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Modelling the Consequences of Increasing Bioenergy Demand on Land and Feed Use

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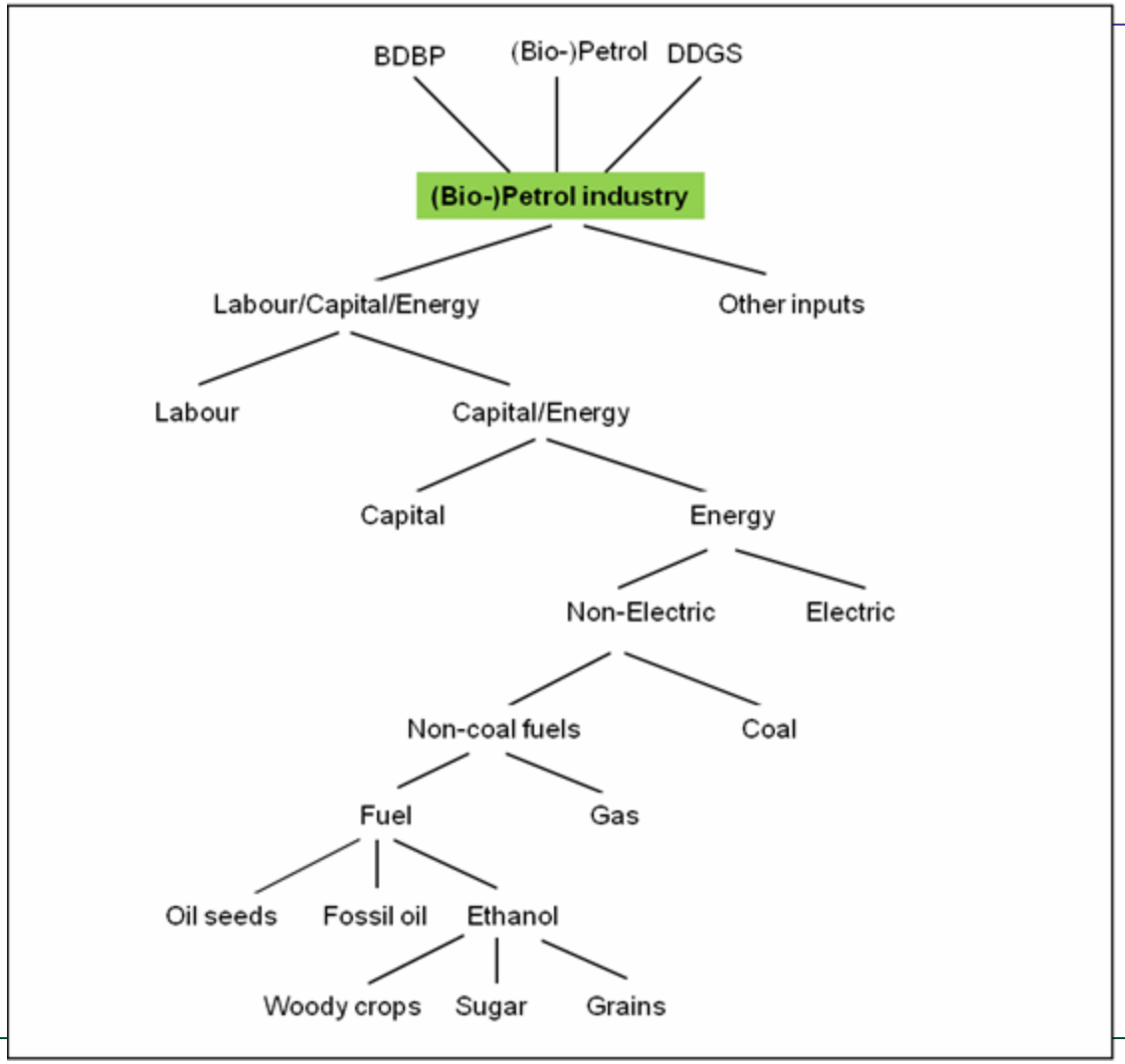
Aim and method

- Taheripour et al. 2010, Birur et al. 2008, and Hertel et al. 2008 have introduced biofuels and their byproducts into the GTAP model
- Aim of the paper:
  - Effects of integration of biofuel by-products in CGE-analysis of EU Renewable Energy Directive (RED)
  - Evaluation of the EU-RED
    - Impact on the EU supply chain of biofuel crops (grains and oilseeds) production and processing for food, feed and fuel purposes.
    - Effects of covering by-products on land use
- Method:
  - Simulation experiments based on an extended version of the Global Trade Analysis Project (GTAP) model:
    - Production of biofuels and its by-products
    - Substitution between different feed components including biofuel by-products.

