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Agricultural reform: Which type of models do we need?

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Agriculture related AGE-modeling at SOW-VU (1)

- World models
  - MOIRA (1979, for Club of Rome) : International equilibrium, 127 countries, 2 commodities, 12 income groups per country
  - BLS (1988, with IIASA) : International AGE, 10 commodities, 34 countries/regions, 2 income groups per country

Agriculture related AGE-modeling at SOW-VU (2)

- National and regional:
  - Completed: Thailand (1981), Bangladesh (1986), Indonesia (1990), Nigeria (1997)
  - Ongoing: EU-15 (1991-present, originally with LEI&CPB, now with CPB)
  - Ongoing: Ghana, China
- Texts:
  - Gunning & Keyzer (1995) Handbook Dev. Ec., North Holland
  - Ginsburgh & Keyzer (1997/2002), MIT Press

Which type of models do we need?

Overview of presentation

Current demands of agricultural policy analysis: three topics

#1 Improving capacity to analyze current CAP-reform

#2 Accounting for present trends on meat and feed markets

#3 Representing spatial heterogeneity: land, population density, transport

#1 Improving capacity to model CAP-reform

- Importance of agriculture in EU
  - all key agricultural policies under Common Agricultural Policy (CAP)
  - agricultural budget of around 40 billion Euro by far largest item on EU budget
  - even WTO negotiations on agriculture are led by agricultural commissioner
  - modalities of CAP central item in accession 10 new EU members
  - CAP-reform currently under discussion: Mid Term Review

(#1 Improving capacity….)

Mid Term Review (MTR)

- MTR, July 2002 proposal:
  - Area & livestock premiums replaced by farm-specific, land-tied payment rights
  - Cross compliance: nitrate directive, good agricultural practice, …
  - Payments rights only tradable with the plots
- MTR, January 2003 legal texts, same but:
  - Land-tied payment rights tradable independently from land
  - But only one payment right on a hectare
  - All land not under permanent crops is eligible

(#1 Improving capacity….)

MTR decoupling scenarios with GTAP

- Joint outputs obtained as derivatives of restricted profit function with factor inputs (labor, land, equipment)
- Current Agenda 2000-package of CAP (v. Meijl-v.Tongeren,2003)
  - Subsidy inclusive prices in objective
  - Policies among resource constraints: milk quotas, manure quotas, set-aside (GEMPACK)
- Payments under MTR fully decoupled to fixed factor, and tradable
- GTAP-model cannot explicitly accommodate
  - Flat area subsidies by class of commodity (arable crops vs others)
  - Cross compliance requirements
  - Modalities of limited tradability of payment rights among farmers

(#1 Improving capacity….)

MTR requires farm management type of model (1)

- Crop yields by category and land type (e.g. for cross compliance)
  - depend on fertilizer/ha, pesticides, labor etc.
  - positive intercept reflecting natural fertility (soil)
  - ceiling reflecting natural potential (climate, soil)
- Land requirement by crop: land balance
- Animal yields by breed and technology type (extensive, etc.)
  - depend on feed/head (roughage, composite feed)
  - negative intercept reflecting basic metabolic requirement
  - ceiling reflecting potential of breed, under assumed technology
- Feed requirement by animal: feed balance (incl. roughage)

=> **Farmer to solve revenue maximizing NLP, preferably by farm type, with yield functions, and land and feed balances**

MTR requires farm management type of model (2)

- Farm management type of NLP can account for effect cross compliance: e.g. cattle farmer may
  - Sell payment rights and stop farming
  - Sell herd, keep payment rights and mow grass
  - Buy additional payment rights and develop multifunctional agriculture etc.
- Suitable AGE-formats to embed NLP, allowing for primal constraints, (see Keyzer, Merbis & Van't Riet, in CEC, 2003):
  - Negishi welfare program (welfare weights to meet budgets)
  - Full format (budgets in constraint set)

