



# AGRISPACE model

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- ❑ Provide a state of the-art-model economic simulation model for Norwegian agriculture and key food sectors
- ❑ Must be innovative enough such that methodology can in part be published, and to survive the next decade or so
- ❑ Key output of current “Jordmod” model must be produced: supply, demand and prices at regional level, welfare analysis; new output: structural change

- Multi-Commodity PE for agriculture, deterministic, competitive
  - Recursive-dynamic with yearly resolution
  - 32 regions for Norway, fixed world market prices
  - Spatial equilibrium model, intra-regional trade
  - Aggregate farms (up to 16 per region) from statistical cluster analysis, in average representing about 140 farm
  - Explicit (nested) CES production functions, CET functions to depict competition for primary factors between activities and aggregate farms
  - Labor and capital supply from aggregate household to farm
  - Land supply from regional non-agriculture to agriculture

Outputs:

- Crops: 6 cereals, rape seed, potatoes, pulses, tomatoes, other vegetables, apples, other fruits
- Animal products: beef, pork, poultry, sheep and goat meat, eggs, milk, horses
- Dairy sector: Butter, Skim milk powder, Cheese, Fresh milk and derived products, cream, concentrated milk, whole milk powder

 Inputs:

- Land, differentiated by arable, grass land and permanent; capital, labor, intermediates, 4 types of feed

- ❑ Cluster farms represent full farm population from census (~34.000 single farm)
- ❑ Subsidies in cluster farms derived from detailed calculation of payments to single farms, reflecting cut-off levels etc.
- ❑ Simulated changes in prices, input/output quantities used to update single farm records and re-estimate profits
- ❑ Profits at single farm level determine probability of farm exit

## Basic model feature

Update policy variables, border prices, population, wage rate and technology

Calculate premiums for all single farms

Calculate per unit subsidies for aggregate from single farms

Full farm population

t+1

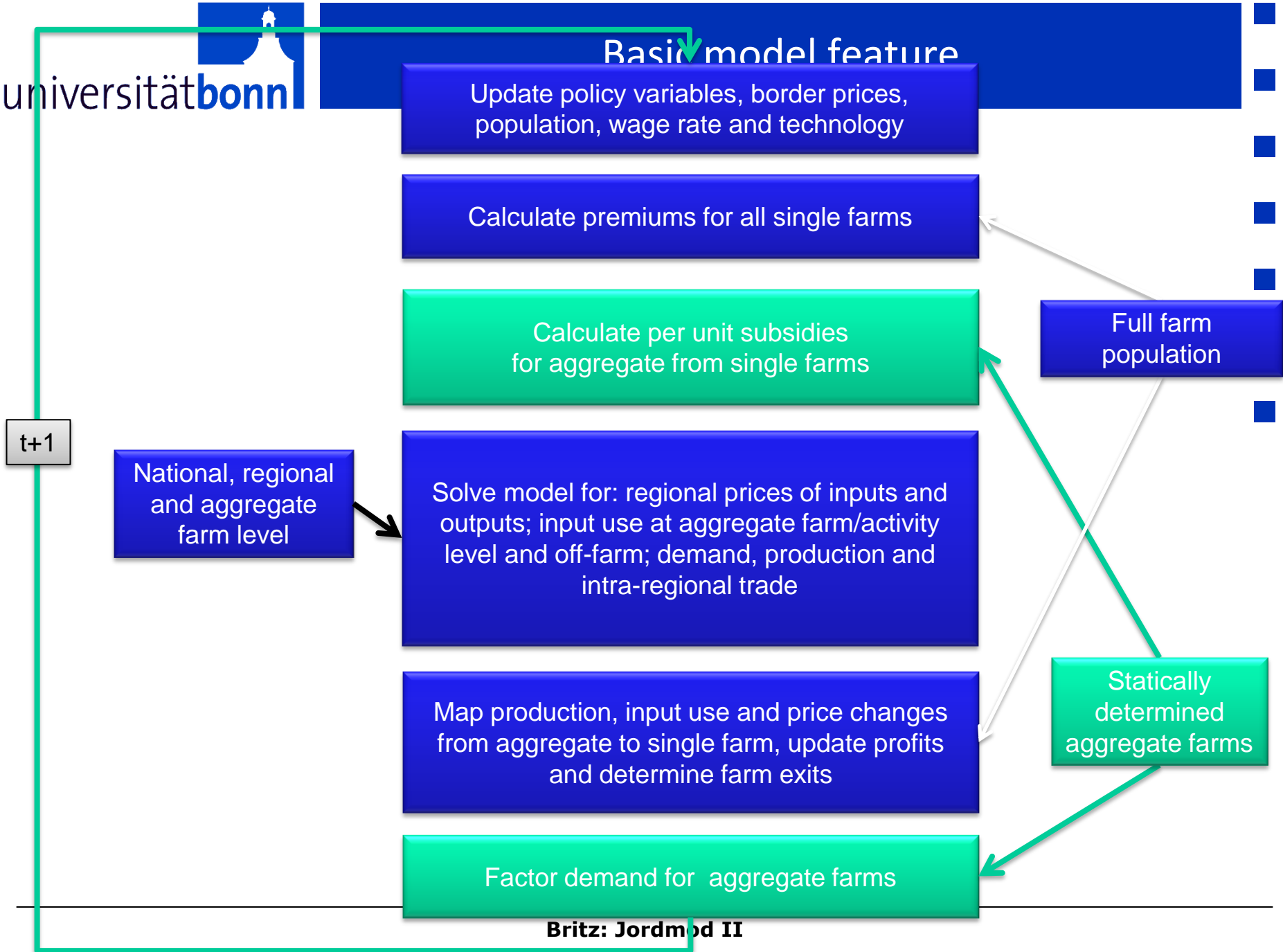
National, regional and aggregate farm level

