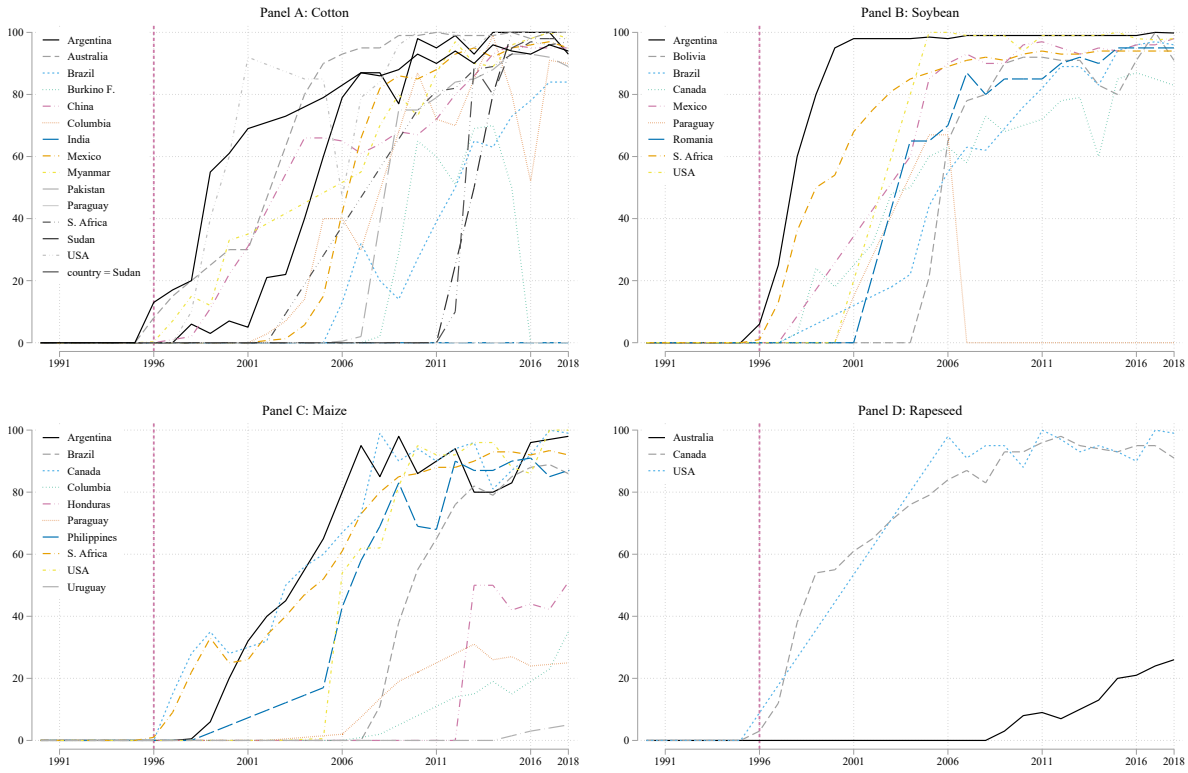
Online Appendix: National and global impacts of genetically modified crops

Casper Worm Hansen Asger Mose Wingender*

August 2022

A Additional figures and tables

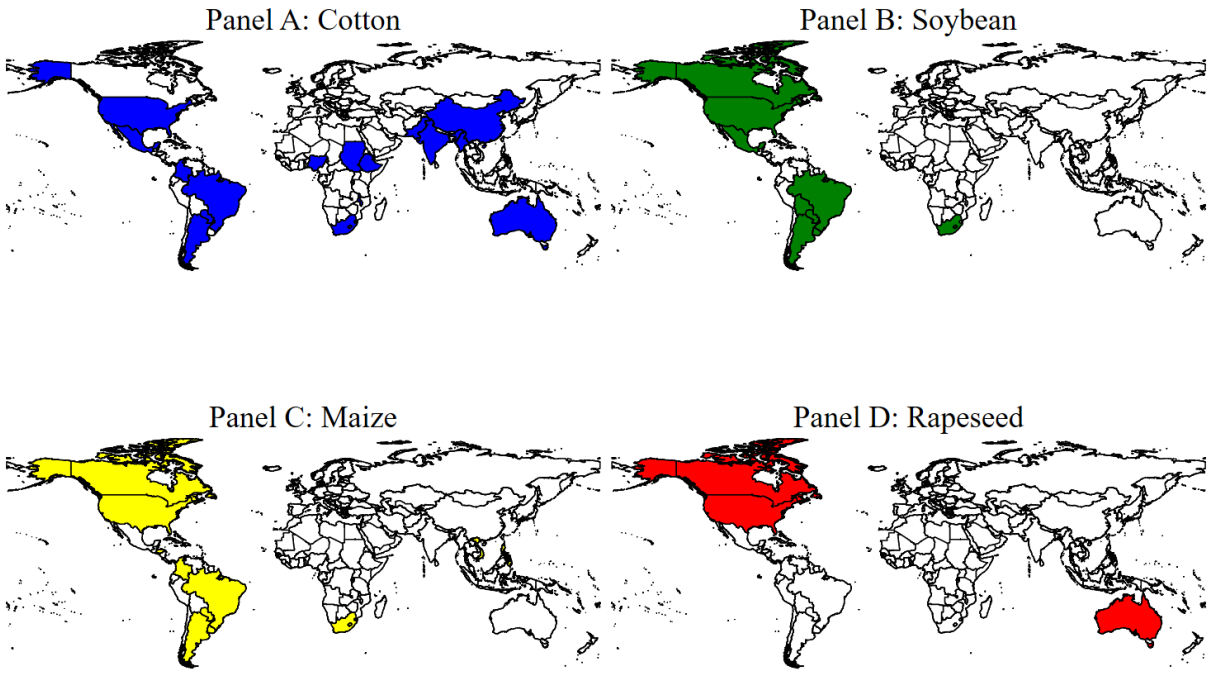
Figure A.1: GM-adoption rates



Notes: *This figure shows GM-adoption rates, defined as the share of GM varieties in the total planted area of a crop. Note that planting may be in a different calendar year than harvest. See Appendix B for the data sources.*

*Hansen: University of Copenhagen, casper.worm.hansen@econ.ku.dk; Wingender: University of Copenhagen, amw@econ.ku.dk.

