Modeling the Impacts of Agricultural Support Policies on Emissions from Agriculture

2020 NBER

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30 April 2020

Research question

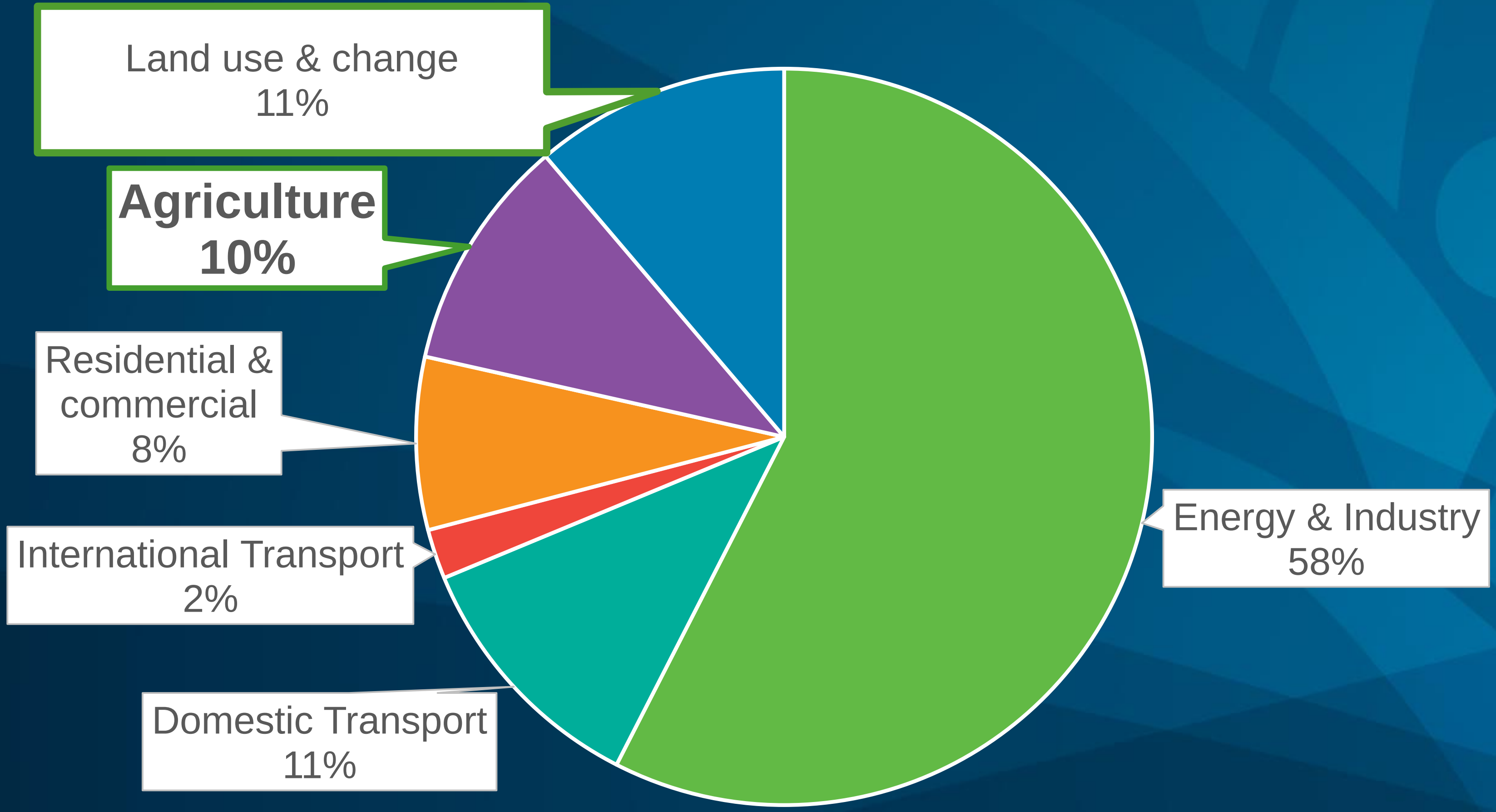
How might the vast amount of agricultural support be repurposed to better serve environmental, economic and resilience goals?

