption of food and fuel in 2012.

	US			India			ROW		
	Observed	Predicted	% diff	Observed	Predicted	% diff	Observed	Predicted	% diff
Rice	8.00	8.21	2.63	70.00	74.40	6.29	53.00	54.87	3.53
Wheat	80.00	78.67	−1.66	60.00	57.69	−3.85	65.00	63.56	−2.22
Sugar	60.00	61.42	2.37	23.00	24.38	6.00	22.00	22.57	2.59
Meat	375.00	383.84	2.36	75.00	77.07	2.76	70.00	71.57	2.24
Corn	12.00	12.31	2.58	6.00	6.36	6.00	21.00	21.72	3.43
Other food	119.00	120.88	1.58	80.00	81.36	1.70	116.00	117.12	0.97
Fuel	9250	9810	6.05	69	73	5.80	752	763	1.46

Note: Consumption units for food in kg/capita and fuel in VMT/capita. Observed values are rounded off. % diff is the percent difference between observed values and model predictions. *Sources*: consumption of food commodities: FAO (2016), transport fuel: EIA (2014).

TABLE A8. Model validation: world commodity prices in year 2012.

	Observed	Predicted	% diff
Rice	450	462	2.66
Wheat	250	270	8.00
Sugar	450	471	4.66
Meat	1960	1820	−7.14
Corn	250	241	−3.60
Other food	280	271	−3.21

Note: % diff represents the percentage difference between observed values and model predictions. Prices are in 2005 dollars. *Source*: World Bank (2015).

TABLE A9. Model validation: average growth rate of food prices, 2005–2012.

	Observed	Predicted
Rice	7%	7%
Wheat	9%	8%
Sugar	7%	6%
Meat	5%	3%
Corn	11%	14%
Other food	7%	9%

Note: Average growth rates of observed prices are calculated from annual real food prices in 2005 dollars. *Source*: World Bank (2015).

TABLE A10. Parameters used in the sensitivity analysis and Monte Carlo simulations.

	US			India			ROW		
	Mean	Std. Dev.	Shock (%)	Mean	Std. Dev.	Shock (%)	Mean	Std. Dev.	Shock (%)
Price elasticity									
Cereals	−0.15	0.022	15	−0.35	0.105	30	−0.20	0.060	30
Sugar	−0.23	0.038	17	−0.34	0.085	25	−0.25	0.065	26
Meat	−0.28	0.039	14	−0.37	0.063	17	−0.30	0.096	32
Other food	−0.28	0.038	14	−0.58	0.116	20	−0.30	0.096	32
Fuel	−0.50	0.074	15	−0.21	0.063	30	−0.78	0.026	3
Income elasticity									
Cereals	0.15	0.021	14	0.57	0.037	6	0.65	0.12	18
Sugar	0.41	0.049	12	0.71	0.001	0.1	0.65	0.05	7.6
Meat	0.43	0.120	28	0.97	0.038	4	0.77	0.07	9
Other food	0.41	0.042	10	0.71	0.009	1	0.71	0.06	8
Fuel	1.30	0.016	1.2	1.30	0.020	2	1.20	0.12	10
Crop yield (tons/hectare)									
Rice-H	7.1		12	3.2		13	4.0		3
Rice-M	5.1	0.936	16	2.8	0.482	15	3.0	0.122	4
Rice-L	3.5		24	1.8		22	2.0		6
Wheat-H	6.8		3.5	4.0		9	2.9		16
Wheat-M	5.0	0.273	5	1.8	0.439	21	1.8	0.472	26
Wheat-L	2.9		8	1.5		26	0.8		50
Sugar-H	86		5.5	79		7	70		6.5
Sugar-M	72	4.706	7.5	60	5.598	9	60	4.563	7.5
Sugar-L	65		8.5	52		11	50		8
Corn-H	9.3		12	3.9		10	4.7		13
Corn-M	7.1	1.329	16	3.3	0.430	21	4.3	0.681	14
Corn-L	4.7		25	1.9		20	2.6		23
Other crops-H	4.5		11	2.0		10	2.2		9
Other crops-M	3.5	0.49	14	1.5	0.30	12	1.8	0.308	10
Other crops-L	2.5		20	1.0		20	0.9		19
Unit extraction cost of oil ($/barrel)									
Unit Cost	50	7.500	15	50	7.50	15	50	7.500	15
Unit cost of biofuel ($/gallon)									
Ethanol	0.73	0.025	3.5	0.63	0.02	3	0.63	0.02	3
Cellulosic ethanol	0.99	0.150	15	na	na	na	na	na	na
Demand parameters in base year									
GDP/capita ($)	43,210	1022	2.4	3295	105	3.2	10,714	284	2.5
Population (Billion)	0.31	0.0070	2.3	1.22	0.020	1.6	5.36	0.120	2.4

