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Modeling and Forecasting Agricultural Commodity Support in the Developing Countries

J. Isaac Miller, Julian Binfield, Jing Zhao, and Wyatt Thompson

Invited Paper prepared for presentation at the International Agricultural Trade Research Consortium's (IATRC's) 2018 Annual Meeting: Interlinkages among Global Value Chains, Trade, and Transformation of the AgriFood Industry, July 25-27, 2018, Whistler, BC, Canada.

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Modeling and Forecasting Agricultural Commodity Support in the Developing Countries

ISAAC MILLER, JULIAN BINFIELD, JING ZHAO, WYATT THOMPSON

IATRC, WHISTLER JULY 25-27, 2018



The project

We want to investigate how agricultural support has evolved in different countries

- In particular the link between support and income

Agricultural support has varied between countries. In general:

- Agriculture tended to be taxed in less developed or developing countries
- Developed countries were more likely to subsidize their agriculture

Using support data over 1961–2011 from the World Bank Agricultural Distortion database, estimate econometric models

Aim is to then use projections of macroeconomic and other variables to generate estimates of future agricultural commodity support

Primary research goals

- Analyze how agricultural support evolved in the past
- Identify the major factors that influence agricultural support over time
- Forecast agricultural commodity support in the developing countries for the medium-term future
- Put these results in perspective through some comparisons to developed countries' support and to WTO commitments

Countries and Commodities

Countries: China, India, Brazil, Russia (emerging countries)

- Include agricultural commodity importers and exporters
- Include a range of policy environments
- Include different macroeconomic environments

Commodities: Wheat, Rice, Maize, Soybean, Sugar, Cotton

- Widely produced
- Contain food crop, feed crop and cash crop
- Different markets and policy environments

GDP, Population and Land

	GDP per capita (constant 2000 USD)	Agriculture population (Million)	Population (Million)	Agricultural land (Ha per capita)
Brazil	4699	21	195	1.40
China	2423	834	1372	0.37
India	830	592	1225	0.15
Russia	2923	12	143	1.50

Source: World Bank, 2010

Production (million tons)

	Wheat	Rice	Maize	Soybeans	Sugar	Cotton
Brazil	6	11	55	69	717	1
China	115	197	178	15	121	6
India	81	144	22	13	292	6
Russia	42	1	3	1	22	n.a.

Sources: FAO, 2010

Trade Status

	Wheat	Rice	Maize	Soybean	Sugar	Cotton
Brazil	M	M	X	X	X	X
China	X	X	X	M	M	M
India	H	X	H	X	M	H
Russia	X	n.a.	X	n.a.	M	n.a.

Notes: data are based on 2010.

Agricultural Distortions database

---World Bank

Time period: 1955-2011

Countries : 75

Commodities : almost all major

Major indicators: NRA, Nominal Rate of Assistance, by product

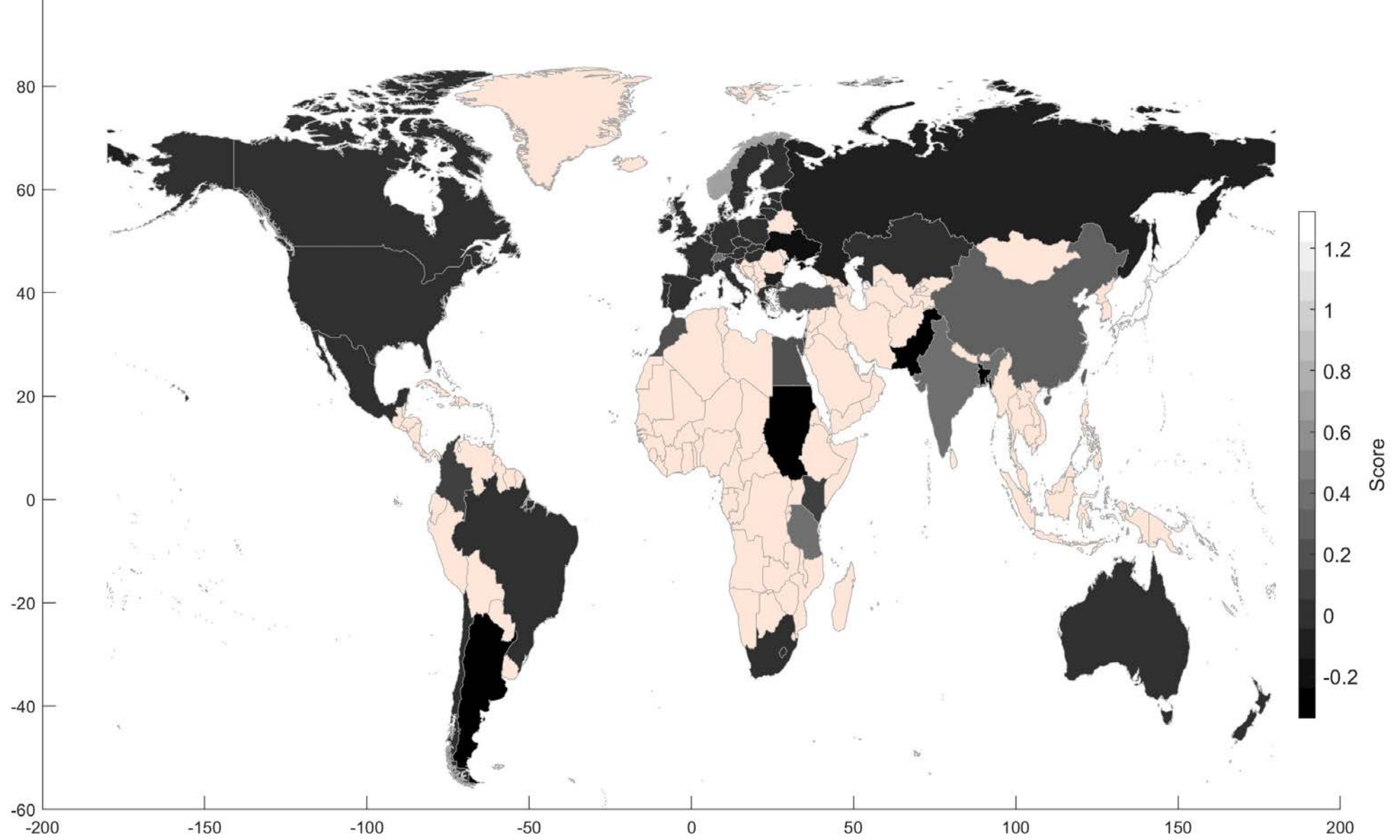
Definition of NRA: farmers' gross return with/without policy

$$NRA = \frac{\text{Gross return with government policy} - \text{gross return without government policy}}{\text{gross return without government policy}}$$

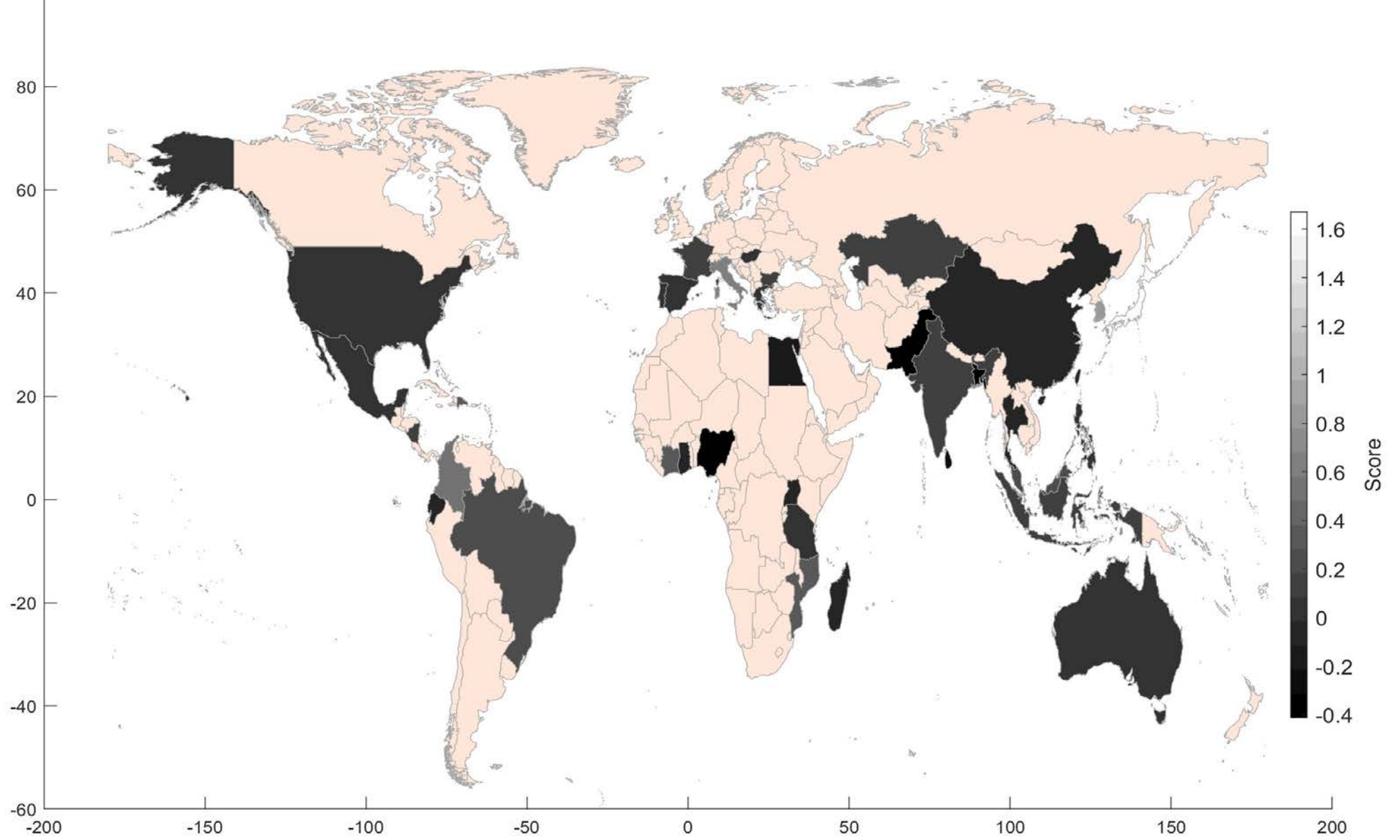
NRA=NRA_O(output) +NRA_I(input), NRA_O=NRA_B+NRA_D

