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Keynote article

Risk, uncertainty, crises management and public intervention in agriculture

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Abstract. Climate variability and extremes, socio-economic conditions, crisis and market shocks are among the main factors determining risk in the agricultural sector. Drought, heat stress, flood, market volatility among the others, have caused heavy losses in the recent past and both the occurrence and intensity of these extremes are expected to increase in the coming decades. Emerging and re-emerging diseases represent a serious concern for the future of agriculture. Here, we provide a synthetic overview of the theoretical framework that could lead public intervention in this specific field and discuss measures that have been taken to reduce economic losses for Italian farmers. We also tried to highlight the difference between risk and uncertainty that in a new global scenario will substantially characterize the reliability of empirical analyses in this complex research field.

Keywords: risk management in agriculture, green portfolio, public support, risk vs uncertainty.
JEL codes: Q14, G18, G22, G32.

HIGHLIGHTS

- Need for radical reformed risk transfer tools and greater public intervention both ex-ante and ex-post.
- defining a theoretical framework for a correct approach to income risk management in agriculture built on the "green portfolio" concept.
- highlight the difference between evaluating risk and uncertainty, which will pose new challenges when dealing with risk management in agriculture.
- risk management in agriculture cannot be identified by crop insurance subscription alone.

1. INTRODUCTION

Winter 2021 in Italy was the warmest on record for the third consecutive year, with rain and snowfall decreased by 50%; furthermore, spring and summer 2022 saw a long period of drought and above-average temperatures (JRC Global Drought Observatory, 2022). These unusual weather conditions have brought the topic of climate change back to the fore and have forced farmers to take a closer look at crop insurance coverage and other methods of stabilizing farm income, including the role of public interventions.

It would seem that we are now in a moment when farmers and consumers alike are painfully aware of the precariousness of Italy's food supply and people are beginning to realise that permanently stocked shelves cannot simply be taken for granted.

It has been established that agriculture is arguably the sector of production where factors outside managers' control are more heavily responsible for the final result of the enterprise, something that has contributed to the development and acceptance of forms of public intervention aimed at reducing income variability that have no parallel in other sectors of the economy (Moschini, Hennessy, 2001; Wright, 2006). The nature of the risks facing farms has changed greatly in recent decades, as have the potential negative impacts of different forms of risk: production, markets, financial, and institutional. What is often overlooked, however, is the changing nature of the needs of farmers, who will surely require radically reformed risk transfer tools (new crop insurance, financing, loans) and greater public intervention, both ex-ante and ex-post.

However, the recent climatic trends mean unpredictable economic performance for farmers. This, together with other reasons, has traditionally fostered legislators around the world to build agricultural policies that are designed to shield farmers from the inherent risks associated with food production.

Indeed, policies to develop infrastructure in the agricultural sector have increasingly given way to policies directed at price and yield stabilisation mechanisms. In the same vein, of the many tools available for income risk management, the most heavily applied continues to be crop insurance.

Since 1970, in Italy, there has been a complex structure of state insurance subsidies for the primary sector. Priority has been given to subsidies for insurance policy premiums and ex-post interventions to compensate farmers for damages in the event of a natural disaster.

The main aim of this paper is to clearly define a theoretical framework for a correct approach to income risk management in agriculture built on the "green portfolio" concept, where private risk management tools are used alongside public interventions. The paper also tries to highlight the difference between evaluating risk and uncertainty, which will pose new challenges when dealing with risk management in agriculture.

The theoretical framework is therefore instrumental in defining the scope of intervention for a variety of public and private instruments that can be applied to income risk management for farmers. The synergy between different instruments highlights the complexity of the issue and suggests that simplistic solutions will not suffice. In order to indemnify the agricultural sector against future risks in the long term, an innovative approach to risk management is required, one which also incorporates a strong relationship between banks and agricultural businesses and can finally tackle the criticalities amplified by the de-specialisation of credit introduced under the Basel II Accord (Adinolfi *et al.*, 2012).

Of course, the difficulties in accessing credit (credit crunch) must also be taken into consideration, not doing so would be short-sighted and result in a strategy destined to fail the Italian agricultural sector. Similarly, it is necessary to bear in mind that Italy has reduced public spending for the primary sector and that forecasts predict a decline in the value of national land assets. Indeed, in the next 80 years, it is expected that Italy's farmland will lose 50 billion euros in value in the "best-case scenario" of a +1°C temperature increase; in the "worst-case scenario" of a +5°C increase, the loss is estimated to reach 185 billion euros) (IFPRI, 2022). This is rarely taken into account but suggests an urgent need for evolution – and revolution – in public intervention, which must be better focused on the implementation of new risk management tools and strategies.

