# Don’t Bet the Farm on Insurance Subsidies

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# Farmers face increasing climate risks

ENVIRONMENT • AGRICULTURE

## In France, warmer winter temperatures disrupt agriculture

**With the winter of 2022-2023 ranking among the 15 warmest on record since 1900, fruit tree growers must manage the impacts of shorter cold spells and temperature shocks.**

By Mathilde Gérard

Published on March 7, 2023, at 11:50 pm (Paris), updated on March 8, 2023, at 4:59 pm · 5 min. · Lire en français

FRANCE • AGRICULTURE

## 'We don't even have time to take a breath': French farmers struggle with the effects of climate change and inflation

By Camille Bordenet

Published on July 17, 2022, at 4:47 am (Paris), updated on July 17, 2022, at 4:47 am

(a) La fréquence des pertes de production alimentaire liées au climat dans les cultures, l'élevage, la pêche et l'aquaculture a augmenté au cours des dernières décennies.

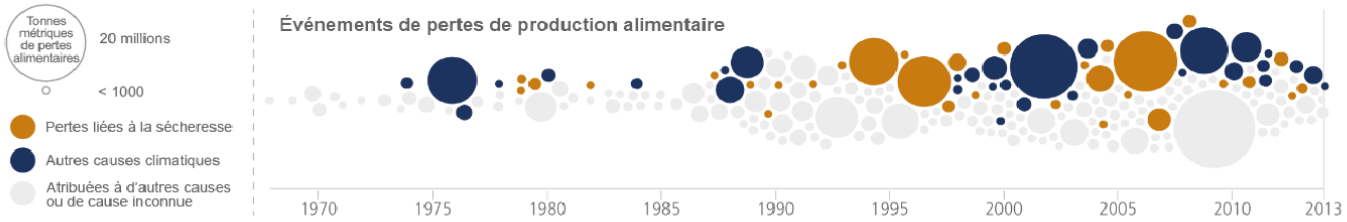



Figure: Sources: Le Monde, GIEC

# Yet crop insurance uptake remains extremely low

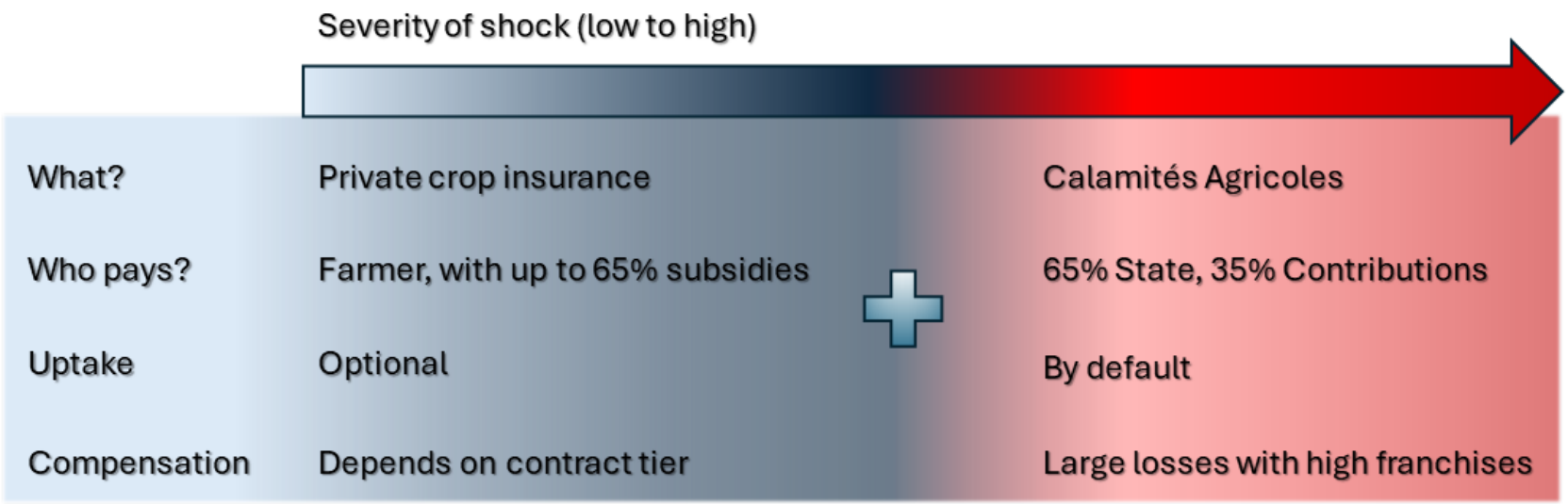
- Insurance uptake: only 13.3% of farms insured in 2020
- Stable/slight increase: from 12% (2016) to 13,3% (2020)
- Larger farms are more insured than smaller ones
- 30% of surfaces are insured

A paradox since

- High insurance subsidies: 45%–65% of premiums paid before the 2022 reform!
- Farmers otherwise insured: buildings, vehicles, liability, etc.

Source: Ministry of Agriculture

# The insurance system in France (until 2022)



# Q1: Impact of crop insurance on the revenue distribution of farmers

**Incomes highly variable by nature yet insurance reduces variance**

**Crop insurance is on average a "good deal"**

- Insurance increases average revenue
- Farmers benefit greatly from insuring: +20% in expected revenues

**But** this does not mean that every farmer should insure

**Heterogeneity in insurance benefits could explain the paradox of underinsurance**

# Q2: Who benefits the most from insurance?

- **No simple links between individual insurance uptake and benefits**
  - Larger farms are more insured, yet derive less benefits than smaller farms from their contracts
  - This suggests informational barriers or hidden costs (unobserved)
- Marginal Treatment Effects à la Heckman-Vytlacil: signs of negative selection into treatment
  - Translation: treatment = insured, control = not insured
  - Treatment is NOT randomly assigned, but chosen
  - Hence the instrumental variable methods
- Farmers who would benefit the most are the most reluctant to insurance

# Q3: Can increasing insurance subsidies solve the paradox?

- **Increasing insurance subsidies does not solve the issue and may even hurt (public finance)**
- Farmers who would benefit the most from insurance are highly "resistant" to insurance subsidies
- Farmers with little profits from insurance would be pushed into the insurance market to grab the subsidy
- Targeting the barriers directly
  - Information campaigns
  - Direct help on the paperwork
  - Targeted subsidies
  - Incentives on insurance companies

# Contributions

**Methodology**

- Analysis of heterogeneous treatment effects on both observable and non-observable characteristics
- Probit/interaction and MTE framework $\Rightarrow$ Never been used in crop insurance literature (ex: Di Falco et al. 2014, Wang et al. 2021)
- Counterfactual analysis of policies

**Data:** Finer at micro-level (as compared with previous works)

- Continuous instrument $\Rightarrow$ Enables MTE analysis and large-scale study
- Weather variables AND agronomic indicators

# Data sources

- **Farm-level data**
  - RICA (part of the FADN: Farm Accounting Data Network)
  - Pseudo-panel data between 2002 and 2021 for 17,743 individuals with localization
  - Floods and droughts on a declarative basis
- **Weather data**
  - Reanalysis data from the National Meteorological and Hydrological Services from EU countries
  - Temperatures and precipitations at a 0.1° lat/long resolution, about 6 $\times$ 6 km, every 6 hours

$\Rightarrow$ **Index of Growing Degree Days**
Sum of out-of-bound for hot and cold days for 3 types of crops (C3, C4, potatoes and roots)

# Variable choice: Revenue, insurance, inputs

- **EBITDA for total impact**
  - Revenues (including production, costs, subsidies, insurance payments, etc.) before taxes
  - 2 measures: gross and net of insurance subsidies
- **Insurance:** Dummy $(0, 1)$ for insurance status
  1 if more than 20 €/Ha for insurance in a given year
- **Controls**
  - Farm characteristics (work hours, total used agricultural surface, fuel and pesticides, agrotourism revenues, cattle, greenhouse, diversification)
  - Climate variables (hot and cold GDDs, floods, droughts + lags)
  - Two-way fixed effects

# IV to deal with endogeneity

- Insurance choice is highly endogenous
- Instrumenting insurance decision through the average insurance subsidy rate and using as dependent variable farmer revenue net of insurance subsidies
- IV: national insurance subsidy rate by year and crop
- Changes every year (French decision until 2015, EU decision after)