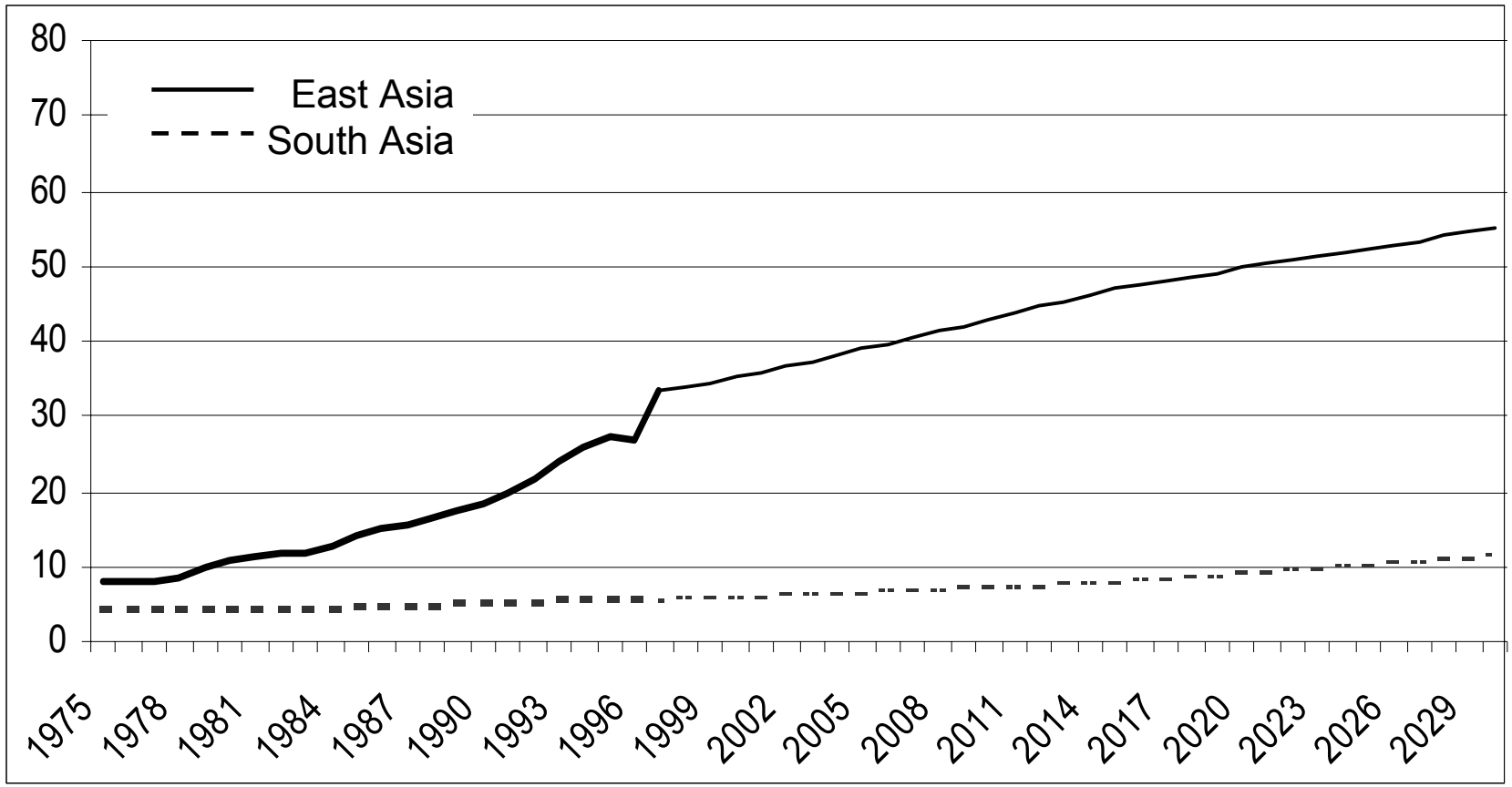
#2 Accounting for key trends on meat and feed markets

Stylized facts on meat and feed demand:

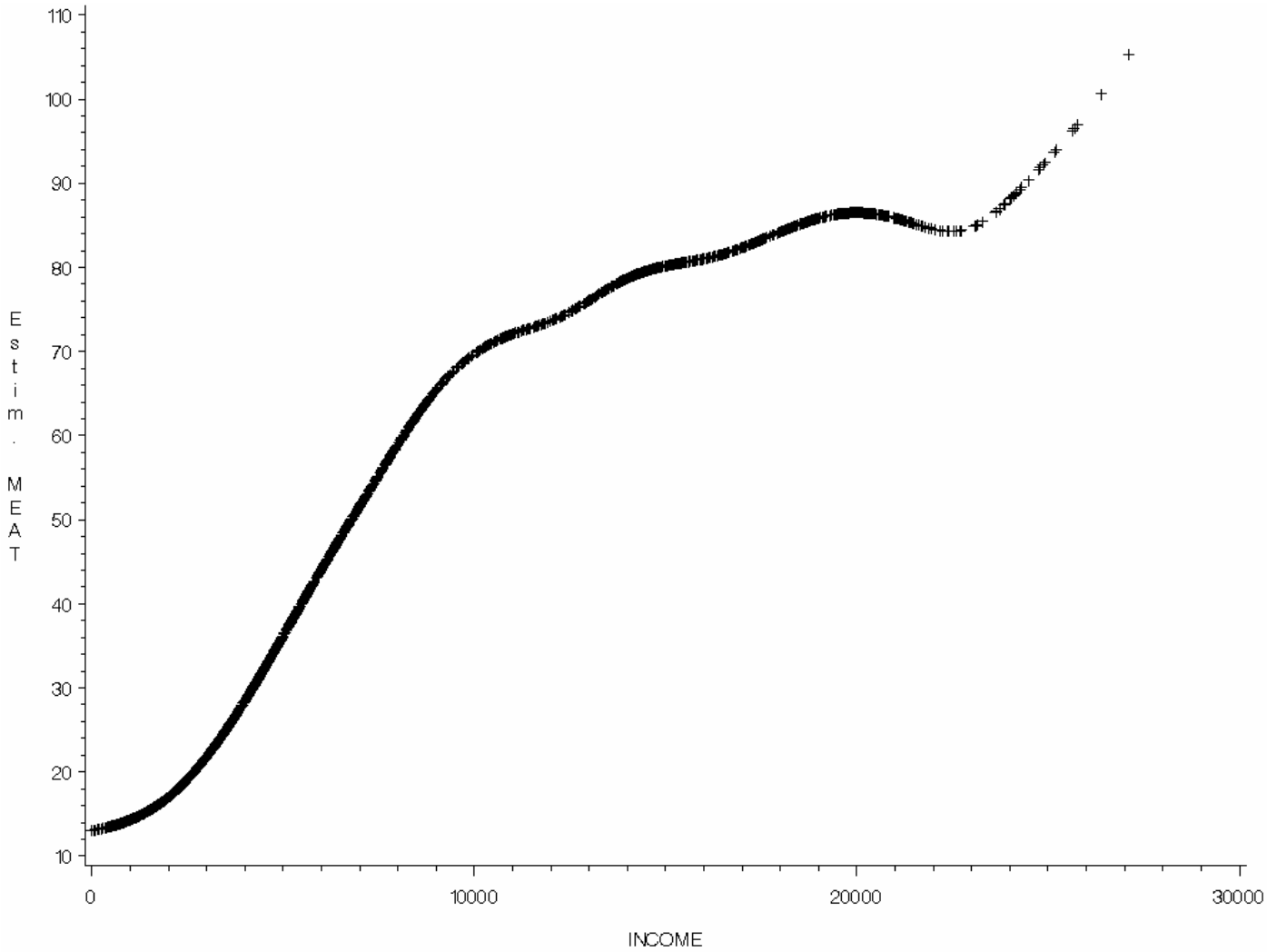
- with increasing per-capita income, especially in Asia, consumer demand is shifting towards meat and dairy
- in LDCs livestock production in Asia currently relies mainly on traditional technologies based on rangeland, household waste etc.
- expansion only feasible with more feed intensive techniques