NPS, non-product specific support

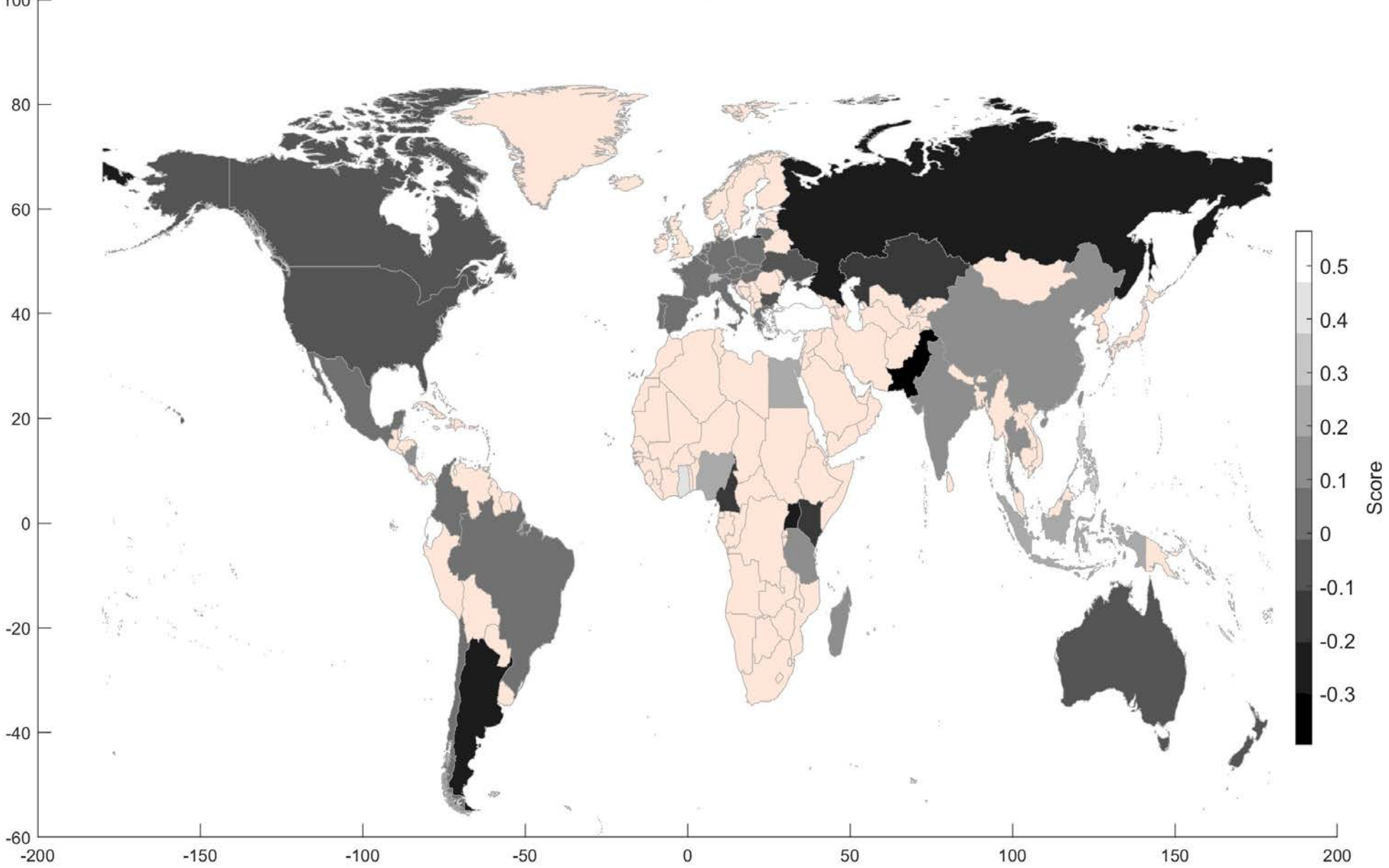
Wheat



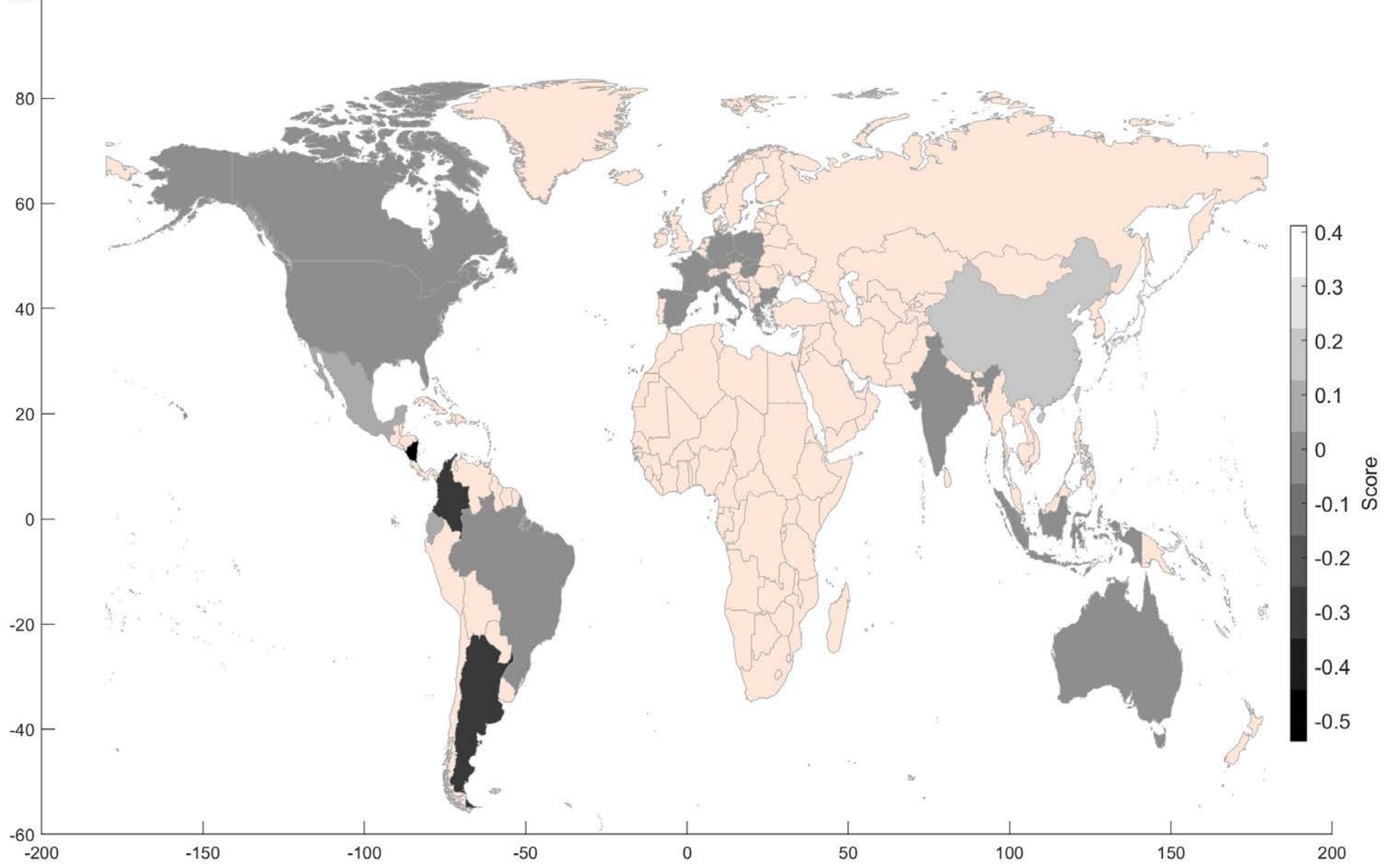
Rice



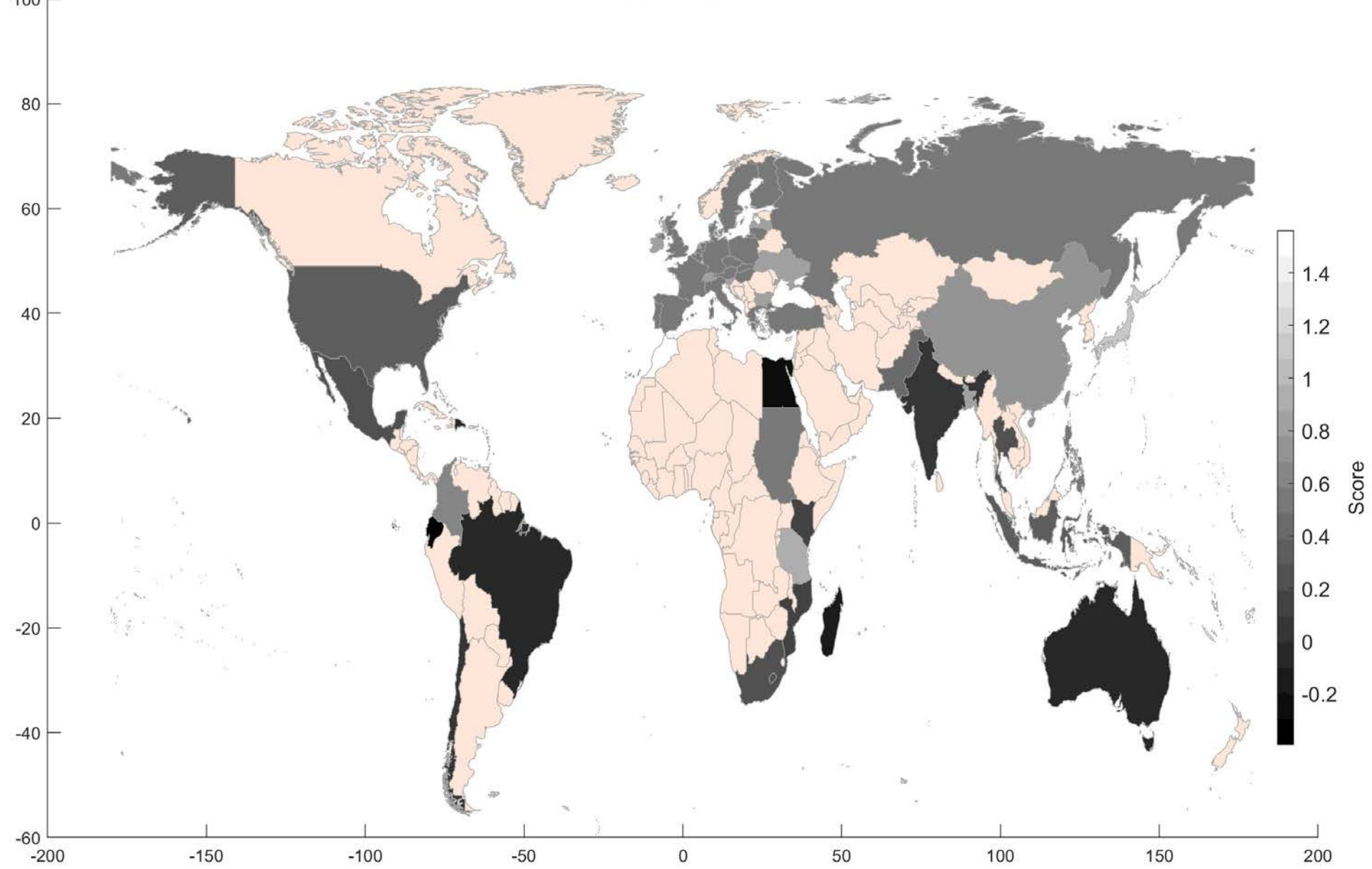
Maize



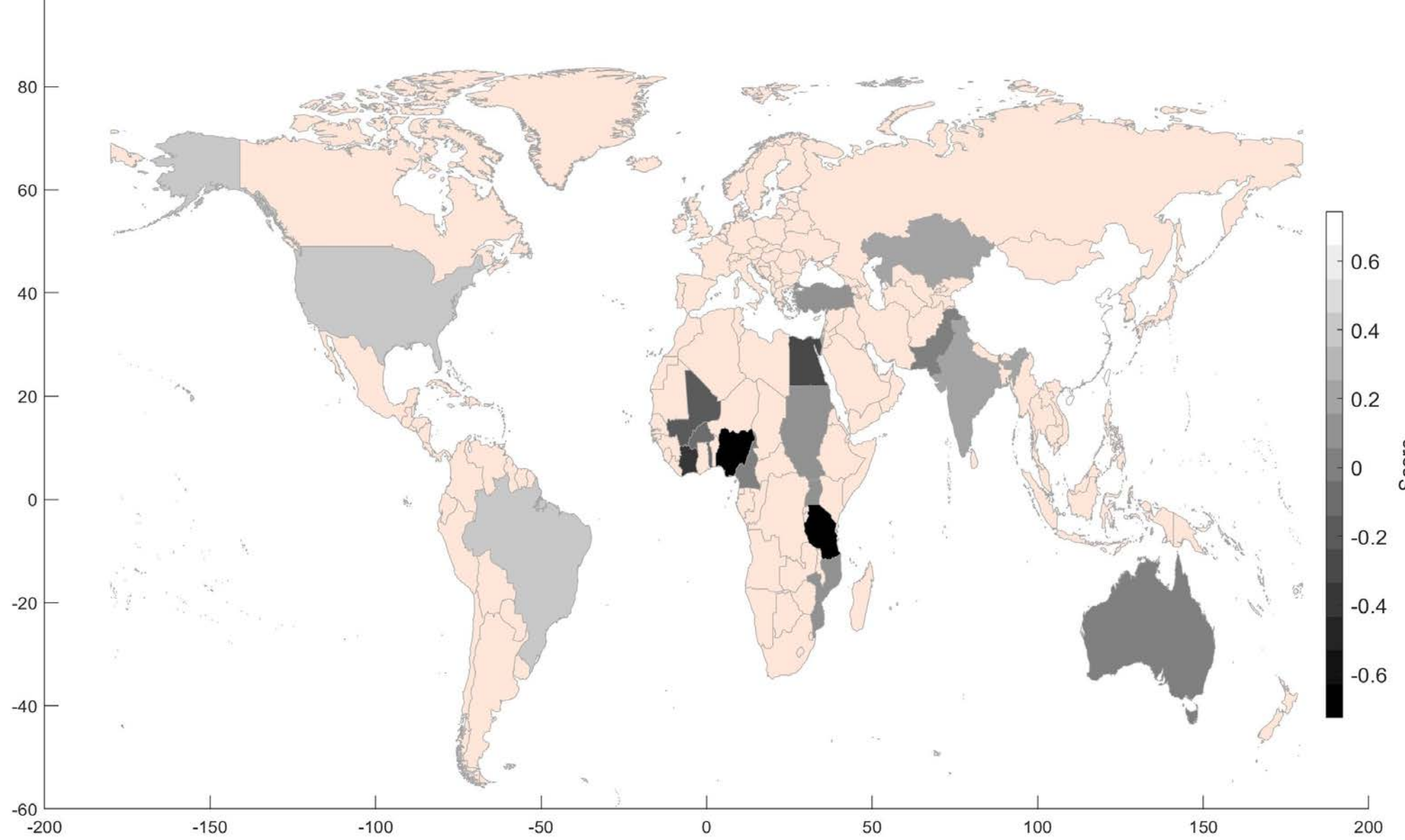
Soybean



Sugar



Cotton



Econometric model

$$y_{it} = \alpha + \rho y_{i,t-1} + x_{it}'\beta + d_i'\delta + \varepsilon_{it}$$

y_{it} stands for NRA components,

$x_{it} = (Inc_{i,t-1}, Inc_{i,t-1}^2, Inc_{i,t-1}^3, APR_{it}, PAL_{it}, D_{1it}, D_{2it}, D_{3it}, TM_{it}, TH_{it}, S_{it})'$,

d_i represent a vector of $N-1$ binary country indicators,

ε_{it} is an idiosyncratic error term.

Estimation method: OLS Fixed effect model---best linear predictors

Major factors

Variable Name	Definition
NRA (NRA_B, NRA_D, NRA_I)	Indicators of aggregate market distortion
INC	Real GDP per capita
APR	Agricultural population rate
PAL	Per capita agricultural land
D ₁ , D ₂ , D ₃	Dummy for food crisis or slump(73-74, 86-88,06-08)
DUMMY (TM,TH)	Dummy for trade status
S	Dummy for WTO membership

Results

Estimation results for different commodities

Forecasting of support levels in different countries

Estimation Results(1)

	Wheat			Rice		
	NRA_B	NRA_D	NRA_I	NRA_B	NRA_D	NRA_I
NRA_lag	0.594***	0.662***	0.736***	0.798***	0.738***	0.270
INC_lag	-1.669**	-0.252	0.167*	1.306	0.018	0.206***
INC_lag^2	0.243**	0.033	-0.022*	-0.176	-0.001	-0.026***
INC_lag^3	-0.011**	-0.001	0.001**	0.008	0.000	0.001***
APR	0.175	-0.055	-0.029**	-0.257*	-0.013	-0.020**
PAL	0.000	0.002	0.000	0.004	0.000	0.000
S	-0.037*	-0.025***	-0.008**	-0.092***	-0.008	-0.003*
73-74	-0.281***	-0.028**	0.005	-0.311***	-0.025**	0.002