Solve model for: regional prices of inputs and outputs; input use at aggregate farm/activity level and off-farm; demand, production and intra-regional trade

Map production, input use and price changes from aggregate to single farm, update profits and determine farm exits

Statically determined aggregate farms

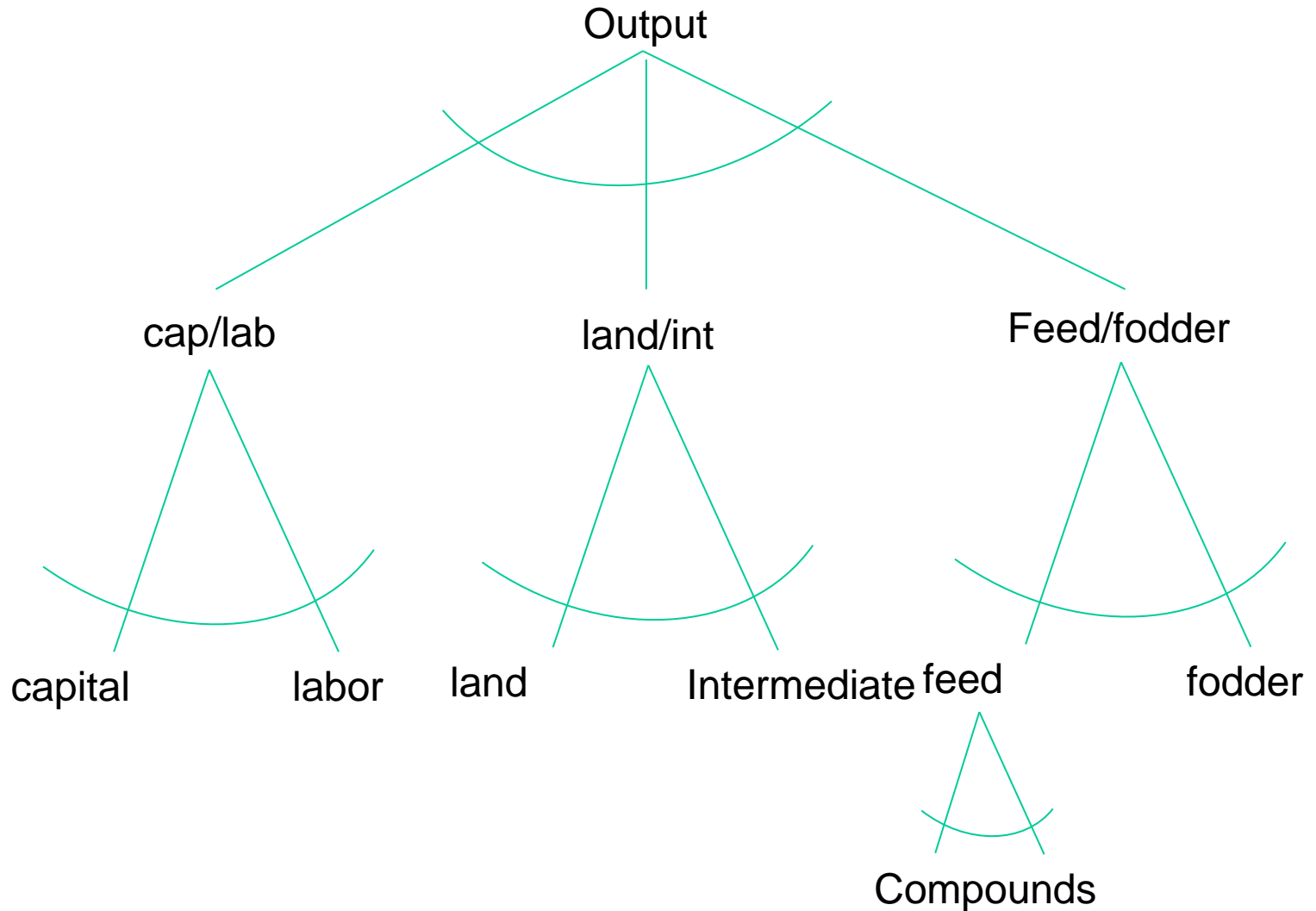