A global public good issue

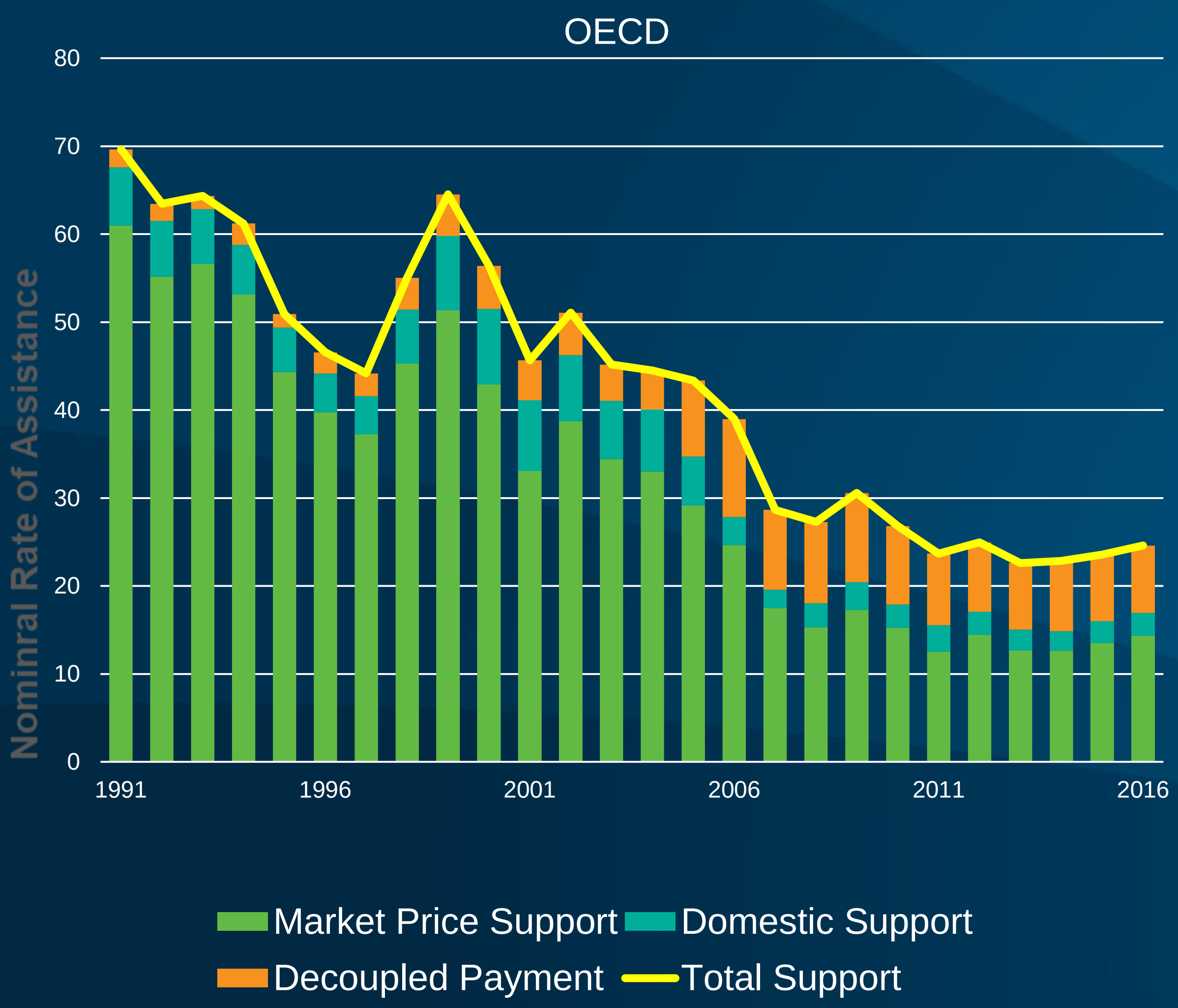
Agriculture matters for GHG emissions

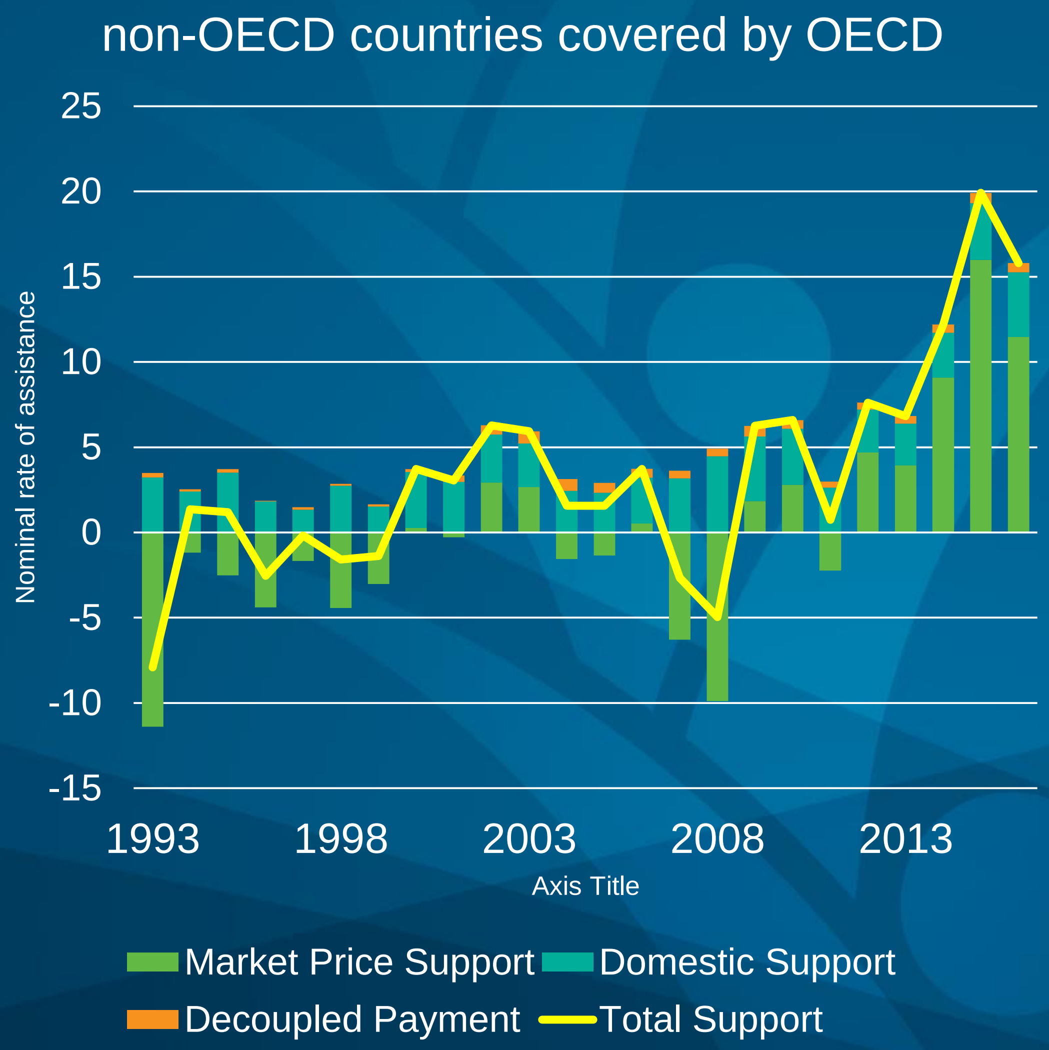
Sources of global emissions (2010) in percentage



Source FAO

Impacted by a global shift in public policies

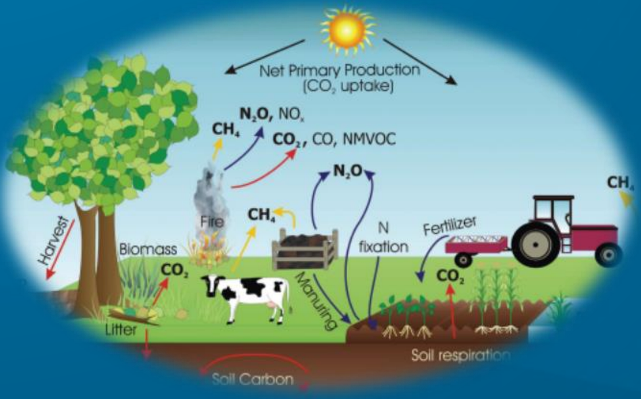




Source: OECD

Extended set of instruments

Data



GHG database

- Based on FAOSTAT (Tubiello and al.)
- Extended for energy and fertilizers

Agincentives
FACILITATED BY IFPRI

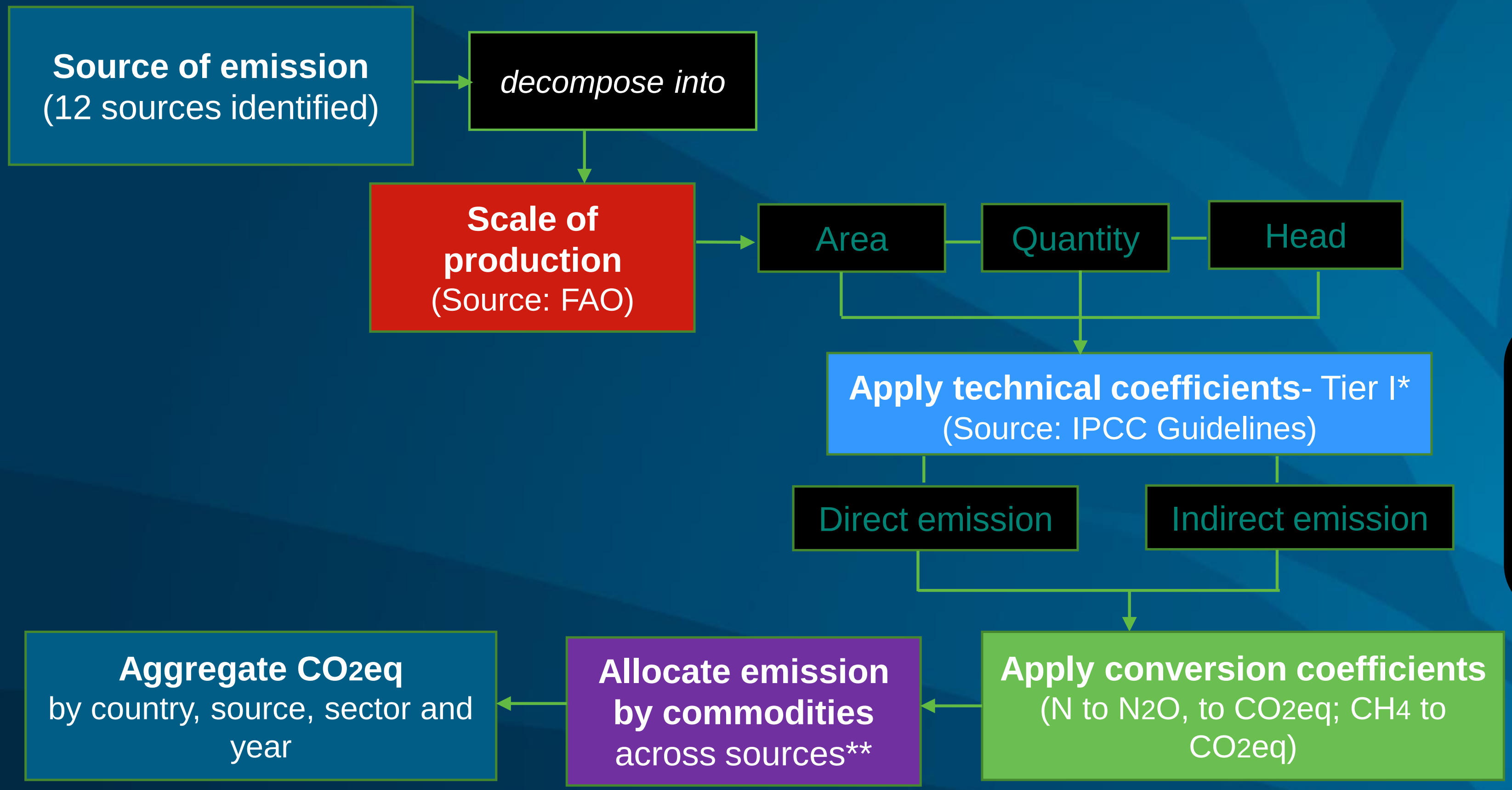
2019 release
+ Extensions for domestic support policies
With reclassification of payments