86-88	0.257***	-0.014	0.004	0.027	0.009	0.004
06-08	-0.089***	0.011	-0.001	-0.127***	-0.007	-0.003
TM	0.070***	0.019	-0.001	-0.043	0.010**	0.007**
TH	0.114**	-0.039	0.023	-0.126**	0.053**	0.028*
Obs	2609			2071		

Estimation Results(2)

	Maize			Soybean		
	NRA_B	NRA_D	NRA_I	NRA_B	NRA_D	NRA_I
NRA_lag	0.544***	0.455***	0.614***	0.588***	0.765***	0.392**
INC_lag	-2.714***	-0.479*	0.142**	-0.525	-10.314***	-0.070
INC_lag^2	0.398***	0.065*	-0.018**	0.077	1.356***	0.010
INC_lag^3	-0.018***	-0.003*	0.001**	-0.004	-0.056***	0.000
APR	0.430**	0.049**	-0.001	0.145	0.321	0.036
PAL	-0.006***	0.001	0.000	-0.002	0.009	0.000
S	-0.008	-0.005	-0.006**	-0.021	-0.040	-0.002
73-74	-0.230***	-0.005	0.005	-0.078	-0.004	-0.001
86-88	0.195***	0.008	0.003	-0.080**	0.089	0.010
06-08	-0.076***	0.000	-0.001	-0.026	-0.089*	-0.002
TM	-0.023	0.010	0.005**	0.009	-0.018	0.004**
TH	-0.045	-0.046	0.002	0.023	-0.048	0.014*
Obs	2320			1216		

Estimation Results(3)

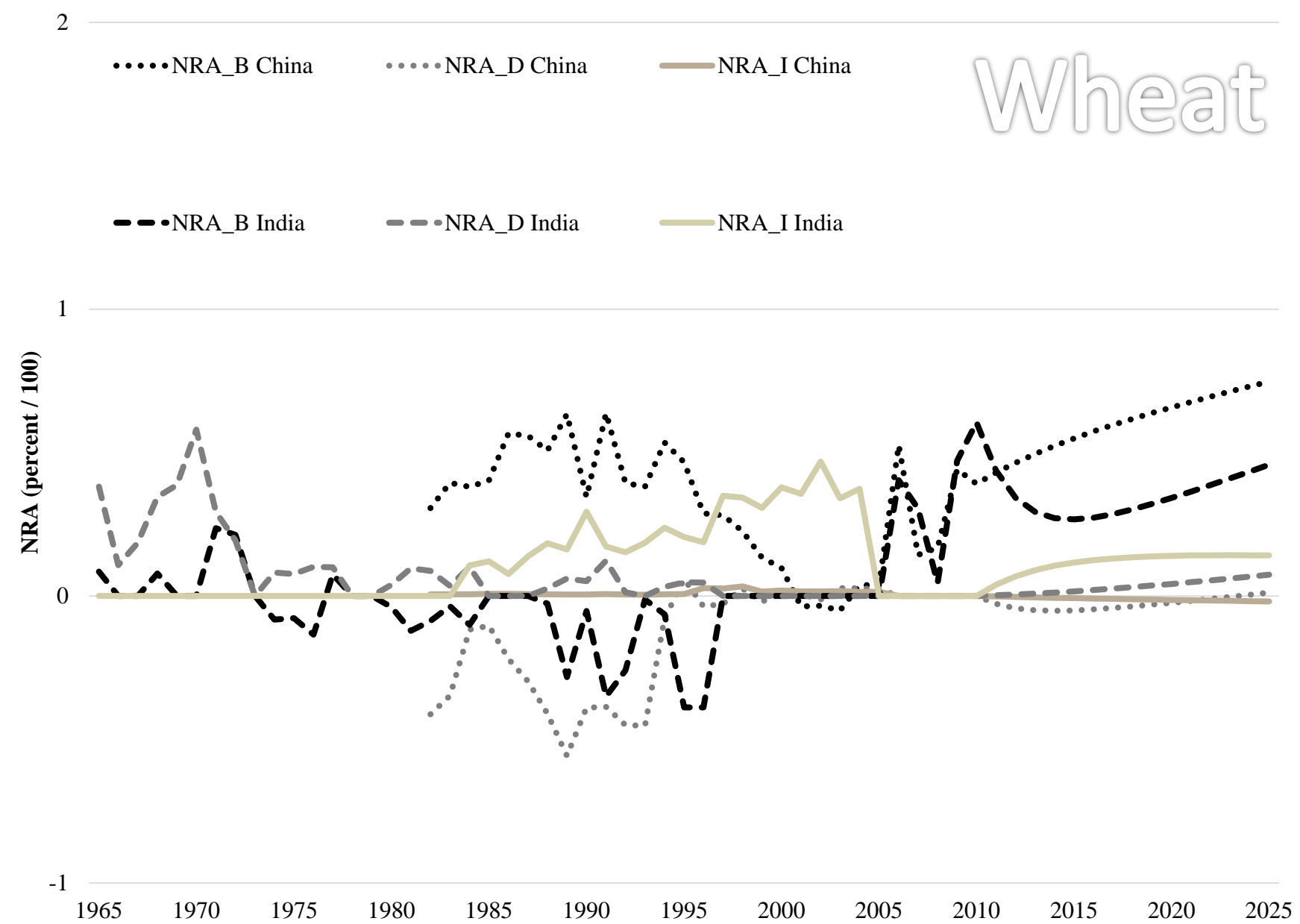
	Sugar			Cotton		
	NRA_B	NRA_D	NRA_I	NRA_B	NRA_D	NRA_I
NRA_lag	0.678***	0.577***	0.604***	0.508***	0.467***	0.277
INC_lag	-3.080*	-0.759*	0.110	-0.206	0.337	0.346***
INC_lag^2	0.439**	0.104*	-0.014	0.066	-0.063	-0.044***
INC_lag^3	-0.020**	-0.005*	0.001	-0.004	0.004	0.002***
APR	0.127	0.071*	-0.014	0.058	0.055*	-0.035***
PAL	-0.005	-0.001**	0.000	0.012*	0.005**	0.000
S	0.096***	-0.009	-0.005	0.076***	0.010	-0.008***
73-74	-0.571***	-0.012**	0.004*	-0.042	-0.001	0.002
86-88	0.043	-0.025	0.001	-0.019	0.010	0.006
06-08	-0.255***	-0.002	-0.002	0.006	0.025	-0.006**
TM	0.063	0.006	0.007*	0.011	0.077***	0.013
TH	0.006	-0.043**	0.016**	-0.077	-0.043	0.013
Obs	2579			1365		