(#2 Accounting for key trends ...)

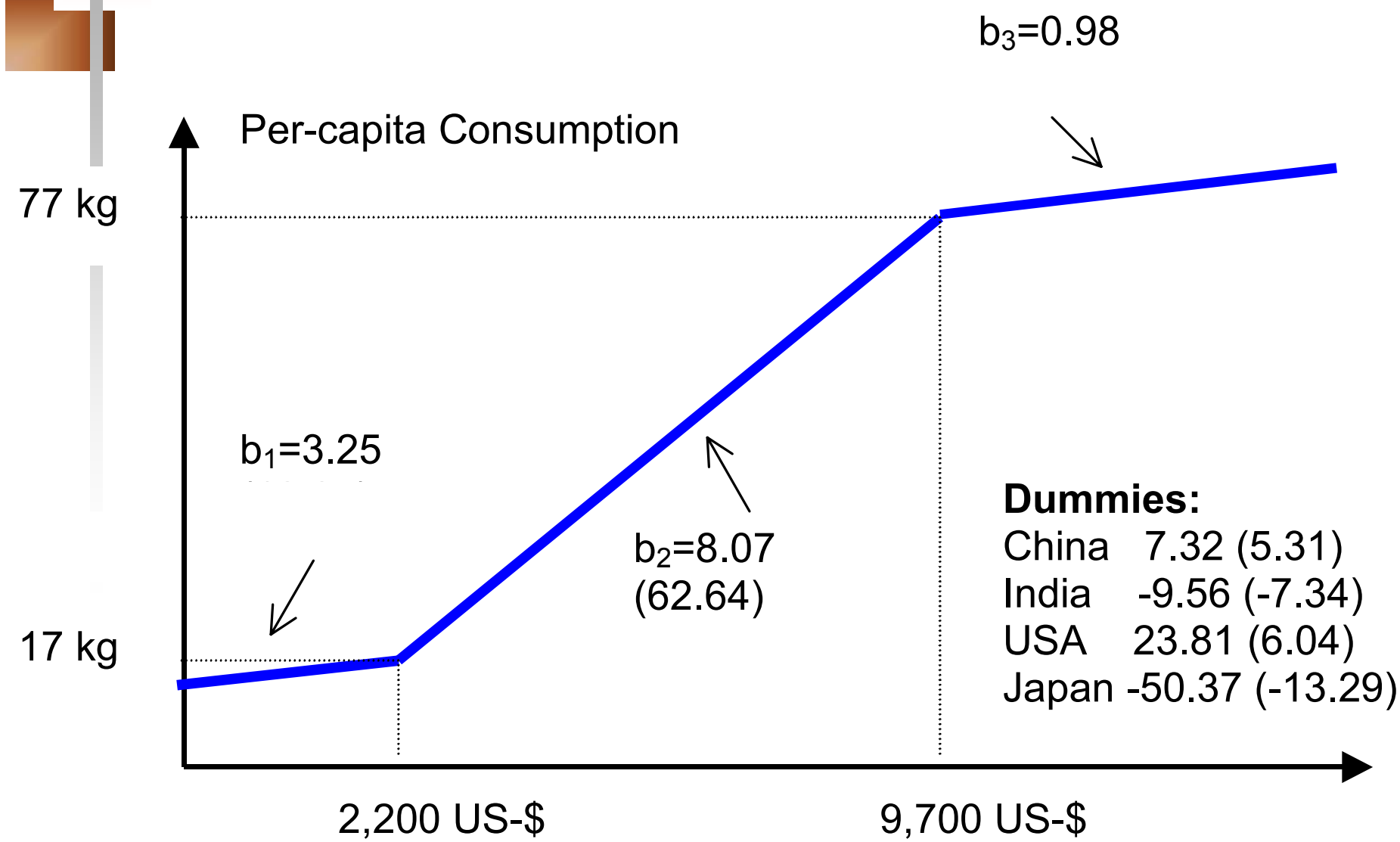
Per-capita meat consumption in Asia (data and FAO projections)