Model

+ GTAP 10 database
+ Extensions / adaptation

A proper dataset

GHG Database: Reconstruct with bottom-up approach



Technical coefficients

Emission per unit
N extraction per head
N content in residue
Leaching and volatilization rate
Share let on soil etc.

* Tier I: Default emission factors from IPCC guidelines

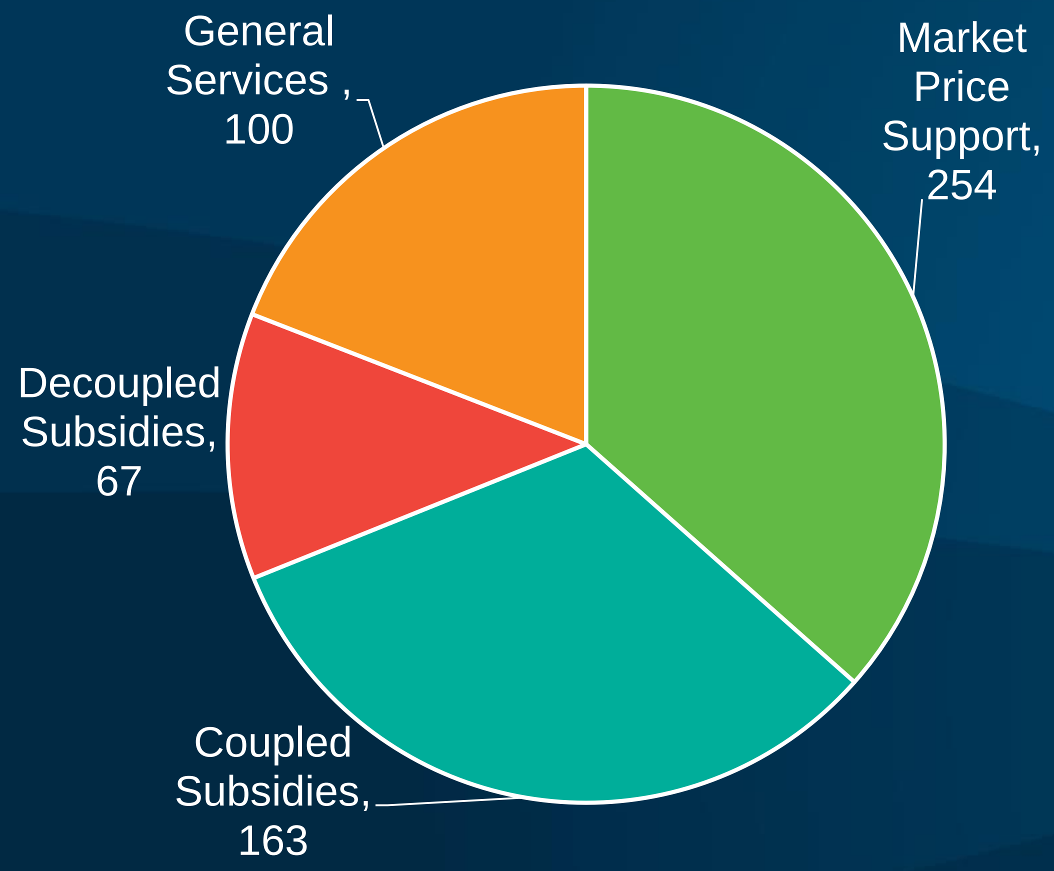
** Using disaggregation space and linkage matrix

Emissions by commodity & source 2015
% of total Ag. Production emissions

	Rice	Other Cereals	Milk	Beef	Pigmeat	Poultry	Total
Crop residues	1.5	3.6	0	0	0	0	5.1
Enteric fermentation	0	0	**11**	**30.5**	0.6	0	**42.1**
Manure	0	0	**6.2**	**16.8**	3.7	2.9	**29.6**
Pesticides	0.2	0.8	0	0.1	0	0	1.1
Rice cultivation	**12.6**	0	0	0	0	0	12.6
Synthetic Fertilizers	2.4	6.5	0	0.7	0	0	9.6
Total	16.7	10.9	17.2	48.1	4.3	2.9	100