# Local average treatment effects

Two-way fixed effects + IV ($D$ instrumented) + Antle method of moments:

$$D_{it} = \alpha + \beta_{11} E(S|t, \text{crop}) + \beta_{21} \boldsymbol{X_{it}} + \beta_{31} \boldsymbol{\Lambda_{it}} + \beta_{41} \boldsymbol{\Lambda_{it-1}} + \theta_i + \theta_t + \epsilon_{it}$$

$$R_{it} = \alpha' + \beta_{12} D^*_{it} + \beta_{22} \boldsymbol{X_{it}} + \beta_{32} \boldsymbol{\Lambda_{it}} + \beta_{42} \boldsymbol{\Lambda_{it-1}} + \theta'_i + \theta'_t + \epsilon'_{it}$$

$$\epsilon'^2_{it} = \alpha'' + \beta_{13} D^*_{it} + \beta_{23} \boldsymbol{X_{it}} + \beta_{33} \boldsymbol{\Lambda_{it}} + \beta_{43} \boldsymbol{\Lambda_{it-1}} + \theta''_i + \theta''_t + \epsilon''_{it}$$

$\beta_{12}$ effect of insurance (LATE) on expected income

$\beta_{13}$ same thing on Variance

Estimated via 2SLS (standard)

# Heterogeneity 1: Selection into treatment based on observable characteristics

- Probit (on insurance decision, exit, entry) to identify key observable characteristics in $\boldsymbol{X}$: size, diversification
- Interaction terms combined with IV (Woolridge 2010) to assess heterogeneous impacts + Quartile regressions (LATE)
- Coefficients on the interaction terms interpreted as "change in treatment effect when characteristic increases"

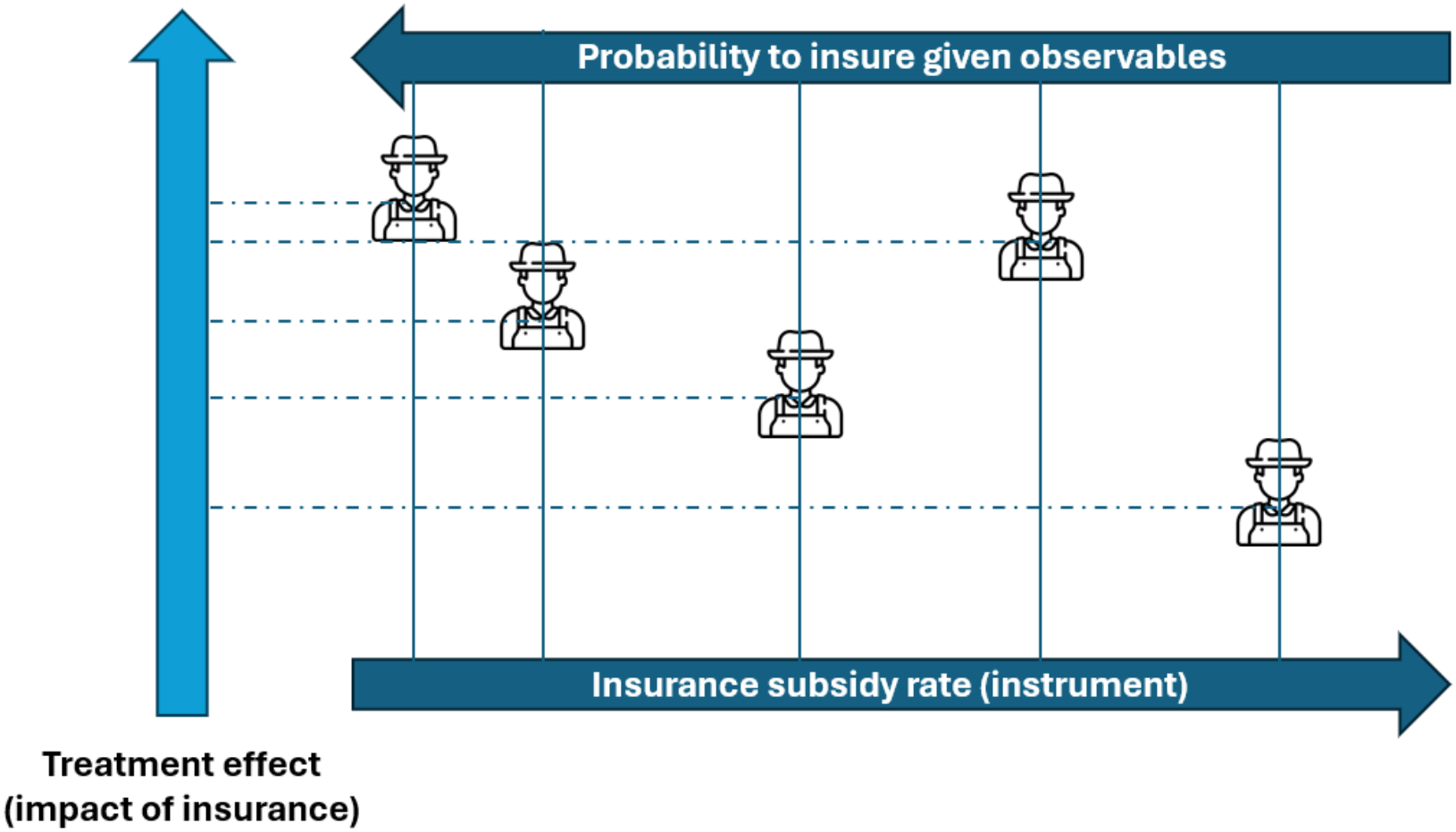
**1st angle:** $q$ is the price of insurance net of subsidy

$$P(D_{it} = 1) = \phi(E(q|t, \text{crop}), \boldsymbol{X_{it-1}}, \boldsymbol{\Lambda_{it-n}}, R_{it}, \theta_t, \epsilon_{it})$$

**2nd angle:** modified measure of causal effect (interaction added)

$$R_{it} = \alpha'' + \beta_{13} D^*_{it} + \beta_{23}(D^*_{it} * \boldsymbol{x_{it}})^* + \beta_{33}\boldsymbol{X_{it}} + \beta_{43}\boldsymbol{\Lambda_{it}} + \beta_{53}\boldsymbol{\Lambda_{it-1}} + \theta''_i + \theta''_t$$

# Heterogeneity 2: Unobservables



# Marginal treatment effects

- Inspired by Heckman & Vytlacil 2005 (and others since)
- ATE estimated over quantiles of a propensity score based on a continuous instrument (insurance subsidy rate)
- Measures the impact of insurance across the resistance to treatment scale

Formally:

$$\text{MTE}(X, p(Z)) \equiv \frac{\partial E(R|\boldsymbol{X}, p(Z))}{\partial p(Z)}$$

With $\boldsymbol{X}$ observable characteristics, $p$ quantiles of the instrument $Z$, $R$ revenues

# LATE: Large average impacts of insurance on revenue

| | EBITDA with insurance subsidies | | EBITDA without insurance subsidies | |
|---|---|---|---|---|
| | Mean | Variance | Mean | Variance |
| Dummy for crop insurance status (1=insured) | 0.221*** | -0.002 | 0.187*** | 0.002 |
| | (0.028) | (0.008) | (0.026) | (0.007) |
| Observations | 69790 | 69790 | 69006 | 69006 |
| Weak Ident. | 168.984 | 168.984 | 180.817 | 180.817 |
| Hansen J | 0.000 | 0.000 | 0.000 | 0.000 |
| Farmer FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes |
| Instrument | Yes | Yes | Yes | Yes |
| Insurance subsidy rate (1st stage) | 0.004*** | | 0.004*** | |
| | (0.000) | | (0.000) | |

Table: 2nd stage IV log estimations for the impact of insurance on the revenue distribution (NB: All coefficients are elasticities)

## Behavorial implications

- Mean: shielding + mispricing
- Variance: shielding + moral hazard (for different crops or strategies), compensating each other

