CONTENTS:

Supplementary Materials for

Determinants of Comparative Advantage in GMO Intensive Industries

Appendix A. --Expected Signs of Parameter Estimates of Equations (7)-(11)

Variable	Abbreviation	Eq. (7)	Eq. (8)	Eq. (9)	Eq. (10)	Eq. (11)
Baseline						
Capital	k	+ / -	+ / -	+ / -	+ / -	+ / -
Labor	l	+ / -	+ / -	+ / -	+ / -	+ / -
Land	t	+ / -			+ / -	+ / -
Endowment Disaggregation						
GMO Land	tg or tg'		$\alpha 3 > 0$	$\alpha 3 > 0$		
Non-GMO Land	tn or tn'		$\alpha 4 < \alpha 3$	$\alpha 4 < \alpha 3$		
GMO Policies						
GMO Index / Policy Regime	PR				+ / -	
Approval Process	AP					+ / -
Risk Assessment	RA					+ / -
Labeling Policies	LP					+ / -
Traceability Requirements	TR					+ / -
Coexistence Guidelines	CG					+ / -
Membership in Intl. Agreements	IA					+ / -

NOTES:
Eq. (7): Positive signs indicate endowment confers comparative advantage; negative signs indicate endowment confers comparative disadvantage.
Eq. (8): Parameter estimates on disaggregated endowments indicate the trade effects of converting non-GMO land into GMO land (across countries
Eq. (9): Parameter estimates on time interaction terms indicate the trade effects of converting non-GMO land into GMO land (over time).
Eqs. (10) and (11): Positive signs indicate policy decreases net costs and increases comparative advantage;
negative signs indicate policy increases net costs and decreases comparative advantage.

Appendix B: Data Description and Sources

Below we describe the variable measures and data sources. All data are country cross-sections for the years 1995 and 2010 unless otherwise noted. For comparability, value data for 1995 are converted to 2010 dollars such that all data are in constant 2010 dollars. The data described below are those corresponding with the results reported in the paper and not described elsewhere in the text.

Variable Measures and Data Sources

Trade is measured as the dollar value of countries' net exports (X-M) to the rest of the world, where net exports are exports (X) minus imports (M). The trade data are detailed by country, year and industry. The industries include soybeans, maize and cotton. These industries are defined using the SITC Revision 3 as follows: *Soybeans:* 08131, 09841, 2222, 4211; *Maize:* 044, 04711, 04721, 05461, 08124, 4216, 59212; *Cotton:* 08133, 2223, 263, 4212. The export and import data used to construct the measures of net exporters are from the Comtrade database of the United Nations.

Endowments include aggregate measures of capital, labor and land, detailed by country and year. Labor endowments are measured as the number of people in the labor force of each country, and are from the World Development Indicators of the World Bank. Capital endowments are measured as the dollar value of gross machinery of each country, and are from the United Nations-Food and Agriculture Organization (FAO). Land endowments are measured as hectares of arable land of each country, and are from the United Nations-FAO. We disaggregate the land endowment into the GMO and non-GMO components. GMO land is measured as hectares of biotech crops of each country, and are collected by the International Service for the Acquisition of Agri-Biotech Applications and published in James (2011). We

construct a measure of non-GMO land as the difference between the total land endowment and GMO land of each country.

Policies include six individual measures, plus a composite measure that represents the policy regime. These data were constructed by Vigani, et. al., (2012) and are detailed in Section 3.2. The policy stringency captured in the measures is as follows. First, the a*pproval process* reflects the country's approach to assessing product risk. The approach known as the "precautionary principle" places the responsibility on regulators to prove that GMOs are harmless before released into the market. The alternative "substantial equivalence principle" focuses on whether GMO and traditional products are equivalent and thus subject to identical regulation. The latter is the weaker form of regulation. Country differences in policy range from the absence of GMO approval procedures, to mandatory processes based on the substantial equivalence principle, to mandatory processes based on the precautionary principle, to complete bans on GMOs.

Second, *risk assessment* reflects the extent to which an evaluation process for GMO products is implemented. Country policies range from the absence of risk analysis, to proposed risk assessment without enforcement, to mandatory risk assessment, to complete bans on GMOs.

Third, *labeling* concerns the information provided to buyers about the contents of a product. The two primary approaches for GMOs are voluntary and mandatory labeling. Mandatory labeling varies depending on threshold requirements--the percentages of GMO content contained in a product that must be exceeded before mandatory labeling is required. Country policies range from the absence of labeling regulations, to voluntary GMO labeling, to mandatory labeling with high thresholds, to mandatory labeling with low thresholds, to complete bans on GMOs.