Domestic support policies dataset

Producer Assistance, $bn, 2014-16

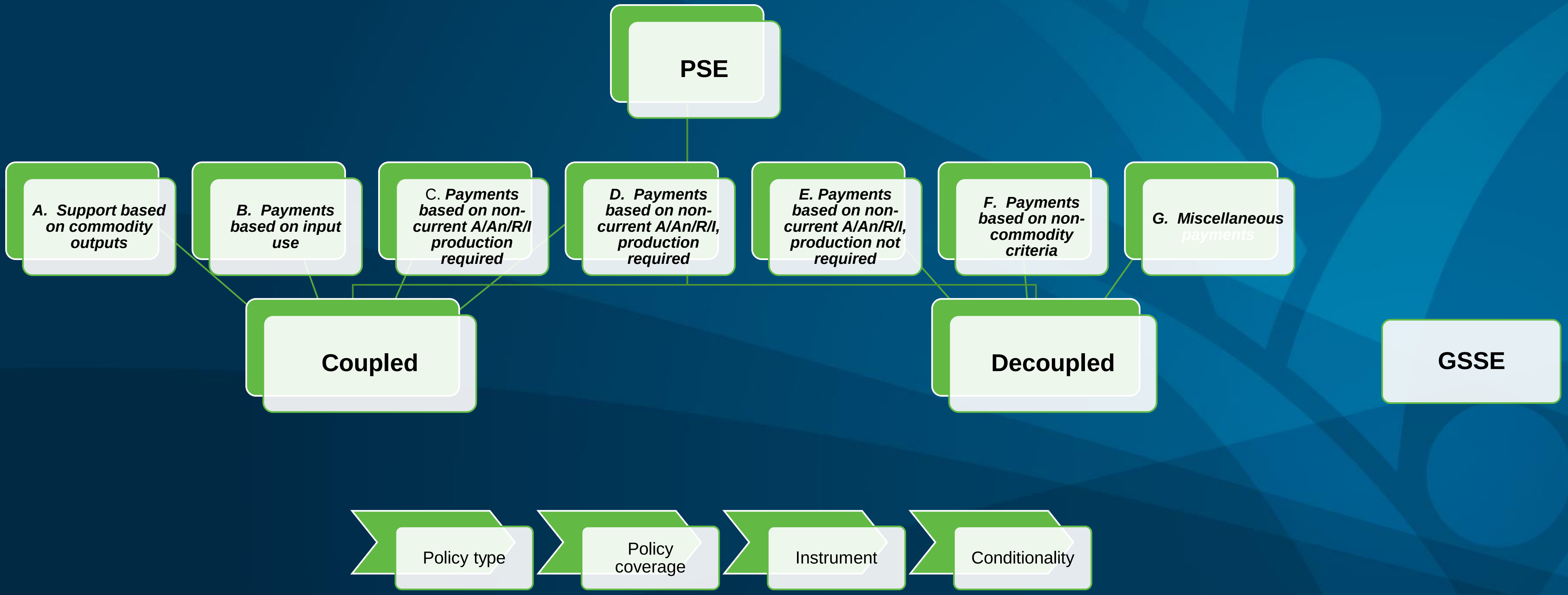


Annual coupled subsidies and GSSE, 2014-16 (US$ billion)

	Narrow Environmental Conditionality	Broader Environmental Conditionality	Fertilizer Subsidies	All Coupled Subsidies	Decoupled Subsidies	GSSE
Australia	0.2	0.1	0.0	0.5	0.4	1.0
Brazil	0.0	2.9	0.0	4.5	0.0	2.7
Canada	0.0	0.0	0.0	1.7	0.0	1.8
Switzerland	0.8	2.6	0.0	1.4	1.1	0.8
Chile	0.0	0.1	0.0	0.4	0.0	0.4
China	0.0	7.2	0.0	53.7	5.9	39.9
Colombia	0.0	0.0	0.0	0.9	0.0	0.6
Costa Rica	0.0	0.0	0.0	0.0	0.0	0.0
EU28	8.8	65.0	0.0	36.2	44.4	12.9
Indonesia	0.0	0.0	1.4	1.9	0.0	1.2
India	0.0	0.0	11.0	28.0	0.0	12.2
Iceland	0.0	0.0	0.0	0.1	0.0	0.0
Israel	0.0	0.0	0.0	0.2	0.0	0.2
Japan	2.4	5.8	0.0	4.8	3.0	8.4
Kazakhstan	0.0	0.0	0.0	1.1	0.0	0.5
Korea	0.8	0.9	0.1	1.0	0.8	2.9
Mexico	1.1	1.1	0.0	3.7	0.0	0.8
Norway	0.1	0.1	0.0	1.4	0.0	0.2
New Zealand	0.0	0.0	0.0	0.0	0.0	0.4
Philippines	0.0	0.0	0.0	0.0	0.0	0.0
Russia	0.0	0.0	0.0	0.0	0.0	0.0
Turkey	0.1	0.1	0.3	3.1	0.0	2.9
Ukraine	0.0	0.0	0.0	1.1	0.0	0.2
USA	5.1	24.9	0.0	16.8	11.2	8.7
Vietnam	0.0	0.0	0.0	0.5	0.0	0.7
South Africa	0.0	0.0	0.0	0.2	0.0	0.3
Total	19.4	110.8	12.8	163.3	66.8	99.7

Source: OECD

Method on domestic support



Nominal rate of protection (NRP), 2016
(as a percent of world price, weighted average)

	GLOBAL	High Income Countries	Middle Income Countries	Low Income Countries
Oilseeds and products	-1.78	-0.26	-2.71	-6.66
Fruits and vegetables	-1.03	12.33	-2.28	28.46
Sugar	15.84	15.66	17.63	-38.28
Bovine Meat	11.12	8.70	13.75	13.95
Maize	9.15	-0.54	26.00	-47.78
Milk	8.21	15.87	1.09	-55.96
Poultry meat	13.22	10.88	14.88	
Rice	30.36	109.31	22.96	17.98
Wheat	19.67	4.58	34.48	-25.86
TOTAL	**7.00**	**9.50**	**7.20**	**-41.18**

Measuring (international) market access distortions

- Two potential approaches:
  - Direct measures of border protection for imports Bouet and al. 2008, RIE) and for exports Laborde and al., 2013, World Economy)
  - Indirect approach through price gaps: OECD (PSE manual, 2016)
- First approach well suited for trade policy reforms but could omit other distortions e.g. NTBs
- We select the second approach building on the Ag-Incentives Consortium data → Nominal Rate of Protection, both positive and negative
- But, NRP are not bilateral!
  - Issue of preferences and relevance for the "where it comes from"
- "Bilateralisation" of NRPs
  - Split of NRP information into two instruments:
    - NRP<0 : export taxes
    - NRP>0 : import duties
  - Rescaling of the bilateral tariff structure to reproduce unilateral NRP (trade weighted)

A Global Model

What is the impact of current farm policies on GHG emissions?

Decisions	Why it matters for GHG?
Which commodity to produce? "Wheat or Rice?"	Different commodities are associated with different levels of emissions of different GHGs (CO_2CH_4, N_2O)
Where to produce? "Brazil or Switzerland?"	Different biophysical conditions and different technologies lead to different level of emissions for the same commodity in different countries
How much to produce? "10 million tons or 100 million tons?"	The more we produce, the more we emit
How to produce? "How much fertilizers should we use?"	Input and output prices change the way we adopt technology and produce farm goods, using more intensive or extensive technologies

The specific role of trade policies

DECISIONS	EFFECT OF TRADE POLICIES
Which commodity to produce	Tariffs vary from one product to another
Where to produce	Tariffs have strong impacts in shifting production around the world
How much to produce	Tariffs increase the price of agricultural products and therefore will deter consumption
How to produce	Tariffs can change the cost of adopting technologies and inputs

Modelling Framework

MIRAGRODEP:

- a Computable General Equilibrium (CGE) model,

built upon the MIRAGE model.

- It is a multi-region, multi-sector model, dynamically recursive CGE model;
- Government explicitly represented;
- Main source of data: GTAP 10 (base year 2014).

