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WISSENSCHAFTSCAMPUS PFLANZENBASIERTE BIOÖKONOMIE HALLE

IAMO Leibniz-Institut für Agrarentwicklung in Transformationsökonomien

# The state-contingent approach to production and choice under uncertainty: usefulness as a basis for economic modeling

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TradeM session

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## Outline

- Basic ideas behind the static model
- Some challenges to empirical implementation
- Current work and future research

**The object of our interest: the state-contingent approach to production and choice under uncertainty**

- From a production economic perspective:

  An approach constructed around a creative formulation of a stochastic production technology. Capable of delivering dual functions, and hence behavioral functions.

- From a decision-making under uncertainty perspective:

  A theory of rational decision-making based on subjective probabilities. The set of alternatives an agent could have a preference over is limited by production and cost conditions.

# Basic idea: linking inputs and *potential* outputs

- Describe the uncertain future as production outcomes $y_s$ assigned to a finite number of mutually exclusive states of nature *s.*

- Each state of nature *s* is perceived by an optimizing agent as occurring with probability $\pi_s$.

- The agent adjusts her efforts in order to *ex ante* maximize her utility given certain technological and cost conditions.

## State-contingent production technology: basics

$$x \in R_{+}^{N} \rightarrow y \in R_{+}^{M \times S},$$

$y_{ms}$ - quantity of output *m* that could be produced in state *s*

Nature draws a state from Ω - $y_s \in R_{+}^{M}$

# Technology representation in terms of sets

- State-contingent output correspondence

$$Y(x) = \{y \in R_+^{M \times S}: x \in R_+^N \text{ can produce y}\}$$

- State-contingent input correspondence

$$X(y) = \{x \in R_+^N: y \in R_+^{M \times S} \text{ can be produced with x}\}$$

# Indirect representations: effort-cost function

$$c(w, y) = \min_{x}\{wx : x \in X(y), w \in R^{N}_{++}\},$$

where

| | |
|---|---|
| x - input quantities | y - output quantities |
| w - input prices | |

# Indirect representations: effort-cost function

$$c(w,y) = \min_{x}\{wx : x \in X(y), w \in R^{N}_{++}\}$$

Optimal value function

Objective function

Technological condition

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# Indirect representations: revenue-cost function

$$C(w, r, p) = \min_y\{c(w, y) : \sum_{m=1}^{M} p_{ms} y_{ms} \geq r_s, s \in \Omega\},$$

where

| | |
|---|---|
| $y$ - output quantities | $y_{ms}$ – quantity of output $m$ in $s$ |
| $w$ - input prices | $p_{ms}$ – price of output $m$ in state s |
| $\Omega$ - space of nature-states | $r_s$ – target revenue in state $s$ |