Growth rate of GDP per capita

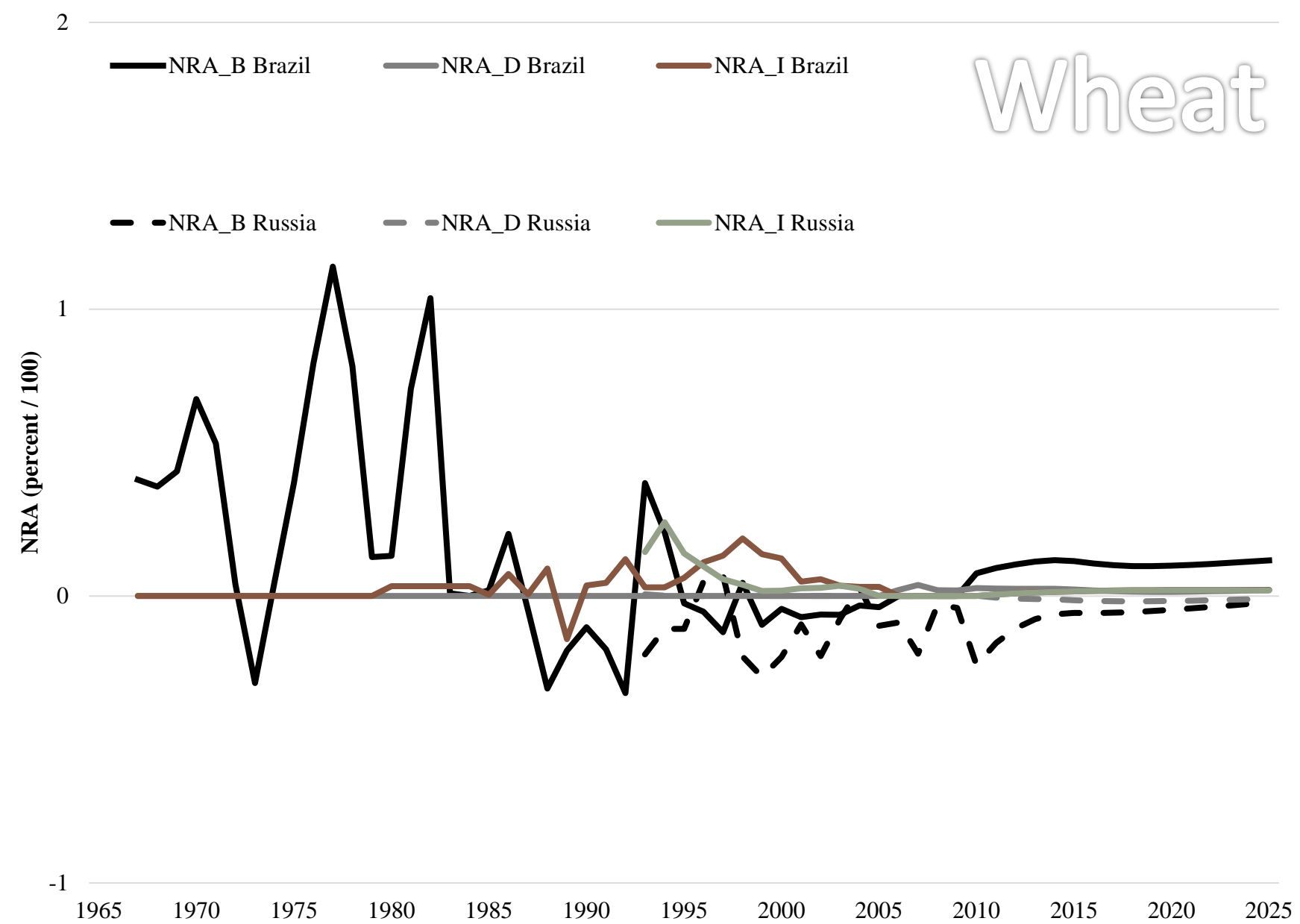
US dollars	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Brazil	7.43	3.96	1.88	2.97	0.5	-3.77	-3.57	0.69	1.49	1.99	1.99	1.99
China	10.55	9.45	7.86	7.76	7.26	6.87	6.67	6.77	6.47	6.27	6.17	5.97
India	10.15	6.48	5.39	6.32	7.4	7.9	7.01	6.61	7.3	7.7	7.8	7.99
Russia	4.5	5.1	3.69	1.79	0.69	-2.8	-0.2	1.8	1.6	1.5	1.5	1.5

Source: IMF.