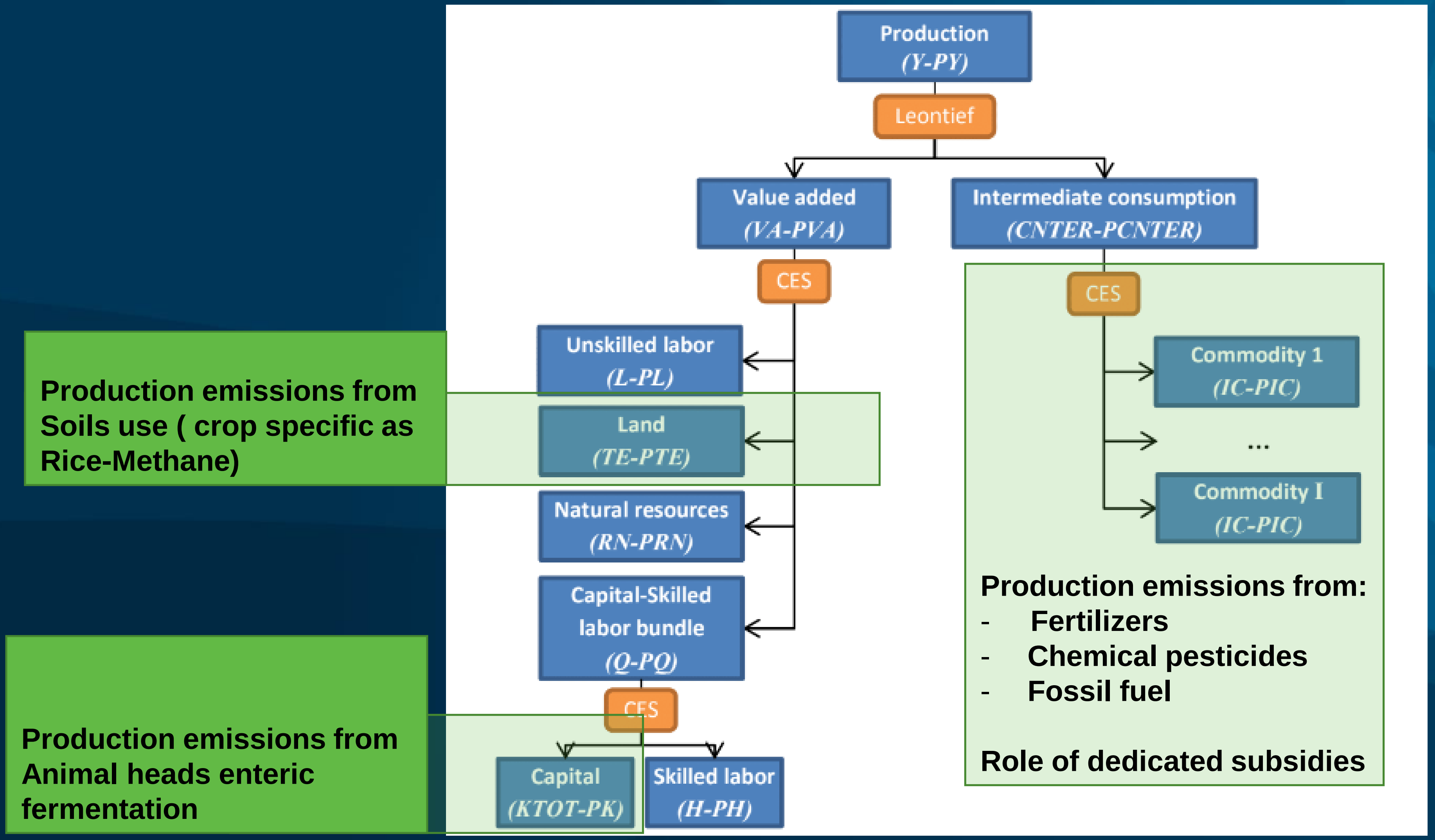
Assumptions:

- Static version of the model
- Public purchases held constant and a variable consumption tax used to hold the deficit to GDP ratio constant,
- Land use held constant to focus on emissions from agriculture
- A constant level of employment.

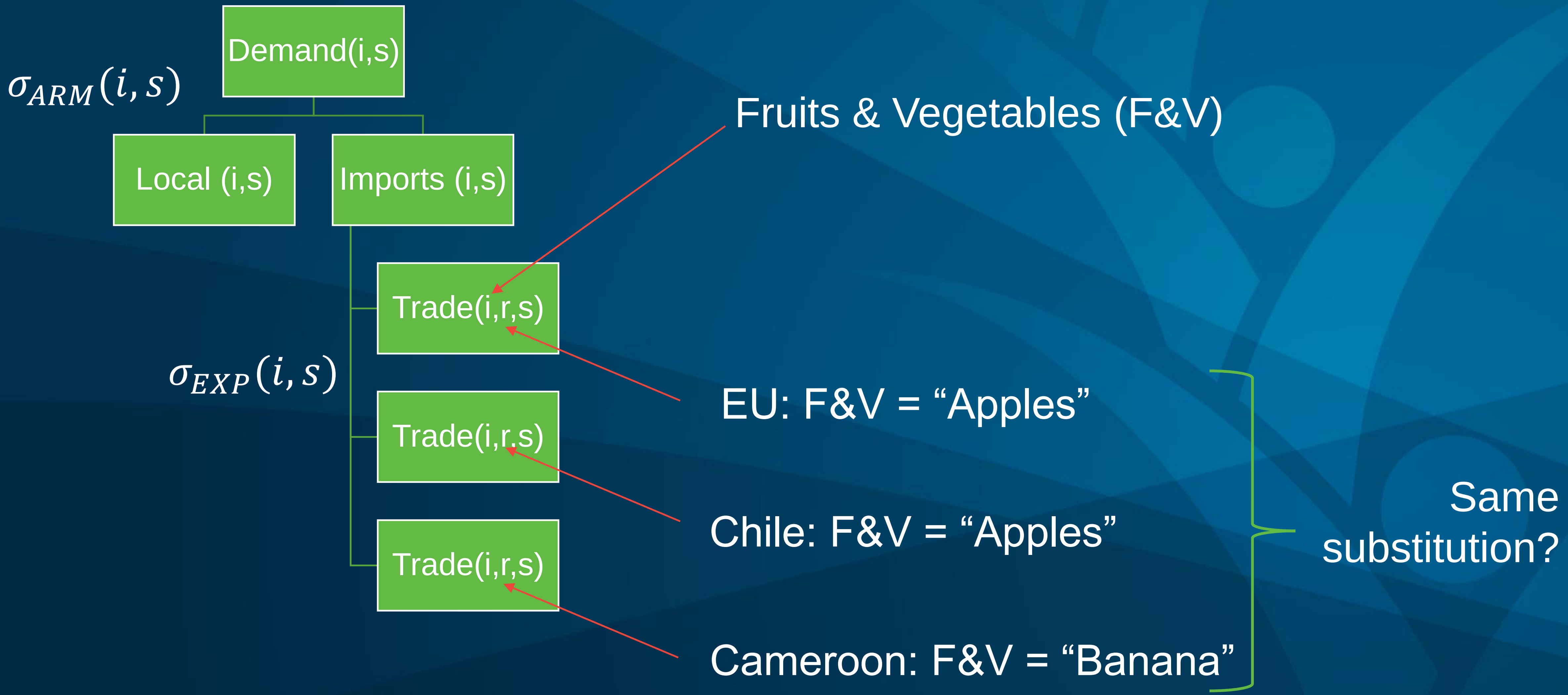
Key closures:

- **Savings** defined investments;
- Current account surplus/deficit [**net foreign savings**] constant in terms of global GDP:
    - Real exchange rate endogenous
    - Foreign capital flows stable
- **Net Public savings** (government surplus/deficit): constant in terms of domestic GDP
    - Endogenous tax reform
    - No change in public investment

How do we produce things?