The need for new management models, both from an economic and financing perspective, is now undeniable; they can no longer be overlooked in the scientific, business and political debate.

This is especially true given the changing face of the Italian primary sector in recent years; the number of farms run by university or high school graduates has increased significantly (up 15,000 for the former; 65,000 for the latter), and the total number of farms run by young people has risen sharply (an increase of 17% in the last three years), just like the percentage of farms run by women, with a rate higher than the EU average (Unioncamere, 2020). Despite the counterfeits and fraudulent use of "Italian sounding" branding, Italy's food products preserve their feature of uniqueness as derived from peculiar pedo-climatic conditions and from centuries-old techniques and heritages in the long history of "Italian food artisanship", which can vary from region to region or even town to town. The "fragmentation" of Italian farms, often referred to as the fragility of the system, could be interpreted as a secular adaptation to the specificity and unique requirements of a multitude of different terrains. From this point of view, such an Italian farm model must be defended and supported; and new future scenarios require us to have a clear and courageous vision for its survival.

2. ANALYSIS OF RISK MANAGEMENT POLICIES

Economists tend to evaluate the effects of policies through the lens of economic theory, which allows them to arrive at objective indicators to measure the benefits of a given policy intervention. In cases involving high degrees of uncertainty, the theoretical framework that is most widely applied is the so-called "maximization of Expected Utility" (EU) (Moschini, Hennessy, 2001). However, careless use of this model can lead to invalid conclusions since they are dependent on the implicit assumptions that are fed into any given analysis. In this sense, three issues are often overlooked in the debate surrounding risk in agriculture.

The first issue is that measuring the benefits of policy intervention in terms of whether it increases or decreases the risks an economic actor is facing, depends on the whole distribution of possible results, not just on the expected value or the combination of mean and variance. This is especially true when the distribution of potential results is very asymmetric as is the case when there is a low probability of events which carry very serious negative consequences, or when the policy itself modifies the symmetry of distribution (e.g., taking out an insurance policy or using other financial aids). The simplification of analysis based on the EU method, such as median-variance approaches, can lead to very serious errors in assessment in cases like the aforementioned (Hardaker, 2000).

The second issue is that theories of economic behaviour based on utility focus on the stability of consumption and not of income (Modigliani, Brumberg, 1954). For this reason, the important role of savings and loans as a means of keeping consumption less variable cannot be overlooked. Unless there is a very substantial change in income and/or the interest rate is very high, the cost-benefit of a transient change in income will be quite low, since stable consumption levels can be maintained through the careful use of savings and credit (Friedman, 1957).

The third issue, too often overlooked in the analysis of benefits tied to risk in agriculture, is that risk exposure at the farm level should be analysed in the context of the wider portfolio of economic activities in farming families. Even for specialized farms, the potential benefits of reducing risks associated strictly with farming activities should always be assessed in conjunction with how they might affect the entire potential family income (e.g. off-farm employment, and other financial activities).

In the literature (Chavas *et al.*, 2010), risks have been classified in various ways. One traditional classification distinguishes production risk *stricto sensu*, which is the possibility of lower-than-expected output quantity and/or quality, from price or market risks (either inputs' price rising or output's price falling after production commitments have been made), personal risks (i.e., risks of personal illness, accidents, death) and institutional risks (i.e., the possibility that relevant norms and regulations would change unexpectedly). Although most of the discussion on risk in agriculture has focused on production risks, the other dimensions are becoming more and more relevant in modern agriculture.

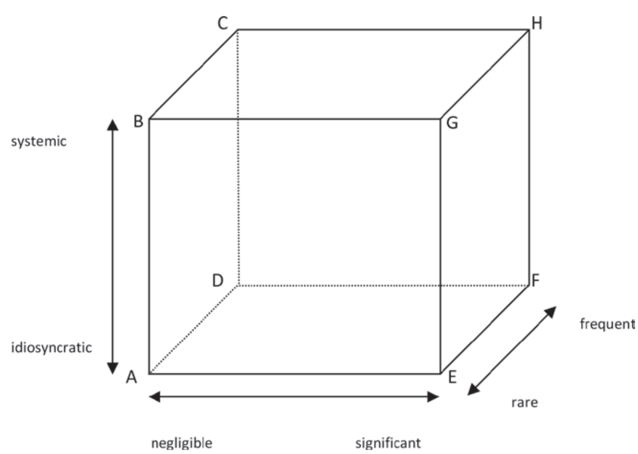
In this perspective, it may be appropriate to introduce a three-dimensional scheme ("risk box") classifying the events that generate risk, according to different degrees of frequency, damage intensity and correlation (Cafiero *et al.*, 2005).