Fourth, *traceability* pertains to the ability to identify the origin, history or use of a product, such as the location of the field it came from, using a registered identification. The related concept of *identify preservation* pertains to processes, protocols, systems, and initiatives to maintain a segregation of products, including GMO vs. traditional varieties. Country policies range from the absence of processes for GMO traceability or identify preservation, to GMO traceability or identity preservation requirements without enforcement, to mandatory GMO traceability, to complete bans on GMOs.

Fifth, c*oexistence* concerns rules designed to preserve the identity of traditional crops vs. GMO crops. Regulations include field rules that seek to prevent pollen flow, either by establishing boundaries between GMO and traditional crops or by creating pollen barriers. Country policies range from the absence of coexistence rules, to coexistence policies that are unenforced, to partial guidelines for coexistence, to exhaustive guidelines on coexistence, to complete bans of GMOs.

Finally, country memberships to international agreements include the Cartagena Protocol, Codex Alimentarius, and World Trade Organization. The *Cartagena Protocol* reinforces the precautionary principle and extends to trans-boundary movements of GMOs and thus covers international trade. The *Codex Alimentarius* (CA) is a collection of internationally recognized standards, codes of practice, guidelines, and recommendations relating to food. One of the aims is to safeguard consumer health and ensure fair practices in international food trade. The *World Trade Organization* includes agreements on Sanitary and Phytosanitary Measures, Technical Barriers to Trade, and Trade-Related Aspects of Intellectual Property Rights. Countries that are members to these agreements are considered to have relatively stronger regulatory environments.

Appendix C.--Select Data onTrade, GMO Land and GMO Policies

Country	GMO Land (Tg)	Composite Index (PR)	Approval Process (AP)	Risk Assessment (RA)	Labeling (LP)	Traceability (TR)	Coexistence Guidelines (CG)	Intern'l Agreemts. (IA)	Net Exports Soybeans (X-M)	Net Exports Maize (X-M)	Net Exports Cotton (X-M)
Albania	0.00									-21,928,680	-236,142
Algeria	0.00								-789,096,448	-656,178,112	-11,446,489
Antigua and Barbuda	0.00									-393,688	
Argentina	22.90	0.40	0.50	0.67	0.25	0.00	0.50	0.50	17,315,749,888	3,161,603,840	74,549,720
Australia	0.70	0.55	0.75	0.67	0.75	0.33	0.25	0.50	-213,166,160	-15,150,400	990,614,080
Austria	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-194,074,544	-41,970,248	-12,766,555
Azerbaijan	0.00									-8,376,529	6,684,055
Bahamas, The	0.00								-1,538,083	-3,131,090	
Bahrain	0.00								-6,658,883	-10,817,190	-13,843,250
Bangladesh	0.00	0.15	0.00	0.00	0.00	0.00	0.25	1.00			
Barbados	0.00								-8,455,694	-9,293,685	596,657
Belarus	0.00								-153,184,192	-40,281,500	-26,868,500
Belgium	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-501,189,600	-114,565,936	-14,029,816
Belize	0.00									1,451,828	
Benin	0.00								5,199,624	9,319,157	113,601,520
Bhutan	0.00								-6,921,844	-1,603,072	-58,529
Bolivia	0.90								527,390,240	-12,444,651	-6,168,097
Bosnia Herzegovina	0.00								-43,615,192	-40,400,560	-6,610,321
Botswana	0.00								-2,889,330	-14,131,070	-6,677,034
Brazil	25.40	0.50	0.75	0.67	0.75	0.00	0.00	1.00	17,040,158,720	2,194,822,656	766,797,952
Bulgaria	0.00								-56,018,024	135,712,176	-9,558,278
Burkina Faso	0.30								57,078	5,381,999	230,309,392
Burundi	0.00									-731,499	1,474,960
Cambodia	0.00								-3,049,720	-2,128,873	-1,115,046
Cameroon	0.00								-15,984,368	-17,149,276	81,452,560
Canada	8.80	0.30	0.50	0.67	0.25	0.00	0.00	0.50	939,249,664	-112,924,088	-29,023,612
Chile	0.10*	0.35	0.00	0.67	0.75	0.33	0.00	0.50	-172,755,664	6,481,307	-14,075,639
China	3.50	0.50	0.75	0.67	0.75	0.00	0.00	1.00	-25,700,000,000	-124,151,216	-5,819,803,648
China, Hong Kong SAR	0.00	0.10	0.00	0.33	0.25	0.00	0.00	0.00	-65,356,372	-29,521,668	-81,267,856
China, Macao SAR	0.00										
Colombia	0.10*	0.45	0.75	0.67	0.50	0.00	0.00	1.00	-724,366,784	-789,754,560	-107,067,016
Costa Rica	0.10*								-123,133,552	-151,804,688	324,819
Croatia	0.00								-48,184,256	27,943,972	-521,447
Cyprus	0.00								-66,543,424	-45,142,988	-237,356
Czech Republic	0.10*	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-192,978,032	4,553,237	-25,868,046
Denmark	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-679,776,704	-67,569,440	-380,142
Dominican Republic	0.00								-121,403,616	-240,290,640	1,039,130
Ecuador	0.00								-304,911,488	-137,568,896	-31,917,216
Egypt	0.10*								-961,999,488	-1,304,151,040	104,668,352
El Salvador	0.00								-83,664,832	-87,473,208	-60,707,592
Estonia	0.00	0.70	0.75	0.67	0.75	0.67	0.50	1.00	4,100,563	-4,789,791	50,820
Ethiopia	0.00								-2,705,744	4,571,988	6,221,396