Non-parametric estimation of meat demand and per-capita income (125 countries, 1975-1997)



GLS-Estimation of kinked meat demand function (125 countries, 1975-1997) (1)

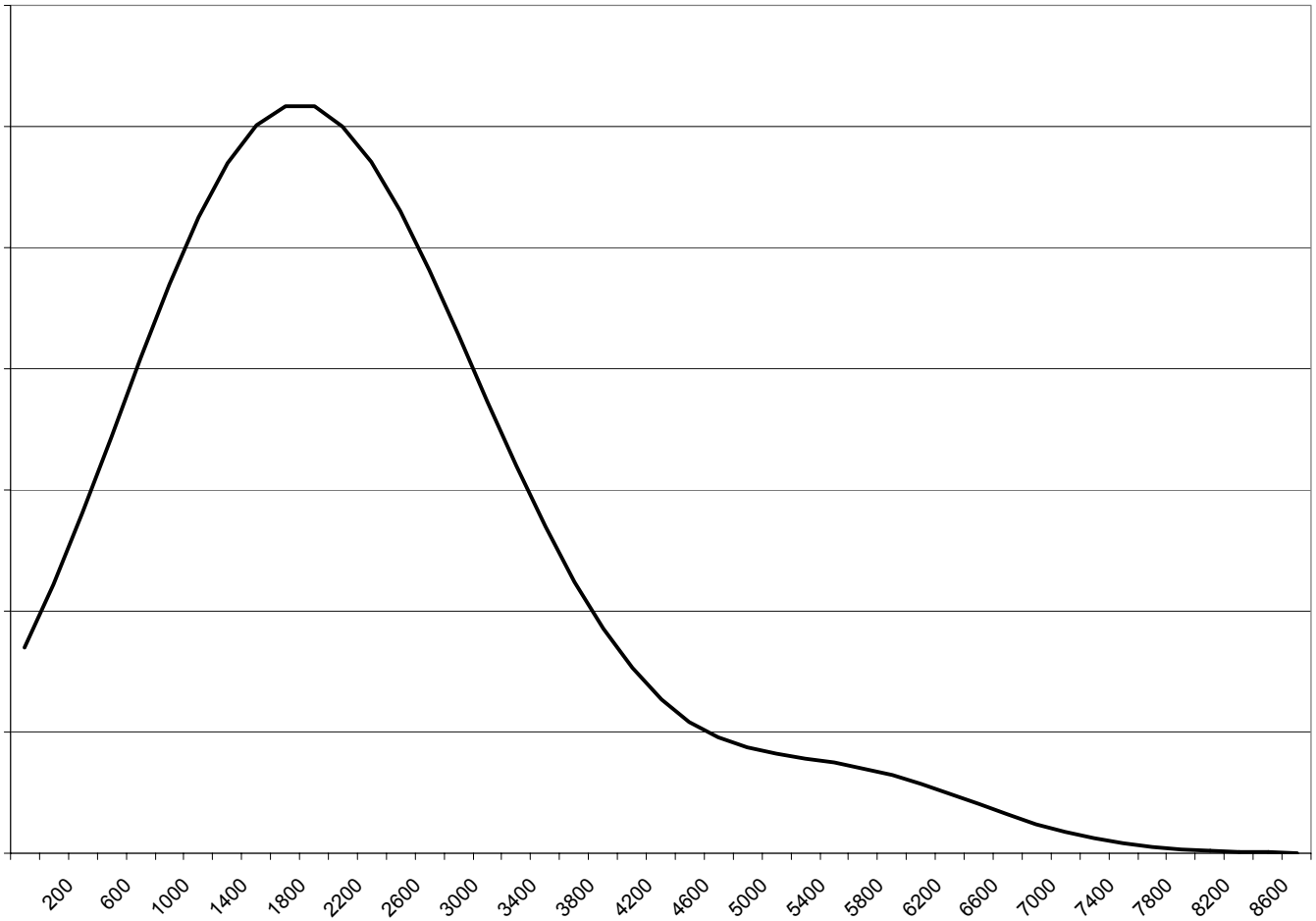


GLS-Estimation of kinked meat demand function (125 countries, 1975-1997) (2)

- Apply kinked meat demand to income distribution
  - In many Asian countries, large segments of population are still to enter high propensity regime (middle bracket)
  - In other parts of the world impoverishment causes segments to adjust consumption (enter middle bracket from right, or shift to left bracket)

(#2 Accounting for key trends ...)