Depending on the combination of these dimensions, a harmful event can be located in a three-dimensional space (Fig. 1) whose vertices correspond to the most extreme forms. Even if, arguably, no real event corresponds perfectly to one of these extreme forms, such classification serves to underline the combination of the most relevant characteristics to choose the most suitable management tool. Except for types of events located at G and H vertices of the box, namely those events that lead to potential and very serious consequences, and for which the only possible strategy should be to elude them (e.g., by avoiding activities in exposed environments), most of the frequent risks associated with "risk box" characteristics can be managed effectively.

A possible classification of management strategies differentiates whether the risk is maintained (so the potential consequences are yet to come), avoided, reduced, or transferred.

When the potential harm is limited (A, B, C and D vertices), farmers can manage the risk by taking *a posteriori* action, known as "risk coping" (Wright, Hewitt,

Fig. 1. The three dimension of risk – "risk box".



1994). The most common risk coping strategy is using savings to avoid reducing consumption. This results in a type of self-insurance policy, allowing the impacts of a harmful event to be “spread” across a longer time frame, in the hope that conditions will improve in the future and that saving reserves can be rebuilt for the next event. This strategy is only feasible if there are enough financial resources to start with or easy access to credit. Its cost is the cost opportunity of the financial reserves that have to be mobilized or the interest paid on the loan.

On the other hand, when the potential harm is very high, the best action to take is probably to avoid the risk altogether, which, however, implies big decisions such as the following: moving the farming activity to an area less susceptible to the risk; investing in physical infrastructure (irrigation systems against drought, protective nets against hail); undertaking actions of so-called *income skewing* (Dercon, 2004), activities that are less averse to risk but are less profitable. This last one is a widespread practice in rural areas of developing countries where the scarcity of financial resources and poor market access make alternative risk management or risk transfer strategies impossible.

As underlined above, in many cases, the best strategy to reduce risk is diversifying sources of income. Farmers all around the world have been doing this for decades, either by diversifying agricultural production (e.g., by diversifying crops or adding crops to livestock farming) or investing some family resources in extra-agricultural sources of income. The cost of this strategy is the loss of the potential benefits of specialisation and, depending on the context, this potential loss can often be less than the cost of, for example, commercial insurance coverage.

As in the case of risk coping, risk transfer can take many different forms. However, the efficacy of risk transfer strategies heavily depends on information sharing between all interested parties. For this reason, a fourth dimension could be added to the “risk box”, in order to classify events based on “predictability”, intended here as the ability to associate a reliable probability distribution with the event. Predictability is a crucial condition for assessing the cost of a given risk management strategy and is a basic requirement for both insurability, that is, the possibility of establishing correct premiums for feasible insurance contracts and the potential for hedging through the use of financial derivatives. When faced with an unpredictable event, since there is not sufficient information on which to base a probability distribution analysis of potential harms, a private market of risk transfer cannot be established. If the consequences of an uninsurable event are grave, the only hope to avoid bankruptcy is relying on some sort of public solidarity. Table 1 summarises the best possible strategies for each extreme event in the “risk box”.

3. PUBLIC INTERVENTION FOR RISK MANAGEMENT IN AGRICULTURE; A HISTORICAL FAILURE

Public intervention in agricultural risk and crisis management started in Italy in 1970 with law No. 364, which established operations of the Fondo di Solidarietà Nazionale (FSN) with two functions: compensation for

Tab. 1. Risks, strategies and management tools.

