REA
RIVISTA DI ECONOMIA AGRARIA

ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Poste Italiane spa - Tassa pagata - Piego di libro
Aut. n. 072/DCB/FI1/VF del 31.03.2005

FIRENZE UNIVERSITY PRESS

Vol. 76 | n. 2 | 2021

REA 75° anniversario

Italian Review of Agricultural Economics

Vol. 76, n. 2 – 2021

Firenze University Press

Italian Review of Agricultural Economics

Published by
Firenze University Press – University of Florence, Italy
Via Cittadella, 7 - 50144 Florence - Italy
http://www.fupress.com/rea

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Editorial note

I am honored and very proud to announce the achievement of the SCOPUS indexing for our journal Italian Review of Agricultural Economics (REA). The journey started in 2014 and successfully concluded a few days ago. This means that our Review will soon enter the world's largest database of scientific journals. In this long journey the Review flourished thanks to the joint efforts between the Executive Board, CREA, the Scientific Society SIDEA and the publisher Firenze University Press (FUP). REA evolved over time by opening up to international debate, never recanting its own identity by publishing articles in Italian and, above all, by directing some research towards the analysis and evaluation of national policies in the sector. This represents an important support for the decision-making bodies of the Ministry of Mipaaf and, more generally, of the Government. For this ambitious purpose REA was created back in 1946 by the founding fathers. Following the best international publishing practices REA provides an open access publishing platform and offers transparent, digitalized and certified editorial procedures from submission to publication. But that's not all. The journal also changed its editorial format implementing new features and an attractive editorial look that meets the international standards. In addition, prominent personalities from the international scientific world, such as the colleagues Pery Shikida (Brazil) and Martin Banse (Germany) joined our editorial board. I cannot say that the journey over the years has been easy. But I think I can say that, like any mountain ascent, the joy, when you reach the top, is proportional to the effort we had to sustain. I want to thank all the authors, the scientific committee, the reviewers and the editors, because without their contributions, this achievement would have been impossible. And I would like to underline that the success of this enterprise is due to the "granitic" collaboration and the great competence of the members of the steering committee Teresa del Giudice (SIDEA), Roberta Sardone (CREA), Mario D'Amico (SIDEA) and Andrea Povellato (CREA), not forgetting the precious technical support of the editorial staff and Alessia Fantini (CREA). A special thanks goes to Dr. Alessandro Pierno, from Firenze University Press, who supported us since the beginning with a positive, professional and constructive spirit, actively contributing to the achievement of this goal.

My personal thanks go to the Sidea Society and to Past President Francesco Marangon with whom I began this enriching editorial experience, to Giulio Malorgio, the current SIDEA President, and to Roberto Henke, Director of CREA-PB. I conclude by saying that I decided to write these few but heartfelt lines at the end of my editorial adventure, which will end in 2021. It has been an extraordinary scientific and academic experience, that concluded with an equally extraordinary success. I sincerely wish my successors will raise REA even more on the international scene with the same dedication, passion and tenacity that characterized my (and our) experience.

Adele Finco
Editor-in-Chief

Italian Review of Agricultural Economics Vol. 76, n. 2: 3-4, 2021
ISSN 0035-6190 (print) | ISSN 2281-1559 (online) | DOI: 10.36253/rea-13098

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Firenze University Press
www.fupress.com/rea

Nota editoriale

È con grande soddisfazione e molta commozione che annuncio il raggiungimento del traguardo di indicizzazione SCOPUS per la nostra rivista *Italian Review of Agricultural Economics (REA)*. Il percorso iniziato nel 2014 si è concluso con successo pochi giorni fa.

Ciò significa che la nostra Rivista entrerà presto nel più grande database mondiale di riviste scientifiche.

In questo lungo cammino la Rivista si è evoluta grazie agli sforzi congiunti tra il Direttivo, il CREA, la Società Scientifica SIDEA e la casa editrice Firenze University Press (FUP).

REA si è emancipata nel tempo aprendosi al dibattito internazionale, senza mai rinunciare alla propria identità pubblicando anche articoli in italiano e, soprattutto, indirizzando alcune ricerche verso l'analisi e la valutazione delle politiche nazionali di settore, che possono e debbono costituire un supporto importante per gli organi decisionali del Ministero Mipaaf e più in generale del Governo Nazionale. Per questo scopo ambizioso REA fu creata nel lontano 1946 dai padri fondatori.

Adeguandosi alle migliori pratiche editoriali internazionali REA si è dotata di una piattaforma di pubblicazione open access e ha digitalizzato e certificato tutti i processi editoriali dalla submission alla pubblicazione. Ma non solo. La rivista ha cambiato anche il formato editoriale e oggi si presenta con un look editoriale accattivante che risponde agli standard internazionali. Inoltre, il comitato editoriale ha accolto personalità di spicco del mondo scientifico internazionale, come i colleghi Pery Shikida (BRASILE) e Martin Banse (Germania),

Non nascondo che il percorso negli anni non sia stato facile. Ma credo di poter dire che, come ogni ascesa in montagna, la gioia, quando si arriva lassù in cima, è proporzionale alla fatica che abbiamo dovuto sostenere.

Voglio ringraziate tutti i nostri autori, il comitato scientifico, i revisori e gli editor, perchè senza i loro contributi questo risultato sarebbe stato impossibile. E ci tengo a sottolineare che il successo di questa impresa lo devo alla vicinanza, alla "*granitica*" collaborazione, alla grande competenza dei membri del comitato direttivo Teresa del Giudice (SIDEA), Roberta Sardone (CREA), Mario D'Amico (SIDEA) e Andrea Povellato (CREA), non dimenticando certo il prezioso supporto tecnico della redazione e di Alessia Fantini (CREA).

Un ringraziamento particolare va al dott. Alessandro Pierno, della Firenze University Press, che ci è stato vicino fin dagli inizi con spirito positivo e con professionalità ed ha concorso fattivamente al raggiungimento di questo obiettivo.

Un ringraziamento personale lo dedico alla Società Sidea e al Past President Francesco Marangon con il quale ho iniziato questa esperienza editoriale che mi ha molto arricchito, a Giulio Malorgio, attuale Presidente SIDEA e a Roberto Henke, direttore del CREA-PB. Tutti loro non mi hanno mai fatto mancare il loro quotidiano sostegno e la loro stima.

Concludo nel dire che mi sono decisa a scrivere queste poche ma sentite righe in occasione della fine del mio mandato, che si chiuderà di fatto con il 2021. È stata una straordinaria esperienza, scientifica e accademica, conclusasi con un successo, per quanto mi riguarda, altrettanto straordinario. A chi mi seguirà, l'augurio sincero di elevare REA ancora di più nel panorama internazionale con la stessa dedizione, passione e tenacia che hanno caratterizzato questo mio, questo nostro mandato.

Adele Finco
Direttore della Rivista

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Firenze University Press
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Citation: André Luis Ramos Sanches, Cassiano Bragagnolo, Geraldo Sant'Ana de Camargo Barros, Lucilio Rogerio Aparecido Alves (2021) Optimal Storage in Brazilian Corn Market: application of a rational Dynamic Model. *Italian Review of Agricultural Economics* 76(2): 5-15. DOI: 10.36253/rea-12018

Received: September 4, 2020

Revised: November 5, 2020

Accepted: June 7, 2021

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Optimal Storage in Brazilian Corn Market: application of a rational Dynamic Model

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Abstract. This paper aims to analyze the decision regarding corn storage (for the first and second crops) in the current context of the Brazilian market through an economic model of dynamic storage. We consider storage as a competitive economic activity and that agents can maximize profit through rational expectations. Our results provide a comprehensive analysis of how growth in the Brazilian second crop and high level of exports has impacted corn storage dynamics. The export rule suggests increasing exports when availability exceeds 37.3 million tons in the first crop and 56.3 million tons in availability in the second crop. The storage rule suggests that storage formation occurs increasingly in the first crop when supply exceeds 38.1 million tons and 60.9 million tons in the second crop.

Keywords: Brazilian corn market, commodity price dynamics, storage model.
JEL codes: Q11, C61, D41.

1. INTRODUCTION

The volatility of agricultural commodity prices tends to be high over time, with greater sensitivity to supply shocks due to the biological nature of production, as well as seasonal and cyclical components. The high volatility of agricultural prices poses risks for both producers and consumers. The potential of storage for moderating such risks is widely recognized (Bobenrieth *et al.*, 2013; Cafiero *et al.*, 2011; Miranda, Helmberger, 1988; Williams, Wright, 1991). However, studies that analyze the important recent changes in the Brazilian grain market are scarce.

This paper provides a numerical simulation of the storing strategies in the Brazilian corn market. For that, an economic model is applied to predict optimal storing behavior and ultimately the impact on prices and consumption with different levels of supply.

The possible interest for an international audience is associated with the possibility of replicating the equilibrium equations and the model calibration for different contexts. Also due to the importance of Brazilian production

in global trade, Brazil is currently responsible for the second-largest volume of corn exports. A better understanding of the decision to store and export can help international agents operating in this market.

The Brazilian corn market underwent important structural changes, both in the production system with the introduction of the second harvest and in greater integration with the foreign market, via exports (Alves *et al.*, 2018; Mattos, Silveira, 2018). Production jumped from 41.5 million tons in 2000/2001 to 101 million tons in 2018/2019. The development of new seed technologies and expansion of the joint soy and corn production system in the same crop year allowed the Brazilian production of second-crop corn to increase significantly, going from 15% of the total production in 2000/2001 to 73% in 2018/2019. The greater supply was accompanied by an increase of 491% in exports in the same period. With this, Brazil consolidated itself as one of the main corn producers and exporters worldwide (CONAB, 2020; USDA, 2020).

Much of the government policies for controlling agricultural prices and/or managing government stocks frequently implemented in the second half of the 20th century has been extinguished. A detailed discussion of agricultural price policies in Brazil is available in Schwantes & Bacha, 2019. Currently, the decision to store corn in the Brazilian market rests exclusively with the private sector reflecting market conditions.

In this context, the stock-to-use ratio in the Brazilian corn market is lower compared to other main producing countries. Between the 2000/2001 and 2018/2019 harvests, the average stock-use ratio in Brazil was 0.14, while in the same period in the United States it was 0.16, and in China, 0.51(USDA, 2020). The lower stock-to-use ratio tends to reflect higher price volatility and, consequently, higher price risk for producers and consumers (Bobenrieth *et al.*, 2013) demonstrated the relevance of the standard storage model for understanding the relations between stocks and prices of commodities.

This study analyzes the decision to store corn in the recent context of the Brazilian market. Specifically, we propose a dynamic stochastic economic model to analyze private storage under the assumption of rational expectations of agents. Besides, using the calibrated model, we verify the market's responses and the expected prices expressed by quantity stored with different levels of supply.

Due to the peculiar evolution that corn production in Brazil has had in recent decades, none of the preexisting storage models in the literature are adequate to study the corn market in Brazil as it evolved to the current configuration. Thus, this study sought to adapt the existing models in the literature to this new reality in the corn market, incorporating in the model the greater integration to foreign markets via exports and the expansion of second crop production. The impacts of these changes on corn storage activity in Brazil have not yet been discussed previously in the literature.

2. RELATED STUDIES

Literature about storage is extensive and beyond the scope of this paper. The purpose of this section is to present the reader with works that contributed to a better understanding of the decision to stock grain, on the hypothesis that storage competitive market and that agents rationally make decisions.

It is widely recognized in the economic literature that speculative storage activity provides an efficient market-based way to reduce price volatility in commodity markets (Bobenrieth *et al.*, 2013; Cafiero *et al.*, 2011; Miranda, Helmberger, 1988; Williams, Wright, 1991). Agricultural price risk is a concern of both producers and consumers, which justifies an active academic debate on the role of storage regarding agricultural price volatility.

The seminal storage model proposed by Gustafson (1958) presents a numerical solution for the problem of deciding how much to store out of a given available amount of a storable product.

Wright & Williams (1982) revisited Gustafson's (1958) approach by analyzing the storage economy as a dynamic problem. The authors develop numerically and develop polynomial approximations to the function relating expected price and current storage level. The authors demonstrated that the possibility of storage affects producers and consumers.

The extension of the numerical model to the case of competitive supply by producers maximizing expected profits, and holding rational expectations, was introduced by Wright & Williams (1984). In their model, both production and storage begin to respond rationally to economic incentives. Thus, the decisions to produce and store are made by agents who seek to maximize profit in a competitive environment and all form rational expectations.

Miranda & Helmberger (1988) assess the effects of regulatory stocks policy on the U.S. soybean market in which the government attempts to stabilize agricultural prices through open market purchases and sales. The model allows for private storage, government stocks, and expected price-responsive production. Miranda & Glauber (1993) develop a method for systematically estimating a rational expectations commodity market model that explicitly incorporates both private and government

stockholding dynamics, in an empirical application to the U.S. soybean market.

Fackler & Livingston (2002) discuss storage management related to the marketing decision of harvested crops. They pointed out that agricultural producers with access to storage have flexibility in choosing the timing and quantities of sales. The decision rule is demonstrated to result in substantial gains from storage.

Williams & Wright (1991) synthesize the modern theory of competitive storage. The authors have a detailed discussion about supply, demand, and market clearing conditions to the intertemporal arbitrage equation. Williams & Wright (1991) and Cafiero *et al.,* (2011) present a wide review of the empirical relevance of the competitive storage model and results from optimal competitive storage under stochastic supply and demand shocks.

Peterson & Tomek (2005) apply the rational expectations competitive storage model to solve the unknown functional forms of expected price in the United States of America corn market. This model is used to examine the performance of this framework in explaining price behavior in an actual commodity market.

With a less price-sensitive consumption demand curve, Cafiero *et al.* (2011) show that storage can generate in their model levels of sample correlations and variation of price in the observed ranges for some commodities. Thus, the relevance of the storage model is re-established as an empirical question.

Serra & Gil (2013) studied US corn price observed from January 1990 to December 2010 by allowing for the influence of ethanol markets, corn stocks forecasts, and macroeconomic conditions. The results showed the impacts of stocks-to-disappearance forecasts in the short run are very high relative to the effects of energy price and macroeconomic instability.

Bobenrieth *et al.* (2013) have presented a procedure to construct, using global commodity price data and a commodity storage model estimated on those price data and stocks-to-use ratios. The results suggest that stock data can be valuable complements to imperfect price data as indicators of vulnerability to shortages and price spikes.

Guerra *et al.* (2015) explored the limits of econometric estimations of the standard commodity storage model. They present the application of a maximum likelihood estimator of the storage model using the case of the United States corn price.

Zhou & Babcock (2017) use the competitive storage models to estimate the impact of ethanol and fueling investment on corn prices in the United States. The results showed that corn prices could decrease by 5% or 6% if the US biofuel mandates were to be reduced.

Oglend & Kleppe (2017) have investigated the commodity price implications of bounded speculative storage. Storage capacity introduces another source of limits-to-arbitrage in commodity markets. In general, a fixed capacity reduces the shock smoothing effect of storage.

Only two papers of this nature studied the Brazilian grain market. Guimarães & Barros (2006) analyzed the corn market through dynamic models of rational expectations with data from 1986 to 2000. The authors show that the opening of the market transfers to the external trade part of the role of buffering internal supply and demand shocks.

Bragagnolo *et al.* (2009) analyzed the decision to store rice in Brazil using dynamic models of rational expectations capable of capturing the effects of imports and policies to sustain producer prices adopted by the Brazilian government. The authors demonstrate that, in the presence of storage activity, there is less dispersion of consumption over time, which makes the variation of prices lower.

3. THE RATIONAL STORAGE MODEL

The storage problem can be understood as the allocation of a given quantity of product between current consumption and the formation of stocks for future consumption.

In a perfectly competitive economy, it would be economically viable for an individual agent to store one more unit of product, as long as the difference between the expected price and the current price is greater than or equal to the storage cost.

Our empirical estimation follows the approach of Williams & Wright (1991), and adaptations for the Brazilian case proposed by c. This method allows predicting optimal storing behavior with different levels of supply and the respective variations on prices and quantity consumed.

In recent years, corn production in Brazil on a large scale occurs in two periods in the same crop year[1]. In this context, we propose a dynamic stochastic economic model to analyze private corn storage in the first and second harvests. The characteristics of each period are evaluated.

The simulation models assume that the data of the first corn crop refer to the first semester of the year (the period in which the harvest and commercialization of the crop are concentrated), while the data of the second crop refer to the second semester.

[1] More details on the characteristics of grain production and marketing in Brazil are showed by Alves *et al.* (2018).

Keeping these parameters constant for all periods, the problem becomes stationary and, therefore, it is possible to find the optimal storage rule for equilibrium. In addition to the hypothesis that stocking activity is a competitive activity, the model assumes a constant return of scale in land use and the existence of neutrality about risk. That is, the economic agents involved in the economic process are neutral for the risk inherent in the storage activity (Bragagnolo *et al.*, 2009).

Technical details of the estimation procedure can be found in Williams & Wright (1991). We present a general overview of the method in Appendix Awith the steps of the different functions.

4. PARAMETERS SPECIFICATION

The parameters used to calibrate the model are based on the Brazilian corn market between the crop years 2000/2001 and 2018/2019. Pieces of information on corn supply and demand in Brazil are presented in Appendix B.

The method used requires the following parameters: the relationship between domestic consumption and prices, domestic consumption shocks, expected profit per area, supply shocks, average export price, the cost of storage, the real interest, and storage losses.

The relationship between domestic corn consumption and domestic corn prices were estimated by ordinary least squares, where the semiannual average of domestic consumption was the independent variable. It was estimated based on the amount of domestic consumption per crop year released by the National Supply Company (CONAB, 2020). It was assumed that domestic consumption occurs linearly throughout the year. The daily prices of corn for the region of Campinas/SP released by the Center for Advanced Studies in Applied Economy - Cepea/Esalq/USP were used as a reference for domestic prices with values for the period 2001- 2019. The prices were deflated by the official Prices General Index – Internal Availability (IGP-DI) for December 2019 and it was used to calculate the semiannual price average.

To estimate shocks in consumption, residues were computed based on the regression of demand for consumption. From the residues, a normal probability distribution of a zero mean and standard deviation of each sample (first and second crops) was simulated for 8 equally spaced values. The lowest and highest values are considered equivalent to the 99% confidence interval of the distribution.

The relationship between the planted area and the expected profit per acre is estimated by ordinary least squares. The production cost is an independent variable. The planted area data and the cost of production were obtained from Conab. All data were deflated by the IGP-DI to December 2019 values.

The productivity frequency distribution of the first and second corn crops was calculated by the average productivity between crops 2000/2001 and 2018/2019 released by (CONAB, 2020), disregarding the trend of productivity gain over the period. From the mean and standard deviation of both the first and second crops yield series, two normal distributions were generated, one for each crop, with 16 values each, equally spaced, with the highest and lowest values equivalent to the confidence interval of 99 % of the distribution.

The average prices of the first and second semesters were calculated from the average monthly price of Brazilian corn exported values for the period 2001 to 2019, released by the Ministry of Industry, Foreign Trade and Services. All data were deflated by the IGP-DI to December 2019 values.

The storage cost was calculated based on the information released by the Storage Information System (Siarma/Esalq-Log/Esalq/USP, 2020).

The Selic interest rate (which is the basic interest rate in Brazil) has been adjusted to remove the effects of inflation to reflect the real interest rate in December 2019. It was based on domestic inflation rates (IGP-DI) between 2001 and 2019.

Our model considers the fixed deterioration of inventories or storage losses of 1.5% per year. It was based on the works of Faroni, Barbosa, Sartori, Alenar, 2005; Siarma/Esalq-Log/Esalq/USP, 2020.

The generation of random numbers, the frequency distribution of variables, the relationship between consumption and prices, the demand function, and the relationship between expected profit per area were made using the statistical program R. All other numerical calculations and procedures were performed using an electronic spreadsheet.

We calibrate the model described in Section 3 assuming parameters specification reported in Table 1.

5. THE OPTIMAL STORAGE RULE IN THE FUNCTION OF THE EXPECTED PRICE AND PLANTED AREA

As mentioned above, the analyses consider as periods the first and second semesters of each year. The estimation of the algorithm for the functions of the expected price and the expected area begins with the definition of a vector of n elements, equally spaced, for the ending storage in the previous period *(t-1)*. In this model,

Tab. 1. Parameters specification.

Parameters	First crop	Second crop
The relationship between domestic consumption and prices		
- Constant	1.042,92	1.053,30
- Angular coefficient	-0,0118	-0,0136
Domestic consumption shocks		
- Mean	0,0000	0,0000
- Standard deviation	4.294,58	3.455,44
Expected profit per area (acres)		
- Constant	10.713,88	25.310,29
- Angular coefficient	0,234	0,4133
Supply shocks		
- Average productivity (tons/acres)	1,7357	1,63
- Standard deviation	0,1646	0,3066
Real interest rate (%/ year)	*5,3367*	*5,3367*
Storage losses (%/ton/year)	*1,5*	*1,5*
Storage cost (R$/ton)	5,06	5,06
Average export price (R$/ton)	601,8248	582,465

Note: Standard errors are in parentheses.
Source: Research results.

29 storage values were defined, spaced by 500 thousand tons, between zero and 14 million tons. The definition of this set of values was based on the context of the Brazilian corn market.

The multiplication of the planted area and the 16 possible values of productivity gave rise to 16 values of total production for each of the 29 initial values of storage, thereby generating 464 different values of products in the period. The initial availability of the model is generated from the sum of preliminary storages and domestic production, less physical losses during storage.

In this simulation, 8 values were used for each demand shock in period t. Total availability resulted from the sum between initial availability and demand shocks, generating a simulation of 3.712 values.

The decision of the farmer to store or not is taken on the basis of the expected price, storage costs, interest rate, storage losses, and area and demand functions. The optimal storage rule to different levels of product availability (initial stocks plus current production) is exposed in Figure 1. It is worth mentioning that stocks in the domestic market only occurs when the profit prospect of storing the commodity is greater than that from exporting it.

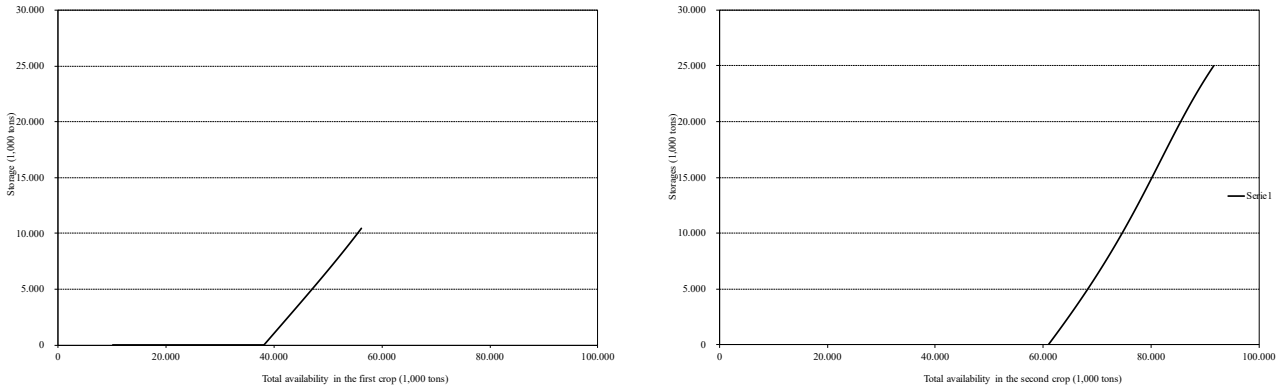
The formation of storage in any given period (year) occurs when availability exceeds 38.01million tons from the first crop and when it exceeds 60.9 million tons from the second crop (Fig. 1). Availability lower than these values would lead to no stock formation.

The parameters of the expected price equations $E(Pt+1)$ as a function of the storage(S_t) of the previous period were approximated by fourth-degree polynomials from the results obtained in the model simulations. So for any period t:

$$E(P_{t+1}) = 1.85497*10^{-16}*S_t^4 + 5.12895*10^{-12}* S_t^3 + 8.13277*10^{-8}* S_t^2 - 1.06156*10^{-2}*S_t + 724.527603.$$

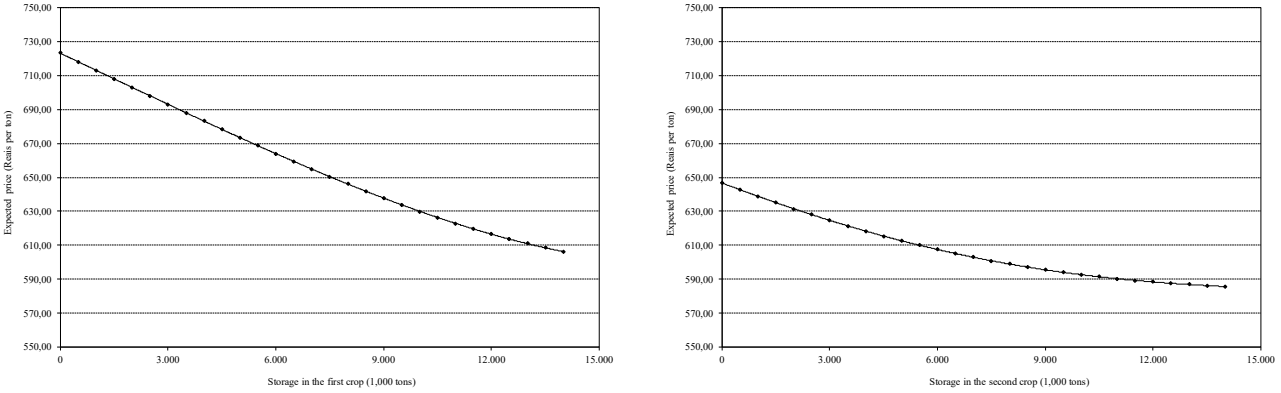
For the first crop (period 1), the results of the simulation indicate that when there is no preliminary storage ($S_0 = 0$), the expected price for the next period is R$ 724.53 per ton.

Fig. 1. Storage Rule.



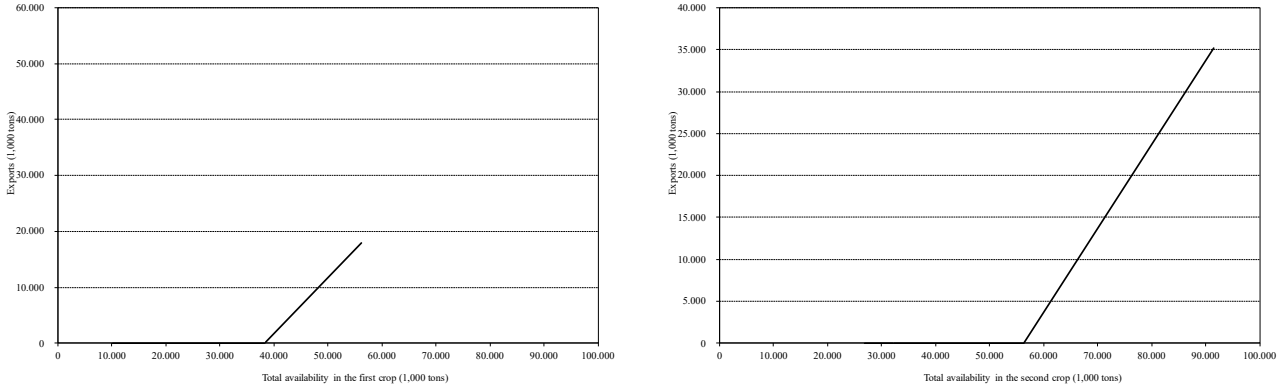
Source: Research results.

Fig. 2. Expected price based on storage.



Source: Research results.

Fig. 3. Exports based on supply.



Source: Research results.

For the second harvest, the results indicate that when the final storage of the previous crop is zero, the expected price is R$ 646.72 per ton. The equation of the expected price for the second crop as a function of the storage of the previous crop is presented below:

$$E(P_{t+1}) = -4.39569*10^{-16}*S_t^4 + 1.03133*10^{-11}* S_t^3 + 2.04989*10^{-7}* S_t^2 - 8.04279*10^{-3}*S_t + 646.72501$$

The higher the storage levels, the lower the price level expected for the next period. Figure 2 shows the expected price according to the storage found in the model for the simulations referring to the first and second crops.