Fiji	0.00								-8,935,186	-1,204,390	-64,238
Finland	0.00	0.70	0.75	0.67	0.75	0.67	0.50	1.00	-84,940,344	-7,648,131	-6,747,565
France	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-1,943,008,640	1,642,731,520	-58,657,616
Gambia	0.00									-312,255	
Georgia	0.00								1,032,877	-1,823,604	
Germany	0.10*	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-2,126,193,024	-393,383,808	-83,694,912
Ghana	0.00								-3,389,378	10,764,127	-1,058,377
Greece	0.00	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-278,808,544	-148,931,504	561,404,416
Guatemala	0.00	0.30	0.25	0.67	0.25	0.00	0.00	1.00	-194,275,680	-166,107,024	-47,742,012
Guyana	0.00								-8,534,871	-10,085,709	
Honduras	0.10*										
Hungary	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-255,019,008	895,286,976	-2,401,000
Iceland	0.00								-10,512,437	-7,002,272	-36,001
India	9.40	0.35	0.75	0.67	0.00	0.00	0.00	1.00	546,214,656	547,793,344	2,901,308,928
Indonesia	0.00	0.35	0.25	0.67	0.50	0.00	0.00	1.00	-2,020,914,688	-474,145,600	-1,105,110,656
Iran	0.00								-1,475,193,984	-926,615,872	-104,993,760
Ireland	0.00	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-213,488,512	-99,292,712	-2,614,371
Israel	0.00	0.20	0.25	0.67	0.00	0.00	0.00	0.50	-270,452,000	-261,166,000	29,775,000
Italy	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-1,460,768,896	-382,874,688	-193,678,400
Japan	0.00	0.70	0.75	0.67	0.50	0.67	0.75	1.00	-2,792,618,496	-4,025,553,920	-220,924,080
Jordan	0.00								-151,570,688	-199,201,424	-133,318
Kazakhstan	0.00								-1,318,791	-1,147,327	116,472,928
Kenya	0.00	0.20	0.25	0.33	0.00	0.00	0.00	1.00	-10,902,288	-77,353,912	-8,506,597
Korea	0.00	0.45	0.75	0.67	0.50	0.00	0.00	1.00	-1,505,860,736	-1,957,259,648	-438,531,648
Kyrgyzstan	0.00									-776,576	21,139,580
Latvia	0.00								-29,868,254	-4,489,611	-170,149
Lebanon	0.00								-80,733,720	-106,623,624	-768,175
Lithuania	0.00								-53,178,196	-7,783,907	-317,177
Luxembourg	0.00	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-7,111,608	-5,868,663	-20,706
Macedonia	0.00								-14,604,291	-14,669,599	-1,186,014
Madagascar	0.00								-22,316,580	-2,265,347	36,935
Malawi	0.00								-18,225,440	-3,205,290	13,709,800
Malaysia	0.00	0.35	0.25	0.67	0.50	0.00	0.00	1.00	-675,163,520	-845,131,840	-47,358,484
Mali	0.00								-660,986	-845,367	165,051,552
Malta	0.00								-10,860,813	-13,823,597	
Mauritius	0.00								-27,157,882	-24,671,664	-35,786,028
Mexico	0.10	0.35	0.25	0.67	0.50	0.00	0.00	1.00	-2,091,263,488	-1,416,956,032	-652,944,768
Moldova	0.00								13,866,922	11,773,549	-45,150
Montenegro	0.00									-6,768,905	
Morocco	0.00								-607,741,120	-447,263,808	-70,743,456
Mozambique	0.00								-20,956,390	-11,192,698	10,723,186
Namibia	0.00								-1,974,172	-20,717,252	-1,366,873
Nepal	0.00								-145,736,864	-25,044,100	-2,639,839
Netherlands	0.00	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-715,285,248	-620,386,560	-21,420,964
New Zealand	0.00	0.65	0.75	0.67	0.75	0.33	0.50	1.00	-76,659,848	21,356,110	-2,009,416
Nicaragua	0.00								-56,978,988	-37,633,416	-672,314
Niger	0.00									-16,939,586	-333,678
Norway	0.00	0.60	0.75	0.67	0.75	0.67	0.00	1.00	-118,158,912	-31,560,968	-468,732
Oman	0.00								-24,662,956	-19,447,268	-1,379,069

