Ethanol production under endogenous crop prices:

Theoretical analysis with an empirical application to barley

Rinne, J. *Univ. of Helsinki, Department of Economics and Management, Helsinki, Finland*

Lankoski, J. *OECD, Directorate for Trade and Agriculture, Paris, France*

Ollikainen, M. *Univ. of Helsinki, Department of Economics and Management, Helsinki, Finland*

Background

- **European union**:

  Plans to increase bioethanol production from crops
- **Worries**:

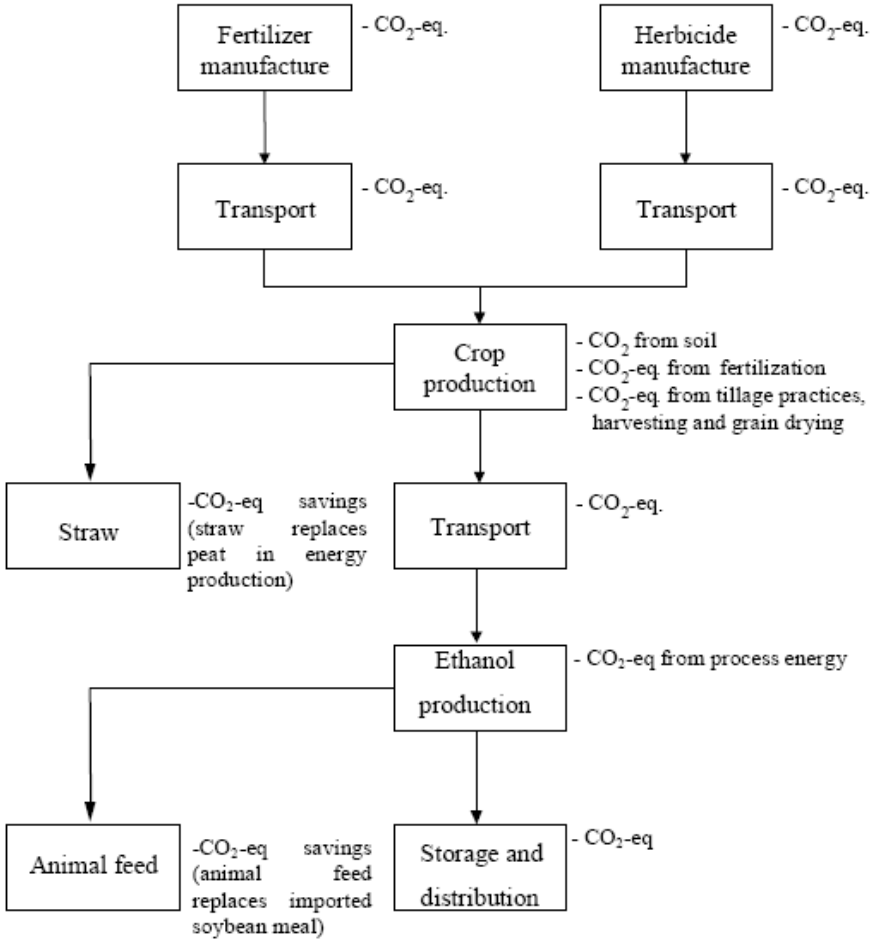
  1. Competition on arable land: what happens to food production and crop prices?

  2. Climate benefits: are there really any when life cycle impacts of production are are accounted for?

Research problem

- Is bioethanol production from crops socially desirable?
- Analysis combines:
  1. Full life-cycle greenhouse gas balances
  2. Land allocation between different cereal crops and green set-aside
  3. Endogenous crop prices (demand and supply of crops)

