OECD-FLAN

Measurement of Resilience using Farm-Level Data -

Impact of Flood and Drought Shocks on UK Crop Farms‘ Resilience

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content

I. intro - the overall project, static indicators

II. dynamic analysis of shocks

- impact of flood events on UK crop farms' resilience
- impact of drought events on UK crop farms' resilience
- resilience groups' analysis

III. outlook - future work

I - the project „characterising and measuring farm and sector resilience”

- 1st step - i.e. **static** analysis of preparedness at **farm** level - indicators for resilience capacities are measured using various statistical proxies

- 2nd step - i.e. **dynamic** analysis at **farm** level - matched samples of crop farms that have experienced flood/drought shocks (“shock treatments”) and crop farms without this experience will be formed; indicators are analysed over time by means of robust statistical techniques to identify and measure effects of flood/drought shocks on farms resilience capacities

- 3rd step - i.e. **dynamic** analysis at **sector** level - Markov shares for major resilience indicators are calculated and analysed in their dynamics for farm group with flood/drought shock experience and farm group without such experience

- 4th step - i.e. **composite** analysis - a **resilience index** based on various indicators and weights using robust analysis (e.g. principal component analysis, latent class regression); trade-offs or synergies with other indeces (as e.g. productivity and/or sustainbaility related indices) are explored

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I - static analysis | selection of indicators

Indicator	Targeted Capacity/(ies)	Target Scale	Data
diversification / herfindahl index (on-farm sources)	absorption	farm / sector	financial farm accounts
off-farm income	absorption	farm / sector	financial farm accounts
assets (productive assets)	absorption	farm / sector	financial farm accounts
equity/debt ratio	absorption	farm / sector	financial farm accounts
contracts	transformation	farm/ sector	specific survey
net investment	absorption	farm / sector	survey
scale economies	absorption / adaptation	farm / sector	OECD phase I
productivity level	absorption	farm / sector	OECD phase I
technical change	absorption / adaptation	farm / sector	OECD phase I
performance switch	absorption / adaptation	farm / sector	OECD phase II

OECD „performance project“

II - dynamic analysis | extreme events | general

- external **disturbances/shocks are likely to impact resilience** related capacities of farms
- academic literature on resilience is based in the socio-ecological and climate change related areas and robust links to management and economics based research are rare
- in many cases a robust and state-of-the-art **counterfactual approach is missing**
- depending on target sources for risk (droughts, floods etc.) traditional counterfactual approach not possible if large areas/whole states are affected….

  but: **certain extreme events only hit parts of a country/region**, allowing for a comparison of **affected** (‘treated’) and **non-affected** (‘control’) farms

II - dynamic analysis | extreme events | general

- in the second stage we aim to empirically investigate if and how **crop farms in the UK** have responded to extreme natural events during the time period considered
- matched samples of farms that have experienced adverse events and farms without this flood/drought shock experience are designed, i.e. **a farm group with and a farm group without**
- resilience related impacts are estimated based on the dynamics of farm adjustment after these shocks **analysing indicators before and after the external shock** event and contrasting them with the farm dynamics without this shock experiences
- Markov type transition matrices will be also presented for these resilience indicators and are analysed in their dynamics for matched crop farm samples

II - dynamic analysis | extreme events | UK | background

- we focus on **climatic hazards in the UK** (regional **flood events** in the years 2007, 2009 and 2012; **droughts** between 2010 and 2012) and measure their impact on farm and sector performance using resilience indicators

- we apply Propensity Score Matching (PSM) in combination with Difference-in-Difference (DID) techniques (in the case of flood events) and Time Series as well as Panel Regression Techniques (in the case of drought events)

- **flood events** in the UK in 2007, 2009 and 2012: e.g. the 2007 UK floods affected parts of central and northern England, northern Scotland and big parts of Northern Ireland in summer 2007

- **droughts** are climatic events that affect the whole geographical entity: the UK droughts between 2010 and 2012 are such events, they affected all crop farms almost equally

II - dynamic analysis | UK | floods | methods

www.gov.uk

- **overview flood events analysis**
  - **propensity-score-matching** → treatment and control group of crop farms
    - logistic regression
    - matching algorithm
  - **difference-in-difference regression** → impact of flood shock event
    - resilience indicators as outcome indicator
    - control group are non-affected crop farms
  - **weighted aggregation of treatments** → impact over different flood events

II - dynamic analysis | UK | floods | results

→ flood events impacts on UK crop farms resilience indicators

	2007		2009		2012		Pooled	
Indicator	**Effect**	**Sign.**	**Effect**	**Sign.**	**Effect**	**Sign.**	**Effect**	**Sign.**
Productivity	-	n.s.	+	n.s.	+	n.s.	+	n.s.
Technical Change	0	n.s.	0	n.s.	0	n.s.	0	n.s.
Scale Elasticity	-	n.s.	-	n.s.	0	n.s.	-	n.s.
Sustainability	0	n.s.	0	n.s.	+	n.s.	0	n.s.
Equity/Debt Ratio	**+**	**	0	n.s.	0	n.s.	0	n.s.
Assets	0	n.s.	0	n.s.	0	n.s.	0	n.s.
Technology	0	n.s.	0	n.s.	0	n.s.	0	n.s.
Diversity	0	n.s.	-	n.s.	+	n.s.	0	n.s.
Innovation	0	n.s.	0	n.s.	+	n.s.	0	n.s.

