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# Price Formation on Agricultural Land Markets – A Microstructure Analysis

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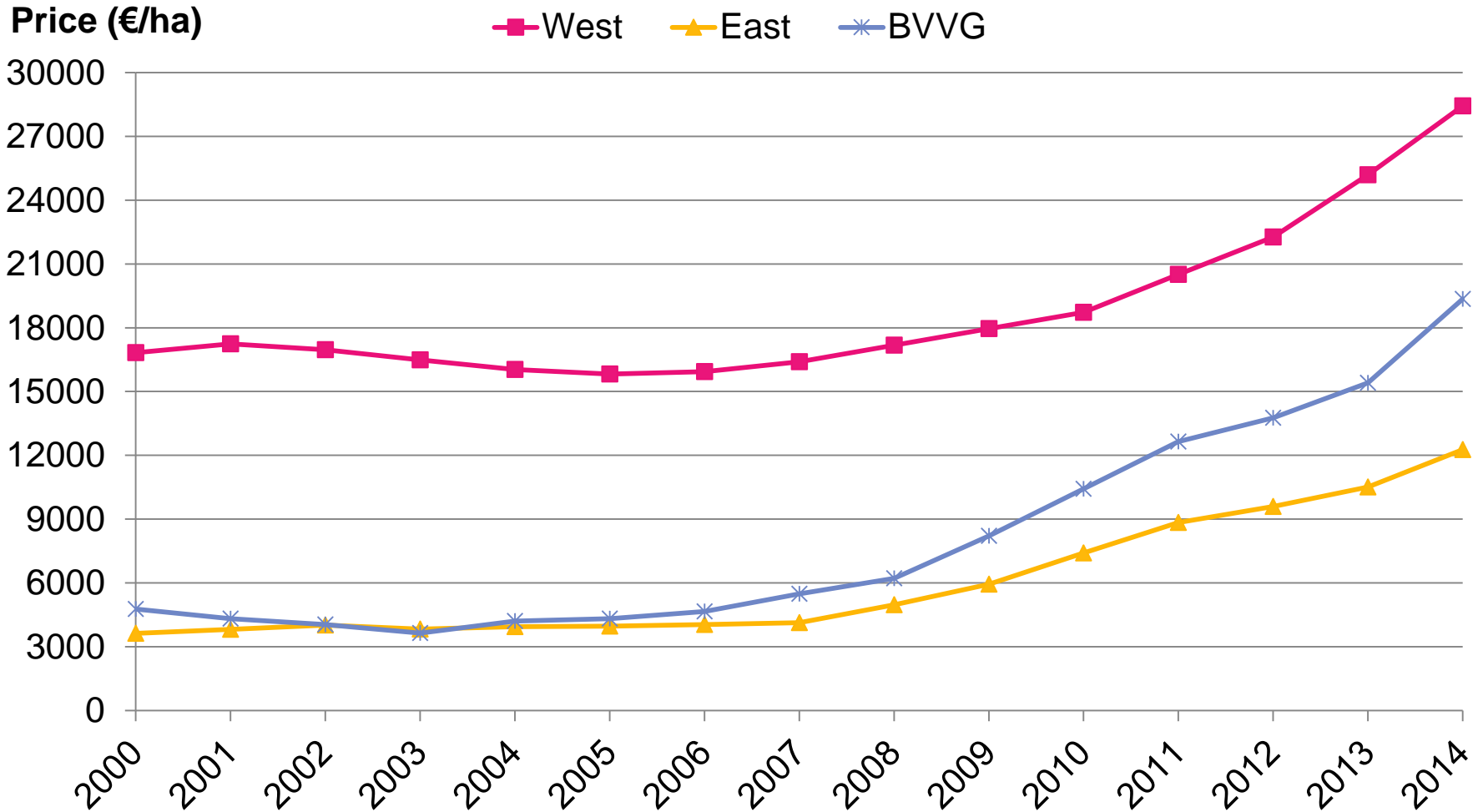


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# Development of Land Prices in Germany

(Source: Destatis)

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## Relevant literature

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### “Classical” Hedonic land pricing

e.g. Palmquist & Danielson (1989), Huang et al. (2006)

- Productivity characteristics
- Location & regional characteristics
- Environmental variables
- Policy impact / subsidies

### Market (micro)structure

- Market power  
Cotteleer & Gardebroek (2008)
- Role of market mechanism  
e.g. Lusht (1996), Mayer (1996), Quan (2002)
- Forced sales  
e.g. Allen & Swisher (2000), Campbell et al. (2009)

