Extreme Weather Events in Wine Grape Production: an Economic Assessment of Mitigation Measures at Farm Level

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Introduction

• Climate Change is expected to increase extreme weather events in Germany

• Main extreme weather events in wine grape production:
  – Hail storm
  – Late frost
  – Drought

• Hail storms:
  – Cause severe damages
  – Spatially very restricted
  – Cannot be predicted

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Introduction

• Late frosts:
  – Impact vines when flowering
  – May cause severe damages in affected areas
  – Two different developments:
    ▪ in traditional flowering periods temperatures increase → lower late frost danger
    ▪ due to increasing average temperatures flowering starts earlier → increased late frost occurrence
    ▪ combined effect still unknown

• Drought:
  – Relevant throughout whole growing period
  – May lead to reduced growth and yield losses
Introduction

• Effects of higher frequencies of extreme weather events on farm level:
  – Increased production risk due to potential crop losses
  – Costs of implementing mitigation measures

• Problem: lack of data
  – Probabilities of occurrence of extreme weather events, hail storms in particular: forward-looking and retrospective
  – Extend of short, medium and long term damages caused by extreme weather events
Objective of study

Identification of efficient mitigation measures to cope with increasing frequencies of extreme weather events
Methodology

• Data sources:
  – Regional statistics
  – Expert knowledge of viticulture advisors
  – Focus groups of wine growers
  – Expert interviews to estimate probabilities of
    ▪ occurrence of extreme weather events
    ▪ potential damages due to extreme weather events

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Methodology

• Typical farm:
  – Hypothetical – but close to reality - whole farm model representing a vineyard of a selected region: buildings, machinery, labor, production inputs
  – Reflects regionally prevailing production system by modeling the different operations specified by the corresponding combination of labor, machinery and production inputs
  – Covers a complete set of price and quantity data, thus allowing a magnitude of economic analyses, e.g. costs of production, gross margins, productivities

• Typical vineyards were established for Franconia (Franken, FR) and Rheinhessen (RH)
Methodology

Three stage analysis for year 2013:

1. Comparison of the production system in 2013 with the hypothetical situation in 2013 including one of the extreme weather events (before and after analysis based on gross margins)

2. Comparison of the hypothetical production system in 2013 with extreme weather to a scenario, where the mitigation measures were implemented (with and without analysis based on gross margins)

3. Calculation of the net present values of the gross margins of the different scenarios over a period of thirty years taking into account the assumed probabilities of the occurrence of the extreme weather events (discount rate 3.5 %)
Results

• Typical vineyard for Rheinhessen:
  – Size: 30 ha, family managed, bulk wine
  – Main grape varieties: Müller Thurgau, Riesling, Dornfelder
  – Labor: 162 h/ha
  – Gross margin: 6,596 €/ha

• Typical vineyard for Franconia:
  – Size: 10 ha, family managed, bottled wine
  – Main grape varieties: Müller Thurgau, Silvaner, Bacchus
  – Labor: 460 h/ha
  – Gross margin: 9,964 €/ha
Results

• New production system: minimum pruning trellising system (MP; hail and late frost mitigation, only in Rheinhessen, 30 % of vineyard)

• Extreme weather scenarios:
  – Hail: 1. total loss on 50 % of vineyard every 15 years (2x in 30 years)
    2. total loss on 10 % of vineyard every 3 years (10x)
  – Late frost: 1. total loss on 15 % (RH) and 40 % (FR) of vineyard every 5 years (6x)
    2. 30 % (RH) and 40 % (FR) loss on 15 % of vineyard every 5 years (6x)
  – Drought is not analyzed as irrigation water is not available or access to water prohibited in most areas
Results

• Mitigation measures:
  – Hail: 1. Hail insurance (premium: 3 % of sum insured; only available if whole vineyard is insured)
    2. MP (RH only, 30 % of vineyard)
  – Late frost: 1. Wind machines
    2. MP (RH only, 30 % of vineyard)
    3. Frost protecting candles (FR)
## Results Rheinhessen (Bulk Wine, 30 ha)

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- Introduction of MP increases gross margin
- Hail insurance is effective in both hail scenarios
- ... so is MP
- Investment in wind machines is profitable only in the more severe late frost scenario
- Focusing on gross margins only can be misleading: in hail scenario 2 the hail insurance is not efficient
## Results Franconia (Bottled Wine, 10 ha)

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<td>111.9</td>
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</tr>
</tbody>
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- Hail insurance is profitable only in the heavier hail scenario 2
- Against late frost the efficient measure is an investment in wind machines
Conclusions

• Hail insurance is advisable in areas prone to higher probabilities of hail storms and in particular for risk averse decision makers

• Hail insurance has a liquidity saving effect (not subject to our analysis)

• Against hail storms and late frost minimal pruning is potentially beneficial for bulk wine producers and for grape growers

• Investments in wind machines are meaningful to counteract late frost in suitable, i.e. flat and coherent, production areas (high investments; cooperation with neighbors could be useful)

• Frost protecting candles can be suitable as an emergency measure in small plots and steep slopes (high labor demand)
Conclusions

• The selection of mitigation measures should be grounded on a rational decision basis, i.e. on a comparison of different alternatives over time (net present value)

• Nature and extend of risk management differs individually: framework conditions, risk attitude etc.

• Accurate data is missing for more precise analyses:
  – Frequencies of extreme weather events
  – Impact of such weather events on wine grapes
  – Effects of mitigation measures
Thank you!

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