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Norsk institutt for  
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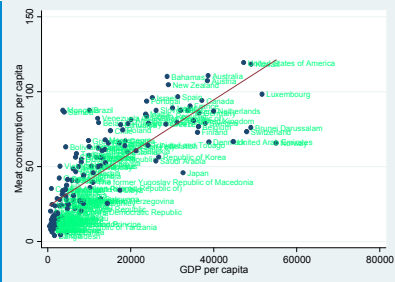


**THÜNEN**

## Changing meat consumption patterns – Combining cross-country analysis with an applied trade model

**Anna Birgitte Milford, NILF (Norway); Martin Banse, Thünen Institute (Germany)**

TradeM Workshop MACSUR on ‘Scaling in global, regional and farm models’. Vienna, 24/09/2014



24 September 2014

## Introduction

### Motivation

- MACSUR strongly focuses on supply side of agriculture and food sector
- Contribution of demand to CC and impact of (changing) consumption pattern is not reflected in current work
- Anne Birgitte Milford presented an interesting paper at the MACSUR mid-term meeting in Sassari
- Regression analysis about long-term drivers of meat demand
- Integrating this work in (better) calibrated demand functions in market models applied in MACSUR

## Introduction

### Outline

- Empirical analysis of food (meat) demand based on FAO and International Comparison Program (ICP) data
- Regression analysis to derive price and income responsiveness of food (meat) demand
- Scenario analysis:
  1. BAU: (business as usual) scenario until 2030
  2. LowInc: Same as under 1. but with lower increase of per capita income
- Recalibration of demand elasticities in an international trade model
  - Comparison of results of both scenarios with original and new demand elasticities
- Conclusions

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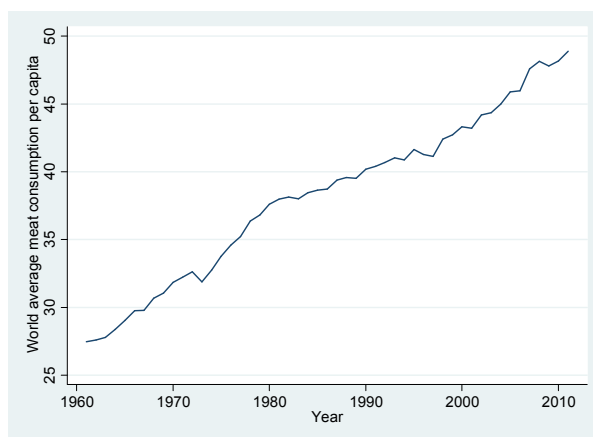


## Food choices matter...

- Producing 1 kg of animal protein requires about 100 times more water than producing 1 kg of grain protein (Pimentel and Pimentel 2003)
- A heavy meat-based diet requires three times as much land area as a vegetarian diet (Mozner and Csutora 2013)
- The CO<sub>2</sub> emissions per gram of protein is 70 times higher for beef than for peas (Gonzalez et al 2011)
- The potential to reduce GHG emissions through changes in consumption is substantially higher than that offered by supply-side, technical GHG mitigation measures (Popp 2010)
- Demand-side measures offer a greater potential in meeting the challenges of both GHG mitigation and food security than do supply-side measures (Smith et al 2013)



## World average meat consumption per capita, 1960-2011

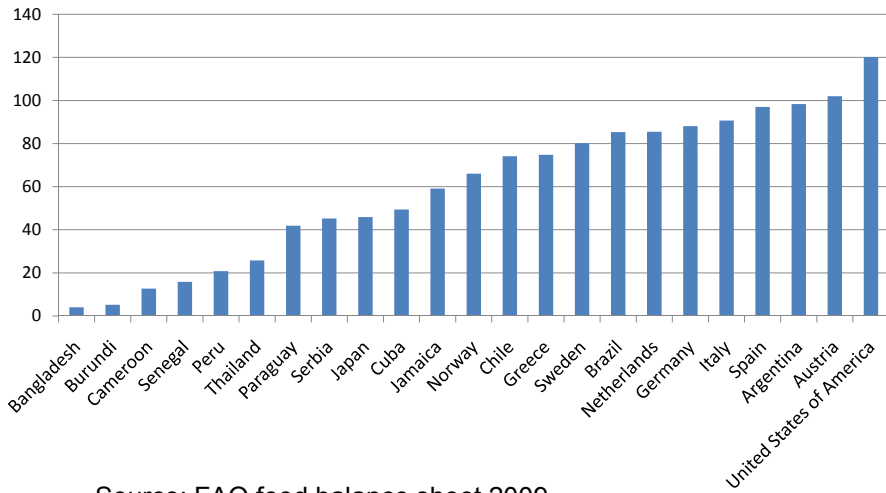


- Source: FAO food balance sheet

## Drivers for meat consumption

- There are large differences between countries when it comes to meat consumption
- What are the drivers?
- Income, prices, urban population, religion, and agricultural landscape