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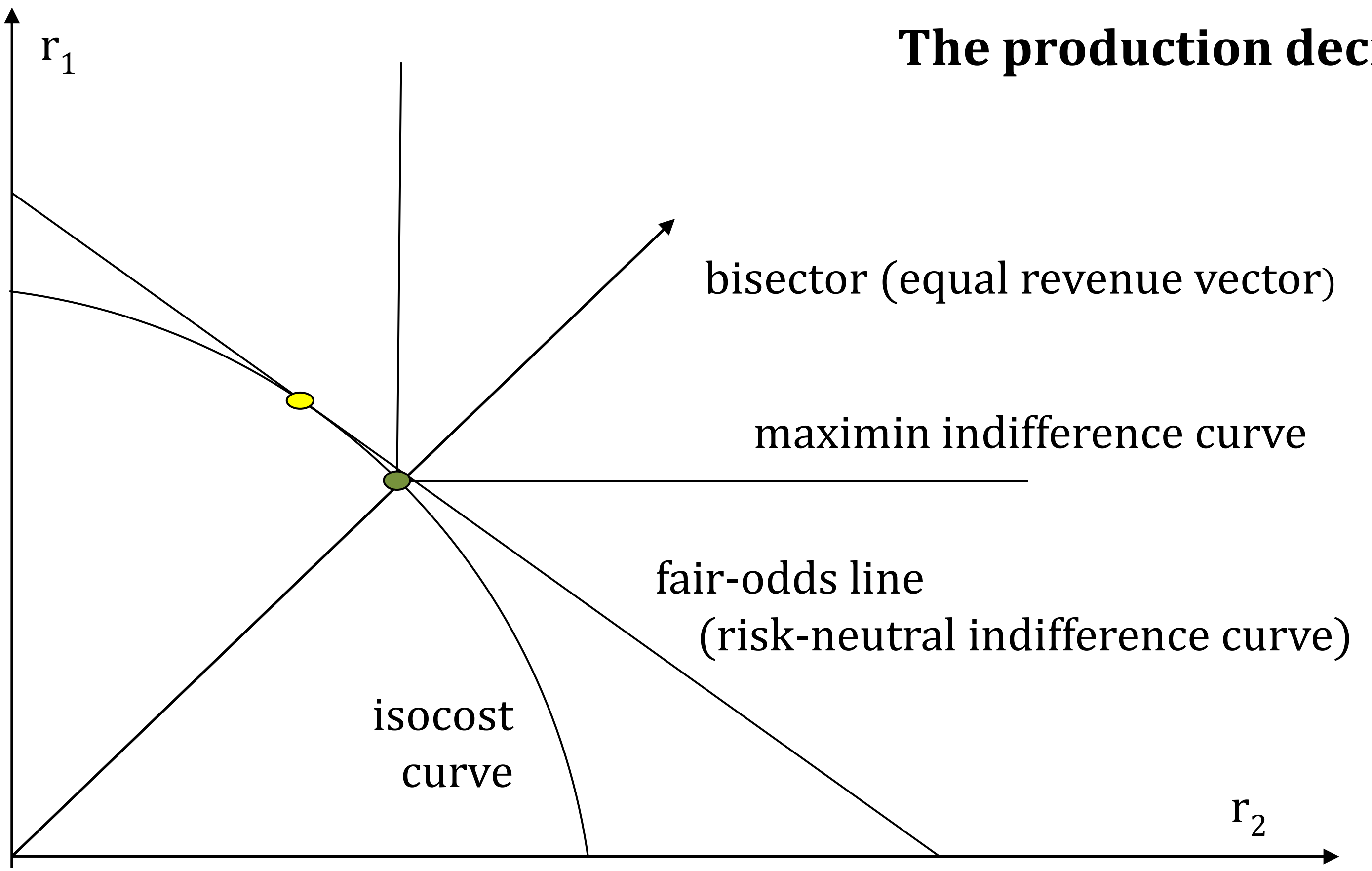
Optimal value function from the cost minimization problem

Target revenue condition

# The production decision



## Challenge I: identifying states of nature

- Challenge: Let us assume we would like to estimate the parameters of a state-contingent production technology. How do we attribute input and output observations to a certain state of nature while being aware of the dangers posed by overusing data?