# Outline

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1. Motivation ✓
2. Forced sales and farmland prices
3. Price formation in agricultural land auctions
4. Conclusions

# Forced Sales: Hypotheses

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## Interference of two, possibly opposed effects

1. Pressured sale → price ↓
2. Auction effect → price ↑
3. Net effect foreclosure → price ?

# Empirical Application

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- Region:  
State of Brandenburg/Germany
- Data Source:  
Expert panel (Oberer Gutachterausschuss)
- Individual transaction data:  
26,786 observations, 1% foreclosures
- Period:  
1/2000 – 9/2011
- Variables:  
Price, soil quality, plot size, location (county), date of sale

# Econometric approach

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## 1. Regression model

$$\ln p_i^0 = x_i^0 \beta^0 + u_i$$

$$ATT = \frac{1}{n^1} \sum_{i=1}^{n^1} p_i^1 - \frac{1}{n^1} \sum_{i=1}^{n^1} x_i \hat{\beta}^0$$

$x_i$ : [soil quality index,  
size, size<sup>2</sup>,  
18 county dummies,  
11 time dummies]

## 2. Matching

- Direct covariate matching
- K-nearest neighbor
- Mahalanobis distance

$$ATT = \frac{1}{n^1} \sum_{i=1}^{n^1} (p_i^1 - p_i^{1\text{match}})$$



# Results:

## Effects of Forced Sales (ATT)

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Year	Observed price forced sales	Observed price non-forced sales	Counterfactual (regression)	Counterfactual (matching)	Price difference (regression)	Price difference (matching)
	(1)	(2)	(3)	(4)	(1)-(3)	(1)-(4)
<b>2000</b>	3,246	2,410	2,354	2,764	892	744
<b>2001</b>	1,151	2,390	2,445	1,985	-1,294	-834
<b>2002</b>	2,692	2,450	1,958	2,311	734	508
<b>2003</b>	2,368	2,400	2,075	2,477	293	-110
<b>2004</b>	1,960	2,340	1,878	2,355	82	-395
<b>2005</b>	2,595	2,450	1,969	2,177	626	412
<b>2006</b>	1,589	2,470	2,279	2,409	-690*	-884*
<b>2007</b>	3,418	2,620	2,237	2,602	1,181*	815*
<b>2008</b>	3,437	3,070	2,584	2,956	853*	481
<b>2009</b>	3,183	3,470	2,902	3,134	281	49
<b>2010</b>	4,070	3,610	3,295	3,629	775	440
<b>2011</b>	5,125	3,960	3,159	3,625	1,966*	1500*
<b>Total</b>	3,075	2,844	2,475	2,781	600*	282*

# Land Market Auctions in Saxony-Anhalt

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- LGSA (Landgesellschaft Sachsen-Anhalt)  
Land administration agency.  
Privatization of formerly state-owned land
- First price sealed bid auction with public tenders
- Tendering results of the LGSA from 2003-2010;  
~760 transactions (arable and grassland)
- Available information:  
price, size, location, soil quality, number of bids,  
bidder status (residential farmer, non-agricultural investor)

# Prices formation on land auctions: Hypotheses

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## Auction theory:

- Optimal bid increases with number of bidders  
⇒ higher number of bids = higher price (private value auction)
- Different optimal bids among different groups of bidders:  
⇒ non-agricultural bidders: higher optimal bids = higher price

# Results: Spatial Lag Model

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	Estimated coefficient
<b>Soil quality</b>	0.011***
<b>Plot size (linear) (ha)</b>	0.013
<b>Plot size (quadratic)</b>	0.000
<b>Share arable land</b>	0.414***
<b>Number of bids</b>	0.033***
<b>Share of bids from agriculture</b>	-0.217***
<b>Local buyer</b>	0.061*
<b>Dummy 2008 (Basis 2003)</b>	0.203***
<b>Dummy 2009 (Basis 2003)</b>	0.286***
<b>Dummy 2010 (Basis 2003)</b>	0.370***

\*\*\*, \*\* and \* denote statistical significance at 1, 5 and 10 percent, respectively

## Conclusions

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- Market structure and characteristics play a role for the market outcome
- Prices on auctions appear higher than on search markets
- Share of non-agricultural bidders drives up prices
- Prices are higher if winning bidder is a resident
- Land prices in Germany can be well explained by market fundamentals (no evidence for land price bubbles)
- No need for tighter regulations of land markets