Type of event	Examples	Strategy	Best action when the event is predictable	
			Ex-ante	Ex-post
A – Idiosyncratic, rare and negligible	Minor personal illnesses		None	Coping
B – Systemic, rare and negligible	Minor epidemics (like the flu)		Vaccination	
C – Systemic, frequent and negligible	Minor droughts Price swings	Retain	Investments, savings	Coping, storage management
D – Idiosyncratic, frequent and negligible	Personal illnesses. Minor car accidents		Mutual insurance	Coping
E – Idiosyncratic, rare and significant	Hail, Fire, Theft		Market-based insurance	Rely on public solidarity
F – Idiosyncratic, frequent and significant	Livestock illness	Not retain	Relocate; hedge on financial markets.	None
G – Systemic, rare and significant	Earthquakes, tsunamis, major epidemics (like the BSE)		Hedging on the global market (CAT bonds)	Rely on public solidarity
H – Systemic, frequent and significant	Drought in the desert!	Avoid	Public investments, relocation.	

farmers suffering a sudden and severe drop in their farm income for reasons beyond their control and support to crop insurance. The law that established the FSN also authorized operation of farmers' mutual associations (the Consorzi di Difesa), which are intended to play two roles. The first is the collection of farmers' insurance demands (mainly hail until 2003) at the provincial level and their placement to insurance companies; the second is the coordination and enforcement of common preventive measures. The mutual approach was intended to reduce the usual problems of asymmetric information and improve power relationships in fixing insurance premiums. Despite the presence of subsidies up to 65% of actual premiums, the diffusion of crop insurance in the Italian agriculture has been rather weak: the share of insured value on total crop production has never been more than a maximum of 20%. The products covered by insurance are mainly fruit crops and vineyards (up to 65%). The past two decades have been marked by tackling the low insurance demand and a considerable amount of public funds has been poured into the system; this raises the crucial question as to whether scientific representation and related knowledge claims used in the problem framing and formulation of solutions (e.g. multiperil insurance) have been incomplete or incorrect.

From the above, we could consider that public interventions in Italy have largely failed (Cafiero *et al.*, 2007; Capitanio *et al.*, 2011; Enjolras *et al.*, 2012; Santeramo *et al.*, 2016). This is because these policies have probably lost sight of the sheer complexity of the interrelations between the myriad of risks that are an inherent part of farming, and instead exclusively subsidized farm insurances and neglected the potential role of other risk management tools and strategies. Also in 2013, whereas throughout the CAP reform process mutual funds and the income stabilization tool (IST) were introduced under reg. 1305/2013 art. 35-38, Italy chose to continue what has always been done: subsidize traditional insurance policies (Severini *et al.*, 2019; Cordier, Santeramo, 2020).

If, on the one hand, the timid conservative approach can be justified for pragmatic reasons (spending efficiency, and preservation of a rigid system with evident risks of "*rent-seeking*"), on the other, it has created the conditions for an urgent need to broaden horizons and look towards a completely different system.

As highlighted (Cafiero *et al.*, 2007; Capitanio *et al.*, 2011; Enjolras *et al.*, 2012; Santeramo *et al.*, 2016), the demand for insurance is generally low and highly concentrated in Italy; there is a dramatic gap between different parts of the country and very few question its real causes. Many factors limit the uptake of subsidized farm insurance, especially in central and southern Italian regions, but the main ones are the following: i) the propensity to take a more traditional and local approach to farm management rather than seeing their farms as competitive businesses; ii) extremely diversified production with two or more different annual crop cycles and, more importantly, less exposure to the risks typically covered by insurance policies (e.g., hail); iii) smaller-scale farms in southern Italy compared with the centre and north of the country, which have to tackle greater administrative complexities to join risk management systems by comparison to bigger farms with more homogeneous farming activities; iv) lack of action by *Consorzi di Difesa* in the centre and south of Italy compared with a more consolidated tradition of these associations in northern Italy; v) insurance policy models designed predominately on the agronomic and climatic needs of the northern regions; vi) lack of innovation in public management models.

Therefore, one might wonder how we got to this point. One possible answer could be the inertia of the public-private system, which is impervious to any attempt to innovate production, despite the evolution of EU legislation (most recently with the Omnibus Decree of 2017 (reg. EU 2393/2017). Political action comes at private costs for those who implement any kind of state intervention, while the public benefits will remain largely external to those individuals. It therefore follows that those individuals are less willing to actively participate in building new policy measures; those who choose to undertake this difficult task will tend to do it for private benefit. The absolute unawareness of farmers of the inefficiencies in both policy construction and expenditure in the agricultural sector has no other explanation; farmers normally ignore public action, and the state is therefore an unreliable "agent". Lawmakers and bureaucrats have vested (and legitimate) interests which systematically lead them to favour one course of policy action over another, often wittingly or unwittingly to the detriment of the community as a whole. Results of public intervention in crop insurance in Italy can be summarized as follows (ISMEA, 2022): a very low rate of participation (never above 20% of Gross Domestic Product (GDP) insured in the last 15 years); a huge divide between different areas of the country (80% of all insured GSP located in a few provinces in northern Italy); the creation of an anti-selective portfolio with growing costs of reinsurance (only businesses that are deemed "risky" by the parameters of the insurance contract are insured); 51% of the budget allocated for the National Measure (Measure 17) for the programming period 2014-2020 has been guaranteed by six southern regions; around 30% of the National Measure funds are intercepted from Trento and Bolzano, which account for less than 3% of Italy's gross saleable vegetable production that represents up to 90% of the overall insured production (MIPAAF, 2015; ISTAT, 2022).