Pakistan	2.40								-191,655,520	-14,199,184	-474,165,216
Panama	0.00								-98,031,128	-92,955,848	-200,310
Paraguay	2.60								2,111,553,024	210,490,304	18,702,034
Peru	0.00	0.15	0.00	0.33	0.00	0.00	0.00	1.00	-748,333,568	-432,157,344	-138,758,528
Philippines	0.50	0.30	0.25	0.67	0.25	0.00	0.00	1.00	-440,985,248	-86,497,712	-31,570,900
Poland	0.10*	0.60	0.75	0.67	0.75	0.67	0.00	1.00	-852,114,176	-79,040,288	-17,993,888
Portugal	0.10*	0.75	0.75	0.67	0.75	0.67	0.75	1.00	-454,026,528	-348,225,824	-64,978,704
Qatar	0.00								-4,402,277	-12,901,970	
Romania	0.10*	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-138,530,672	402,573,728	-5,191,834
Russian Federation	0.00	0.45	0.75	0.67	0.75	0.00	0.00	0.50	-581,637,184	-42,212,448	-139,920,096
Saudi Arabia	0.00	0.45	0.75	0.33	0.75	0.33	0.00	0.50	-361,359,104	-491,501,408	-32,103,508
Senegal	0.00								-75,902,368	-22,703,252	20,589,648
Serbia	0.00								43,077,248	353,761,664	-2,655,259
Singapore	0.00	0.30	0.75	0.67	0.00	0.00	0.00	0.50	-21,177,334	-16,659,768	-802,860
Slovakia	0.10*	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-39,678,724	12,237,574	-2,298,256
Slovenia	0.00	0.65	0.75	0.67	0.75	0.67	0.25	1.00	7,369,557	-27,521,708	-6,410,384
Solomon	0.00								-163,864		
South Africa	2.20	0.30	0.50	0.67	0.25	0.00	0.00	0.50	-527,172,096	353,892,448	-58,714,276
Spain	0.10	0.60	0.75	0.67	0.75	0.67	0.00	1.00	-2,101,479,424	-839,433,856	3,573,323
Sri Lanka	0.00	0.15	0.00	0.33	0.00	0.00	0.00	1.00	-52,020,344	-8,382,079	-2,102,026
Suriname	0.00								-18,057,644	-6,002,948	
Sweden	0.10*	0.65	0.75	0.67	0.75	0.67	0.25	1.00	-174,067,296	-28,214,160	-8,056,863
Switzerland	0.00	0.55	0.75	0.67	0.75	0.00	0.25	1.00	-157,290,000	-41,809,560	-16,571,762
Syria	0.00								-357,739,712	-412,707,296	158,697,808
Tanzania	0.00								-20,240,748	-18,904,982	95,346,072
Thailand	0.00	0.40	0.75	0.67	0.50	0.00	0.00	0.50	-1,837,361,536	96,281,600	-734,894,848
Togo	0.00								1,116,468	955,698	142,611,488
Tonga	0.00										
Trinidad and Tobago	0.00								-36,656,652	-28,745,390	-250,155
Tunisia	0.00								-310,367,840	-220,969,184	-26,420,600
Turkey	0.00	0.15	0.00	0.33	0.00	0.00	0.00	1.00	-912,950,272	-117,052,424	-1,565,125,248
Uganda	0.00								3,916,021	30,895,264	27,330,112
Ukraine	0.00	0.15	0.25	0.00	0.00	0.00	0.00	1.00	186,939,504	701,102,976	-13,200,956
United Arab Emirates	0.00								-82,356,632	-49,850,196	-844,161
United Kingdom	0.00	0.60	0.75	0.67	0.75	0.67	0.00	1.00	-1,430,673,280	-366,083,040	-31,554,538
United States	66.80	0.35	0.50	0.67	0.25	0.33	0.00	0.50	22,901,841,920	10,279,348,224	6,097,641,984
Uruguay	1.10								659,788,928	17,477,348	-2,359,772
Venezuela	0.00	0.15	0.00	0.33	0.00	0.00	0.00	1.00	-845,945,728	-322,780,896	-13,522,448
Vietnam	0.00	0.30	0.25	0.33	0.50	0.00	0.00	1.00	-1,467,179,264	-458,892,448	-654,773,056
Yemen	0.00									-111,284,384	1,855,504
Zambia	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3,270,001	39,784,512	57,393,808

NOTES:

GMO land data (Tg) are million hectares in 2010. * indicates positive amounts less than 1 million hectares. Source of raw data is James (2011).