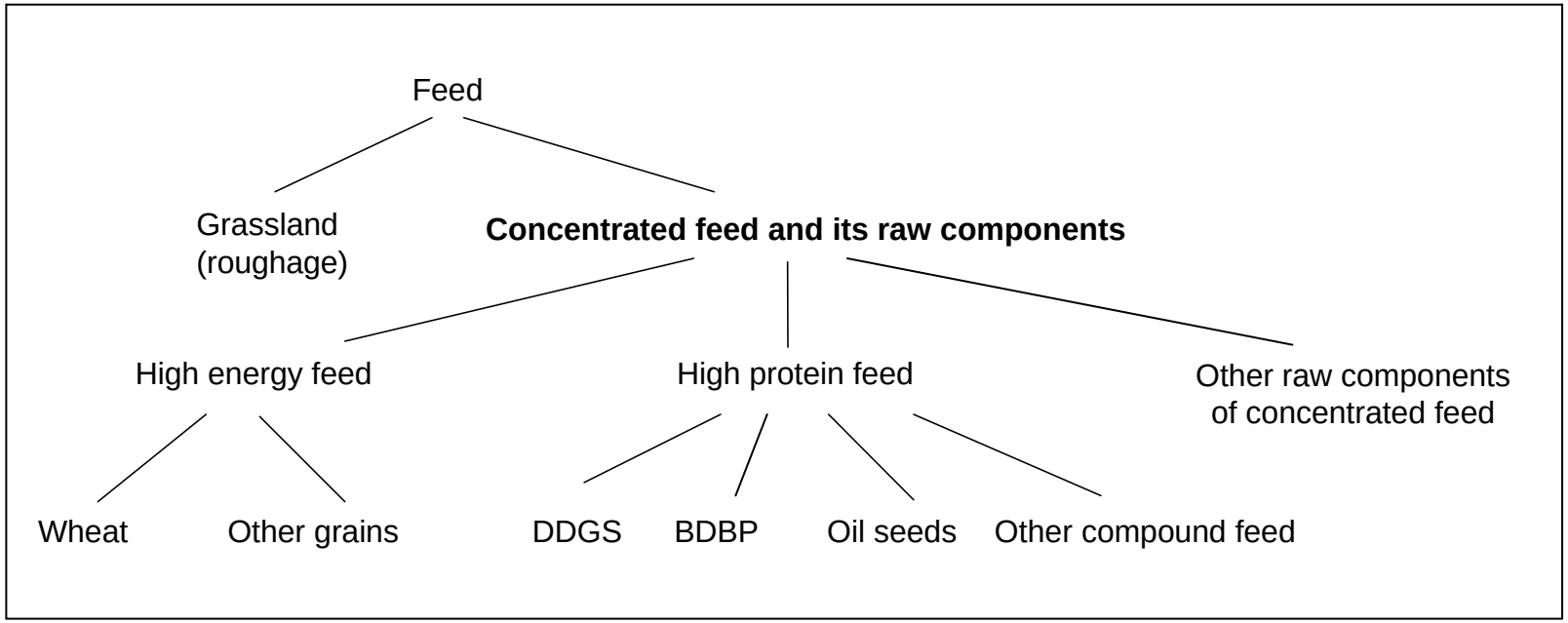
The model

- GTAP: applied general equilibrium model based on neo-classical microeconomic theory
  - multi-regional
  - multi-sector
  - static
- LEITAP extension of GTAP:
  - land market modeling
  - capital - energy sources (including biofuels) substitution
  - biofuels and biofuels (feed) by-products production
  - feed components - feed by-products substitution

The model: Technology tree – Petrol industry



The model: Animal feed - nested structure



The database (1/2)

- Version 6 of the GTAP database - worldwide data for 2001
  - bilateral trade, transport and protection data characterizing economic linkages among regions
  - individual country input-output databases which account for intersectoral linkages
  - aggregation 36 regions (EU countries and most important countries and regions outside EU) and 25 sectors (16 agri-food sectors; 5 energy sectors)

The database (2/2)

- Data base adjustments to model the biofuels and biofuel policy:
  - modification of intermediate input of grain, sugar and oilseeds in the petroleum industry to reproduce 2004 biofuels shares in the petroleum sector .
  - implementation of biofuel by-products (Dried Distillers' Grains with Solubles – DDGS and oils seed meals – BDBP).
    - constant conversion ratio between grains and oilseeds quantities used to produce biofuels and resulting by-products production
    - implementation of intermediate inputs of by-products in the feed production for the livestock sectors.