# Backup Slides



# Data:

## Summary Statistics of the Farmland Prices and Characteristics

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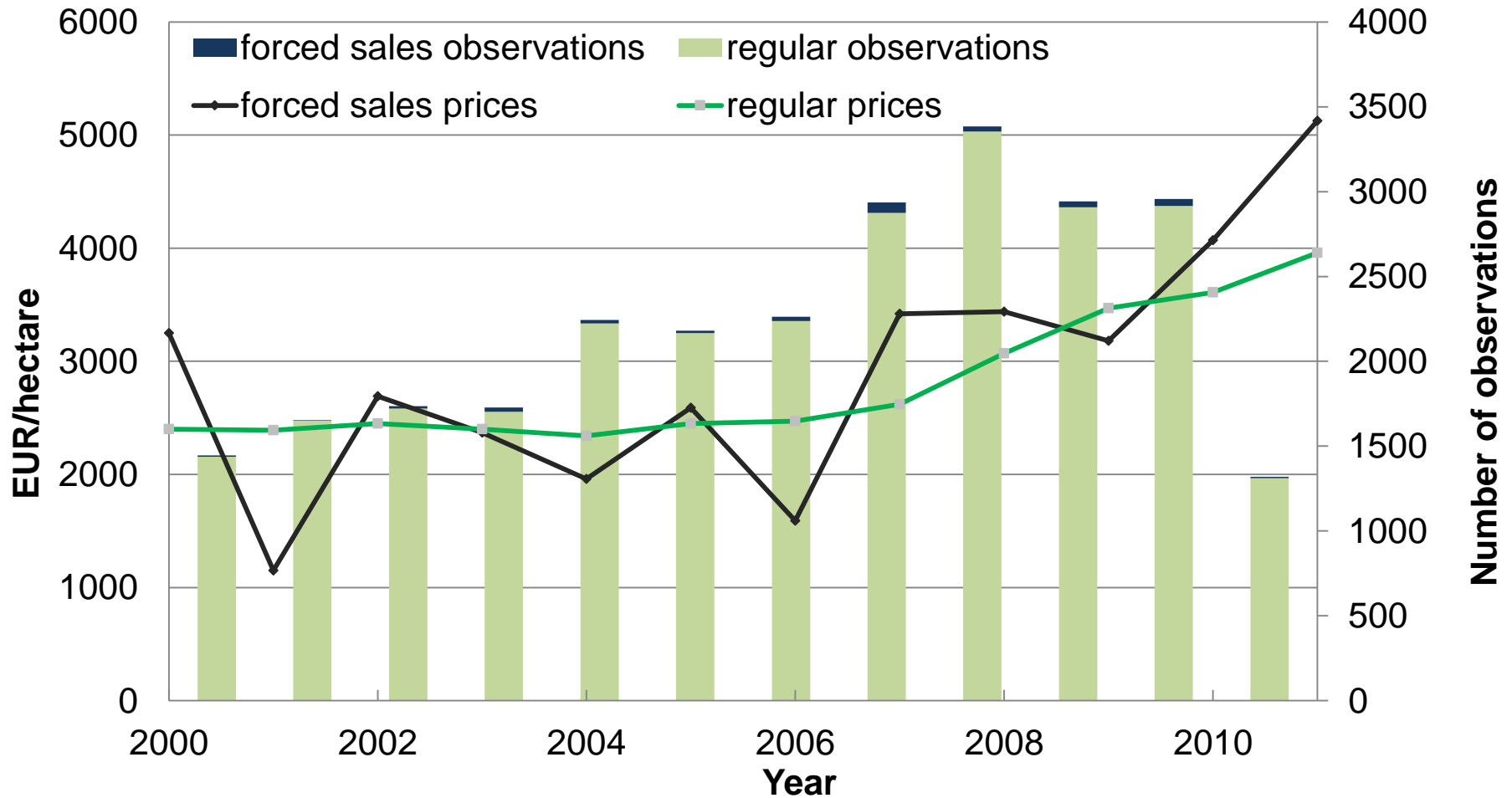
Group	Statistic	Price (€/hectare)	Soil quality arable land	Soil quality grassland	Area (hectares)
<b>Non-forced sales</b> N=26,502	Mean	2,844	26.34	25.51	4.38
	Std. deviation	1,572	11.19	7.03	10.22
	Min.	58	1	1	0,01
	Max.	19,397	80	60	427.77
<b>Forced sales</b> N=284	Mean	3,074	26.98	23.46	3.08
	Std. deviation	2,588	11.01	6.15	5.82
	Min.	154	1	8	0.01
	Max.	20,835	72	40	47.56
<b>Total</b> N=26,786	Mean	2,847	26.34	25.49	4.36
	Std. deviation	1,586	11.19	7.02	10.18
	Min.	58	1	1	0,01
	Max.	20,835	80	60	427.77