In this scenario there are at least two critical elements to be highlighted:

1. The projections for future climate change indicate that the south of Italy is one of the areas at the highest risk of erosion and yield loss (Bozzola *et al.*, 2018; Chavas *et al.*, 2019);
2. The geographic concentration of the crop insurance market in Italy negatively affects price dynamics, since the cost of the premiums has increased by 44% in recent years (ISMEA, 2022).

This is because of the massive concentration of certificates of insurance that reduces the ability of insurance companies to diversify risks among the insured pool.

This trend seriously jeopardizes the continued subsidization of 65% of policy premiums, even to those farmers who have historically been insured; without a considerable increase in budget, it is plausible that the agricultural insurance system in Italy will collapse.

As for the 2014-2020 programming period, from 2023 on there will be an important new addition to the National Mutual Fund, the so-called METEOCAT[1] (Zaccarini, Lasorsa, 2020), which will be financed through a 3% deduction from direct farm payments and co-financed with resources coming from the European Agricultural Fund for Rural Development (EAFRD), with annual funding estimated at around 350 million euros.

METEOCAT, which was strongly advocated by Italy during the new CAP discussions, is a tool that intervenes in case of catastrophic risks (frost, drought and flood), and covers all Italian farms receiving direct payments. The idea is that it would intervene as a compulsory first-level coverage to compensate at least 50% of the average national damage from catastrophe. This would then encourage Italian farmers to join the second level of coverage, which includes the subsidized system of agricultural insurance policies, mutual funds and Income Stabilization Tools (IST).

Nevertheless, the adoption of such ex-post intervention could imply the risk of umpteenth failure, as Italy has experienced for decades, or rather of another waste of public money.

Indeed, in the last twenty years, Italy has experienced an annual average of verified damages equal to 1.2 billion euros; the National Solidarity Fund (FSN) has effectively liquidated an amount of money equal to 4.8% of these damages on average (MIPAAF decree, several years). So, practically nothing. It is quite clear that using these resources based exclusively on the indemnity principle will add no real economic value.

Another sensitive issue is the marginal role that Mutual Funds and the IST have been given in the forecasts for post-2023 CAP, which could play an important role in some management risk types (Trestini *et al.*, 2018). The growing price volatility in energy and agricultural commodities in international markets, with prices peaking in the first trimester of 2022, sparked an important debate on the repercussions for the economic resilience of farms, particularly in the livestock sector, and opened a reflection on how and to what extent State intervention could mitigate undesirable knock-on effects. Persevering with a system of actions aimed at identifying risk management with the underwriting of an insurance policy can only be justified if public decision-makers are willing to accompany the necessary change.

4. RISK AND UNCERTAINTY: NEW METHODS FOR NEW SCENARIOS

When does managing uncertainty become managing risk? Generally, it is possible to distinguish between two types of uncertainty: "ambiguity" and "risk". This distinction depends on whether the uncertainty can be quantified or not; risk is quantifiable, and ambiguity is not.

This simple distinction was first introduced by Knight (1921) in the early 20th century and has subsequently become known as "Knightian uncertainty". The thought experiment introduced by Ellsberg (1961) adds some clarity to the distinction.

If we imagine we have two urns in front of us, each containing 100 balls. In the first urn, we know that half of the balls are white, and half are black; in the second urn, we do not know the colour distribution. The first urn, therefore, represents a situation where the uncertainty is quantifiable, and risk is an important concept. Instead, in the second urn, the key concept is ambiguity (the aforementioned "Knightian uncertainty"), that is uncertainty that cannot be quantified.

In many works on risk management in agriculture attention has been focused on the concept of risk, therefore on what happens in the first urn; the situation of the second urn, however, is covered by an area of research that is still relatively unexplored, but that will become crucial in the light of the frequency of weather events caused by climate change and by the heightened price volatility of agricultural commodities (De Castro *et al.*, 2012).