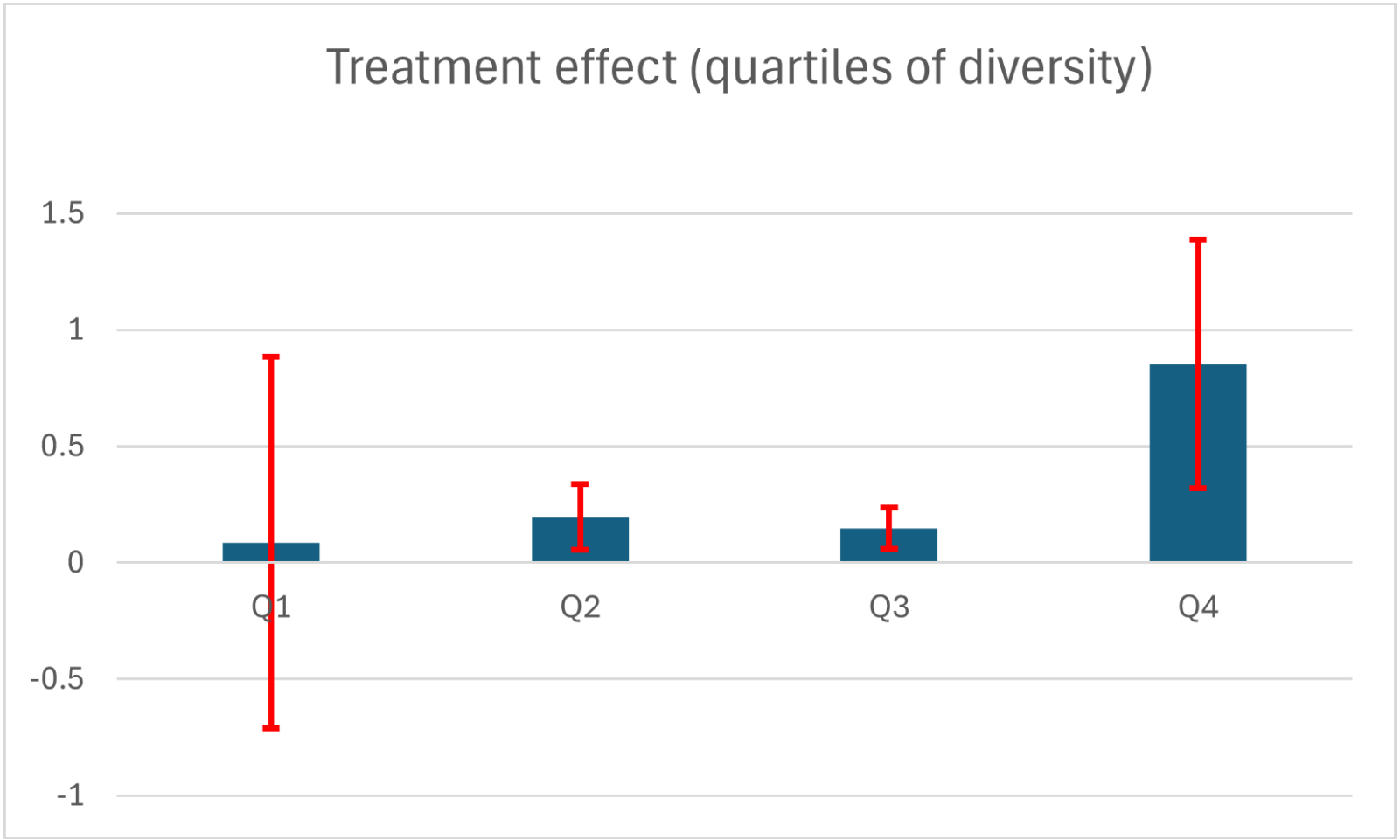
# Probit: Size and diversification are the main determinants of insurance subscription

| | (1) Static | (2) Exit | (3) Entry |
|---|---|---|---|
| Turnover (log) | 0.178*** | -0.345*** | 0.064 |
| | (0.058) | (0.086) | (0.072) |
| Total work hours (log) | 0.004 | -0.076*** | -0.122*** |
| | (0.020) | (0.018) | (0.017) |
| Total surface of the farm (log) | 0.002 | 0.042** | 0.097*** |
| | (0.022) | (0.020) | (0.019) |
| Greenhouse dummy | -0.331*** | 0.080 | 0.173** |
| | (0.104) | (0.079) | (0.074) |
| Cattle dummy | -0.291*** | -0.064*** | -0.158*** |
| | (0.021) | (0.023) | (0.022) |
| Diversification index (1=Not diversified) | 0.942*** | 0.307*** | 0.185*** |
| | (0.059) | (0.057) | (0.055) |
| Mean real price of insurance (year, crop) | 0.000 | -0.000 | -0.001*** |
| | (0.000) | (0.000) | (0.000) |
| Observations | 71524 | 71524 | 71524 |

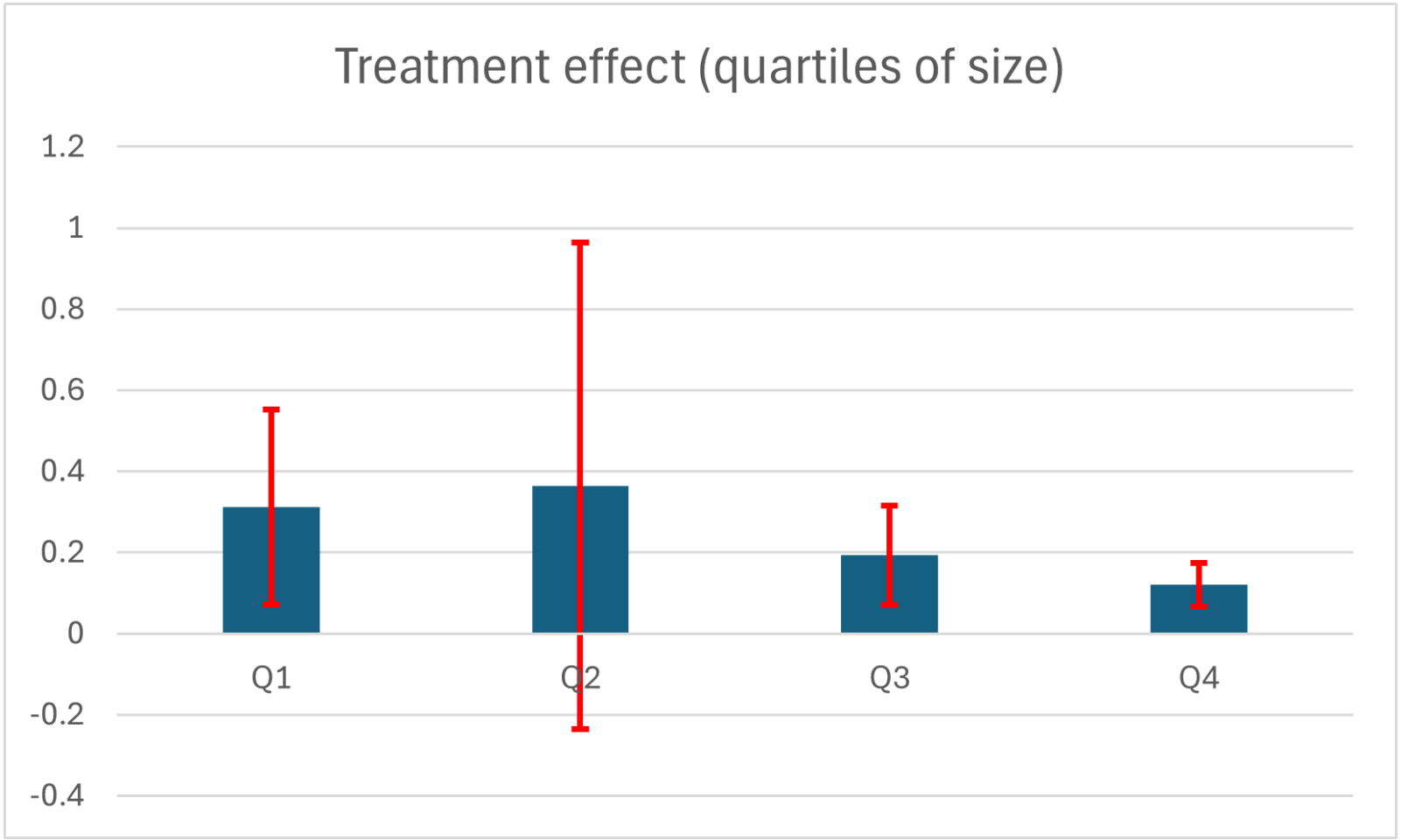
Table: Probit results: The determinants of insurance subscription