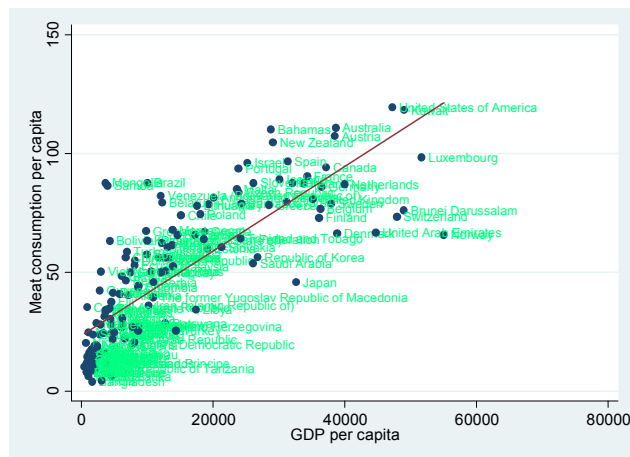
## Meat consumption in a selection of countries



• Source: FAO food balance sheet 2009



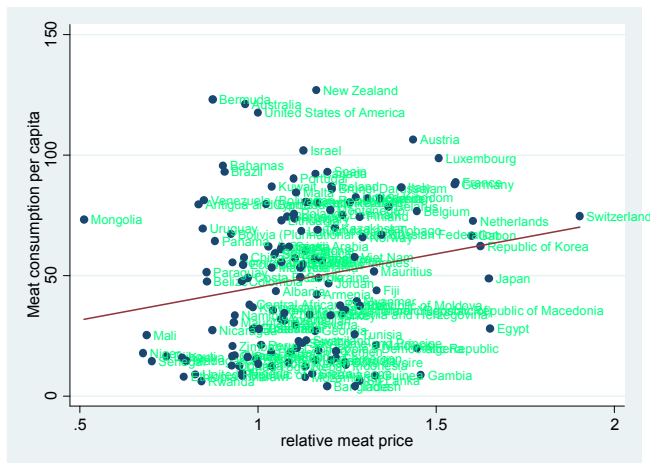
## Meat consumption relative to income



• Source: FAO food balance sheet 2011 and World Bank data

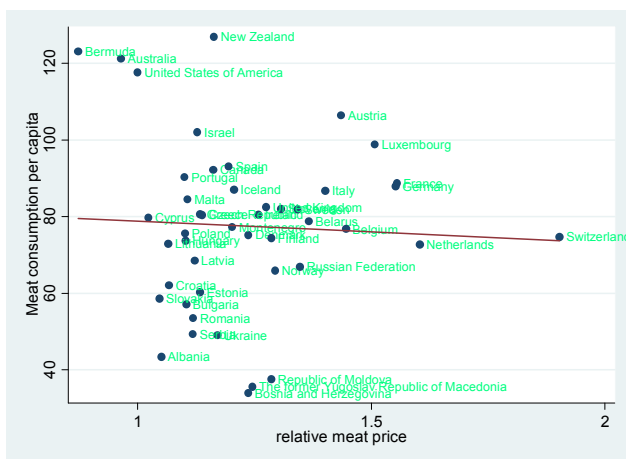


## Meat consumption and price, all countries



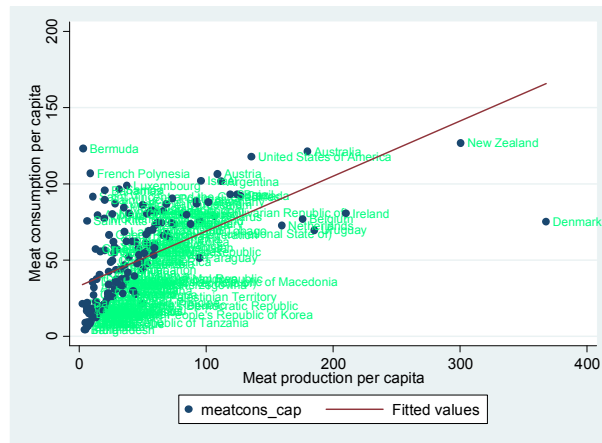
- FAO food balance sheet and World Bank ICP price data, 2011