From Deininger/Squire to a smooth income distribution (China 1997) (2)



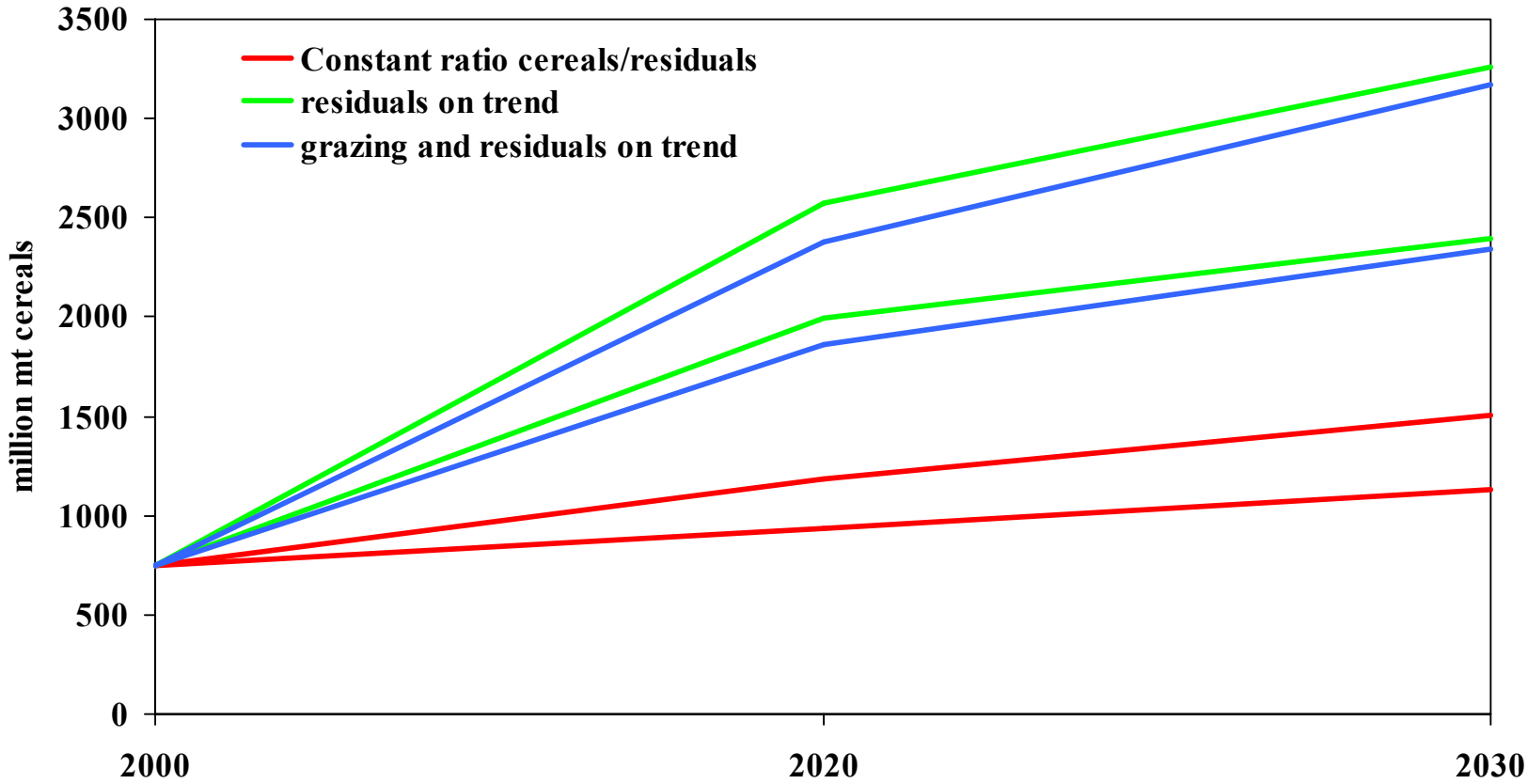
(#2 Accounting for key trends ...)

From meat demand to feed demand

- Three general types of animal systems
  - grazing systems
  - mixed production systems
  - intensive production system
- Within intensive system
  - Backyard production largely relying on household and crop residuals
  - Specialized households
  - Large commercial units
- How does composition of animal systems change in response to increased meat demand ?
- How does cereal share in feed change in response to increased meat demand?

(#2 Accounting for key trends ...)

Projections of feed demand



(#2 Accounting for key trends ...)

Key trends on meat and feed demand: findings

- Allowing for income distribution effect under three consumption regimes leads to significantly higher projections for meat demand
- Increasingly, limited availability of residual feed in developing countries causes shift towards modern technology and raises demand for cereal feeds even further
- The magnitude of effects on cereal markets is dramatic:
  - Meat demand/technology shift: up to +1,800 mill. t. in 2030
  - Climate Change (IIASA, 2001): - 105 mill. t. in 2080
  - GMOs: no large effects on yields expected
- Environmental consequences of increased meat production (in particular emissions of Methane and Ammonia) should be looked into, especially for China

#3 Representing spatial heterogeneity: land, population density, transport etc.