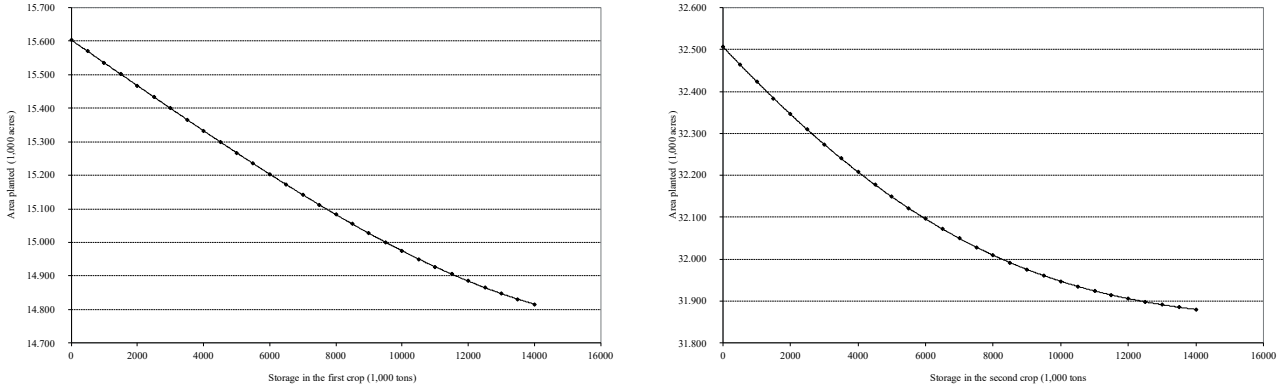
Model simulations indicate that exports during the first crop start when supply reaches 37.3 million tons. During the second crop, the period of greatest corn supply in the Brazilian market, exports occur in greater quantities. Exports start when availability reaches 56.3 million tons and increase up to 35.2 million tons when supply is approximately 91.5 million tons.

From the simulated values, it is possible to define an export rule to corn availability, assuming the assumptions and parameters considered in this model. Figure 3 shows the export quantities according to the supply found in the model.

The parameters of the equation of the area to be planted (A_{t+1}) as a function of the ending storage of the previous period (S_t) were approximated by fourth-degree polynomials from the results obtained in the simulations of the model. The simulations indicate that the higher the final storage of the previous crop the lower the expected price, and consequently, the lower the planted area.

For the first harvest, the simulations indicate that the largest planted area is 15.6122 million acres when the ending storage of the previous period is zero and decreasing successively as the ending storage of the pre-

Fig. 4. Area planted based on storage.



Source: Research results.

vious period increases. The polynomial used to describe the planted area of the first crop as a function of the ending storage of the previous period is presented below:

$$A_{t+1} = 1.06647*10^{-15}*S_t^4 + 4.03052*10^{-11}* S_t^3+5.11583*10^{-7}* S_t^2- 7.15466*10^{-2}* S_t + 15.6122$$

For the second crop, the simulations indicate that the maximum observed area is 32.500 million acres when the ending storage of the previous period is zero. The polynomial used to describe the planted area of the second crop to the ending storage of the previous period is presented below:

$$A_{t+1} = -4.84389*10^{-15}*S_t^4 + 1.02693*10^{-10}* S_t^3 + 2.44394*10^{-6}*S_t^2 – 8.58213*10^{-2}* S_t + 32.5069*10^4$$

Figure 4 shows the area planted according to the storage found in the model for the simulations referring to the first and second crops.

6. CONCLUDING REMARKS

The model purposed to analyze the decision to store corn from the perspective that storage is a competitive economic activity and that agents are profit maximizers. The decision to store corn is taken in the context of the recent structural changes in the Brazilian market, with the greater participation of the second crop in total production and increasing exports.

The simulations show that expansion of production, consequently greater cereal supply is accompanied by increasing levels of storages and exports. The simulations corroborate the trend of expansion of the production of second-crop corn in Brazil, and, consequently, higher levels of supply, export, and storage. Actual data on prices, corn supply, and demand in Brazil are presented in Appendix B.

The results suggest the strong influence of external demand, via exports, under the dynamic equilibrium of the Brazilian corn market. With the expansion of domestic production, mainly of corn produced in the second crop, the levels of storage and export balance are increasing, supported by the greater cereal surplus and pressure on domestic prices.

The supply of corn in Brazil has increased expressively in recent years with the expansion of second-crop corn production. Actual data show that corn production in Brazil was significantly higher than consumption in recent years, for example in 2016/2017 crop production was 70% higher than consumption. The greater supply of the commodity enabled increases in exports and the quantity stored. After the 2012/2013 crop, Brazilian production has surpassed 80 million tons, a period in which there was a large increase in the stock-consumption ratio (Appendix B).

The calculated export rule suggests increasing exports when availability exceeds 37.3 million tons in the first crop and 56.3 million tons in availability in the second crop. The calculated storage rule suggests that storage formation occurs increasingly in the first crop when supply exceeds 38.1 million tons and 60.9 million tons in the second crop.

Between the 2000/2001 and 2018/2019 harvests, Brazilian corn exports rose from 5.9 to 41.2 million tons, while public stocks ranged from 347 thousand tons to 19.2 million tons (Appendix B). Exports proved necessary for the balance between supply and demand and, consequently, profitable prices for farmers.

The expected prices are inversely related to the ending storages of the previous period, as expected. As

already discussed by Bragagnolo *et al*. (2009), in the presence of stocking activity, there is a lower dispersion of consumption over time, which makes the variation of prices lower. Actual data show that prices showed higher price levels when the quantity in inventories was lower. For instance, the prices of the first crop 2014/2015 increased from R$ 586 per ton to R$ 923 per ton in the following harvest, in the same period the stock-to-use ratio dropped from 23.3% to 16.3 % (Appendix B). Our results suggest that for levels of equilibrium storages, higher price levels are expected in the first crop compared to equilibrium prices for the second crop.

In Brazil, most of the supply has been concentrated in the second harvest in recent years, which is why exports take place in greater quantities in the second half. With greater integration with the foreign market, prices have shown a higher level in the second half (Appendix B). The context was observed in our simulation.

With the greater volume of exports, the foreign market imposes a price range for the Brazilian market. As described by Guimarães & Barros (2006) the effect is similar to that intended by a policy of regulatory storages, but without the government building inventories. Our simulations show that the storage formed by agents in a competitive economy also occurs within this price range, which in turn follows the oscillations of the international market.

The results of this study should not be compared to the values observed in previous years. The implemented model considers the initially established parameters constant over time, while in previous years these parameters were not constant (Guimarães, Barros, 2006).

The possibility of updating the parameters established initially and finding market equilibrium in the different contexts is the main contribution of this type of study. This paper advances the modeling of storage when analyzing the storages in two periods within the same crop year and the current context of the Brazilian corn market. This study provides a comprehensive analysis of how growth in the Brazilian second crop and high level of exports has impacted corn storage dynamics.

Low levels of commodity storages to consumption can imply high price volatility, and greater risk for farmers and consumers as discussed by Bobenrieth *et al*. (2013). Our results should offer useful insights for policymakers, risk-management strategies adopted by farmers, processors, and merchandisers operating in Brazil.

REFERENCES

Alves L.R.A., Barros G.S. de C., Sanches A.L.R., Ribeiro R.G., Osaki M. (2018). *Estrutura de mercado e formação de preços na cadeia produtiva de milh*o. In Alves L.R.A., Bacha C.J.C. (eds.), Panorama da Agricultura Brasileira: Estrutura de mercado, comercialização, formação de preços, custos de produção e sistemas produtivos (1st ed., pp. 133-176). Campinas: Alínea.

Bobenrieth E., Wright B., Zeng D. (2013). Stocks-to-use ratios and prices as indicators of vulnerability to spikes in global cereal markets. *Agricultural Economics (United Kingdom)*, 44(suppl 1): 43-52. https://doi.org/10.1111/agec.12049

Bragagnolo C., Guimarães V.D.A., Barros G.S. de C. (2009). A regra ótima de armazenamento de arroz no Brasil. *Economia Aplicada*, 13(1): 153-181. https://doi.org/10.1590/S1413-80502009000100007

Cafiero C., Bobenrieth H. E.S.A., Bobenrieth H. J.R.A., Wright B.D. (2011). The empirical relevance of the competitive storage model. *Journal of Econometrics*, 162(1): 44-54. https://doi.org/10.1016/j.jeconom.2009.10.008

CEPEA/ESALQ/USP. (2020). *Center for Advanced Studies in Applied Economy*. Available at: https://www.cepea.esalq.usp.br/br/indicador/milho.aspx

CONAB. (2020). *Companhia Nacional de Abastecimento. Produtos e Serviços. Safras*. Séries Históricas. Available at: http://www.conab.gov.br/conteudos.php?a=1253&t=2 (accessed on 30 June 2020).

Fackler P.L., Livingston M.J. (2002). Optimal Storage by Crop Producers. *American Journal of Agricultural Economics*, 84(3): 645-659. https://doi.org/10.1111/1467-8276.00325

Faroni L.R.D., Barbosa G.N. de O., Sartori M.A., Alenar E.R. de (2005). Avaliação qualitativa e quantitativa do milho em diferentes condições de armazenamento. *Engenharia Na Agricultura*, 193-201.

Guerra E.A., Bobenrieth H. E.S.A., Bobenrieth H. J.R.A., Cafiero C. (2015). Empirical commodity storage model: The challenge of matching data and theory. *European Review of Agricultural Economics*, 42(4): 607-623. https://doi.org/10.1093/erae/jbu037

Guimarães V.D.A., Barros G.S.A. de C. (2006). Análise do armazenamento de milho no Brasil em um mercado de economia aberta. *Revista de Economia e Sociologia Rural*, 44(4): 751-771. https://doi.org/10.1590/s0103-20032006000400007

Gustafson R.L. (1958). *Carryover levels for grains: a method for determining amounts that are optimal under specified conditions* (Technical). Washington DC: USDA.

Mattos F., Silveira R.F. da (2018). The Expansion of the Brazilian Winter Corn Crop and Its Impact on Price Transmission. *International Journal of Financial Studies*, 6(2): 45. https://doi.org/10.3390/ijfs6020045

Miranda M.J., Glauber J.W. (1993). Estimation of Dynamic Nonlinear Rational Expectations Models of Primary Commodity Markets with Private and Government Stockholding. *The Review of Economics and Statistics*, 75(3): 463-470. https://doi.org/10.2307/2109460

Miranda M.J., Helmberger P.G. (1988). The Effects of Commodity Price Stabilization Programs. *The American Economic Review*, 78(1): 46-58. https://doi.org/10.2307/1814697

Oglend A., Kleppe T.S. (2017). On the behavior of commodity prices when speculative storage is bounded. *Journal of Economic Dynamics and Control*, 75: 52-69. https://doi.org/10.1016/j.jedc.2016.11.007

Peterson H.H., Tomek W.G. (2005). How much of commodity price behavior can a rational expectations storage model explain? *Agricultural Economics*, 33(3): 289-303. https://doi.org/10.1111/j.1574-0864.2005.00068.x

Schwantes F., Bacha C.J.C. (2019). Análise da formulação da política de garantia de preços mínimos no Brasil pela ótica da economia política. *Nova Economia*, 29(1): 161-192. https://doi.org/10.1590/0103-6351/3926

Serra T., Gil J.M. (2013). Price volatility in food markets: Can stock building mitigate price fluctuations? *European Review of Agricultural Economics*, 40(3): 507-528. https://doi.org/10.1093/erae/jbs041

Siarma/Esalq-Log/Esalq/USP. (2020). Storage Information System. Available at: https://esalqlog.esalq.usp.br/en/storage-information-system-siarma

USDA. (2020). United States Department of Agriculture. Foreign Agricultural Service (FAS). Available at: https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (accessed on 07 June 2020).

Williams J.C., Wright B.D. (1991). *Storage and commodity markets*. Cambridge: Cambridge University Press.

Wright B.D., Williams J.C. (1982). The Economic Role of Commodity Storage. *The Economic Journal*, 92(367): 596-614. https://doi.org/10.2307/2232552

Wright B.D., Williams J.C. (1984). The Welfare Effects of the Introduction of Storage. *The Quartely Journal of Economics*, 99(1): 169-192. https://doi.org/10.2307/1885726

Zhou W., Babcock B.A. (2017). Using the competitive storage model to estimate the impact of ethanol and fueling investment on corn prices. *Energy Economics*, 62: 195-203. https://doi.org/10.1016/j.eneco.2016.12.017

APPENDIX A. THE RATIONAL STORAGE MODEL

Each producer individually decides how much area he is willing to allocate to planting by maximizing the expected profit ($E\Pi_t^i$). In our model, the planted area by producer *i* in crop year *t* is defined by A_t^i; and productivity in crop year *t* is defined by y_t, and price of the commodity by *P*. The function of profit expected ($E\Pi_t^i$) by the producer *i* in period *t* can then be restated as:

$$E\Pi_t^i = \frac{1}{1+r} E_t(P_{t+1} \times y_{t+1}) \times A_t^i - C_t\left(A_t^i\right) \quad (1)$$

Specifically for the simulation model:

$$y_t = \mu + \varepsilon_t$$
$$\varepsilon_t \sim (0, \sigma_\varepsilon^2)$$

The present value of the income expectation is given by the expectation of the revenue per acre $E_t(P_{t+1} \times y_{t+1})$, that is the product of the price (*P*) in crop year *t + 1* and productivity y_{t+1} multiplied by the planted area. The expectation is discounted by the interest rate *r*. The cost of production (C_t) is defined as a function of the planted area. In the case of competitive equilibrium, with zero economic profit, $E\Pi_t^i$. Then:

$$\frac{1}{(1+r)} E_t(P_{t+1} \times y_{t+1}) \times A_t^i = C_t(A_t^i) \quad (2)$$

Based on the first-order condition of the agents' problem of profit maximization, the farmer chooses the planted area. With perfect competition, the marginal cost per acre is equal to the marginal profit per acre. The function can then be presented as:

$$\frac{\partial E\Pi_t^i}{\partial A_t^i} = \frac{1}{(1+r)} E_t(P_{t+1} \times y_{t+1}) - \frac{\partial C_t\left(A_t^i\right)}{\partial A_t^i} = 0 \quad (3)$$

$$\frac{1}{(1+r)} E_t(P_{t+1} \times y_{t+1}) = \frac{\partial C_t\left(A_t^i\right)}{\partial A_t^i} \quad (4)$$

From the equilibrium condition defined by equation (4), the farmer defines the area to be planted:

$$A_t = A[E_t(P_{t+1} \times y_{t+1})] \quad (5)$$

It is assumed that the planted area has a positive relationship with the expected price:

$$\frac{\partial A_t}{\partial E_t(P_{t+1} \times y_{t+1})} > 0 \quad (6)$$

The production *x* in the year *t*, is the result of the planted area in the previous period multiplied by the expected productivity in *t*:

$$x_t = A_{t-1} \times y_t \tag{7}$$

The quantity consumed (Q_t) in period t can be represented by the following relation $Q_t=I_t - S_t$ where S_t is the quantity stored in period t for period $t + 1$, and I_t is the domestic availability in period t. That is, the domestic availability (I_t) is the result of the sum between the quantity consumed (Q_t) and the storage (S_t),

$$I_t=S_t + Q_t. \tag{8}$$

The product availability in period t can also be expressed as:

$$I_t = x_t + (1 - \theta)S_{t-1} \tag{9}$$

The product due to storage in the previous period (S_{t-1}) is added to the current period production to obtain the quantity of domestic supply. The physical loss of product due to storage is incorporated into the models by the parameter $0 \leq \theta \leq 1$.

Intertemporal price arbitrage results in the optimal amount of storage. The agents will store the commodity until the marginal storage cost (k) added to the current product price (P_t) is equal to the expectation of price in the following period (E_tP_{t+1}) discounted to present value by the interest rate r considering the physical loss of product (θ).

$$\left(\frac{1-\theta}{1+r}\right)(E\mathrm{P}_{t+1}) = P_t + k \tag{10}$$

The price is defined utilizing the inverse demand of consumption for a given produced quantity (Q_t). In addition to the quantity, we consider a random shock associated with the inverse demandin year t, as expressed below:

$$P_t = P(Q_t, \vartheta_t) \tag{11}$$

Especifically, for the simulation model:

$$P_t = a + b\vartheta_t \; ; \; \vartheta_t \sim (0, \sigma_\vartheta^2)$$

For an open economy, the possibility of exporting should be incorporated for the calculation of the level of domestic supply. The model considers only exports since it is understood that Brazilian corn imports were insignificant compared to the quantity produced in the analyzed period.

As a condition of international trade, agents will export when the level of export price is higher than the domestic price; otherwise export will not occur. Therefore the following constraints are imposed on the model:

$$\begin{aligned} &M_t > 0, \text{if } P_t^{EXP} - P_t \geq 0 \\ &M_t = 0, \text{if } P_t^{EXP} - P_t < 0 \end{aligned} \tag{12}$$

where P_t^{EXP} is the export price and, M_t is the quantity exported, in year t. International trade is incorporated into domestic availability by the equation:

$$I_t = x_t + (1 - \theta)S_{t-1} - M_t \tag{9'}$$

Considering (9') and (8), the domestic availability (I_t) can be used for current consumption or storage:

$$I_t = x_t + (1 - \theta)S_{t-1} - M_t = Q_t + S_t. \tag{13}$$

Storage will occur in period t, when the expectation of prices in $(t+1)$, that is, (E_tP_{t+1}), net of the physical storage loss of product (θ), discounted to value present is higher than the price in period t, added to the marginal cost of storage k. The intertemporal rule for storage activity can be represented as:

$$\begin{aligned} &S_t \geq 0, \text{if} \left(\frac{1-\theta}{1+r}\right)(E\mathrm{P}_{t+1}) \geq P_t + k \\ &S_t = 0, \text{if} \left(\frac{1-\theta}{1+r}\right)(E\mathrm{P}_{t+1}) < P_t + k \end{aligned} \tag{14}$$

It is assumed that the agents' choices are optimized from the perspective of rational expectations. The expected price for period $t + 1$ is a function of the storage to be formed in the period t and the storage, production, and exports in the following period $t + 1$.

$$E_tP_{t+1} = f((1 - \theta)S_t + x_{t+1} - S_{t+1} - M_{t+1}) \tag{15}$$

The positive quantity to be stored in period t is defined by the following expression:

$$\left(\frac{1-\theta}{1+r}\right)(E_tP_{t+1}) - P_t(Q_t) - k = 0 \tag{16}$$

By replacing equations (13) and (15) in equation (16) the quantity to be stocked can then be restated as:

$$\begin{aligned} &\left(\frac{1-\theta}{1+r}\right) f[(1 - \theta)S_t + x_{t+1} - S_{t+1}) - M_{t+1}] - \\ &P_t[(1 - \theta)S_{t-1} + x_t - \mathrm{M}_t - S_t + \vartheta_t] - k = 0 \end{aligned} \tag{17}$$

The goal is to identify the amount of storage that maximizes the gains of the agents using equation (17). By keeping the parameters constant over time, the problem of storage optimization becomes stationary. The convergence of the parameters is sought through computational methods of simulation, thus defining the optimal rule of constant storage over the years.

Appendix B. Corn supply, demand, and prices in Brazil.

Crop	Beginning Stocks (1,000 tons)	1º Crop Production (1,000 tons)	2º Crop Production (1,000 tons)	Total Production (1,000 tons)	Imports (1,000 tons)	Supply (1,000 tons)	Consum-ption (1,000 tons)	Exports (1,000 tons)	Ending Stocks (1,000 tons)	Stocks to Use Ratio (%)	Price in 1º crop* (R$/ ton)	Price in 2º crop* (R$/ ton)
2000/01	3,591	35,833	6,457	42,289	549	46,429	34,449	5,918	6,062	*17.6*	519.93	726.49
2001/02	6,062	29,086	6,181	35,281	362	41,705	36,358	2,509	2,838	*7.8*	712.24	1112.66
2002/03	2,838	34,614	12,797	47,411	806	51,055	37,463	4,050	9,542	*25.5*	929.45	788.62
2003/04	9,542	31,554	10,574	42,129	299	51,970	38,707	4,688	8,575	*22.2*	772.71	699.72
2004/05	8,575	27,298	7,708	35,007	596	44,178	40,410	883	2,885	*7.1*	651.79	672.89
2005/06	2,885	31,809	10,706	42,515	1,011	46,411	40,811	4,340	1,260	*3.1*	540.23	726.10
2006/07	1,260	36,597	14,773	51,370	1,164	53,794	42,584	10,863	347	*0.8*	699.65	912.18
2007/08	347	39,964	18,688	58,652	652	59,652	44,962	7,369	7,321	*16.3*	861.92	717.08
2008/09	7,321	33,655	17,349	51,004	1,182	59,506	46,601	7,334	5,571	*12.0*	645.50	619.96
2009/10	5,571	34,079	21,939	56,018	389	61,978	47,793	10,882	3,303	*6.9*	534.29	687.51
2010/11	3,303	34,947	22,460	57,407	764	61,474	49,963	9,278	2,232	*4.5*	802.89	803.54
2011/12	2,232	33,867	39,113	72,980	776	75,988	51,108	22,293	2,587	*5.1*	689.86	803.52
2012/13	2,587	34,577	46,929	81,506	893	84,986	52,576	26,163	6,246	*11.9*	694.90	589.95
2013/14	6,246	31,653	48,399	80,052	789	87,087	53,676	20,883	12,528	*23.3*	660.01	555.20
2014/15	12,528	30,082	54,591	84,672	315	97,516	54,651	30,131	12,734	*23.3*	586.01	641.12
2015/16	12,734	25,758	40,773	66,531	3,336	82,601	54,837	18,847	8,916	*16.3*	923.86	800.50
2016/17	8,916	30,462	67,381	97,843	953	107,712	57,644	30,813	19,255	*33.4*	603.03	563.97
2017/18	19,255	26,811	53,899	80,710	901	100,865	60,945	23,742	16,178	*26.5*	722.40	671.83
2018/19	16,178	25,647	73,178	100,046	1,596	117,820	65,716	41,173	10,931	*16.6*	669.61	686.40
Maximum	19,255	39,964	73,178	100,046	3,336	117,820	65,716	41,173	19,255	*33.4*	929	1,113
Minimum	347	25,647	6,181	35,007	299	41,705	34,449	883	347	*0.8*	520	555
Average	6,946	32,015	30,205	62,285	912	70,144	47,961	14,851	7,332	*14.7*	696	725

Note * First-half average of the CEPEA-ESALQ/BM&FBove spa for real corn daily index (Campinas, SP); **Second-half average of the ESALQ/BM&FBove spa for real corn daily index (Campinas, SP).
Source: Research (CEPEA/ESALQ/USP, 2020; CONAB, 2020).

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: Nusrat Akber, Kirtti Ranjan Paltasingh (2021) Agricultural Growth and Investments in India: Assessment of Recent Trends, Breaks and Linkages. *Italian Review of Agricultural Economics* 76(2): 17-30. DOI: 10.36253/rea-12057

Received: September 22, 2020

Revised: November 12, 2020

Accepted: June 7, 2021

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Agricultural Growth and Investments in India: Assessment of Recent Trends, Breaks and Linkages

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Abstract. This paper reviews the recent trends in agricultural investments (both public and private) and tries to find structural breaks in the trends over the period of 1960-2017. Comparing the growth performance of investments and farm output (GDPAg and production) in various sub-periods based on breakpoints in both investment series the study finds that the recent agricultural stagnation spawns from a low capital formation in Indian agriculture, especially low public investment. This has been further strengthened by the regression results where both public and private investments along with fertilizer consumption, HYV seeds, terms of trade, and weather pattern significantly affect the agricultural output. Therefore, the policy implication of the study calls for an immediate arrest of the declining trend of public investment in order to stimulate more private investment. This may break the shackles of growth stagnation in Indian agriculture.

Keywords: investments, structural break, kinked growth, regression, Indian agriculture.

JEL codes: E20, 013, Q14.

1. INTRODUCTION

Since independence, Indian agriculture has gone through different phases of growth influenced by several institutional and technological interventions during various policy regimes. The current crisis in agriculture is not new. Because in the 1950s and early 1960s, before the onset of the "Green revolution" (henceforth GR), the growth rate of agricultural Gross Domestic Product (henceforward GDPAg) used to be mostly less than 2%. However, due to a shift in policy emphasis and technological intervention in the late 1960s in the form of GR technology adoption, the sector saw some revival. The growth rate revived to 2.5-3% and for the next decade, during the 1980s and also early 1990s, the growth of output maintained that steady rate. However, again, the shift in policy regimes towards reform, rendered the sector to lose its tempo and the deceleration set in (Bhalla, Singh, 2001; Rao, 2003). During the 9th plan and also 10th plan, the growth rate dropped down to 2.50% and further to 2.47% (Dash, 2009). Till date, the growth rate of Indi-

an agriculture sector has not touched the targeted 4% (Nadkarni, 2018; Sainath, 2018). The root causes of this slowdown in the primary sector have been intensively studied. Bhattarai and Narayanamoorthy (2003), pointed out that irrigation development and rural literacy could bring a reversal of growth stagnation. Gulati and Bathla (2002), Chandrasekhar and Ghosh (2002) argued that the relative "neglect of agriculture" in India's fiscal policy has slowed down the increase in public canal irrigation intensity rendering some deleterious impact on its growth prospect. Chand *et al*. (2007) pointed out the slowdown in the growth of fertilizer use, energy consumption (electricity), irrigation. Cropping intensity and gross cropped area either grew at a very slow rate or remained stagnant. Chand and Kumar (2004) argued that erratic and deficit rainfall is responsible for the slowdown in early post-reform periods after 1995-1996, other factors also played their role[1]. Similarly, other studies like Vyas (2001), Bhalla and Singh (2009) found the technology fatigue, reduction in public spending on irrigation, water management, and the gradual breakdown of agricultural extension systems in the country. Singh *et al*. (2015) and Akber and Paltasingh (2019a) also argued that there is a crowding-in effect of public investment on the private investmentat farmers' level which implies that significant public investment could be a major policy stimulus for sustained growth of Indian agriculture. Very recently, some studies like Bathla (2017), Bathla *et al*. (2020), and Kumar *et al*. (2020) analyzed investment as a major source of agricultural growth and thereby alleviation of rural poverty. Bathla (2017), Bathla *et al*. (2020) found that public spending on irrigation, agricultural research, and education and health have reaped higher returns.

In this context, a study by Chand and Parappurathu (2012) is a noteworthy one. They hypothesized that GDPAg has gone through different regimes of agricultural policy in India. Therefore, the series is characterized by multiple breaks. Using the Bai-Perron (2003) method of multiple breaks, they found five optimal break-points giving rise to six phases, and then they went on explaining the growth dynamics of GDPAg during those phases. Here, we build on that study and try to go beyond. We also hypothesize that capital formation in Indian agriculture has also gone through various phases of policy reforms and therefore, characterized by multiple structural breaks. So a similar attempt is made to find out the multiple breaks in the farm investment series (both public sector and private sector farm investments) by using the same Bai-Perron method over the period of 1960-2017. We then determine various sub-periods based on structural breaks in investment series and work out the growth performance of investments and farm output. The major objective of this paper is to check whether or not the growth performance in both the public sector and private sector capital formation in Indian agriculture corroborate sits growth performance in the form of GDPAg and production. This is done in two steps. First, we compare the growth performance of farm investments with that of GDPAg and agricultural production during those sub-periods. This will give us a broad idea of whether the growth dynamics in investments match the growth performance of farm output. But this linkage is further strengthened in the second step by finding the influence of growth rates of investments and other factors on the growth rate of GDPAg and production by adopting a "growth accounting method". Thus, by doing so we may probably arrive at an unambiguous and decisive conclusion that whether the growing crisis in Indian agriculture is somewhat driven by the slack performance of agricultural investments or something else.