## Meat consumption and price, western countries



- FAO food balance sheet and World Bank ICP price data, 2011

## Meat consumption and production



- FAO Food balance sheet 2011

## Meat consumption and urbanization



- FAO Food balance sheet 2011

## Regression analysis

- Estimate the effect on meat consumption (FAO data) of:
  - Meat prices (controlling for general food price level) (World Bank International Comparison Program (ICP) data) from 2011
  - Share of population living in urban areas (FAO data)
  - Income (PPP adjusted GNI per capita) (World Bank data) from
  - Religion dummies (ARDA data)

The regression analysis is an OLS with data from 2011, from 136 countries

## Results: The drivers of meat consumption



|                |           |          |
|----------------|-----------|----------|
| pricemeat      | -16.793** | (6.293)  |
| pricefood      | 28.115**  | (10.290) |
| meatprod_cap   | 0.060**   | (0.028)  |
| meadowagric    | 7.842*    | (4.541)  |
| agricpop       | 0.487     | (0.298)  |
| hdi            | 63.878*** | (17.873) |
| GNIPPP         | 0.001***  | (0.000)  |
| urbanshare     | 15.477*   | (8.506)  |
| Muslim         | -3.382    | (3.435)  |
| Catholic       | 0.967     | (2.862)  |
| western        | 8.869*    | (4.627)  |
| africa         | -1.279    | (4.858)  |
| latinamer      | 5.229     | (5.125)  |
| middleeast     | -6.276    | (5.956)  |
| _cons          | -30.525   | (11.743) |
| <hr/>          |           |          |
| R <sup>2</sup> | 0.829     |          |
| Observations   | 136       |          |

## The models: CGE-model - MAGNET

**GTAP: applied general equilibrium model based on neo-classical microeconomic theory**

- multi-regional
- multi-sector
- static



**MAGNET 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

**Main developer LEI-WUR:**

- Thünen-Institute in a consortium with LEI-WUR and JRC-IPTS

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## Outcomes of MAGNET

**Complete picture of the economy, including changes in:**

- consumption and production of commodities, incl. important crops and food
- prices
- trade (exports and imports)
- employment, land supply and use across agricultural sectors
- developments in wages and rental rates for land and capital
- GDP

**Makes visible impacts: all sectors & all activities**

- across countries and/or regions in the world
- within countries: consumers vs. producers, etc.

**Time horizon: 2007-2020**

- Comparison of (policy) scenarios with the BAU reference scenario

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## Consumption Structure of MAGNET

### Consumption of private households in GTAP is a Constant Difference of Elasticity (CDE) Function:

- a more flexible, non-homothetic function
- allows for non-constant marginal budget shares
- is calibrated using data on income and price elasticities of demand
- and will be further re-calibrated in this analysis

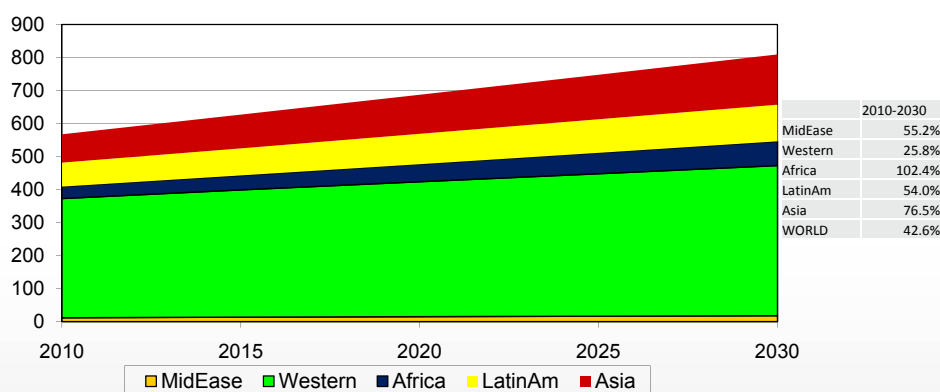
### No constant income elasticities over time

- leading to unrealistically high consumption of food items in fast growing economies
- in MAGNET: income elasticities are dynamically adjusted using real GDP per capita (in the form of a decreasing function)