Source: Own calculations based on data from Oberer Gutachterausschuss Brandenburg.

# Data:

## Development of farmland prices

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# Results:

## Hedonic price model

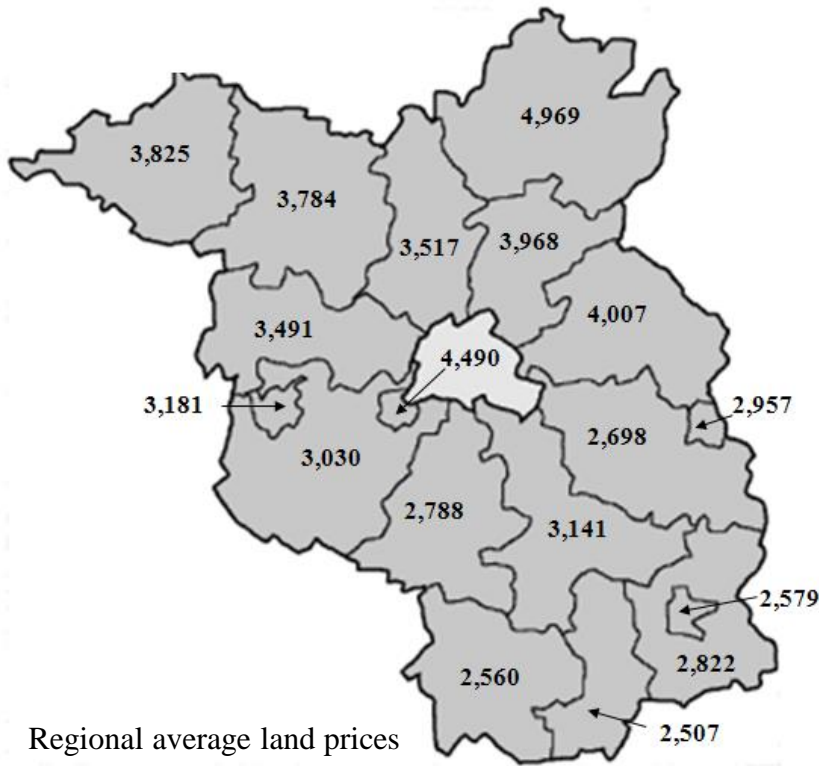
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Dependent variable log price (€/m <sup>2</sup> )	Coefficient estimates	P-value
Soil quality arable land (AZ)	0.006	0.000***
Area (hectares)	-0.002	0.000***
Area squared (hectares)	1.33e-05	0.001***
D <sup>2001</sup>	-0.016	0.364
D <sup>2002</sup>	0.013	0.462
D <sup>2003</sup>	0.026	0.163
D <sup>2004</sup>	-0.008	0.631
D <sup>2005</sup>	0.0175	0.305
D <sup>2006</sup>	0.025	0.133
D <sup>2007</sup>	0.086	0.000***
D <sup>2008</sup>	0.237	0.000***
D <sup>2009</sup>	0.375	0.000***
D <sup>2010</sup>	0.426	0.000***
D <sup>2011</sup>	0.498	0.000***