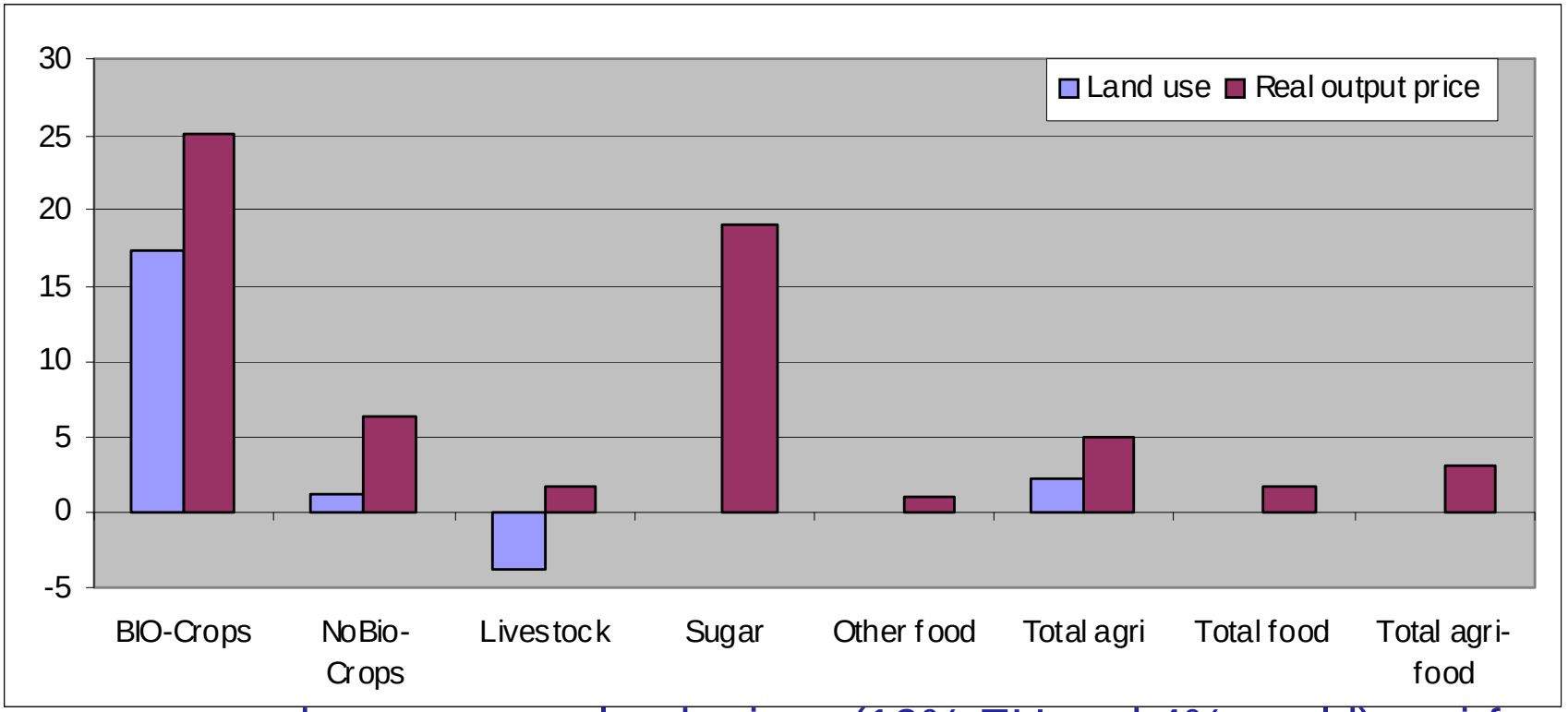
The simulation scenarios

- Two model version:
  - with and without by-products in bioenergy sector
- Two scenarios:
  - Reference (Ref) scenario without EU RED
  - EU-RED with a 10% blending share for transportation fuel by 2010
- Common scenario assumptions:
  - Macro-economic assumptions (technical progress, population growth, labor and capita availability, associated GDP growth)
  - Update of policy changes