GMO policy scores (AP, RA, LP, TR, CG, IA) and composite index (GI) are based on regulations in 2007 or before. Source of raw data is Mauro Vigani.

Net exports (X-M) are U.S. dollars in 2010. Source of raw data is the United Nations Comtrade Database.

Appendix D. --Counterfactual: Cross-Country Estimates of Equation (8) for non-GMO Industries in 2010

Variable	Durum Wheat (SITC 0411) Net Exports		Other Wheat (b) (SITC 0412) Net Exports	
Constant	-0.09	*	-0.13	**
	(0.05)		(0.06)	
Capital (k)	-0.00		0.02	**
	(0.00)		(0.01)	
Labor (l)	-4.09	*	-6.95	***
	(2.26)		(2.13)	
GMO Land (tg) (a)	-1.33		-14.03	
	(4.76)		(36.42)	
Non-GMO Land (tn) (a)	13.11	*	20.32	**
	(7.23)		(7.78)	
R2	0.11		0.52	
N	68		84	

NOTES: Equation (8)
Positive parameter estimates indicate endowments that confer comparative advantage.
Negative parameter estimates indicate endowments that confer comparative disadvantage.
(a) Parameter estimates on disaggregated endowments indicate the trade effects of converting non-GMO land into GMO land.
(b) Defined as "Other wheat (including spelt) and meslin, unmilled"
Heteroscedasticity-corrected standard errors are in parentheses.
**Significant at the 5% level. *Significant at the 10% level.

Appendix E. --Cross-Country Estimates of Equation (8) for 2010, with Lagged Land Variables

Variable	Soybeans			Maize			Cotton		
	1998 Lag	2003 Lag	2008 Lag	1998 Lag	2003 Lag	2008 Lag	1998 Lag	2003 Lag	2008 Lag
Constant	-0.01	-0.16	0.02	-0.09 **	-0.11 **	-0.10 **	-0.07 **	-0.08 **	-0.08
	(0.19)	(0.17)	(0.13)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.06)
Capital (k)	-0.02	-0.02	-0.03	-0.01 **	-0.01 **	-0.01 **	0.00	0.00	0.00
	(0.01)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Labor (l)	-34.87 **	-35.64 **	-32.45 **	0.34	-0.83	-0.53	-8.23 **	-8.79 *	-8.20 **
	(10.21)	(9.19)	(6.43)	(0.98)	(0.82)	(0.83)	(3.13)	(2.93)	(2.66)
GMO Land (tg)	1145.48 **	656.79 **	564.62 **	627.34 **	295.48 **	203.95 **	179.90 **	83.87 **	75.32 **
	(408.04)	(168.31)	(109.82)	(49.88)	(23.64)	(19.99)	(92.33)	(39.22)	(21.94)
Non-GMO Land (tn)	72.47	72.21 *	47.93 *	9.28 *	10.62 **	3.74	20.70	22.44	18.92
	(44.91)	(41.82)	(27.03)	(4.96)	(4.40)	(2.95)	(14.07)	(14.06)	(13.39)
R2	0.67	0.74	0.85	0.44	0.85	0.85	0.67	0.67	0.69
N	116	116	116	123	123	123	115	115	115

NOTES: Equation (8)
Positive parameter estimates indicate endowments that confer comparative advantage.
Negative parameter estimates indicate endowments that confer comparative disadvantage.
(a) Parameter estimates on disaggregated endowments indicate the trade effects of converting non-GMO land into GMO land.
Heteroscedasticity-corrected standard errors are in parentheses.
**Significant at the 5% level. *Significant at the 10% level.