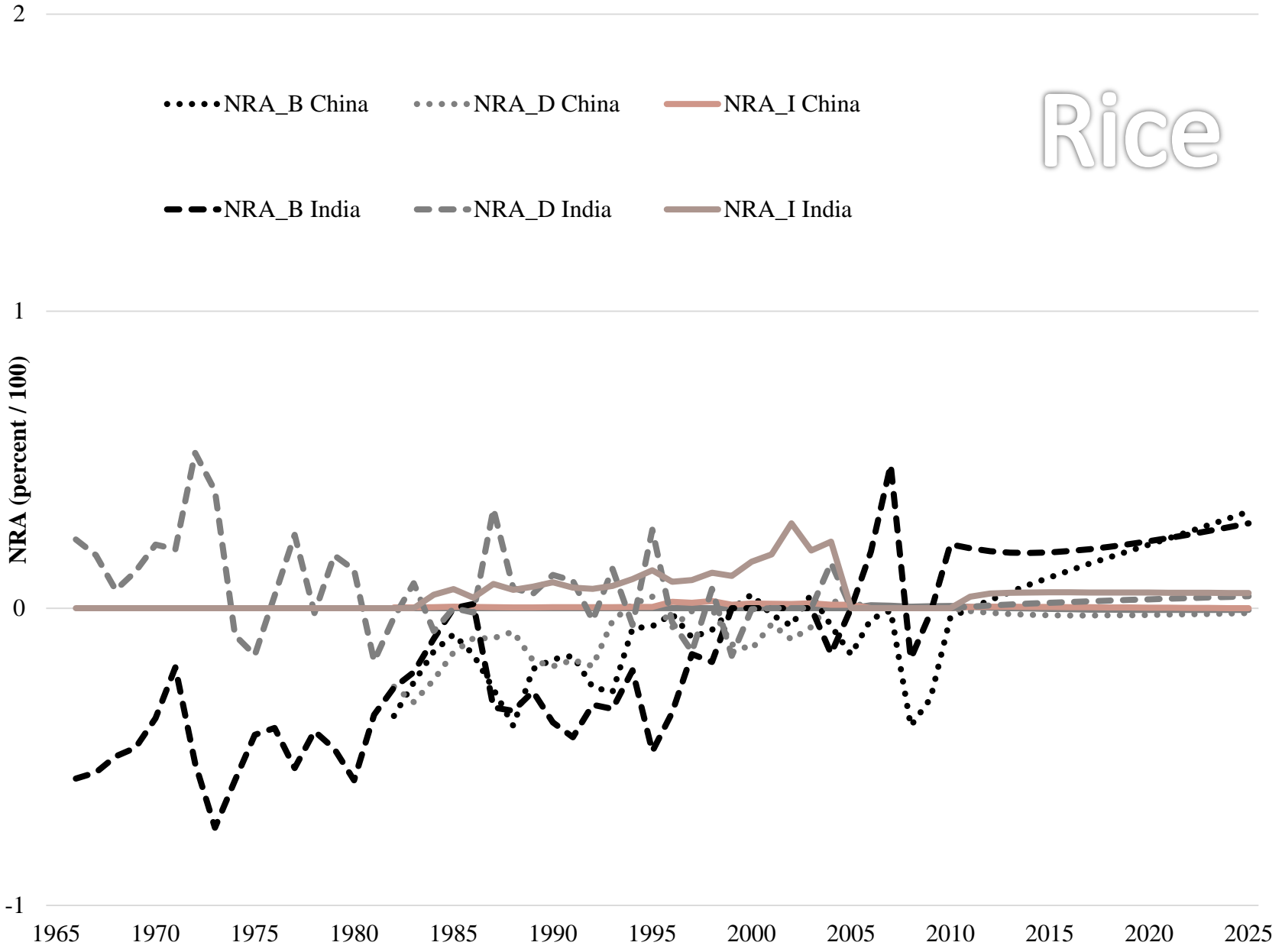
Wheat



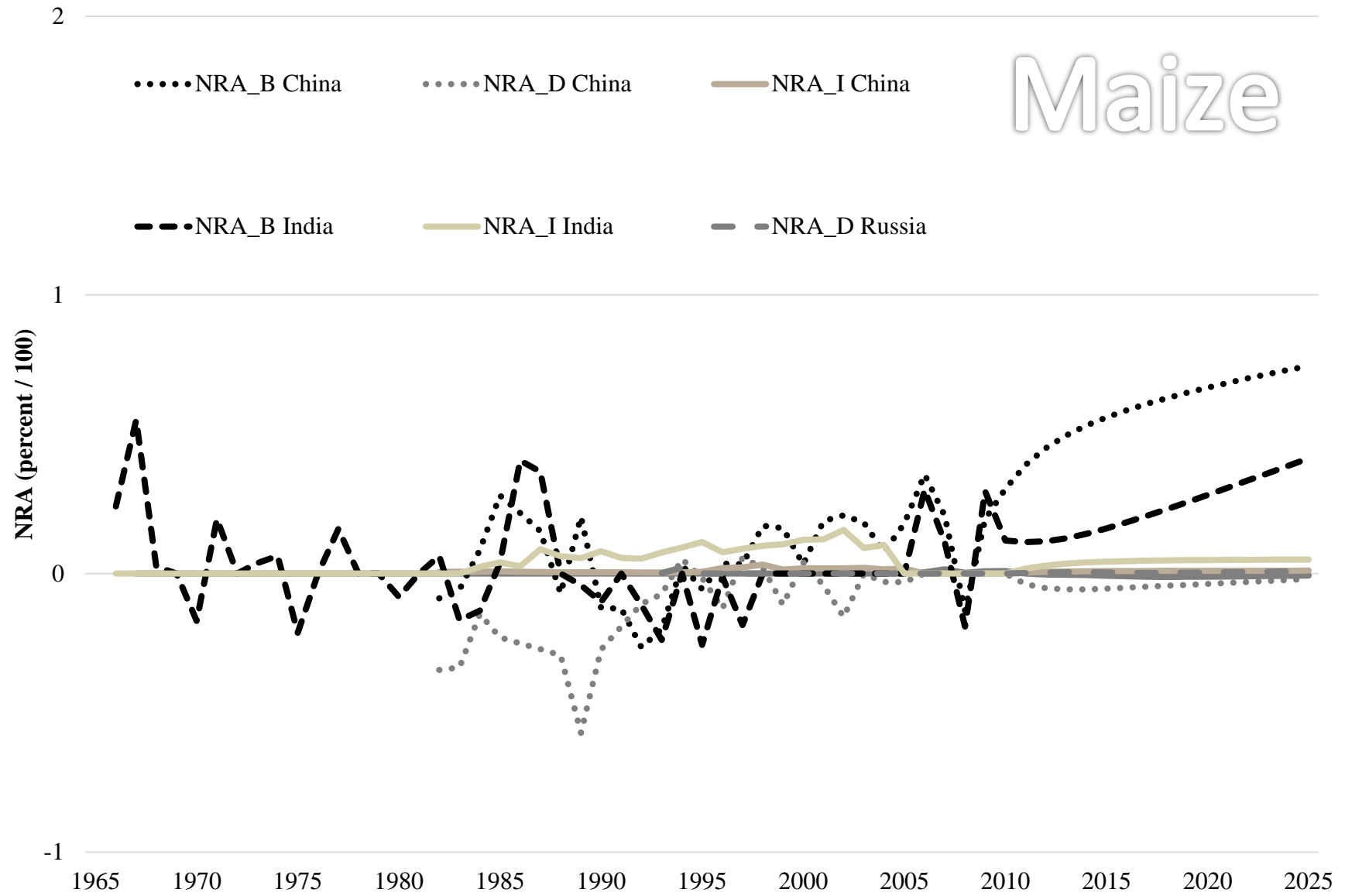
Wheat



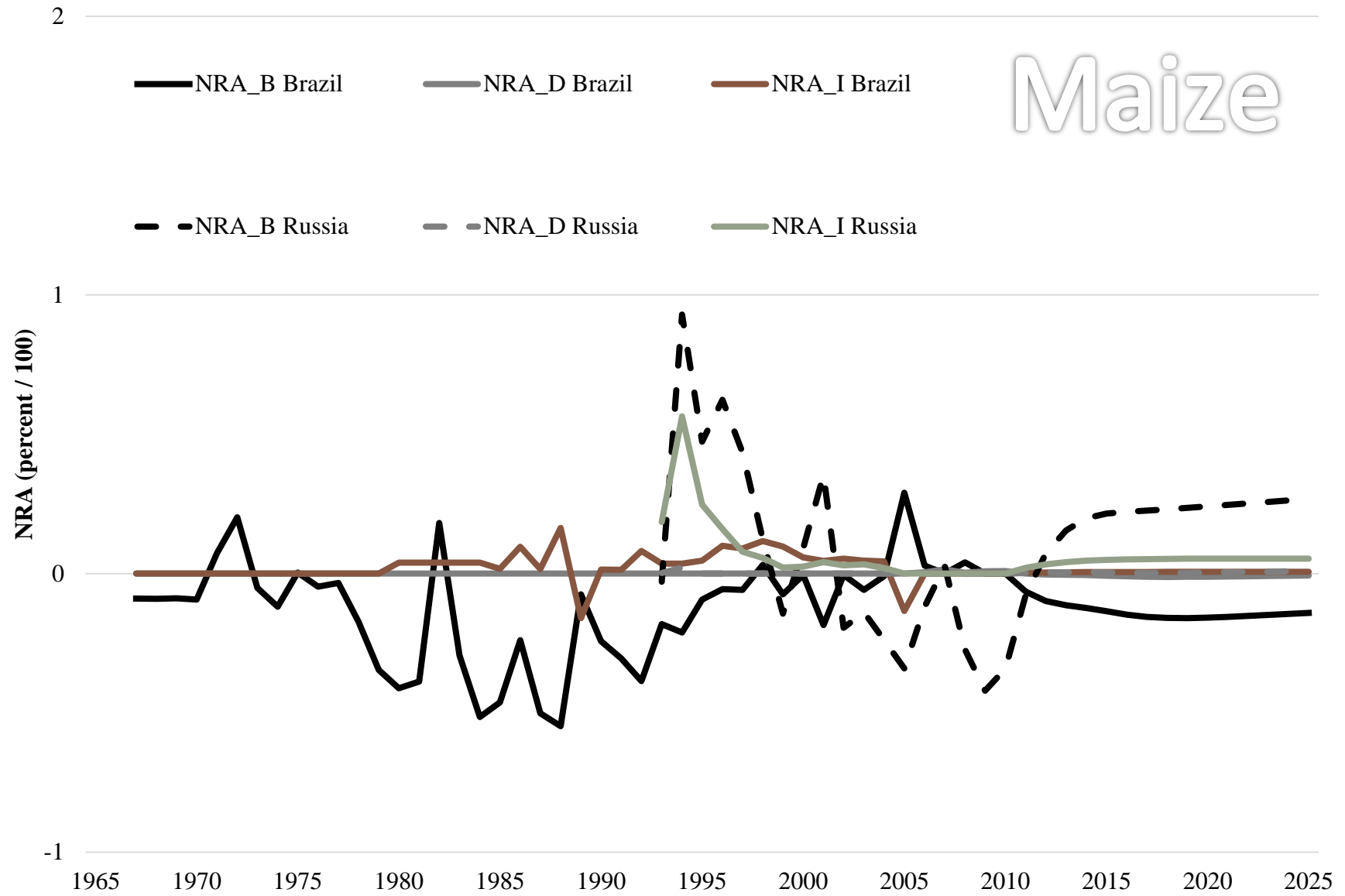
Rice

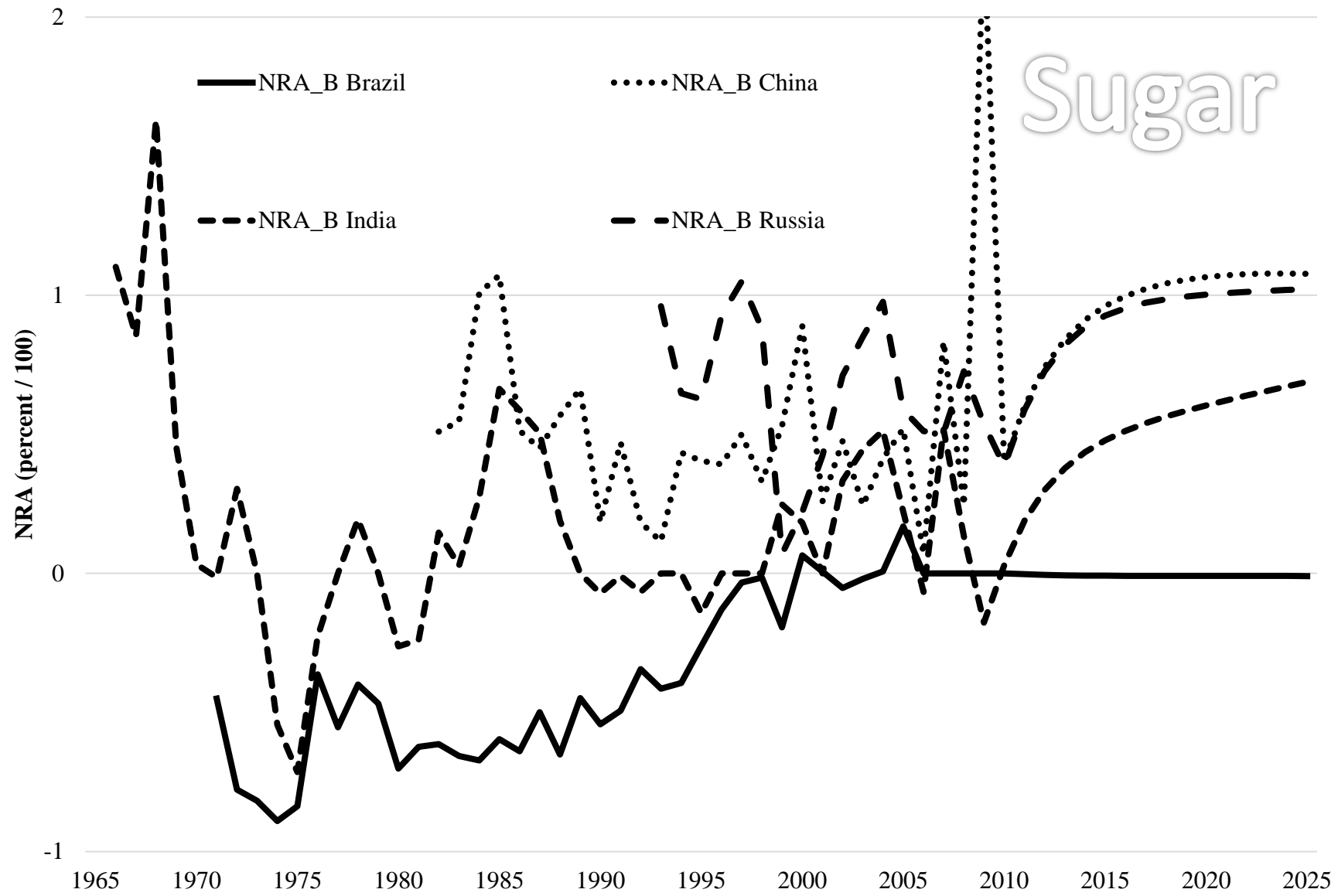


Maize

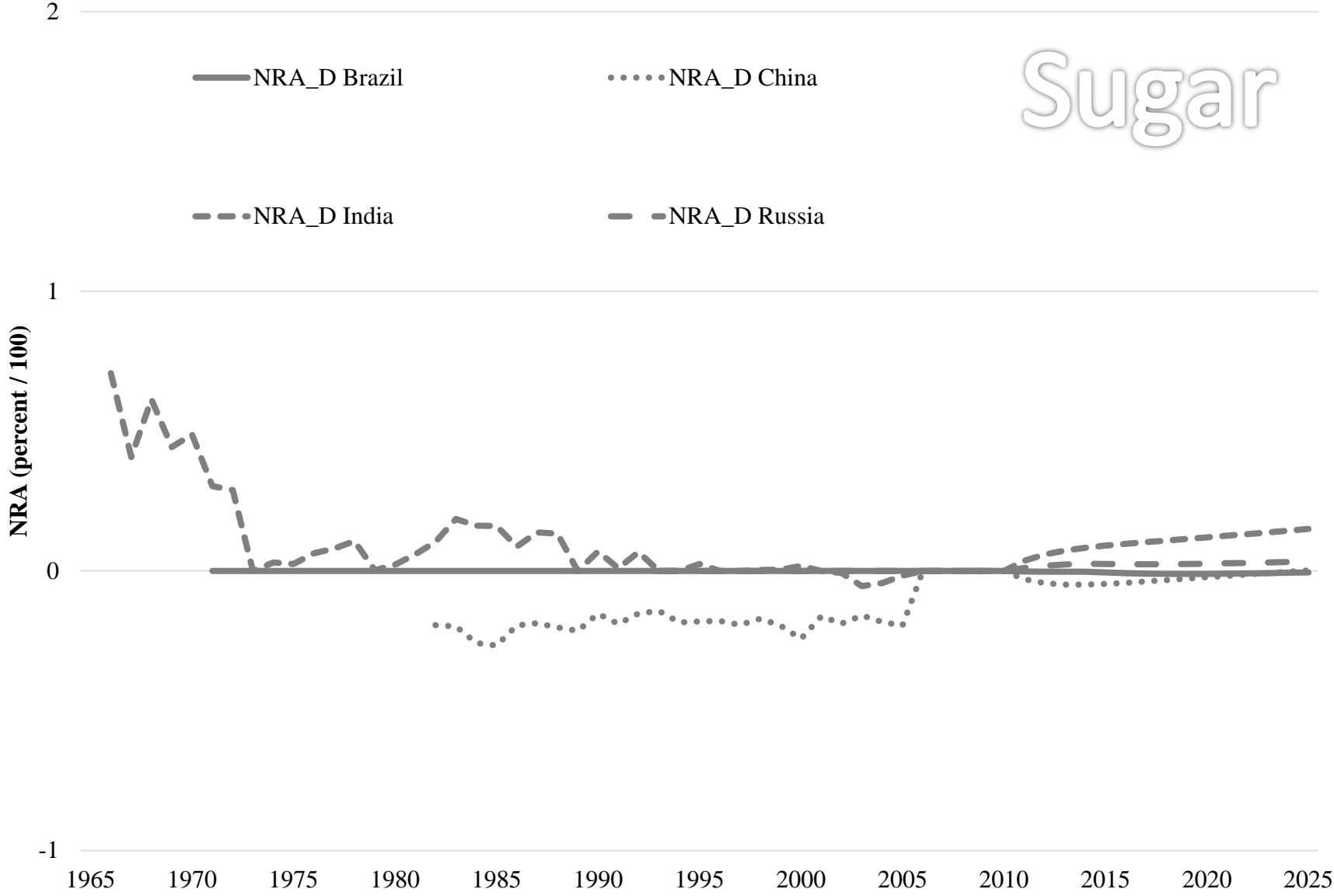


Maize

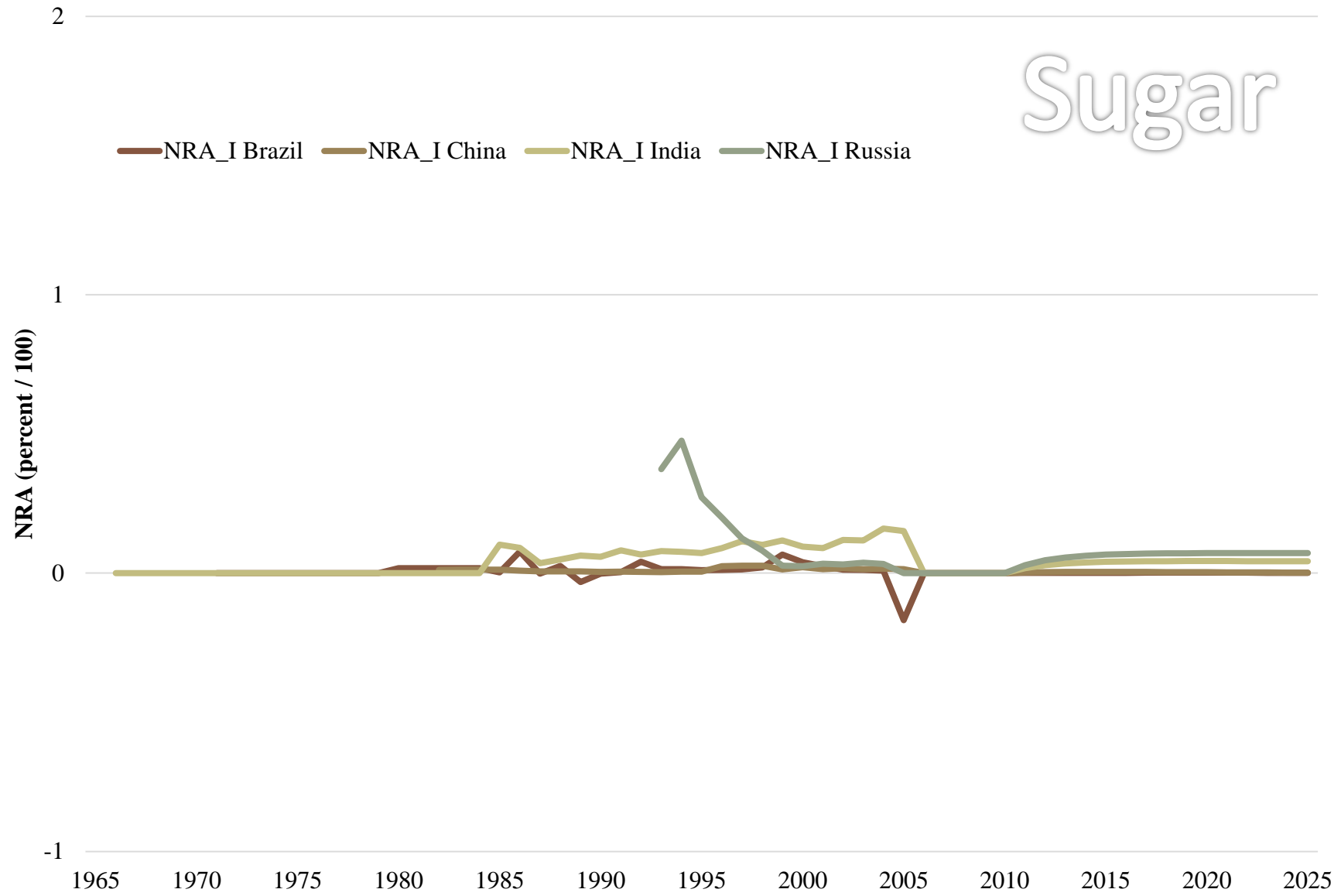




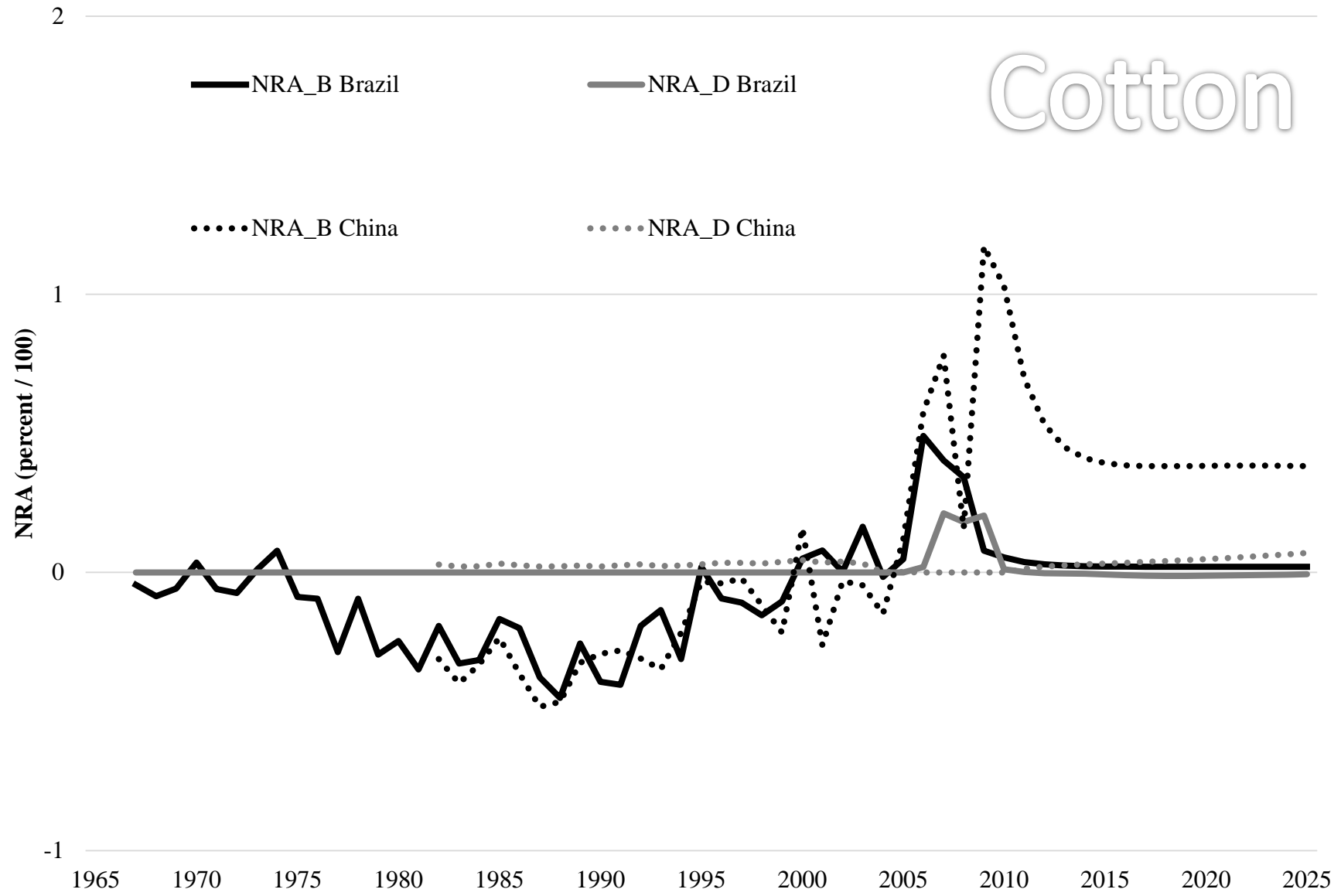
Sugar

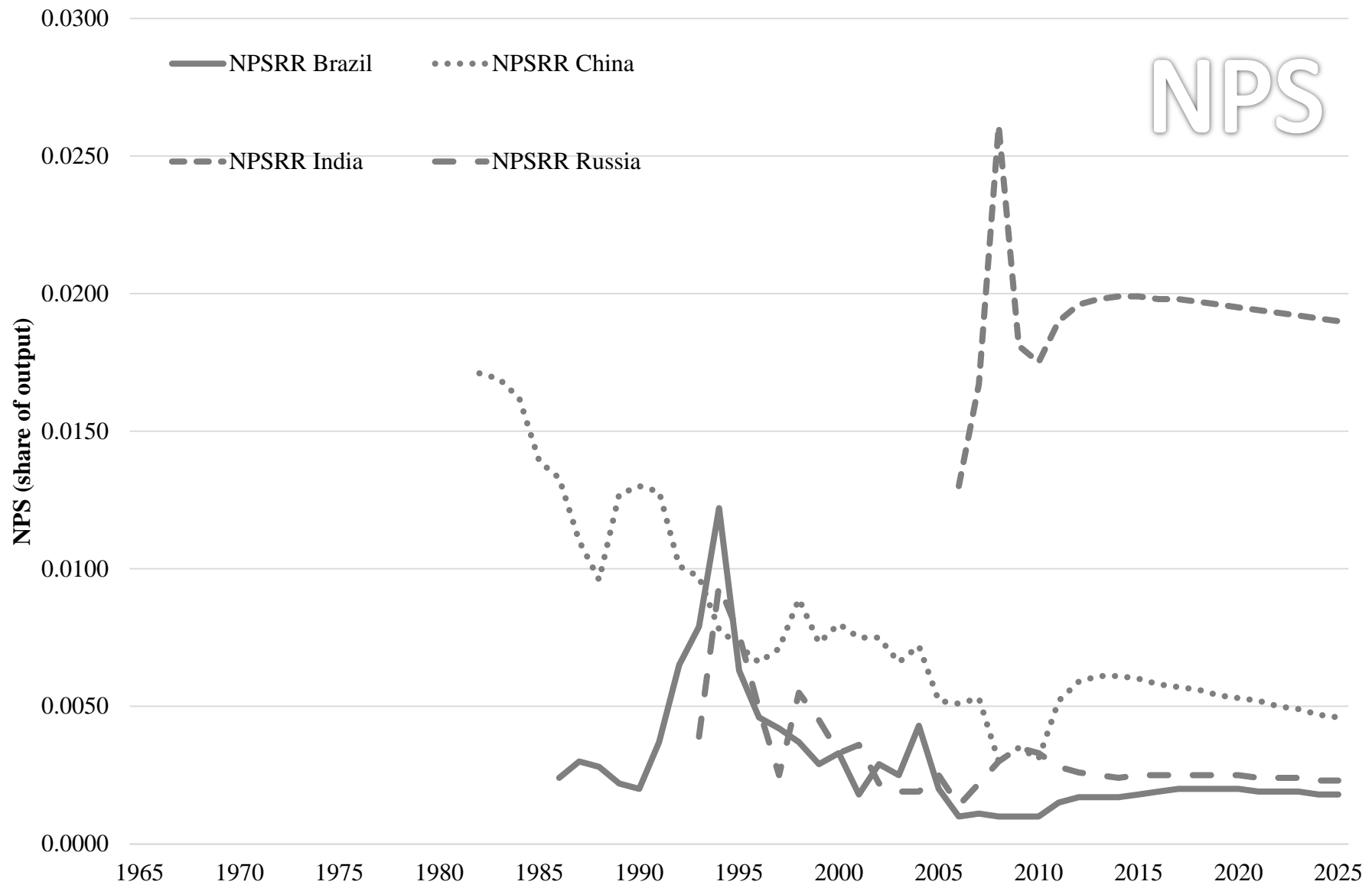


Sugar



Cotton





Relating these projections to developments in policy

Having estimated these relationships, how might these projections be of use to policy makers/academics?

Have to be realistic about what we can get from the estimations:

- Highly complex set of issues that enter into policy decisions with an environment that is changing rapidly
- Dataset only goes to 2012

But there is still information that can be useful:

- From the estimations
- From the projections

From the estimations

Confirming the link between some support to incomes and other factors

- Especially border policies
- The method here enables more complex relationships to incomes to be explored

The WTO variable indicates that membership has reduced some support

From the projections

Can look at projections to see if they can isolate areas of future issues

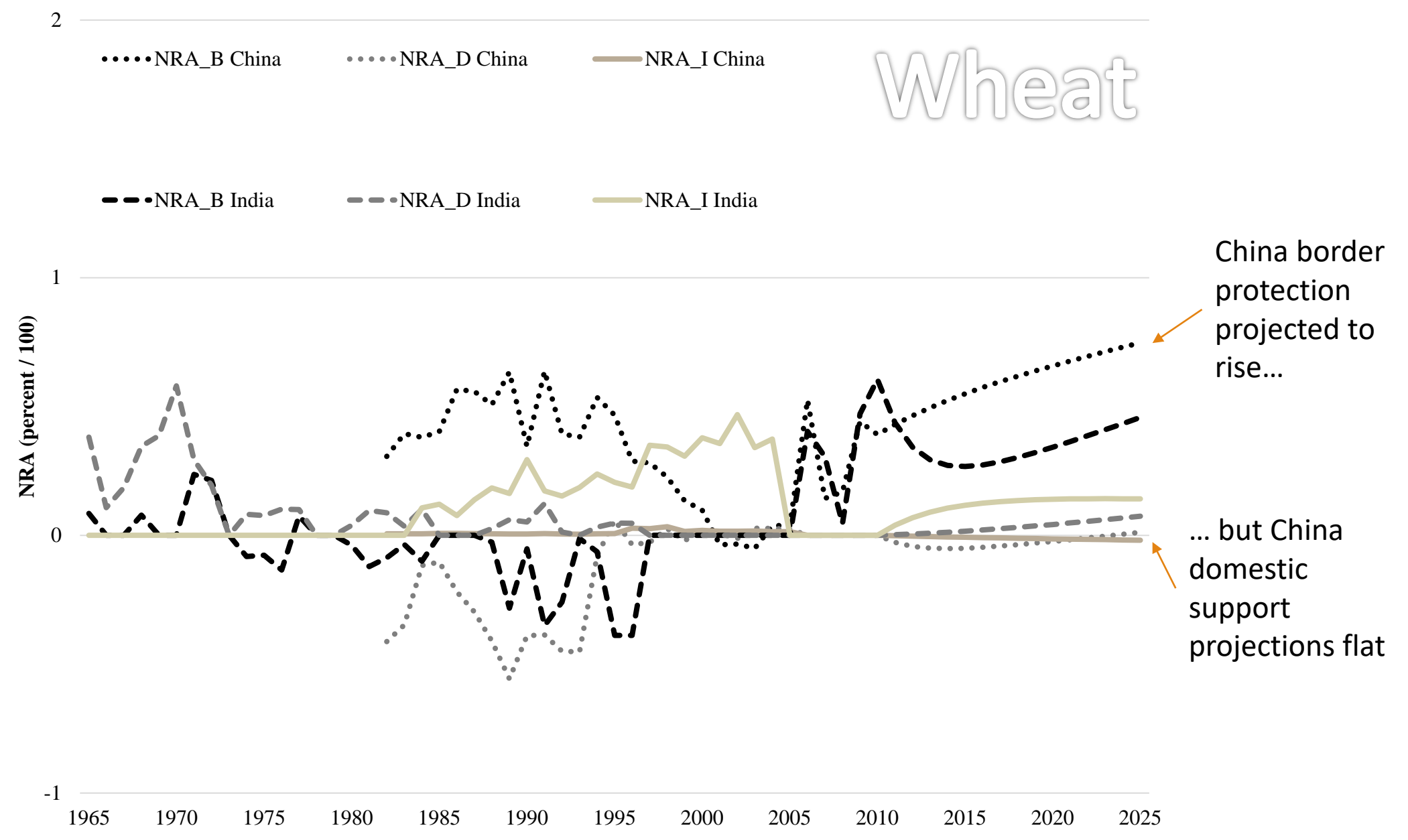
- Where countries may want to increase support but run into conflict over WTO commitments
- Where support has not materialized, may be able to attribute some of this to the value of multilateral agreements

As we could only estimate until 2012, we can look at what has happened since then to evaluate our projections