General simulation results

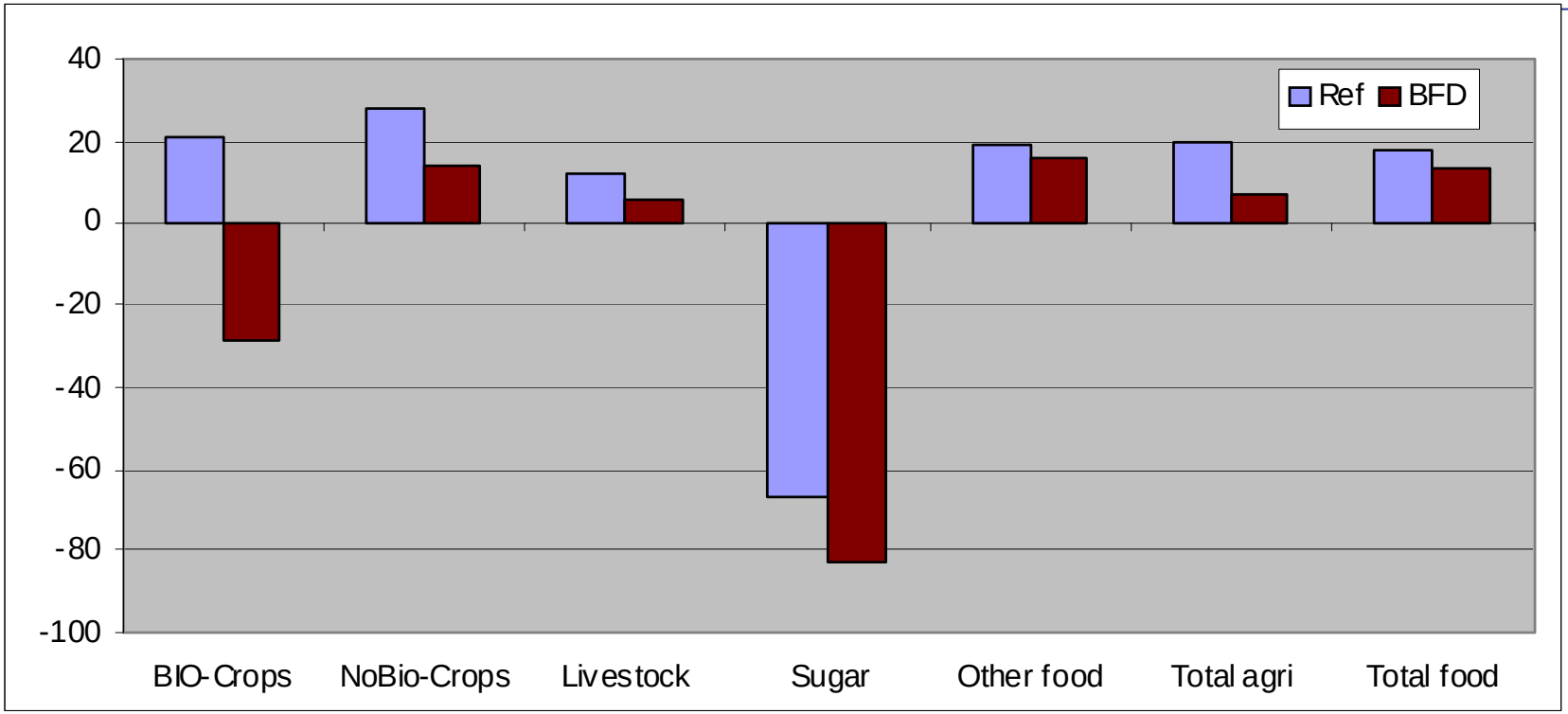
- Biofuels Directive stimulates the demand for biofuel crops and sugar in the EU biofuel industry
- Demand for other agri-food products remains similar to the level observed in the Reference scenario because:
  - small price effects of RED – apart from the directly affected crops
  - relative small cross-effects of the RED on other agri-food products due to the low income and price elasticities for agri-food products
- RED results in a 0.23 percentage points lower GDP growth in EU countries in 2007-20 compared with the Reference scenario,
  - equivalent to almost 24 billion EUR in 2001 prices.
- Inflationary effect induced by extra demand for biofuel crops is mitigated by the production increase encouraged by higher biofuel crops prices

Land use and output prices in EU in 2007 – 2020, BFD less Reference (%)



…an upward pressure on land prices (19% EU and 4% world) agri-food prices (3.1% EU and 0.8% world) and harvested area (2.2% EU and 0.8% world), but biofuel crops area in EU 27% up whereas pasture 4% down.