# Heterogeneity: Positive selection into treatment for diversification

(1=Not diversified)



# Heterogeneity: Negative selection into treatment for size

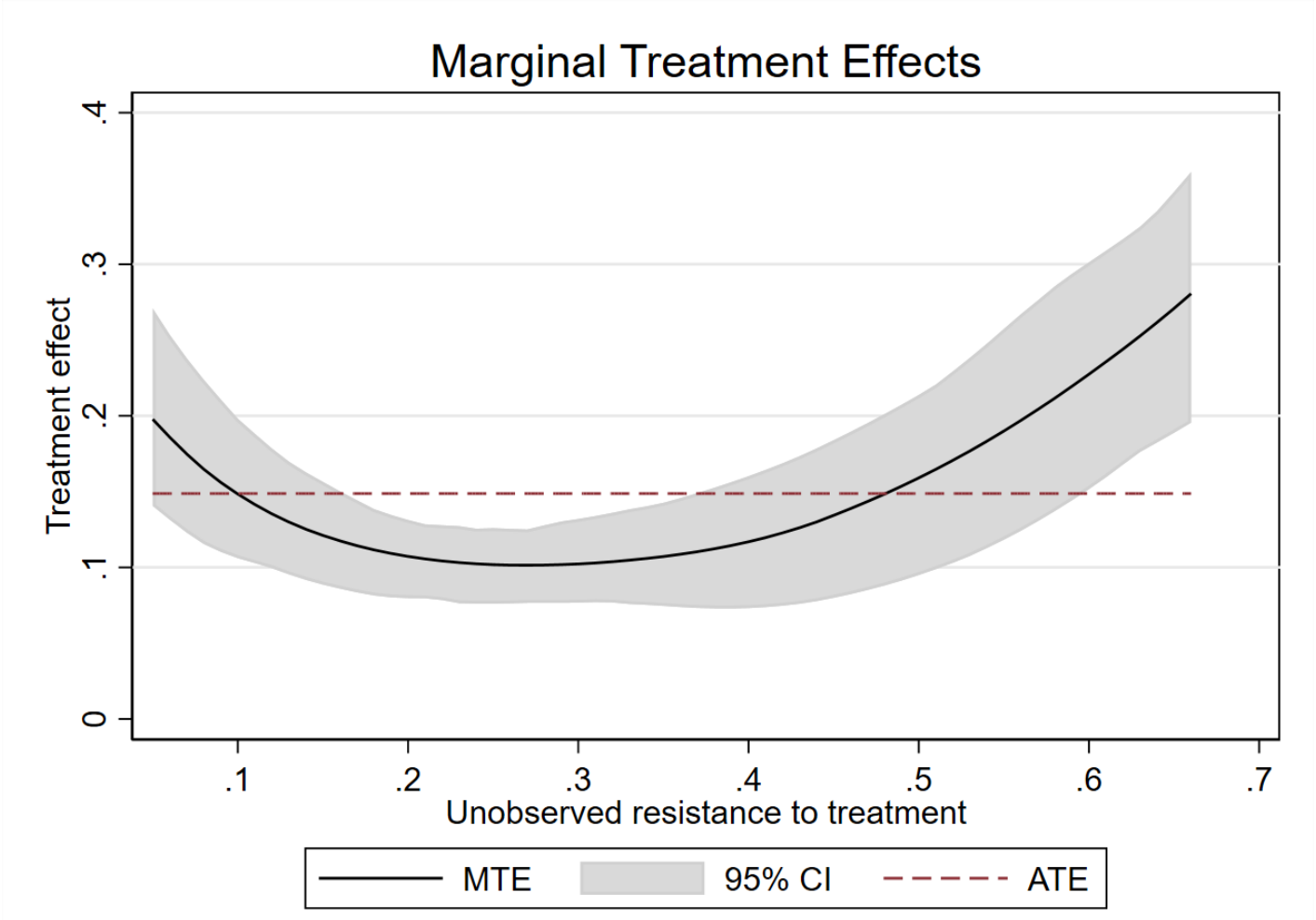


# Heterogeneous effects: Insurance benefits do not increase with size

| | EBITDA with insurance subsidies | | EBIDTA without insurance subsidies | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Dummy for crop insurance status (1=insured) | 2.093*** | -0.296** | 1.715*** | -0.143 |
| | (0.397) | (0.129) | (0.329) | (0.097) |
| Insurance status X Surface | -0.199*** | 0.030** | -0.163*** | 0.015 |
| | (0.039) | (0.013) | (0.032) | (0.010) |
| Surface (log) | 0.153*** | -0.014*** | 0.142*** | -0.007** |
| | (0.014) | (0.004) | (0.012) | (0.003) |
| Observations | 69790 | 69790 | 69006 | 69006 |
| Weak Ident. | 26.376 | 26.376 | 30.783 | 30.783 |
| Hansen J | 0.000 | 0.000 | 0.000 | 0.000 |
| Farmer FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes |
| Instrument | Yes | Yes | Yes | Yes |

Table: Interaction results : The benefits of insurance

# MTE: Highly heterogeneous effects on the unobservables (Mean)




Left: "good" managers / Mid.: risk averse managers / Right: "bad" managers

# Policy design

20% increase in the insurance subsidy budget

| | Mean | SD |
|---|---|---|
| Average subsidy per insured farmer (baseline) | 646 | 1624 |
| Average subsidy per insured farmer (20% increase) | 721 | 1949 |
| Uptake rate (baseline) | 0.27 | 0.45 |
| Uptake rate (20% increase) | 0.29 | 0.16 |