- Issues:
  - Spatial aggregation problem in large countries such as India or China, also worldwide
  - TRQs require linking countries bilaterally, while accounting for transport costs, and without recurring to trade matrices
- Here, short discussion on the scope for constructing large scale spatial equilibrium model with transport costs
- General message: it is now possible to construct spatially explicit equilibrium models
  - datawise: population density maps (Deichman),
    digital elevation maps (DEM)
    satellite images (NDVI for crops)
  - Transport modeling less data hungry at fine scale
  - Hence, it now pays to work on algorithms

(#3 Representing spatial heterogeneity…)

Large scale spatial equilibrium (1)

- Objective : Find equilibrium
  supply, demand, flows and price on a map
- Tool : A new algorithm to solve a large scale, spatially explicit welfare program
- Advantage : Integration between disciplines:
  hydrology, soil science, transportation,
  regional sciences, international trade …

(#3 Representing large countries…)

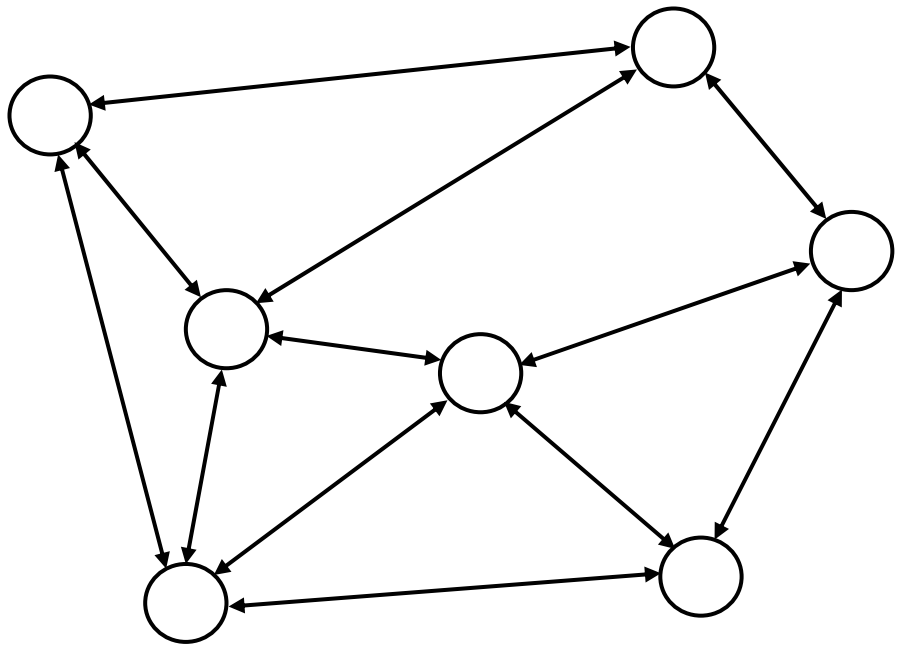
Large scale spatial equilibrium (2)

- Relevance to development
  - assessment potential of the areas
  - construction poverty maps
  - infrastructural planning
- Scientific relevance
  - interdisciplinarity
  - algorithms not available (in civil sphere)

Spatial equilibrium versus Spatially explicit equilibrium

Spatial equilibrium models

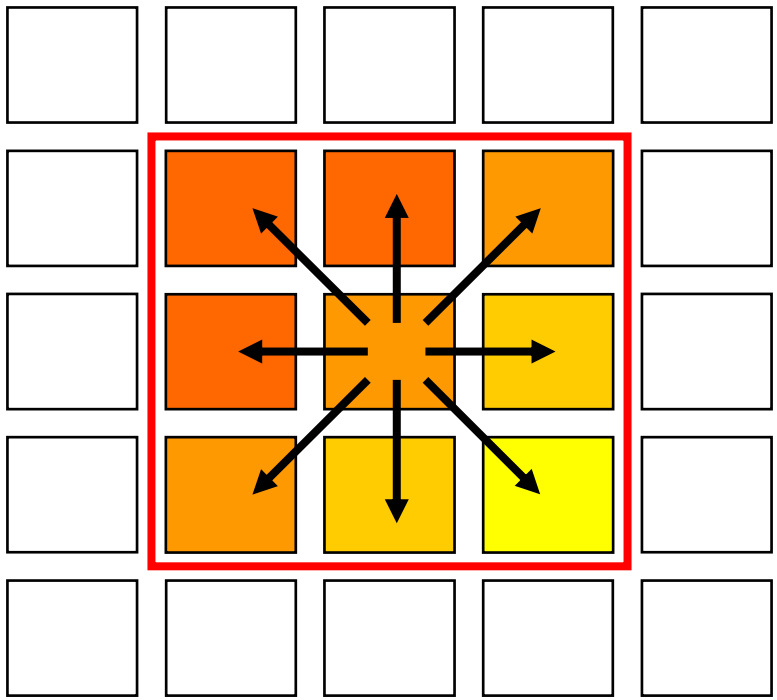
- Connect districts, or nodes in a network
- Not spatially explicit



(#3 Representing large countries…)