Factor demand for aggregate farms



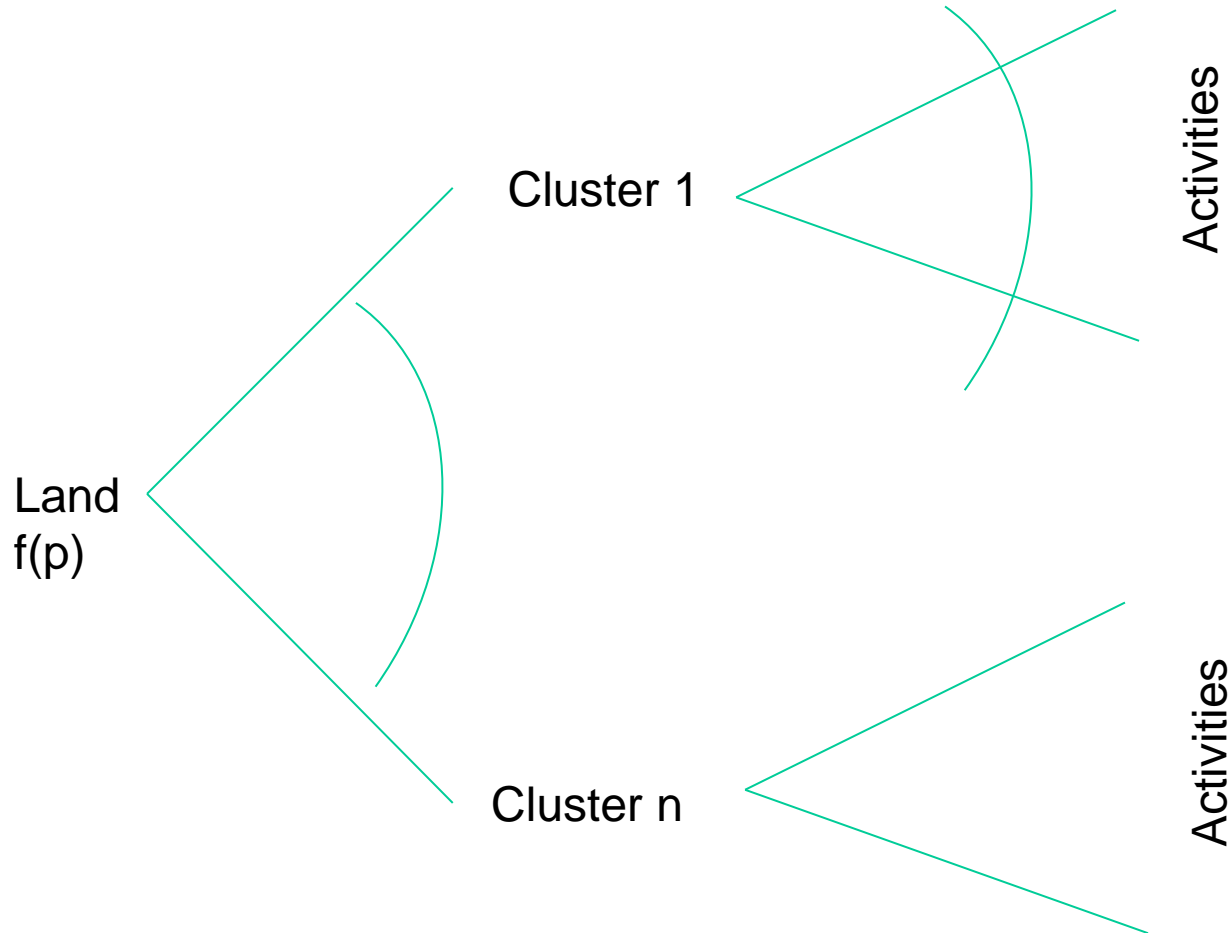
- ❑ Mixed Complementarity Problem, PATH
- ❑ Spatial Arbitrage  $\leq$  price differences cannot exceed transport costs + tariffs
- ❑ Flexible functional form for final demand, parameterization draws on CAPRI
- ❑ Dairy and feed processing industry via CES / CET

