Penone *et al.*
Agricultural and Food Economics (2024) 12:39
https://doi.org/10.1186/s40100-024-00333-7

Agricultural and Food Economics

RESEARCH Open Access

Exploring farmers' intention to adopt marketing contracts: empirical insights using the TOE framework

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Abstract

The European agricultural sector faces considerable exposure to price risk, which poses a threat to farmers' income and long-term resilience. Marketing contracts have emerged as a potential risk mitigation strategy by enabling farmers to fix the selling price of their output. Despite their benefits, the adoption of marketing contracts among European farmers remains limited. To investigate the factors influencing farmers' participation in MCs, this study applies the Technology-Organization-Environment (TOE) framework, marking its first application in this field of research. By analyzing data from an online survey of 84 Italian arable crop producers using a partial least squares structural equation model, this study investigates the factors influencing farmers' participation in marketing contracts. The results demonstrate the effectiveness of the TOE model in examining farmers' intentions to adopt marketing contracts. Specifically, the perceived usefulness of marketing contracts, their compatibility with farm characteristics, the positive attitude of farm owners towards these tools, and normative pressure from buyers all exhibit positive associations with farmers' intention to adopt marketing contracts. These findings offer valuable insights for the development of targeted strategies aimed at promoting the widespread use of marketing contracts among European farmers.

Keywords: Technology-organization-environment framework, Price risk management, Marketing contracts, Italian arable crop sector

Introduction

Over the last twenty years, agricultural commodity prices have been characterised by high volatility. For example, both European and international prices spiked in 2006–2008, in 2011, and again in the summer of 2021 (Baffes and Haniotis 2010; Tadesse et al. 2014; USDA 2021). Compounding this, the effects of the COVID-19 crisis are expected to persist over the next decades (Coibion et al. 2020), inflating price volatility and strongly influencing global agricultural prices (Elleby et al. 2020). Today, significant increases are registered as a consequence of the changing geopolitical balance related to the conflict in Ukraine (USDA 2022; Mustafa et al. 2024). Given this scenario, nowadays,

European farmers dealing with exchange-traded hard commodities, such as cereals and protein crops, are threatened by great uncertainty over their income.

Until the end of the last century, the direct price support provided by the Common Agricultural Policy (CAP) in the European Union was used to protect farmers' incomes against commodity price fluctuations. However, after the progressive switch from price support policies to direct payment schemes, a new interest in risk management instruments has emerged, albeit slowly, among European farmers (Giampietri et al. 2020).

To secure their income, farmers have several options at their disposal, using strategies that range from crop diversification to the use of advanced financial instruments (Meraner and Finger 2019). Indeed, they can use on-farm self-coping strategies (i.e., crop diversification, farm's financial management and informative marketing of the products) or off-farm instruments (i.e., insurances, mutual funds, the Income Stabilisation Tool—IST), or they can hedge with financial instruments as agricultural contracts (i.e., forward contracts, futures contracts, and marketing contracts). Marketing contracts (MCs) (or agricultural contracts) represent a pre-sale agreement between the farmer and the buyer (i.e., storage centre, farmers' cooperative or consortia) that fixes a price or pricing mechanism before the harvest. The set price (or pricing mechanisms) limits farmers' exposure to large price fluctuations, thereby mitigating the risk of negative price movements (Kirsten and Sartorius 2002; MacDonald et al. 2004). Therefore, MCs represent useful tools for improving farmers' welfare (Bellemare 2012) and for stabilising farm income (Wilson and Dahl 2009; Penone et al. 2021; Viganò et al. 2022). It is worth mentioning that, as for the durum wheat, the literature (Ciliberti et al. 2020; Frascarelli et al. 2021) highlights the role of MCs in addressing the request to adopt more sustainable agronomic practices, thus responding to future consumers' expectations in terms of sustainability, and ensuring the supply of a high-quality product. According to this literature, in addition to mitigating the risks associated with quality uncertainty and addressing socio-environmental sustainability needs, MCs can also help to reduce transaction costs (e.g. those related to finding buyers or monitoring market prices), thus providing incentives for farmers to use them.

However, the adoption of marketing contracts by farmers is limited, particularly in Europe (Michels et al. 2019; Solazzo et al. 2020). This can be attributed to their perceived complexity and constraints, which discourage farmers from adopting them (Michels et al. 2019). This study aims to better understand these motivations and provide insights for improving adoption rates.

The adoption of agricultural contracts has recently gained the attention of researchers (Vamuloh et al. 2019; Michels et al. 2019). Farmer and farm characteristics (e.g., demographic information, farm size, risk profile, etc.) are considered important factors affecting farmers' participation in MCs (Roussy et al. 2018; Ricome and Reynaud 2021). However, evidence on Italian farmers is scarce, with one exception to the authors' knowledge. Solazzo et al. (2020) linked the low adoption of MCs' to the trade-off farmers perceive between "*…risk and independence, on one side, and income stability, on the other*" (pp. 106). This limited adoption is also due to farmers' preference for long-term, trust-based relationships with local buyers over formal contracts (Solazzo et al. 2020).

Given the limited accounts, this paper investigates which factors drive farmers' intention to participate in MCs. This study focuses on these intruments as they represent a potential

price risk management tool for Italian farmers, which has a limited diffusion among farmers, but is also a known form of contracting for cereals producers (Solazzo et al. 2020). While the literature (as reported above) has already analysed the interest in MCs as a governance solution aimed at reducing transaction costs for farmers, but also as a tool to guarantee product quality standards to consumers and compliance with good agronomic practices, as a novel contribution this paper focuses on their usefulness in reducing price uncertainty and thus the risk of income loss for farmers. Therefore, given the low adoption rate and the farmers' familiarity with the instrument, this study applies for the first time a framework commonly used in innovation adoption studies.