- Proposal: define states of nature in relative terms.

| | Crop 2 | |
|---|---|---|
| Crop 1 | (good, good) | (good, bad) |
| | (bad, good) | (bad, bad) |

Assume a researcher can infer the subjective perception of the world and its possible states from *field observations*. Test the assumption subsequently.

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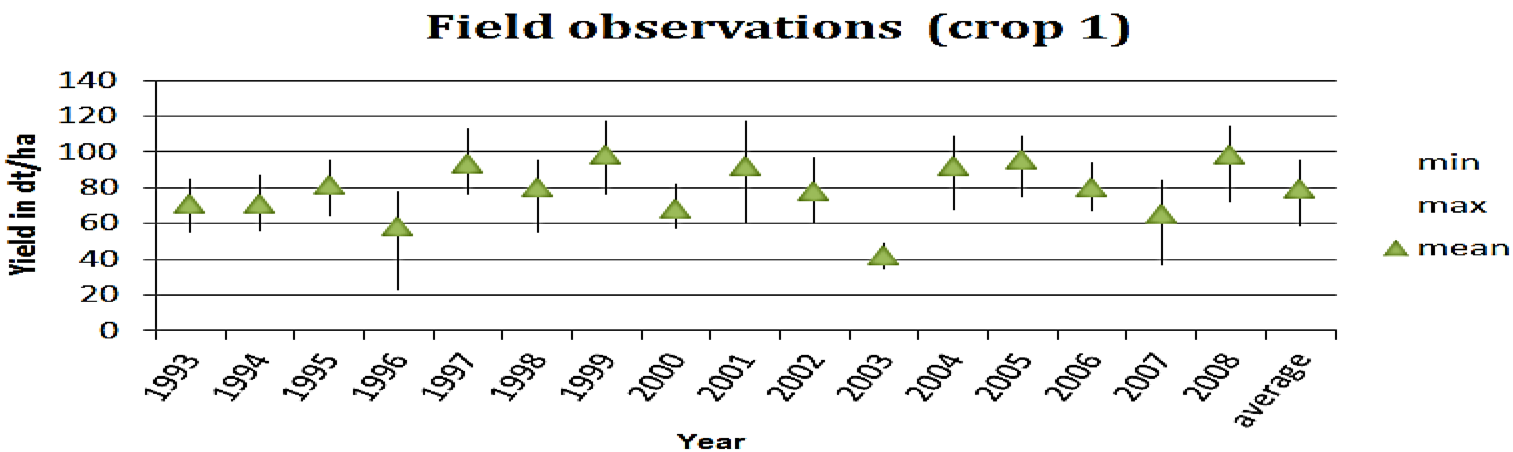