[1] Set up under art. 1 of Italy's 2021 Budget Bill 234/2021 commas 515-519, for the implementation of UE reg. 2115/2021 (art. 19 and 76),

Due to climate change that will modify the effects of weather on crop yields, nowadays exposure to pervasive production risks, brought upon by biotic and abiotic stress, represents a fundamental determinant of agricultural productivity and food insecurity (Hennessy, Moschini, 2001; Just, Pope, 2002; Chavas, 2004). Since the 1970s scholars in agricultural economics have developed empirical tools to model the distribution of yields and identify potential ex-ante risk management strategies (Just, Pope, 1978; Antle, 1983). But the estimation of the distribution of yields is challenging for several reasons. First, as adverse risk shocks are located in the lower tail of yield distributions, a simple mean-variance analysis is not sufficient to evaluate the effects of possible crop failure (Antle, 1983; Di Falco, Chavas, 2009; Chavas *et al.*, 2019; Chavas *et al.*, 2022). Second, genetic selection and improved management have affected yield distributions both across crops and over time. And climate change has generated concerns about its adverse effects on crop yields and agricultural production risk (Ray *et al.*, 2012; Lobell *et al.*, 2014; Nelson *et al.*, 2014; Gammans *et al.*, 2017; Arora *et al.*, 2020). Third, crop yields vary in space: agro-climatic conditions and soil fertility change across locations (Jones *et al.*, 2013; Amundson *et al.*, 2015; Stevens, 2018). Capturing the spatial distribution of yields requires estimating a multivariate distribution. And establishing linkages between the spatial and temporal agricultural risk and food insecurity remains difficult.

In methodological terms, the correlation between risk and food security (or food insecurity) is therefore a critical challenge for the kind of analysis that researchers will need to develop in coming years, precisely about the "re-mixing" of the colour distribution in the aforementioned urns. In practical terms, when research focuses on agricultural risk and its linkages with food security, either weather (including drought, flood, cold spell, heat waves, etc.) or market shocks are the main sources of risk in agricultural production, as is well-known. Even if you are only analyzing ex-ante production risks, perhaps weather instances in previous years should be included, so that weather shocks can be serially correlated.

The key point is that if we included them as explanatory variables, they would be treated as if they were "known". This would be appropriate if we wanted to develop an ex-post analysis of agricultural production (e.g., to investigate how droughts or heat waves contribute to low yields). But, weather shocks are typically not known ahead of time (e.g., weather conditions during the growing season are not known at planting time). It means that a risk analysis of agricultural production must be conducted ex-ante, treating weather shocks as uncertain. This is a key motivation for risk analysis: try to treat unanticipated weather shocks as random variables (Chavas *et al.*, 2019).

It will be increasingly difficult to make predictions with "certainty" about the world of farming, what future climate patterns will look like and/or how market prices will trend. As a result, the kind of analyses based on the Arrow and Pratt model (Arrow, 1964; Pratt, 1964) will be relegated to a minority role. The Arrow-Pratt measure of risk aversion has been a theoretical cornerstone to describe productive decision-making behaviour. The authors identified the coefficient of absolute risk aversion, which is the measure of individual aversion to changes in levels of wealth; the coefficient of relative risk aversion, however, identified an agent's risk aversion to changes in wealth and risk factors of the same proportion.

To meet the theorem of expected utility it is crucial to identify the benefit (utility) derived from the elimination of risk to the future income, thereby maximizing the utility for individuals.

Different agents have different levels of risk aversion. For a risk-averse investor, there is a trade-off between the level of yield and the level of risk. In other words, a farmer could accept low returns if the implicit risks of the production system are low or aim at high returns if the risks of the production portfolio are high; behaviours like these reflect the aversion to risk.

However, this approach suggests that farmers "act" as in the case of the first urn. That is to say, their choices are predictable; farmers base their decisions regarding production on their perceptions of the likelihood of future events and, acting individually, they react differently to policy and price changes based on their aversion to risk and levels of wealth.

There is a consensus in the literature that farmers are averse to risks and this declines as their levels of wealth increases.

This attitude to production choices is known as Decreasing Absolute Risk Aversion (DARA) and is accepted as "rational behaviour" for agents who are averse to risk.

The bottom line is that more risk-averse farmers will be more likely to make less risky production choices; if potential income is equal, they will naturally lean towards those choices that they perceive as having "greater future certainty".

This may all seem pretty self-evident, perhaps obvious.