Figure A.2: Countries cultivating GM crops in 2019



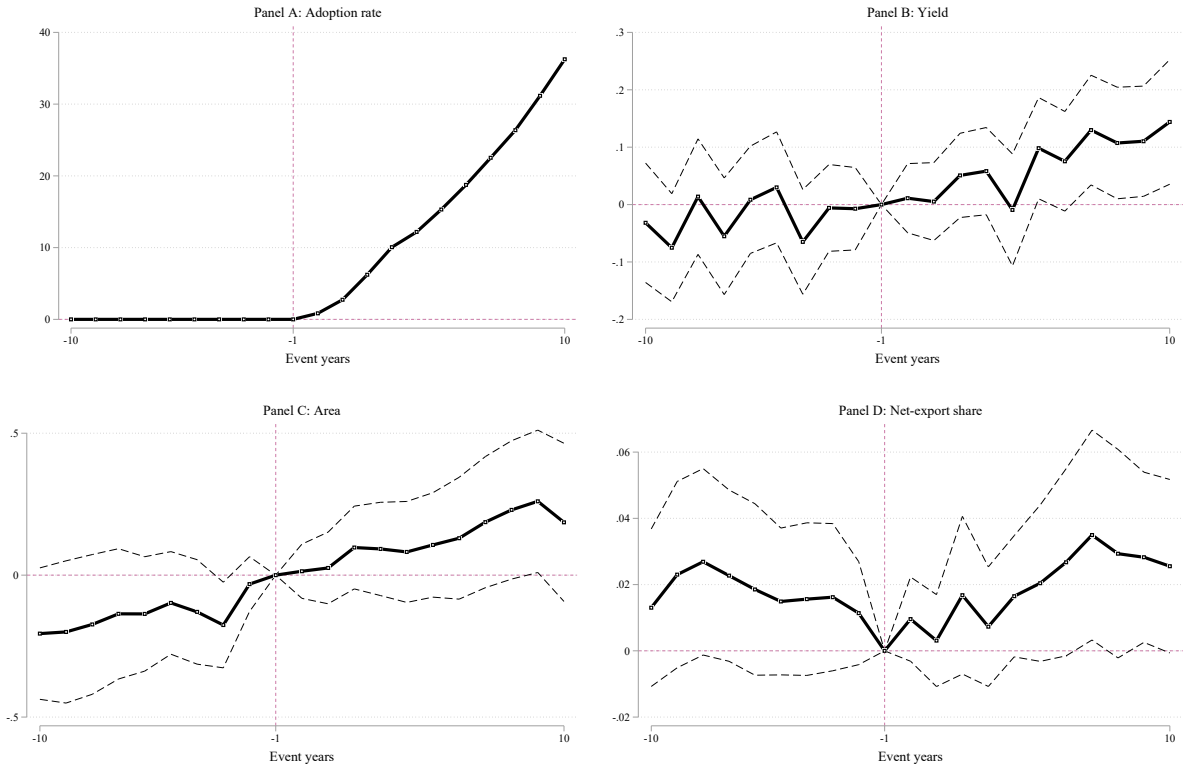
Notes: *This figure shows the countries that cultivated GM cotton (blue), GM soybean (green), GM maize (yellow), and GM rapeseed (red) in 2019, the end of our sample period. See Appendix B for the data sources and additional details*

Table A.1: Balancing tests on pre-GM characteristics

	mean diff.	
agricultural employment share, 1995	-0.904	(-0.14)
agricultural share of GDP, 1995	-2.968	(-0.74)
ln agricultural VA per worker, 1995	-0.621	(-1.44)
pesticide per area, 1995	-0.205	(-0.26)
population density, 1995	-0.0146	(-0.51)
ln GDP per capita, 1995	0.0769	(0.25)
absolute latitude	1.137	(0.30)
share frost days, 1960-90	-0.0182	(-0.36)
precipitation, 1960-90	-22.47	(-0.14)
temperature, 1960-90	-0.284	(-0.15)
growing period, 1960-90	-7.478	(-0.34)
rainfed soil suit., good or more, 1960-90	6.525	(1.01)
tropical and subtropical land, 1960-90	4.205	(0.48)

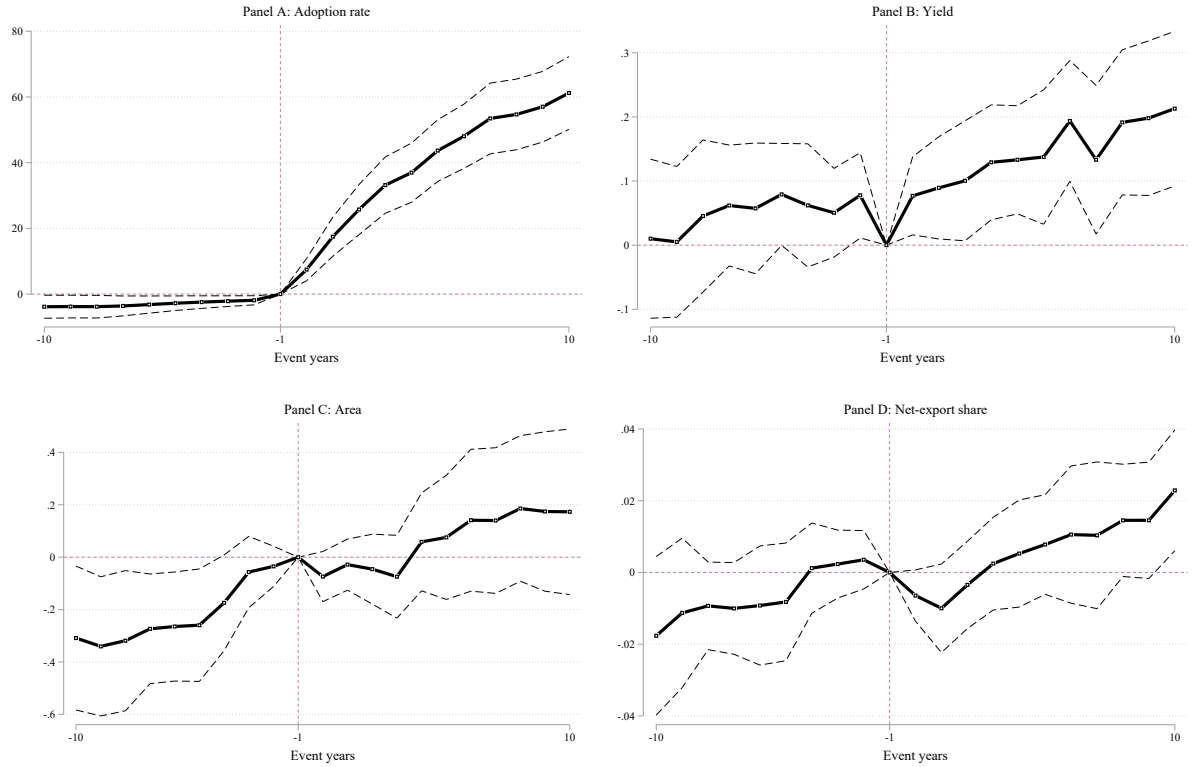
Notes: *This table reports mean difference t-tests between GM and non-GM approving countries for different pre-GM characteristics. The first column reports the mean difference, while the second column reports the corresponding t-statistics in parentheses. The agricultural employment share (row 1) is from the International Labor Organization, and the remaining three agricultural variables (rows 2-4) are from FAOSTAT. Population density is from World Development Indicators (n.d.), GDP per capita is from Feenstra et al. (2021). Latitude is from Galor and Özak (2016) and the remaining geographical and climatic variables are from FAO GAEZ v3.0. "Absolute latitude" is the numerical latitude of the centroid of the country, "share frost days, 1960-90" is the number of days with frost (out of a year) on agricultural land measured as an average over the period 1960-1990, "precipitation, 1960-1990" is the average annual precipitation over the period 1960-1990, "temperature, 1960-1990" is the average annual temperature over the period 1960-1990, "growing period, 1960-90" is the average number of days during the growing period measured over the period 1960-1990, "rainfed soil suit., good or more, 1960-90" is the share of land in a country that FAO classifies a having good or better than good suitability for rainfed agriculture using climate data for the period 1960-1990, and "tropical and subtropical land, 1960-90" is the share of land in a country with tropical or subtropical climate.*

Figure A.3: Event-study estimates for all GM crops using 1996 to define the post-GM period for all adopting countries