Table: Parameters of the counterfactual policy

# PRTE results: Increasing insurance subsidies seems inefficient

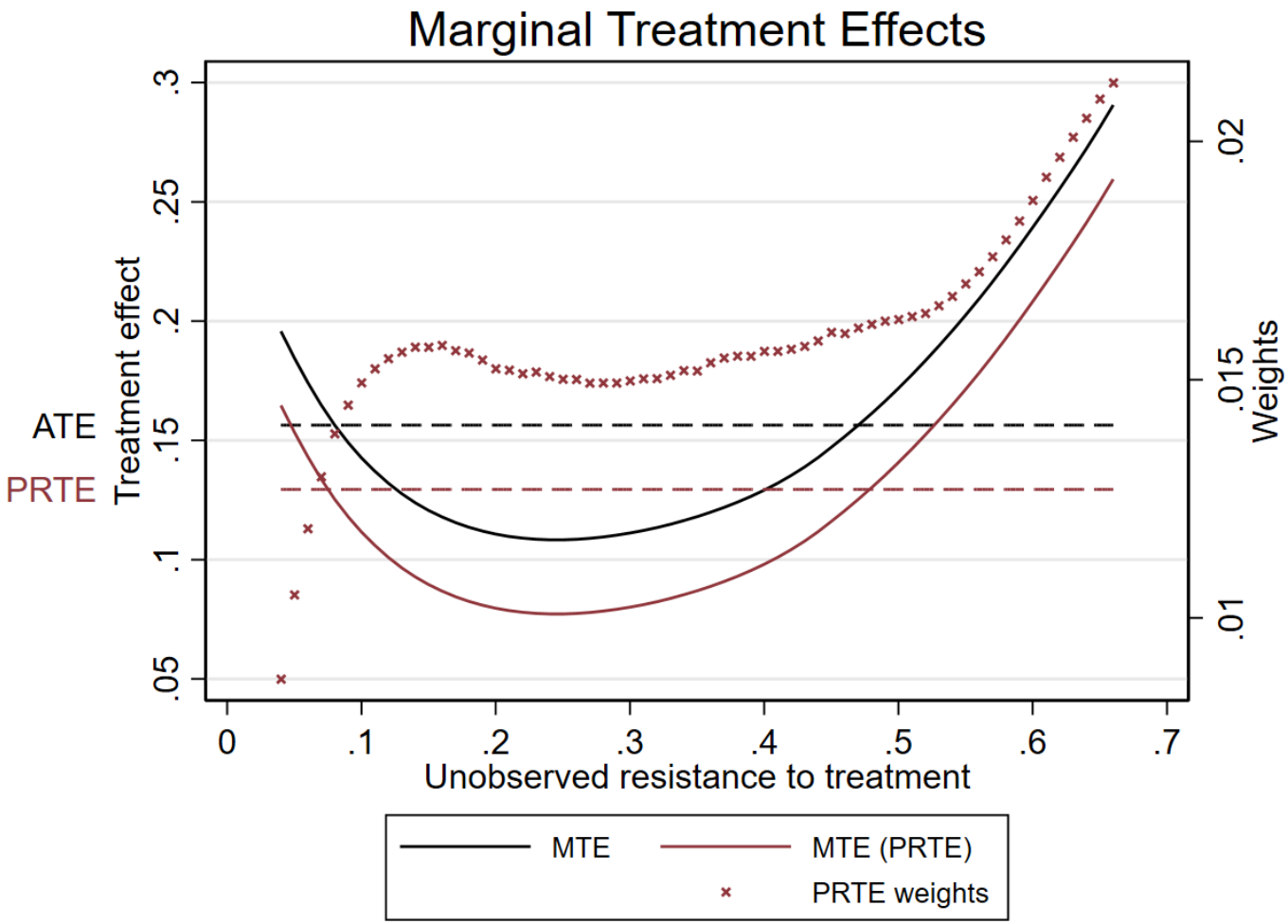



Figure: PRTE Results for a 20% increase in insurance subsidies

# Numbers

- Effects scaled down to our sample of 17,000 farmers
- Numbers
  - Cost for the Government: An additional 4.6 M Euros
  - 305 new contracts
  - Welfare increase of 3.3 M Euros (+13%)
- **Multiply by about 24** to get the estimated costs over the actual population
  - Cost 110 M Euros
  - 7,320 new contracts
  - Welfare increase of 81 M Euros.
- Total welfare impact negative
  (assuming that indemnities are just transfers)

# MPRTE results:

Targeting the propensity score directly appears to be the way to go

| | (1) EBITDA net of insurance subsidies (log) | (2) Variance |
|---|---|---|
| effects | | |
| ate | 0.149*** | 0.018 |
| att | 0.132*** | 0.014 |
| atut | 0.158*** | 0.026 |
| late | 0.079*** | 0.009 |
| mprte1 | 0.159*** | 0.001 |
| mprte2 | 0.135*** | 0.002 |
| mprte3 | 0.156*** | 0.022 |
| Observations | 100329 | 70213 |

Table: MPRTE estimators (semiparametric)

## Conclusions

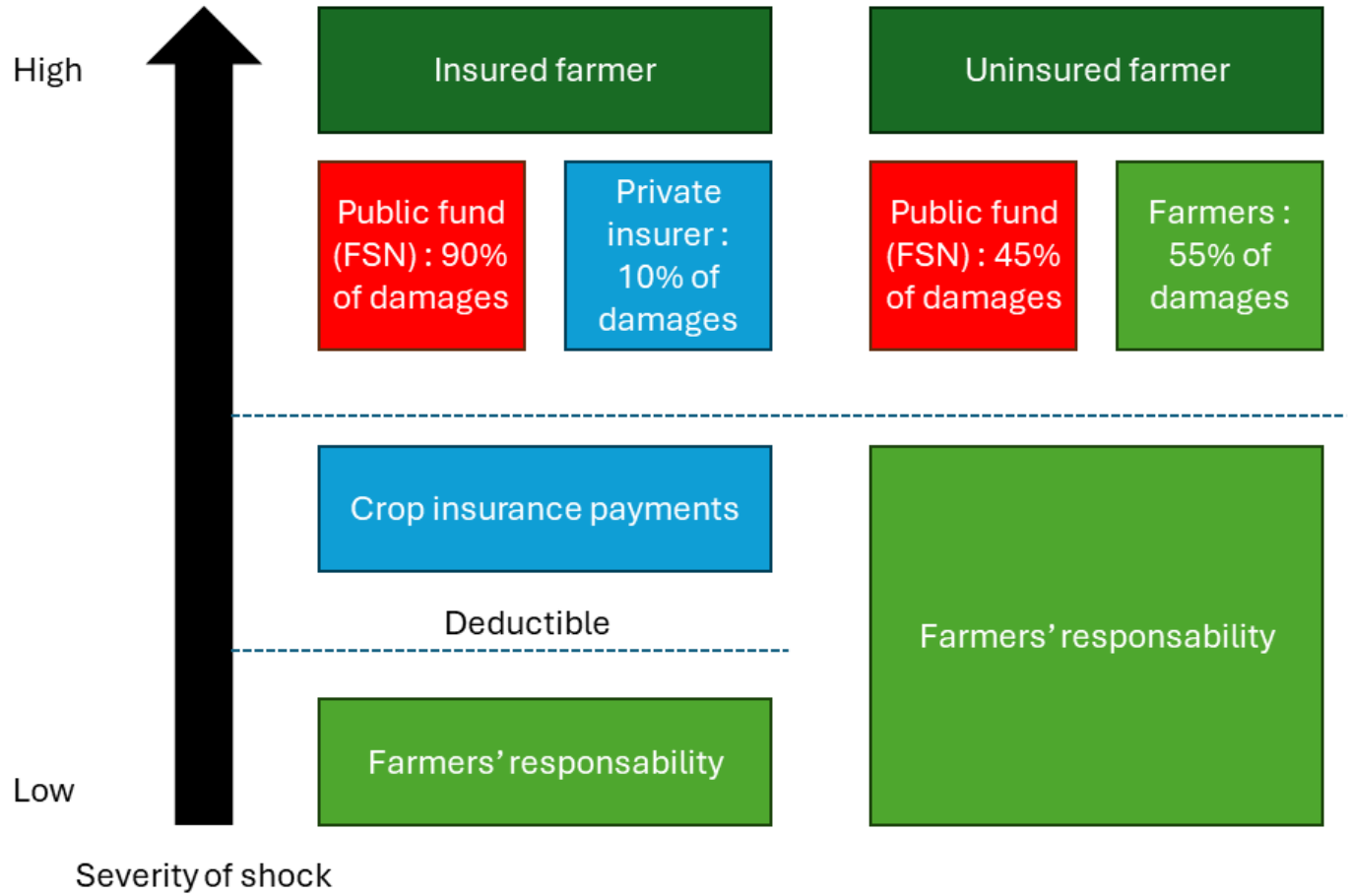
- Crop insurance benefits most farmers in terms of average revenues
- Impacts of insurance globally positive (shielding behavior)
- Farmers who would benefit the most from insurance are the ones who are insured the least

## Policies

- Need to better aim insurance subsidies at smaller farms, rather than a flat increase over the distribution
- Timing of subsidies payment to reduce financial barriers
- Better information is needed to encourage insurance
- The 2023 reform is a good start for simplification but subsidies are strongly increased and still not differentiated by size/turnover

# Thank you for your attention!

# Presentation of the 2023 reform



# Theoretical intuitions (model not presented)

- **Mean:** a necessary condition for the revenue net of subsidies $\mathbb{E}R_{\text{NS}}$ to increase with coverage is that farmers exhibit shielding behavior
- If $\mathbb{E}R_{\text{NS}}$ increases with respect to coverage, at least of the the following conditions is true: (i) moral hazard is weak, (ii) farmers exhibit shielding behavior, (iii) insurance is underpriced
- **Variance:** in our results, shielding behavior and moral hazard (for different crops or strategies) appear to be compensating each other

# Impacts of insurance on revenue and yields

Following Antle 1983, Di Falco 2014 and Wang et al. 2021, we use the parametric moments-based approach

$$R_{it} = \alpha + \beta_1 D_{it} + \beta_2 \boldsymbol{X_{it}} + \beta_3 \boldsymbol{\Lambda_{it}} + \beta_4 \boldsymbol{\Lambda_{it-1}} + \theta_i + \theta_t + \epsilon_{it}$$
$$\epsilon_{it}^2 = \alpha' + \beta_{12} D_{it} + \beta_{22} \boldsymbol{X_{it}} + \beta_{32} \boldsymbol{\Lambda_{it}} + \beta_{42} \boldsymbol{\Lambda_{it-1}} + \theta_i' + \theta_t' + \epsilon_{it}' \quad (1)$$

With $R_{it}$ the revenue variable, $D_{it}$ the decision to insure (binary), $\boldsymbol{X_{it}}$ the vector of individual characteristics, $\boldsymbol{\Lambda_{it}}$ the vector of climate variables. All variables except dummies are expressed in log