If, however, we accept the hypothesis that after the first urn, we turn to the second urn, the embarrassment would vanish, and we realise that the methodological questions will be decisive in determining the robustness of the analysis that will form the basis of economic policy on agricultural risk management.

In different terms, the less information individuals have (uncertainty vs. risk), the more they fail to sufficiently discriminate between different levels of likelihood (Tversky, Kahneman, 1992). The behavioural economic literature shows aversion towards uncertain compared to risky choices: individuals prefer known probabilities over unknown probabilities, even if the known probability is low and the unknown probability could be a guaranteed win (Ellsberg, 1961). Recalling the urns, if winning is achieved by drawing a white ball. when asked this question, most people opt for the known urn. However, if they win when drawing a black ball, they also opt for the known urn. This decision contradicts the notion of probability: people act as if the chance of drawing a white ball from the unknown urn is less than 50%, but also as if the chance of drawing a black ball from that same urn is less than 50%. This so-called Ellsberg paradox illustrates our initial statement: when asked to choose, individuals prefer risk over uncertainty.

Moreover, in the theoretical setting outlined above preferences are given. The utility function is taken to be a fundamental individual characteristic. As with demand elasticity, risk aversion coefficients should be estimated empirically from representative samples of the population, and projections outside the sample should always be taken with some degree of caution.

Unfortunately, as opposed to traditional demand estimation, in this case it is virtually impossible to find sufficient data to identify the structure of the risk preference from, for example, the underlying distribution of the relevant variable. For example, does the fact that a farmer does not buy insurance mean that he is not risk averse, or that he does not believe a bad outcome would occur? The simple observation of not buying insurance could be used as evidence of lack of risk aversion, if one is willing to assume the probability distribution of outcomes, or of evidence that the subjective distribution of outcomes is not very spread if one assumes a certain degree of risk aversion.

As difficult as it might be, however, to distinguish between the two is imperative from a policy point of view. In the previous example, if the farmer is not risk averse, why should he be compensated in the case that a bad outcome occurs and he decided not to insure? After all, no government would ever engage in compensations to unlucky gamblers. Different would be the case if a real damage occurred for lack of sufficient information on the probability distribution of the events, in which case a compensation might be justifiable.

Put in simpler ways, it is always possible to justify an intervention in favour of an agent or a group of agents by assuming that they suffer a damage facing whatever the current conditions are. The point is that the customary habit of analysts in this case has been to assume a certain degree of risk aversion, which would invariably lead to "discovering" that facing a risky prospect implies a damage and therefore that an intervention is justified, without taking the care to check whether the assumed degree of risk aversion is consistent with other observed behaviour of the agents.

A better "code of best practice", as Hardaker suggests, would be to focus on trying to address the "objective" probabilities of the possible outcomes, and therefore to make the best use of the observed behaviour to try and assess the real propensity of farmers towards risk, and perhaps one would discover that «agricultural economists have paid too much attention to risk aversion» (Hardaker, 2000, p.13) and that «from a social welfare perspective, most risks faced by individual farmers or groups of farmers are very unimportant.» (ibid.)

5. FINAL CONSIDERATIONS

Due to the multiplicity of risks faced by farmers, a first general observation that can be inferred from the Italian context as described is that it would be unrealistic to identify the stability of farmers' incomes by the adoption of one single risk management tool.

One of the aims of this work is to frame the theoretical aspects that should inform policy design to manage risks and crises in agriculture in the context of an advanced economy.

The lessons to be learnt from what has previously been discussed can be summarised as follows:

1) The importance of risk factors and their potential positive or negative effects on farmers must be well understood ex-ante (Tinbergen, 1952 and 1956).
2) The need to determine the consequences of those risks in terms of benefits and therefore the value of implementing public risk reduction policies; this implies that the risks farmers face must be measured in terms of their potential effects on the consumption levels of farming families and not on current levels of income. In many cases, consumption depends on the anticipated permanent income levels of the whole family. The theory of consumer behaviour postulates that the yearly level of consumption is not directly linked to current income, but rather to the expected value of long-term wealth, and this is widely confirmed by the empirical evidence. This emphasizes the role of savings and borrowing as private risk management tools.
3) Such a preliminary analysis would recognise the fact that there are risks that can be managed effi-

ciently by farmers, both through the diversification of income sources and the use of mechanisms such as savings and credit, which can help farmers deal with limited fluctuations in income without the need for state subsidies. Since the work of Friedman and Savage (1948), and Markowitz (1952) who discussed the expected utility approach to the cases of monetary outcomes, it is clear that the argument of the von Neumann and Morgenstern (VNM) (1944) utility function should be wealth, not income, i.e. a measure of a monetary stock and not of a flow, and there is a good reason for that: what really provides utility should never be considered to be "money" per se, but rather, it is the level of consumption that money permits that individuals care about. It is well established that consumption is much more closely linked to wealth, or what we could term as "permanent" income rather than to current or "transitory" income (Friedman, 1957). Of course, income contributes to wealth formation, and transitory fluctuations in income may have consequences. However, the impact in terms of welfare of a temporary change in current income, and therefore what would justify public intervention, is admittedly much lower than the impact of a similar change in permanent income.