Appendix F. --Cross-Country Estimates of Equations (10) and (11) for 2010, with GMO Land as Dependent Variabl

Variable	Equation (10)a		Equation (11)a	
	GMO Land		GMO Land	
Constant	0.01		-0.08	
	(0.14)		(0.60)	
Capital (k)	0.01		0.01	
	(0.01)		(0.01)	
Labor (l)	-3.63	**	-3.49	*
	(1.63)		(1.83)	
Land (t)	19.03	*	18.65	*
	(9.99)		(10.85)	
GMO Index / Policy Regime (PR)	-0.28			
	(0.26)			
Approval Process (AP)			-0.42	
			(0.44)	
Risk Assessment (RA)			0.62	
			(0.48)	
Labeling Policies (LP)			-0.03	
			(0.83)	
Traceability Requirements (TR)			-0.12	
			(0.63)	
Coexistence Guidelines (CG)			0.09	
			(0.37)	
Membership to Intl. Agmts. (IA)			-0.16	
			(0.58)	
R2	0.66		0.67	
N	55		55	

NOTES: Equations (10) and (11)
(a) Dependent variable is redefined as GMO land in 2010, rather than net exports
Heteroscedasticity-corrected standard errors are in parentheses.
**Significant at the 5% level. *Significant at the 10% level.

APPENDIX G: Derivation of HOV Equations with Technology Differences

In this appendix, we derive a modified expression of the HOV equations where technologies are allowed to differ across GMO and non-GMO countries. The implication of technology differences in the context of the HOV model was first addressed by Trefler (1995 and 1993). Trefler (1995) focuses specifically on "factor augmenting" technologies, where the technology augments the factor endowment such that fewer inputs of the factor are required per unit of output. In other words, the technology improves the factor's productivity.

To consider technology differences in the spirit of Trefler (1995), we introduce factor augmenting technologies into equation (1) as follows:

$$(\underline{X} - \underline{M}) = A_c^{-1} \Pi (\underline{V} - s \underline{V}_w) \quad (14)$$

where Π_c is an $m \times m$ diagonal matrix of factor augmenting technologies; A_c^{-1} is an $n \times m$ inverted technology matrix of factor input requirements (e.g., Rybczynski coefficients) of country c; and $A_c^{-1} \Pi = A^{-1}$ which is the $n \times m$ inverted technology matrix of factor input requirements shown in equation (1). Recall that $(\underline{X} - \underline{M})$ is a $n \times 1$ vector of a country's net trade (exports minus imports) to the rest of the world; $\underline{V}$ is an $m \times 1$ column vector of country endowments; $\underline{V}_w$ is an $m \times 1$ column vector of world endowments; s is a scalar that equals a country's output share of world output (Y/Y_w); and m and n are the number of endowments and industries, respectively.

The matrix A_c is the technology matrix comprised of factor input requirements that link endowments to both output and net trade. These factor input requirements take non-negative values. In contrast, the inverted form of this matrix (A_c^{-1}) is comprised of Rybczynski coefficients. These Rybcznyski coefficients take positive or negative values depending on

whether the corresponding endowment is a source of comparative advantage or disadvantage. Thus, the elements of both matrixes are related to the factor augmenting technologies (Π). This is because in the presence of a factor augmenting technology, less of the corresponding factor is required to produce one unit of output.

We can now apply equation (14) to allow for technology differences across countries that use GMO technologies and those who don't. To this end, we define the reference country *c* to be countries without GMO technologies (e.g., countries that use "conventional" technologies). If all countries fall in this category, then the factor augmenting matrix Π would be an identity matrix and we would revert back to our original equation (1) where technologies are identical across countries (e.g., $A_c^{-1} = A^{-1}$ for all countries). However, if we allow for two groups of countries (GMO and non-GMO countries), then we would expect the elements of Π to be positive and greater than one for those countries in the GMO group, assuming that the use of GMO technologies does in fact reduce factor input use. Note that equation (14) is consistent with Trefler (1995, p 1034, equation (3). The only difference is that we have moved the A term from the left to right-hand side of the equation by inversion (for the purpose of regression analysis) and we have established our reference country as non-GMO countries rather than as the US.

In equation (14), the parameters comprising the inverted technology matrix (A_c^{-1}) for countries *c* are standard Rybczynski coefficients which link a country's endowments to her net exports (and outputs) in each industry. For example, a_{ij} would be the Rybczynski coefficient corresponding with the i^{th} industry and j^{th} endowment of the inverted technology matrix (A_c^{-1}) for country c. If $a_{ij} > 0$, then the j^{th} endowment confers a comparative advantage in industry i; and if $a_{ij} < 0$ then the j^{th} endowment confers a comparative disadvantage in industry i. Further, in equation (14), the elements comprising the *m x m* diagonal matrix of factor augmenting

technologies (Π_c) are positive. For example, π_j would be the diagonal element corresponding with the j^{th} endowment. We expect these terms to take values greater than one ($\pi_j > 1$) if factor productivities under GMO technologies are relatively higher than with conventional technologies (as assumed above); equal to one if GMO technologies are identical to non-GMO technologies ($\pi_j = 1$); and less than one if factor productivities under conventional technologies are relatively higher than with GMO technologies ($0 < \pi_j < 1$). Thus, we expect factor augmenting technologies to increase the absolute value of the Rybczynski effects for endowments whose productivity increases due to the GMO technologies.