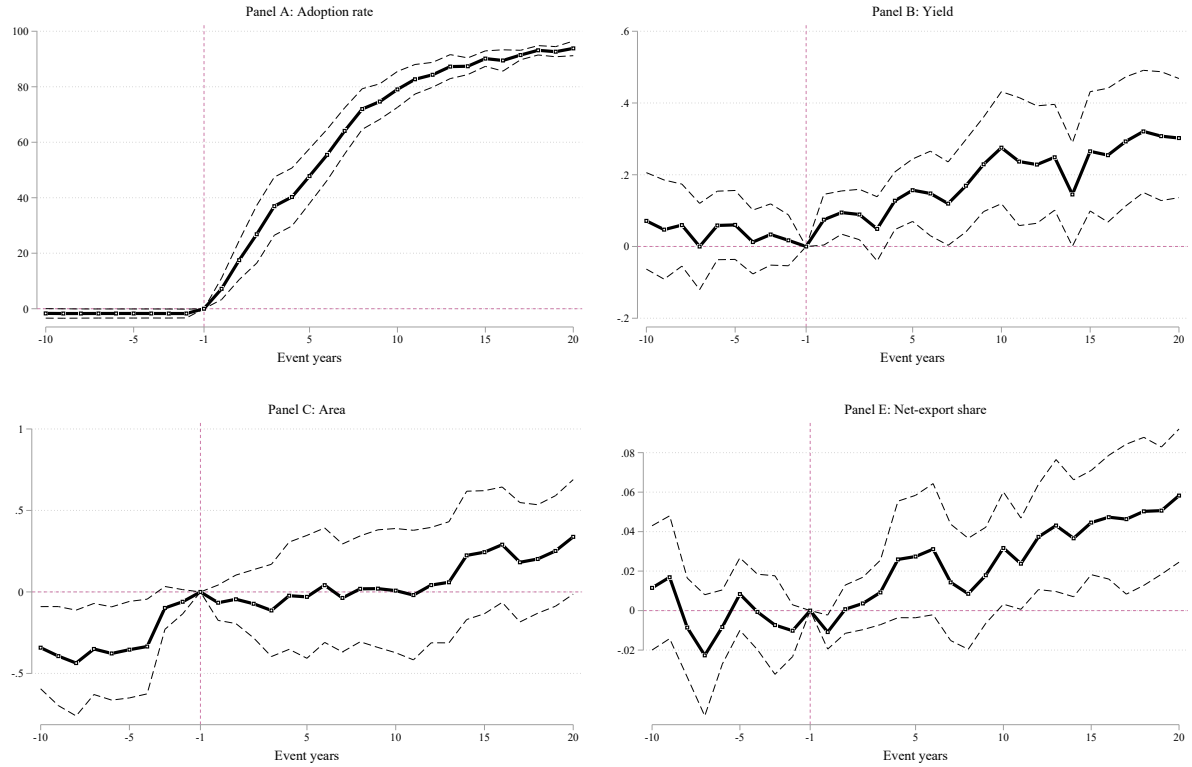
Notes: *This figure reports event-study estimates based on a specification similar to one used in Figure 2, but using 1996 as the event-year (year 0) for all GM approving countries irrespective of when GM crops were actually approved. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

Figure A.4: Event-study estimates for all GM crops using de jure approval years



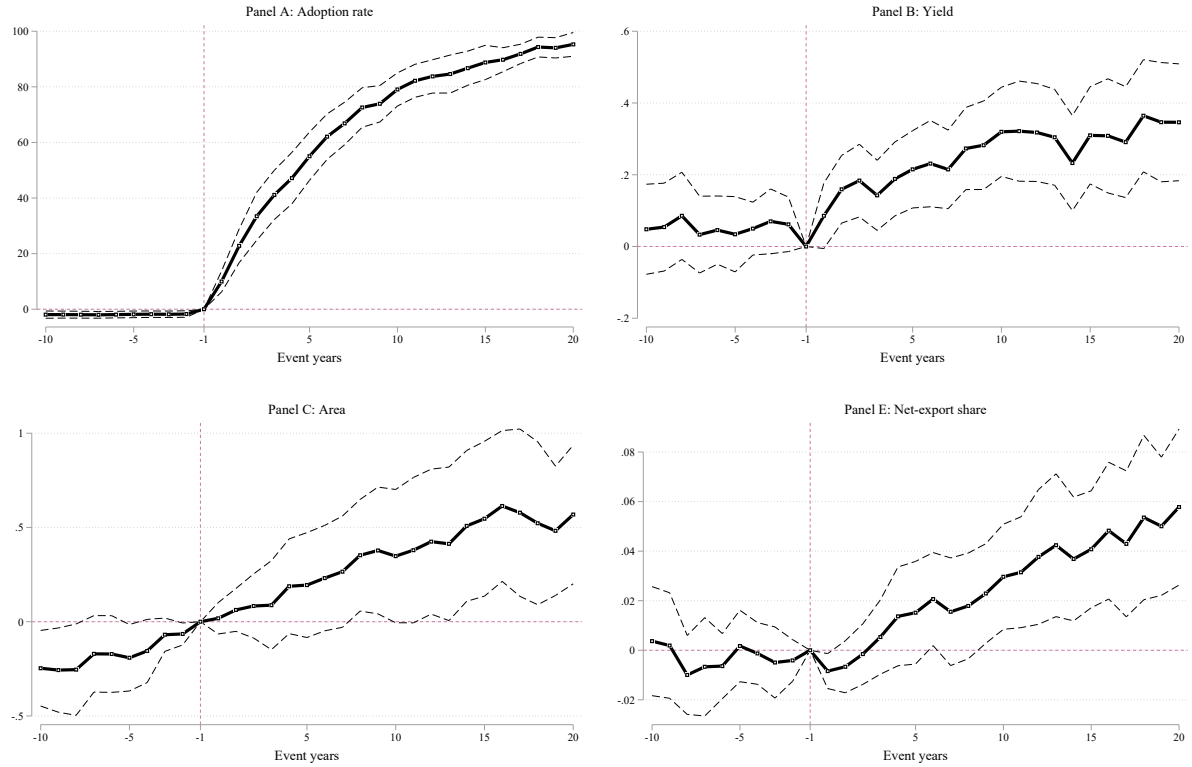
Notes: *This figure reports DDD event-study estimates based on a specification similar to one used in Figure 2, but using the year after formal GM approval to define the events instead of the first actual harvest, which may be both before or several years after formal approval. See Table B.2 for the dates we use.*

Figure A.5: Event studies with a 20-year post treatment window (balanced sample)