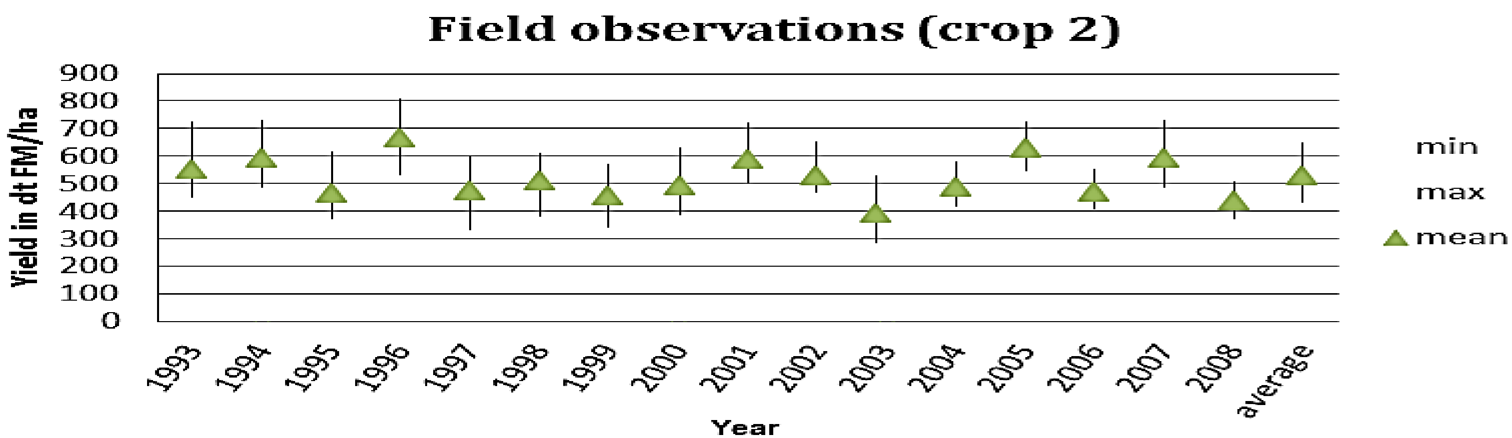

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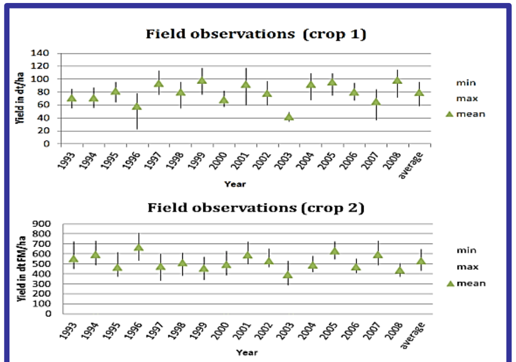
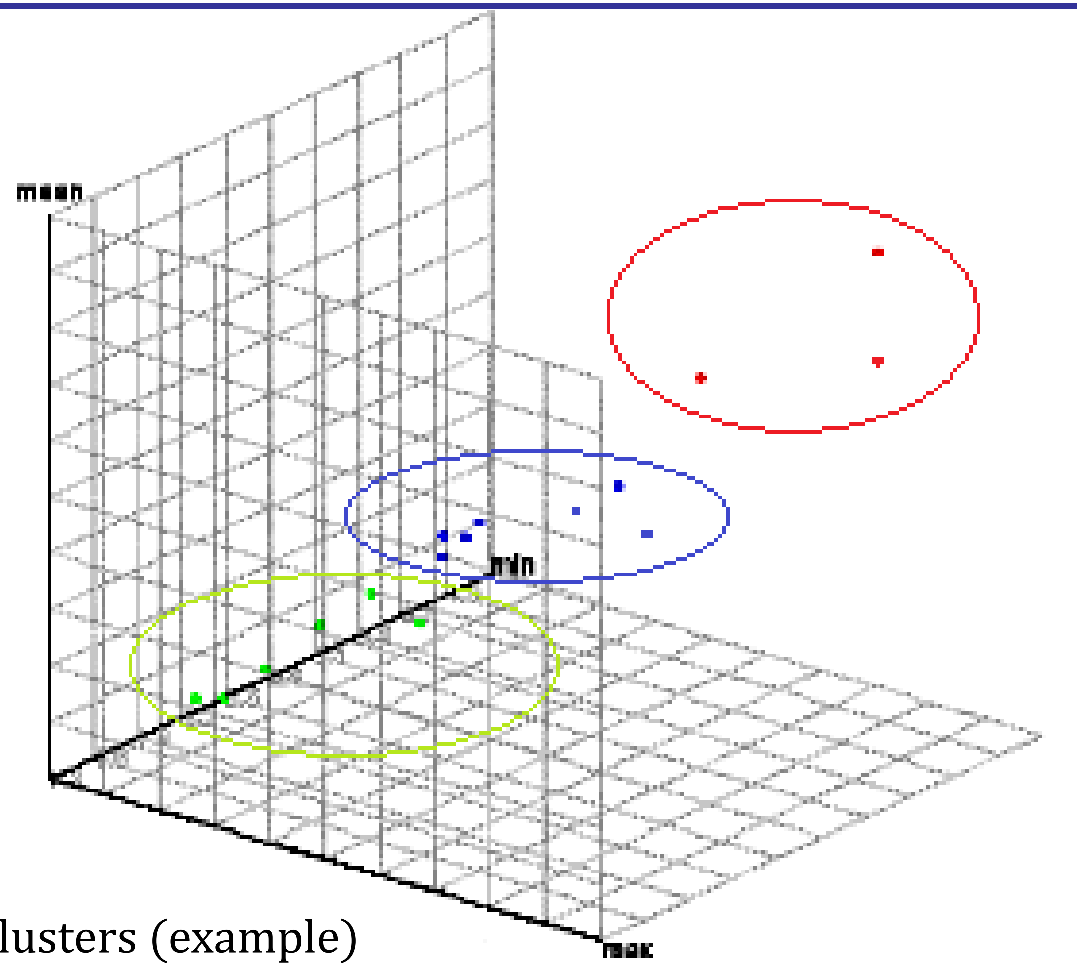



- set in relation
- group by k means

- Test the assumption: design an experiment.
- Is state attribution sensitive to scaling and temporal issues?




Clusters (example)