In general have seen an increase in agricultural support in the countries we have looked at

Use China as an example

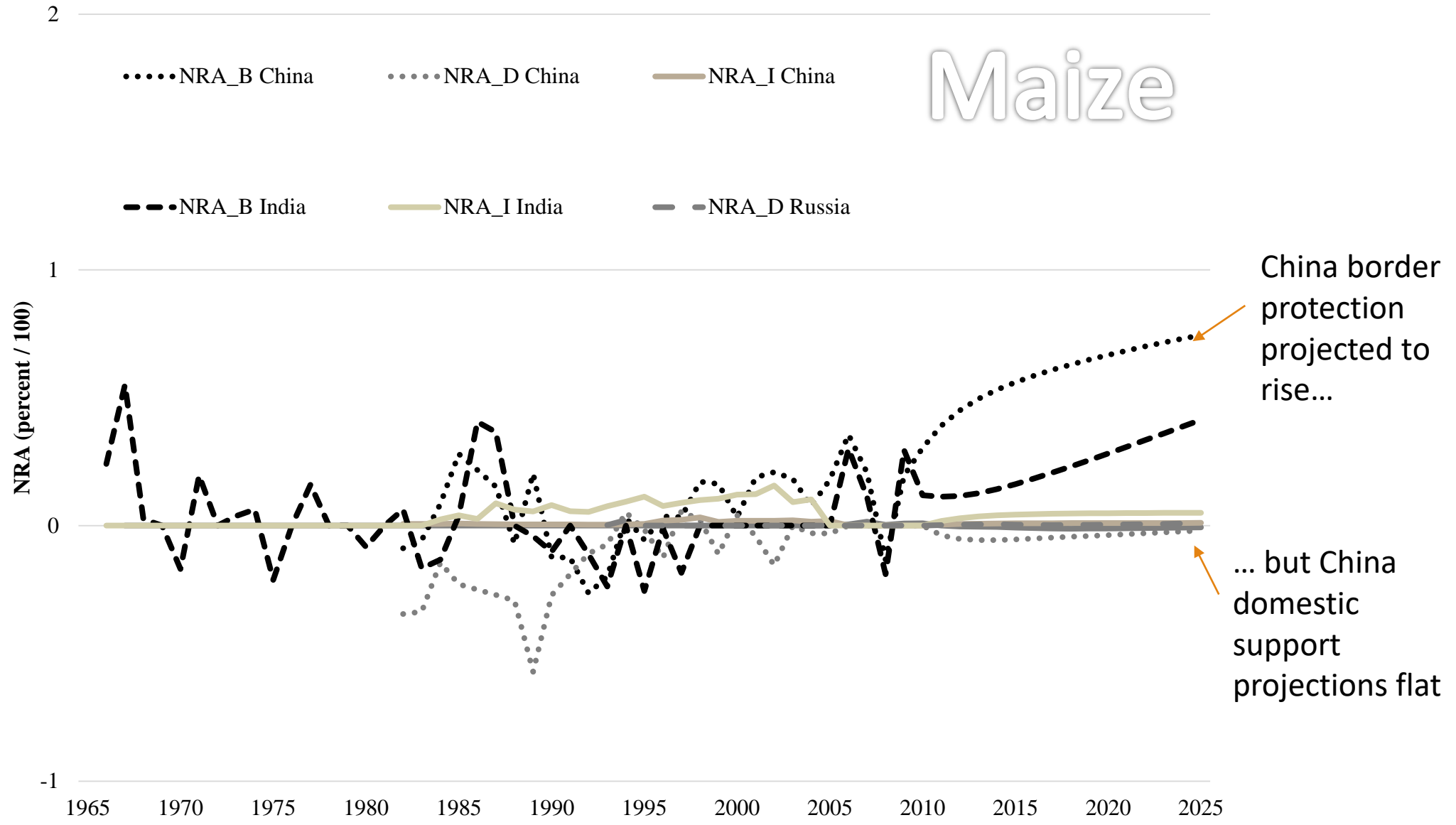
Wheat



China border protection projected to rise...

... but China domestic support projections flat

Maize



Summary

Have a lot of results to go through

We are working on linking the projections of

In general find strong link between border support and incomes

For projections income growth implies that countries want to increase border support

Has happened in some cases

Hope that in some cases this sort of modelling can yield useful information in the discussion of the evolution of agricultural support and how this might evolve especially with regard to multilateral trading arrangements

Thanks!

Many thanks to the IATRC for commissioning this research.