This study differs from the earlier literature on numerous grounds. First, very few studies have been initiated to examine this relationship between investment and agricultural growth exclusively (Bathla, 2014; Bathla, 2017; Bathla *et al*., 2020; Kumar *et al*., 2020). So this will be an addition to the literature. Again, this study deviates from past literature in its approach. It finds the structural breaks in the investment series and then draws a comparison of the growth performance of investments with that of farm output during those sub-periods based on the breakpoints in the investment series. Second, by considering a long period of analysis from 1960-2017, we cover almost all regimes of major policy reforms in Indian agriculture. Hence, a better understanding of the dynamics of the farm investment and the fact of how it influences the growth prospects in the sector emerges from the analysis. This would help in devising an effective policy to boost farm sector growth. Third, we consider both components of farm investment, i.e., public and private investment over a long period, and carry out the exercise in order to delineate the relationship between investment and growth clearly. Fourth, this study is an improvement over others from a methodological point of view. It uses the "kinked growth model" developed by Boyce (1986) to work out the growth performance of investment and farm out-

[1] Chand and Kumar (2004) also argued that GDPAg is affected by subsidies and capital formation along with terms of trade. Though rate of return of one rupee spent on subsidies is much higher than that of public sector capital formation, but for long-term returns from investment is more than double. So capital formation is required for long-term growth of agriculture (p. 5616).

put. This is the most appropriate method in the case of sub-period growth analysis[2]. Hence, we believe that this study would be a worthy contribution to literature and a pertinent reference for policymakers.

The paper is organized in the following manner: after a brief introduction, the second section contains the data and methods. The third section analyses the empirical results and discussion on the recent trends in investments, GDPAg, and production, breakpoints, and growth performance at the national level, a quantitative relationship between the agricultural growth and growth of investment and other factors. Finally, the study concludes with some policy implications.

2. MATERIALS AND METHODS

2.1. Data

The present study is based on time-series data over a period of 58 years (1960-2017) and 38 (1980-2017) years of input subsidy data. Data has been compiled from various sources like *National Account Statistics*, *Reserve Bank of India* (RBI) database and *Agricultural Statistics at Glance*. Apart from public investment (GCFA) as per CSO, public canal intensity is also used as a proxy for public investment. The data on GCFA is compiled from various issues of *National Account Statistics (NAS),* and data on canal intensity, the area under HYV seeds, and cropping intensity is compiled from various issues of *Agricultural Statistics at Glance.* Agricultural gross barter terms of trade variable is taken from NAS of Central Statistical Organization (CSO) by making the ratio of agricultural GDP deflator to non-agricultural GDP deflator. The subsidy data has been compiled from the Ministry of Agriculture & Farmers' Welfare, Government of India, and some other sources[3]. The wholesale price index (WPI) has been used to deflate the data and to convert it into constant series (2011-2012 prices). The credit data has been compiled from the *Reserve Bank of India* (RBI) database. Weather data is from the Ministry of Statistics and Programme Implementation, Government of India. The descriptive statistics along with the definitions of all variables are given in Table A.1. in the Appendix.

2.2. Bai-Perron method for structural breaks

A structural break in time series data is characterized as an unexpected shift which leads to huge forecasting errors. There area number of methods to test the structural breaks in time series data. Chow test (Chow, 1960) is one of the widely used methods where the break date is randomly chosen based on the judgment of the researcher. This problem of relying too much on the subjective assessment of researcher renders this method a little biased. But, the recently developed Bai-Perron (2003) method tests the presence of multiple breaks automatically without individually choosing the break date. Bai-Perron (2003) method is explained in detail here. To find out the multiple breakpoints that are not known before, Bai-Perron prepared a test on the basis ofthe following hypotheses as Ho: m = 0 against H_1: m = 1. When m=0, no structural breaks are present in the time series data and m =1 indicates that the structural breaks are present in the data set. This can be mathematically written as:

$$Y_t = x'_t\beta + z'_t\delta_j + u_t, \qquad (t = T_{j-1}+1,\ldots,T_j) \tag{1}$$

For j=1,…,m+1. In this model, Y_t is the observed dependent variable at time t; $x_t(p\times1)$ and $z_t(q\times1)$ are the vectors of covariates and β and δ_j (j=1,…,m+1) are the corresponding vectors of the coefficients; u_t is the disturbance term at time t. The indices (T_1,…,T_m) are treated as unknown (we use the convention that T_0=0 and T_{m+1}). The purpose is to estimate the unknown regression coefficients together with the breakpoints when T observations on (y_t,x_t,z_t), are available. This is a partial structural change model since the parameter vector β remains constant. When p=0, we obtain a pure structural change model where all the coefficients are subject to change. The variance u_t needs not to be constant. Indeed, breaks in variance are permitted provided they occur at the same dates as in the parameters of the regression.

This multiple linear regression as mentioned in (1) can be written in matrix form as:

$$Y = X\beta + \bar{Z}\delta + U \tag{2}$$

Where Y=(y_1,…,y_t), X=(x_1,…,x_t), U=(u_1,…,u_t), δ=(δ'_1,δ'_2,…,δ'_{m+1}) and $\bar{Z}$ is the matrix which diagonally partitions Z at ($T°_1$,…,$T°_m$) with Z_i=(zr_{t-1}+1,…,zr_i). We denote the true value of a parameter with a 0 superscript. In particular, $\delta°$=($\delta°_1$,$\delta°_2$,…,$\delta°_{m+1}$) and ($T°_1$,…,$T°_m$) are used to denote, respectively the true values of the parameters δ and the true breakpoints. The matrix $\bar{Z}$ diagonally partitions Z at ($T°_1$,$T°_m$). The data generating process is assumed to be as:

[2] Most of the studies including the one by Chand and Parappurathu (2012), Bathla (2014) and others use semi-log compound growth model for sub-period growth analysis. But that method has got some serious methodological loopholes. For details see Boyce (1986: 385).

[3] The other sources include Gulati *et al.* (2018) and also compiled from Indiastat.com.

$$Y = X\beta^{\circ} + \bar{Z}^{\circ}\delta^{\circ} + U \quad (3)$$

The method of estimation is based on the least-squares principle

$$(Y - X\beta - \bar{Z}\delta)Y - X\beta - \bar{Z}\delta =$$

$$\sum_{i=1}^{m+1} \sum_{Ti-1+1}^{Ti} (Y_t - X_t\beta - \acute{Z}_t\delta)^2 \quad (4)$$

To carry out the asymptotic assumptions, we need to impose some restrictions on the possible value of break dates. Each break date should be asymptotically distinct and bounded from the boundaries of the sample. Let $\lambda_i = {}^{T_i}/_{T}(i=1,\ldots,m)$ and define the following settings for some arbitrary positive number ϵ, a trimming parameter which imposes the minimal lengthfor a segment h, i.e. $\epsilon = {}^{h}/_{T}$,

Before constructing the Sup F type test, we need to limit the possible breakpoints which give the following set:

$$\Lambda_{\epsilon} = \{(\lambda_1, \lambda_2, \ldots, \lambda_k) : (\lambda_i + 1 - \lambda_i \geq \epsilon, \lambda_1 \geq \epsilon, \lambda_k \leq 1 - \epsilon\} \quad (5)$$

Let $\hat{\beta}(\{T_j\})$ and $\hat{\delta}(\{T_j\})$ denote the estimates based on the given m partition $(T_1,\ldots,T_m)$, denote $\{T_j\}$. Substituting these in the objective function and denoting the sum of squared residuals as $S_t(T_1,\ldots,T_m)$, the estimated breakpoints are:

$$(\hat{T}_1,\ldots,\hat{T}_m) = \arg min_{(\lambda_1 \ldots \lambda_m) \in \Lambda_{\epsilon}} S_t(T_1,\ldots,T_m) \quad (6)$$

The minimization is taken over all partitions $(T_1,\ldots,T_m)$ such that $T_i,\ldots,T_{i-1} \geq h = T_{\epsilon}$. Finally, the regression parameter estimates are associated with the m- partition $\hat{T}_j$. For the empirical illustration, we use the method based on a dynamic programming algorithm developed by Bai and Perron (2003).

2.3. Kinked compound growth rates

After finding out the breakpoints of the data series, we find out the growth rates of agricultural investments, GDPAg, and production by using the kinked compound growth model. The method of kinked compound growth rate estimation provides a clear picture of growth rates at different sub-periods (Boyce, 1986).

The unrestricted generalized kinked model for '***m***' sub-periods with '***m-1***' kinks such as $k_1, k_2 \ldots, k_{m-1}$, and $D_1, D_2, \ldots D_m$ sub-periods dummiescan be written as:

$$LnY_t = \alpha_1 D_1 + \alpha_2 D_2 + \ldots + \alpha_m D_m + (\beta_1 D_1 + \beta_2 D_2 + \ldots + \beta_m D_m)t + \epsilon_t \quad (7)$$

Applying ***m-1*** linear restrictions as $\alpha_i + \beta_i k_i = \alpha_{i+1} + \beta_{i+1} k_i$ for all i =1, 2,3,**…..*m-1***, the restricted generalized kinked compound model as:

$$\begin{aligned} LnY_t &= \alpha_1 + \beta_1\left(D_1 t + \textstyle\sum_{j=2}^{m} D_j k_1\right) + \\ &\beta_2\left(D_2 t - \textstyle\sum_{j=2}^{m} D_j k_1 + \textstyle\sum_{j=3}^{m} D_j k_2\right) + \cdots \\ &\ldots + \beta_i\left(D_i t - \textstyle\sum_{j=i}^{m} D_j k_{i-1} + \textstyle\sum_{j=i+1}^{m} D_j k_i\right) + \\ &\cdots + \beta_m(D_m t - D_m k_{m-1}) + \epsilon_t \end{aligned} \quad (8)$$

The βs give the values of growth rates for respective periods. From this generalized model, the required growth model for a fixed number of sub-periods depending on the number of kinks / breakpoints in the series can readily be derived.

2.4. Investment and agricultural growth linkage: first-difference regression model

Birthal *et al.* (2014) argue that the competition for land for non agricultural use is likely to be intensified. Therefore, to augment production and output, intensive cultivation is the only way out for which a large-scale investment is required. After linking the growth performance broadly between investment and farm output during various sub-periods based on break-points, here we try to further strengthen that connection. Hence, we try to find out the impact of investment growth and growth of other relevant factors on the growth of GDPAg and agricultural production by using the "first difference" (FD) regression model based on the growth accounting method[4]. This method adopted here is similar to that of Ricker-Gilbert *et al.* (2013), Chand (2005)[5], and Kumar *et al.* (2019)[6]. The regression models are:

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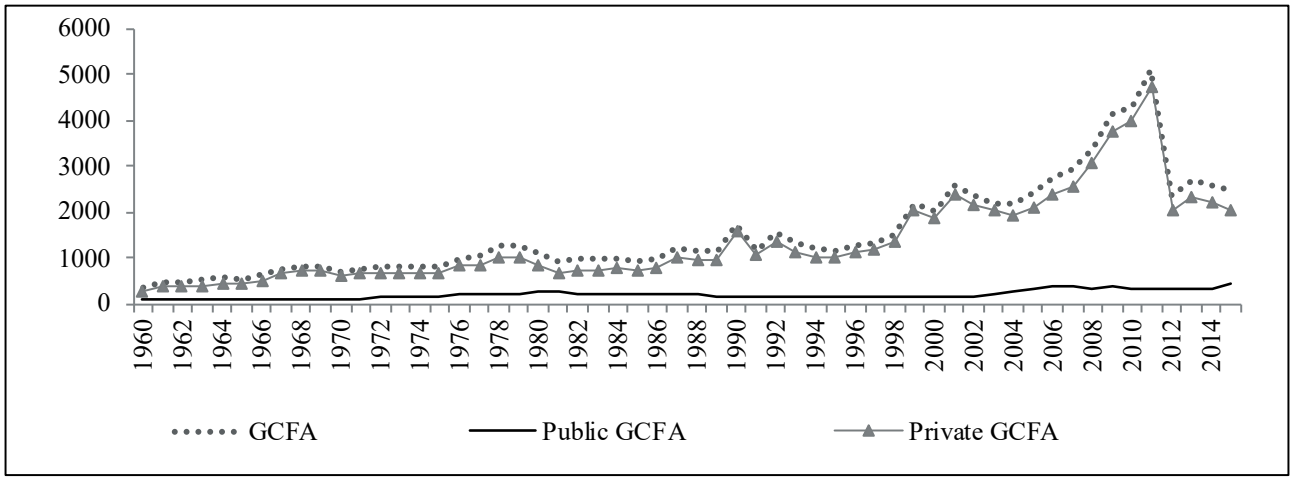
[4] We know that the growth rate of Y can be written as $\Delta \ln Y_t = {}^{\dot{Y}}/_{Y}$. Because, approximating of $\Delta \ln Y_t$ as $d\ln Y_t$ for infinitesimal change and differentiating it with respect to time t we get as: $\frac{dlnY_t}{dt} = \frac{dlnY_t}{dY}\frac{dY}{dt} = {}^{\dot{Y}}/_{Y}$. So taking a Cobb-Douglas production function approximation of output we get $Y = I_g^{\beta_1} I_d^{\beta_2} S^{\beta_3} C^{\beta_4} CI^{\beta_5} P^{\beta_6} W^{\beta_7} F^{\beta_8} e^{\mu}$ and taking difference of logarithmic approximation of it we arrive at the estimable form of the equation (9) and (10). This is similar to the growth accounting method to find total factor productivity (TFP) of a sector.

[5] Chand (2005), using this growth accounting method found the growth contribution of one factor by either assuming or estimating the growth rate of other factors. But here we just regress the annual growth of output on annual growth of inputs which will give the sources growth in output.

[6] Kumar *et al.* (2019) used the same methodology but regressed the agricultural growth on irrigation growth and rainfall deviation only.

Fig. 1. Trend in agricultural investments (GCFA, Public and Private sector GCFA).



Source: National Account Statistics-2011 back series, 2014 and 2017.

$$\Delta InPR = \beta_0+\beta_1\Delta lnI_g + \beta_2\Delta lnI_p + \beta_3\Delta lnSBDY + \beta_4\Delta lnCRDT + \beta_5\Delta lnCI + \beta_6\Delta lnTOT + \beta_7\Delta lnW + \beta_8\Delta lnHYV + \alpha_9\Delta lnFERT + \mu_{1t} \quad (9)$$

$$\Delta InGDPA = \alpha_0 + \alpha_1\Delta lnI_g + \alpha_2\Delta lnI_p + \alpha_3\Delta lnS + \alpha_4\Delta lnC + \alpha_5\Delta lnCI + \alpha_6\Delta lnTOT + \alpha_7\Delta lnW + \alpha_8\Delta lnHYV + \alpha_9\Delta lnFERT + \mu_{2t} \quad (10)$$

All the variables are in logarithmic form and Δ is the difference term. PR and GDPAg are total agricultural production (million tonnes) and gross domestic product-agriculture (crores Rs) respectively. I_g is public sector GCFA (crore Rs), I_p is private sector GCFA (crores Rs), C is farm institutional credit (crore Rs), CI- cropping intensity (index), ToT is gross barter term of trade and W is weather index[7] and HYV stands for the area under high yielding varieties (million ha), FERT is fertilizer consumption (thousand tones); SBDY is total subsidies (crores Rs); s are the error terms, αs, and βs represent the parameters to be estimated. The FD framework used here has certain advantages: first, it is based on the theoretical justification; second, it takes care of the non-stationarity problem as many variables are non-stationary in nature. In addition to this, it also solves the problem of time constant heterogeneity in the regression models, and in the presence of serial correlations, the consistency of estimates will not be affected (Ricker-Gilbert *et al*., 2013: 679). Following the study of Akber and Paltasingh (2019a) and Gulati and Bathla (2001), we set up two baseline models for both production and GDPAg growth. One contains public investment as per CSO and the second contains public canal intensity as a major component of public investment.

3. RESULTS AND DISCUSSION

3.1. Trends and Pattern of Investments in Indian Agriculture

The trends of agricultural investment as a share of GDPAg and as a share of total investment undertaken in the economy as a whole are depicted in various figures. Doing so captures the relative position of agricultural investment within the economy as a whole and the agricultural sector in particular. First, the trend of agricultural investments is analyzed, and then the ratio of investment to GDPAg, and finally the trends of the ratio of agricultural investment to the total aggregate investment in the economy are analyzed.

Figure 1 depicts the trend of agricultural investment in terms of gross capital formation in agriculture (GCFA), public sector GCFA, and private sector GCFA in India at 2011-2012 prices. It is clear that total agricultural investment increased during the period of the 1960s and 1970s and then declined in the 1980s and 1990s followed by an increasing trend since 2000 but this increase continued only for a decade. Since 2011, it again faced a decline in its trend. It is because the total investment is majorly contributed by private sector investment and the private investment is on a secular increasing trend mostly characterized with very little volatility till 2011

[7] For making the weather index, we use the Angstrom aridity index which is expressed as: $W = \left({}^{R}/_{T^{1.07}}\right)$ where R and T are average rainfall and average temperature. For details see Paltasingh *et al*. (2012), and Paltasingh and Goyari (2018).

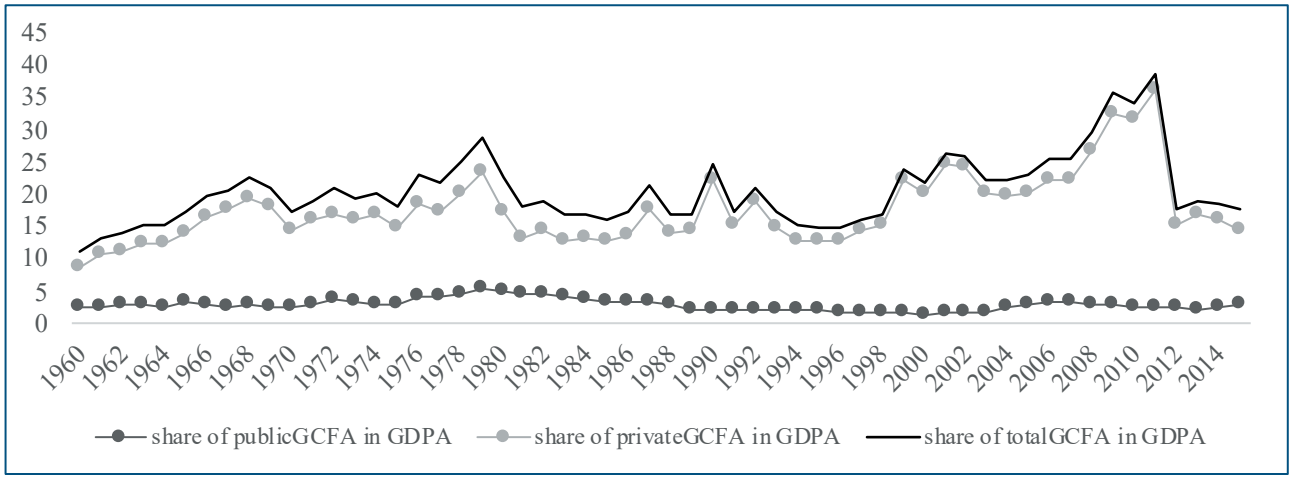
after which it declined. This corroborates the increasing trend in total investment. Hence, both trends are found increasing during the 1960s and 1970s and a decline since the 1980s and 1990s. Private sector GCFA again reversed its trend since 2011 but, the public sector GCFA continued to be mostly stagnant or increase very slowly, except little recovery in 2000. But again after 2000, it continues to be stagnant till 2004 after which it has slightly increased. This continuous stagnation or decline in public investment is caused by mounting expenditure from the public exchequer in the form of various input subsidies (Gulati, Narayanan, 2003; Mogues *et al.,* 2012; Akber, 2020). Though once considered crucial in helping the adoption of GR technology initially, these input subsidies are now found to be ineffective in enhancing production and productivity (Fan, 2008; Akber, Paltasingh, 2019b; Akber, Paltasingh, 2020). So there is a greater demand for their rationalization.

The trends of the share of agricultural investments as a percentage share of GDPAg in India at 2011-2012 prices are depicted in Figure 2. The share of public sector GCFA in GDPAg has remained very little within the range of 1 to 5% in the entire period of study. Since the 1960s, the share of total and private GCFA in GDPAg showed an increasing trend at constant prices (2011-2012), and their trends reversed during the 1970s. Since the 1970s, wide fluctuations between the share of total and private GCFA in GDPAg is observed. An improvement was observed in the year 1979, and thereafter it further declined. Since 1998, both started to revive and were at their peak in the year 2011 when the share of total GCFA in GDPAg was 38.84%, in the private sector it was 36.23%. However, they further declined afterward. Despite some fluctuations, the share of public sector GCFA remained almost constant. However, an increasing trend was observed in the case of private sector GCFA till 2011. The increasing trend of total GCFA as a ratio of GDPAg was recorded due to the increasing share of private-sector GCFA.

Many studies have tried to analyze the GCFA as a percentage of GDPAg. Shetty (1990) examined the relationship between GCFA and real GDP at 1980-1981 prices and found the share at 6-7% during the early 1960s and 1970s. In the period 1979-1981, the share was at its peak at 14%. Gulati and Bathla (2001) after refining and re-examining the capital formation in Indian agriculture have concluded that GDPAg varies narrowly with public sector GCFA. Since the 1980s, public sector GCFA has shown a decline while GDPAg increased due to an increase in private GCFA. The share of public GCFA at 1993-1994 prices have shown a declining trend in GDPAg while the private sector has shown an increasing trend during the period of 1980-2009 (Singh, 2014). Despite some fluctuations, there has been an increasing trend in the share of GCFA in GDPAg at current prices (Paltasingh *et al.,* 2017). Similarly, in this study, we also observed that public sector GCFA as a share of GDPAg (at 2011-2012 prices) constitutes very little for the whole period of study. But, the private sector share in GDPAg was found to be much higher as compared to the public sector.

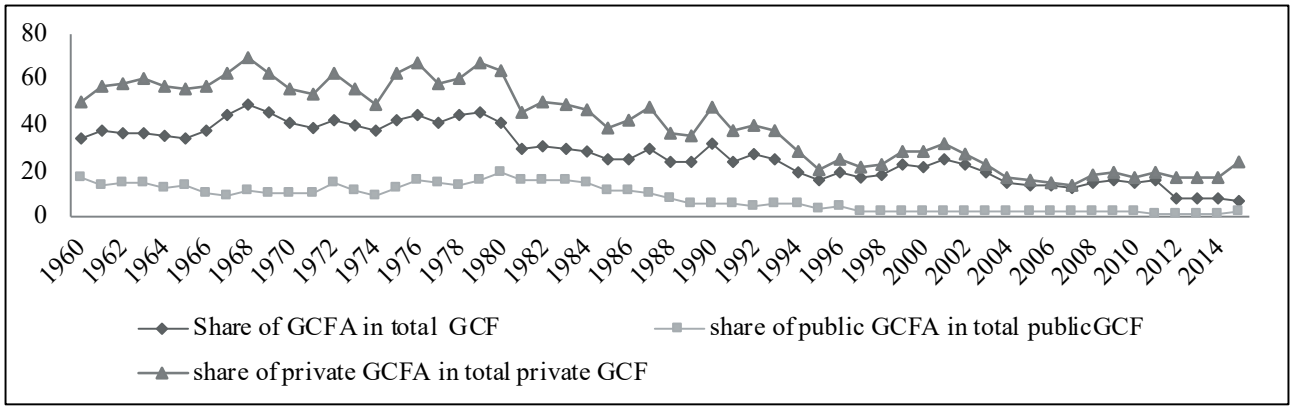
Figure 3 shows the trends of agricultural investment as a share of total investment in an economy. Two important points have been observed in the case of the trends of the ratio of total GCFA in total GCF, public sector GCFA in public sector GCF of the economy and

Fig. 2. Public, private and total GCFA as percentage of GDPAg (at 2011-2012 prices).



Source: National Account Statistics-2011 back series, 2014 and 2017.

Fig. 3. Public, private, and total GCFA as percentage of total GCF of Indian economy at 2011-2012 prices.



Source: National Account Statistics 2011 back series, and 2014 and 2017.

private sector GCFA in private sector GCF of the economy. The share of total agricultural investment in the economy-wide investment maintained its higher share up to 1979, but thereafter a secular declining trend has been observed in case of. Interestingly, the rising trend in the initial period from 1960 to 1979-1980 is coupled with much volatility while the declining trend is with almost no fluctuations. It means the decline in agriculture investment as a share of total investment has taken place constantly and continuously at a much faster rate after the 1980s. Public sector GCFA as a percentage of public GCF remained within the range of 1-16%, and the share of private-sector GCF in private GCF was in-between 6-48%. Similarly, the share of total GCFA in total GCF of the economy remained within the range of 13-66%. Initially, it was around 66% but now came down to little more than 10%. Since 1998 the share of public sector GCFA remained constant at 1-2%. The share of private-sector GCFA in private GCF has remained highest in all the periods of the study.

3.2. Structural breaks in investments series

Table 1 reveals the structural breakst hat exist in time-series investment data at the national level. Since we are finding the structural breaks in two investment series, public GCFA, and private GCFA, we don't name the periods as Chand and Parappurathu (2012) have done. Rather we just name them as 1st, 2nd and 3rd period and so on. However, the classification done in their study can be broadly followed here since the breakpoints found here in GDPAg by using the Bai-Perron method are more or less similar or very close to the ones found by them in their study. In the case of public GCFA we observe four optimal breaks while in for the private GCFA, we find five optimal breaks. For subsidies, only three break points are observed. The optimal numbers of breakpoints are decided on the basis ofthe "Bayesian Information Criterion" (BIC)[8], an appropriate method as suggested by Bai and Perron (2003). From Table 1, the four optimal global breakpoints in public investment series are found in 1968, 1976, 1988, and 2003. Similarly, five optimal breaks in the case of private investment are found to be 1968, 1988, 1997, 2004, and 2011. The comparison of breakpoints between private and public GCFA reveals that three breaks points of public GCFA match with that of private GCFA. Even the breakpoints in total subsidies in later periods of the 1980s onwards don't follow the private GCFA. So, it does not support the arguments that the mounting input subsidies pave the way for a rise in private investment. Now the question of whether the investment growth corroborates a

Tab. 1. Structural breaks in investments and output series.

Breaks	Public GCFA	Private GCFA	Subsidy
1st breakpoint	1968	1968	1991
2nd breakpoint	1976	1988	2007
3rd breakpoint	1988	1996	2011
4th breakpoint	2003	2004	---
5th breakpoint	---	2011	---

Note: All estimate breakpoints are significant at a 5% level and a trimming percentage of 15% (in the Bai-Perron test of 1 to M globally determined breaks). For subsidies, the available data series considered here is from 1980-2015.
Source: Data compiled from *National Accounts Statistics*, Govt. of India and *Agricultural Statistics at Glance.*

[8] BIC figures are shown in Table 2. But can be produced on request from the authors.

similar growth trend in GDPAg and production needs to be analysed carefully?

3.3. Growth Performance of Investments, GDPAg, and Production

In this section, we work out the growth performance of both investment series separately and then draw a comparison with the trend growth rates of GDPAg and production during those phases based on the breaks in that particular investment series. For instance, the public GCFA has got four breaks leading to five sub-periods. So in this case, we compute the growth rates of public GCFA, GDPAg, and production for those five sub-periods. Similarly, for private GCFA, we repeat the same exercise. In this way, ensuring the temporal coincidence of sub-periods, it allows a homogenous comparison of growth trends of these macroeconomic variables in the farm sector. This would partially explain the relationship between investment and farm outputs if there found to be a co-movement of their growth trends.