II - dynamic analysis | UK | floods | results

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- floods in the UK in the years 2007, 2009 and 2012 do not seem to influence farm-level performance indicators
- resilience indicators do not show signs of adaptation behavior, except for *equity_debt_ratio* in 2007, which might point towards investments
- counterfactual analysis can be applied to study resilience of farms if extreme events do not hit all farms equally
- detailed (GIS) data on level of being affected by extreme events might improve analyses
- compared to floods, droughts can be expected to stronger impact resilience of farms …

II - dynamic analysis | UK | droughts | methods

www.theguardian.com

- **overview drought events analysis**
  - **Wald test** → structural breaks in resilience indicators for crop farms
    - resilience indicators
    - control variables
  - **weighted aggregation at sector level** → structural breaks at sector level
  - **time series and panel regressions** → estimated drought effects
    - autoregressive distributed lags estimation
    - panel fixed-effects estimation

II - dynamic analysis | UK | droughts | results

→ drought events impacts on UK crop farms' resilience indicators

2010-2012

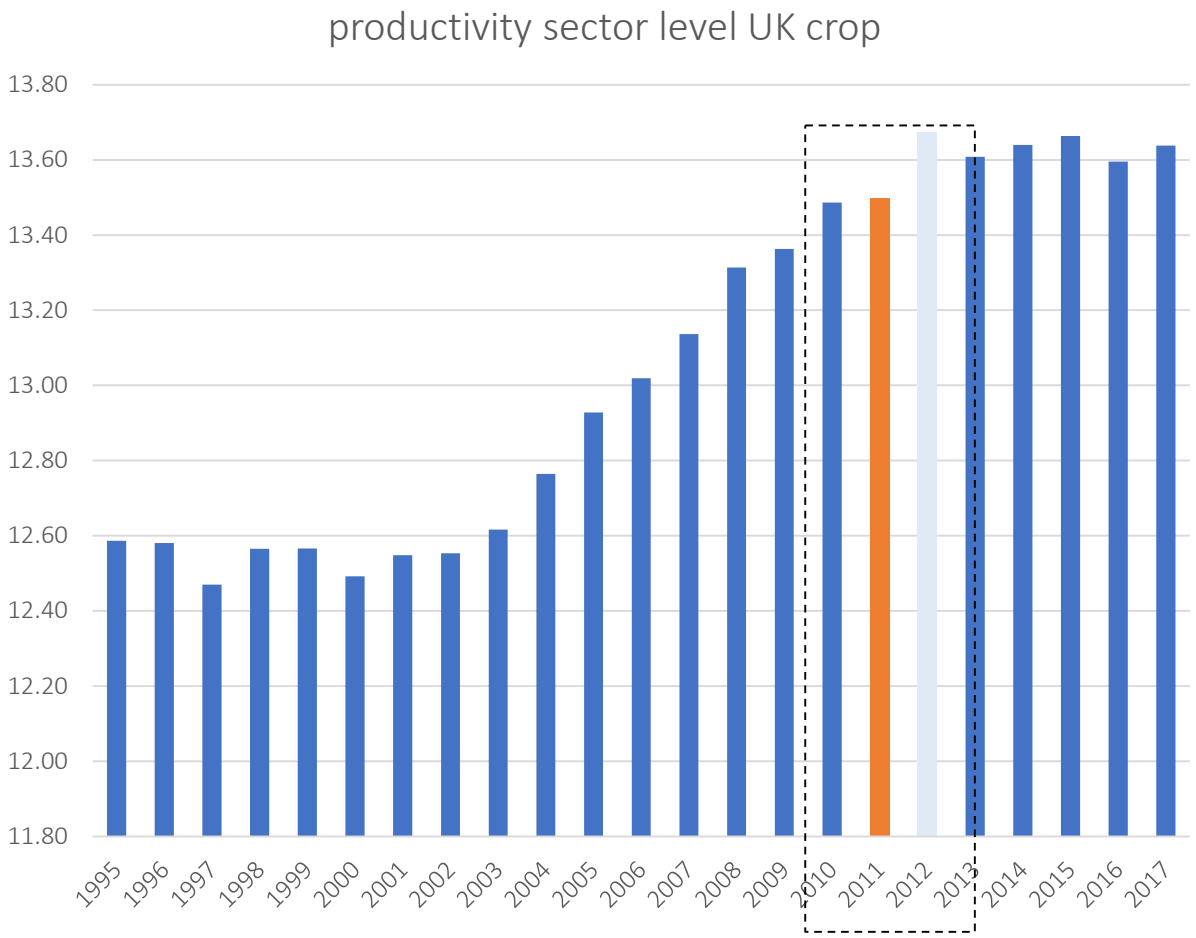
	Panel Fixed Effects Model		ARDL Model	
Variable	**Effect**	**Sign.**	**Effect**	**Sign.**
Productivity	+	***	+	n.s.
Sustainability	-	***	+	n.s.
Technology	+	***	+	n.s.
Diversity	+	***	-	n.s.
Innovation	+	***	+	***
Net investment	+	***	+	**
Assets	+	***	+	n.s.
Equity/debt ratio	-	n.s.	-	*
Scale elasticity	+	***	+	n.s.