Social-psychological factors, including other individual opinions, influence the intention to adopt an innovation, and several behavioural decision-making models have been applied in agricultural contexts (Rehman et al. 2007; Montes de Oca Munguia et al. 2021). For instance, the application of the Technology Acceptance Model (TAM) has recently proven useful for agricultural risk management analysis to investigate the adoption of futures contracts by German farmers (Michels et al. 2019). A similar model, the Technology-Organization-Environment (TOE) model, has recently been applied to Italian farmers' adoption of web marketing by Giampietri and Trestini (2020), who reports a significant effect of constructs from the technological, organisational and environmental contexts. Given the multiplicity of contexts analyzed by the TOE framework, this study focuses on investigating whether the TOE model contributes to understanding farmers' intention to participate in MCs in Italy. As a novel contribution to agricultural risk analysis, it marks one of the first applications of the TOE framework in this field. The results of this study provide valuable insights into factors influencing farmers' adoption decisions and offer a new perspective on the use of the TOE framework in agricultural risk management research. Based on a survey conducted of 84 Italian arable farmers, the aim of this study is to evaluate the factors that affect their intention to participate in marketing contracts. Data were analysed using partial least squares structural equation modeling (PLS-SEM). The relevance of this article is multifaceted. First, it represents the first application of the TOE framework to MCs and contributes to expanding knowledge on this topic for researchers, policymakers and other stakeholders. Additionally, it provides empirical evidence on the factors influencing the adoption of marketing contracts by Italian farmers, helping to tailor future interventions and support mechanisms. The study also identifies specific technological, organizational, and environmental factors that can promote the adoption of risk management practices, providing actionable insights for enhancing farm resilience and contributing to the broader literature on the adoption of agricultural innovations by providing a case study that can be used as a reference for similar studies in different contexts or regions.

The structure of this paper is as follows: Sect. 2 illustrates the literature on contract farming and describes the theoretical background on the adoption of innovations; Sect. 3 presents the research hypotheses, the data and the methods used; Sect. 4 reports and discusses the results. Finally, the concluding remarks are presented in Sect. 5.

Background

Literature on contract farming

Contract farming involves an agreement between the producer and the buyer for the marketing of a product. Worley and McCluskey (2000) identified three types of contract

farming, namely MCs, production management contracts (PMCs), and production contracts with provided inputs (PCs). MCs can be defined as written agreements between the producer and the buyer that define a price for a specified quality and quantity of a commodity before the marketing (Harwood et al. 1999). Among other categories, MCs comprise forward contracts in which the growers remain in charge of all the productive decisions and input supply. However, some form of control (granted product characteristics) could be found in some types of MCs (Solazzo et al. 2020). Similarly, PMCs and PCs constitute an agreement for the commodity sale, but they involve the provision of technical support by the contractor (PMCs and PCs) and the furnishing of productive input (PCs). In this type of contract, farmers are not entrepreneurs, as they get paid for services (Vamuloh et al. 2019). Also, futures contracts represent a form of standardised contract which does not require the presence of a local buyer, providing effective hedging on price risk for European farmers (Penone et al. 2022).

Literature on contract farming is heterogeneous in terms of contract types, geographical location, contracts' users and applied methodology. Different reviews are available focusing on a specific category of contract farming, such as PCs and PMCs (Bellemare and Bloem 2018), futures and forward contracts (Tomek and Peterson 2004), or contract farming engagement from small farmers in developing countries (Vamuloh et al. 2019). However, to the authors' knowledge, an overall review that comprises all the relevant aspects of contract farming, especially for developed countries, is lacking. Similarly, for the MCs super-category, literature is diversified and disproportionated regarding contract types, geographical location and applied methodology.

As generally stated by Vamuloh et al. (2019), the adoption of MCs is linked to three main variable categories: the farmer demographic characteristics, the farm structure, and the farmer risk profile. For North American crop producers, the literature reports that the demographic characteristics (age, education level, and experience) show heterogeneous results (Goodwin and Schroeder 1994), while farm size and its capital structure (i.e., high level of debt to asset ratio) are constantly positively correlated with MCs' and futures contracts adoption (Sartwelle et al. 2000; Pennings et al. 2008). Moreover, North American farmers' individual risk profile is broadly confirmed as a relevant factor influencing the adoption of risk management instruments (Goodwin and Schroeder 1994; Sartwelle et al. 2000; Pennings et al. 2008; Franken et al. 2012; Coffey and Schroeder 2019).

Similarly, for European hog farmers, literature reports that factors like farm size, risk exposure, risk perception, and risk attitude help explain futures contracts adoption, explicitly suggesting a positive relationship between risk aversion and perceived risk exposure and the futures contracts' usage (Pennings and Leuthold 2000; Pennings and Garcia 2004). Interestingly, a recent paper by Ricome and Reynaud (2021) confirms this by stating that the probability of using MCs among French cereal producers increases when their price risk exposure increases, and their price expectations are lower. Finally, Solazzo et al. (2020) investigated the factors affecting Italian wheat growers' propensity to adopt MCs, linking the adoption of written contracts to more dynamic farmers that are more prone to innovation and farm development.

Nonetheless, in Europe, the analysis of farmers' adoption of MCs remains limited. European farmers' adoption of price risk management contracts, focusing on futures

contracts, has been recently studied within an innovation adoption framework based on latent variable identification (Michels et al. 2019). The approach develops on the possibility that the decision regarding whether to adopt a price risk management tool may not only depend on economic reasoning. Farmers' attitudes and beliefs toward a technology or a practice could indeed play a crucial role.

In Italy, where the adoption rate for MCs is scarce (Solazzo et al. 2020), research on this is lacking, representing a potential research area. Moreover, given that what influences a producer's risk management decisions is not necessarily the same across risk management strategies (Pennings et al. 2008), the specific analysis of farmers' intentions toward MCs is paramount.