Spatially explicit flow model

Allows for all possible flows on the Union Jack grid

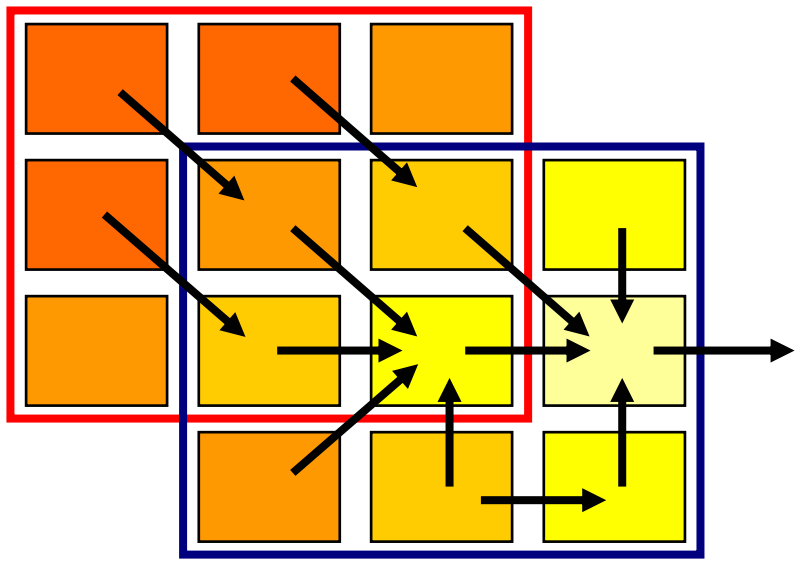


(#3 Representing large countries…)

Spatially explicit equilibrium model

- Key algorithmic principle: gravity driven flow
- Gravity : water does not flow uphill
- Transport : goods never flow to lower price

Low price



High price

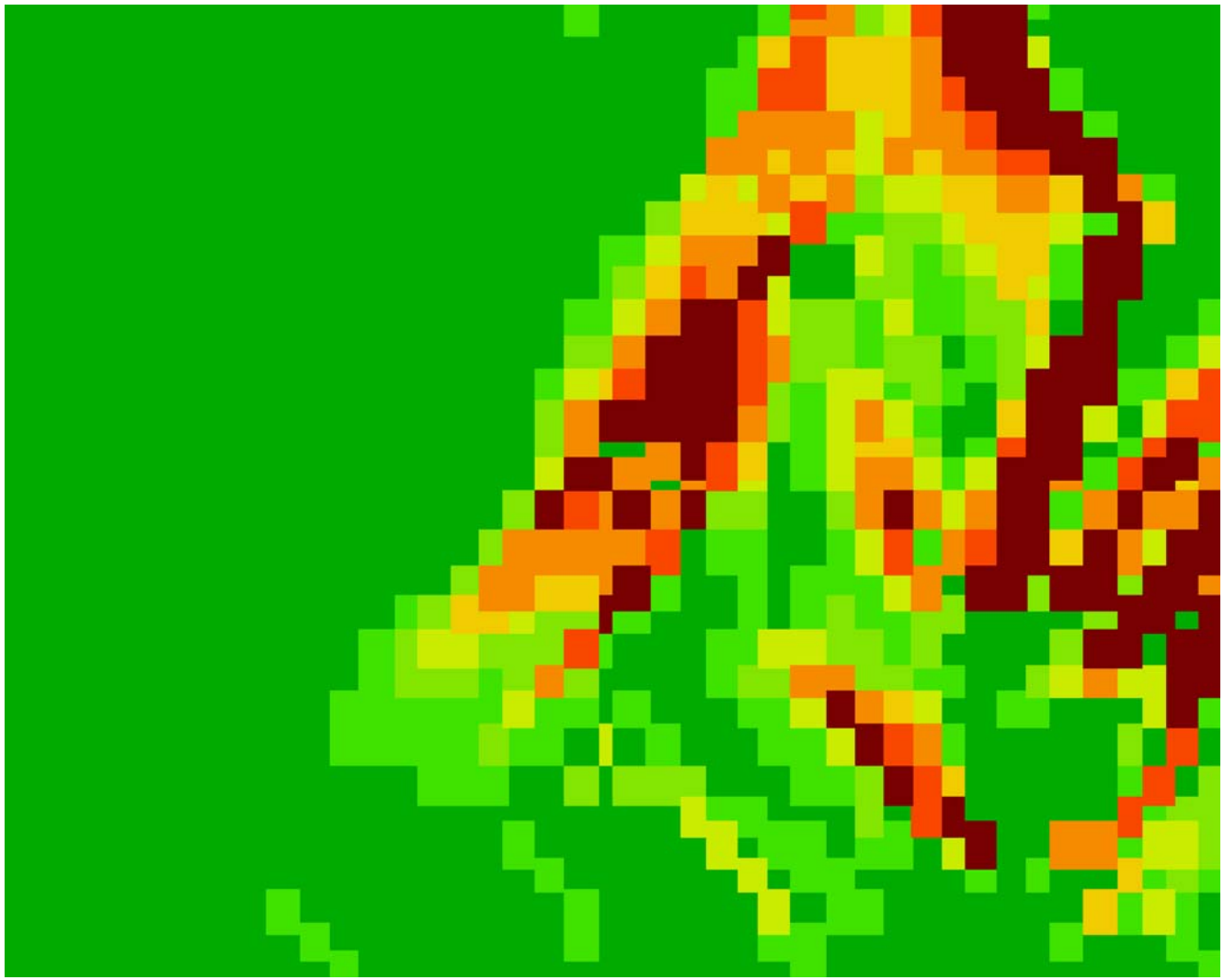
(#3 Representing large countries…)