Feel free to contact us with any comments or questions:

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Jing Zhao, jzm95@mail.missouri.edu

WTO notifications, Brazil

Large exporter of many products

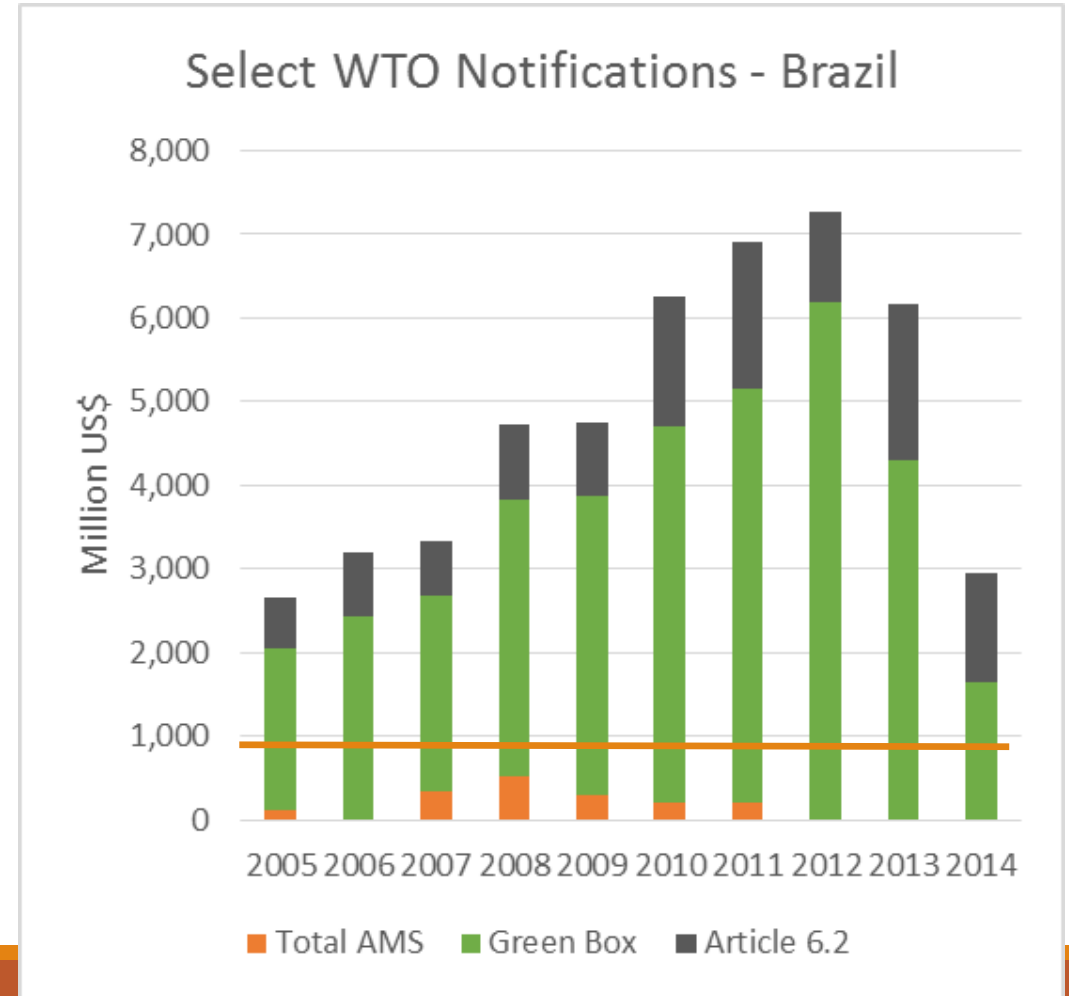
Previously had negative NRA_B

Over time NRA_B has tended towards zero

Model wants NRA_B to become positive, NRA_D to stay low

Ag support has risen, but not part of AMS

Using Article 6.2 exemption and green box



WTO notifications, Russia

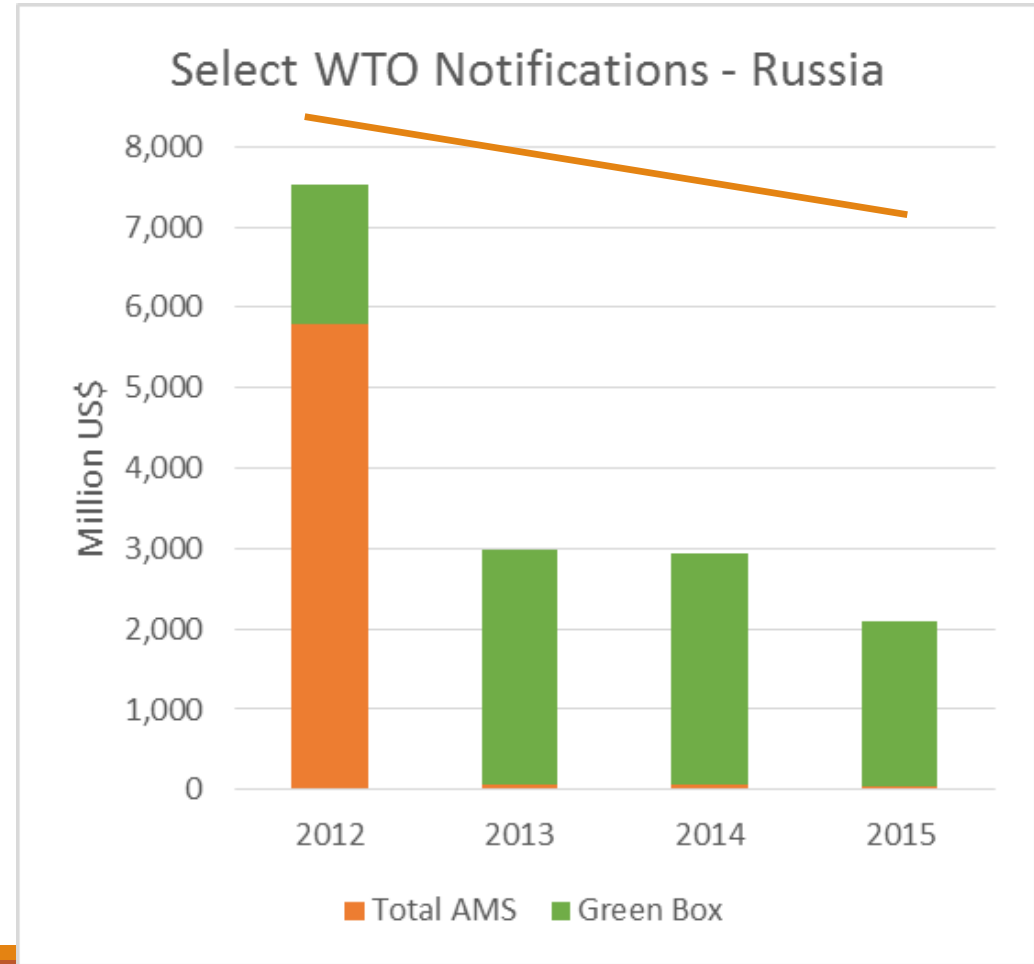
Joined WTO in 2012

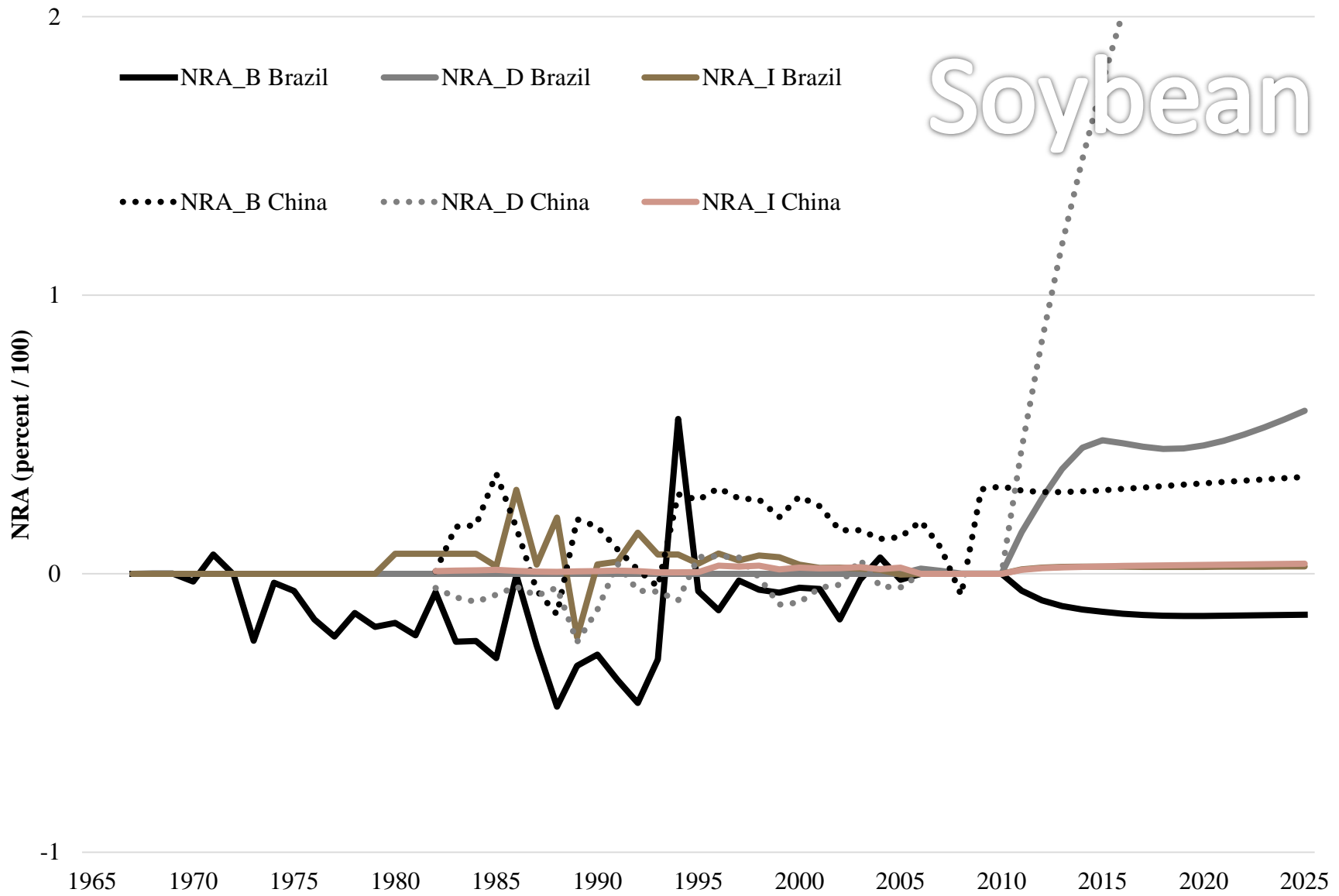
Mixture of policies:

- Crops exports often taxed
- Border protection for livestock products

Dataset ends pre-WTO, has negative NRA_B for wheat and maize

Our projections have NRA_Bs going positive





WTO notifications, India

Self sufficiency also an important driver of policy

- Significant border controls, some non-tariff

- Significant state involvement in markets

Volatile NRA_Bs

Projections positive for cotton and sugar, slightly negative for wheat and maize