Theoretical framework

Decision on adopting an innovation (e.g., a new technology or a new strategy) at the farm level is a necessary part of the farming activity (Kumar and Joshi 2014). Various theoretical frameworks have been developed to study this. Among these we find: the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), the Diffusion of Innovation (DOI) Theory, the Technology Acceptance Model (TAM), the Technology-Organization-Environment (TOE), the Awareness Knowledge Adoption Product (AKAP),the Awareness Knowledge Adoption Implementation Effectiveness (AKAIE), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Fishbein and Ajzen 1975; Ajzen 1991; Rogers 1962; Davis 1989; Tornatzky and Fleisher 1990; Venkatesh et al. 2003; Vecchio et al. 2023). Following the technology-organisation-environment framework developed by Tornatzky and Fleisher (1990), three factors' categories affect the intention to adopt an innovation. First is the technological context (TC), which includes the internal and external factors that can influence innovations' adoption. Second, the organisational context (OC) includes the firm's characteristics, such as the leader's opinion or the firm's readiness to adopt an innovation. Last is the environmental context (EC) concerning the role of policy, competitors, trading partners and customers in influencing the decision to adopt an innovation. Another relevant framework is the technology-acceptance model (TAM) (Davis 1989). According to TAM, the decision regarding the adoption of an innovation is determined by the perceived usefulness (PU) and the perceived ease of use (PEOU) of the innovation. Both TOE and TAM frameworks have been extensively applied in small and medium enterprises (SMEs) research. Demonstrating its broad applicability and relevance, the Technology-Organization-Environment (TOE) framework has been widely applied beyond agriculture in fields such as healthcare, education, and business (Emon 2023). Regarding the agricultural sector, the TOE model has been recently applied to explain farmer cooperatives' adoption of agricultural information technology (Wang et al. 2019) and the Italian farmers' adoption of web marketing (Giampietri and Trestini 2020). Similarly, the TAM model has been recently applied to understand German farmers' intention to use commodity futures contracts (Michel et al. 2019). Inspired by the application of an innovation adoption model (TAM—Michel et al. 2019) for the use of risk management tools, this study applies a similar approach by selecting the TOE framework as a model for the empirical analysis of farmer decisions. By using the TOE framework, this study integrates key determinants from technological, organizational and environmental perspectives,

allowing for a nuanced analysis of how these factors interact and influence the adoption rate of marketing contracts among farmers, particularly in the Italian agricultural sector. The overall completeness of the TOE in considering more latent variables, and incorporating the TAM model latent variables, encourage this decision.

Research hypothesis

In this study, TOE allowed modelling the effect of different factors belonging to three different contexts on farmers' intention to participate (INT) in marketing contracts to sell their yields. Several indicators have been used (Table 1) derived from the existing literature applying adoption behaviour models (Junior et al. 2019; Michels et al. 2019; Giampietri and Trestini 2020) and adapted to our research topic. In particular, the study considers the following constructs: perceived ease of use (PEOU), perceived compatibility (PC), perceived usefulness (PU), and security concerns (SC) related to the

Table 1 Latent variables, related indicators, and statements for each indicator

Context	Construct	Code	Indicator
	INT	int_1	I intend to market my next crop production through MCs
		int_1	My farm intends to participate in MCs to sell the production
		int_1	I think I will subscribe a MC to sell my next production
TC	PEOU	$peou_1$	For me, MCs are simple to use
		$peou_2$	In my opinion, MCs are easy to use
	PC	pc_1	The use of MCs is compatible with the production characteristics (quality and quantity) of my farm
		pc_2	The use of MCs is compatible with the management of my farm
		pc_3	The use of MCs is compatible with the size of my farm (i.e., minimum production)
	PU	pu_1	MCs make it possible to mitigate price risk at farm level
		pu_2	I think that the use of MCs can help me to protect my finances
		pu_3	The adoption of MCs reduces the fluctuations in my turnover
	SC	sc_1	As for MCs, I am concerned that buyers may not comply with the contract in the event of price drops
		sc_2	I don't trust marketing my products through MCs
		sc_3	In case of MCs, it is possible that the buyer does not respect the contract
OC	PLR	plr_1	The use of MCs in my farm requires additional investments
		plr_2	The use of MCs in my farm requires additional work
		plr_3	The use of MCs in my farm requires new specialised workers (e.g., consultants)
		plr_4	The use of MCs in my farm requires additional specific training
	TMS	tms_1	The farm owner is in favour of MCs
		tms_2	The farm owner is inclined to the use of MCs
EC	MP	mp_1	More and more farmers are using MCs
		mp_2	Many farmers already participate in MCs
		mp_3	The use of MCs is spreading more and more among farmers
	NP	np_1	My buyer (e.g., agricultural consortium, feed mill, mill, dryer, etc.) strongly recommends MCs' adoption to me
		np_2	My buyer (e.g., agricultural consortium, feed mill, mill, dryer, etc.) encourages the use of MCs
		np_3	My buyer (e.g., agricultural consortium, feed mill, mill, dryer, etc.) suggests the use of MCs

MCs Marketing contracts; *INT* Intention to participate in MCs at farm level; *PEOU* Perceived ease of use; *PC* Perceived compatibility; *PU* Perceived usefulness; *SC* Security concerns; *PLR* Perceived lack of resources; *TMS* Top management support; *MP* Mimetic pressure; *NP* Normative pressure

technological context; perceived lack of resources (PLR) and top management support (TMS) related to the organisational context; finally, mimetic pressure (MP) and normative pressure (NP) related to the environmental context.

First, following Michels et al. (2019), the perceived usefulness of marketing contracts has been investigated through three indicators, all measuring the extent to which the farmer perceives that MCs can enhance the economic performance of his farm by reducing price risk (hedging purpose). Within TOE technological context, PU is expected to positively influence INT. The literature also stresses the positive role of the perceived ease of use (PEOU) on the intention to adopt a specific innovation (Davis 1989). Hence, it is expected that the more the farmer perceives that marketing contracts are easy to use, the more likely he will adopt them. Similarly, given that the literature reports that the lack of compatibility (PC) of the innovation with the farm infrastructure and management could generate limits on the adoption of that innovation, it is assumed that the more MCs are considered compatible with the farms' characteristics, the higher the intention to adopt them at farm level (Junior et al. 2019). Moreover, previous research (Solazzo et al. 2020) suggests that the lack of trust in MCs can represent a barrier to their adoption among farmers, thus making the analysis of farmers' security concerns (SC) relevant. Moreover, previous research (Solazzo et al. 2020) highlights that a significant barrier to the adoption of MCs among farmers is the preference for long-standing relationships based on trust rather than formal contracts. Drawing on SC indicators from the e-commerce and web marketing literature (see Schaupp and Carter 2010; Giampietri and Trestini 2020), we investigated specific security concerns such as the risk of buyers not honouring contracts when prices fall, a general lack of trust in using MCs for product marketing, and the potential for buyers to disregard contractual agreements.