# OLS results

| | EBITDA with insurance subsidies | | EBITDA without insurance subsidies | |
|---|---|---|---|---|
| | (1) Mean | (2) Variance | (3) Mean | (4) Variance |
| Dummy for crop insurance status (1=insured) | 0.004*** | -0.000 | 0.003** | 0.000 |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Observations | 71524 | 71524 | 70750 | 70750 |
| $\rho$ | 1 | 0 | 1 | 0 |
| Farmer FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes |

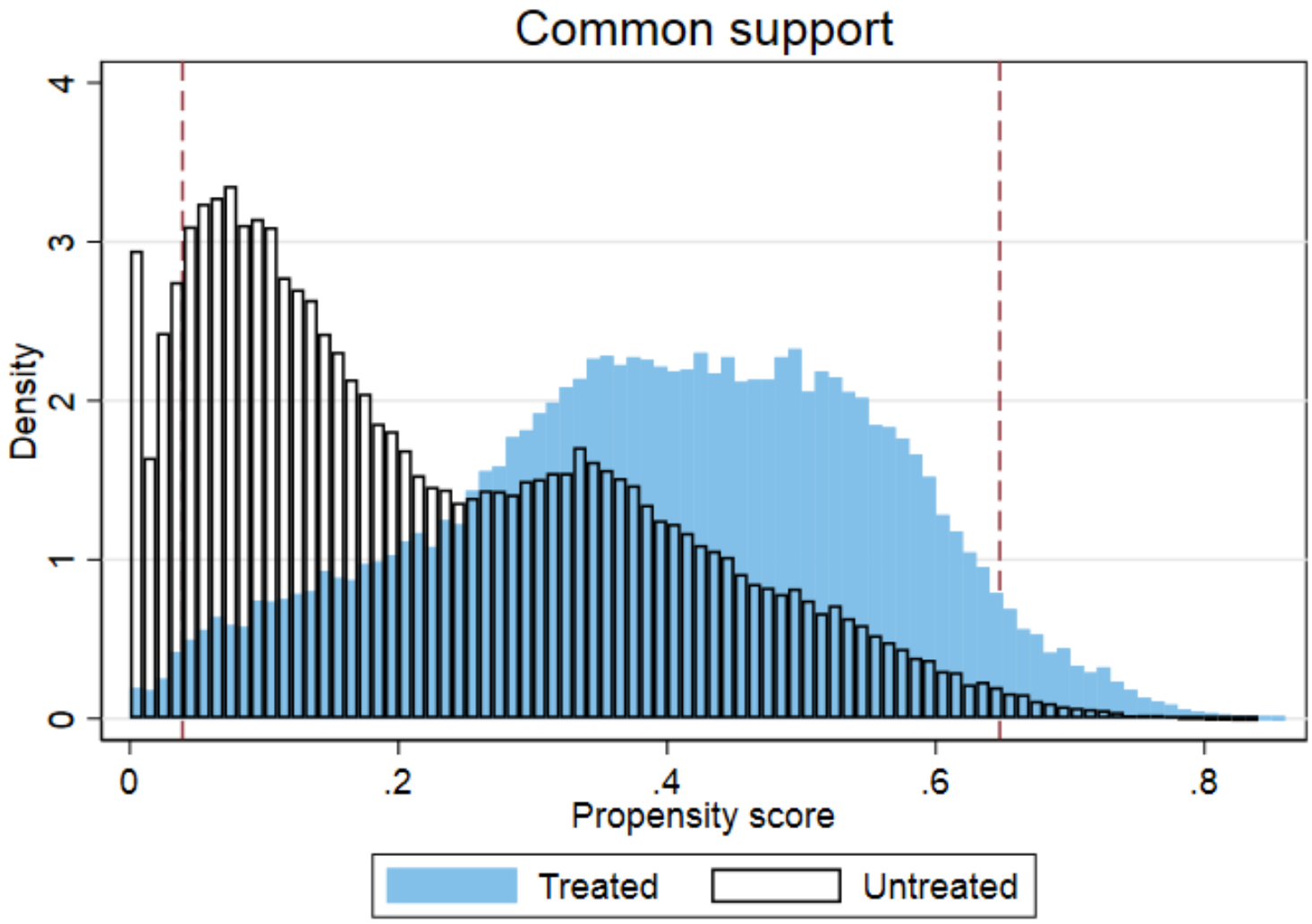
Table: OLS log estimations for the impact of insurance on the revenue distribution

# Continuous effects

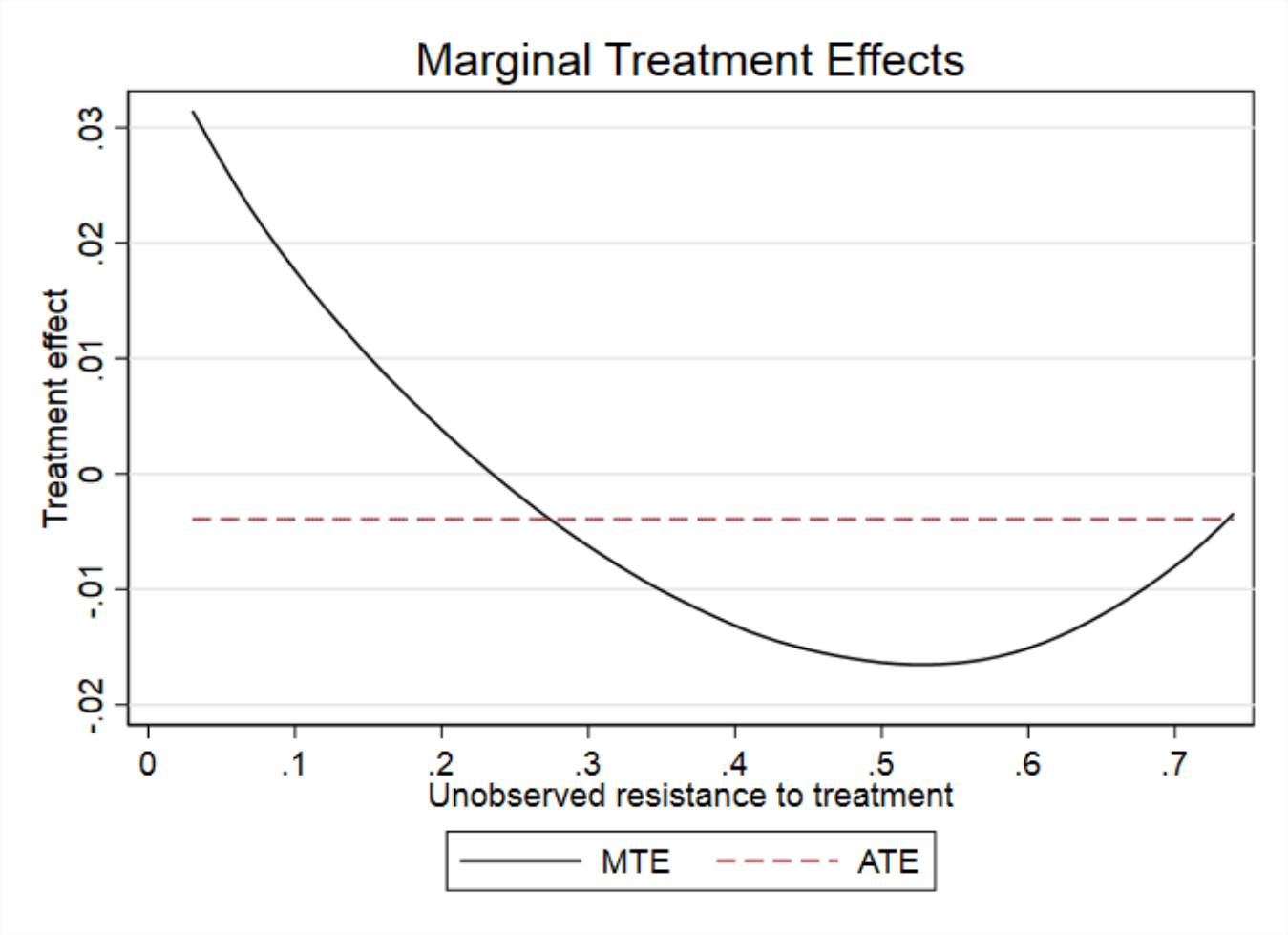
| | EBITDA with insurance subsidies | | EBITDA without insurance subsidies | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Insurance spending (log) | 0.046*** | -0.003 | 0.039*** | -0.001 |
| | (0.007) | (0.002) | (0.006) | (0.002) |
| Observations | 69790 | 69790 | 69006 | 69006 |
| Weak Ident. | 72.028 | 72.028 | 77.879 | 77.879 |
| Hansen J | 0.000 | 0.000 | 0.000 | 0.000 |
| Farmer FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes |
| Instrument | Yes | Yes | Yes | Yes |