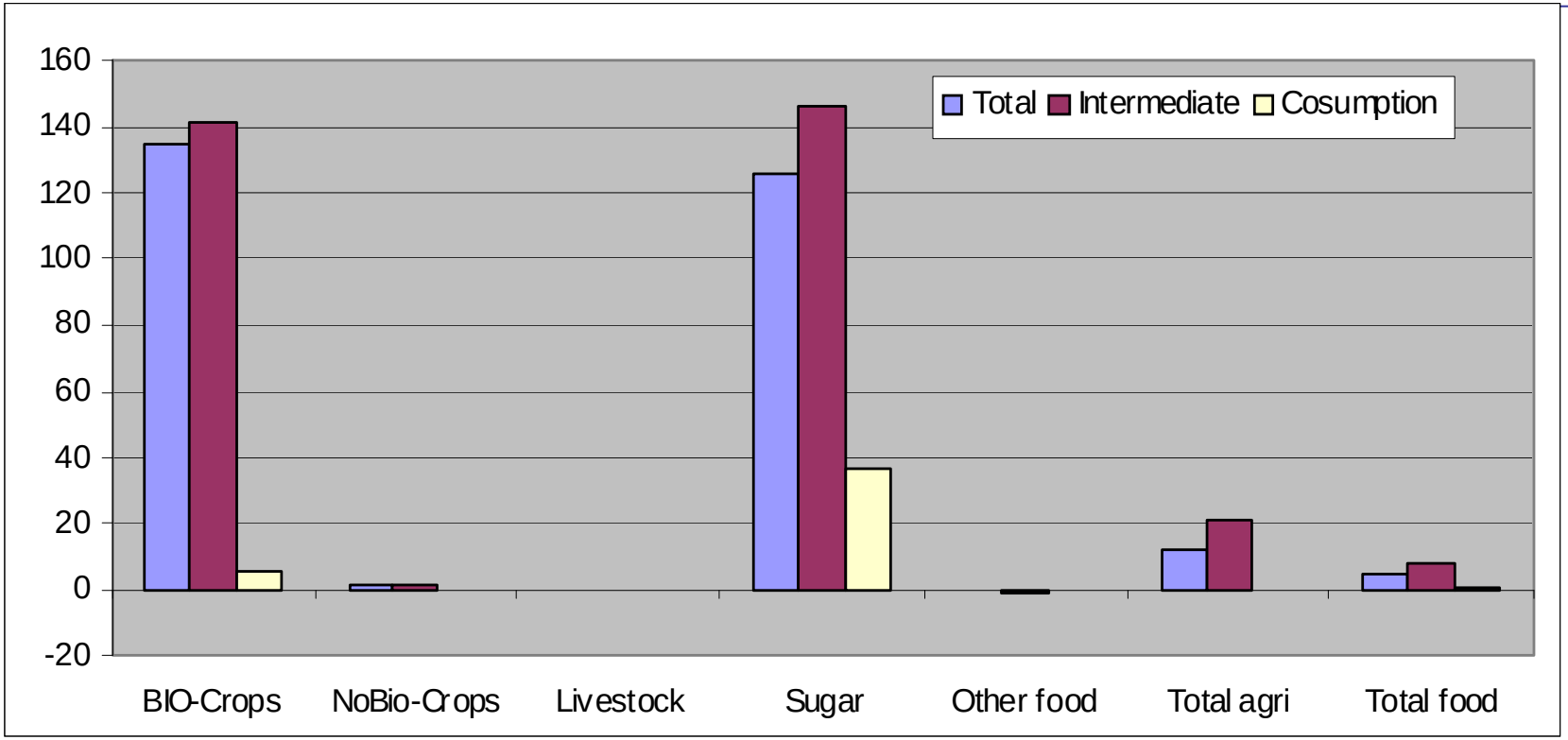
EU agri-food exports growth in 2007 - 2020, in %



… high domestic prices and declining exports for biofuel crops (50% in BFR compared with Ref) of biofuel crops in the BFD scenario have a negative impact on agri-food exports

… other crops and sugar exports are significantly lower (by 13% and 15% respectively) in the BFD scenario compared with the Ref scenario.

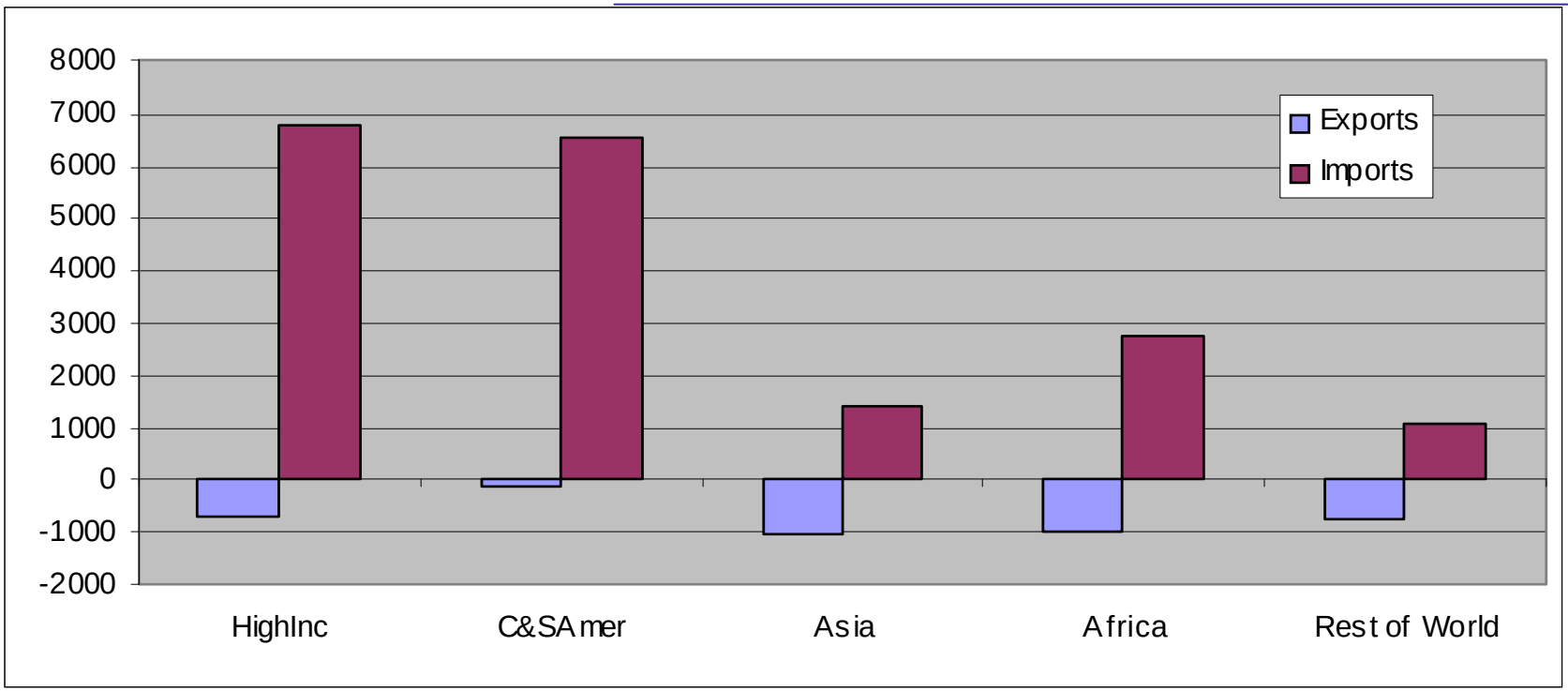
EU agri-food import growth by destination: 2007-2020, BFD less Reference (%)