Regarding the organisational context, the perceived lack of resources (PLR) could lower the intention to adopt. Indeed, following Giampietri and Trestini (2020), this study investigates whether the adoption of marketing contracts at the farm level is perceived as requesting additional resources (i.e., additional investments, additional work for the farmer, new specialised workers as consultants), thus being a non-sustainable choice in the short-run. Additionally, it has been explored the effect of the farm size on participation in MCs. Indeed, according to different authors, the larger the firm, the higher the probability that MCs are adopted as a marketing strategy (Ricome and Reynaud 2021). Lastly, the support from the top management (TMS) is fundamental for adopting an innovation due to the willingness of the manager (herein the farm owner) to understand the benefits of the innovation (Gangwar et al. 2015). Hence, we test its effect on the intention to enter a marketing contract agreement.

Last, within the environmental context, this study considered the effect of mimetic and normative pressure on adoption. The mimetic pressure (MP), namely the imitation of other organisation in the same environment, proved to play a significant role in encouraging innovation adoption (Yoon and George 2013). In the context of agricultural risk management, to test the effect of this latent variable, we measured if farmers' intention to participate in MCs mimics what other farmers do. Furthermore, normative pressures (NP) primarily arise from farm professionals and trade associations or customers and suppliers: these, through recommendations and suggestions, can influence the adoption of marketing contracts by the farm (Yoon and George 2013). Here we investigate the

role of the buyer (e.g., agricultural consortium, feed mill, dryer, etc.) in influencing MCs adoption by farmers.

Following the TOE framework (Fig. 1), the research tested the following hypotheses:

- H1: perceived ease of use (PEOU) influences INT;
- H2: perceived compatibility (PC) influences INT;
- H3: perceived usefulness for price risk reduction (PU) influences INT;
- H4: security concern (SC) influences INT;
- H5: perceived lack of resources (PLR) influences INT;
- H6: SIZE of the farm influences INT;
- H7: top management support (TMS) influences INT;
- H8: mimetic pressure (MP) influences INT;
- H9: normative pressure (NP) influences INT.

Material and methods

Structural Equation Modelling (SEM) allows the simultaneous estimation of relationships between multiple independent and dependent constructs. Recently, participation in futures contracts has been analysed by applying SEM both in its covariance-based (Franken et al. 2017) and variances-based form (Michels et al. 2019). Partial Least Squares Structural Equation Modelling (PLS-SEM) is a variance-based procedure to analyse the simultaneous relationship between different variables (for a detailed

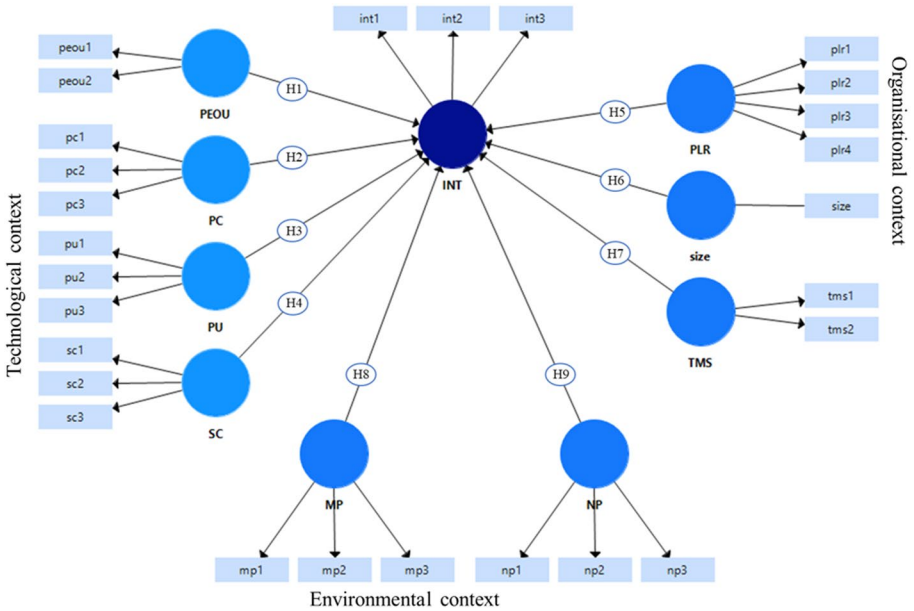

Fig. 1 Structural model and path analysis of the hypotheses. *Notes: the figure represents the three contexts (technological, environmental and organisational) of TOE framework and their related constructs: INT = intention to participate in MCs at farm level; PEOU = perceived ease of use; PC = perceived compatibility; PU = perceived usefulness; SC = security concerns; PLR = perceived lack of resources; TMS = top management support; MP = mimetic pressure; NP = normative pressure. The figure also shows the number of indicators used to infer the value of each corresponding construct (i.e., latent variable).* Source: authors' own illustration

methodology description see Hair et al. 2017). Like the model presented here, explanatory studies have been shown to perform better with PLS-SEM (Aktar and Pangil 2017). This is due to the flexibility of PLS-SEM in analysing data that are not normally distributed (Hair et al. 2017) and in its ability to perform even with a limited sample (Willaby et al. 2015; Richter et al. 2016).