The growth performance of public sector GCFA, GDPAg, and production in those five sub-periods is given in Table 2. The results clearly reveal that public investment experienced growth stagnation (0.64%) during the first sub-period (1960-1968) which happens to be the pre-GR period. But, at the same time, private investment grew at a rate of 2.41%. Though the growth rate of public investment improved in the second period at 1.55%, this improvement does not continue for a long, it further declined in the third period (0.85%) and also continuously slide down in the fourth period. However, an improvement in public expenditure took place in the early 2000s so that its observed growth rate for the last period of 2004 onwards was 1.45%. Now looking at the trend growth of GDPAg and farm production, we observed a clear-cut co-movement of growth trends of GDPAg and also production with that of public sector GCFA. In the pre-GR period, the growth rate of GDPAg was found to be merely 0.56%. But, in the subsequent GR period (1969-1976), which is considered as the initial-GR period, the GDPAg and production grew at an impressive rate of 4.37% and 3.23% respectively. In this period, special emphasis was put on GR technology along with the development of public irrigation system. So the massive increase in public expenditure towards the transformation of Indian agriculture with irrigation development reaped the benefit. There was a phenomenal growth of GDPAg as well as production. Perhaps this is the only period when the growth rate of GDPAg touched that elusive 4% growth target. However, as public investment declined in the subsequent period (1977-1988), the growth rate of both GDPAg and production also declined, though the decline in production is relatively less in comparison to GDPAg. The next period, i.e., the 1990s registered a further decline in public expenditure towards agriculture. This crisis period of the 1990s which also marked the initiation of "Economic Reform", is termed as the period of "complete neglect of agriculture", and characterized by a huge cut-down in the public expenditure toward agriculture, irrigation, and rural development (Gulati, Bathla, 2002). The near-stagnation in irrigation intensity conjoined with intermittent droughts and the rising cost of inputs rendered agrarian distress in the farm sector (Haque, 2016; Bathla, 2017). However, realizing this crisis, there was an increase in the budgetary outlays during the 2000s by almost all state governments in the Indian union to control this situation. As Chand and Parappurathu (2012) evidenced that there was a significant hike in expenditure for drought relief measures as well as rural employment generation programs coupled with rising minimum support prices of key crops and rise irrigation intensity, etc. led to some improvement in public capital formation in agriculture. The growth rate of public sector GCFA during this period (2004-2017) comes out to be 1.45%. The corresponding growth rate of GDPAg and production were 2.88% and 2.53%. However, it is noteworthy to mention that there was a phenomenal achievement in the growth performance of agriculture in the decade of 2000s which came close to the 4% target growth rate. But, here since we calculated the growth of GDPAg and production for the entire sub-period of 2004-2017 on the basis of the breakpoint in the public GCFA, the growth rate comes out to be 2.88% and 2.53% respectively. It is because this period is also marked by a huge decline in private GCFA after 2011-2012 (refer to Fig. 1 and 2). So this dismal growth performance of private investment

Tab. 2. Growth rates of public investments and farm output during various phases (in 2011-2012 prices).

Periods	Public GCFA	GDPAg	Prod.
1st period (1960-1968)	0.64***	0.56*	1.07
2nd period (1969-1976)	1.55**	4.37***	3.23***
3rd period (1977-1988)	0.85**	2.78***	2.24***
4th period (1989-2003)	0.55***	2.29**	1.84***
5th period (2004-2017)	1.45**	2.88***	2.53***

Note: (a) The asterisks (***), (**) and (*) indicate significance at 1%, 5%, and 10% respectively. (b) The periods are based on their respective break points in public GCFA.
Source: Authors' estimation from compiled data. Data compiled from *National Accounts Statistics*, Govt. of India and *Agricultural Statistics at Glance.*

Tab. 3. Growth rates of private investments and farm output during various phases (in 2011-2012 prices).

Periods	Private GCFA	GDPAg	Prod.
1st period (1960-1968)	2.41***	0.56*	1.07
2nd period (1969-1988)	1.95***	3.77***	2.56***
3rd period (1989-1997)	4.37*	2.49***	1.85***
4th period (1998-2003)	3.73***	3.01*	1.66***
5th period (2004-2011)	7.63***	3.77***	2.33***
6th period (2012-2017)	- 3.13*	2.21*	2.46**

Note: (a) The asterisks (***), (**) and (*) indicates significant at 1%, 5%, and 10% respectively. (b) The periods are based on their respective breaks private GCFA.
Source: Authors' estimation from compiled data. Data compiled from *National Accounts Statistics*, Govt. of India and *Agricultural Statistics at Glance.*

might have nullified the achievement in the growth rate of GDPAg and production to some extent. But, overall growth trends of all three series move in tandem in one direction. This suggests that public financing of agriculture is crucial for its growth and should be emphasized in the economy's fiscal policy adequately (Bathla, 2017).

Now observing the trend growth of the private investment and GDPAg and production in various sub-periods based on the breakpoints in private GCFA series, we don't find a close co-movement like that of public investment up to the third sub-period (Tab. 3). But subsequently, we find the co-movement growth trends of these variables. The growth rate of private investment in the pre-GR period (1960-1968) was 2.41%, but in the subsequent period, it dipped down to 1.95%. This is a strange phenomenon because this is the period of early GR period where public investment took off, but private investment did not follow it. Nonetheless, in the three subsequent periods (1988-1997, 1998-2003 and 2004-2011), the growth rates of private GCFA have been a little impressive (4.37%, 3.73%, and 7.63% respectively). But, after 2011 there was a sudden collapse in the rising trend and it fell so steeply after 2011 that we got a negative growth rate of -3.13 for the period of 2012-2017. Now drawing the comparison of sub-period growth rates of private investment series with that of GDPAg and production, we observed that growth stagnation inagricultural Production and GDPAg during the first sub-period, i.e., the pre-GR period could possibly be explained by the growth stagnation in public investment, though the private investment was slightly higher. But, when public investment peaked in the second period, the output growth rate also moved up, though the private investment was lower than the previous period. This period happens to be the period in which this elusive 4% growth in GDPAg target was achieved. But, this sub-period of private investment (1969-1988) is actually a combination of two sub-periods of public investment (1969-1976, and 1977-1988). So the growth rate of GDPAg in this period happens to be a little less than 4%. In the succeeding two sub-periods, the growth rates of GDPAg and production slowed down, which might be due to a slowdown in the growth of public investment, though slightly higher growth in private investment sustained the growth in GDPAg just above 3%. But subsequently, in the fifth sub-period (2004-2011) there was phenomenal growth in the private investment which sustained the agricultural growth at 3.77%. It should be noted that during this period, the public expenditure in the form of both investment and input subsidies also increased which led to a rise in private sector investment. Bathla (2017) showed that the subsidies and private investment grew at a rate of 6% and 9% respectively (at 2004-2005 prices) and irrigation intensity touched 50%. Therefore, the farm sector was able to achieve an all-time high growth rate of 3.8% annually during this period. So probably it can be argued that the increase of public investment not only directly affects the agricultural growth, it also stimulates a private sector capital formation, and thereby positively influences farm sector growth prospects. But in the subsequent sub-period (2012-2017) there is a sudden decline in private investment which rendered a slump in the farm sector growth as GDPAg and production grew at merely 2.16% and 2.24% respectively. Though the possibility of other factors driving the farm sector growth during different phases cannot be ruled out, this somehow explains the importance of investment in stimulating growth in the farm sector. Therefore, in the next section, we explore in detail the sources of agricultural growth.

3.4. Linkage between output growth and investment growth

Table 4 reveals the sources of GDPAg growth. It is clearly observed that agricultural GDPAg growth is positively and significantly affected by both the investment growth (public and private sector) in Indian agriculture. The coefficient of public investment growth ranges between 0.216-0.211% and significant at 10% probability level and the coefficient of growth of public canal intensity varies from 0.48 to 0.34 which are significant at 5% level of significance respectively, indicating that with a 1% increase in growth of public investment, the growth of GDPAg increases by 0.216-0.211% and 1% increase in growth of public canal intensity would raise the growth of GDPAg by 0.48% to 0.34%. The impact of private investment growth is observed to be little high and

Tab. 4. Determinants of GDPAg growth in Indian agriculture.

Variable	(1)		(2)		(3)		(4)	
	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.
Constant	0.011**	0.020	0.010**	0.037	0.011**	0.028	0.012**	0.014
Δ(Ig)	0.216*	0.081	---	---	---	---	0.211*	0.067
Δ(CNI)	---	---	0.481**	0.039	0.344**	0.044	---	---
$\Delta(I_P)$	0.420**	0.043	0.38***	0.007	0.361**	0.036	0.414**	0.025
Δ(CRI)	3.306***	0.000	3.679***	0.000	3.643***	0.000	3.262***	0.000
Δ(CRDT)	0.010	0.337	0.014	0.191	0.014	0.188	0.010	0.340
Δ(FERT)	0.202***	0.009	0.207***	0.010	0.211***	0.008	0.206***	0.008
Δ(HYV)	0.037**	0.029	0.064**	0.035	0.063*	0.055	0.035**	0.032
Δ(W)	-0.028*	0.091	-0.023	0.193	-0.023	0.191	-0.028*	0.091
Δ(TOT)	0.399**	0.026	0.340*	0.079	0.363*	0.064	0.425**	0.020
Δ(SBDY)	0.031*	0.098	0.028	0.124	---	---	---	---
Adj. R-sq.	0.84		0.83		0.92		0.91	
Log-likelihood	97.957		96.73		93.56		94.84	
F-stat.	10186.420		9533.29		10676.16		11463.12	
Prob.(F-stat)	0.000		0.00		0.00		0.00	
D-W Stat.	2.14		2.33		2.29		2.11	
AIC criterion	-4.754		-4.68818		-4.698		-4.769	
BIC criterion	-4.319		-4.2528		-4.302		-4.373	

Note: (a) The asterisks (***), (**) and (*) indicate significance at 1%, 5%, and 10% respectively. (b) The number of observations in the case 3rd and 4th specification is only 38 as the time period is only 36 years from 1980-2017. For the other two specifications, it is 48 from 1970-2017.
Source: Author's estimation.

coefficient values are varying within the range of 0.36-0.42 at a 1% level of significance. Other significant contributors to the growth of GDPAg are growth cropping intensity, fertilizer consumption, and area under HYV seeds, weather risk, and growth of terms of trade. The coefficient of weather risk showed a negative impact on GDPAg growth. No significant impact is observed by the growth of institutional credit while aggregate subsidies show a very weak impact on GDPAg. The value of adjusted R-squared is around 83-92%, Durbin-Watson statistics vary in-between 2.14 to 2.11 which are higher than R-squared values, indicating the non-existence of spurious regression.

Table 5 depicts the sources of growth of agricultural production, which clearly indicates that investment growth has a positive effect on the production growth (both public and private sector investment). The coefficient of public investment varies within the range of 0.361 to 0.346 while the impact of public canal intensity varies within the range of 0.435 to 0.463 in various specifications. In the case of private investment, the coefficient values are all statistically highly significant and varying within the range of 0.321 to 0.362. Among other vital sources of production growth, we get growth of cropping intensity, fertilizer, HYV seeds, and terms of trade. The credit and subsidies are not significant while weather risk is significant in one of the specifications. Recently, Akber and Paltasingh (2019b) evidenced that public investment augments farm productivity more in comparison to input subsidies as a whole. The results of Table 5 in the case of growth of production resemble the results of the previous Table. The results are also in line with previous studies like Chand (2005), and Chand and Kumar (2004), and Mathur *et al.* (2006)[9]. The values of adjusted R-squared are around 91% and also Durbin-Watson Statistic values are 2.14 to 2.25 in all the specifications which confirm the non-existence of spurious regression.

From the given analysis, we get various facts. First, the public sector investment in Indian agriculture declined during the 1980s and 1990s and the private sector investment maintained its pace till 2010-2011. Though in 2003-2004 there was a slight improvement inthe trend of public sector GCFA, it still remains less in comparison to private investment in the farm sec-

[9] The results they got by using linear OLS model with or without logarithmic approximations but not with the FD framework.

Tab. 5. Determinants of production growth in Indian agriculture.

Variable	(1)		(2)		(3)		(4)	
	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.
Const.	0.007**	0.036	0.007**	0.052	0.008*	0.058	0.008*	0.079
Δ(Ig)	0.361*	0.063	---	---	---	---	0.346**	0.028
Δ(CNI)	---	---	0.435**	0.049	0.463**	0.045	---	---
Δ(Ip)	0.343***	0.006	0.362**	0.037	0.346***	0.008	0.321**	0.043
Δ(CRI)	1.383***	0.000	1.260***	0.001	1.242***	0.005	1.513***	0.001
Δ(CRDT)	-0.005	0.610	-0.002	0.871	-0.003	0.977	-0.002	0.810
Δ(FERT)	0.275**	0.024	0.264*	0.063	0.271**	0.027	0.237**	0.026
Δ(HYV)	0.113*	0.689	0.190**	0.050	0.174**	0.030	0.166*	0.063
Δ(W)	-0.021	0.170	-0.014	0.368	-0.019	0.229	-0.026*	0.091
Δ(TOT)	0.076	0.510	0.102	0.370	0.111	0.507	0.025	0.880
Δ(SBDY)	---	---	---	---	-0.003	0.669	0.002	0.954
Adj. R-sq.	0.911		0.885		0.910		0.892	
Log-likelihood	119.718		120.922		101.213		99.703	
F-stat.	1701.73		1793.43		1781.22		1641.35	
Prob.(F-stat.)	0.000		0.000		0.000		0.000	
D-W stat.	2.159		2.163		2.241		2.218	
AIC criterion	-4.814		-4.866		-4.495		-4.413	
BIC criterion	-4.456		-4.508		-4.777		-4.695	

Note: (a) The asterisks (***), (**) and (*) indicate significance at 1%, 5%, and 10% respectively. (b) The number of observations in the case 3rd and 4th specification is only 38 as the time period is only 36 years from 1980-2017. For the other two specifications, it is from 1970-2017. *Source*: Authors' estimation.

tor. Again, the growth rates of public sector investment closely follow the trend growth rates of GDPAg and production in various sub-periods while the co-movement of private investment with GDPAg and production appeared after 2000 onwards. This temporal coincidence of growth performance of investment and farm output partially explains the causal effect of investment on agricultural performance. However, this aspect was further explored in the next section with the help of the first difference regression analysis. From the regression results, it is confirmed that the growth in GDPAg and production is affected by the growth of public and private investment, fertilizer use, HYV seeds and weather index, and agricultural terms of trade.

4. CONCLUSION AND POLICY IMPLICATION

We examined the hypothesis of investment as a major driver of farm sector growth in a two-step manner. First, we found out the structural breaks in investment series and then drew a comparison of growth performance of the investment with that of GDPAg and farm production, by keeping the base period of analysis same. In the second step, we examined the sources of growth of GDPAg and agricultural production by using the "first difference regression" method. The major findings are as follows: public sector investment in agriculture declined since the 1980s and 1990s followed by a slight improvement since the early 2000s but it was lower than increase private investment in the whole study period. The public GCFA as a ratio of GDPAg at 2011-2012 prices has revealed a declining trend while the share of private investment has been on an increasing trend with fluctuations till 2011 after which it started declining. Similar declining trends have been observed in the case of ratio of GCFA in economy-wide gross capital formation (GCF). Five optimal breakpoints in the case of private investment and four breakpoints in public GCFA were found by the Bai-Perron method. The growth trend of public GCFA followed that of GDPAg and production very closely. But the same co-movement was absent in the case of private investment till the late 1990s. But from 2003 onwards, growth trends of all three were found to move in the same direction. However, this linkage was further explored by analyzing the sources of growth of GDPAg and production which established the fact that growth in GDPAg and production are largely driven by the growth of both types of investment, fertilizer use, HYV seeds, and weather index

and also terms of trade. So the findings made it clear that the decline in investment, especially public sector investment could be one of the major reasons for the current growth stagnation of Indian agriculture though other important factors are also there.

The above-mentioned finding carries astrong policy implication for agricultural development in India. Agriculture is the mainstay of the Indian economy as the prime objectives of economic policy relating to price stability, output growth, and rural poverty alleviation are best served with help of the growth of this sector. It contributes around 14% to the GDP and accommodates 50% of the population but it is still neglected in the fiscal policy budgetary allocation. Therefore, it has been in crisis for a longtime. The declining public sector capital formation, as found in this analysis, is one of the pivotal reasons. Therefore, for sustainable growth in Indian agriculture, there is an urgent need to speed up the process of public sector capital formation which may stimulate more private investment at the farmers' level due to complementarity between the two. There is a specific need to enhance public sector investment in irrigation and rural infrastructure, research and development activities, storage facilities and transport, developing efficient marketing networks, revamping the agricultural extension system for smooth diffusion of information and technology, and so on. As evidence by one study that agriculturally dominant but economically poor states of North India experienced a huge decline in poverty in the late 2000s because of the rapid capital deepening process in agriculture which greatly enhanced their income. Therefore, the objective of rapid poverty eradication would be better served if the public investment is undertaken. Along with this, there is a need to link farmers with the food processing industry so that they can find a bigger market for their products and thereby get higher profit.

The main limitation of the present study is that due to the non-availability of private investment time-series data at the state level we have not extended the analysis to the state level. However, the length of the paper also puts some reasonable restrictions to have disaggregated analysis.

ACKNOWLEDGEMENT

The authors are thankful to professors Phanindra Goyari, Pratap Singh Birthal, Bezbaruah M.P., and two anonymous reviewers for their insightful comments on the earlier draft of this paper. However, the usual disclaimer applies.

REFERENCES

Agricultural Statistics at Glance (various years), Ministry of Agriculture and Farmers Welfare, Directorate of Economics and Statistics, Government of India.

Akber N. (2020). Does input subsidy discourage public investment in Indian agriculture? Evidence from ARDL applications. *Journal of Public Affairs*, e2337. https://doi.org/10.1002/pa.2337

Akber N., Paltasingh K.R. (2019a). Is public investment complementary to private investment in Indian agriculture? Evidence from NARDL approach. *Agricultural Economics*, 50(5): 643-655. https://doi.org/10.1111/agec.12515

Akber N., Paltasingh K.R. (2019b). Investment, subsidy and productivity in Indian Agriculture: An empirical analysis. *Agricultural Economics Research Review*, 32(3):13-25. DOI: 10.5958/0974-0279.2019.00014.4

Akber N., Paltasingh K.R. (2020). Public financing of Indian agriculture and its return. *Agricultural Economics Research Review*, (Forthcoming). DOI: 10.22004/ag.econ.310332

Bai J., Perron P. (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, 18(1): 1-22. https://doi.org/10.1002/jae.659

Bathla S. (2014). Public and private capital formation and agricultural growth in India: state-levelanalysis of inter-linkages during pre- and post-reform periods. *Agricultural Economics Research Review*, 27(1): 19-36. DOI: 10.5958/j.0974-0279.27.1.002

Bathla S. (2017). *Public investment in agriculture and growth: An analysis of relationship in the Indian context*. In Bathla S., Dubey A. (eds) Changing Contours of Indian Agriculture (pp. 13-28). Springer, Singapore.

Bathla S., Joshi P.K., Kumar A. (2020). *Agricultural growth and rural poverty reduction in India*. Singapore: Springer. https://doi.org/10.1007/978-981-15-3584-0

Bathla S., Joshi P.K., Kumar A. (2020). *Changing composition of private investment and its relation to public investment and input subsidy in agriculture*. In Bathla S., Joshi P.K., Kumar A. (eds) Agricultural Growth and Rural Poverty Reduction in India (pp. 57-78). Springer, Singapore. https://doi.org/10.1007/978-981-15-3584-0

Bhalla G.S., Gurmail S. (2001). *Indian Agriculture: Four Decades of Development*. Sage Publications, New Delhi.

Bhalla G.S., Singh G. (2009). Economic liberalisation and Indian agriculture: a state wise analysis. *Economic & Political Weekly*, 44(53): 34-44.

Bhattarai M., Narayanamoorthy A. (2003). *Irrigation impact on agricultural growth and poverty alleviation: Macro level impact analyses in India*. In IWMA–Tata Workshop.

Birthal P.S., Joshi P.K., Negi D.S., Agarwal S. (2014). *Changing sources of growth in Indian agriculture*, IFPRI Discussion paper-01325, International Food Policy Research Institute, Washington D.C., USA.

Boyce J.K. (1986). Kinked compound models for growth rate estimation. *Oxford Bulletin of Economics and Statistics*, 48(4): 385-391. https://doi.org/10.1111/j.1468-0084.1986.mp48004007.x

Chand R. (2005). Exploring possibilities of achieving four percent growth rate in Indian agriculture. NCAP Working paper 01, National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.

Chand R., Kumar P. (2004). Determinants of capital formation and agriculture growth: Some new explorations. *Economic & Political Weekly*, 39(52): 5611-5616.

Chand R., Raju S.S., Pandey L.M. (2007). Growth crisis in agriculture: severity and options at national and state levels. *Economic & Political Weekly*, 42(26): 2528-2533.

Chand R., Parappurathu S. (2012). Temporal and spatial variations in agricultural growth and its determinants. *Economic & Political Weekly*, 47(26-27): 55-64.

Chandrasekhar C.P., Ghosh J. (2002). *The market that failed: a decade of neoliberal economic reforms in India*. Left Word Books, New Delhi.

Chow G.C. (1960). Tests of equality between sets of coefficients in two linear regressions. *Econometrica*, 28(3): 591-605.

Dash R.K. (2009). Revisited export-led growth hypothesis: An empirical study on India. *South Asia Economic Journal*, 10(2): 305-324. https://doi.org/10.1177%2F139156140901000203

Fan S., Gulati A., Thorat S. (2008). Investment, subsidies, and pro-poor growth in rural India. *Agricultural Economics*, 39(2): 163-170. https://doi.org/10.1111/j.1574-0862.2008.00328.x

Gulati A., Bathla S. (2001). Capital formation in Indian agriculture: re-visiting the debate. *Economic & Political Weekly*, 36(20): 1697-1708.

Gulati A., Bathla S. (2002) Capital formation in Indian agriculture: Trends, composition and implications for growth. National Bank for Agricultureand Rural Development Working Paper. Mumbai.

Gulati A., Narayanan S. (2003). *Subsidy Syndrome in Indian Agriculture*. Oxford University Press, New Delhi.

Gulati A., Terway, P. Banerjee, P. (2018). *Trends in Input Subsidies and Investments in Indian Agriculture*. In: Gulati A., Ferroni M., Yuan Zhou (eds.) Supporting Indian Farms: the Smart Way. New Delhi: Academic Foundation.

Haque T. (2016). *Agrarian distress in India: causes and remedies*. New Delhi: Concept Publishing.

Kumar A., Bathla S., Verma S. (2020). *Changing composition of private investment in Indian agriculture and its relationship with public investment and input subsidies* (Vol. 1905). International Food Policy Research Institute (South Asia Office), New Delhi.

Kumar M.D., Ganguly A., Sivamohan M.K. (2019). What drives agricultural growth in India. *Economic & Political Weekly*, LIV (1): 33-36.

Mathur, A.S., Das S., Sircar S. (2006). Status of Agriculture in India: Trends and Prospects. Economic & Political Weekly, 41(52): 5327-5336.

Mogues T., Bingxin Y., Fan S., McBride L. (2012). The impact of public investment in and foragriculture: synthesis of the existing evidence, ESA working paper no 12-06, Food andAgriculture Organization of the United Nations.

Nadkarni M.V. (2018). Crisis in Indian agriculture: can it be overcome? Economic *& Political Weekly*, 53(17): 28-34.

National Accounts Statistics (back series 2011, 2017): National Accounts Statistics, Central Statistical Organization, and Government of India.

Paltasingh K.R., Goyari P. (2018). Statistical modeling of crop-weather relationship in India: A survey on evolutionary trend of methodologies. *Asian Journal of Agriculture and Development*, 15(2): 43-60. DOI: 10.22004/ag.econ.275688

Paltasingh K.R., Goyari P., Mishra R.K. (2012). Measuring weather impact on crop yield using aridity index: evidence from Odisha. *Agricultural Economics Research Review*, 25(2): 205-216. DOI: 10.22004/ag.econ.137373

Paltasingh K.R., Goyari P., Tochkov K. (2017). *Indian agriculture after the Green Revolution: An overview*. In Goswamy B., Bezbaruah M.P., Mandal R. (eds.) Indian Agriculture after Green Revolution (pp. 8-28). Routledge Publication, New Delhi.

Rao C.H. (2003). Reform agenda for agriculture. *Economic & Political Weekly*, 38(7): 615-620.

Reserve Bank of India (RBI), Handbook of Statistics on Indian Economy (Various issues).

Ricker-Gilbert J., Mason N.M., Darko F.A., Tembo S. T. (2013). What are the effects of input subsidy programs on maize prices? Evidence from Malawi and Zambia. *Agricultural Economics*, 44 (6): 671-686. DOI: 10.1111/agec.12081

Sainath P. (2018). In India, farmers face a terrifying crisis, New York Times, 13 April 2018. Accessed on 25th May 2020.

Shetty S.L. (1990). Investment in agriculture: brief review of recent trends. *Economic & Political Weekly*, 25(7-8): 389-398.

Singh A., Pal S., Jha G.K. (2015). Transitioning India's public expenditure in agriculture towards higher growth and equity. *Indian Journal of Agricultural Economics*, 70(3): 246-258.

Singh P. (2014). Declining public investment in Indian agriculture after economic reforms: an interstate analysis. *Journal of Management & Public Policy*, 6(1): 21-33.

Vyas V.S. (2001). Agriculture: second round of economic reforms. *Economic & Political Weekly*, 36(10): 829-836.

APPENDIX

Tab. A.1. Descriptive statistics and definition of all variables.

Variable	Definition	Mean	SD
Production (PR)	Total agricultural production (in million tonnes)	156.24	35.6
Agri. GDP (GDPAg)	Agricultural GDP at 2011-12 prices (in ₹crores)		
Investment(Ig)	Public investment by government (in ₹crores)	23631	8401
Canal Intensity (CNI)	It is a ratio between area under government canals and net sown area	116.41	5.98
Subsidy (SBSD)	Total subsidies provided (total of subsidies on irrigation, fertilizer, and electricity) (in ₹crores)	54,599	78,353
Terms of Trade(TOT)	Gross barter terms of trade (ratio of agricultural GDP deflator to nonagricultural GDP deflator)	36.96	14.18
Credit (CRDT)	Institutional credit provided to farmers ((in ₹crores))	1,606	1,825
Area under HYV Seeds (HYV)	Area under high yielding variety seeds (in million ha).	61,475	10,509
Cropping Intensity(CRI)	It is the ratio of net sown area to the total cropped area (area in million ha).	132.55	5.292
Weather index	Weather index WI=(Rt/1.07T)is calculated as:	95.263	86.75

Note: Data on all these variables are taken for the period 1960-2017 except input subsidy for which data is available for the period 1980-2017.

Source: All the data are compiled from various sources like National Account Statistics, Govt. of India, Agricultural Statistics at Glance, Reserve Bank of India, and Indiastat.com, etc.

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: Francesco Scalamonti (2021) Bottled Water Industry: a quantitative study approach. *Italian Review of Agricultural Economics* 76(2): 31-44. DOI: 10.36253/rea-13095

Received: October 2, 2020

Revised: January 19, 2021

Accepted: June 7, 2021

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Bottled Water Industry: a quantitative study approach

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Abstract. This paper is a survey of the Italian bottled water industry that with quantitative approach relates the consumes or operative volumes of mineral water market based on the middle trend of temperatures, the consumed income per-capita and the trend of the population. We present the weight-OLS models for four macro-markets – north western, north eastern, centre, southern – on the data of the Bevitalia survey and the ISTAT-Time Series dataset from 1980 to 2020. The results confirm that the operative volumes depend positively and significantly on itself lagged by one order and the other explicative variables up cited. However, the study not consider other important correlated industries as soft drinks or flavoured waters. In addition, the analysis could be more indepth at the level of regions, provinces and municipalities, or for case-study whit a qualitative approach. In conclusion, the study captures the market dynamics of the industry at long-term, and it brings to the attention of managers, researchers and business economists an industry much important for socio-economic implications and environmental impacts that can cause the consumption of bottled water that policy makers cannot afford to ignore.