Note: *Sources*: The magnitude of the shock equals the ratio of standard deviation to mean, as shown. Price elasticities: Regmi et al. (2001), Parry and Small (2005), Dimaranan, McDougall, and Hertel (2007), Muhammad et al. (2010), Regmi and Seale (2011), Roberts and Schlenker (2013) and Bento, Klotz, and Landry (2015); Income elasticities: Parry and Small (2005), Dimaranan, McDougall, and Hertel (2007), Muhammad et al. (2010), Bento, Klotz, and Landry (2015); Crop yields: FAO (2016); Oil cost: World Bank (2015); Ethanol cost: OECD/IEA (2011) and IEA-ETSAP (2013); Cellulosic ethanol cost: Carriquiry, Du, and Timilsina (2011), OECD/IEA (2010), OECD/IEA (2011) and IEA-ETSAP (2013); GDP per capita: EIA (2014); Population: UNDP (2015). *Notes*: Cereals include rice, wheat, and corn. Rice-H, Rice-M and Rice-L should be respectively read as: yield of rice on high, medium, and low land qualities. The same notation applies for wheat, corn, sugar, and other food. The standard deviation is uniform across the different land classes since it is calculated from historical data. Cellulosic ethanol is not produced in India and ROW. Due to a lack on data on land conversion cost, we could not calculate the standard deviation. We assume a shock of 15%.

TABLE A11. Matching between commodities, expenditure categories, and industries.

Products	NSS Codes	NSS Description	NIC Codes	NIC Description
(1)	(2)	(3)	(4)	(5)
Rice	101–102	Rice	1111	Growing of food grain crops
	103	Chira	1403	Activities establishing a crop, promoting its growth or protecting it from disease and insects.
	104	Khoi, lawa	1404	Harvesting and activities related to harvesting, such as preparation of crop cleaning, trimming, grading, drying.
	105–106	Muri and Other Rice Products		
Wheat	107–108	Wheat, atta	1111	Growing of food grain crops
	110	Maida	1403	Activities establishing a crop, promoting its growth or protecting it from disease and insects. Transplantation of rice in rice fields.
	111	Suji, rawa	1404	Harvesting and activities related to harvesting, such as preparation of crop cleaning, trimming, grading, drying.
	112–114	Bread, bakery, sewai, noodles, other wheat products		
Sugar	269	Sugar (subtotal)	1115	Growing of sugarcane or sugar beet
Meat/Dairy	160	Milk: liquid (liter)	1407	Activities to promote propagation, growth and output of animals and to obtain
	161	Baby food	1409	Other agricultural and animal service activities, n.e.c.
	162	Milk: condensed/powder	1211	Farming of cattle, sheep, goats, horses, asses, mules and hinnies; dairy farming
	163	Curd	1212	Rearing of goats, production of milk
	164	Ghee	1213	Rearing of sheep; production of shorn wool
	165	Butter	1214	Rearing of horses, camels, mules, and other.
	166	Ice cream	1221	Raising of pigs and swine
	167	Other milk products	1222	Raising of poultry (including broiler) and other domesticated birds; production of eggs and operation of poultry hatcheries

(*Continues*)

TABLE A11. *Continued.*

Products	NSS Codes	NSS Description	NIC Codes	NIC Description
(1)	(2)	(3)	(4)	(5)
	180	Eggs (no.)	1223	Raising of bees; production of honey
	181	Fish, prawn	1224	Raising of silk worms; production of silk worm cocoons
	182	Goat meat/mutton	1225	Farming of rabbits including angora rabbits
	183	Beef/buffalo meat	1229	Other animal farming; production of animal products n.e.c.
	184	Pork	1500	Hunting, trapping, and game propagation including related service activities
	185	Chicken	5011–5012	Fishing on commercial basis in ocean, sea, and coastal areas
	186	Others: birds, crab, oyster, tortoise, etc.	5021–5023	Fishing, fish farming, gathering of marine materials, other fishing activities
Other food	115–122	Jowar, bajra, maize, barley, small millets other cereal	1112	Growing of oilseeds including peanuts or soya beans
	139	Cereal substitutes: tapioca, jackfruit, etc.	1119	Growing of other crops, n.e.c.
	159	Pulses and pulse products	1121	Growing of vegetables
	179	Edible oil (subtotal)	1122	Growing of horticultural specialties including: seeds for flowers, fruit or
	229	Vegetables (subtotal)	1131	Growing of coffee or cocoa beans
	249	Fruits (fresh, subtotal)	1132	Growing of tea or mate leaves including the activities of tea factories associated
	259	Fruits (dry, subtotal)	1133	Growing of edible nuts including coconuts
	289	Spices (subtotal)	1134	Growing of fruit: citrus, tropical pome or stone fruit; small fruit such as berries;
	290–293	Tea and coffee	1135	Growing of spice crops including: spice leaves

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