Table: IV estimations for the impact of insurance on the revenue distribution

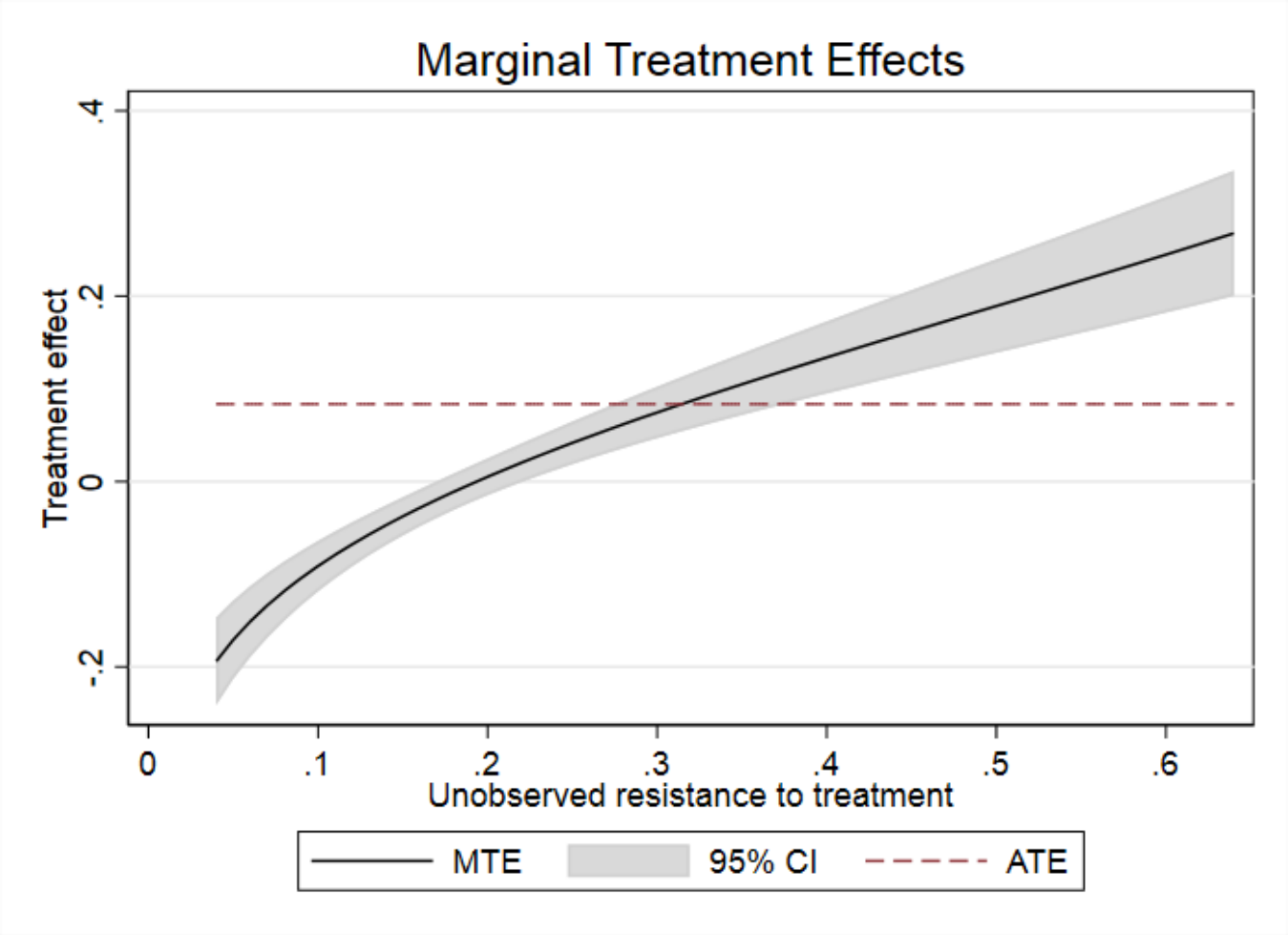
# MTE common support



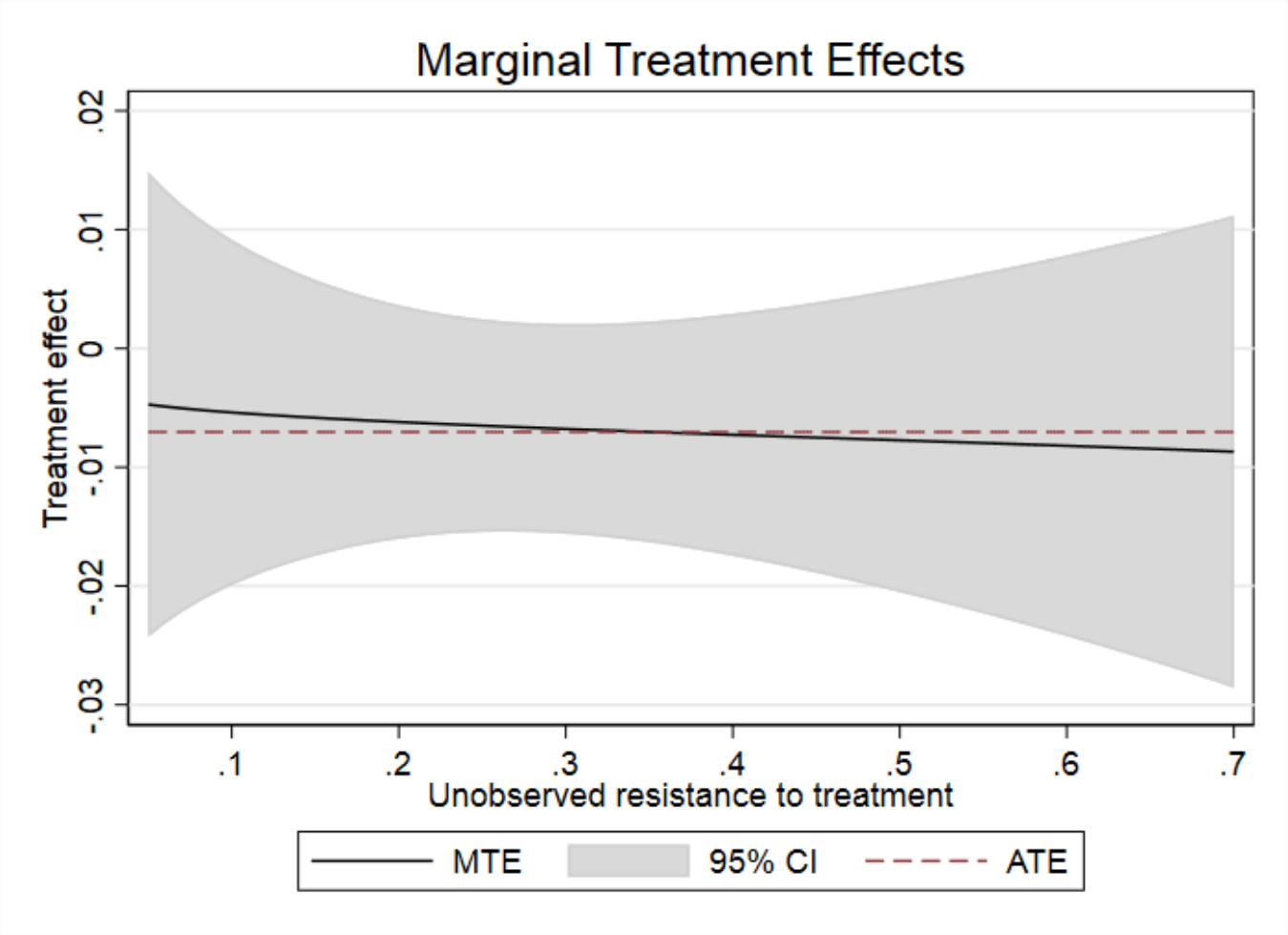
# MTE: Highly heterogeneous effects on the unobservables (Variance)