Keywords: bottled water, quantitative study, sustainable development.
JEL codes: C51, L10, L66, M21.

1. INTRODUCTION

The drink water[1] or for human consumption is the most precious common good found in nature, a source of life but also a cause of war in many parts of the world. The well-known problem of water scarcity and climate change triggered by globalisation have led to a reconsideration of this important issue also in the debate of economists and beyond (Nanni, Prodi,

[1] The drink water is that which, as found at the spring, is bottled and placed on the market in compliance with Legislative Decree 105/1992 and its subsequent amendments and additions – Legislative Decree 339/1999, Legislative Decree 176/2011, and the Decrees of the Ministry of Health on food safety. The industry is subject to a complex and fragmentated normative to protect consumers, reviewed on several occasions and in different historical periods (Amorosino, 2009; Enrichens, 2018). Thus, the law definition of the good is also important into public law of economy, because the drink water is part of the public and unavailable property of the State (Mattei *et al.*, 2007; Rodotà, 2018). The code ATECO (2007) of industry identification is: *C - Manufacturing activities*; *11.00 - Beverage industry*; *11.07 - Soft drinks, mineral water and other bottled water industry*, with specific reference to bottled mineral water production.

2008; Parag, Opher, 2011; Caniglia *et al*., 2012; Collins, Wright, 2014; Carlucci *et al*., 2016; Enrichens, 2018; Lee *et al.,* 2019; Lee *et al.,* 2020).

The mineral bottled water business could be said to exemplify the modern global economy and some studies have focused on (Gironi, Piemonte, 2010; Niccolucci *et al*., 2011; La Moreaux, Tunner, 2012; Torretta, 2013; Kajtazi, Reshidi, 2018; De Marchi *et al.,* 2020), while few studies considered management and governance implication for the firms (Disanto *et al*., 2007; He *et al*., 2008; Caniglia *et al*., 2012; Carlucci *et al*., 2016; Bal, Oraman, 2019).

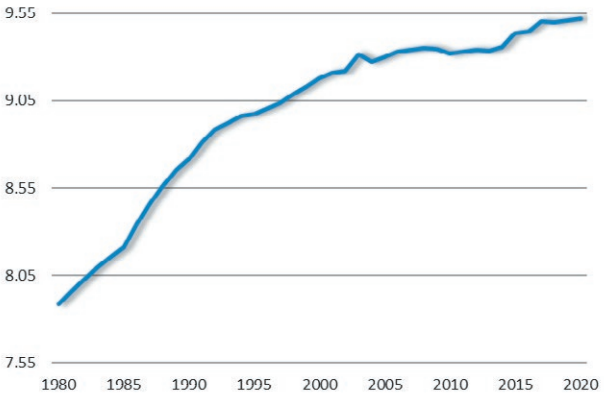
This study starts from these brief considerations to try to increase the debate among scholars of business economics and management on the topic of the marketing of bottled water, now of increasing interest in all markets (Fhelboom, Brika, 2020; Abdah *et al.,* 2020; Mahmood *et al.,* 2020).

The issue of water is certainly a matter of great importance and of general interest today, no longer confined to developing countries or linked to hydrogeological desertification conditions, but which must also be assessed on the basis of climatic impacts. The relationship between climate change and the uses of the resource leads us to investigate the possible causes of its wastage. In other words, bottled water is also under attack for its relatively high impacts on the environment and consumer prices (Gleick, 2010). Given its free availability in nature but not unlimited drinking water found in nature is a common and public good, but its bottle distribution is in the hands of a few dealers, creating thus the premises for the industry concentration and enforcement substantially high average prices per litre to bottled water (Spar, Bebenek, 2008; Marty, 2020).

Since the nineties, Italy has become the first country for bottling and for consumption of mineral drink water (ISTAT, 2020; Bevitalia, 2020). The graph in Figure 1 is the trend of operative volumes of bottled mineral water market from 1980 to 2020.

In the others hands, this is a representation of the industry life cycle (Vernon, 1966; Hymer, 1972) who since the 1990s has entered the shake-out stage and then the maturity stage. Therefore, the most appropriate form of market at these stages is monopolistic competition where weaker competitors are expelled and potential entrants find barriers to entry, which are structurally high for this industry. Consumers then make their purchases more selectively and the operating volumes of incumbent firms can slow down. It is therefore becoming more difficult for them to increase market shares and they must fight to maintain their position, including in international markets.

Fig. 1. The life cycle of bottled mineral water industry, log-values.



Source: reconstruction on Bevitalia survey.

The growth of purchases of bottled mineral water is attributable in sum to at least three qualitative factors (Hawkins, 2017): *(i)* the use of polymers in packaging, with significant savings for enterprises, but certainly a cause of environmental disease, *(ii)* a greater consumer focus on their health and a healthier lifestyle, *(iii)* a careful strategy of brand differentiation by firms, who are very careful in finding the most suitable levers of operative marketing. On the other hand, from a quantitative point of view they could depend, at instance, on the willingness of individuals to spend money and their consumption styles or even on the climatic situation of the period that binds to the need for water necessary to the organism, thus modifying the amounts of water needed.

Therefore, the purchase of bottled mineral water respect to consume tap water is now well structured and cross-structured by income groups, ages and geographical areas for several decades now (Ferri, 1999; Raspadori, 2002; Bevitalia, 2020). Just think that Italy is the first European country for consumption of bottled mineral water and exported volumes.

Italy is a country rich in water resources but where there is also a great differentiation between regions in the north, centre and south as regards the relative abundance of resource, access to markets and distribution networks. Umbria, at instance, according to its hydrogeological conformation and the particular orographic conditions of the soil is very rich in water. In another way, Umbria is the Italian region leading in consumption (ISTAT, 2020), and where several firms and groups are located: Cogedi, owner of established brands such as Oliveto and Rocchetta; Motette, one of the best performing groups in the industry (Competitive Data, 2020), and Siami, with a growing production (Bevitalia, 2020).

The bottled mineral water industry in Italy creates an interesting market and with important employment implications. Therefore, in the industry whose production has constantly grown there are some leader brands that are in the high price ranges and that have a good distribution capacity, both in domestic and foreign markets.

The paper has been structured in this way: *(i)* a part in which an expositive survey of the literature and the dynamics of the industry are reported, *(ii)* follows the presentation of empirical analysis and results, ultimately, *(iii)* in the conclusion we report considerations, limitations, future lines of research and policy implications.

2. AROUND THE DYNAMICS OF BOTTLED WATER INDUSTRY

Water has become in the last hundred years from a free, accessible and necessary natural resource to all one of the most marketable products and a profitable business for firms in the industry (Gleick, 2010). In economics, two goods are interchangeable if they meet similar needs to the same extent, such that an increase in the price of one causes an increase in demand from the other, whit the choice of the consumer being based mainly on the price convenience between the two goods (Katz *et al*., 2020). Although these conditions may apply to bottled and tap water, on closer examination these hypotheses must be considered rather fallacious because the consumption of bottled water does not depend strictly on the price of the tap and vice versa.

Generally, the consumption of bottled water increases with increasing per capita income (IBWA, 2019) and the price can be increased by up to about five hundred times compared to the cost of tap water (Ferrier, 2001). Therefore, drinking bottled water is more a reflection of a wealthy lifestyle, and generally, it is perceived as a healthy or safe consumption due to the investments in communication and marketing of bottling firms of the industry (Disanto *et al*., 2007; He *et al*., 2008; Caniglia *et al*., 2012; Carlucci *et al*., 2016; Bal, Oraman, 2019).

Consumer choice then appears more complex and depends on additional factors (Lancaster, 1966), which go beyond the sole satisfaction of thirst or comparison between prices of competing brands (Abrahams *et al*., 2000; Wilk, 2006; Doria *et al.,* 2009; Hu *et al*., 2011; Del Giudice *et al*., 2016; Biro, 2017; Capehart, Berg, 2018). Thus, defining two goods in this industry as interchangeableis by no means a foregone conclusion, and this is particularly true for mature markets or in those where the mean quality of tap water is not so lower than that of bottled water. In fact, another aspect not to be overlooked is that the consumption of tap water would exist regardless of the consumption of bottled water precisely because of the other uses that are made of this resource.

The bottled water market, not by chance, is the example taken by Cournot to describe its model of oligopoly, where the marginal cost of production – practically given by that of the bottle alone – and the sunk costs of starting the business are represented by the only fee paid for the use of the resource (Sutton, 1991; Carlton, Perloff, 2005; Laino, 2013; Cabral, 2018). Thus, in front of the cost structure of the firms and the profit margins that expect, the industry is certainly very attractivity for those firms that are manage to enter. For these reasons, it is a very good business opportunity.

The industry is characterised by barriers to entry, as the authorisation of regional government for the exploitation of water resources is required (Nicoletti, Fredella, 2005). In addition, incumbents may decide to lower sales prices at least to the level of the total middle cost of production of the newcomer, therefore, it will have to operate below the minimum efficient production scale represented by its marginal cost (Archibald, Rosenbluth, 1975; Salop, 1979; Dixit and Stiglitz, 2001).

The potential of the market has also attracted the big international corporations such as Nestlé, Danone, Coca-Cola – present in the industry through their own commercial divisions or marketing agreements – which together with the major Italian groups increase the competition (Brei, Tadajewski, 2015; Brei, 2017). Thus, the market has entered the maturity stage of its life cycle and competitive pressures on enterprises intensified (Mascha, 2006; Clarke, 2007; La Moreaux, Tunner, 2012). By the way, water is the main input for the production of soft drinks and this makes the two industries related and vertically integrated (Galizzi *et al*., 1997; Senauer, Venturini, 2005).

Concentration processes in the industry began in the seventies, when firms start competitive strategies of horizontal growth and marketing differentiation (Balliano, Lanzetti, 1976). The competitive structure of the industry has now been consolidated with a level of concentration that anyway is not negligible (Bevitalia, 2020). Mineral water is a market composed of a heterogeneous productive system, which includes large groups and firms with a territorial characteristic. The first are able to invest in internationalization processes – now more necessary than ever to escape the stagnation of internal markets – the second are conditioned by the local market and usually have a poor marketing vocation. Therefore, these are the firms that suffer most from the raising

of barriers to the entry of the industry due to the marketing sunk costs of the bigger competing firms.

In other words, the bottled water market has entered a stage of maturity, in which the leaders are the ones that manage to guarantee high operating volumes and that have the financial resources to invest in marketing activities. Finally, this has repercussion on the structure of the industry and it is to the detriment of small competitors who, despite having the same peculiarities as the other firms in the industry in terms of productive plants, however, fail to reach satisfactory market shares.

Therefore, sunk costs both economic and bureaucratic necessary for the start of the water mining and bottling in an appropriate plant near the source are a natural barrier to the entry of new firms into the industry. This means that incumbent firms can increase market share through merger and acquisition operations. In such a market, the gap between middle production costs and middle revenues is very wide, thus retail and marketing costs are spread over higher operative volumes. Firms with higher operative volumes can benefit from an impact of the middle retail cost on the middle total cost of production lower as a result of economies of scale, and at the end, they apply lower prices than their competitors (Bliss, 1988; Corstjens *et al.*, 1995; Sciarelli, Vona, 2000; Bolton, Shankar, 2003; Kopalle *et al.*, 2009; Biffignandi, Church, 2012; Ceccacci, 2013).

The competitive tension in the industry is justified by the fact that all the supply is aimed at the satisfaction of the same need, which is the supply of water to the organism. In this sense, horizontal differentiation of the production is fundamental to competitive strategies of the firms and the affirmation of the symbolic qualities of the product (Porter, 1985). In other words, it is about the perception that consumers have of the product. Thus, in the market can be found a multitude of brands and bottles (Gruber, 1994; Dube, Manchanda, 2005; Disanto *et al.*, 2007; Dolnicar *et al.*, 2014; Carlucci *et al.*, 2016; Bal, Oraman, 2019). In general way, the bottle and packaging are the constituents of the positioning of mineral water, which from a primary good for the satisfaction of a physiological need, it undergoes a process of sophistication that gives it new meanings, especially thanks to the proliferation of marketing activities that have made possible new forms of packaging, promotion and consumption (Finlayson, 2011; Twede, 2012).

The real discriminators for firms are marketing investments and transport costs. Therefore, consumers may prefer to purchase locally sourced water, because of the less impact they would have on its final price (Lambin, 2012; Kotler *et al.*, 2012; Caniglia *et al.*, 2012; Capehart, 2015; Carlucci *et al.*, 2016; Mundel *et al.*, 2017; Bal, Oraman, 2019). However, this does not, affect the movements of the stocks of bottled water on the national territory, and the exports absorbs a not insignificant share of the operative volumes of the major enterprises in the industry (Bevitalia, 2020).

Ultimately, globalisation has certainly increased competitive pressures that weigh on management and corporate governance (Ferrucci, 2000; Milgrom, Roberts, 2005; Volpato, 2010; Hamilton *et al.*, 2011; Bosi, Trento, 2012; Gibbons, Roberts, 2013; Tunisini *et al.*, 2014; Grant, 2016; Golinelli, 2016; Sciarelli, 2017; Ferrucci, 2019), but it also represents for decision makers who manage to catch the benefits one a chance for extend the business into new markets (Chakrabarti 2011; Brouthers 2012; Matarazzo, Resciniti 2014; Cantele, Campedelli, 2016; Ruzzier *et al.*, 2017; Bannò *et al.*, 2018; Scalamonti, 2020a), such as those in the near Middle East or the Mediterranean countries of Africa (Ferrucci, Paciullo, 2015; Scalamonti, 2020b), or in Southern Asianand Eastern Europe – however already manned of the firms – in which the emergence of the middle class shifted the general consumption preferences towards more western styles (Wang *et al.*, 2000; Kim *et al.*, 2002; Florida, 2005; Lin, Wang, 2010; Vescovi, 2011; Guercini, Runfola, 2016; Neacşu, 2017). For many Southern Asian countries, the tap water is considered not safe especially for those who are not locals, at instance, the Middle East is characterized by consolidated bottled water consumption, with Turkey being by far the biggest consumer of bottled water in the region, which does it the more developed market and most easily accessible by firms in the industry (Akpinar, Gul, 2014). On the other hand, Africa has a constellation of emerging markets, but Latin America and Oceania also have growing consumer markets (IBWA, 2019; Kansole, Beidari, 2020).

3. EMPIRICAL ANALYSIS

From a macro perspective there has been a rise of the bottled water industry in both developed and emerging markets (Patsiaouras *et al.,* 2015; Howell *et al.,* 2020). At instance, Cohen *et al.* (2017) recently conducted a quantitative study to investigate predictors of bottled water consumption in China. Their results show that bottled water purchases are influenced by the mean age of the household, the mean level of education, a fairly high consumed income and the male gender component.

Therefore, to influence the purchases of bottled mineral water and the development of this market there are a whole range of socio-economic and cultural factors as ethnic group, age, income, employment, gender, but pur-

chasing patterns can vary by country or region (Abrahams *et al.*, 2000; Wilk, 2006; Doria *et al.,* 2009; Hu *et al.*, 2011; Del Giudice *et al.*, 2016), while, less important seem to be the health properties of the water or the organoleptic properties shown in the labels (Carlucci *et al.*, 2016; Biro, 2017; Capehart, Berg, 2018; Bal, Oraman, 2019).

3.1. Research question, methodological note and results

This study uses quantitative explicative variables to investigate the determinants of the operative volumes of bottled mineral water, which is an industry that operates just-in-time and in which market demand asks to face the peaks due to seasonality, or which depends on other seasonal factors such as incremental consumption due to the tourist presence.

Therefore, the research questionis as follows: *are which determinants can explain purchases of bottled mineral water in Italy?*

We use aggregated data for ISTAT macro-markets: north-western, north-eastern, centre and southern with islands. Therefore, in reference to survey of literature, for explain the operative volumes of the bottled mineral water used: *(i)* the same dependent variable with one order of lag, which can be a measure of consolidated consumption style, according to the assumption that to influence the purchase at the time t there are implicitly marketing investments of the firms, *(ii)* the trend of the middle temperatures of the period which was reconstructed using a barycentric value for each macro-markets - the two most important chief city, *(iii)* the trend of population in the markets, and *(iv)*the consumed income per-capita.

The time series data on the operative volumes of bottled mineral water from 1980 to 2020 were reap and reconstructed by integrate the Bevitalia survey, while the other data were taken from ISTAT-Time Series dataset. In Table 1 we report the main panel descriptive statistics of the log-variables. The H_θ indicator is a measurement that we present to seepanel heterogeneity[2], which we find in mean not to be high. For the mean of the groups is 0.02 and for their standard deviation is 0.15.

In Table 2 we report the statistical associations at panel level for regressors, which show that there may be a not insignificant problem of autocorrelation between variables, such that, we decided to model the variance of the cross-sectional type sample using a weight-OLS regression model. Therefore, with weights based on the estimated variances of regression errors and model convergence for maximum likelihood after iterations. In this way, we catch the heterogeneity not observed using the dichotomous variables that identify the four macro-markets and that stabilize the parameters, then submitted to regular significance test. With this technique we have the dual advantage of estimating efficient parameters even in the presence of correlation between the regressors and of being able to control any other effects induced by omitted variables. The parameters are estimate with Gretl open-source statistical software.

The model with the control for the four macro-markets dummies, which are not significant and whose effects are very similar to each other, produces more efficient estimates after taking the individual effects.

It confirms the assumption behind the growth of the operative volumes of the bottled mineral water. Therefore, markets feed their growth over time, but they are also positively correlated mainly to the trend of middle

Tab. 1. The main descriptive statistics of log variables.

	Operative volumes	Temperature trend	Consumed income per-capita	Population trend
μ	7.554	2.748	4.568	7.240
σ_w	0.485	0.051	0.584	0.034
σ_b	0.301	0.083	0.000	0.301
min	6.190	2.551	3.050	6.941
Max	8.438	2.909	5.129	7.646
Unit	4.000	4.000	4.000	4.000
Obs	41.000	41.000	41.000	41.000
Std	litre	°C	Euro	unit
Source	Bevitalia	ISTAT-TS	ISTAT-TS	ISTAT-TS

Source: our elaboration.

Tab. 2. The correlation between variables used in regression models.

	Operative volumes	Temperature trend	Consumed income per-capita	Population trend
Operative volumes	1.000			
Temperature trend	0.609***	1.000		
Income per-capita consumed	0.872***	0.416***	1.000	
Population trend	0.546***	0.519***	0.075	1.000

Source: our elaboration.

[2] It was calculated as:

$$H_\theta = \frac{1}{N_i N_j} \sum_{i=1}^{N} \sum_{j=1}^{N} \left| \frac{\mu_\theta - \theta_{ij}}{\mu_\theta} \right|$$

Tab. 3. The regression model.

	Model 1	Model 2	Model 3
	Operative volumes		
Operative volumes (t-1)	0.763*** (0.040)	0.796*** (0.040)	
Temperature trend	0.213*** (0.054)	0.052* (0.028)	0.113** (0.057)
Consumed income per-capita	0.146*** (0.034)	0.125*** (0.034)	0.783*** (0.007)
Population trend	0.166** (0.079)	0.192*** (0.041)	0.984*** (0.017)
North-Western effect	−0.610 (0.506)		
North-Eastern effect	−0.630 (0.485)		
Centre effect	−0.652 (0.488)		
Southern effect	−0.624 (0.525)		
Constant		−0.532*** (0.167)	−3.460*** (0.131)
Standard error	0.023	0.024	0.050
Log-likelihood	378.079	372.617	261.962
LR-test (p-value)	(0.857)	(0.984)	(0.997)
Convergence iterations	3	2	2
Not observation (%)	*4 (2)*	*4 (2)*	-
Observations (%)	*160 (98)*	*160 (98)*	*164 (100)*

Note: *** significant at α = 0.01; ** significant at α = 0.05;* significant at α = 0.10.
Source: our elaboration.

temperatures for the period, and after also trend of consumed income per-capita and that of the population.

The parameters we have estimated are all positive and significant (Tab. 3) and in progression from model 3 to 1 the estimates of parameters improve after first inserting the delay of an order of the dependent variable and then explaining the composition effects of the panel for the four macro-markets.

4. CONCLUSIONS

4.1. Final considerations

The analysis that we propose investigates the quantitative determinants of its operative volumes. The consumption of bottled mineral water should not be a matter of preference, since water is a vital and necessary good to the organism of living beings, but in most western economies or in westernized world this is provided as tap water or as bottled mineral water. Thus, the choice between the two increasingly becomes a matter of preferences and styles of consumption (Disanto *et al.*, 2007; He *et al.*, 2008; Caniglia *et al.*, 2012; Carlucci *et al.*, 2016; Bal, Oraman, 2019). This is true in countries with mature markets such as Italy, or where on mean the quality of tap water is not said to be worse than that of bottled mineral water (Cidu *et al.,* 2011).

The purchase of bottled mineral water today can be considered as a habit or a style of consumption, which many people adopt because they perceive this type of good as safer, or healthy, or of better quality (Ferrier, 2001). Although, a more complete background must consider other factors such as the level of education or the demographic aspect (Abrahams *et al.*, 2000; Wilk, 2006; Doria *et al.,* 2009; Hu *et al.*, 2011; Del Giudice *et al.*, 2016; Biro, 2017; Capehart, Berg, 2018).

Consumption of bottled mineral water is geographically popular in all regions with some differences that have attenuated over time (ISTAT, 2020; Bevitalia, 2020). The high consumption of bottled mineral water is then promoted by the fact that there are numerous springs in all regions. Thus, among the most interesting discriminated elements is the income gap between northern and southern. It is no coincidence that the southern macro-market is the one where there is some great consumption of bottled mineral water and in which firms manage with to have a better positioning of the product according to the applied sale price (Carlucci *et al.*, 2016). In addition, firms that adopts competitive price strategies may prefer to increase the operative volumes obtained in the nearest markets, as this policy of marketing has a better impact on their costs.

The literature that debates the industry shows that consumers pay for bottled mineral water a mark-up mainly due to effective brand position strategies of the firms through the levers of operative marketing, whose aim is to have the maximum depth in the typology of product offered (Gruber, 1994; Dube, Manchanda, 2005; Disanto *et al.*, 2007; Dolnicar *et al.*, 2014; Carlucci *et al.*, 2016; Bal, Oraman, 2019).

Therefore, it is not surprise that due to consolidated consumption styles, the variations in the operative volumes of the bottled mineral water in Italy – considered in the four ISTAT macro-markets: north-western, north-eastern, centre and southern with islands – depend positively and significantly mainly of the operative volumes lagged by one year, and more marginally also by variations in middle temperatures trend of the period (IRI, 2016).

The analysis could be suitable for regions, but it could also extent to provinces and municipalities (Bol-

lino, Espa, 2015) and it could also be in-deep. In this sense, it might be interesting to use spatial regression models or the more appropriate linearly approximated almost ideal demand system(AIDS-LA), which is the more simplified version of the popular AIDS model used in the empirical demand analyses (Deaton, Muellbauer, 1980; Green, Alston,1990; Moschini, 1995; Banks *et al*., 1997). Base assumption is that non-linear Engel curves cause an increase in consumed income, but at the same time they also cause a decrease in income share allocated to each good, with a consequent decrease in income elasticity. In other way, a specific case study (Yin, 2017) could be made on significant enterprises of the industry.

The study discounts the methodological limitations, such as it refers only to the product category of bottled mineral water. Thus, it overlooks other important correlated industries such as soft drinks and flavoured water. A mineral water producer can make use of any excess production capacity to produce soft drinks and flavoured water, provided that it has the necessary flexibility of the plants to benefit of the economies of scope, even if the reverse is not possible as water is the main input for the production.

Among other things, within the industry identified by ATECO taxonomy are included categories of goods which are lowly interchangeable on both the demand and supply-side. There is a problem of delimitation the market or industry, specifically to bottled water and, within this, a problem of differentiation between mineral water or flavoured water, which in turn are different from soft drinks. Therefore, the possibility to produce with flexible plants and to benefit of economies of scope does not seem sufficient for to include in the same market or industry of the productions that are different from each other like soft drinks. Moreover, the hight horizontal differentiation of products also confirms that flexibility demand-side is not an appropriate criterion for one wide definition of the industry and market.

Attention in the law and economic debate on issues of competition protection has grown over the years in Italy. Thus, it is important the definition of *geographic relevant market* given by authority of the protection of competition, in addition to typical definition for industry of the industrial economics for bottled mineral water. Since, it is more useful for to identify situations where there is risk of situations of abuse of market power of the incumbents (Bruzzone, 1995). This can be defined as the smallest of competitive contexts – product set or geographical area, within which it is possible to create significant market power by incumbent firms given the degree of products substitutability. Finally, these brief considerations can be extended to all those industries grouped into conglomerate and spurious taxonomies.

4.2. Policy implications

We close with a few brief considerations on the good that identifies this particular industry, as the profile of the water resource remains complex and multifaceted (Urbani, 2009). For the market and the economy in general, it is necessary to minimise the gap between consumer demands and the need for businesses to make profits (Katz *et al.,* 2020). In this sense, the allocative function of the market and its efficiency are not compromised. The management of complex goods such as water must necessarily involve two aspects. The first is that of the management of a common good, and the second is that of productivity. This means that water management and its market need idiosyncratic industrial investments and economic policy choices that respect the objectives of social and environmental sustainability in a now changed global social, political and economic background (Marelli, Signorelli, 2019).

For economists, when a good is not exclusive or the subject of rivalry and its consumption is accessible to all, thus it is a common good and it is precisely from this type of goods that a whole series of problems arise about their governance (Ostrom, 1990). Therefore, in the current stage of globalization characterized by high fragmentation, the role of enterprises in society also changes and for businessman and managers is important to increase their ethical awareness (Orlitzky, Moon 2011; Chirieleison, 2017). Specifically, there has been a rise in enterprises responsibilities initiatives providing bottled drinking water in emerging and developed markets (Brei, Böhm, 2011).

Business decision makers – businessman and managers – could adopt more selective and responsible behaviour in respect to manage the environmental impacts of their business (Fhelboom, Brika, 2020; Abdah *et al.,* 2020; Mahmood *et al.,* 2020). It is also essential in Italy to prepare appropriate policy for the protection of environmental and territory sustainability, as is already being done in other parts of world (Tao, Xin, 2004; Barnes, Cao, 2014; Kooy, Walter, 2019; Tosun *et al*., 2020). On the other hand, consumers may also decide to adopt better purchasing behaviours, maybe inspired by the economy of small decisions (Erev, Haruvy, 2016), or more focused on a common civic sense and responsibility (Zamagni *et al.,* 1999; Bruni, Zamagni, 2004; Becchetti, Rosati, 2007). Thus, policy makers should take note of the possibility that greenhouse gas emissions – linked to higher development rates – can be reduced by

pushing active demand substitution policies that change consumption habits over time (Hallett *et al.,* 2010; Niccolucci *et al*., 2011; Sarkodie, Strezov, 2019).

Among the many definitions that characterize today's debate on the future of man and the environment, of particular attention is certainly that of sustainable development in the sense of satisfying the needs of the present without compromise of the possibilities for development for future generations. This concept has since been extended also in relation to the direct and individual responsibility of people, which refers to a voluntary and conscious adherence of each to these principles.

In the face of possible growing water famines, it is necessary to establish strategies to reduce waste within a clear framework of market regulation – including for territorial levels – and that politics must have the will to govern (Bollino, Signorelli, 2018). It will also be up to the policy to redefine a framework for reconciling efficiency in industrial management – which requires the remuneration of capital – and the needs in the management of a public and common good (Polytechnic of Milan, 2019; UNESCO, 2020).

Indeed, climate change is more unpredictable and is making water an increasingly scarce and polluted resource, threatening sustainable development while reducing biodiversity. A growing demand for water will determine the need for a policy response that can improve water management in the light of the effects of climate change (Carullo, 2009).