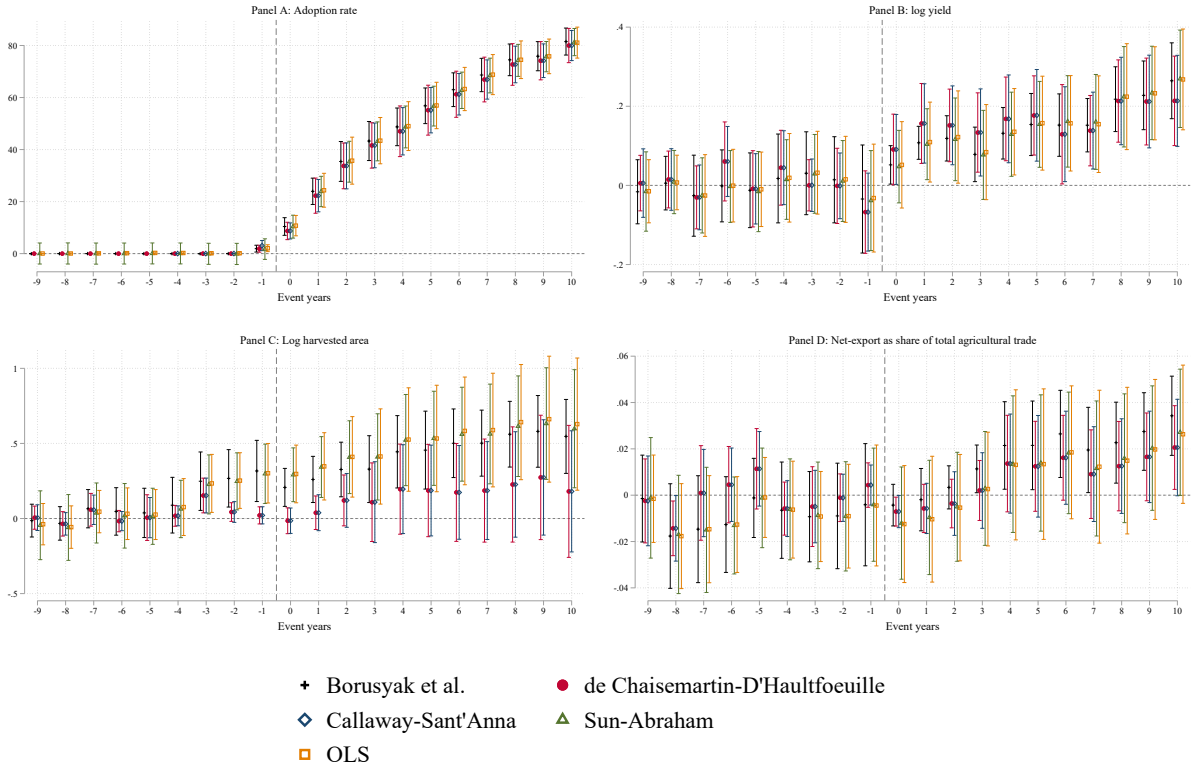
Notes: *This figure reports DDD event-study estimates from estimation Equation 1. We assume homogeneous treatment-effects across GM crops. The event-window for adopting country-crop units is 10 years before and 20 years after the first unrestricted GM harvest. The estimation window is 1986-2019. Units treated in 1999 or later are omitted in order to balance the sample. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

Figure A.6: Event studies with a 20-year post treatment window (unbalanced sample)



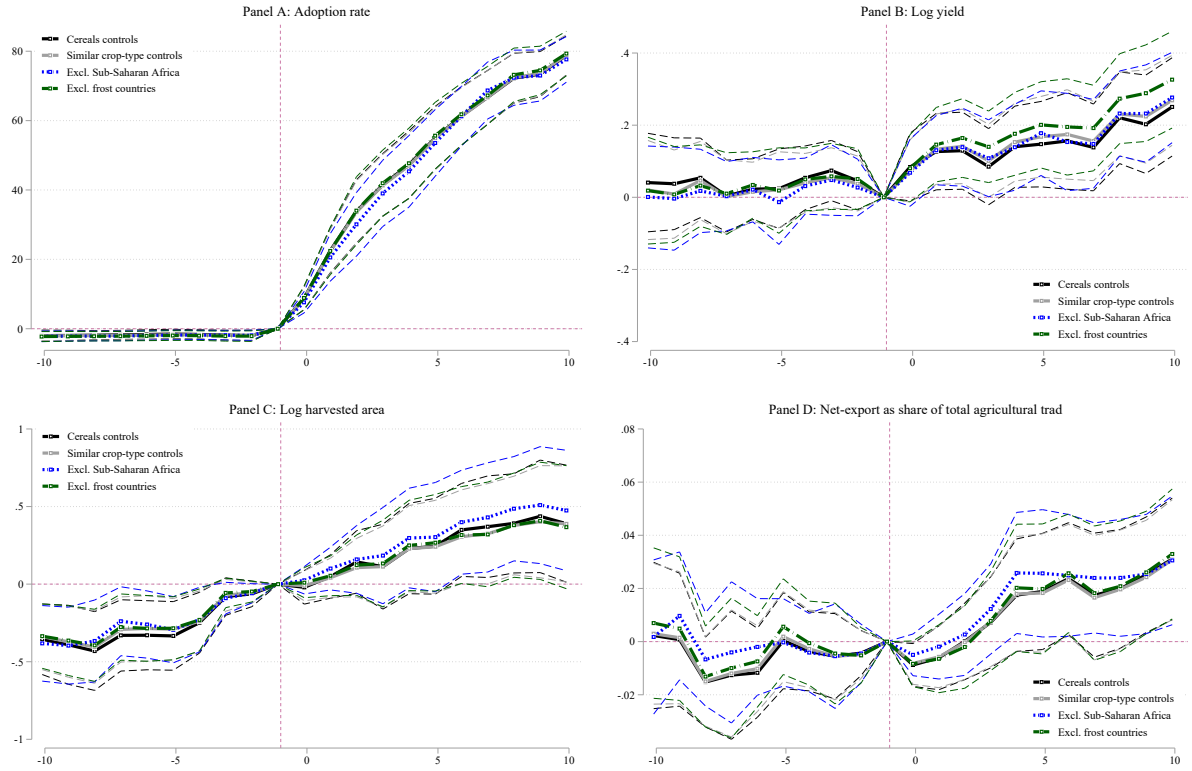
Notes: *This figure reports DDD event-study estimates from estimation Equation 1. We assume homogeneous treatment-effects across GM crops. The event-window for adopting country-crop units is 10 years before and 20 years after the first unrestricted GM harvest. The estimation window is 1986-2019. All treated units are included, which means that the sample is unbalanced in the later post-event years. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

Figure A.7: Event-study estimates using alternative rollout estimators



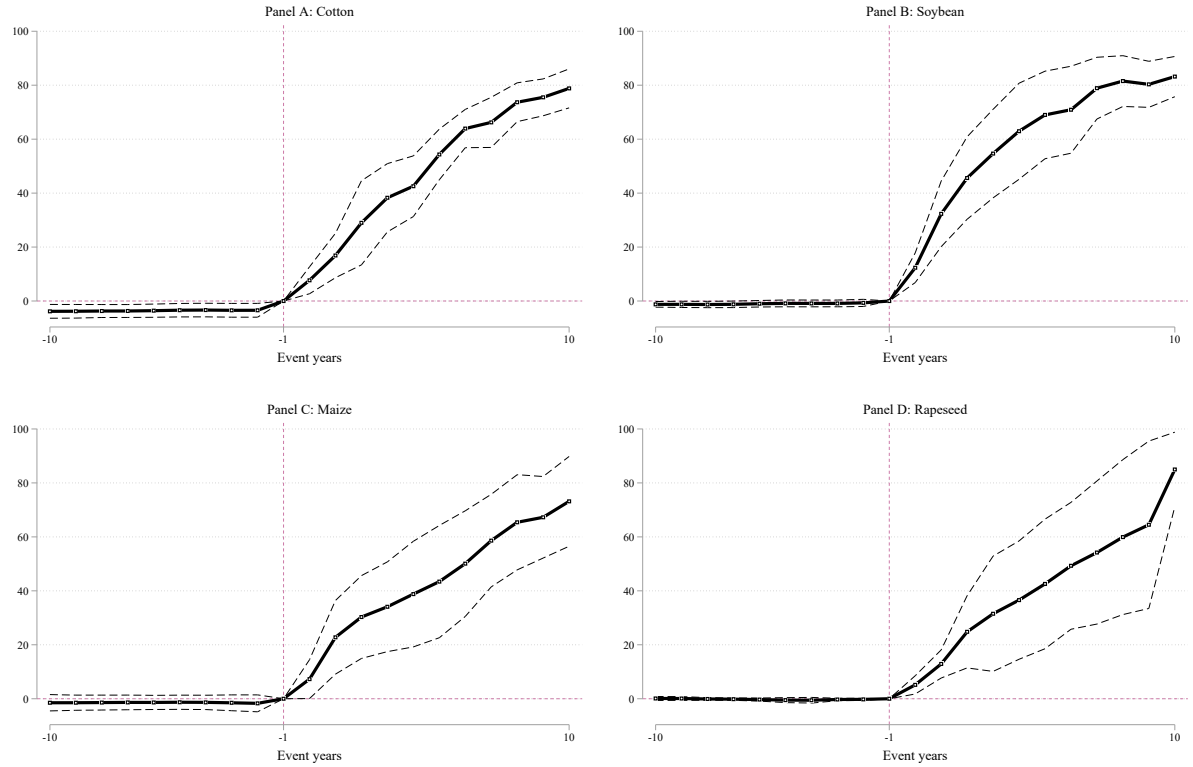
Notes: *This figure reports event-study estimates for our baseline specification (Figure 2) but using alternative roll-out estimators as proposed by Sun and Abraham (2021); Borusyak et al. (2021); De Chaisemartin and d'Haultfoeuille (2020); Callaway and Sant Anna (2020). To compare the OLS estimates with the alternative rollout estimates, the omitted comparison year is 10 years before the first GM harvest in all specifications, and not one years before as in the main paper.*