II - dynamic analysis | UK | droughts | results

www.theguardian.com

- both models (ARDL | PFE) indicate that farms and the agricultural sector as a whole **increase productivity growth after a drought disturbance** (positive, and for the panel model also significant, coefficient for the drought dummy variable)
- this productivity increase was **driven by innovation behaviour and investments in technology** (positive coefficients for the indices ‘innovation’ and ‘technology’)
- panel model results also point towards **farms diversifying their businesses after droughts**
- this development as well as productivity growth seems to come at the cost of environmental degradation as the coefficient of the ‘sustainability’ index shows

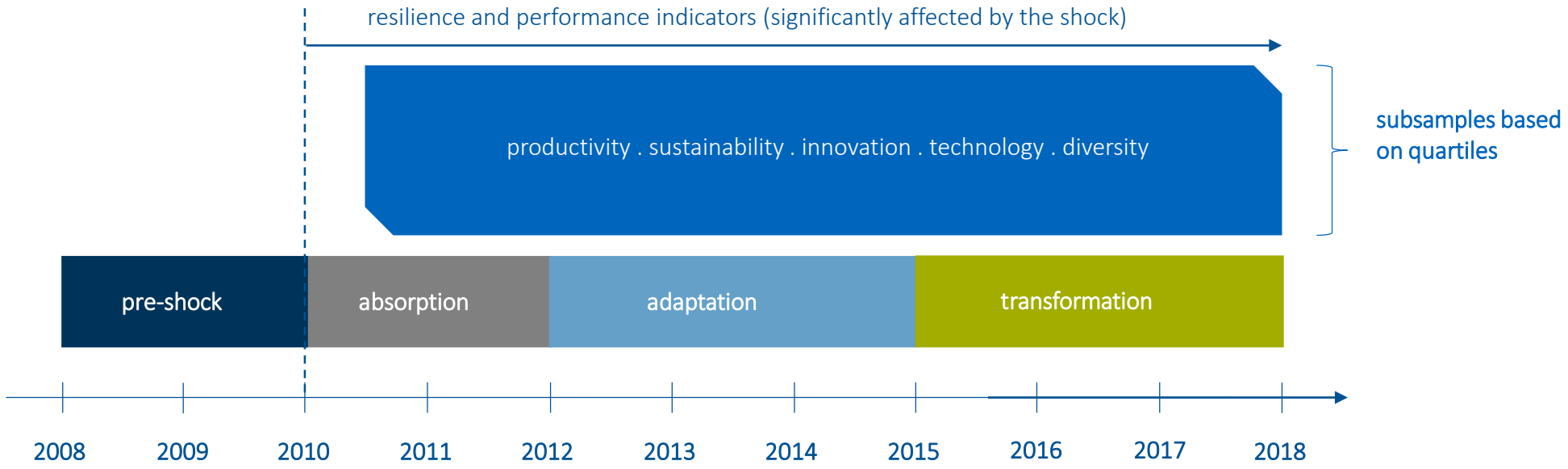
II - dynamic analysis | UK | droughts | results