In PLS-SEM, the latent variables (or constructs) are determined by one or more observed variables (namely the indicators). The link among constructs constitutes the inner model, while the relationship between each construct and its indicators represents the outer model (Hair et al. 2014; Sarstedt et al. 2014). Moreover, the constructs can be divided into exogenous (independent variables) and endogenous (dependent variables) variables. Our model consists of one endogenous construct: the intention to adopt marketing contracts (INT), which is explained by the variables included in the TOE model (Table 1). The relationships between exogenous and endogenous constructs are estimated by a sequence of Ordinary Least Squares (OLS) regressions, making the path coefficient interpretation equal to the OLS standardise β coefficients (Hair et al. 2014; Sarstedt et al. 2014).

To develop the TOE model, after a pre-test on a small sample (N = 10), an online survey addressed to Italian farmers was conducted via social media and online advertisement during summer-autumn 2021. Even if the internet is scarcely accessible in many European rural areas, 86% of Italian rural area households have access to it (Eurostat 2020), making online questionnaires a valid instrument that effectively reaches a large number of farmers. After deleting four incomplete questionnaires, the final sample consists of 84 responses. The use of small samples in similar studies (see for instance, Michels et al. 2019) is common in studies focusing on farmers (Chèze et al. 2020), due to the difficulty to reach them with surveys. The results were analysed through PLS-SEM using Smart-PLS software (Ringle et al. 2015). The survey was structured as follows: after providing farmers with a description of marketing contracts,[1] they were presented with several Likert type scales ranging from 1 (totally disagree) to 5 (totally agree) to measure the constructs of the TOE model (Table 1). To conclude, farmers were asked to provide sociodemographic information.

Results and discussion

Description of sample characteristics

As reported in Table 2, the sample is composed mainly of men (93%), with an average age of 44 years. 38% of the sample has a higher education (i.e., university degree). Thus, our limited sample consists of comparatively younger, well-educated farmers than the average Italian farmer. 57% of the farms are specialised in the arable crop sector, and the average farm size amounts to 76 hectares. Farm size, however, shows high values of variability, ranging from a minimum of 1.7 hectares to a maximum of 900 hectares. Moreover, 63% of the farms sell/deliver their product to a farms' association as a cooperative or a consortium. The majority of farms (93%) use some self-copying risk management

[1] Description of MCs in the questionnaire: "Marketing contracts (such as forward contracts or supply chain contracts) consist of an agreement signed between the farmer and the buyer (e.g. agricultural consortia, mills, dryers, etc.) which establishes a fixed price for the sale of the product before harvesting (e.g., at the sowing)".

Table 2 Descriptive statistics of the sample

Variable	Description	%	Mean	SD	Min	Max
Age	years (C)		44	13	23	72
Education	1 if the farmer has a university degree, 0 otherwise (D)	38				
Gender	1 if male, 0 otherwise (D)	93				
Farm size	hectares of arable land (C)		76	127	1.7	900
Full-time farmer	1 if full-time farmer, 0 otherwise (D)	77				
Arable crop	1 if specialized farm (exclusively arable crop), 0 otherwise (arable crop and other productions) (D)	57				
Association	1 if the farmer is associated (consortia), 0 otherwise (D)	63				
Previous MCs' use	1 if yes, 0 otherwise (D)	63				

Observations n. = 84; *C* Continuous variable; *D* Dummy variable

strategies such as irrigation, insurance and modernisation (49%, 44%, 39%, respectively), whereas only 20% apply financial savings or diversification with related activities (e.g., direct sales or agritourism).

Description of PLS-SEM results

Table 3 reports the results of the outer model. The average score for each indicator is always above the mean value, except for one SC item and all PLR items. This indicates that our sample's respondents intend to adopt marketing contracts and perceive them as useful and easy to use. Moreover, they perceive that MCs are compatible with their farm characteristics, management, and size. Coherently, they do not perceive a lack of resources (i.e., additional investments, work, specific training, and new specialised workers as consultants) that impede participation in MCs. Being consistent with the literature (Solazzo et al. 2020), farmers show some scepticism concerning the contract fulfilment from the buyer (sc_2), showing some security concerns. In addition, subjects in our sample affirm that the farm owner is prone to, and their buyer encourages the adoption of marketing contracts. Finally, our respondents are conscious that many farmers that they know already participate in MCs.

Table 3 also reports the outer model evaluation criteria. In particular, we tested the indicator reliability, collinearity, internal consistency, convergent validity, and discriminant validity. First, the standardised loadings are equal to or higher than 0.7 for most of the indicators implying the reliability of the indicators (Hair et al. 2017). However, sc3 and prl1 are slightly under the cut-off level. Nonetheless, Hair et al. (2013) suggest an acceptable loading of 0.4 for exploratory studies. Furthermore, their removal worsens the overall internal consistency results. Therefore, we decided to maintain these in the model. This means that all the indicators in our model well predict the overall variance of each construct (Hair et al. 2019).

This means that all the indicators in our model well predict the overall variance of each construct (Hair et al. 2019). As regards the model collinearity, variance inflation factor (VIF) values are uniformly below the threshold of 5 (Hair et al. 2019). Moreover, internal consistency is given since all the constructs report Cronbach's α values, composite reliability, and Dijkstra-Henseler's ρa higher than 0.7. It is also important to notice that composite reliability for the INT and TMS indicator are slightly above the desired threshold value. Indeed, as stated by Hair et al. (2017), values above 0.95