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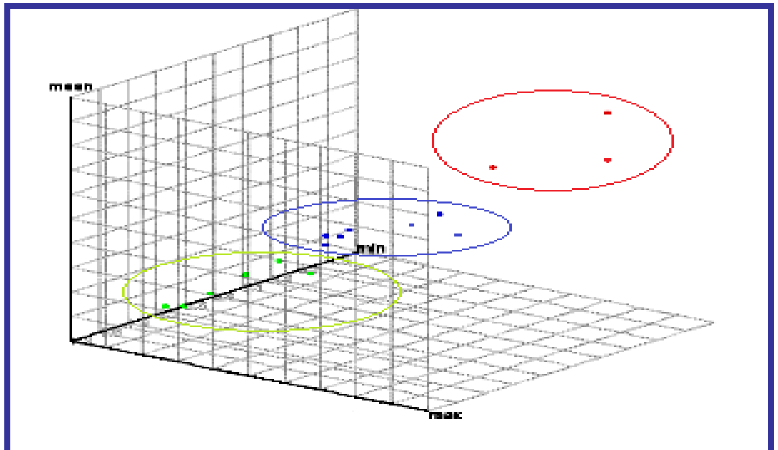
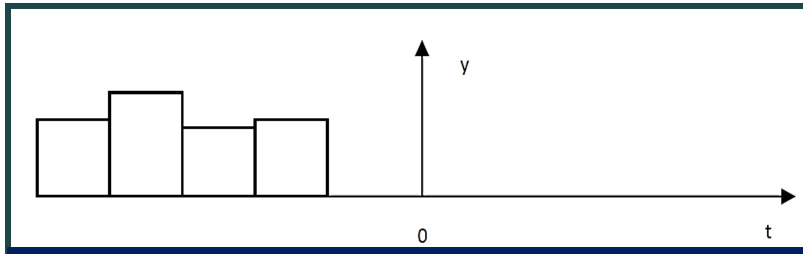
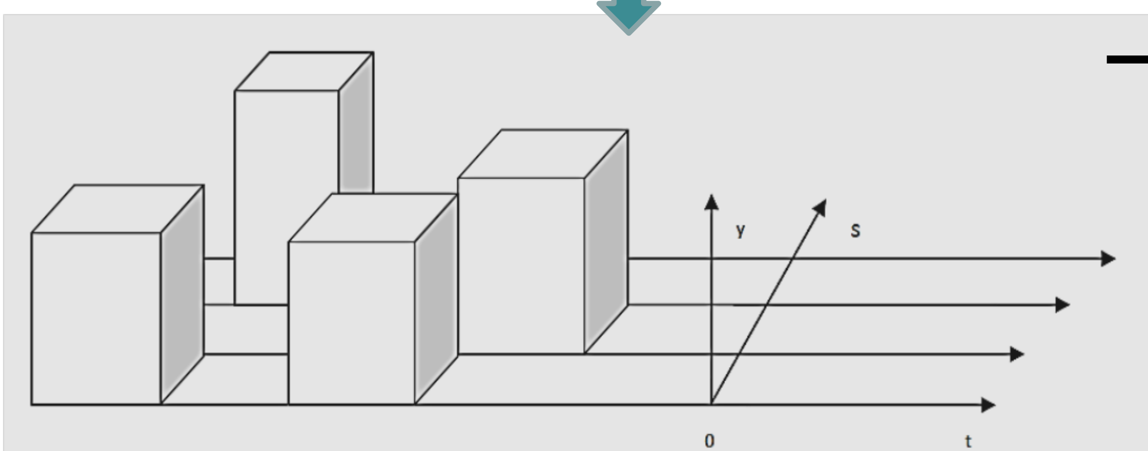



Aggregated agricultural output *y*, plotted on a timeline. The origin represents the present point.

Match




Ready for regression

## Challenge II: price expectations, revenues and probabilities

- Challenge: Let us assume we would like to explicitly model decision-making. Whether it is possible to arrive to a closed form representation of the effort-cost function depends on the functional form of the production technology. Let us assume it is. What parameters of the problem are unknown?

$$C(w, r, p) = \min_y \{c(w, y) : \sum_{m=1}^{M} p_{ms} y_{ms} \geq r_s, s \in \Omega\},$$