Figure A.8: Event-study estimates when restricting the control crops and countries



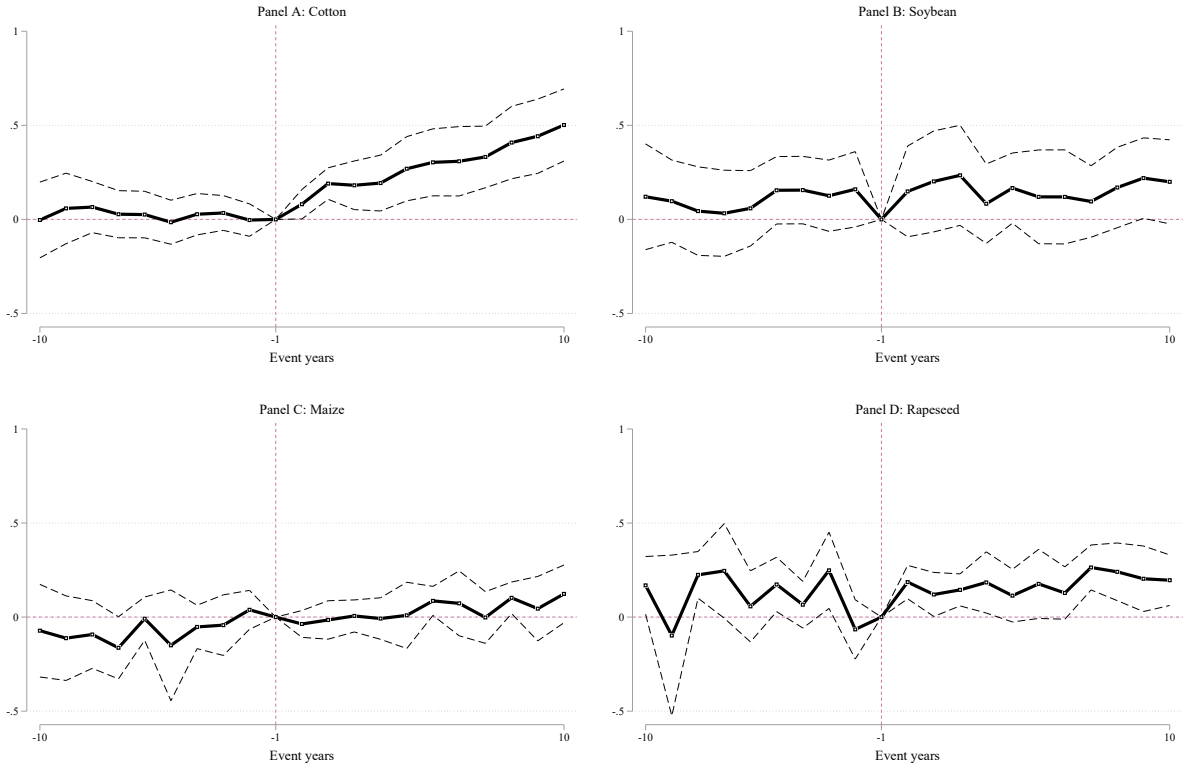
Notes: *This figure reports DDD event-study estimates based on a specification similar to one used in Figure 2, but where we restrict the number of control crops and countries included in the sample: "Cereals controls" includes only cereal crops as controls; "Similar crop-type controls" includes only control crops of similar types as the treated GM crops (i.e., fiber, oil crops, and cereals); "Excl. Sub-Saharan countries" excludes Sub-Saharan countries; "Excl. frost countries" excludes countries with more than six month of frost per year. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level. The indicator for Sub-Saharan countries is obtained from Galor and Özak (2016) and frost-country variable is based on own calculations. See the main paper.*

Figure A.9: Adoption estimates for each GM crop



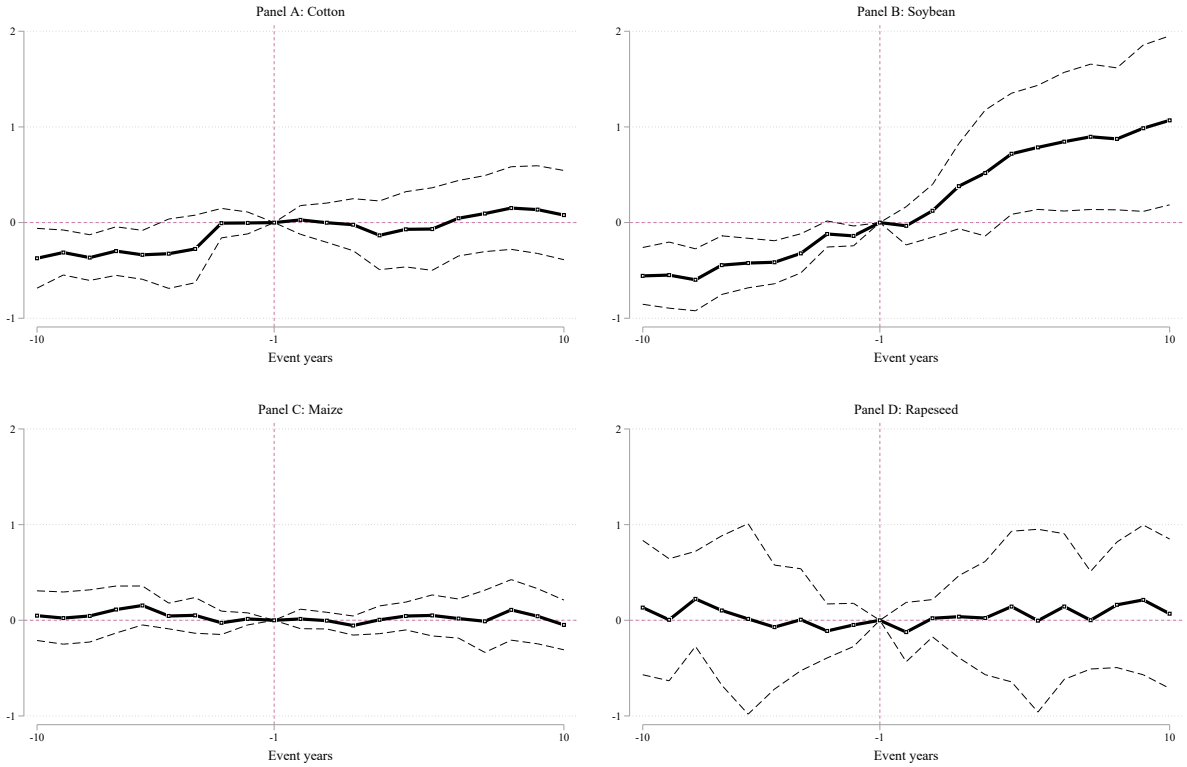
Notes: *This figure reports event-study estimates based on a modified version of Equation 1 in which we interact the event indicators with GM crop indicators (cotton, soybean, maize, rapeseed). The modification allows for heterogeneous speeds of adoption across the four crops. All possible interaction fixed effects are included. The event-window for adopting country-crop units is 10 years before approval and 10 after. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