Table 3 Outer model evaluation criteria

TOE context	Construct	Indicator	Factor Loading	Mean	Standard Deviation	Cronbach's α	Composite reliability *ρc*	Dijkstra-Hensler's *ρa*	AVE
	INT	int_1	0.931	3.155	1.435	0.929	0.955	0.932	0.875
		int_2	0.923	3.202	1.297				
		int_3	0.952	3.060	1.391				
TC	PEOU	$peou_1$	0.911	3.560	1.206	0.744	0.886	0.788	0.795
		$peou_2$	0.872	3.786	1.131				
	PC	pc_1	0.825	3.810	1.156	0.812	0.888	0.832	0.727
		pc_2	0.903	3.690	1.140				
		pc_3	0.827	3.726	1.245				
	PU	pu_1	0.895	3.571	1.400	0.827	0.897	0.874	0.744
		pu_2	0.921	3.536	1.227				
		pu_3	0.763	3.393	1.280				
	SC	sc_1	0.710	3.333	1.417	0.759	0.819	1.279	0.606
		sc_2	0.930	2.619	1.325				
		sc_3	0.670	3.143	1.363				
OC	PLR	plr_1	0.699	2.726	1.356	0.811	0.875	0.870	0.639
		plr_2	0.821	2.607	1.299				
		plr_3	0.758	1.940	1.176				
		plr_4	0.905	2.202	1.159				
	TMS	tms_1	0.934	3.488	1.331	0.921	0.956	0.930	0.927
		tms_2	0.949	3.274	1.302				
EC	MP	mp_1	0.902	3.298	1.200	0.842	0.902	0.885	0.756
		mp_2	0.801	3.381	0.981				
		mp_3	0.901	3.405	0.983				
	NP	np_1	0.865	3.143	1.214	0.900	0.938	0.902	0.834
		np_2	0.931	3.286	1.082				
		np_3	0.942	3.333	1.134				

INT Intention to participate in MCs at farm level; *PEOU* Perceived ease of use; *PC* Perceived compatibility; *PU* Perceived usefulness; *SC* Security concerns; *PLR* Perceived lack of resources; *TMS* Top management support; *MP* Mimetic pressure; *NP* Normative pressure. Latent variables are measured through five points agree-disagree Likert scales. Cut-off levels: standardized indicator loadings > 0.7; Cronbach's α > 0.7; Composite reliability ρc > 0.7; Dijkstra-Henseler's ρa > 0.7; AVE > 0.5

indicate that all the indicator variables measure the same phenomenon. However, they also state that high composite reliability values occur when semantically redundant items measure constructs. All the indicators for the INT and TMS constructs have been kept in the model given that they measure different aspects of the construct domain through semantically precise sentences (Table 1). Also, convergent validity, namely the variance captured by each item with respect to the variance explained by measurement error for each construct, is approved as the average variance extracted (AVE) shows results that are consistently above the 0.5 threshold (Hair et al. 2019). As regards the discriminant validity, Table 4 shows the results for the Heterotrait-Monotrait (HTMT) criterion, which measures how each indicator corresponds to only one construct (Henseler et al. 2015; Hair et al. 2019).

Moving to the estimation of the inner model, which considers PLS path coefficients, the explained variance (R^2) is 0.757, and the predictive relevance (Q^2, cut-off level > 0) is 0.612. The TOE model explains 75% of the variance of farmers' intention to adopt marketing contracts.

Table 5 reports the estimated effect size f^2, the path coefficients from PLS-SEM algorithm and their t-values and significance. Following Hair et al. (2017), 5,000 subsamples were run through bootstrapping, a non-parametric approach to check for the significance statistics of path coefficients. The results show consistency between the effect size and the path coefficients, and that the intention to adopt MCs is influenced by different constructs belonging to the three dimensions of the TOE framework.

First, from the technological context, it is possible to appreciate the significant positive effect that MCs' perceived usefulness ($\beta_{PU}=0.180$) has on farmers' intention. Consistently with Michels et al. (2019), the PU construct was included to evaluate if the farmers' perceived usefulness for price risk management purposes positively influenced the intention. Our result, however, contrasts with Michels et al. (2019), which found no significant effect for the perceived usefulness of futures contracts on farmers' intention to adopt these for risk management purposes. The reason for this may lie in the different external conditions in which farmers operated in 2017 in Germany and in 2021 in Italy. Indeed, as confirmed by the literature (Ricome and Reynaud 2021), if the farmers' price risk exposure increases, the probability of using MCs increases as well. Thus, the more uncertain framework (COVID-19; productive factor prices) in which Italian farmers operated in 2021 results in this construct's positive significance. A recent study (Rippo et al. 2023) shows that farmers who recognize substantial weather risks are more inclined to adopt risk management tools covering income risks, unlike those who do not perceive such risks. This suggests that risk management policies need to account for heterogeneity due to the specific conditions each sector operates in. Hence, it is impossible to give a policy indication based merely on observing what happens in a single sector. Moreover, within the technological context, the perceived compatibility of MCs with the farm characteristics is positively associated with the intention to participate ($\beta_{PC}=0.301$). Hence, perceived compatibility is confirmed as an essential determinant of innovation adoption (Tornatzky and Klein 1982). Linked to farmers' dislike of constraining production practices (see Solazzo et al. 2020), the more a contract is perceived as compatible with farm production characteristics (i.e., quantity and quality), management, and size, the greater the intention to adopt MCs is. Since the compatibility is farm-specific (Saenger et al. 2013; Vamuloh et al. 2019), developing a differentiated offer of MCs (e.g., regarding contracts specifications) could effectively match the heterogeneity of farmers' needs and broaden the range of beneficiaries. Moreover, this finding complements the conclusions of Ciliberti et al. (2023), who highlighted the importance of contract design in the durum wheat sector in Italy. Our findings add that producers are also more inclined to adopt these contracts when they perceive them as compatible, thus well-design, with their operational needs and goals, thus increasing the likelihood of successful implementation. The PEOU and SC indicators had no substantial contribution to the analysed dependent variable ($f^2=0.001$ and 0.002, respectively). However, their effects are different from zero thus, the relevance of the construct could be important for further research aiming at increasing the sample size. Regarding the organisational context, the results show a significant association between top management support ($\beta_{TMS}=0.487$) and the perceived lack of resources ($\beta_{PLR}=0.131$) and the overall intention on MCs adoption. This means that the more prone to MCs the farm owner is, as he understands the benefits from their adoption at the farm level, the higher will be

Table 4 Outer model evaluation criteria (HTMT ratios for discriminant validity)