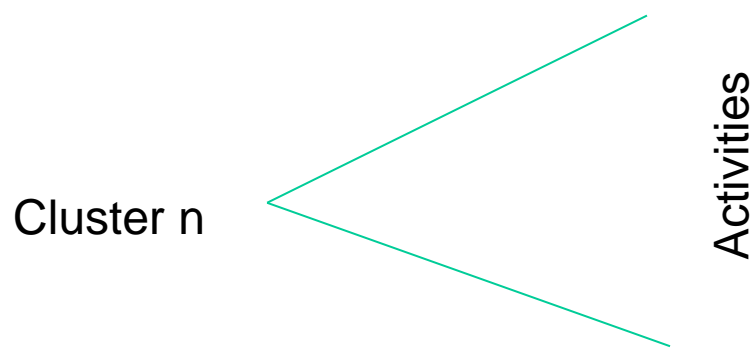
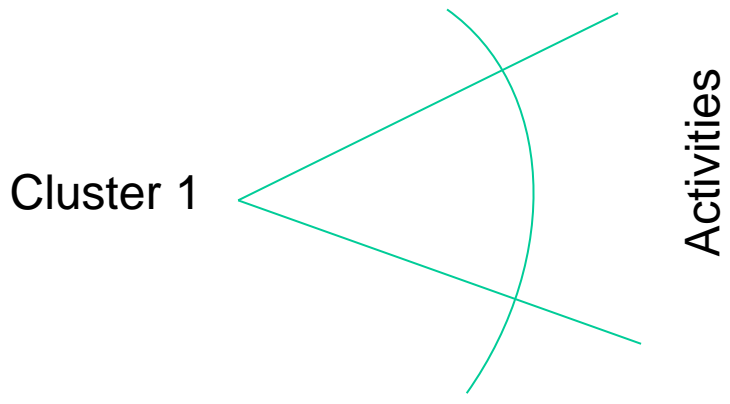
- ❑ Layout similar to Computable General Equilibrium models, also used in a similar fashion for instance in PEM Model of OECD
- ❑ Nested Constant Elasticity of Substitution (CES) function:
  - CES production functions at activity level (= 19 production activities) in each aggregate farm
  - Input differentiations: (3 types of land, labor, capital, general intermediates, compound feed, fodder)
  - Nestings: Capital+Labour / Land+Inpe / Feed+Fooder, see next
  - Constant returns to scale





- Again, inspired by “sluggish” factor supply in CGE models
- Factor supply to agriculture:
  - Linear function for each cluster for capital and labour, driven by fixed exogenous interest rate/wage rate relative to returns in agriculture
  - Linear demand function for land categories (arable, permanent, grass) depending on given exogenous returns relative to returns in agriculture
  - Primary factors not fully homogenous  $\Leftrightarrow$  CET function distribute endowments from aggregate farm to production activity





## □ Generalized Leontief Expenditure system:

- (Semi)-Flexible demand system
- Enough parameter to calibrate against any set of own, cross-price and demand elasticities, as long as these are in-line with demand theory and are not Hicksian complements
- Driven by consumer prices which differ from market prices of agricultural/dairy products by fix per-unit margins (costs for processing, transport, marketing ...)
- Calibration ensures that regular demand system is depicted, i.e. in line with utility maximization at given income

- ❑ Norway assumed as small country, i.e. world market prices at border fixed
- ❑ Import tariffs and export subsidies drive a wedge between c.i.f. prices and prices in harbor
  - Tariffs might be endogenous if import prices are fixed by government
- ❑ Price differences between regions reflect transport cost between regions in Norway, assuming cost minimal routing (spatial arbitrage)

- ❑ First, note that part of structural change – competition for land between types of farms – is covered by market module
- ❑ Determination of farm exits:
  - In each year, the premiums for each single farm are recalculated
  - In each year, the simulated relative changes in I/O quantities are mapped from cluster to single farm along with relative changes in prices at regional / cluster level => re-calculate profit
  - Based on profit, determine exit: (1) Absolute threshold level – depends on size, and (2) Stochastic component where standard deviation depends on profit change

## □ Simulations reflect:

- Policy changes from year to year
- Population and income growth a regional level
- Changes in wages and capital costs
- Changes in world market prices
- Technical progress in agriculture



- ❑ GAMS + GUI (based on GGIG user interface generator)
- ❑ Strictly modular, clear separation of model code, data and parameters
- ❑ Coding style a la CAPRI redbook, English
- ❑ Software Versioning System