Figure A.10: Crop-yield estimates for each GM crop



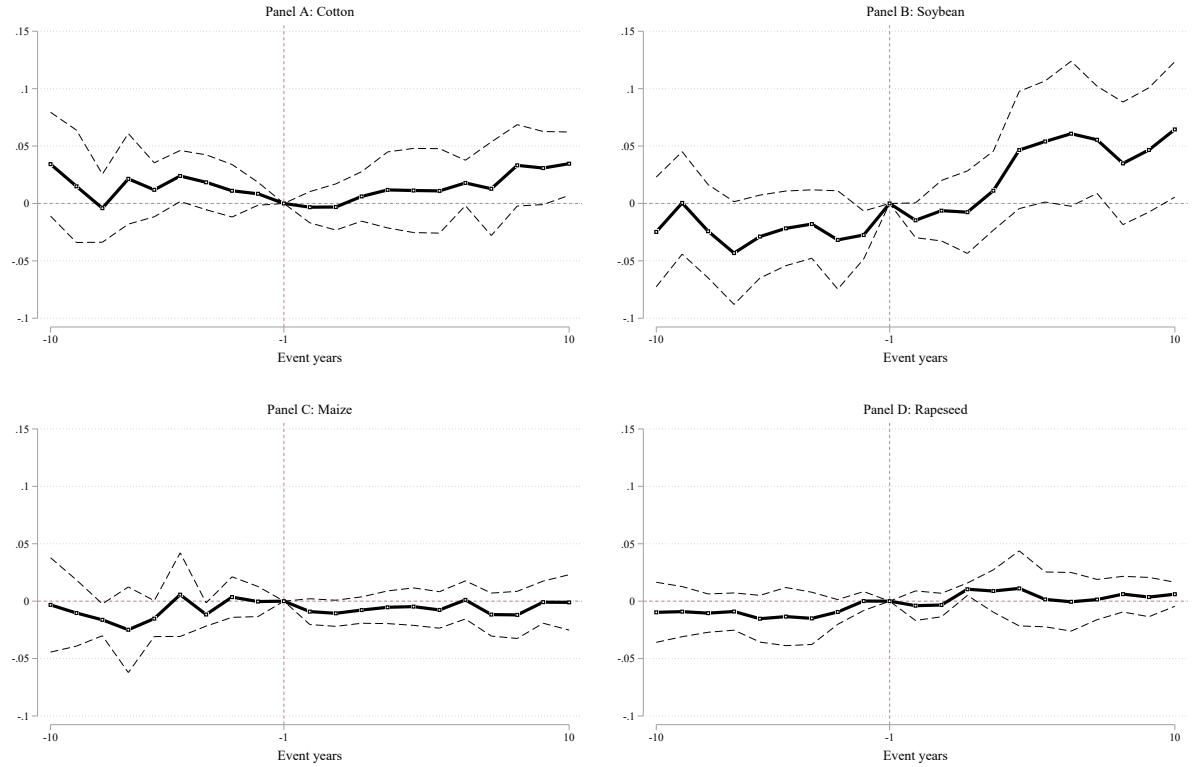
Notes: *This figure reports event-study estimates based on a modified version of Equation 1 in which we interact the event indicators with GM crop indicators (cotton, soybean, maize, rapeseed). The modification allows for heterogeneous treatment effects (on crop yields) across GM crops. All possible interaction fixed effects are included. The event-window for adopting country-crop units is 10 years before approval and 10 after. Standard errors are clustered at the country-crop level. Note that the positive effect on maize yields we find in Table 1 of the main paper is not visible here because this figure omits countries with less than ten years of treatment in order to balance the sample. The omitted are all relatively poor and have had substantial yield gains following GM adoption. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

Figure A.11: Harvested area estimates for each GM crop



Notes: *This figure reports event-study estimates based on a modified version of Equation 1 in which we interact the event indicators with GM crop indicators (cotton, soybean, maize, rapeseed). The modification allows for heterogeneous treatment effects (on harvested area) across GM crops. All possible interaction fixed effects are included. The event-window for approving country-crop units is 10 years before approval and 10 after. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

Figure A.12: Net-export-share estimates for each GM crop



Notes: *This figure reports event-study estimates based on a modified version of Equation 1 in which we interact the event indicators with GM crop indicators (cotton, soybean, maize, rapeseed). The modification allows for heterogeneous treatment effects (on net-export shares) across GM crops. All possible interaction fixed effects are included. The event-window for approving country-crop units is 10 years before approval and 10 after. The dashed lines are 95 percent confidence bands based on standard errors clustered at the country-crop level.*

B Further data documentation: GM approval, first GM harvest, and adoption rates

Table B.2 reports the years in which GM varieties of cotton, maize, rapeseed, and soybean were formally approved. For each crop, we report information on all countries in which planting of GM varieties have been approved by the national legislature. Approval did not necessarily mean that farmers were free to plant GM crops. In some cases, GM varieties were approved at the national level, but banned at the state level (e.g., rapeseed in Australia). In other cases, planting of GM crops were heavily restricted. Chile and Nicaragua, for instance, only allow GM crops

for the purpose of seed export, and the EU regulates how and where GM crops may be grown to an extent that effectively bans GM cultivation. In certain low and middle income countries, GM cultivation began before the government formally approved GM crops. Farmers in Brazil and Paraguay imported GM seeds from Argentina without any government interference years before legislation made them available for domestic purchase. Farmers in Pakistan likewise started to grow GM cotton as soon as they could obtain seeds from India next door. In the tables, we therefore report two sets of approval dates: the formal approval date by national legislation, and one labeled "first unrestricted harvest", defines as the actual year in which farmers could harvest GM crops without any government interference. The first unrestricted harvest is usually one or two years after formal approval of GM varieties depending on the agricultural calendar. In some cases, GM cultivation continued to be effectively banned due to regulatory restrictions, in others, GM cultivation were tolerated long before any formal legislation. We describe such special cases in the notes to the table. Table B.2 also reports the few cases of GM approval being repealed after some years of commercial production.

On a side note, Scheitrum et al. (2020) also compare adopters to non-adopters, but count among adopters countries that at some point formally have approved cultivation a GM variety even if they still ban commercial production, or regulate it to an extent that it becomes unviable. Including countries with no commercial GM production in the treatment group, while leaving countries with extensive GM cultivation, but no formal approval in the control group, presumably helps to explain why they find little effect on yields.

Our main sources of GM adoption rates are the International Service for the Acquisition of Agri-biotech Applications (ISAAA) (James 1996-2019) and PG Economics Ltd. (Brookes and Barfoot 2008-2020). We supplement these data with data from country-specific sources for Argentina (Trigo 2011), Bolivia (Zeballos 2012), Canada (Smyth 2014), the United States (USDA Economic Research Service n.d.), and Uruguay (USDA Foreign Agricultural Service 2009). The many different sources we use means that our GM adoption data are more comprehensive than any other such data set currently available.