…BFD boosts agri-food imports compared with Ref (biofuel crops 2 times, agri 12% and food 4%);

…additional biofuel crops and sugar imports are mainly used as an intermediate input in the petrol sector

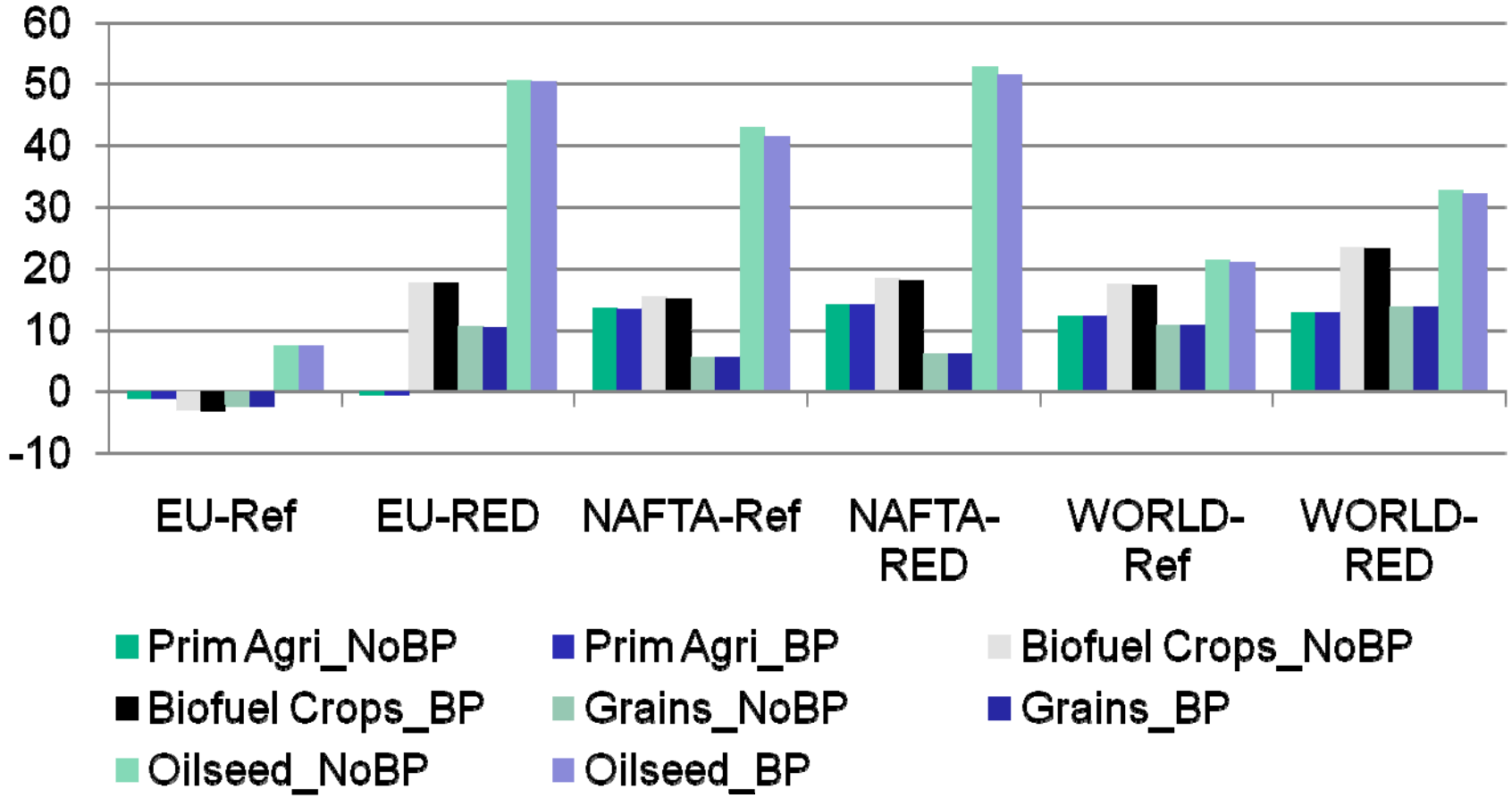
EU agri-food exports and import value (mil 2001 USD) per group of counties in 2020, BFD less Reference, in mill. $