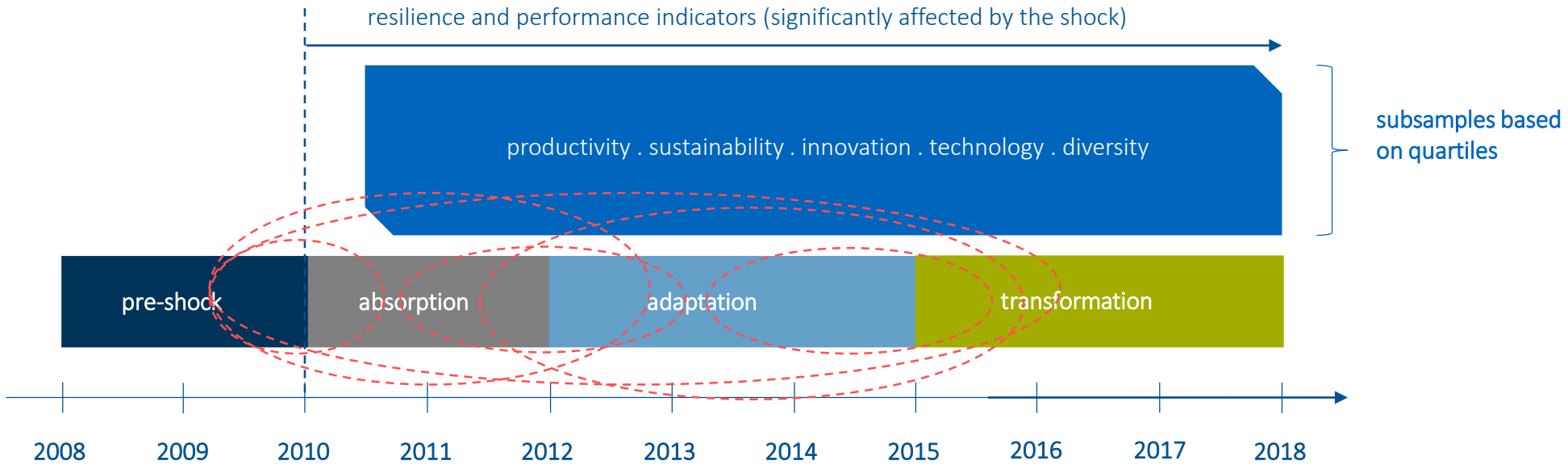
- sector-level development of productivity
- growth seems to stagnate in the second drought year 2011, which was characterised by an exceptionally dry spring that had adverse effects on agricultural production
- in 2012, a sharp productivity increase can be observed
- increase might be linked to that year's precipitation pattern, which saw normal rainfall after dry months from January to March
- ! but also linked to farmers **absorping/adapting/transforming in response** to changing agronomic conditions

- subsequently we have a closer look on resilience related farm behaviour after experiencing a drought shock event
- we distinguish different **resilience phases** with respect to crop farms
- specific research questions of policy interest:
  - *„what are characteristics of successful absorbers, successful adapters and successful transformers?“*
  - *„which static resilience indicators can be used to identify such farms?“*
  - *„what can be done to increase the probability of effective absorbtion, effective adaptation and effective transformation?“*

II - dynamic analysis | UK | droughts | follow-up analysis



II - dynamic analysis | UK | droughts | follow-up analysis



II - dynamic analysis | UK | droughts | follow-up analysis

- what drives the probability of successful **absorption**?

  → focus on resilience indicator „productivity“ - change from pre-shock to absorption phase

  drivers: net investment, farm size, less intensive pesticide use, younger farmers..

- what drives the probability of successful **adaptation**?

  → focus on resilience indicator „productivity“ - changes up to adaptation phase

  drivers: net investment, technology, contracts, less subsidies but more targeted env subsidies, less intensive pesticide use, farm size not important..

- what drives the probability of successful **transformation**?

  → focus on resilience indicator „productivity“ - change up to transformation phase

  drivers: net investment, less subsidies but more targeted env subsidies, diversity, younger farmers, less intensive pesticide use..

- the larger the time lag between the pre-shock period and the resilience related period, the higher the correlation in productivity level
- the more time has passed after the shock the more important is the current productivity level for future resilience behaviour
- a certain degree of **path-dependency in resilience capacities** can be observed for UK crop farms (i.e. autoregressive explanatory power)

correlation matrix

	Prob_top_pre	Prob_top_abs	Prob_top_adapt	Prob_top_trans
Prob_top_pre	1.0000			
Prob_top_abs	0.3263	1.0000		
Prob_top_adapt	0.4630	0.6242	1.0000	
Prob_top_trans	0.5417	0.5990	0.7318	1.0000

II - summary

- significant changes can be identified with respect to farms' adaptation and absorption capacities after major drought events
- we find that crop farms tend to successfully increase their productivity as well as their technology investments (both might indicate significant recovery)
- crop farms in the UK also tend to increase their on-farm diversification activities after such major drought events
- net investment as main driver for successful absorption, adaptation and transformation behavior after shock experience
- others: less but more targeted subsidies, more sustainable production decisions, younger farmers seem more flexible, diversity of production (transformation)
- novel policy insights that should lead to more effective resilience policies and measures

III - outlook | future work

- we work on final refinement of resilience group related analyses
- we extend analysis to French and Italian crop farms
- we collaborate with EC Joint Research Center on sector level resilience indicators and analyses
- we prepare report and academic paper

Thank you.

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