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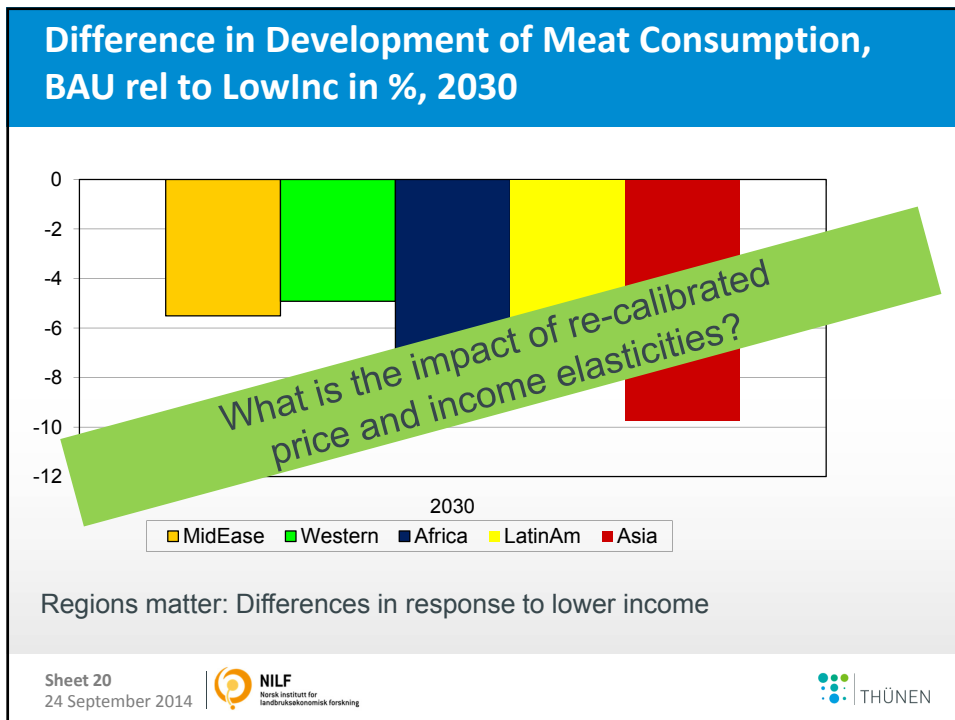
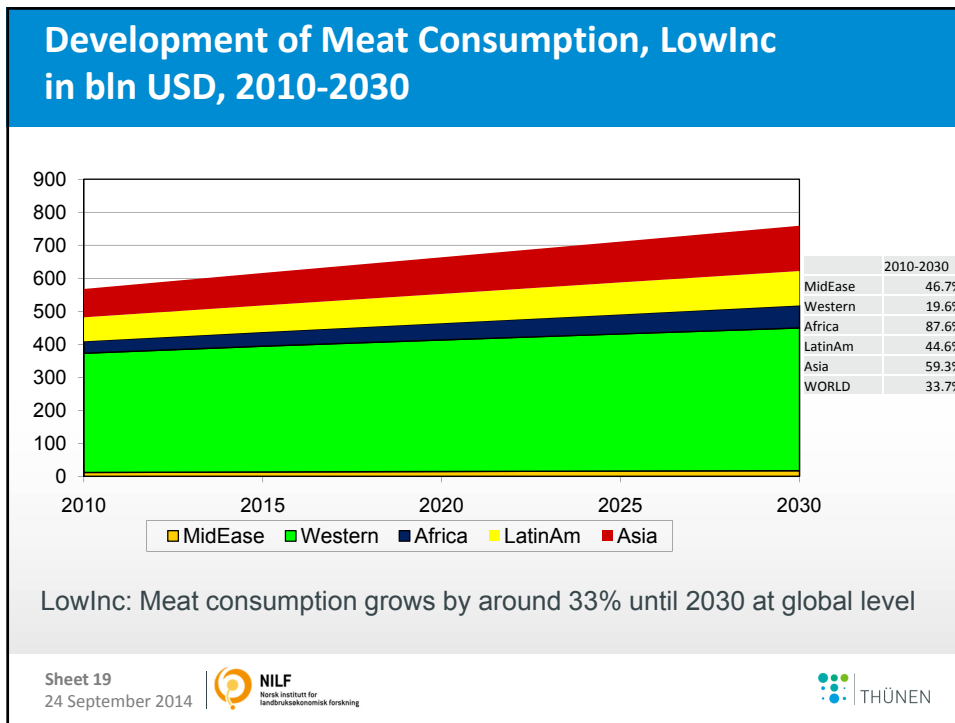
## Development of Meat Consumption, BAU in bln USD, 2010-2030