Climate projections indicate an increase in precipitation in Northern Europe and a reduction in Southern Europe (UNESCO, 2020). Therefore, key actions to achieve effective adaptations and resilience to extreme events in the European region include: *(i)* increased water efficiency and savings strategies, *(ii)* monitoring and data sharing, *(iii)* coherence between climate change adaptation measures and their prevention by reducing the risk of related natural disasters, *(iv)* the possibility of drawing on structural funds to meet these objectives.

In this sense, the agricultural sector is the one that will suffer most from climate change compared to other production sectors with negative shocks on farmers' incomes (Day *et al.,* 2018). Therefore, while the impact of these changes is difficult to quantify, it is conceivable that both a decrease in water availability and an increase in demand due to higher consumption may occur locally (Dell *et al.,* 2014; Costantini *et al.,* 2018). Therefore, it becomes necessary to plan coordinated industrial policy actions in order to mitigate climate impacts and reduce the waste of resources (Luciani, 2020), who must find, in farmers and producers/bottlers, the main actors and interpreters aware of the management and protection of a resource of the highest value for the community.

Finally, a reference to the long-standing problem of negative externalities and environmental impact – wastes and emissions – or the "shifting of burdens" problems in industrial processes that that shifts the attention on identification of appropriate fees that enterprises must pay for the exploitation of the common economic resource (Alesina, Passarelli, 2010; Bollino, Micheli, 2012). In other words, the problem of the congruence of concession fees that enterprises have to pay for water bottling – but more generally for the exploitation of public resources – and the problem of the governing the common resources are now topical in Italy.

In this sense, the assessment of the impacts of the life cycle of production processes (LCA) and therefore of products is of extreme importance. This analysis can help interpret data on emissions and resource consumption associated with a product's life cycle in terms of environmental burdens and human health (Bigerna, Polinori, 2015). At instance, the European LCA platform, which provides guidelines, is an important added value to the work of researchers and professionals who want to assess the negative externalities of production processes (Baldo, 2008; EU, 2010).

Therefore, even for water resources, attention is being paid in the various institutional levels to the risk of a possible crisis caused by water scarcity, especially in light of the latest climate change (Polytechnic of Milan, 2019; UNESCO, 2020). The strong global dependence of the markets has led many bottled mineral water firms to improve the attractiveness of their products through packaging, transforming the historic glass bottle into an additional and design element. The glass bottle that constituted a "void to render" and that biggest firms could sometimes produce by integrating the production process downstream, was progressively replaced by a container accessible outside the production chain at low cost, keeping the organoleptic qualities of water unchanged (Twede, 2012; Hawkins *et al.,* 2015; Marty, 2020). In other ways, this has allowed firms to greatly reduce the costs attributable to plants, thus making production more profitable and cheaper distribution thanks to the use of polymers in packaging. Therefore, today, firms are also required to make a further effort towards the use of biodegradable materials, in order to have as eco-friendly water bottling as possible.

In this sense, the Mineracqua Federation – a section that is part of Confindustria network and that brings together the biggest Italian firms in the industry, could also play an important role in raising awareness of water but, in general, of the importance of the circular

economy today (Hawkins *et al.,* 2015; De Marchi *et al.,* 2020). It is precisely in an area where the use of recycled polymers would help to reduce greenhouse gas emissions that are responsible for rising temperatures (Holtz-Eakin, Selden, 1995; Goldewijk, 2001; Houghton, 2008; Ciccone, Jarocinski, 2010; Jones *et. al.,* 2011).

In conclusion, the operative implications of this study are: *(i)* to have caught the market dynamics at long-term of the bottled mineral water industry (Makov *et al.,* 2019), and *(ii)* to want to bring to the attention of managers, researchers and business economists a market of considerable interest for the socio-economic implications and environmental impacts that arise from the consumption of bottled mineral water – especially if these are in plastic (Orset *et al.*, 2017) – and that policy makers cannot afford to overlook.

REFERENCES

Abdah B., Al-Khatib I.A., Khader A.I. (2020). Birzeit university students' perception of bottled water available in the West-Bank market. *Journal of Environmental and Public Health*, 2020: 1-10. DOI:10.1155/2020/5986340

Abrahams N.A., Hubbell B.J., Jordan. J.L. (2000). Joint production and averting expenditure measures of willingness to pay: do water expenditures really measure avoidance costs?. *American Journal of Agricultural Economics*, 82(2): 427-437. DOI:10.1111/0002-9092.00036

Akpinar M.G., Gul M. (2014). An assessment of consumer preferences on the drinking water market: today to the future. *Journal of Water Supply: Research and Technology Aqua*, 63(7): 525-531. DOI:10.2166/aqua.2014.106

Alesina A., Passarelli F. (2010). *Regulation versus taxation*. NBER Working Paper, 16413: 1-32, September.

Amorosino S. (2009). Le acque più "pregiate": i regimi amministrativi delle acque minerali e termali. *Revista Aragonesa de Administración Pública*, 11: 179-189.

Archibald G.C., Rosenbluth G. (1975). The "new" theory of consumer demand and monopolistic competition. *The Quarterly Journal of Economics*, 89(4): 569-590. DOI:10.2307/1884693

Bal D.Ç., Oraman Y. (2019). A contemporary approach for strategic management: the research in bottled water industry. *Journal of Global Strategic Management*, 13(1): 5-15. DOI:10.20460/Jgsm.2020.273

Baldo G.L., Marino M., Rossi S. (eds.) (2008). *Analisi del ciclo di vita LCA – Life Cycle Assessment: gli strumenti per la progettazione sostenibile di materiali, prodotti e processi*. Milano: Edizioni Ambiente.

Balliano P., Lanzetti R. (1976). *Studio sull'evoluzione della concentrazione nell'industria delle bevande in Italia*. Bruxelles: Commissione della Comunità Europea.

Banks J., Blundell R., Lewbel A. (1997). Quadratic Engel Curves and Consumer Demand. *Review of Economics and Statistics*, 79(4): 527-539. DOI:10.1162/003465397557015

Bannò M., Pozza E., Trento S. (2018). La famiglia fa male all'internazionalizzazione dell'impresa?. *Sinergie Italian Journal of Management*, 34(100): 133-154. DOI:10.7433/s100.2016.09

Barnes A., Cao W. (2014). Muddy waters: the public health risks and sustainability of bottled water in China. *Vermont Law Review*, 38: 971-1025.

Becchetti L., Rosati F. (2007). Global social preferences and the demand for socially responsible products: empirical evidence from a pilot study on fair trade consumers. *World Economy*, 30(5): 807-836. DOI:10.1111/j.1467-9701.2007.01012.x

Bevitalia (2020). *Acque minerali: annuario 2019-2020*. Milano: Edizioni Beverfood.

Biffignandi S., Chiesa F. (2012). *Il comparto alimentare e beverage: produzione, consumo, packaging e macchinari*. Milano: Franco Angeli.

Bigerna S., Polinori P. (2015). *Efficienza di costo e qualità della vita: un'analisi nei principali comuni italiani*. In Bollino C.A., Espa G. (eds.) Analisi e Modelli di Efficienza e Produttività a Livello Microterritoriale: 99-123. Milano: Franco Angeli.

Biro A. (2017). Reading a water menu: bottled water and the cultivation of taste. *Journal of Consumer Culture*, 19(2): 231-251. DOI:10.1177/1469540517717779

Bliss C. (1988). A theory of retail pricing. *The Journal of Industrial Economics*, 36(4): 375-391. DOI:10.2307/2098445

Bolton R.N., Shankar V. (2003). An empirically derived taxonomy of retailer pricing and promotion strategies. *Journal of Retailing*, 79(4): 213-224. DOI:10.1016/j.jretai.2003.09.005

Bollino C.A., Espa G. (eds.) (2015). *Analisi e modelli di efficienza e produttività a livello microterritoriale*. Milano: Franco Angeli.

Bollino C.A., Signorelli M. (2018). *Evolution of production structure in the Italian regions*. In Di Matteo M., Piacentini P. (eds.), The Italian Economy at the Dawn of the 21st Century: 150-171. New York: Routledge.

Bollino C.A., Micheli S. (2012). On the relative optimality of environmental policy instruments: an application of the work of Alberto Alesina. *Atlantic Economic Journal*, 40: 385-399. DOI:10.1007/s11293-012-9338-y

Bosi G., Trento S. (eds.) (2012). *Il Governo dell'impresa: economia e diritto della corporate governance*. Bologna: Il Mulino.

Brei V.A., Böhm S. (2011). Corporate social responsibility as cultural meaning management: a critique of the marketing of "ethical" bottled water. *Business Ethics: A European Review*, 20 (3): 233-52. DOI:10.1111/j.1467-8608.2011.01626.x.

Brei V.A. (2017). How is a bottled water market created?. *WIREs Water*, 5(1): e1220. DOI: 10.1002/wat2.1220

Brei V.A., Tadajewski M. (2015). Crafting the market for bottled water: a social praxeology approach. *European Journal of Marketing*, 49(3/4): 327-349. DOI:10.1108/ejm-03-2013-0172

Brouthers K.D. (2012). Institutional, cultural and transaction cost influences on entry mode choice and performance. *Journal of International Business Studies*, 44(1): 1-13. DOI:10.1057/jibs.2012.22

Bruni L., Zamagni S. (2004). *Economia civile: efficienza, equità, felicità pubblica*. Bologna: Il Mulino.

Bruzzone G. (1995). *L'individuazione del mercato rilevante nella tutela della concorrenza*. Temi e Problemi–Studi dell'AGCM, 1: 7-60.

Cabral L. (2018). *Economia industriale*. Roma: Carocci.

Caniglia E., Foti V.T., Timpanaro G. (2012). Analisi del comportamento del consumatore di acqua minerale in Sicilia. *Economia Agro-Alimentare*, 2: 153-180. DOI:10.3280/ECAG2012-002008

Cantele S., Campedelli B. (2016). Internationalisation and performance of SMEs: exploring the moderating effects of intangible assets and capital intensity. *International Journal of Business and Globalisation*, 17(2): 205-223. DOI:10.1504/ijbg.2016.078407

Capehart K.W. (2015). Fine water: a hedonic pricing approach. *Journal of Wine Economics*, 10(2): 129-150. DOI:10.1017/jwe.2015.15

Capehart K.W., Berg E.C. (2018). Fine water: a blind taste test. *Journal of Wine Economics*, 13(1): 20-40. DOI:10.1017/jwe.2017.50

Carlton D.W., Perloff G.M. (2005). *Modern industrial organization*. Boston: Addison Wesley.

Carlucci D., De Gennaro B., Roselli L. (2016). Competitive strategies of Italian bottled water industry: evidence from a hedonic analysis. *Rivista di Economia Agraria*, 1: 292-304. DOI:10.13128/REA-18648

Carullo A. (2009). La gestione reddituale del demanio idrico regionale in finanza di progetto. *Revista Aragonesa de Administración Pública*, 11: 201-223.

Ceccacci F. (2013). *La private label nei percorsi di modernizzazione del trade*. Torino: Giappichelli.

Ciccone A., Jarociński M. (2010). Determinants of economic growth: will data tell?. *American Economic Journal: Macroeconomics*, 2(4): 222-246. DOI:10.1257/mac.2.4.222

Cidu R., Frau F., Tore P. (2011). Drinking water quality: comparing inorganic components in bottled water and Italian tap water. *Journal of Food Composition and Analysis*, 24(2): 184-193. DOI:10.1016/j.jfca.2010.08.005

Clarke T. (2007). *Inside the bottle: an exposé of the bottled water industry*. Ottawa: Polaris Institute.

Cohen A., Zhang Q., Luo Q., Tao Y., Colford Jr J.M., Ray I. (2017). Predictors of drinking water boiling and Bottled Water Consumption in Rural China: a hierarchical modeling approach. *Environmental Science and Technology*, 51(12): 6945-6956. DOI:10.1021/acs.est.7b01006

Collins H., Wright A. (2014). Still sparkling the phenomenon of bottled water: an Irish context. *Journal of Marketing Management*, 2(1): 15-31.

Competitive Data (2020). Acqua *minerale e bevande analcoliche: l'analisi delle prime 140 aziende nel 2019*. Available at: monitoraitalia.it/acqua-minerale-bevande-analcoliche-aziende-2019 (accessed on 10 January 2020).

Corstjens J., Corstjens M., Lal R. (1995). Retail competition in the fast-moving consumer goods industry: the case of France and the UK. *European Management Journal*, 13(4): 363-373. DOI:10.1016/0263-2373(95)00028-j

Costantini V., Markandya A., Paglialunga E., Sforna G. (2018). Impact and distribution of climatic damages: a methodological proposal with a dynamic CGE model applied to global climate negotiations. *Economia Politica*, 35: 809-843. DOI:10.1007/s40888-018-0129-z

Chakrabarti A., Vidal E., Mitchell W. (2011). Business transformation in heterogeneous environments: the impact of market development and firm strength on retrenchment and growth reconfiguration. *Global Strategy Journal* 1: 6-26. DOI:10.1002/gsj.3

Chirieleison C. (2017). CSR education in Italian economics departments: an exploratory study. *Journal of Corporate Citizenship*, 65: 12-29. DOI:10.9774/gleaf.4700.2017.ma.00004

Deaton A.S., Muellbauer J. (1980). *Economics and Consumer Behavior*. Cambridge: University Press.

Day E., Fankhauser S., Kingsmill N., Costa H., Mavrogianni A. (2018). Upholding labour productivity under climate change: an assessment of adaptation options. *Climate Policy*, 19(3): 367-385. DOI:10.1080/14693062.2018.1517640.

De Marchi E., Pigliafreddo S., Banterle A., Parolini M., Cavaliere A. (2020). Plastic packaging goes sustainable: an analysis of consumer preferences for plastic water bottles. *Environmental Science and Policy*, 114: 305-311. DOI:10.1016/j.envsci.2020.08.014

Del Giudice T., Cicia G., Grunert K.G., Krystallis A.K., Zhou Y., Cembalo L., Verneau F., Caracciolo F.

(2016), New trends in the Chinese diet: cultural influences on consumer behaviour. *Italian Journal of Food Safety*, 5(2): 106-110. DOI:10.4081/ijfs.2016.5273

Dell M., Jones B.F., Olken B.A. (2014). What do we learn from the weather? The new climate-economy literature. *Journal of Economic Literature*, 52(3): 740-798. DOI:10.1257/jel.52.3.740.

Disanto R., Pilone V., Viscecchia R. (2007). *Il posizionamento comunicativo delle acque minerali: un possibile modello interpretativo*. Atti del XLIV Convegno Studi SIDEA: 1-19. Taormina: 8-10 Novembre.

Dixit A.K., Stiglitz J.E. (2001). *Monopolistic competition and optimum product diversity* (May 1974). In Brakman S., Heijdra B.J. (eds.), The Monopolistic Competition Revolution in Retrospect: 70-88. Cambridge: University Press.

Dolnicar S., Hurlimann A., Grün B. (2014). Branding water. *Water Research*, 57: 325-338. DOI:10.1016/j.watres.2014.03.056

Doria M.F., Pidgeon N., Hunter P.R. (2009). Perceptions of drinking water quality and risk and its effect on behaviour: across-national study. *Science of The Total Environment*, 407(21): 5455-5464. DOI:10.1016/j.scitotenv.2009.06.031

Dubé J.P., Manchanda P. (2005). Differences in dynamic brand competition across markets: an empirical analysis. *Marketing Science*, 24(1): 81-95. DOI:10.1287/mksc.1040.0087

Enrichens N. (2018). Le acque private. *Agricoltura Istituzioni Mercati*, 1: 120-134. DOI:10.3280/aim2016-001006

Erev I., Haruvy E. (2016). *Learning and the economics of small decisions*. In Kagel J.H., Roth A.E. (eds.), The Handbook of Experimental Economics: 638-716, Vol. 2. Princeton: University Press.

EU (2010). *Analysing of existing environmental impact assessment methodologies for use in Life Cycle Assessment*. Joint Research Centre Europena Union–JRCEU and Institute for Environment and Sustainability–IES, Luxembourg: European Union Publications. Available at: eplca.jrc.ec.europa.eu/uploads/ILCD-Handbook-LCIA-Background-analysis-online-12March2010.pdf (accessed on 10 January 2020).

Ferri M. (1999). *L'evoluzione del settore delle acque minerali: aspetti di produzione e di commercializzazione*. Padova: Cedam.

Ferrier C. (2001). Bottled water: understanding a social phenomenon. *Journal of the Human Environment,* 30(2): 118-119. DOI:10.1579/0044-7447-30.2.118

Ferrucci L. (2000). *Strategie competitive e processi di crescita dell'impresa*. Milano: Franco Angeli.

Ferrucci L. (2019). *Modelli di corporate governance e varietà evolutiva delle imprese*. Milano: Franco Angeli.

Ferrucci L., Paciullo G. (eds.) (2015). *Internazionalizzazione in Africa tra imprese, istituzioni pubbliche e organizzazioni no-profit*. Milano: Franco Angeli.

Fhelboom R., Brika B. (2020). Bottled water sold in the Tripoli markets: challenges and shortcomings. *Water Conservation and Management*, 4(2): 73-77. DOI:10.26480/wcm.02.2020.73.77

Finlayson D. (2011). *Market development of bottled waters*. In Dege N., (eds.), Technology of Bottled Water: 5-32. Hoboken: Wiley-Blackwell.

Florida R. (2005). *Cities and the creative class*. London: Routledge.

Galizzi G., Venturini L., Boccaletti S. (1997). Vertical Relationships and dual branding strategies in the italian food industry. *Agribusiness*, 13(2): 185-195. DOI:10.1002/(sici)1520-6297(199703/04)13:2<185::aid-agr7>3.0.co;2-z

Gibbons R.S., Roberts J. (eds.) (2013). *The handbook of organizational economics*. Princeton: University Press.

Gironi F., Piemonte V. (2010). Life cycle assessment of polylactic acid and polyethylene terephthalate bottles for drinking water. *Environmental Progress and Sustainable Energy*, 30(3): 459-468. DOI:10.1002/ep.10490

Gleick P.H. (2010). *Bottled and sold: the story behind our obsession with bottled water*. Washington D.C.: Island Press.

Goldewijk K. (2001). Estimating historical land use changes over the past 300 years: the hyde database. *Global Biogeochemical Cycles* 15: 417-433. DOI:10.1029/1999GB001232

Golinelli G. (2016). *L'approccio Sistemico – ASV al Governo dell'impresa*. Vol. 1-2. Padova: Cedam.

Grant R. (2016). *L'analisi strategica per le decisioni aziendali*. V ed. Bologna: Il Mulino.

Green R., Alston J.M. (1990). Elasticities in AIDS Models. *American Journal of Agricultural Economics*, 72(2): 442-445. DOI:10.2307/1242346

Gruber H. (1994). Differenziazione del prodotto ed evoluzione della struttura del mercato: il caso del mercato delle acque minerali. *L'Industria–Rivista di economia e politica industriale*, 2: 336-343.

Guercini S., Runfola A. (2016). How western marketers respond to the new middle class in emerging market cities: the case of Italian fashion marketers. *International Business Review*, 25(3): 691-702. DOI:10.1016/j.ibusrev.2015.10.003

Hallett A.H., Acocella N., Di Bartolomeo G. (2010). Policy games, policy neutrality and Tinbergen controllability under rational expectations. *Journal of*

Macroeconomics, 32(1): 55-67. DOI:10.1016/j.jmacro.2009.07.002

Hamilton G., Petrovic M., Senauer B. (eds.) (2011). *The market makers: how retailers are reshaping the global economy*. Oxford: University Press.

Hawkins G. (2017). The impacts of bottled water: an analysis of bottled water markets and their interactions with tap water provision. *WIREs Water*, 4(3): e1203. DOI:10.1002/wat2.1203

Hawkins G., Potter E., Race K., (2015). *Plastic water: the social and material life of bottled water*. Cambridge: University Press.

He S., Jordan J., Paudel K. (2008). Economic evaluation of bottled water consumption as an averting means: evidence from a hedonic price analysis. *Applied Economics Letters*, 15(5): 337-342. DOI:10.1080/13504850600706040

Holtz-Eakin D., Selden T.M. (1995). Stoking the fires? CO2 emissions and economic growth. *Journal of Public Economics*, 57: 85-101. DOI:10.1016/0047-2727(94)01449-X

Houghton R.A. (2008). *Carbon flux to the atmosphere from land-use changes 1850-2005*. In Trends A Compendium of Data on Global Change: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory and U.S. Energy Department. Available at: cdiac.ess-dive.lbl.gov/trends/landuse/houghton/houghton (accessed on10 January 2020).

Howell R., Sinha K.M., Wagner N., Doorn N., van Beers C. (2020). Consumption of bottled water at the bottom of the pyramid: who purchases first?. *Journal of Macromarketing*, 40(1): 31-50. DOI: 10.1177/0276146719866890

Hu Z., Morton L.W., Mahler R. (2011). Bottled Water: united states consumers and their perceptions of water quality. *International Journal of Environmental Research and Public Health*, 8(2): 565-578. DOI:10.3390/ijerph8020565

Hymer S. (1972). The internationalization of capital. *Journal of Economic Issues*, 6(1): 91-111. DOI:10.1080/00213624.1972.11503013

IBWA (2019). Market report findings: different years. *International Bottled Water Association*: 1-20. Available at: bottledwater.org/statistics/ (accessed on 10 January 2020).

IRI (2016). *Il clima impatta i consumi: il mercato dell'acqua minerale nel canale moderno*. White Paper, Settembre. Available at: iriworldwide.com/IRI/media/IRI-Clients/International/it/White-paper-Acqua-minerale_2016.pdf (accessed on 10 January 2020).

ISTAT (2020). *Le statistiche dell'Istat sull'acqua relativa agli anni 2018-2019*. Available at: istat.it/it/files/2020/03/Le-statistiche-Istat-sull%E2%80%99acqua.pdf (accessed on 10 January 2020).

Jones C.D., Hughes J.K., Bellouin N., Hardiman S.C., Jones G.S., Knight J., Liddicoat S., O'Connor F.M., Andres R.J., Bell C., Boo K.-O., Bozzo A., Butchart N., Cadule P., Corbin K.D., Doutriaux-Boucher M., Friedlingstein P., Gornall J., Gray L., Halloran P.R., Hurtt G., Ingram W.J., Lamarque J.-F., Law R.M., Meinshausen M., Osprey S., Palin E.J., Parsons Chini L., Raddatz T., Sanderson M.G., Sellar A.A., Schurer A., Valdes P., Wood N., Woodward S., Yoshioka M., Zerroukat M. (2011). The HadGEM2-ES implementation of CMIP5 Centennial Simulations. *Geoscientific Model Development*, 4: 543-570. DOI:10.5194/gmd-4-543-2011

Kajtazi S., Reshidi N. (2018). Consumer-side decision factors on their selection of bottled water brands: statistical method study in a Kosovo sample. *Ekonomika*, 97(1): 105-116. DOI:10.15388/ekon.2018.1.11782

Kansole M.R., Beidari M. (2020). Investigating the taste, odor and appearance of selected bottled and sachet sold drinking water in Burkina Faso. *Journal of Water Resources and Ocean Science*, 9(1): 1. DOI:10.11648/j.wros.20200901.11

Katz M.L., Rosen H.S., Bollino C.A., Morgan W. (eds.) (2020). *Microeconomia*. VI ed., Milano: McGraw-Hill.

Kim J., Forsythe S., Gu Q., Jae-Moon S. (2002). Cross-cultural consumer values, needs and purchase behavior. *Journal of Consumer Marketing*, 19(6): 481-502. DOI:10.1108/07363760210444869

Kooy M., Walter C. (2019). Towards a situated urban political ecology analysis of packaged drinking water supply. *Water*, 11(2): 225. DOI:10.3390/w11020225

Kopalle P., Biswas D., Chintagunta P.K., Fan J., Pawels K., Ratchford B.T., Sills J.A. (2009). Retailer pricing and competitive effects. *Journal of Retailing*, 85(1): 56-70. DOI:10.1016/j.jretai.2008.11.005

Kotler P., Keller K.L., Ancarani F., Costabile M. (2012). *Marketing Management*. Milano: Pearson.

La Moreaux P.E., Tunner J.T. (2012). *Springs and bottled waters of the world*. London: Springer.

Laino A. (2013). *Imprese e mercati imperfetti*. Milano: Franco Angeli.

Lambin J.J. (2012). *Market-driven management: Marketing strategico e operativo*. Milano: McGraw-Hill.

Lancaster K.J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74(2): 132-157. DOI:10.1086/259131

Lee B.D., Oh Y.H., Kim W.B., Hwang J., Lim W.-R., Choi S.-J., Hamm S.-J. (2020). State and strategy of production, market and integrated management of mineral water, South Korea. *Water*, 12(6): 1615. DOI:10.3390/w12061615

Lee K.H., Park S.Y., Jo E.H., Lee D.H. (2019). A comparison of taste of drinking water for water purifier filter development. *Indian Journal of Public Health Research and Development*, 10(5): 1119. DOI:10.5958/0976-5506.2019.01221.x

Lin X., Lu Wang C. (2010). The heterogeneity of Chinese consumer values: a dual structure explanation. Cross Cultural Management. *An International Journal*, 17(3): 244-256. DOI:10.1108/13527601011068342

Luciani F. (2020). The new horizons of the economy. *Bioeconomics Review*, 3(2): 1-7. Available at: bioeconomicsreview.unipg.it/index.php/bioeconomics/article/view/18 (accessed on 10 January 2020).

Mahmood A.K., Kamal A.A., Hama A.R. (2019). Study and evaluation of stored drinking water characteristics using three types of roof water tanks in Kirkuk governorate, Iraq. *Wasit Journal of Engineering Sciences*, 7(1): 11-16. DOI:10.31185/ejuow.vol7.iss1.110

Makov T., Meylan G., Powell J.T., Shepon A. (2019). Better than bottled water? Energy and climate change impacts of on-the-go drinking water stations. *Resources, Conservation and Recycling*, 143: 320-328. DOI:10.1016/j.resconrec.2016.11.010

Marelli E., Signorelli M. (eds.) (2019). *Politica economica: le politiche nel nuovo scenario europeo e globale*. Torino: Giappichelli.

Marty N. (2020). The true revolution of 1968: mineral water trade and the early proliferation of plastic 1960s–1970s. *Business History Review*, 94(3): 483-505. DOI:10.1017/S0007680520000549

Mascha M. (2006). *Fine waters: a connoisseur's guide to the world's most distinctive bottled waters*. Philadelphia: Quirk Books.

Matarazzo M., Resciniti R. (2014). New trends in foreign market entry mode choices: the case of Italian mid-sized companies. *Journal of International Business and Economics*, 2(4): 57-70. DOI:10.15640/jibe.v2n4a4

Mattei U., Reviglio E., Rodotà S. (eds.) (2007). *Invertire la rotta: idee per una riforma della proprietà pubblica*. Bologna: Il Mulino.

Milgrom P., Roberts J. (2005). *Economia organizzazione e management*. Vol. 2. Bologna: Il Mulino.

Moschini G. (1995). Units of Measurement and the Stone Index in Demand System Estimation. *American Journal of Agricultural Economics*, 77(1): 63-68. DOI:10.2307/1243889

Mundel J., Huddleston P., Vodermeier M. (2017). An exploratory study of consumers' perceptions: what are affordable luxuries? *Journal of Retailing and Consumer Services*, 35: 68-75. DOI:10.1016/j.jretconser.2016.12.004

Nanni T., Prodi F. (2008). *Cambiamenti climatici: la situazione in Italia*. Energia, 1: 66-71.

Neacşu N.A. (2017). Implementing quality strategies to increase competitiveness on mineral waters' market. Bulletin of the Transilvania University of Braşov Series V. *Economic Sciences*, 10(59): 103-110.

Niccolucci V., Botto S., Rugani, B., Nicolardi V., Bastianoni S., Gaggi C. (2011). The real water consumption behind drinking water: the case of Italy. *Journal of Environmental Management*, 92(10): 2611-2618. DOI:10.1016/j.jenvman.2011.05.033

Nicoletti G.M., Fredella F.L. (2005). *Le concessioni per le acque minerali in Italia*. In Spada V., Tricase C. (eds.), Risorse Naturali e Sviluppo Economico-Sociale: Vol. 1-2. Bari: WIP edizioni.

