How do Western European farms behave and respond to climate change: A simultaneous irrigation-crop decision model

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Motivation

- Farmers have access to a wide range of adaptation options to reduce the vulnerability of agricultural systems to climate change.
- Most preferred adaptation options are incremental, and therefore run the risk of being long term sub-optimal.
- European Commission proposes that more sustainable combinations of crop selection and irrigation are needed.
- Aim of the paper is to get better insights in combined crop-irrigation adaptation decisions and the resulting climate change impacts.

Structural Ricardian method

- A binary logit model that captures the decision to irrigate
- Simultaneously, a multinomial probit model that evaluates the probability that a certain crop will be cultivated
- Estimate the value of land ($\text{LANDV}_i$) conditional on the choices of irrigation ($\text{IRR}_i$) and crops ($\text{crop}_i$)

**Generalized Structural Equation Model (GSEM)**

$$\Pr[crop_i = j] = \frac{\exp(x'b_{ij})}{1 + \sum_{j=1}^{k} \exp(x'b_{ij})}$$

$$x'b_{ij} = \beta_{ij} + \beta_1\text{IRR}_i + \beta'_2\text{Z}_i + \beta'_3\text{M}_i + \beta'_4\text{C}_R + \eta_i + \varepsilon_{ij}$$

$$\text{IRR}_i = \alpha_0 + \alpha'_1\text{Z}_i + \alpha'_2\text{M}_i + \alpha'_3\text{C}_R + \alpha'_4\text{crop}_i + \eta_i + \varepsilon_i$$

$$\text{LANDV}_i = \begin{cases} y_0 + y'_1\text{Z}_i + y'_2\text{M}_i + y'_3\text{C}_R + y'_4\text{IRR}_i + \lambda_1 + \zeta_{ij}, & \text{IRR}_i = 0 \\ y_0 + y'_1\text{Z}_i + y'_2\text{M}_i + y'_3\text{C}_R + y'_4\text{IRR}_i + \lambda_1 + \zeta_{ij}, & \text{IRR}_i = 1 \end{cases}$$

Data

- Farm Accountancy Data Network of 18 036 crop farms (2012)
- Climate data (temperature and precipitation), soil data, water stress and flood occurrence data and market conditions data
- Rain-fed (10 273) and irrigated farms (7763)
- Large (4269) and small farms (13 767)

Results

![Graph showing the conditional marginal effect of temperature on land value](image)

Concluding remarks

- Irrigation is an endogenous farm choice that is influenced by climatic influences:
- Southern regions: irrigated crops are more resistant to increases in temperature and in Northern regions, irrigated agriculture is more sensitive to temperature
- Larger farmers face more negative marginal effects of temperature than small farms everywhere in Europe.
- For policy, it is important to give economically proper incentives to ensure that all farmers pay the real price of water scarcity