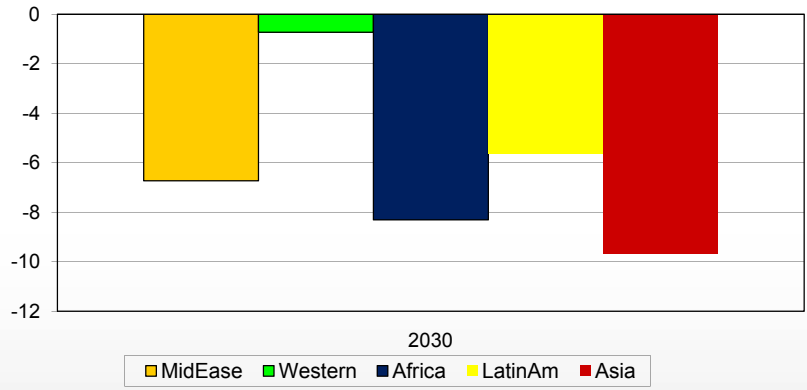
Meat consumption grows by more than 40% until 2030 at global level

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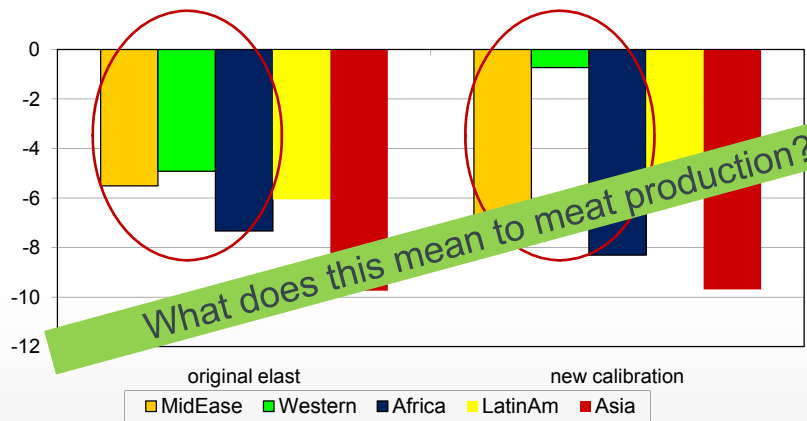


### Difference in Development of Meat Consumption, BAU rel to LowInc in %, 2030



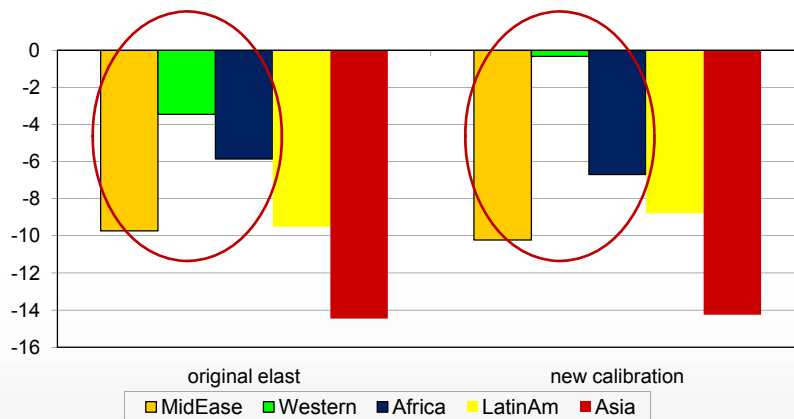
Regions matter: Differences in response to lower income

### Impact of re-calibrated Price and Income Elasticities: Change in Meat Consumption, in %, 2030



Calibration matter too:  
Regional differences in response to lower income change substantially

## Impact of re-calibrated Price and Income Elasticities: Change in Meat Production, in %, 2030



Calibration matter too on Production side:  
Regional differences in response to lower income change substantially

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## Conclusion

### Empirically estimated price- and income elasticities

- Strong differences in responsiveness among different regions
- First attempt to use this information in MAGNET

### Price- and income elasticities for meat re-calibrated in MAGNET

- First results show strong effects especially for Western, industrialized countries on consumption and on production
- Main focus of MACSUR analyses

**MACSUR-2 will include consumption behavior in integrate risk assessment of climate change in Europe**

**This work should contribute to a more carefully calibration of import behavioural parameters**

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