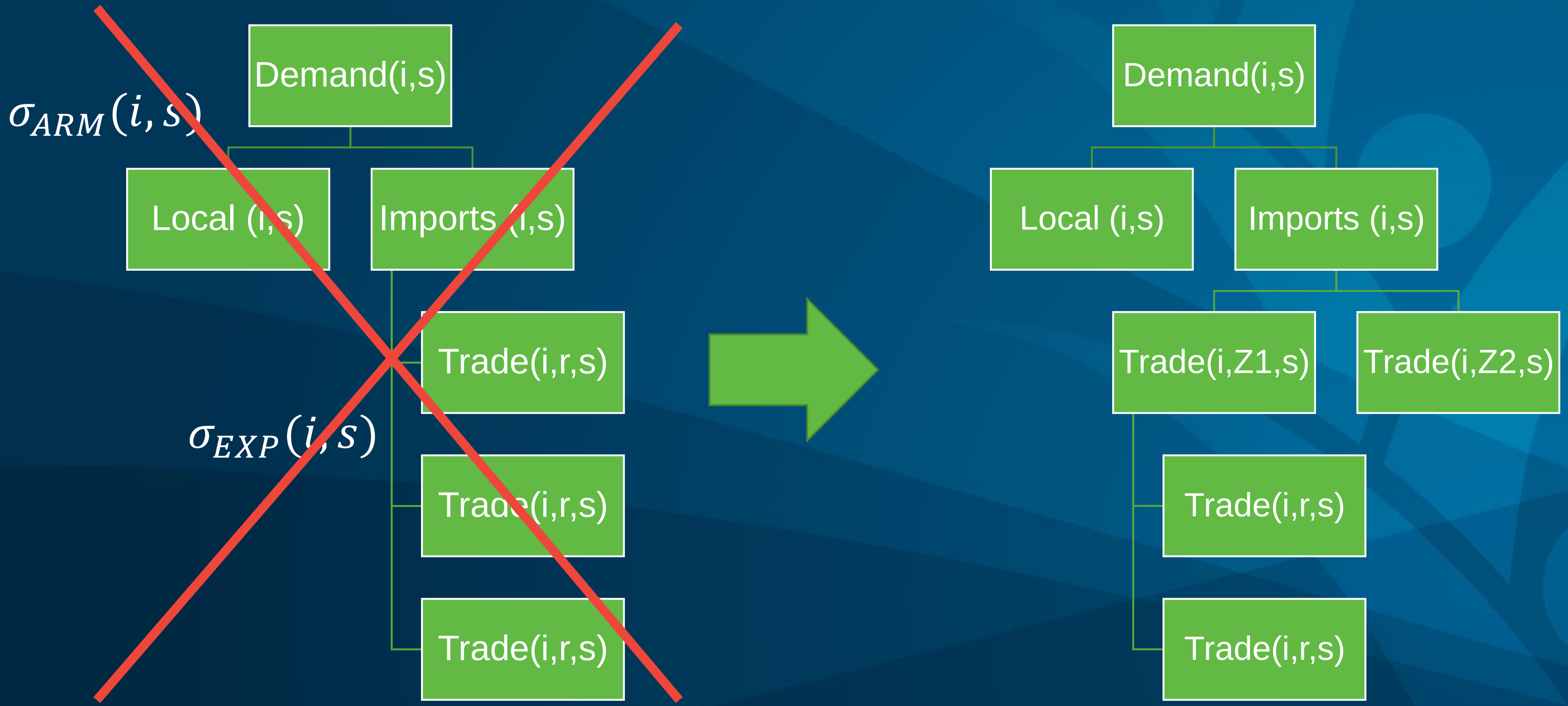


Where does it come from?
The role of properly capturing trade deviation effects



Where does it come from?

Each tree is built for each sector and each importer based on **cluster analysis made at the HS6 level** and done for the specific aggregation of the model



How much do we produce and which products?

- CES-LES demand system, with a sub CES nest for food products
- The role of price and income elasticities

Results

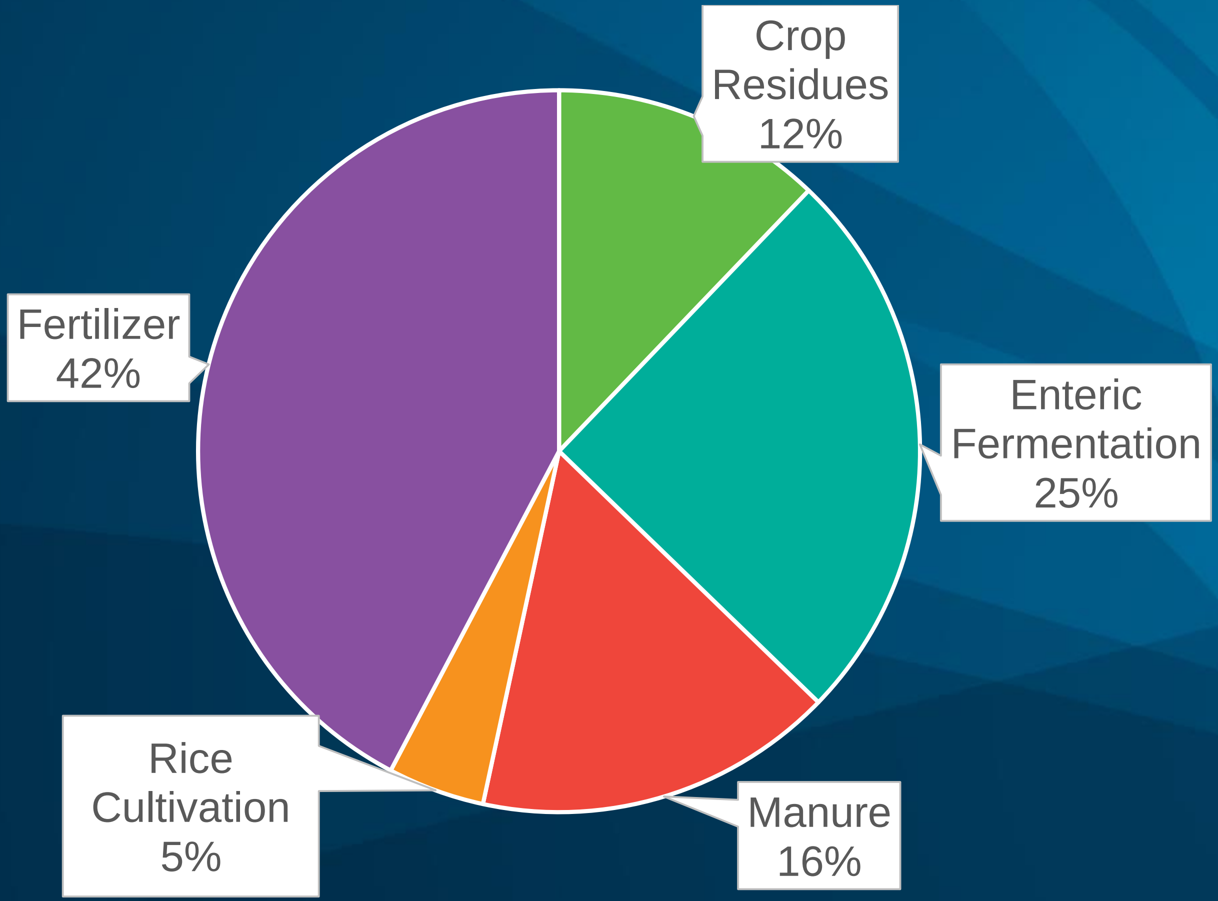
Key scenarios

- S1 Domestic support
- S2 Market Access
- S3 Full policy removal
- S4 S3+increase of Multi Factor Productivity
- S5 S3+productivity changes that reduces emissions

Removing coupled subsidies:

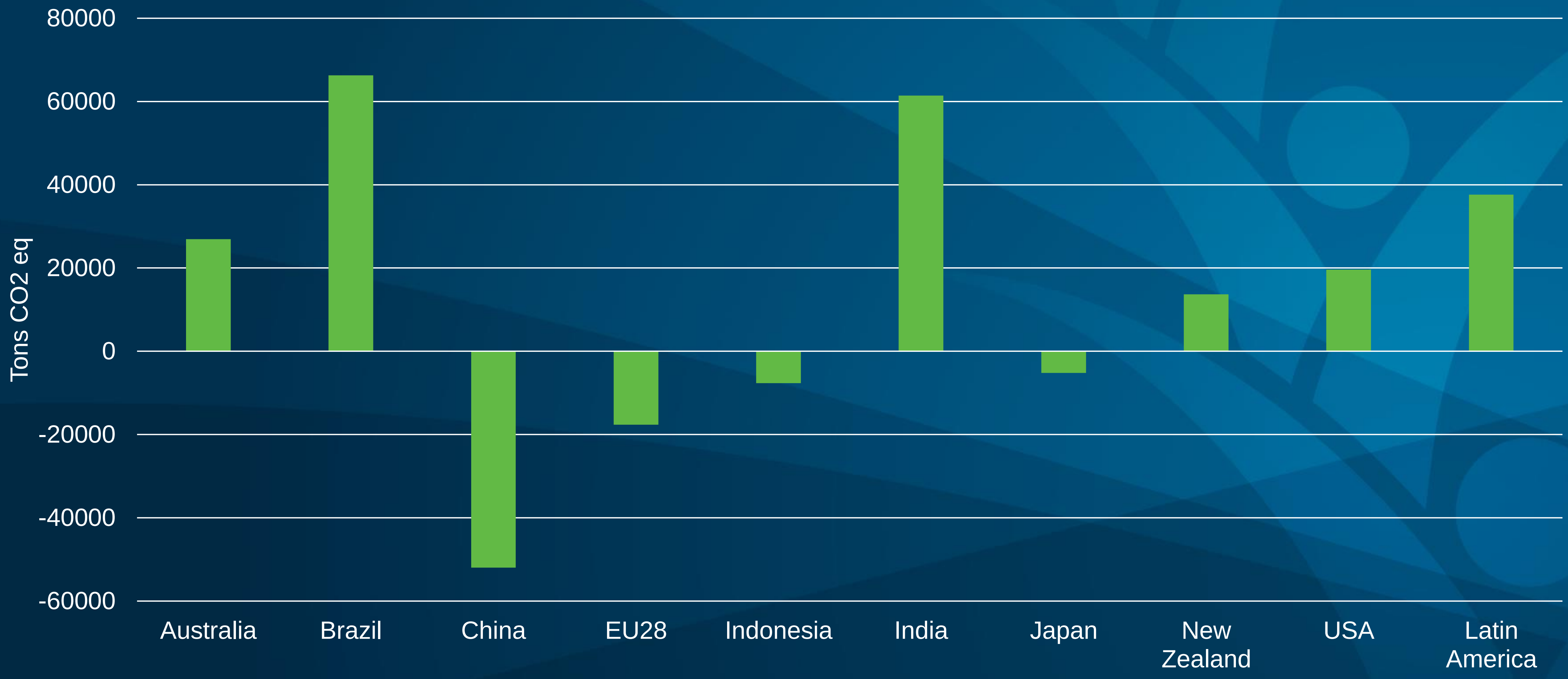
Total Impact
-34mt CO_2 equivalent
-0.6% of Ag. Production emissions

