IMPact Assessment of extreme climatic events on the Italian agriculture – incentivize Adaptation to ClimaTe change (IMP-ACT)

Background

In 2022 an unprecedented series of heat waves, combined with unusually dry conditions, have led to a long period of extreme condition with record temperature and drought in many parts of Europe. Italy has experienced the most severe drought in the last 70 years (Toreti et al., 2022) and it is forecasted that this shock will result in a yield drop by -11% for maize and -32% for rice, relative to the average 2017-2021(Baruth et al., 2022). Future trends are not reassuring: in Northern Italy the number of consecutive weeks of extreme drought is projected to increase from 2-12 weeks observed in the 1971-2000 period, to 5-30 weeks expected over the 2021-2050 (Baronetti, et al.,2022). Drought is just one of the several manifestations of a changing climate. Localised and rapid-onset climate extremes, such as flash floods, heatwaves, rainstorms and hail, are also dramatically increasing in their frequency and intensity: we are entering an era in which these events are considered as the 'new norm" (WHO, 2022; Fowler et al., 2021). Climate anomalies can severely alter the quality of the main agricultural inputs, land and water, affecting the biophysical process of plant growing and reducing yield (Deschênes & Greenstone, 2007; Ortiz-Bobea, 2021). Therefore, famers have tried to adapt to changing climate conditions by adopting a range of risk mitigation measures (Auffhammer & Schlenker, 2009). However, the abnormal intensification of climate extremes in recent years is likely to generate unexpected consequences for the agricultural and food systems, as climate impacts are highly non-linear (Schlenker & Roberts, 2009; Hultgren et al., 2022). Some evidence focused on the effects of changing conditions in agriculture is available from limited geographical areas (mostly developing countries) and focus on shocks of limited intensity and on a constrained range of outputs, mainly on productivity (Ray et al., 2019). Yet, with a climate that is "changing before our eyes", the impacts can be much larger and severely affect other socio-economic dimensions on which we have very limited knowledge. This implies that the current portfolio of farms' responses to adapt and mitigate risk, ranging from crop and labor diversification, defensive capital investments, insurance or mutual fund participation (Asfaw et al., 2018, Aragon et al., 2021; Santeramo, 2019), may be much less effective than they used to in past, leaving policy makers with little guidance. Recent studies are documenting how severe climatic shocks can threaten firms' resilience capacity, with impacts that can spill over into the labor market causing unemployment due to the job displacement of agricultural workers, mostly low-skilled, who cannot reallocate in other less-climate sensitive sectors (Albert et al., 2021; Colmer, 2021). Trade patterns can also be affected, as severe shocks can change the agricultural comparative advantages and threaten food security (Brenton et al., 2022).

Despite these contributions**, we know very little about how the disruptive impacts of a rapidly changing climate will affect farms and agricultural workers in advanced economies. As a contribution, IMP-ACT will address this gap by investigating the direct (firm) and indirect (labor market) effects of severe climatic shocks, and it will assess farms' interest in different adaptation and risk mitigation strategies in a modern agricultural system.**

We focus on Italy, an ideal case study for three reasons. First, due to its geographic features, Italy is the most exposed EU country to extreme climate variability, and it is already facing the consequences of a rapidly changing climate; therefore, Italy may represent a precursor with much to learn. Second,

the Italian agricultural sector is characterized by a limited input substitution as a large fraction of the production value comes from protected geographical indications, which mostly include products considered as national heritage (Curzi & Huysmans, 2022). Finally, the uptake of adaptation measures both capital and insurance, remains low and highly heterogenous across areas due to the presence of asymmetric information and frictions (Cerroni, 2020; Citino et al., 2022; Ramsey & Santeramo, 2017), which can be either complementary or substitute. There is limited empirical evidence on how these factors affect farms' decisions to adopt risk mitigations measures (Rippo & Cerroni, 2022). The unprecedented intensification of climate extremes makes farms' response much more uncertain and the few existing evidence less informative (Khan et al., 2021; Tol, 2021). The second contribution of IMP-ACT is, thus, to study farms' preferences for different portfolios of risk mitigation, by focusing on understanding the substitutability/complementarity of different options and the factors increasing/decreasing participation in a new climatic setting characterized by a larger uncertainty.

2. Detailed description of the project

IMP-ACT contributes to the state of the art by expanding our knowledge on the socio-economic effects of extreme climatic events on the Italian agricultural sector and its adaptation capacity through the assessment of alternative options available to farms. To reach this goal, the project builds on two pillars with distinct, but complementary, objectives and methodologies.

The main objective (O) of Pillar I, "Impacts", is: O1 – "empirical evaluation of the impacts of extreme climatic events on three important economic dimensions: farms' efficiency, their export performance, their capacity to survive and the effects on labor demand".