Table B.2: GM approval dates and first permitted harvest

Crop	Country	Formal approval	First unrestricted harvest	Approval withdrawn	Notes	Sources*
Rapeseed	Canada	1995	1996			ISAAA, Smyth (2014)
Rapeseed	United States	1995	1996			ISAAA, FAO
Rapeseed	Australia	2003	2008		Approved by federal govt in 2003, but banned by all states until 2007. First GM rapeseed planted in 2008, harvested in 2009	ISAAA, FAO
Cotton	United States	1996	1996			ISAAA, FAO
Cotton	Australia	1996	1997			ISAAA, FAO
Cotton	China	1996	1997			ISAAA, Qiao (2015)
Cotton	Mexico	1996	1997			ISAAA, FAO
Cotton	South Africa	1997	1999			ISAAA, FAO, Brookes and Barfoot (2008)
Cotton	Argentina	1998	1999			ISAAA, FAO, Trigo and Cap (2003)
Cotton	Colombia	2002	2003		Some quantities were planted in 2002, according to the official data, presumably as a trial as commercial GM cotton was not approved for the 2002 planting season.	ISAAA, Dargent and Urteaga (2019)
Cotton	India	2002	2002			ISAAA, FAO
Cotton	Brazil	2005	2007		Permitted in 2005, but seeds unavailable for the 2005 planting season. Cotton planted in 2006 harvested in 2007	ISAAA, FAO
Cotton	Myanmar	2006	2007			ISAAA, FAO
Cotton	Costa Rica	2008			Cultivation limited to seed export	ISAAA
Cotton	Burkina Faso	2009	2008	2016		ISAAA
Cotton	Pakistan	2010	2003		GM cotton widespread before formal approval. Seeds were imported from India, which permitted GM cotton in 2002. We assume import began for the next agricultural year.	ISAAA, Kouser and Qaim (2013)
Cotton	Paraguay	2011	2012			ISAAA, FAO
Cotton	Sudan	2012	2012			ISAAA, FAO
Cotton	eSwantini	2018	2019			ISAAA, FAO
Cotton	Ethiopia	2018	2020			ISAAA, FAO
Cotton	Malawi	2018	2020			ISAAA, FAO
Cotton	Nigeria	2019	2019			ISAAA, FAO
Maize	United States	1995	1996			ISAAA
Maize	Canada	1996	1996			ISAAA, Smyth (2014)

Continuation of Table B.2						
Crop	**Country**	**Formal approval**	**First unrestricted harvest**	**Approval withdrawn**	**Notes**	**Sources**
Maize	Mexico	1996				ISAAA, USDA Foreign Agricultural Service (2012, 2021a)
Maize	South Africa	1997	1999			ISAAA, FAO, Brookes and Barfoot (2008)
Maize	Argentina	1998	1999			ISAAA, FAO, Trigo and Cap (2003)
Maize	Czechia	1998			EU regulation effectively bans GM cultivation. Local regulation did the same before EU membership	ISAAA, USDA Foreign Agricultural Service (2020b)
Maize	Portugal	1998			EU regulation effectively bans GM cultivation	ISAAA, USDA Foreign Agricultural Service (2020b)
Maize	Romania	1998			EU regulation effectively bans GM cultivation. Local regulation did the same before EU membership	ISAAA, USDA Foreign Agricultural Service (2020b)
Maize	Slovakia	1998			EU regulation effectively bans GM cultivation. Local regulation did the same before EU membership	ISAAA, USDA Foreign Agricultural Service (2020b)
Maize	Spain	1998			Spain grows a modest amount of GM maize, so the country is a partial exception to the rule that EU regulations makes it unprofitable although legal. Still, EU regulation keeps the GM adoption rate in Spain below one third.	ISAAA, Brookes and Barfoot (2020)
Maize	Honduras	2001			GM maize introduced in 2002 on a pre-commercialization basis, later commercialized but only allowed in three of the 18 Honduran department, and only in certain areas within the three departments. GM maize therefore remains marginal.	ISAAA, USDA
Maize	Philippines	2002	2003			ISAAA, FAO
Maize	Uruguay	2003	2005			ISAAA, FAO
Maize	Brazil	2008	2009		The first approval of biotech maize was in 2007 but could not be deployed until 2008 because of regulatory constraints related to environmental impact assessments. Crops planted in 2008 were harvested in 2009	ISAAA
Maize	Cuba	2011			GM cultivation very restricted. Farmers need to apply for a permit, and only a negligible amount of GM maize is cultivated.	ISAAA
Maize	Paraguay	2012	2013			ISAAA, FAO
Maize	Colombia	2013	2013		Not approved for commercialization until 2013, although some quantiies were grown in a controlled planting program from 2007.	ISAAA
Maize	Vietnam	2014	2015			Brookes and Barfoot (2018)
Maize	Pakistan	2017			Trials halted in 2019	USDA Foreign Agricultural Service (2021b)

Continuation of Table B.2

Crop	Country	Formal approval	First unrestricted harvest	Approval withdrawn	Notes	Sources
Soybean	United States	1995	1996			ISAAA
Soybean	Argentina	1996	1997			ISAAA, Trigo and Cap (2003)
Soybean	Mexico	1996			Allowed on a trial basis from 1996, first commercial permit granted 2012 but immediately repealed locally due to concerns about honey exports to the EU. Suspended at the national level in 2016 and revoked in 2017	ISAAA, USDA, Villanueva-Gutiérrez et al. (2014)
Soybean	Canada	1997	1998			ISAAA, Smyth (2014)
Soybean	Uruguay	1997	2001		Approved in 1997, but not implemented until the 2000 planting season.	ISAAA, Brookes and Barfoot (2008)
Soybean	Romania	2000	2001	2007	Ended on EU ascension in 2007	ISAAA
Soybean	Costa Rica	2001			Limited to seed export	ISAAA
Soybean	South Africa	2001	2002			ISAAA, FAO, Brookes and Barfoot (2008)
Soybean	Brazil	2003	1998		GM seeds imported from Argentina before formal approval	Brookes and Barfoot (2008)
Soybean	Paraguay	2004	1998		GM seeds imported from Argentina before formal approval	ISAAA, Brookes and Barfoot (2008), Sciscioli (2003)
Soybean	Bolivia	2005	2005		GM seed import began in 2004 in anticipation of approval	ISAAA, AEMP (2012)
Soybean	Chile	2007			Only permitted for seed export	ISAAA, USDA Foreign Agricultural Service (2020a)

Notes: **We use the following abbreviation for the main sources. ISAAA: International Service for the Acquisition of Agri-biotech Applications. We use the annual ISAAA Brief (James 1996-2019). FAO: Cropping calendars provided by the Food and Agriculture Organization of the United Nations. The remaining sources are listed in the references.*

References

AEMP, "Estudio del Productor Primario de la Soya," *Offcial report, Autoridad de Fiscalizacion y Control Social De-empresas, Bolivia*, 2012.

Borusyak, Kirill, Xavier Jaravel, and Jann Spiess, "Revisiting event study designs: Robust and efficient estimation," *arXiv preprint arXiv:2108.12419*, 2021.

Brookes, Graham and Peter Barfoot, "GM crops: global socio-economic and environmental impacts 1996-2006," *PG Economics Ltd, Dorchester, UK*, 2008.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2007," *PG Economics Ltd, Dorchester, UK*, 2009.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2008," *Dorchester, UK: PG Economics Ltd*, 2010.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2009," *Dorchester, UK: PG Economics Ltd*, 2011.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2010," *Dorchester, UK: PG Economics Ltd*, 2012.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2011," *Dorchester, UK: PG Economics Ltd*, 2013.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2012," *Dorchester, UK: PG Economics Ltd*, 2014.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2013," *Dorchester, UK: PG Economics Ltd*, 2015.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2014," *Dorchester, UK: PG Economics Ltd*, 2016.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2015," *Dorchester, UK: PG Economics Ltd*, 2017.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2016," *UK: PG Economics Ltd*, 2018.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996-2017," *UK: PG Economics Ltd*, 2019.