where

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|---|---|
| $y$ - output quantities | $y_{ms}$ – quantity of output $m$ in $s$ |
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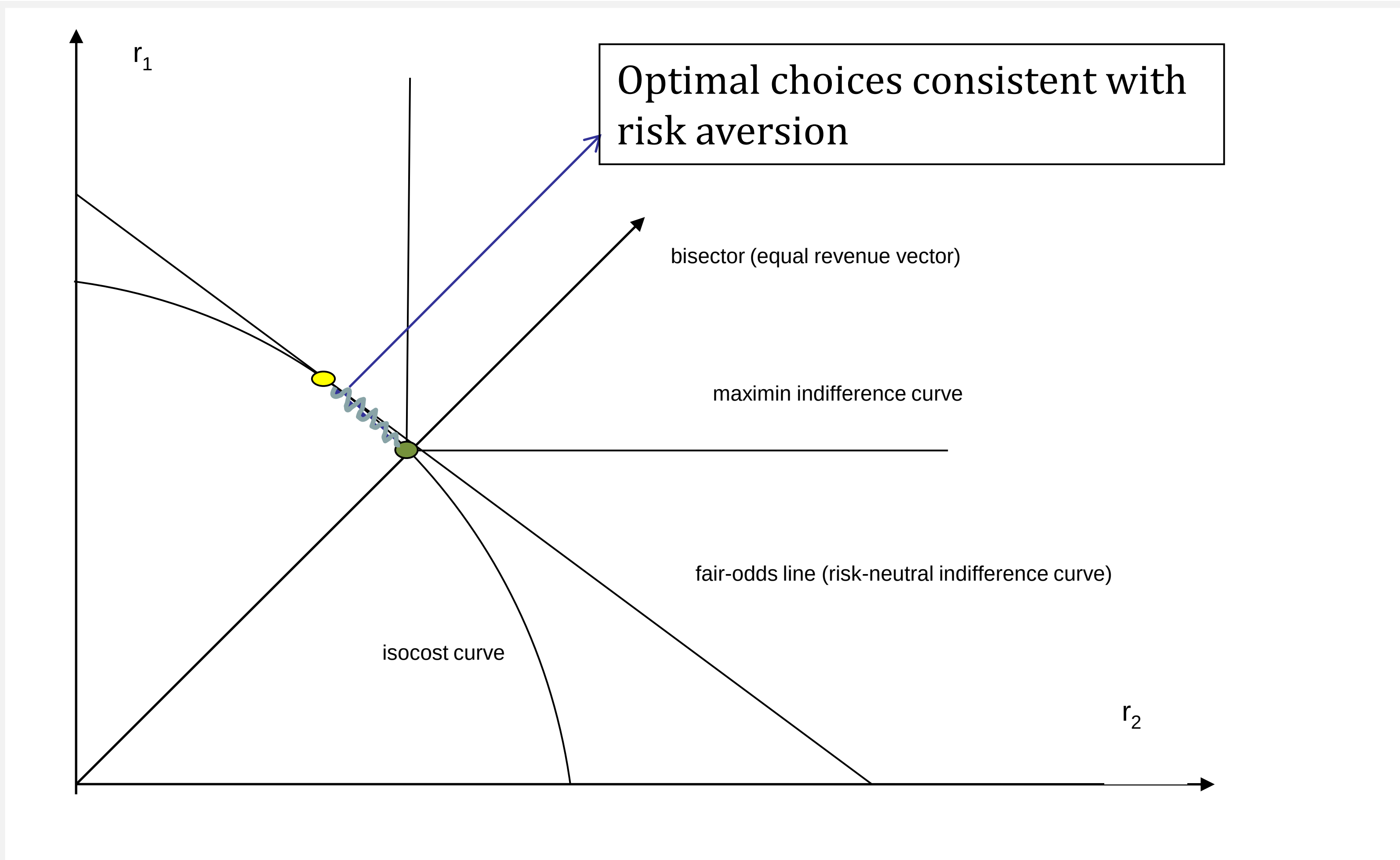
r1
Optimal choices consistent with risk aversion
bisector (equal revenue vector)
maximin indifference curve
fair-odds line (risk-neutral indifference curve)
isocost curve
r2