We can now modify equation (14) to derive our new empirical specification which allows for technology differences across countries. First, we express equation (14) in industry form as

$$(X_i - M_i) = A_c^i \, \Pi \, (\underline{V} - s \, \underline{V}_w) \tag{15}$$

where $(X_i - M_i)$ is the i^{th} row of column vector $(\underline{X} - \underline{M})$; A_c^i is the i^{th} row of matrix A_c^{-1}; and Π is the *m × m diagonal* matrix of factor augmenting technologies.

Second, we divide all variables in equation (15) by country output (Y). This gives

$$(X_i - M_i) / Y = A_c^i \, \Pi \, (\underline{V} / Y - \underline{V}_w / Y_w) \tag{16}$$

where the term "s" cancels out because $s/Y = (Y/Y_w) / Y = 1/Y_w$.

Third, we collect all terms that are constant across countries. In equation (16), the terms $\underline{V}_w$ and Y_w are world aggregates and do not vary by country. However, we now allow the elements of the row vector A_c^i and diagonal matrix Π to differ across countries due to factor augmenting technologies. Collecting constant terms gives

$$(X_i - M_i) / Y = A_c^i \, \Pi \, (\underline{V} / Y - \underline{C}_i) \tag{17}$$

where $\underline{C}_i = (\underline{V}_w / Y_w)$.

Fourth, we rewrite equation (17) using lower case letters to represent the variables that

are scaled by country output (Y). This gives

$$(x_i - m_i) = A_c^{\,i}\, \Pi\, (\underline{v} - \underline{C}_i) \qquad (18)$$

Fifth, we can define endowments in the familiar way to include country aggregates of capital (K), labor (L) and land (T). Thus, the column vector ($\underline{v}$) includes scaled expressions of these endowments (denoted k, l and t). Equation (18) can then be rearranged and rewritten as

$$(x_i - m_i) = b_{i0}\, C_i + b_{i1}\, k + b_{i2}\, l + b_{i3}\, t \qquad (19)$$

In equation (19), the term $b_{i0}\, C_i = -\,(b_{i1}\, k^w + b_{i2}\, l^w + b_{i3}\, t^w)$, where k^w, l^w, and t^w are scaled world aggregate endowments that are constant across countries (e.g., K^w/Y^w, L^w/Y^w and T^w/Y^w). Further, the terms $b_i = a_i\, \pi$, which are the product of the Rybczynski coefficients and factor augmenting technologies.

In equation (19), net exports are defined at the industry level while endowments are aggregates, as the HO theory suggests. That is, a country's *industry* level trade depends on the country's aggregate endowments (not factor inputs). However, the traditional Rybczynski coefficients (a_i) are now replaced with what we refer to as "effective Rybczynski coefficients" (ERCs) or ($b_i = a_i \pi$). We expect these ERCs to vary across the GMO and non-GMO countries if technologies differ across these two groups.

Thus, to empirically estimate equation (19) using cross-country data, we need to allow both the intercept ($b_{i0}\, C_i$) and slope estimates to differ for GMO and non-GMO countries. To this end, we construct a dummy variable that equals one for countries that have adopted GMOs and zero otherwise. We include this dummy variable along with the constant to allow the intercept term to differ between GMO and non-GMO countries. We also interact this dummy variable with each right-hand-side endowment to allow the slope estimates to differ between GMO and non-GMO countries. The resulting empirical specification is

$$(x_i - m_i) = \beta_{i0} + \beta_{i1} G + \beta_{i2} k + \beta_{i3} l + \beta_{i4} t + \beta_{i5} G \cdot k + \beta_{i6} G \cdot l + \beta_{i7} G \cdot t + \varepsilon_i \quad (20)$$

where G is a GMO dummy variable that equals one if the country has adopted GMOs and zero otherwise; ε_i is a randomly distributed error term; and all other variables are as previously defined. This is the baseline expression of the HOV equations which allow for factor-augmenting technology differences across GMO and non-GMO countries. The new interaction terms allow us to examine deviations in ERC's for GMO countries relative to non-GMO countries. Our *a priori* expectation is that the ERCs will be larger in absolute value for GMO countries relative to non-GMO countries for those endowments where GMO technologies are factor augmenting.