_ **and** _ , "GM crops: global socio-economic and environmental impacts 1996–2018," *Dorchester, UK: PG Economics Ltd*, 2020.

Callaway, Brantly and Pedro HC Sant Anna, "Difference-in-differences with multiple time periods," *Journal of Econometrics*, 2020.

Chaisemartin, Clément De and Xavier d'Haultfoeuille, "Two-way fixed effects estimators with heterogeneous treatment effects," *American Economic Review*, 2020, *110* (9), 2964–96.

Dargent, Eduardo and Madai Urteaga, "The Power of the Seed: Timing, Quick Structural Change, and Genetically Modified Crop Regulations in the Andes," *Comparative Politics*, 2019, *51* (4), 539–561.

FAO, "Global Agro-Ecological Zones (GAEZ) v. 3.0," https://www.gaez.iiasa.ac.at/. Accessed: February 2, 2022).

FAOSTAT, "Statistical database," http://www.fao.org/home/en/ n.d. Accessed: January 21, 2022.

Feenstra, Robert C., Robert Inklaar, and Marcel P. Timmer, "Penn World Table version 10.0," *Groningen Growth and Development Centre [distributor]*, 2021. Accessed on January 21, 2022.

Galor, Oded and Ömer Özak, "Replication data for: The Agricultural Origins of Time Preference.," *Nashville, TN: American Economic Association [publisher], 2016. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-10-12*, 2016. Accessed on March 8, 2021.

James, Clive, "Brief 1: Global Review of the Field Testing and Commercialization of Transgenic Plants, 1986 to 1995: The First Decade of Crop Biotechnology," *ISAAA Brief*, 1996, *1.*

_ , "Brief 5: Global Status of Commercialized Biotech/GM Crops: 1997," *ISAAA Brief*, 1997, *5.*

_ , "Brief 8: Global Status of Commercialized Biotech/GM Crops: 1998," *ISAAA Brief*, 1998, *8.*

_ , "Brief 12: Global Status of Commercialized Biotech/GM Crops: 1999," *ISAAA Brief*, 1999, *12.*

_ , "Brief 17: Global Status of Commercialized Biotech/GM Crops: 2000," *ISAAA Brief*, 2000, *17.*

_ , "Brief 24: Global Status of Commercialized Biotech/GM Crops: 2001," *ISAAA Brief*, 2001, *24.*

_ , "Brief 27: Global Status of Commercialized Biotech/GM Crops: 2002," *ISAAA Brief*, 2002, *27.*

_ , "Brief 30: Global Status of Commercialized Biotech/GM Crops: 2003," *ISAAA Brief*, 2003, *30.*

_ , "Brief 32: Global Status of Commercialized Biotech/GM Crops: 2004," *ISAAA Brief*, 2004, *32.*

_ , "Brief 34: Global Status of Commercialized Biotech/GM Crops: 2005," *ISAAA Brief*, 2005, *34.*

_ , "Brief 35: Global Status of Commercialized Biotech/GM Crops: 2006," *ISAAA Brief*, 2006, *35.*

_ , "Brief 37: Global Status of Commercialized Biotech/GM Crops: 2007," *ISAAA Brief*, 2007, *37.*

_ , "Brief 39: Global Status of Commercialized Biotech/GM Crops: 2008," *ISAAA Brief*, 2008, *39*.

_ , "Brief 41: Global Status of Commercialized Biotech/GM Crops: 2009," *ISAAA Brief*, 2009, *41*.

_ , "Brief 42: Global Status of Commercialized Biotech/GM Crops: 2010," *ISAAA Brief*, 2010, *42*.

_ , "Brief 43: Global Status of Commercialized Biotech/GM Crops: 2011," *ISAAA Brief*, 2011, *43*.

_ , "Brief 44: Global Status of Commercialized Biotech/GM Crops: 2012," *ISAAA Brief*, 2012, *44*.

_ , "Brief 46: Global Status of Commercialized Biotech/GM Crops: 2013," *ISAAA Brief*, 2013, *46*.

_ , "Brief 49: Global Status of Commercialized Biotech/GM Crops: 2014," *ISAAA Brief*, 2014, *49*.

_ , "Brief 51: 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015," *ISAAA Brief*, 2015, *51*.

_ , "Brief 52: Global Status of Commercialized Biotech/GM Crops: 2016," *ISAAA Brief*, 2016, *52*.

_ , "Brief 53: Global Status of Commercialized Biotech/GM Crops: 2017," *ISAAA Brief*, 2017, *53*.

_ , "Brief 54: Global Status of Commercialized Biotech/GM Crops: 2018," *ISAAA Brief*, 2018, *54*.

_ , "Brief 55: Global Status of Commercialized Biotech/GM Crops: 2019," *ISAAA Brief*, 2019, *55*.

Kouser, Shahzad and Matin Qaim, "Valuing financial, health, and environmental benefits of Bt cotton in Pakistan," *Agricultural Economics*, 2013, *44* (3), 323–335.

Qiao, Fangbin, "Fifteen years of Bt cotton in China: the economic impact and its dynamics," *World Development*, 2015, *70*, 177–185.

Scheitrum, Daniel, K Aleks Schaefer, and Kjersti Nes, "Realized and potential global production effects from genetic engineering," *Food Policy*, 2020, *93*, 101882.

Sciscioli, Alejandro, "AGRICULTURE-PARAGUAY: Legalisation of GM Crops Imminent," *Inter Press Service*, November 10, 2003. http://www.ipsnews.net/2003/11/agriculture-paraguay-legalisation-of-gm-crops-imminent/. Accessed on January 15, 2022.

Smyth, Stuart J, "The state of genetically modified crop regulation in Canada," *GM crops & food*, 2014, *5* (3), 195–203.

Sun, Liyang and Sarah Abraham, "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects," *Journal of Econometrics*, 2021, *225* (2), 175–199.

Trigo, Eduardo and Eugenio Cap, "The impact of the introduction of transgenic crops in Argentinean agriculture," *AgBioForum*, 2003, *6* (3), 87–94.

Trigo, Eduardo J, "Fifteen years of genetically modified crops in Argentine agriculture," *ArgenBio–Argentine Council for Information and Development of Biotechnology*, 2011.

USDA Economic Research Service, "Adoption of Genetically Engineered Crops in the U.S.," https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx n.d.

USDA Foreign Agricultural Service, "Uruguay agricultural biotechnology annual," *GAIN Report Number: [missing in original]*, 2009.

_ , "Mexico agricultural biotechnology annual," *GAIN Report Number: MX2051*, 2012.

_ , "Chile agricultural biotechnology annual," *GAIN Report Number: CI2020-0019*, 2020.

_ , "European Union agricultural biotechnology annual," *GAIN Report Number: E42019-0053*, 2020.

_ , "Mexico agricultural biotechnology annual," *GAIN Report Number: MX2020-0062*, 2021.

_ , "Pakistan agricultural biotechnology annual," *GAIN Report Number: PK2021-0011*, 2021.

Villanueva-Gutiérrez, Rogel, Carlos Echazarreta-González, David W Roubik, and Yolanda B Moguel-Ordoñez, "Transgenic soybean pollen (Glycine max L.) in honey from the Yucatan peninsula, Mexico," *Scientific reports*, 2014, *4* (1), 1–4.

World Development Indicators, "Population density (people per sq. km of land area)," http://www.databank.worldbank.org/ n.d. Accessed: July 27, 2021.

Zeballos, H, "Bolivia: Desarrollo del Sector Oleaginoso 1980–2010: Comercio Exterior n-7," *Instituto Boliviano de Comercio Exterior (IBCE), Santa Cruz, Bolivia*, 2012.