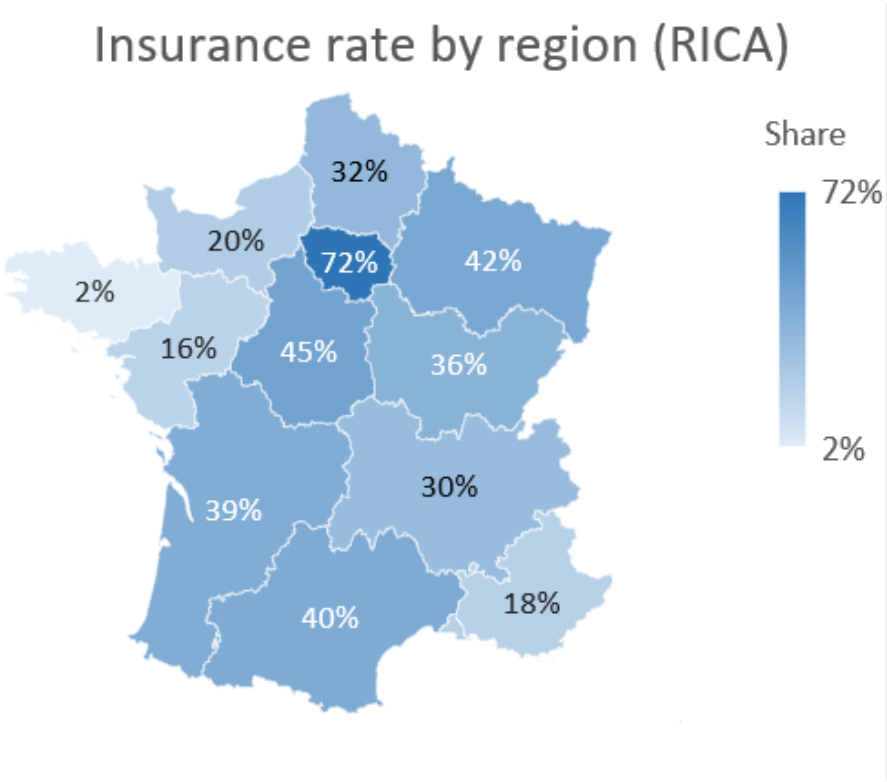
# MTE mean results (parametric)

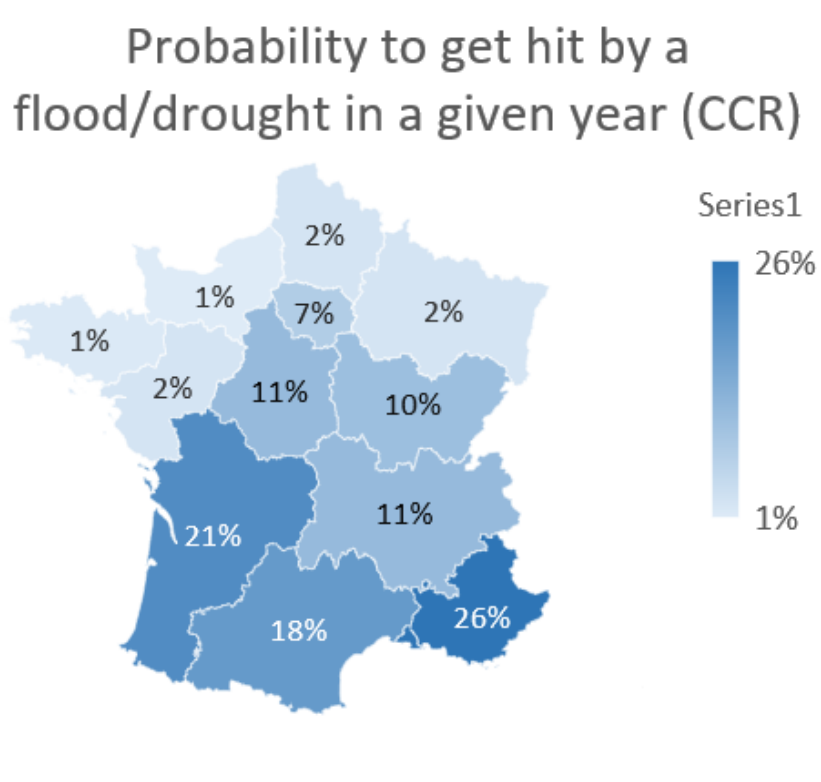


# MTE variance results (parametric)



# No correlation between risk and uptake



# Summary statistics (1/2)

| | Mean | SD | Q1 | Q2 | Q3 | Min | Max | Count |
|---|---|---|---|---|---|---|---|---|
| Dummy for crop insurance status (1=insured) | 0.27 | 0.44 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 123700 |
| Insurance spending per Ha (EUR/Ha) | 24.22 | 55.91 | 0.00 | 2.32 | 22.81 | 0.00 | 450.00 | 123700 |
| EBITDA with insurance subsidies (KEUR) | 85.70 | 87.45 | 35.93 | 64.18 | 110.31 | -504.04 | 3755.93 | 123700 |
| EBITDA net of insurance subsidies (KEUR) | 85.70 | 86.94 | 36.08 | 64.29 | 110.32 | -504.04 | 3755.93 | 122039 |
| Subsidy rate (year, culture) | 8.40 | 9.38 | 0.00 | 6.34 | 15.51 | 0.00 | 46.58 | 123575 |
| Sum of cold GDDs across the year (°C) | 49.50 | 50.78 | 15.20 | 33.38 | 65.54 | 1.00 | 582.41 | 119940 |
| Sum of hot GDDs across the year (°C) | 1.06 | 0.46 | 1.00 | 1.00 | 1.00 | 1.00 | 63.79 | 119940 |
| Number of floods/year | 0.07 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 6.00 | 123700 |
| Number of droughts/year | 0.09 | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 4.00 | 123700 |

Table: Summary statistics for the main variables

# Summary statistics (2/2)

| | Mean | SD | Q1 | Q2 | Q3 | Min | Max | Count |
|---|---|---|---|---|---|---|---|---|
| Number of workers (full-time equivalent) | 3922.07 | 4262.48 | 1600.00 | 3200.00 | 4600.00 | 45.00 | 216158.00 | 123700 |
| Used agricultural surface (Ha) | 104.21 | 81.40 | 46.20 | 85.42 | 141.50 | 0.32 | 795.49 | 123700 |
| Diversification index (1=Not diversified) | 0.48 | 0.28 | 0.25 | 0.46 | 0.67 | 0.00 | 1.00 | 123700 |
| Subsidies received (EUR) | 36949.61 | 30564.74 | 15750.69 | 30834.21 | 50784.93 | 0.00 | 1106312.00 | 123700 |
| Cattle dummy | 0.39 | 0.49 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 123353 |
| Greenhouse dummy | 0.02 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 123700 |
| Organic agriculture dummy (1= at least partial) | 0.03 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 123700 |
| Real costs for gas/oil (EUR) | 6744.66 | 6592.25 | 2519.90 | 4890.05 | 8835.00 | 0.00 | 172891.27 | 123700 |
| Real costs for pesticides/Fertilizers (EUR) | 12312.19 | 14809.97 | 2693.80 | 7426.96 | 16614.63 | 0.00 | 311599.00 | 123700 |
| Agrotourism revenues | 77.58 | 1292.50 | 0.00 | 0.00 | 0.00 | 0.00 | 147940.00 | 123700 |
| Debt | 210971.94 | 278329.85 | 60692.84 | 135906.95 | 266040.00 | 0.00 | 12118604.00 | 123700 |
| Rent | 15217.83 | 16619.09 | 4852.00 | 10926.00 | 20064.63 | 0.00 | 654873.00 | 123700 |
| Main activity : Cereals | 0.50 | 0.50 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 123700 |
| Main activity : Wine | 0.12 | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 123700 |
| Main activity : Mixed | 0.32 | 0.47 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 123700 |
| Main activity : Fruits and vegetables | 0.06 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 123700 |

Table: Summary statistics for the control variables