Orlitzky M., Moon J. (2011). *Assessing corporate social responsibility education in Europe: trends and comparisons*. In Fisher D.G., Swanson D.L. (eds.), Toward Assessing Business Ethics Education: 143-75, Charlotte: Age Publication.

Orset C., Barret N., Lemaire A. (2017). How consumers of plastic water bottles are responding to environmental policies?. *Waste Management*, 61: 13-27. DOI:10.1016/j.wasman.2016.12.034

Ostrom E. (1990). *Governing the commons: the evolution of institutions for collective action*. Cambridge: University Press.

Parag Y., Opher T. (2011). *Bottled drinking water, water and health*. Encyclopedia of Life Support Systems-EOLSS: 1-26.Paris: UNESCO.

Patsiaouras G., Saren M., Fitchett J.A. (2015). The marketplace of life? An exploratory study of the commercialization of water resources through the lens of macromarketing. *Journal of Macromarketing*, 35 (1): 23-35. DOI:10.1177/0276146714538454.

Polytechnic of Milan (2019). *Water Management Report*. Available at: energystrategy.it/report/water-management-report.html (accessed on 10 January 2020).

Porter M. (1985). *Competitive advantage: creating and sustaining superior performance*. New York: Free Press.

Raspadori P. (2002). Bollicine: per una storia dell'industria delle acque minerali in Italia dalle origini agli anni Ottanta del Novecento. *Annale di storia dell'impresa*, 13: 357-396.

Rodotà S. (2018). *Verso i beni comuni*. In Preterossi G., Capone N. (eds.), I Beni Comuni: L'inaspettata Rinascita degli Usi Collettivi: 31-89. Napoli: La Scuola di Pitagora.

Ruzzier M., Akbar Y.H., Bortoluzzi G., Tracogna A. (2017). The growth challenge of western SMEs in emerging markets: an exploratory framework and

policy implications. *Managing Global Transitions*, 15(3): 291-314. DOI:10.26493/1854-6935.15.291-314

Salop S.C. (1979). Monopolistic competition with outside goods. *The Bell Journal of Economics*, 10(1): 141. DOI:10.2307/3003323.

Sarkodie S.A., Strezov V. (2019). Economic, social and governance adaptation readiness for mitigation of climate change vulnerability: evidence from 192 countries. *Science of The Total Environment*, 656: 150-164. DOI:10.1016/j.scitotenv.2018.11.349.

Scalamonti F. (2020a). La transizione delle economie a sud del Mar Mediterraneo: il quadro macroeconomico e le determinanti degli investimenti esteri. *L'Industria – Rivista di economia e politica industriale*, 4: 1-46. DOI:10.1430/98711

Scalamonti F. (2020b). Emerging markets and cross-cultural distance: a revisit of drivers of SMEs internationalization process. *Piccola Impresa / Small Business*, 1: 161-187. DOI:10.14596/pisb.361

Sciarelli S. (2017). *La gestione dell'impresa: tra teoria e pratica aziendale*. Padova: Cedam.

Sciarelli S., Vona R. (eds.) (2000). *L'impresa commerciale:economia e gestione*. Milano: McGraw-Hill.

Senauer B., Venturini L. (2005). *The globalization of food systems: a conceptual framework and empirical patterns*. Working Paper of The Food Industry Center – University of Minnesota, 5(1): 1-40.

Spar D., Bebenek K. (2008). Profitable springs: the rise, sources, and structure of the bottled water business. *Entreprises et histoire*, 50(1): 100-118. DOI:10.3917/eh.050.0100

Sutton J. (1991). *Sunk cost and the market structure, price competition, advertising and the evolution of concentration*. Cambridge: University Press.

Tao T., Xin K. (2004). A sustainable plan for China's drinking water. *Nature*, 511: 527-528. DOI:10.1038/511527a

Torretta V. (2013). Environmental and economic aspects of water kiosks: case study of a medium-sized Italian town. *Waste Management*, 33(5): 1057-1063. DOI:10.1016/j.wasman.2013.01.014

Tosun J., Scherer U., Schaub S., Horn H. (2020). Making Europe go from bottles to the tap: political and societal attempts to induce behavioral change. *WIREs Water*, 7(3): e1435. DOI:10.1002/wat2.1435

Tunisini A., Pencarelli T., Ferrucci L. (2014). *Economia e management delle imprese: strategie e strumenti per la competitività e la gestione aziendale*. Milano: Hoepli.

Twede D. (2012). The birth of modern packaging. *Journal of Historical Research in Marketing*, 4(2): 245-272. DOI:10.1108/17557501211224449

UNESCO (2020). *World water development report: water and climate change*. Paris: United Nations Educational, Scientific and Cultural Organization. Available at: unesdoc.unesco.org/ark:/48223/pf0000372985 (accessed on 10 January 2020).

Urbani P. (2009). Il governo delle acque. *Revista Aragonesa de Administración Pública*, 11: 71-85.

Vernon R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics*, 80(2): 190-207. DOI:10.2307/1880689

Vescovi T. (2011). Strategie di marca per i prodotti italiani in Cina. *Micro&Macro Marketing*, 1: 73-92. DOI: 10.1431/34370a

Volpato G. (2010). *Economia e gestione delle imprese: fondamenti e applicazioni*. Roma: Carocci.

Wang C.L., Chen Z.X., Chan A.K., Zheng Z.C. (2000). The influence of hedonic values on consumer behaviors. *Journal of Global Marketing*, 14(1-2): 169-186. DOI:10.1300/j042v14n01_09

Wilk R. (2006). Bottled water. *Journal of Consumer Culture*, 6(3): 303-325. DOI:10.1177/1469540506068681

Yin R.K. (2017). *Case study research design and methods*. Newbury Park: Sage.

Zamagni S., Acocella N., Roncaglia A., Pizzuti F.R. (1999). *Social paradoxes of growth and civil economy*. In Gandolfo G., Marzano F. (eds.), Economic Theory and Social Justice: 212-250. London: Palgrave Macmillan.

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: Francesco Basset, Francesca Giarè (2021) The sustainability of social farming: a study through the Social Return on Investment methodology (SROI). *Italian Review of Agricultural Economics* 76(2): 45-55. DOI: 10.36253/rea-13096

Received: October 9, 2020

Revised: February 4, 2021

Accepted: June 7, 2021

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

The sustainability of social farming: a study through the Social Return on Investment methodology (SROI)

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Abstract. The aim of this paper is to study the sustainability of Social farming (SF), with attention to practices addressed people suffering from addictions. In this study the Social Return on Investment (SROI) has been used as assessment methodology; has been used, which is increasingly used to approach the quantification of social, environmental and economic benefits on different types of investment. The SF activity of the Agricoltura Capodarco Cooperative was studied in order to evaluate the outcome in monetary terms taking into account all the beneficiaries involved. The application of SROI allowed to estimate a return of investment, coming mainly from the social component, ranging from 1,89 to 4,10 times, according to the degree of conservativeness of the estimates. The study extends both the analysis of SF to people categories only marginally addressed before and the application fields of SROI as assessment methodology.

Keywords: sustainability, social farming, social inclusion, social return on investment, quantification of social benefit.
JEL codes: Q15, Q18, Q19.

1. INTRODUCTION

Social Agriculture sustainability is a major new research area in sustainable economics, which is driven by an increasing interest in the multifunctional role of agriculture (OECD 2001; Casini, 2009) and in the economic, environmental and social benefits associated with the agricultural sector. The value of agriculture, when it shapes the landscape, contributing to the conservation of biodiversity (Scher, McNeely, 2008; Henle *et al.,* 2008; Tayleur *et al.*, 2016), to ecological and hydrogeological land protection (Bastiani, 2014), to the sustainable management of natural resources (Clark *et al.*, 2016) and to the historical and cultural heritage of local communities (e.g., Protection and enhancement of the landscape of the monumental olive trees of Apulia by law – Apulia Region l.r. 14/2007), goes beyond its primary function of producing food and fiber. To these environmental, historical and cultural values of multifunctional agriculture, social agriculture further adds

the economic and social benefits related to its peculiar characteristics of social inclusivity, gender equality, and responsible production, which directly contribute to the United Nations' Sustainable Goals Development objective 8 (Deacon, 2016) and also objectives 5, 10 and 12.

The phenomenon of Social Farming (hereafter, SF) is regulated by a broad normative framework which follows the vertical subsidiarity principle. At the European level there is no normative framework to define SF, even though the need for the elaboration of an appropriate normative framework to regulate its activities, as well as to coordinate the policies and institutions of the various countries in this field, has been advocated (EESC, 2013). At a national level, the law 141/2015 regulates the functioning of SF, describes its activities and subjects and defines it as: «one of the aspects of the multifunctionality of agricultural enterprises aimed at the development of social, socio-sanitary, educational and social-work integration interventions and services, in order to facilitate adequate and uniform access to the essential services to be guaranteed to people, families and local communities throughout the national territory and in particular in rural or disadvantaged areas». The directive refers the law 381/1991 defining the functions of Social Cooperatives and the so-called disadvantaged categories of individuals.

Moreover, other policies making significant contributions to SF have been introduced in the Regional Strategic Plan 2014-2020, including those concerning "Cooperation for the diversification of agricultural activities into social activities" (sub measure 16.9), and those concerning "Development and diversification of agricultural holdings and enterprises" (sub measure 6.4) (Giarè,2019).

SF has had a remarkable growth in the last few years in Italy, showing a diversification of actors, experiencesand recipients (Giarè *et al.*, 2018), even if:

- there is a relevant presence of social cooperatives and, to a lesser extent, farms; other typologies of actors are less common;
- the activities concern all the typologies defined by art. 2 of law 141/2015[1], with a prevalence of social and working inclusion (Giarè *et al.*, 2017);
- SF is aimed at different target groups: people with physical or psychic disabilities, prisoners, drug addicts, young NEETs, elderly, refugees and asylum seekers, etc., but the activities addressed to people with disabilities are prevalent.

The aim of this article is to increase knowledge, and to stimulate debate, on methodologies employed to quantify the total benefit of social farming as an inclusive practice at the social-work level for the category of people affected by addictions. In particular, the objectives of this study were:

- to analyse the impact of SF project for people affected by addiction, for which there are few studies in literature;
- to understand to what extent the SF project examined has an impact on the people affected by addictions;
- to test the suitability of the Social Return on Investment methodology for the category of people under study and in this country;
- to analyse the sustainability of the specific project considered.

To achieve these objectives, the Social Return on Investment methodology was used for the identification of financial proxies associating a monetary value with every social and environmental benefit, as regards the project "I frutti della buona terra" of the "Agricoltura Capodarco" Cooperative.

In this work, a review of the literature available on SF will be given. Then we will briefly present the case study, i.e. the farms, specific project analysed and the methodology used. Finally, the results will be presented, starting from the identification of stakeholders and the construction of indicators and financial proxies, to then arrive at the calculation of the SROI indicator and the conclusion considerations on the results obtained.

1.1. Literature review

The literature on the multifunctional role of agriculture is broad and shows a differentiation between practices related to the agricultural world and those who benefit from it. Some studies focus particularly on the well-being role (Hassink, 2016) of agriculture according to categories of people with physical and mental disabilities (Garcia, 2018), while others show the importance of

[1] Article 2 of law 141/2015 defines the activities: «a) socio-labor insertion of workers with disabilities 'and disadvantaged workers […], disadvantaged persons […] and minors of working age inserted in projects of rehabilitation and social support; b) services and social activities and services for local communities through the use of material and immaterial resources of agriculture to promote, accompany and implement actions aimed at the development of skills and abilities, social and labor inclusion, recreation and useful services for everyday life; c) performance and services that accompany and support medical, psychological and rehabilitative therapies aimed at improving the health conditions and social, emotional and cognitive functions of those concerned, including through the use of farmed animals and plant cultivation; d) projects aimed at environmental education and nutrition, the preservation of biodiversity 'as well as' the dissemination of knowledge of the territory through the organization of social farms and educational recognized at the regional level, such as initiatives for the reception and stay of children in age 'preschool and people in difficulty 'social, physical and mental».

the inclusive role of SF for a plurality of recipients (Giarè, 2018), and through descriptive studies on the characteristics of social farms (Lanfranchi, 2015; Borgi *et al.*, 2019; Torquati *et al.*, 2019). In any case, the inclusion of these practices in European development plans (Scuderi *et al.*, 2014) demonstrates the importance that is given at the European level to the phenomenon of social farming. In this context, the importance of evaluating the impact generated by social cooperatives[2] appears evident (Zamagni *et al.*, 2015). Moreover, the importance of an approach to the evaluation of social farming regarding its importance in achieving sustainability objectives (Marchis *et al.*, 2019) was highlighted (Leck, 2012; Leck 2014; Borghi *et al.*, 2020). However, there are many critical issues related to the methodology for evaluating the practices of social cooperatives (Marchis *et al.*, 2019), which globally are mainly focusing on identifying the benefits of this phenomenon rather than on its economic quantification (Di Iacovo, 2020); in addition, in many cases quality of life is the only indicator used to assess the social benefits derived from these practices (Janker, Mann, 2020). Therefore, it follows that there is still a lack of a general agreement on what methods should be used to assess the multifunctionality of agriculture and in particular the social, environmental and economic benefits derived from SF practices.

In the literature there are many studies that have tried to propose methodologies for the evaluation of social impacts. It has been shown the need for a more complex methodology in respect to the most common Cost-Benefit Analysis (Arvidson *et al.*, 2010; Mulgan, 2010). The latter, in fact, has some criticalities regarding the measurement of benefits that are difficult to monetize, such as social ones (Cordes, 2017). Some studies have introduced the use of the Social Impact Assessment (Becker, 2001) to evaluate development projects in agricultural disputes (Ahmadvan *et al.*, 2009), while others have proposed a SWOT analysis (Foti *et al.*, 2013) or the Social Enterprise Impact Evaluation (Zamagni *et al.*, 2015) to assess the social impact generated by social cooperatives.

In the last years, the quantitative assessment of SF's social benefits has been highlighted in recent studies, which have used, as methodology, the Social Return on Investment (Leck, 2012; Leck 2014). The use of this methodology has so far been limited, in most cases (e.g., Tulla, 2018; Leck, 2014), to the category of people with mental and physical disabilities and its applicability to other categories, such as prisoners and former prisoners, people affected by dependencies and migrants, among others, has still to be fully explored. Nevertheless, the results achieved so far, using Social Return on Investment as assessment methodology, have shown that social farming practices are more than sustainable for people with physical or mental disabilities, with a social return of 2.8 – 3 times the investment (Leck, 2014; Tulla, 2018; respectively).

Currently, Social Return on Investment, although not very widespread, has shown to be an appropriate methodology for evaluating projects that generate important social and environmental benefits, in addition to the economic ones, and giving a complete and quantitative evaluation of the project's outcomes (Nicholls *et al.*, 2009). Social Return on Investment is likely to be an appropriate methodology for the study of the social farming practices on all user categories, but still requires validation tests on those user categories, such as that of users affected by addictions, which have received little attention, so far.

2. THE CASE STUDY

The sustainability of SF has been studied by analyzing a specific project realized by a social farm, located in Lazio region. In this region SF has been included as a practice for regional development. (l.r. 7/2018).

The social cooperative "Agricoltura Capodarco", founded 40 years ago in the municipality of Grottaferrata, has been selected for the study, since it has been progressively distinguished for its social projects related to agriculture. This farm stands out not only for the attention on its customers and on the environment, with organic production (breeding and zootechnics, beekeeping, fruit growing, horticulture, olive growing, wine-growing, direct sales and agritourism), but also for numerous activities with social purposes, such as social-work inclusion of disadvantaged people, educational farms, psycho-social therapeutic activities. SF is considered by the Cooperative as the main way to generate well-being for the local community and to carry out socially relevant interventions aimed at people in conditions of hardship.

In the present study, the focus is on a specific "Agricoltura Capodarco" project of SF named "I frutti della buona terra" since it was aimed at the occupational reintegration of people affected by different types of dependencies, mainly by drugs, through one-year work

[2] In the Italian legislation, Social Cooperatives are defined by the law 381/1991, which, at article 1, paragraph 1 defines: «Social cooperatives have the purpose of pursuing the general interest of the community to human promotion and social integration of citizens through: the management of social, health and educational services [..]; the performance of different activities - agricultural, industrial, commercial or services - aimed at the employment of disadvantaged people».

and training grants. The project, lasting 10 months, was started in 2017 as a collaboration among Agricoltura Capodarco, the Municipality of Velletri and the Velletri Public Services for pathological addictions of the National Health System (hereafter, Ser. D) and repeated every year. The project "I frutti della buona terra" is structured into two different phases:

- phase 1 (first three months): setting the institutional network involving the project partners, trainees (hereafter, users) and small farms active in the Velletri peri-urban area, which were available for the training and working stages of the participants to the project;
- phase 2 (seven months): on the job training and working stage in the selected farms.

Regarding the farms involved, it should be emphasized that a match the participants and the farms based on the interests and available activities. Therefore, the chosen companies included farms, both organic and non-organic, but also other companies linked to the agricultural sector, such as those involved in catering and green maintenance activities.

3. THE METHODOLOGY

The methodology used in this study is the Social Return on Investment (hereafter SROI; Nicholls, 2009), which integrates the social, economic and environmental values of the investments on the SF expressing values in financial terms (Nicholls *et al.*, 2009), as characteristic of most economic approaches (Bonazzi, 2005; Fujiwara, Campbell, 2011).

Given the interest in analysing a specific project and not the work of the whole Agricoltura Capodarco cooperative, the SROI was considered the most suitable method. In addition, the SROI methodology was chosen because it allows to quantify the social benefits at a monetary level, which was an objective of the study. Finally, it requires a high level of stakeholder involvement.

The SROI is composed by sequential phases: 1. identifying the main stakeholders of the SA initiative; 2. mapping the positive outcomes for every stakeholder; 3. defining proper quantitative indicators of every outcome; 4. selecting the most compelling financial proxies for each indicator; and, 5. estimating the financial positive impact of every outcome for each of the identified stakeholders. The SROI is evaluated as the ratio of financial gain and financial costs of the SF initiative.

Outcomes, indicators and proxies clearly depend on the category of users considered, on the stakeholders involved, on the type of agricultural practices and on their location in urban, peri-urban or rural areas. Guidelines and proposals for setting outcomes, indicators and proxies are available in the literature as books, manuals and published papers (Leck, 2014), even though adaptation of both outcomes and indicators to the specific categories of subjects, stakeholders and SF considered can be required.

There are two types of SROI analysis (Nicholls *et al.*, 2009): evaluative, conducted ex-post and based on outcomes already achieved; and, predictive, to predict how much social value will be created if the activities achieve the expected outcomes. In view of the cyclic periodicity of the "I frutti della buona terra" project, which has been replicated yearly since 2017 on different user groups, in the present study the SROI analysis has been implemented by integrating both types of analysis. An evaluative SROI analysis was carried out on the three cycles that have already been implemented (in 2017, 2018, and 2019) and a predictive SROI analysis was estimated as a scenario for the next yearly cycles, in view of the possible extension of the project for a second three-year period.

This study has been carried out on 13 participants to the project in the three years considered, with 2 users participating to more than one year cycle, and has considered all stakeholders directly or indirectly involved in the project, i.e. the users, the project proposer (Agricoltura Capodarco), project partners (Velletri municipality and Ser.D.), the small farms where the users had their training and working stages, and the environment. The latter has been included as a stakeholder following the UN Universal Declaration on the Rights of Mother Earth, (law on the Rights of Mother Earth, law 71 of December 2010 [Universal Declaration of Rights of Mother Earth, 2010]) and recent studies (Stone, 2010; Boyd, 2011, 2012; Carducci, 2017), which indicate the environment as a subject with legal personality.

For all stakeholder categories, except the environment, data collection has been carried out through guided questionnaires addressed to all the stakeholders, who gave the availability for the interview and participating to the study. Interviewed were all but two users, the staff of Agricoltura Capodarco and of the small companies involved in the projects, representatives of the Velletri municipality and of the Ser.D. All major actors from every stakeholder category involved in the "I frutti della buona terra" project but two have accepted to be interviewed. A total of 21 people were interviewed: 11 of the 13 recipients, one Agricoltura Capodarco social educator, who was managing the project, the responsible for these kind of actions in the Velletri municipality, two social workers of the Velletri Ser.D. and the six responsible of the farms involved.

The outcomes of both evaluative and predictive SROI have been identified through the answers to the guided questionnaires. Content analysis was done manually and focused on the meaning and semantic relationship of words and concepts regarding indicators. Proxies and proxy financial quantification were derived from the interviews and from the available literature, including the project documentation of "I frutti della buona terra".

4. THE RESULTS

Within the project, the stakeholders identified have different roles: the users, represented by the patients under treatment at the Ser.D. of Velletri, which are the main beneficiaries of the project, Agricoltura Capodarco, the Municipality of Velletri, the Ser. D of Velletri, who designed and implemented the project, and private companies, as they offer the internships to the users and supply them with training. Even if most are service providers, only the Municipality of Velletri is financing the project, with an investment of € 100,343.33 per year.

The identification of the outcomes, the indicators and the financial proxies represent the first results of this study, they are shown in Table 1.

Interviews with users showed that for all of them the major changes (i.e., outcomes) detected are improved quality of life, greater likelihood of finding a job and less social isolation.

The results on users were estimated on a quantitative analysis of the following indicators and proxies:

1. The improvement of the quality of life derives both from economic factors, such as payment deriving from the internships, and psychological factors, which have always weighed on this type of subjects, having led most of their lives in degraded situations. The indicator used to assess this outcome is precisely the amount of money gained from the work grant (internship), with which they can live a more comfortable life.
2. Users are most likely to find a job because they have learned new job skills within this project. In addition, most have said they had good relationships with colleagues and employers, and this has conveyed greater self-confidence, as they now feel able to face interviews, or at least find themselves in new job situations. The approach chosen for the measurement and the choice of this indicator is the number of contracts that have been signed by users after participating in the project. The proxy used is the salary received by the users who have found a job. Since this is a probability, the ratio between the people who found work and all those who participated in the project was calculated and multiplied by the average salary observed.
3. The reduction of social isolation derives from the fact that all users have stated that they feel mentally better, that they have greater self-esteem and that they feel like they have developed friendships, as well as professional relationships within the project. In some cases, they stated that they have started to get out of their home again, to go to the supermarket and to take public transport. All these factors demonstrate an improvement in people's psychological state, which has enabled them to emerge, at least in part, from the social isolation they were in. The approach to evaluation is given by the lower number of sessions for psychological recovery and it is calculated by estimating the average cost of these sessions.

The return of the Capodarco Cooperative has been estimated from the outcome of an interview with the tutor of the Capodarco Agriculture Cooperative, from which it emerged that the greatest benefit obtained by the cooperative is the increase in social value deriving from the successful placement of jobs. This certainly derives from the fact that the company's mission is precisely to help people who find themselves in harsh positions to live a more comfortable life. The indicator chosen is the number of successful social work entries and as a proxy, the cost savings for the tutor, who will be able to follow new users.

The return for Ser.D. has been estimated based on the social and work integration of the users, defining the outcome on the reduction of the probability that the users have a relapse into their addiction. The interviews carried out with a social worker allowed to define as an economic proxy the reduction of costs to prevent the spread of infectious diseases typical of this category of subjects, such as HIV and hepatitis C. This indicator has been estimated in a predictive way, given the small number of users analyzed, and is calculated on the average number of hospital admissions for this category of subjects. The measurement is given by the probability that a Ser.D. patient has contracted the disease, multiplied by the average cost of hospitalization. Previous literature shows that the lower probability of a relapse may result in a lower cost of medicines, resulting from the lower use in more advanced phases of therapy, which is another indicator used to calculate the outcome described above (Serpelloni, 2006). The proxy that represents this indicator, and allows us to measure it, is the cost of medicines used in therapy. Finally, a final indicator that can be used is that of the cost savings resulting from the

Tab. 1. Impact Map.

Stakeholder	Input	Outcome	Index	Possible proxy	Economic value
Users		Improving quality of life	Access to work grant	Salary from work grant	400€*month*users= 68,000€
		Higher probability of finding a job	Post-employment grant contract	Post-sale contract salary	800€*month*0,059 user 450€*month*0,059 user =10,588.2€
		Reduction of social isolation	Number of sessions psychological recovery	Lower social costs psychological recovery	15€*month*user= 1,650€
Cooperative of Capodarco		Increased company social value	Number of social and work placements	Savings in tutoring costs	67,76€*month*user = 67,76€*10*2= 1,355.2€
Farms		Decrease in production costs	Traineeships through work grant	Labour cost savings	400€*month*user = 68,000€
		Increased reputation	Increased sales	Higher revenues	0,05* user labour cost =3,400€
Ser.D.		Reduced probability of relapse for patients	Number of visits to the doctor	Cost of medical examination	40*4=160*user = 2,720€
			Reduction in the use of medicines	Cost of medicines	Da 0*day*month = 0€
					A 0,9€*day*user= 4,590€
			Reduction number of admissions	Cost of hospitalizations for infectious diseases	1024€x0,054= 55,30€
Environment		Increased incidence of organic farming	More careful management of natural resources and less use of chemical inputs	Reduction of environmental risks	10€*month*user = 200€
					1099€*ht*year = 1099€*10*3= 32,970€
			Lower CO2 emissions	Reduction of CO2 emissions	Economic value not estimated by company size and type
		Expansion of Social Farming Practices	Reduction of abandoned land	Better hydro-geological control and less fire risk	Economic value not estimated by company size and type
Municipality of Velletri	Project funding over 3 years = € 100,343.33	Reduced likelihood of this category committing offences and entering the prison system	Lower detention costs	Cost of an inmate to the local prison system	0,0128*user*daily cost*year= 9,831.50€
		Reduction of drug purchase	Reduced use of drugs	Drug costs	68€*day/week*user = from 38,896€ to 272,272€
		Creation of active workers	More money injected into the local economy	Percentage of salary spent in the local community	0,8*400€*month* user = 54,400€

Source: our elaboration.

fewer medical examinations that individuals must do because of their health situation.

For the Municipality of Velletri, intended not only as a public institution, but also as a landmark of the local community and as the place of residence of the subjects, the return on investment was measured on three different outcomes that express an important social benefit coherent with what was stated in the inter-

view by the head of the H5 Zone Plan of the Municipality of Velletri:

1. The decrease in drug related crimes of this category of users, which now are receiving a salary and are less propense to relapse into addiction. The indicator used was the lower cost of imprisonment that the local prison system has to bear, and was measured by the proxy that expresses the ratio between the number of drug addicts held annually in the Italian prison system and the total number of drug addicts in Italy. The results are multiplied by the average daily cost per inmate and then multiplied by the number of days in a year.
2. The decline in purchases of drugs on the black market. The indicator proposed to measure this is the change in the cost of drugs on the market (Serpelloni, 2006). Two different proxies have been calculated depending on the conservativeness of the valuation. The most conservative is based on addicts who use weekly, the less conservative is based on addicts who use daily. The cost of the dose is then multiplied by one year and by the number of users in the study.
3. The creation of an active population, considering that prior to the project the subjects have not had a job, let alone were looking for it, for a long time. It has been calculated through the proxy that expresses the percentage of income that subjects are estimated to spend within the community about 80% of the salary received from the work grant.

Regarding the companies offering the internship service, as mentioned in the previous chapter, their benefit is to have an unpaid worker available to them. Their benefit is the saving of labor costs, which was calculated by multiplying the income, assuming that they would pay a worker for the same hours performed by users with the same salary, multiplied by the number of months and by the number of users. Another benefit that could be seen is a slight increase in sales caused by the so-called reputational effect. It was calculated through an estimate of the 5% increase in companies' revenues, which in the absence of data were estimated to be at least equal to the labor costs.