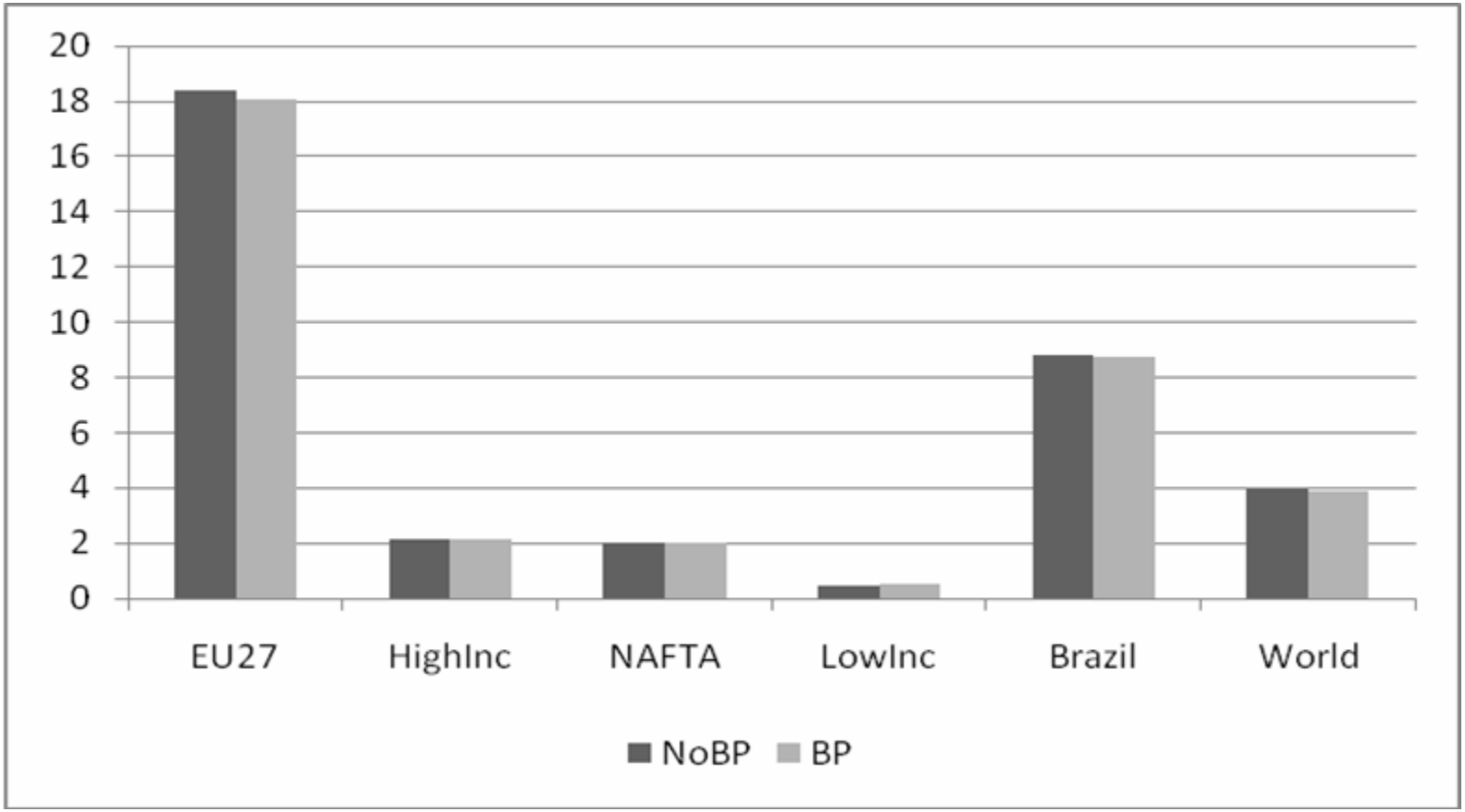
…high Income countries and Central and South America contribute most to additional EU biofuel crops imports (about 90% in 2020) while African countries contribute almost 45% of the total sugar imports

…EU trade balance in agri-food products deceases by 22 billion USD as the result of the BFD

Growth of agricultural production, %, 2007-2020



Change in agricultural land price, 2007-2020, with both types of models, BioF miuns Ref, in percent