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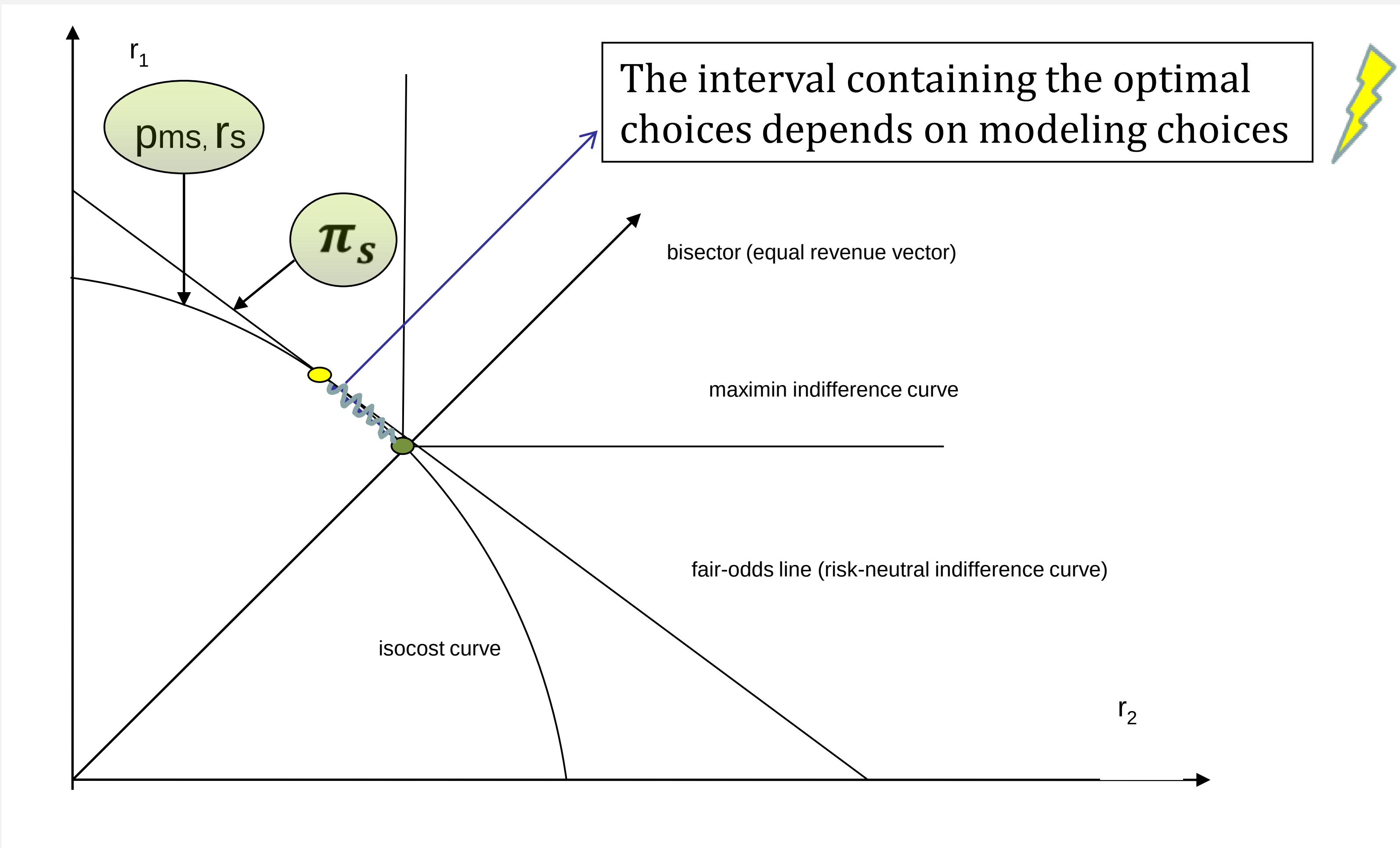

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# Current work: price expectations, revenues and probabilities

- Consult existing theory on the formation of conditional price expectations and subjective probabilities of occurrence.

- Test the behavioral model by comparing predicted input use to observed input use. Develop a criterion for model selection.

➢ Ultimate goal: explain agricultural yields as a combination of optimal decisions and field observations.

# References:


- Angelova, D. (2014a). Statistical identification of nature-states within the state-contingent framework. In *Abstract Book of the FACCE MACSUR CropM International Symposium and Workshop: Modelling climate change impacts on crop production for food security. Oslo, 10-12 February 2014.*

- Angelova, D. (2014b). The state-contingent approach to production and choice under uncertainty: usefulness as a basis for economic modeling. *Contributed to the FACCE MACSUR Mid-term Scientific Conference. Sassari, 01-04 April 2014.*

- Chambers, R., & Quiggin, J. (2000). *Uncertainty, production, choice, and agency: the state-contingent approach*. Cambridge, UK: Cambridge University Press.

- Nauges, C., O'Donnell, C. J., & Quiggin, J. (2011). Uncertainty and technical efficiency in Finnish agriculture: a state-contingent approach. *European Review of Agricultural Economics*, *38*(4), 449–467.

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# Thank you for your attention.

Questions, comments, suggestions?

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