4) On the other hand, when the predictability of events is so limited that is not possible to formulate any form of preventative action, or when the potential harms are too great for a farmer to independently take on, there is no other alternative than some form of state subsidy and transfer of risk to third parties.
5) To avoid inefficient spending of public money, a clear distinction should be made between the normal risks of doing business and truly disastrous events. Farmers should be mainly responsible for the former without recourse to state intervention.
6) Subsidies could take the form of direct payments or financial assistance to pay off the interest on loans taken out to rebuild damaged farms.
7) In the medium to long term, subsidies should be aimed at supporting farmers to implement preventative actions that reduce the scale of damage caused by natural disasters, for example giving farmers incentives to move away from areas that are particularly exposed to risks of natural disasters or to invest in protective infrastructure. Furthermore, public spending could be used where there are large economies of scale or where investment in protective infrastructure can be considered public goods.
8) For normal risks of doing business, state intervention should be limited to determining the necessary conditions for farmers to develop and strengthen their capacity to manage risks by using private instruments such as insurance, credit and financial markets. In this case, state intervention should also aim to promote the activities of private markets.

Various actions could help move us in this direction:

9) Creating institutions and information activities to promote demand for private sector tools to manage risk, whilst fostering greater competition on the supply side.
10) Promoting precautionary saving, through direct and indirect incentives, e.g., tax benefits, to increase farmers' resilience to less serious risks at the farm level.
11) Promoting a greater concentration of demand for risk management tools to give farmers better access to insurance, credit, or financial markets. In this case, supporting the operation of mutual funds can be an effective way to incentivize the development of risk markets in Italy. In addition, a greater concentration of demand will help internalise monitoring costs, thereby increasing the scope of mutual funds for the type of risks that are, by their very nature, difficult to transfer because of the problem of information asymmetry.
12) Securitisation of the risks associated with climate-related impacts must also be considered as a way of leveraging public investments in the agricultural sector, especially for ex-post intervention to compensate for damages (e.g., Cat bond). Given the fact that extreme weather events are increasing in number and intensity, it will be ever more difficult to continue compensating farmers without this kind of financial leverage.

In light of this, farm access to credit plays a fundamental role. The capitalisation and profitability of farms will be the two key elements to access credit and contain costs; credit will be sorely needed to make investments, especially in innovation.

This will mean that farmers need to keep detailed and transparent accounting, which, unfortunately, is not happening on a significant proportion of farms. This study has highlighted the need to continue further down the path of developing assessment systems that can accurately describe the real state of the primary sector. Classic methods to assess credit rating tend to produce high scores for farms because of their high levels of capitalisation, however, these scores can overestimate the real conditions of farms' balance sheets and consequently predict a low risk of default for the majority of farms.

The greater exposure to market risk and the new rules that have changed the conditions of access to credit for farmers, however, make this option more difficult than in the past; data resulting from analysis (ISMEA, 2019) reveals farmers' propensity to avoid taking on debt, highlights the need for many farmers to reorganize their assets and management structures.

In the Italian context, detailed economic data on farms can be difficult to gather because farms tend to be smaller and in many cases are set up in such a way that they are not legally required to provide financial statements or need only to present a very brief overview. For this reason, the data provided by the Farm Accountancy Data Network (FADN) archive is very important, especially given its standardisation of data inputs, making comparisons easier to evaluate.

To conclude, we can say that there is a consensus that all actors who care about the fate of farms, the quality of our products and the beauty of our countryside will no longer be able to procrastinate or get around the unavoidable evolution the sector requires; from the era of risk management to the era of uncertainty management. Precious time, even years actually, has already been wasted on building an effective and efficient system to protect agricultural incomes.

Yet if we continue with the inertia of the status quo, a large part of the productive sector, and a large part of the traditions and landscapes of rural Italy, will cease to exist.

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