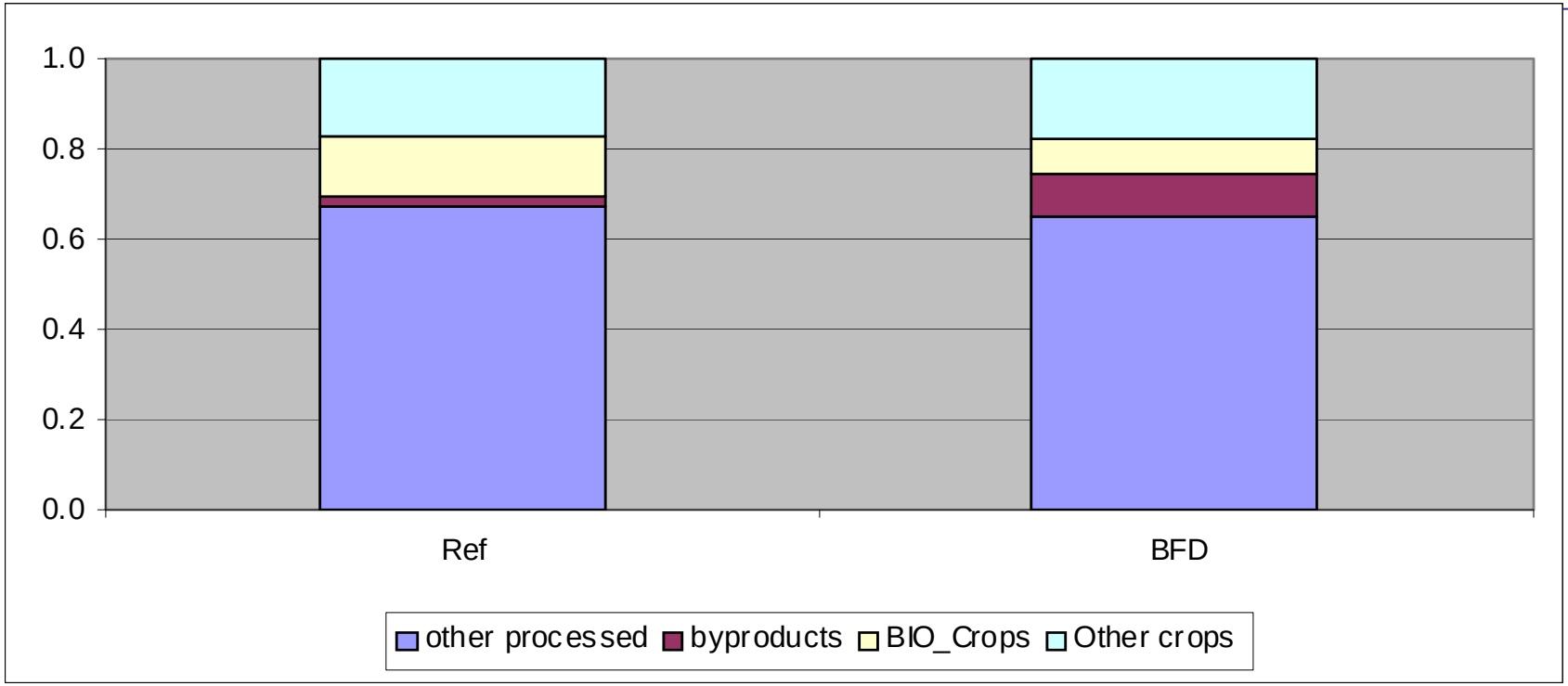
Impact of by-products in global land use expansion (1)

- Without by-products:
  - 2.0 % biofuel share
  - 41.04 million ha
- With by-products:
  - 3.1% biofuel share
  - 40.16 million ha
  - By-products compensate for 0.9 million ha
    - 0.7 million ha in low income countries
    - 0.2 million ha in Brazil

Impact of by-products in global land use expansion (2)

- If biofuel shares in transportation are the same in model BP and noBP
- By-products availability reduce global land use for agriculture by 2.9% or 22.5 million ha

Composition of animal feedstock in the EU in 2020



… grains and oilseeds (the biofuel crops) are replaced by compound feed and especially by feed byproducts (share of the compound feed increases from 69% in the Ref to 75% in the BFD) in 2020

… byproducts share increases from 1.5% to 9.5% and biofuel crops share decreases from almost 14% to 7%.

Summary of Renewable Energy Directive impact

- **Direct effect:**
  - demand stimulation for biofuel crops and sugar
  - biofuel crops harvested area production and imports increase and the EU agri-food exports and trade balance deteriorate
  - inflation of EU prices of these commodities by 25% and 19% respectively but in total agri-food prices increase only by 3.1% for the EU and 0.8% at world level
  - use of biofuel crops in the EU petrol sector increases by almost 10 times
- **Indirect effects:**
  - land use changes from pasture to crops
  - significant increase of biofuel production byproducts and therefore…
  - substitution of biofuel crops in animal feed by biofuel byproducts
  - consequently small impact on meat production