Source of reduction



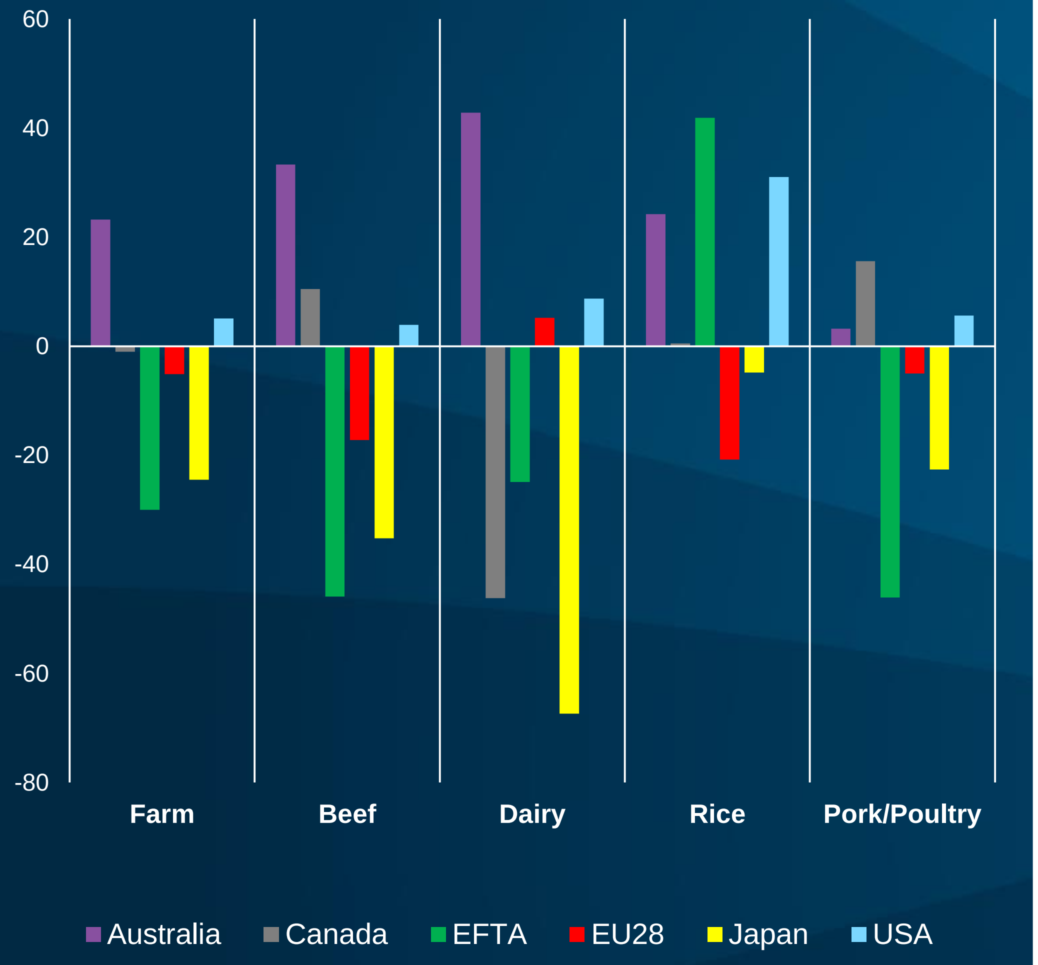
Removing border measures

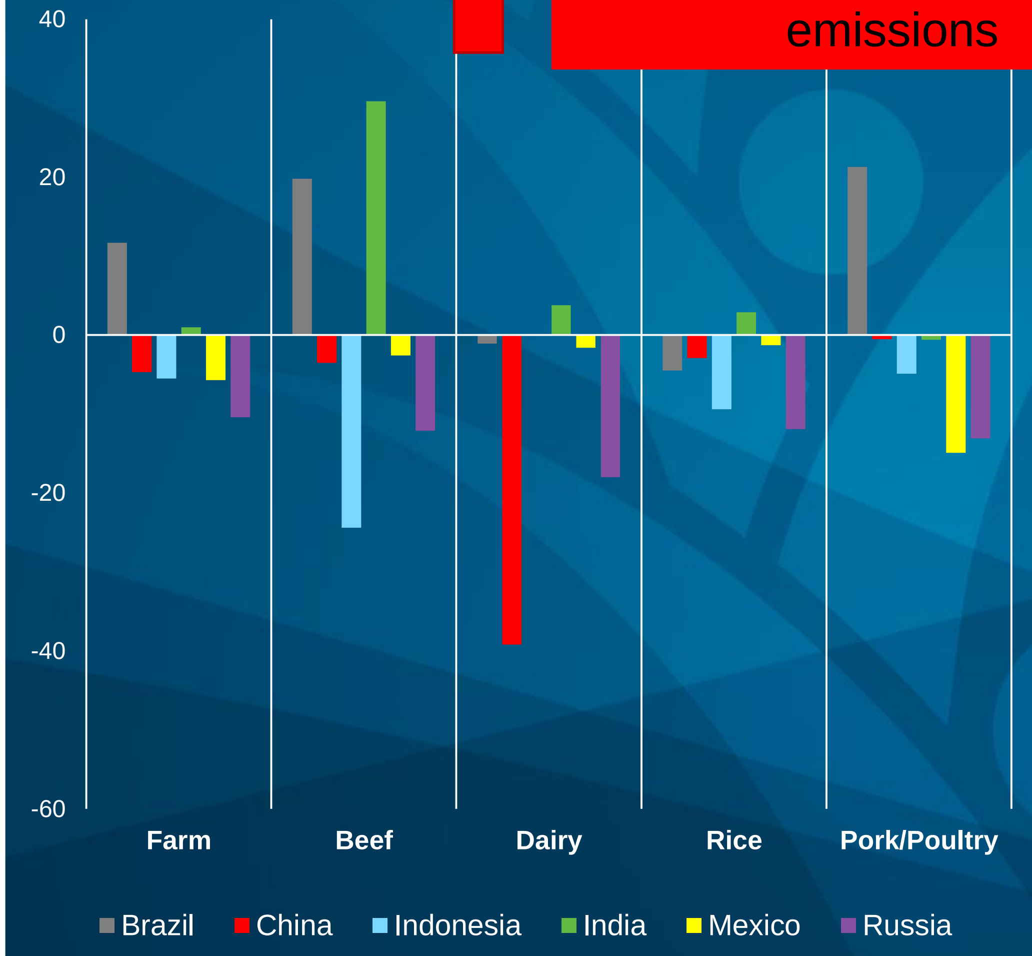
Total Impact
+128 mt CO_2 equivalent
+2.1% of Ag. Production emissions



Removing coupled subsidies and border measures
Output changes, %

Total Impact
+102 mt CO_2 equivalent
+1.7% of Ag. Production emissions





Is it surprising that current trade policies are limiting GHG emissions?

Answer: No

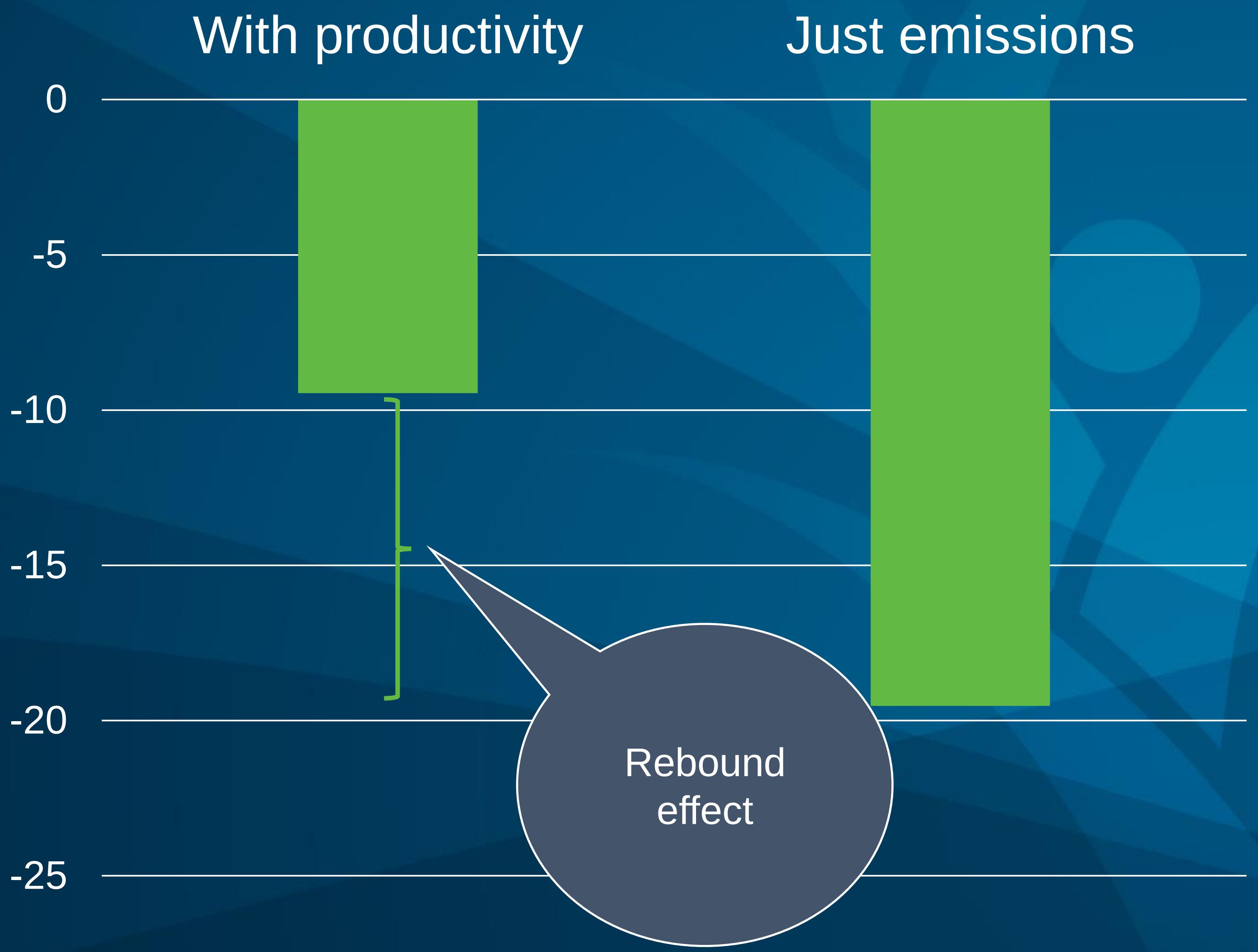
- High prices limit consumption, and therefore reduce the scale of production
- Overall, they shift production from developing countries to more advanced, and protectionist economies. The latter have better technologies and lower emissions per unit of output for many products (but not all!)
- Free trade maximize economic efficiency in a system without externalities. With the lack of market for GHG emissions, free trade could not deliver an optimal environmental solution

What should be done: address the externalities at the source

- Develop technologies that directly reduce emissions per unit of output
- Favor technological adoption, especially in developing countries to realign economic and environmental efficiency
- Address the issue of pricing of the GHG emissions

30% reduction in emissions per unit

Global Emission Change, %



Next steps

Broaden coverage of measures

More about impacts on production methods

Incorporate land use change

Consider broader range of repurposing reforms

Conclusions & next steps

- Agricultural support is very substantial-- subsidies, trade barriers, public goods
  - Policy reform needs to be guided by implications for key policy outcomes
- Agricultural & land use emissions close to a quarter of global emissions
  - Agricultural emissions strongly concentrated in beef, dairy & rice
- Subsidies to emitting commodities increase global emissions
  - Trade barriers reduce emissions by reducing global demand
  - Productivity enhancement cuts emissions
- Building towards a better understanding of impacts of policy redesign

References

- Christophe Gouel & David Laborde, 2018. "**The Crucial Role of International Trade in Adaptation to Climate Change**," NBER Working Papers 25221, National Bureau of Economic Research, Inc.

- Laborde, David & Valin, Hugo, 2010. "**Modelling Indirect Land Use Effects Of Biofuels:**," 14th ICABR Conference, June 16-18, 2010, Ravello, Italy 188100, International Consortium on Applied Bioeconomy Research (ICABR).

- Piñeiro et al, forthcoming. A scoping review on incentives for sustainable agricultural practices: from adoption to outcomes. Nature.