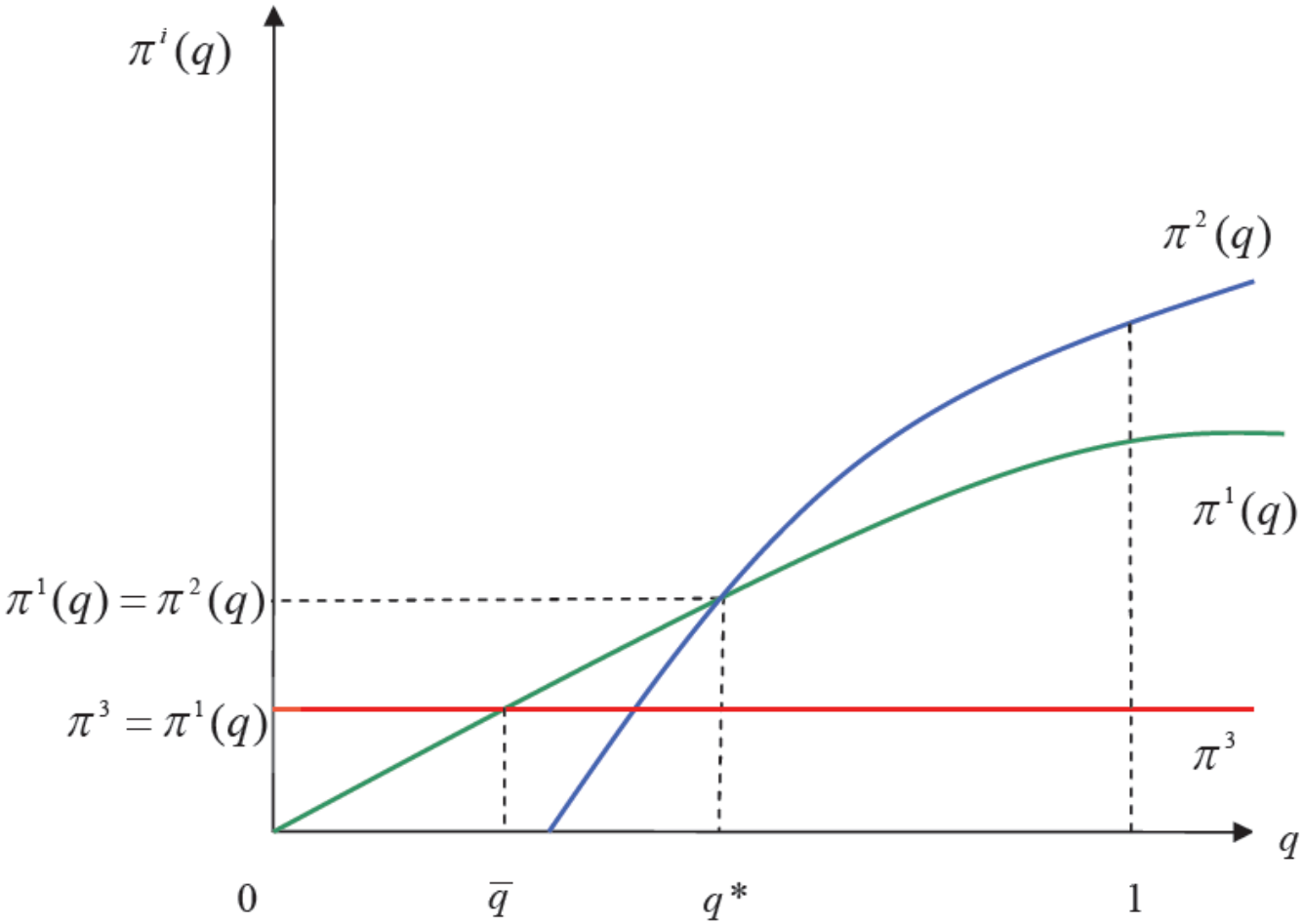
Ethanol production chain and GHG balance



Market model - details

- Ethanol replaces gasoline in traffic; net replacement define the CO_2-savings and climate benefits from ethanol production
- Competition on agricultural land between:
  - Bioenergy crop and an alternative crop
  - Green set-aside
- Land is allocated between these three land use forms on the basis of relative profitability
- Bioenergy crop used by two industries:
  - Ethanol industry (produces ethanol and animal feed as a by product)
  - Animal feed industry

Land allocation by profit maximization



Social optimum

- Social welfare = profits from ethanol, animal feed food plus social valuation of climate impacts
- The economic problem is to choose:
  - Fertilizer intensities for both crops
  - Use of bioenergy crop in both industries
  - Use of energy in ethanol production
  - Land allocation between different land use forms
- Behavioral functions defined to determine the equilibrium price of bioenergy crop in empirical application (supply and demand)

Empirical application:
Model details

- Land allocation:
  - Bioenergy crop – barley
  - Alternative crop – wheat
- Data from Southern Finland
- Cobb-Douglas production function for ethanol calibrated on the basis of Finnish data
- Mitscherlich specification of nitrogen response function, land quality incorporated

Scenarios

- **Basic scenario**: *The most favorable case*

  society is able to utilize grains in bioethanol production, straws in bioenergy production and the residue in animal feed production

- **Other scenarios**: *Critical examination of the basic scenario*

  examine the role of key parts of the bioethanol production chain one by one

Results: Basic scenario

- **Basic scenario**: bioethanol production is socially desirable but close to break-even:
  - Ethanol production from barley: 66 400 tons
  - Climate offsets: 22 600 tons
  - Profits from bioethanol negligible 0.97 million €
  - Profts accrue from animal feed production: 7.4 million €
  - Wheat price increases roughly 3% (more land is shifted to barley production)

Results: CO_2-eq. emissions from soil +20%

- Ethanol production from barley: 66 000 tons
- Climate offsets: - 1 280 tons
- Profits from bioethanol negligible 0.94 million €
- Profts accrue from animal feed production 7.3 million
- Wheat price increase remains quite the same, 3%

- **Conclusion**: No justification for the promotion of bioethanol production from crops

(The case of –20% changes the basic scenario very little; profits from bioethanol production less than 1 million €)

Results: role of straw benefits, animal feed and ethanol price

- No straw benefits:
  - No CO2 offsets from peat in energy production
  - Climate benefits vanish and bioethanol production increases emissions
- No animal feed production from residues
  - No CO2 offsets from imported soybean meal
  - Climate benefits vanish and bioethanol production increases emissions
- Ethanol prices +/- 20%
  - Lower price -20% negative profits from ethanol production
  - Higher price +20% profits increase to 5,5 million €.

Conclusions

- Lesson for the analysis

  Not only the life cycle impacts but also price effects as a source of adjustments by the market must be accounted for when determining the social desirability of bioethanol production

- Lesson for Finland

  Social returns to bioethanol production in the Finnish agro-economic circumstances are very low; GHG balance easily negative

- Lesson for the EU

  Accounting for the life cycle impacts and endogenous crop prices must lead to considerable modification of the EU bioethanol policies