	INT	PEOU	PC	PU	SC	PLR	Size	TMS	MP	NP
INT										
PEOU	0.662 [0.493–0.814]									
PC	0.809 [0.696–0.910]	0.806 [0.610–0.979]								
PU	0.647 [0.470–0.810]	0.750 [0.575–0.918]	0.513 [0.328–0.708]							
SC	0.367 [0.209–0.552]	0.391 [0.377–0.607]	0.433 [0.326–0.666]	0.360 [0.276–0.606]						
PLR	0.213 [0.093–0.431]	0.487 [0.284–0.709]	0.496 [0.315–0.694]	0.318 [0.189–0.546]	0.659 [0.621–0.859]					
Size	0.044 [0.035–0.207]	0.301 [0.211–0.444]	0.089 [0.071–0.285]	0.115 [0.084–0.272]	0.210 [0.106–0.350]	0.143 [0.078–0.286]				
TMS	0.868 [0.803–0.926]	0.642 [0.445–0.782]	0.781 [0.634–0.908]	0.648 [0.445–0.782]	0.382 [0.235–0.585]	0.327 [0.151–0.523]	0.048 [0.019–0.238]			
MP	0.344 [0.155–0.559]	0.318 [0.138–0.542]	0.309 [0.135–0.548]	0.310 [0.153–0.529]	0.227 [0.123–0.438]	0.089 [0.097–0.292]	0.091 [0.034–0.242]	0.343 [0.143–0.568]		
NP	0.479 [0.279–0.662]	0.388 [0.194–0.602]	0.363 [0.165–0.575]	0.154 [0.083–0.372]	0.057 [0.100–0.339]	0.057 [0.084–0.280]	0.141 [0.034–0.367]	0.327 [0.129–0.531]	0.414 [0.237–0.589]	

Notes: INT = intention to participate in MCs at farm level; PEOU = perceive ease of use; PC = perceive compatibility; PU = perceive usefulness; SC = security concerns; PLR = perceive lack of resources; TMS = top management support; MP = mimetic pressure; NP = normative pressure. Heterotrait-Monotrait (HTMT) criterion for discriminant validity (cut-off level < 0.9). Confidence intervals (5–95%) in parenthesis

Table 5 Results for the inner model

Context	Hypothesis		f^2 effect size	Path coefficient	t-statistic (bootstrap results)
TC	H_1:	PEOU → INT	0.001	−0.020	0.196
	H_2:	PC → INT	0.144	0.301***	3.256
	H_3:	PU → INT	0.062	0.180**	1.723
	H_4:	SC → INT	0.002	−0.028	0.321
OC	H_5:	PLR → INT	0.043	0.131**	1.737
	H_6:	size → INT	0.005	0.038	0.820
	H_7:	TMS → INT	0.402	0.487***	4.959
EC	H_8:	MP → INT	0.002	−0.026	0.393
	H_9:	NP → INT	0.096	0.180**	2.474

Notes: INT = intention to participate in MCs at farm level; PEOU = perceived ease of use; PC = perceived compatibility; PU = perceived usefulness; SC = security concerns; PLR = perceived lack of resources; TMS = top management support; MP = mimetic pressure; NP = normative pressure. Bootstrapping procedures = 5,000 subsamples; p < 0.10, p < 0.05**, p < 0.001***. $R^2 = 0.75$; $Q^2 = 0.64$*

the intention to adopt these marketing tools. This result suggests an important focus to policymakers on a knowledge-based development of MCs. In this approach the spread of the specific risk management practice is based on knowledge-intensive practices. These practices contribute to the understanding and advancement of the specific innovation (Powell and Snellman 2004). Indeed, the literature showed that marketing training could increase farmers' adoption of forward-pricing techniques like MCs (Goodwin and Schroeder 1994). Thus, given the strong link of TMS with intention, effective marketing training could increase farmers' motivation and, thereby, their choice to use MCs for their price risk management. As for the perceived lack of resources construct, the literature typically reports evidence of an adverse (negative) effect of PLR on intention (Giampietri and Trestini 2020). The significant positive effect that our results show for PLR finds no evidence on which to build a discussion and interpretation besides being apparently counterintuitive. Further studies are therefore crucial to better understand this relationship, especially by examining larger samples from different regions and contexts. This approach may help to identify any contextual factors that may explain this anomaly. In particular, future research should examine the perceived need for additional investment, increased workload, new specialized workers (e.g., consultants) and specific training required for the use of MCs.

Opposite to what reported by the literature, the farm size does not influence the intention to adopt MCs in our sample. Indeed, Pennings et al. (2004) found that larger firms are believed to participate in marketing contracts more actively because of the higher level of resources and their potential trading volume. Additionally, Vamuloh et al. (2019) linked the higher adoption rate from large businesses to the advantages for the contracting firms in dealing with fewer larger farms than multiple smallholders. Considering this, the use of MCs could be related to a lower compelling from contracting firms to smallholders. Even though the results did not reach statistical significance, this hypothesis may merit further examination. Future research could explore potential mediating variables between farm size and adoption intention. Moreover, we acknowledge that other factors such as age, education, and cooperative membership may also

affect the intention to adopt and are worthy of further investigation. In relation to the environmental context, our findings show a positive association between NP and intention, being consistent with the literature on agricultural innovation adoption (Yoon and George 2013; Giampietri and Trestini 2020). This shows the important role of the buyers (cooperatives, consortia, and storage centers) in suggesting the use of marketing contracts ($\beta_{NP} = 0.169$). Interestingly, given the reported lack of trust in production management contracts (Solazzo et al. 2020), our result highlights the effective role of farmers' buyers to encourage the use of MCs. This may also guarantee buyers a more stable marketing strategy (i.e., defined quantity and quality commodity purchase). However, the significant effect that buyer support shows in influencing the farmer's choice could boost market distortions. Indeed, given that a multiplicity of farmers sells their product to a lower number of buyers, the competitiveness of agricultural markets (namely that all buyers and sellers are price-takers) is uncertain (Sexton 2013). The buyers' higher market power could significantly affect and reduce farmers' choices in participating in MCs. Finally, MP does not influence the intention to adopt marketing contracts and explains a very small parts of the variance of the target constructs. Thus, overall, the environmental context and the resulting network effect are important only in the case of buyers. This focuses the attention of policymakers on these important actors to promote and spread agricultural contracts as risk management tools.