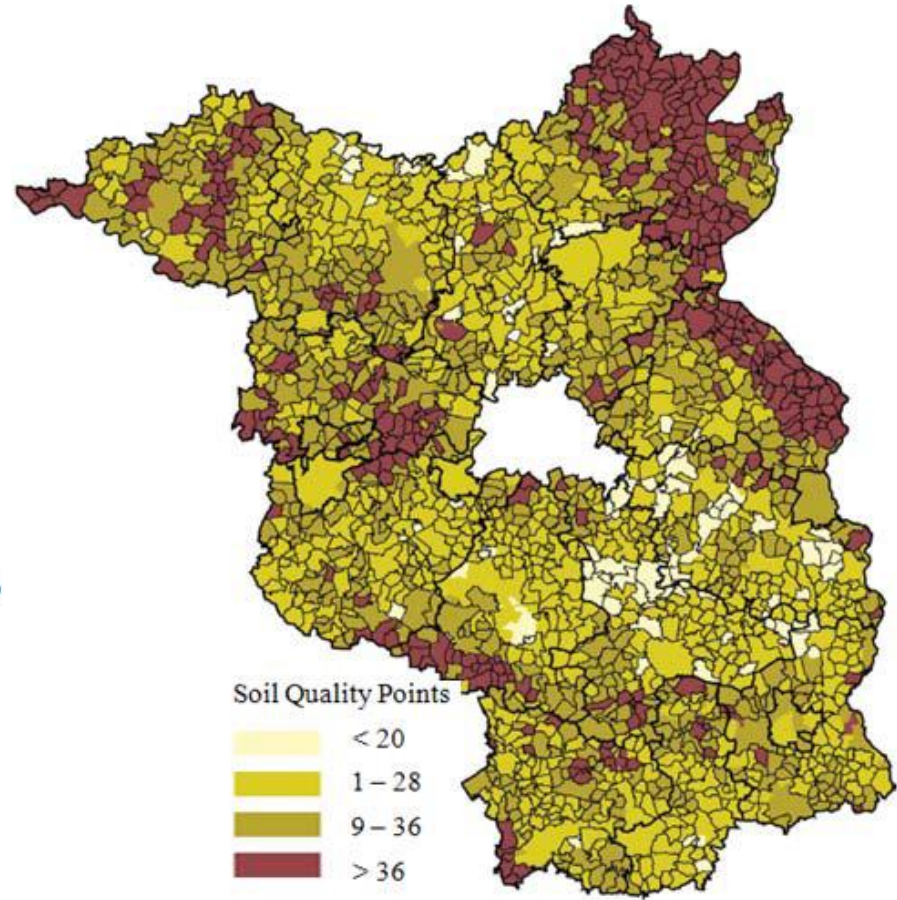
# Data:

## Mean prices for counties

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Regional average land prices  
in €/ha, 2008-2010



Source: Own calculations; data provided by “Oberer Gutachterausschuss Brandenburg“ and “Landesamt für ländliche Entwicklung, Landwirtschaft und Flurneuordnung“.

# Econometric approach

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- Objective:  
Estimation of the average treatment effect on the treated (ATT)

$$ATT = E(p_i^1 - p_i^0 | d_i = 1)$$

- This can be expanded to

$$\underbrace{E(p_i | d_i = 1) - E(p_i | d = 0)}_{\text{observed difference in prices}} = \underbrace{E(p_i^1 - p_i^0 | d_i = 1)}_{ATT} + \underbrace{E(p_i^0 | d_i = 1) - E(p_i^0 | d = 0)}_{\text{selection bias}}$$

- Conditional independence assumption (CIA)

$$\{p_i^1, p_i^0\} \perp\!\!\!\perp d_i | x_i$$

## Explanatory variables: summary statistics

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	mean	s.d.	min	max
<b>soil quality (0-102)</b>	64	22	23	101
<b>% arable land</b>	85	28	0	100
<b>lot size (ha)</b>	7.25	3.47	0.06	26.48
<b>arable land (ha)</b>	6.39	3.54	0	25.86
<b>grassland (ha)</b>	0.67	1.79	0	15.85
<b># of bids</b>	4	3	1	17
<b>% farmers' bids</b>	89	17	30	100
<b>price (€/sq m)</b>	0.82	0.47	0.1	2.61

acceptance bid in 48% of the cases from tenant

N=722

## Econometric procedure

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### Spatial lag model

$$\ln(\text{price}_i) = \rho \sum_j W_{ij} \ln(\text{price}_j) + \sum_k x_{ik} \beta_k + \sum_l d_{il} \delta_l^{\text{county}} + \sum_t d_{it} \delta_t^{\text{year}} + e_i$$

$x$ : explanatory variables;  $e$ : error term;  $W$ : spatial weights;  
 $\rho$ : impact of neighbouring land prices

## Open questions & further research

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- How do buyer and seller characteristics affect price formation?
- What are the motives of non-agricultural investors to buy land?
- What is the effect of farm takeovers on land markets?
- Do market power and strategic decision making play a role in (local) land markets?
- Are (local) land markets spatially integrated or separated?