Appendix H.--Cross-Country Estimates of Equations (12) and (13) for 2010

	Equation (12)			Equation (13)		
Variable	Soybean Net Exports	Maize Net Exports	Cotton Net Exports	Soybean Net Exports	Maize Net Exports	Cotton Net Exports
Constant	-0.23	-0.21	-0.25	-1.66	1.04	-0.75
	(0.60)	(0.24)	(0.23)	(4.14)	(0.90)	(0.66)
*Constant * GMO Dummy (G)*	-0.55	-0.55 *	-0.48 **	-0.34	-0.39	-0.40 **
	(0.87)	(0.29)	(0.17)	(0.92)	(0.29)	(0.15)
Capital	-0.01 **	-0.01 **	0.00	-0.00	-0.02 **	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Labor	-22.37 **	-6.47 *	-9.99 **	-31.69 *	-3.67	-7.62 **
	(6.92)	(3.34)	(1.98)	(18.19)	(4.55)	(3.36)
Land	12.70 **	13.39 *	3.92 *	15.21	12.30 *	7.52
	(3.35)	(7.13)	(2.19)	(16.31)	(6.84)	(4.53)
*Capital * GMO Dummy (G)*	-0.00	0.04 **	0.00	0.01	0.04 **	0.00
	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)
*Labor * GMO Dummy (G)*	-39.44 **	-0.55	-2.75	-32.24 **	-2.59	-4.97
	(10.13)	(3.62)	(2.58)	(15.25)	(4.17)	(3.42)
*Land * GMO Dummy (G)*	206.96 **	11.72	45.25 **	199.62 **	11.95	42.61 **
	(55.10)	(14.43)	(12.70)	(61.05)	(13.48)	(9.49)
GMO Index / Policy Regime (PR)	-0.02	0.37	0.48			
	(1.07)	(0.44)	(0.36)			
Approval Process (AP)				-0.42	-0.72	0.27
				(2.02)	(0.64)	(0.79)
Risk Assessment (RA)				-0.91	-0.99	0.46
				(2.69)	(0.76)	(0.51)
Labeling Policies (LP)				2.16	0.36	-0.91
				(4.49)	(0.88)	(0.74)
Traceability Requirements (TR)				-4.16	-0.21	1.05 *
				(2.97)	(0.72)	(0.54)
Coexistence Guidelines (CG)				2.80	1.53 **	-0.36
				(2.65)	(0.67)	(0.27)
Membership to Intl. Agmts. (IA)				1.96	-0.67	0.52
				(4.04)	(0.82)	(0.59)
R2	0.81	0.79	0.86	0.82	0.83	0.88
N	54	54	54	54	54	54

NOTES: Equations (12) and (13)
Positive parameter estimates indicate endowments that confer comparative advantage.
Negative parameter estimates indicate endowments that confer comparative disadvantage.
Positive parameter estimates on policy variables indicate policies that decrease net costs and increase comparative advantage.
Negative parameter estimates on policy variables indicate policies that increase net costs and decrease comparative advantage.
GMO Dummy (G) equals one if country has adopted GMO technologies and zero otherwise.
Heteroscedasticity corrected standard errors are in parentheses.
**Significant at 5% level. *Signficant at 10% level.

Appendix I. --Cross-Country Estimates of Equation (8), with GMO Adoption Dummy for 2010

Variable	Soybean Net Exports		Maize Net Exports		Cotton Net Exports	
Constant	-0.01		-0.08	**	-0.08	
	(0.11)		(0.04)		(0.05)	
GMO Dummy (G)	0.09		-0.28	**	-0.05	
	(0.26)		(0.12)		(0.09)	
Capital (k)	-0.02		-0.01		0.00	
	(0.02)		(0.01)		(0.00)	
Labor (l)	-31.42	**	-0.43		-8.25	**
	(5.83)		(1.00)		(2.68)	
GMO Land (tg) (a)	536.14	**	181.17	**	68.85	**
	(87.36)		(24.88)		(18.82)	
Non-GMO Land (tn) (a)	37.77		3.65		18.81	
	(23.60)		(3.17)		(13.91)	
R2	0.89		0.83		0.68	
N	116		123		115	

NOTES: Equation (8)
Positive parameter estimates indicate endowments that confer comparative advantage.
Negative parameter estimates indicate endowments that confer comparative disadvantage.
(a) Parameter estimates on disaggregated endowments indicate the trade effects of converting non-GMO land into GMO land.
Heteroscedasticity-corrected standard errors are in parentheses.
**Significant at the 5% level. *Significant at the 10% level.