To sum up, the TOE model allows for the acceptance of H_2, H_3, H_5, H_7 and H_9. The farm's owner supporting the innovation adoption has the highest positive effect on the intention to participate in MCs, followed by the perceived compatibility of MCs. This is in line with the concept suggested by Solazzo et al. (2020), according to which farmers' independence resulted very important. Thus, if an instrument is perceived as compatible, the farm owner has a higher intention for the adoption, compounding the study of Frascarelli et al. (2021) A similar magnitude on the intention to adopt springs from the normative pressure construct, perceived usefulness and perceived lack of resources. Our results suggest that to stimulate Italian farmers' participation in MCs, efforts must be focused on reinforcing the farm owner's understanding of the usefulness of MCs but also on the buyers and their effort to suggest adaptable MCs to farms' characteristics.

Conclusions

Commodity growers are increasingly exposed to price risk, which threatens their income and resilience in the long run. Marketing contracts envisage a strategy to manage the price risk at the farm level as they provide farmers with the possibility to sell their products at a fixed price. Nevertheless, the spread of such marketing contracts in agriculture appears generally scarce in Italy, hence their adoption can be considered an innovation. This paper applies a TOE framework to investigate which factors affect the spread of this innovation among farmers. The methodological approach used to test this framework is PLS-SEM, which allowed to test several relationships simultaneously.

From our sample, we can conclude that farmers' intention to participate in MCs can be considered an innovation adoption, and thus it can be analysed by applying the TOE framework. In particular, the results show that farmers' intention to participate in MCs is driven by factors belonging to the technological, organisational and environmental contexts. The main drivers of farmers' participation in MCs are the perceived usefulness

for risk management, the perceived compatibility with the characteristics of the agricultural production (technology), the positive attitude of the farm owner towards this tool (i.e., if he/she encourages the adoption) (organisation) together with the support and pressure of the buyer in adopting this contractual solution (environment). The results indicate that a farmer's intention to use commodity futures contracts is motivated by farmers' beliefs that MCs can serve as a tool for reducing the price risk. Moreover, confirming the linked heterogeneity in MCs use and farmers' categories, this result suggests that providing favorable different contractual conditions—according to different farm categories—could broaden the range of beneficiaries. Further research could be aimed at deepening the issue. Confirming literature results, MCs support by the farm owner is linked with a higher participation rate. Finally, farmers' intention to adopt MCs relies on buyers' effective recommendations. This evidence demonstrates that the role of buyers in spreading MCs uptake among farmers is significant. Therefore, it is crucial that farmers' cooperatives, consortia, and storage facilities actively disseminate information on the potential benefits of MCs, particularly in terms of risk management. Specific strategies could include organizing targeted educational programs for farmers, highlighting the economic advantages and risk mitigation properties of MCs. Additionally, buyers should provide comprehensive support to farmers in establishing and managing these contracts, potentially through dedicated advisory services or training. Alongside this, the buyer's potential high market power emerges. Buyer support for farmers' participation in MCs may be controversial despite being rationally efficient because of the limitation to the market competitiveness and the implication for the farmers' economic freedom (Sexton 2013). Policymakers should address these concerns by ensuring a balanced approach that promotes the uptake of MCs without compromising the competitive dynamics of the market. This could include regulatory measures to safeguard against monopolistic practices and to ensure that the benefits of MCs are shared equitably among all stakeholders.

In addition, it is crucial that stakeholders and policymakers recognize the wider benefits, such as improving market access, stabilizing incomes and promoting better planning. Tailoring contracts to the different needs of farmers could ensure that they serve not only as tools for immediate financial stability, but also as instruments for long-term resilience and sustainability in the agricultural sector. The study applies a theoretical framework well established in the literature but never applied to the adoption of MCs before, namely the TOE model. The results provide initial evidence to facilitate stakeholders (buyers, policymakers, extension services) to target their efforts by encouraging the use of price risk management tools such as MCs. It, therefore, has a twofold impact: first on the literature (i.e., regarding the usefulness of TOE), and for cooperatives/consortia and regulators who are looking for innovative strategies for farmers to tackle market risks while ensuring product supply also satisfactory in terms of quality (due to contractual requirements that also include clauses on quality).

Albeit its innovativeness, this study is not without limitations: one major lies in the limited sample, which may reduce the possibility of generalising the discussion of the results. On the other hand, the results validate the TOE model for the analysis of farmers' intention towards participating in MCs. Thus, further research should be repeated on a more representative and larger sample. Also, cross country comparisons (for

instance, considering EU member states) are welcome to provide relevant information to policymakers whose aim is to reinforce the sustainability and resilience of the European farms. Finally, the manuscript evaluates the intention on adoption and for further research it would be very interesting to bridge the intention and actual adoption of MCs contracts from farmers.

Abbreviations

MC	Marketing contracts
PMC	Production management contracts
PC	Production contracts
INT	Intention
PEOU	Perceived ease of use
PC	Perceived compatibility
PU	Perceived usefulness
SC	Security concerns
PLR	Perceived lack of resources
TMS	Top management support
MP	Mimetic pressure
NP	Normative pressure

Author contributions

Conceptualization C.P. and E.G; methodology C.P., S.T. and E.G; data collection C.P., S.T. and E.G; data curation C.P.; formal analysis C.P.; writing—original draft preparation C.P. and E.G., writing—review and editing C.P., E.G. and S.T.; supervision S.T. and E.G. All authors have read and agreed to the published version of the manuscript.

Funding

This work has been developed within the PRIN project 20205L79R9 funded by the Italian Ministry of University and Research (MUR).

Availability of data and materials

Data will be made available on reasonable request.

Declarations

Competing Interests

The authors declare that they have no competing interests in the manuscript.

Received: 27 December 2023 Revised: 12 October 2024 Accepted: 24 October 2024
Published online: 11 November 2024

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