All these outcomes have been overlooked in the literature and there is scant evidence for high-income countries with modern agricultural systems: IMP-ACT aims at filling this gap. In particular, we will investigate the first and second dimensions in relation to PDO farms producing olive oil and wine. PDO farms have limited input substitution since their cultivation and production processes are subject to strict regulations but, at the same time, they contribute the most to the agricultural GDP in Italy and they are strongly exposed on the international market. For this important group of farms, we study how climatic shocks affect their technical efficiency (as opposed to their allocative efficiency), and their export capacity. We will also test the hypothesis that prolonged and more diffused climate extremes, such as the heatwaves and severe drought experienced during 2022, generate impacts that go well beyond the firm's dimension and affect the labor market. With these shocks, firms can face a temporary yield loss or even do not survive, and this may impact their labor demand; agricultural workers may thus be unemployed if they are not redeployed to other less climate-sensitive sectors. Considering that agricultural workers have a weak labor market attachment (being seasonal and low skilled), the existing frictions in the labour market can lead to a reallocation failure. The empirical analysis conducted under O1 will employ administrative data at the farm level and rely on state-of-the-art of empirical techniques to estimate causal effects by leveraging on "as-good-as-random variation" due to onset of climatic shocks.

The objective of Pillar II, "Action", is: O2 – "measuring Italian farms' preferences, and their determinants, for a mix of risk mitigation options in a context of "new" extreme climate events".

In the face of intensified and new extreme climatic events, farms' adaptation is expected to change to respond to the novel challenges. They can opt for different portfolios of measures, with these

decisions being affected by phenomena related to behavioural and market frictions, which are in turn mediated by the characteristics of the risk mitigation measure (eg. the costs involved, the perceived effectiveness of the measure, etc.), of the farm (eg. farm size, crop diversification, etc) and of the farm (eg. experience with extreme weather events, risk preferences, etc.). IMP-ACT will contribute to the literature by providing currently missing empirical evidence regarding how these phenomena influence farms' decisions to adopt capital adaptation measures and/or risk transfer strategies when facing new extreme climatic events. To address this gap, we will collect primary data on farms' preferences for alternative portfolios of risk management strategies in the face of more intense and frequent climate shocks. Secondary data on implemented measures of adaptation and observed insurance uptake are, indeed, not appropriate for ex-ante assessments of preferences and welfare values, as the changed climate scenario will pose new challenges that farms have not experienced before. A suitable method to elicit farm's preferences is the discrete choice experiment (DCE), a survey-based, economic technique. DCEs are stated preference methods that require participants to select (state) their preferred among a set of alternative scenarios described by a number of characteristics (attributes), taking different levels following an experimental design. By designing a DCE survey, O2 will shed light on (i) farms' decisions among different portfolios of adaptation strategies to minimize risks (capital measures and insurance) in facing climate extremes; and (ii) the role of frictions (adverse selection, moral hazard and advantageous selection) and related moderating factors (risk management tool, farm and farms characteristics) on these decisions. The work carried out in O2 is relevant for the ongoing policy debate on the future of risk management in agriculture under the new CAP 2023-2027, as policy interventions should facilitate farms' adaptation and adoption of risk transfer contracts, while ensuring financial sustainability and improving farms' welfare.

The achievement of O1 and 2 will expand our knowledge on two roads that should merge in the path toward resilience: the observed costs of climate extremes ("Impacts") and the future benefits of incentivizing risk reduction in an upcoming new climate regime ("Action"). The understanding of both is key and sharing lesson learnt with stakeholders aims to trigger a change at systemic level. For this reason, the third objective of IMP-ACT is: O3 – "involving representatives from at least seven stakeholder groups in the sharing of IMP-ACT results and the co-creation and design of optimal policy recommendations".

The project is endorsed by the World Bank, FAO, IFAD and CREA and distinguished Professors in environmental and agricultural economics expressed their willingness to participate in the **external Scientific Board.**

3. Expected activities of the post-doc Research fellow at the University of Trento

The research fellow at the University of Trento will mainly focus on activities included in Pillar II. In particular, the research fellow will contribute to design the survey of the Discrete Choice Experiment, conduct Focus Group, analyse results and writing papers. These activities will be conducted in cooperation with the team of the local unit researchers and professors, but the cooperation with all the members of other units will be encouraged.

Expected starting date of the Research scholarship: 1th March, 2024

End date of the project: 30th October 2025

Main expected activities from the Post-doc Research fellow

Activities	**Starting bimester**	**Closing bimester**
Focus group to inform DCE survey design	4	4
Drafting of the DCE survey	3	6
DCE questionnaire structuring	3	6
Survey data collection	6	7
Data analysis	7	12
Completion of policy reports and scientific papers	6	12

4. Local units and personnel involved

University of Trento

- Dr. Giacomo Pallante
- Dr. Michela Faccioli
- Prof. Simone Cerroni
- Prof. Roberta Raffaelli

University La Statale di Milano

- Dr. Daniele Curzi
- Prof. Alessandro Olper
- Prof. Valentina Raimondi

Gran Sasso Science Institute

- Dr. Alessandro Palma
- Prof. Andrea Ascani
- Dr. Cecilia Castaldo