Application to China

- Spatially explicit welfare model
- Exogenous variables
  - production map cereals
  - population map
  - tariffs and world market prices cereals
  - freight costs per ton
- Study world market price penetration
- Grid of cells of 10-by-10 km = 93125 cells (markets)

(#3 Representing large countries…)

Zooming in on individual markets



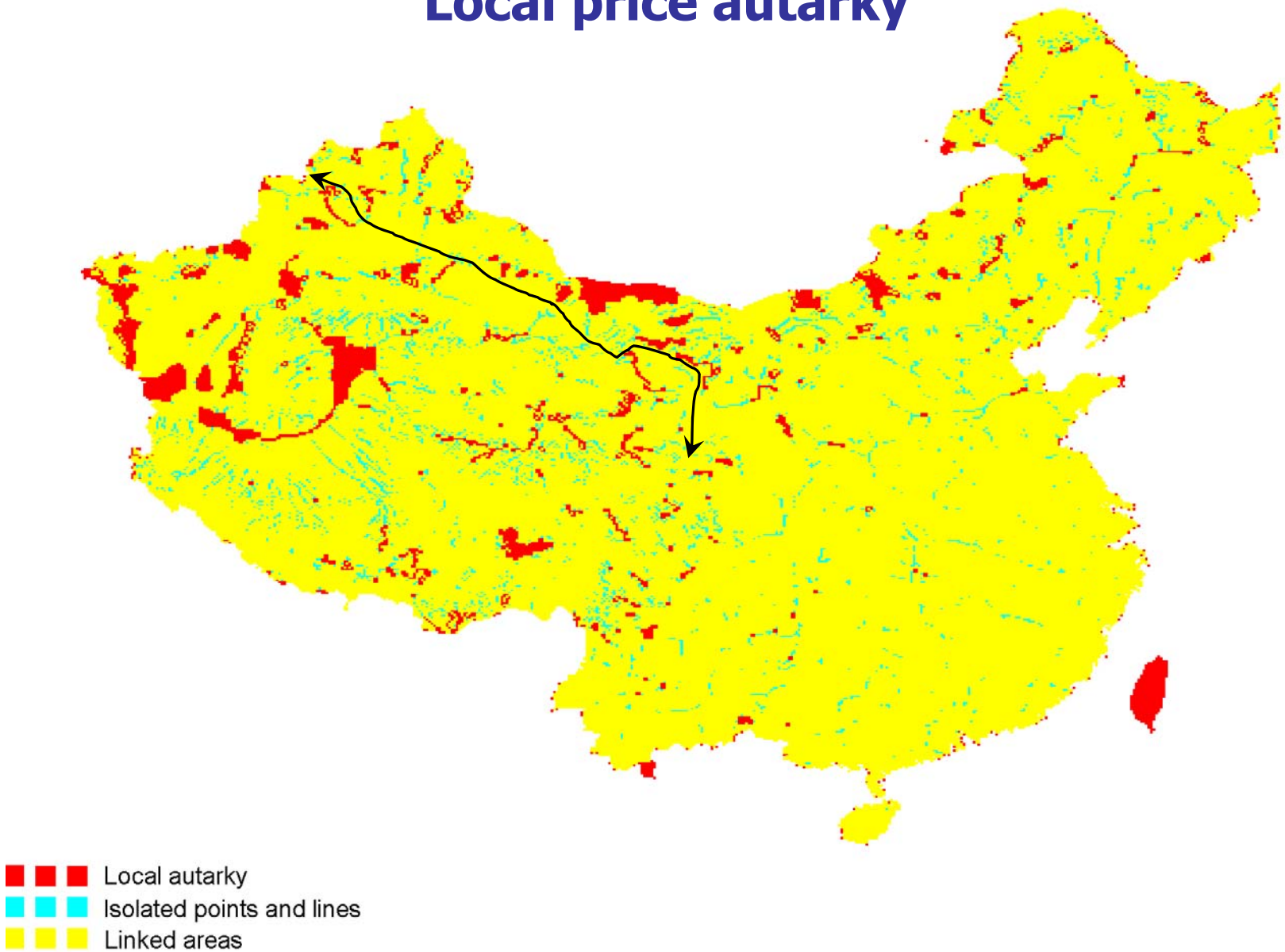
(#3 Representing large countries...)

Post-optimal calculations

- Under alternative international trade regimes, identify
  - Areas served by imports (quantity flows)
  - Unconnected or autarky zones (no price links)

(#3 Representing large countries...)

Local price autarky



Conclusions

#1 (a) MTR representation requires NLP with explicit land and feed balances

(b) These primal constraints are naturally embedded in Negishi or full format AGE

#2 (a) Trends in meat demand can be accommodated through kinked demand function, and some representation of income distribution within country

(b) Generating associated trends in feed demand calls for explicit feed balances, and distinction of livestock systems by intensity

#3 It is possible to generate a meaningful spatially explicit equilibrium, and equilibrium with "very large" number of geographical units to deal with spatial heterogeneity