Finally, interviews with the two farmers who have organic farms showed how Social Farming projects can have important effects on the environment. As organic farming has very high production costs, especially when compared to the large scale costs of traditional large farms, the economic benefits of participating in projects such as the one under study could be an incentive to shift local agricultural production more towards organic products. This would cause an increase in the benefits that derive from organic production, such as the decrease in environmental risks caused by xenobionts which are released from chemicals used as pesticides in traditional agricultural production and slow down the decomposition of organic matter. Another positive effect in organic farming is the decrease in CO2 released into the atmosphere by the chemicals used. The negative effect of xenobionts on soil and water bacteria, and micro fungi can be estimated as a 10% loss of the decomposition rate of dead organic matter (Abelho *et al.*, 2016) which can affect the release of 70% of the nutrients it contains, net of the 30% loss due to leaching. A 7% reduction in ecosystem service "nutrient cyclization" can therefore be estimated at € 15,715 per hectare as an average in the biosphere (Costanza *et al.*, 1997).

Once the values of the various outcomes have been calculated, 10% of the value is subtracted for those outcomes that could also occur outside the project, i.e. for:

- Increase in revenues for companies deriving from the reputational effect, as part of it may not even derive from the AS project in which they participated.
- Reduction of the probability to relapse since it is presumable that part of this change could have occurred even without participation in the project.
- Reduction in the probability of this category committing drug-related crimes, as it is presumable that the category under study does not fall into addiction beyond the participation or non-participation in the project, it is equally presumable that they do not commit crimes.
- Reduction in the purchase of drugs, as the same considerations have been made for the two points preceding this one.

No drop-off value has been subtracted because the longer the duration of the change, the greater the effect of the outcome.

Before proceeding with the calculation of the SROI indicator we summarize the total economic values, net of deadweight values, by stakeholder category (Tab. 2).

According the SROI, economic benefits are those with a remuneration or cost savings, social benefits those with an effect on the quality of life of stakeholders or the local community and, finally, environmental benefits are those with positive effect on natural capital.

Therefore, the category of users has a total benefit of € 80,238.2, resulting from an economic benefit of 68,000, corresponding to the value of wages earned (Tab. 1), and a social benefit of € 12,238.2 resulting from the sum of the values corresponding to the greater probability of finding work in the future and the reduction of social isolation. "Agricoltura Capodarco" Cooperative presents a total benefit of € 1,355.2 composed solely of the economic dimension, as it corresponds to the value deriv-

Tab. 2. Value of benefit for each stakeholder net of deadweight values (10%) and according to the more conservative hypothesis of a reduction in drug purchase spending at a rate of 1 dose per week.

Stakeholder	Economic benefit	Social benefit	Environmental benefit	Total
Users	68,000	12,238.2		80,238.2
Agricoltura Capodarco	1,355.2			1,355.2
Farms	71,060			71,060
Ser.D. Velletri		6,628.77		6,628.77
Environment			33,170	33,170
Municipality of Velletri		98,254.75		98,254.75
	140,415.2	117,121.72	33,170	290,706.92

Source: our elaboration.

ing from the lower cost of tutoring, written off by 10%. The farms also present a total benefit composed entirely of the economic dimension, as it corresponds to the value of the savings on the cost of the worker. The Ser.D of Velletri and the Municipality of Velletri, on the other hand, present a total benefit of € 7,365.3 and € 103,127.5 respectively, composed for both entirely of the social dimension. These results are due to the outcomes identified for these stakeholders that have effects on the local community and on the users' sociality. The economic values of these outcomes have been subtracted from the 10% resulting from deadweight. The environment has a total benefit of 33,170, easily identifiable as an environmental benefit.

The net social return, according to the most conservative hypothesis, which is calculated by subtracting the value of the inputs (€ 100,343.33), corresponding to the value of the initial investment by the Municipality of Velletri, from the total outcome (€ 290,706.92), is therefore € 190,363.59, with a SROI index value of 1.89 (net social return/initial investment).

In this conservative estimate, which considers the consumption of one dose per week by an average user, the SROI ratio will have a measure of 1: 1.89, which means that for every euro invested within the project, there will be a social return on investment of one euro and eighty-nine cents. Estimating instead the daily consumption, instead of weekly, of one dose per user, the SROI ratio would have a measure of 1: 3.99, with a social return of four euros and ten cents for each euro invested.

5. DISCUSSION OF RESULTS AND CONCLUSIONS

The study aimed to evaluate the overall value of SF as a tool for the inclusion of disadvantaged groups of population. In this approach, the work represents an important source of livelihood for these people and an opportunity to facilitate their social inclusion**.** Indeed, the overall value of Social Farming must necessarily combine the economic report of the worker and the company with a social report that considers the effects or changes (outcome) on all the stakeholders involved. For this reason, the Social Return on Investment methodology, which appears to be the most suitable and applied in kind of studies, was applied in the study. The importance of this methodology lies in the fact that it seeks to give an economic value to those social benefits that was previously difficult to estimate and subjected of strong bias or even distortion in the assessment of associated values (Arvidson *et al.*, 2013).

The results obtained show first of all that, depending on the conservatism of the estimates described above, the SF project shows a social return on investment of € 1.89 or € 3.99 for each euro invested. Secondly, it should be noted that around the 90% of the total social return on investment is concentrated on three categories of stakeholders, the disadvantaged people, the companies offering the internship service and the local community, indicating a wide and distributed social impact of the investment. This also shows how SF projects are important for the personal growth, not only for the users but also for the community of which they are part. In fact, the data concerning the users offers a very positive picture, reflected in the improvement of their quality of life, both from an economic, thanks to the salary that allows them to live a more comfortable life, and from a social point of view thanks to the numerous professional and friendship relationships that they have been able to develop within the project and have allowed them to have a lower level of social isolation.

The analysis of sustainability in its three dimensions, social, economic and environmental, emphasizes that as regards "I frutti della buona terra" project almost all sustainability is given by the social and economic dimensions, and just slightly more than 10% by the envi-

ronmental dimension. These results arise both from the nature of the project and from the limited connection in this study case between SF and organic production.

From the results obtained two different critical points emerged. As regards the methodological aspects of SROI, it can be highlighted that still the methodology on the choice of financial outcomes and proxies is not fully standardized, with potential biases due to some level of subjectivity in the analysis. For this reason, when the quantification of the proxies was not already standardized or supported by consolidated literature values, proxies have been quantified as potential range of variation rather than with an average value, as for the return expected from reduced use of drugs, and the most conservative estimate was used in the evaluation. Therefore, this analysis has added something to what already done for the standardization of the SROI methodology, particularly when applied to users affected by drug dependency. As regards the user category, the study has highlighted that the number of users who had managed to get a permanent job as outcome of the project is still extremely limited. These results raise the point on whether the sustainability is equal in the short and long term.

The results obtained do not seem to depend on the methodology used or on bias and uncertainty in the economic estimates of the social return on investment, which may cast doubt on their overall meaning. In fact, as far as the methodology is concerned, the choice of the outcomes, of the characteristics that have undergone a change linked to the SF project, has been defined on the basis of the stakeholders' responses to specific interviews and of the consistency of the responses given by the different stakeholders. The choice of indicators and proxies was therefore made accordingly, with the support of existing bibliographical indications. The outcomes vary according to the range of subjects studied (drug addicts, patients with mental and physical health problems, prisoners) (Leck, 2014; Arvidson *et al.*, 2013), and therefore there remains some uncertainty about the choice of outcomes in this study. This stems from the fact that for the choice of outcomes there is no shared methodology (Leck, 2014), but, as mentioned above, it is based on studies in the literature, which for the category of users studied is still limited. With regard to the quantification of the economic values of the changes, for which there is undoubtedly uncertainty in the estimates, the consistency of the results obtained is supported by the fact that the social return on investment is concentrated on three components – workers, companies offering work and local communities – so that the estimate of the economic value of the change, at least in the specific case of the study, is only minimally subject to uncertainty as the calculation of the values at stake is standardized (salaries to employees) or very well documented in the literature (unit cost drug dose and weekly number of doses consumed). For this last aspect, the design choice to estimate a weekly dose consumption was particularly conservative.

In conclusion, this work allows to extend the evidence of the important role of SF for people with dependencies, so far little studied. Moreover, the methodology was particularly suitable for the study of the SF activities addressed to the category under study and in general for the study of sustainability in its three components, allowing us to understand which component has the greatest impact on the result, and on which one should act on. However, the work presents some limitations due to the small sample size and to the innovative nature of the proposed methodology, which makes comparison with other results difficult. In any case, its purpose was to provide an example of the application of the SROI to the phenomenon of social farming, which will certainly have to be deepened and improved in future research work.

In order to respond to the critical issues arising from this study regarding inclusion processes, a stronger mechanism of protection by local and national governments could be introduced, with the aim of increasing the probability of post-employment by putting users in a position of greater bargaining power in the labour market. Moreover, a greater involvement of organic farms could create a much stronger social return in environmental sustainability.

6. REFERENCES

Abelho M., Martins T.F., Shinn, C., Moreira-Santos M., Ribeiro, R. (2016). Effects of the fungicide Pyrimethanil on biofilm and organic matter processing in outdoor lentic mesocosms. *Ecotoxicology,* 25: 121-131. https://doi.org/10.1007/s10646-015-1574-x.

Ahmadvand M., Karami E., Zamani G.H., Vanclay F. (2009). Evaluating the use of Social Impact Assessment in the context of agricultural development projects in Iran. *Environmental Impact Assessment Review*, 29(6): 399-407. https://doi.org/10.1016/j.eiar.2009.03.002

Arvidson M., Lyon F. (2010). *The ambitions and challenges of SROI University of Southampton University of Birmingham*. Social Research.

Arvidson M., Lyon F., McKay S., Moro D. (2013). Valuing the social? The nature and controversies of measuring Social Return on Investment (SROI).

Voluntary Sector Review, 4(1): 3-18. https://doi.org/10.1332/204080513X661554.

Bastiani M. (2014). Stop the growth of cities: the role of marginal agricultural areas between river and city as a territorial protection and in the reduction of Hydro-geological risk. *Scienze Del Territorio*, 2(0): 55-78. https://doi.org/10.13128/Scienze_Territorio-14323

Becker H.A. (2001). Social impact assessment. *European Journal of Operational Research*, 128(2): 311-321. https://doi.org/10.1016/S0377-2217(00)00074-6

Bonazzi G., Iotti M. (2005). *Analisi per indici nell'impresa agraria.* Annali Facoltà Medicina Veterinaria di Parma 25.

Borgi M., Marcolin M., Tomasin P., Correale C., Venerosi A., Grizzo A., Orlich R., Cirulli F. (2019). Nature-Based Interventions for Mental Health Care: Social Network Analysis as a Tool to Map Social Farms and their Response to Social Inclusion and Community Engagement. Int*ernational Journal of Environmental Research and Public Health*, 16(18): 14-16. https://doi.org/10.3390/ijerph16183501

Borgi M., Collacchi B., Correale C., Marcolin M., Tomasin P., Grizzo A., Orlich R., Cirulli F. (2020). Social farming as an innovative approach to promote mental health, social inclusion and community engagement. *Annuali dell'Istituto Superiore della Sanità*, 56: 206-214. https://doi.org/10.4415/ANN_20_02_10

Boyd D. (2011). *The Environmental Rights Revolution, A Global Study of Constitutions, Human Rights, and the Environment*. UBC Press, Vancouver-Toronto. https://doi.org/ 10.1353/hrq.2013.0061

Boyd D. (2012). *The Rights of Nature: A Legal Revolution That Could Save the World*. ECW Press, Carducci M. (2017). Diritti della natura. Utet Giuridica, pp 486-581. https://doi.org/10.1285/i22840753n11p41

Casini L. (2009). *Guida per la valorizzazione della multifunzionalità dell'agricoltura.* Firenze University Press, Firenze. https://doi.org/10.26530/oapen_343709

Clark W., Tomich T., Van Noordwijk M., Guston D., Catacutan D., Dickson N., Mcnie E. (2016). Boundary work for sustainable development: Natural resource mnagement at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences of the United States of America*, 113(17): 4615-4622. https://doi.org/10.1073/pnas.0900231108

Cordes, J. J. (2017). Using cost-benefit analysis and social return on investment to evaluate the impact of social enterprise: Promises, implementation, and limitations. *Evaluation and Program Planning*, 64: 98-104. https://doi.org/10.1016/j.evalprogplan.2016.11.008

Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R.V., Paruelo J., Raskin R.G., Sutton P., van der Belt M. (1997). The value of the world's ecosystem services and natural capital. *Ecological Economics*, 25(1): 3-15. https://doi.org/10.1016/s0921-8009(98)00020-2

Deacon B. (2016). SDGs, Agenda 2030 and the prospects for transformative social policy and social Development. *Journal of International and Comparative Social Policy*, 32(2): 79-82. https://doi.org/10.1080/21699763.2016.1200112

Di Iacovo F. (2020). Social Farming Evolutionary Web: From Public Intervention to Value Co-Production. *Sustainability*, 12: 3390-5269. https://doi.org/10.3390/su12135269

Foti V.T., Scuderi A., Timpanaro G. (2013). Organic social agriculture: A tool for rural development. *Quality - Access to Success*, 14(suppl. 1): 266-271.

Fujiwara D., Campbell R. (2011). *Valuation Techniques for Social Cost-Benefit Analysis: Stated Preference, Revealed Preference and Subjective Well-Being Approaches – A Discussion of the Current Issues*. London: HM Treasury.

García-Llorente M., Rubio-Olivar R., Gutierrez-Briceño I. (2018). Farming for life quality and sustainability: A literature review of green care research trends in Europe. *International Journal of Environmental Research and Public Health*, 15(6): https://doi.org/10.3390/ijerph15061282

Giarè F., Borsotto P., De Vivo C., Gaito M., Pavoncello D., Innamorati A. (2017). *Rapporto sull'Agricoltura Sociale in Italia.* Rete Rurale Nazionale 2014-2020.

Giarè F., De Vivo C., Ascani M. (2018). L' agricoltura sociale : un modello di welfare generativo. *Italian Review of Agricultural Economics*, 73(2): 125-146. https://doi.org/10.13128/REA-24079

Giarè F. (2019) *L'attuazione dell'Agricoltura Sociale nella programmazione 2014-2020 della politica di sviluppo rurale.* INEA.

Hassink J., Hulsink W., Grin J. (2016) Entrepreneurship in agriculture and healthcare: different entry strategies of care farmers. *Journal of Rural Studies*, 43: 27-39. https://doi.org/10.1016/j.jrurstud.2015.11.013

Henle K., Alard D., Clitherow J., Cobb P., Firbank L., Kull T., McCracken D., Moritz R., Niemela J., Rebane M., Wascher D., Watt A., Young J. (2008). Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe-A review. *Agriculture Ecosystems & Environment*, 124(1-2): 60-71. https://doi.org/10.1016/j.agee.2007.09.005

Janker J., Mann S. (2020). Understanding the social dimension of sustainability in agriculture: a critical

review of sustainability tools. *Environment, Development and Sustainability,* 22(3): 1671-1691. https://doi.org/10.1007/s10668-018-0282-0

Lanfranchi M., Giannetto C., Abbate T., Dimitrova V. (2015). Agriculture and the social farm: expression of the multifunctional model of agriculture as a solution to the economic crisis in rural areas. *Bulgarian Journal of Agricultural Science*, 21: 711-718.

Leck C. (2012). *Social Return on Investment (SROI) evaluation report of the Houghton Project*. Report, University of Worcester, Worcester, August.

Leck C., Upton D., Evans N. (2016). Social Return on Investment: Valuing health outcomes or promoting economic values?. *Journal of Health Psychology*, 21(7): 1481-1490. https://doi.org/10.1177/1359105314557502

Legge n. 381. (1991). *Disciplina delle cooperative sociali,* Italia.

Legge n.14. (2007). *Tutela e valorizzazione del paesaggio degli ulivi monumentali*, Puglia.

Legge n.71. (2010). *Universal Declaration of Rights of Mothers Earth*, United Nations.

Legge n.141. (2015). *Disposizioni in materia di Agricoltura Sociale*, Italia.

Legge n.7. (2018). *Disposizione per la semplificazione e lo sviluppo regionale*, Lazio.

Marchis J., Bortoluzzi S.C., De Lima E.P., Da Costa S.E.G. (2019). Sustainability performance evaluation of agricultural cooperatives' operations: a systemic review of the literature. *Environmental, Development and Sustainability*, 21(3): 1111-1126 https://doi.org/10.1007/s10668-018-0095-1

Mulgan, G. (2013). Measuring Social Value: What do we mean by measuring social value? *Stanford Social Innovation Review*, 2010: 1-7.

Nicholls J., Lawlor E., Neitzert E., Goodspeed T. (2009). *Guida al Ritorno Sociale sull'Investimento.* Human Fondation, OECD, 2000.

OECD (2001). *Multifunctionality: Towards and Analytical framework*. OECD Publications Service, France.

Scherr S., McNeely J. (2008). Biodiversity conservation an agricultural sustainability: towards a new paradigm of "ecoagriculture" landscapes. *Philosophical transactions of the Royal Society B: Biological Sciences*, 363(1491): 477-494. https://doi.org/10.1098/rstb.2007.2165

Scuderi A., Timpanaro G., Cacciola S. (2014). Development policies for social farming in the EU-2020 Strategy. *Quality - Access to Success*, 15(139): 76-82.

Serpelloni M., Gamma M. (2006). *Analisi Economica dei dipartimenti e delle dipendenze: prima analisi dei costi e valorizzazione dei risultati.*

Stone C. (2010). *Should threes have standing? Law, Morality, and the Environment*, Third Edition. Oxford University Press.

Tayleur C., Balmford A., Buchanan G., Butchart S., Ducharme H., Green R., Milder J., Sanderson F., Thomas, D., Vickery J., Phalan B. (2016). *Global Coverage of Agricultural Sustainability Standards, and Their Role in Conserving Biodiversity*. Conservation Letter. https://doi.org/10.1111/conl.12314.

Toronto EESC (2013). *Opinion of the European Economic and Social Committee on 'Social farming: green therapies and social and health policies'*. Official Journal of the European Union C44/44.

Torquati B., Stefani G., Massini G., Cecchini L., Chiorri M., Paffarini C. (2019). Social farming and work inclusion initiatives for adults with autism spectrum disorders: A pilot study. *NJAS – Wageningen Journal of Life Sciences*, 88 (February 2018): 10-20. https://doi.org/10.1016/j.njas.2019.02.001

Tulla A.F., Vera A., Valldeperas N., Guirado C. (2018). Social Return and economic viability of social farming in Catalonia: a case study analysis. *European Countrys*, 10(3): 398-428. https://doi.org/10.2478/euco-2018-0023

Zamagni S., Venturi P., Rago S. (2015). Valutare l'impatto sociale. La questione della misurazione delle imprese sociali. *Rivista Impresa Sociale,* 6(12): 77-97.

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: Mafalda Monda, Giuliano Gabrieli, Matteo Mazziotta (2021) An indicator of well-being for Italian agriculture. *Italian Review of Agricultural Economics* 76(2): 57-72. DOI: 10.36253/rea-13097

Received: October 11, 2020

Revised: May 12, 2021

Accepted: June 7, 2021

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

An indicator of well-being for Italian agriculture

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Abstract. The paper presents a composite indicator of well-being for Italian agriculture.Well-being is defined as the health condition of the agricultural sector from the point of view of farmers. The indicator is based on four dimensions: social, environmental, institutional and economic, allowing comparability of well-being at regional level. The novelty of the approach consists in presenting a well-being indicator at sectorial level, by applying a new method of aggregation, the Adjusted Mazziotta-Pareto index (2016). It is a non-compensatory approach for summarizing a set of individual indicators which accounts for unbalanced distribution among the indicators. Results show that central and northern regions are in the top ten for the regional agricultural well-being in years 2013 and 2016.

Keywords: well-being, farmers, agriculture, sustainability, composite index.
JEL codes: Q01, R11, Q18.

1. INTRODUCTION

The role of statistical indicators as tools that allow the evaluation and orientation of public policies has changed over time, thanks to data availability and the development of new methods enabling synthesizing complex and multidimensional phenomena. The constructing of composite indicators comes under the discussion, carried out in the international arena, that the country development cannot be measured by considering only economic aspects.

Indeed, the gross domestic product (GDP) is not a suitable indicator for complex concepts such as well-being and sustainability. For this reason, in the last years, composite indicators have been constructed to evaluate country's well-being, in broader terms, taking into consideration social and environmental aspects (e.g.: the Waterloo University's Canadian Index of Well-being, the Measures of Australia's Progress, the Buthan Gross National Happiness Index, the Economist Intelligence Unit's Quality of life).

In 1990, the UN's human development index was built by considering three individual indicators such as the per capita income, the life expectancy and the level of education. The human development index has included other

aspects such as the environmental sustainability which is considered of fundamental importance in order to measure country life conditions.

The objective of this paper is to build a composite indicator of well-being for Italian agriculture. The indicator wants to describe the health condition of the agricultural sector from the point of view of farmersat regional level. It is constructed on 4 dimensions (social, environmental, institutional and economic), taking into account subjective aspects of well-being (e.g.: perception of environmental conditions) as well as dimensions not overlooked before (e.g. institutional aspects). The indicator allows us to measure the well-being of an economic sector in a new perspective that is complementary to that one derived from the human well-being indicator at country level.

2. AN OVERVIEW OF THE ECONOMIC LITERATURE ON COMPOSITE INDICATORS OF WELL-BEING AND SUSTAINABILITY

In June 2007 the European commission, the OECD, the organization of Islamic conference, the United Nations for development (UNDP) and the World Bank adopted the Istanbul declaration that stated the need to measure social development in every country of the world, going beyond the conventional measures such as the gross domestic product per capita (GDP).

In line with this, the Stiglitz-Sen-Fitoussi Commission proposed to shift the focus from the measurement of economic production to people's well-being by considering aspects linked to environmental, economic and social sustainability.

In 2010, following the inclusion of the Stiglitz-Sen-Fitoussi Commission's recommendations in the memorandum of Sofia, the measurement of well-being entered the official statistics.

2.1. Indicators of "Sustainability"

A number of sustainability indicators have been developed in the last years, on the basis of the United Nations Brundtland Commission's definition of sustainability. It states: "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987).

However, the definition of sustainability varies considerably when applied to the agricultural sector (Binder *et al.*, 2010). This is due to the existence of alternative agriculture such as organic, regenerative and ecological (Lockeretz, 1988) and to the variability of agricultural aspects in different regional and country contexts (Zhen, Routray, 2003).

Agricultural production impacts on the environment and the quality of life in rural areas with social and economic implications. For this, most definitions of agricultural sustainability take into consideration three pillars of sustainability and according with them group sustainability indicators in three dimensions: social, economic and environmental (Lebacq *et al.*, 2013).

Specifically, economic indicators of sustainability focus on yields, input expenditures, income derived by on-farm and off-farm activities and land ownership (Becker, 1997; Herzog, Gotsch, 1998; Karami, 1995; Nambiar *et al.*, 2001; Rasul, Tapa, 2004; Nijkamp, Vreeker, 2000; Van Cauwenbergh *et al.*, 2007). Furthermore, economic sustainability indicators also examine changes in yields and total factor productivity (Lynam, Herdt, 1989). Other sustainability indicators consider salaries paid to farm workers and employment opportunities (Herzog, Gotsch, 1998; Rasul, Tapa, 2004) as part of the economic dimension.

Environmental indicators of sustainability are linked with physical and chemical input use (pesticides, herbicides, fungicides), efficiency in the use of inputs, soil erosion and energy use (Hayati, 1995; Ingels *et al.,* 1997; Nambiar *et al.,* 2001; Comer *et al.,* 1999; Van Cauwenbergh *et al.,* 2007). In this context, the sustainable management of land and water resources is one of the major requirement for a sustainable agriculture (Hayati *et al.*, 2010).

Sustainability indicators also include the social dimension by considering aspects such as: the education level of the household members (Herzog, Gotsch, 1998; Van Cauwenbergh *et al.,* 2007), the nutritional status of the farmers' family members (Herzog, Gotsch, 1998; Rasul, Tapa, 2004; Van Cauwenbergh *et al.,* 2007) and social equity (Becker, 1997; Rigby *et al.,* 2001; Rasul, Tapa, 2004).

While the majority of existing research considers the sustainability indicators separately, few studies have proposed to synthetize them in one composite indicator (Valko, 2016) thus facilitating country and region comparability.

2.2. Composite indicators of "well-being"

There are various approaches to the measurement of well-being which are based on various methods to combine individual indicators. Several authors have explored challenges in constructing an indicator of well-being identifying, among the major difficulties, the reliability and availability of data; the methodology to be applied

which can vary depending on the objectives and data; the selection of relevant indicators which may cover subjective and objective aspects of well-being. Among them we can find the index of sustainable economic welfare (ISEW), the Genuine Savings (Hamilton, 1994 and 1996) and the measure of economic welfare (MEW).

The ISEW, introduced by Daly and Cobb (1989), has been conceived as a substitute measure for the GDP integrating the traditional measures of macroeconomic performance with social and environmental aspects, taking into account inequalities in the income distribution.

In 1995, the ISEW was reviewed and renamed the Genuine progress indicator (GPI) (Talberth *et al.*, 2007) with the objective to measure the country's progress taking into account environmental degradation, pollution, depletion of resources and other costs. However, the difficulties to quantify these costs and the subjectivity of selecting the indicators that form the basis of the index are among the main limits of both ISEW and GPI.

The measure of economic welfare (MEW), proposed by Nordhaus and Tobin (1972) wants to measure welfare by calculating the consumptions of goods and services while subtracting some costs such as pollution.

The criticism raised around the capacity of these indicators to reflect economic welfare and sustainability (Giannetti *et al.*, 2015) led to the application of non-monetary approaches to measure country progress. Some examples are: the physical quality life index (PQLI), the Gross national Happiness (GNH) and the Happy Planet Index (HPI).

The PQLI is based on the assumption that nations could have a poor life quality despite high income per capita. For this, it considers measures such as infant mortality, life expectancy and basic literacy, excluding income or other measures of economic well-being.

In line with it, the GNH, firstly suggested by the king of Buthan in 1980, measures the general people well-being or happiness on the basis of indicators belonging to four pillars: the conservation of natural environment, the promotion of cultural values and sustainable development and proper governance. In particular, used indicators are: time use, living standards, good governance, community vitality, health, education.

Finally, in 2006 the New Economic Foundation launched the HPI based on three dimensions: life expectancy at birth, life satisfaction and ecological footprint.

In Italy, the Indicator of equitable and sustainable well-being (BES) was introduced in 2010, with the ambitious objective of measuring the human well-being by considering important aspects related to people's lives, together with the equity in the distribution of well-being among people and the sustainability among generations (Bacchini, Baldazzi, Morrone, Savioli, Sorvillo, Tinto, 2016).

Indicators of equitable and sustainable well-being currently cover 12 dimensions, taking into consideration subjective and objective aspects. Subjective indicators allow the capture of perceptions of individuals. Objective indicators synthesize aspects related to the representativeness of political Institutions, territorial conditions and human health.

3. ISSUES IN BUILDING COMPOSITE INDICATORS

There are some issues in composite indicators to be taken into account for their construction. Firstly, composite indicators allow the aggregation of a large amount of information. This could make them incapable to reflect complexities of phenomena they want to measure.

Furthermore, composite indicators may suffer from methodological difficulties due to the number of decisions to be taken for their construction (Freudenberg 2003). Each step needed for building composite indicatorshas a number of issues, the most controversial of which concern the selection of indicators and their aggregation.

Regarding the indicators' selection, there is no a universally agreed set of indicators for any given phenomenon. Variables to incorporate in composite indicators are, generally, subjective. Furthermore, indicators should be carefully chosen on the basis of their soundness, measurability, and relevance to the phenomenon being measured (Saltelli, 2007). However, relevant data maybe not available or not comparable across domains, countries or areas.

Regarding the aggregation of indicators, it is possible to distinguish two approaches: compensatory and non-compensatory. The compensatory approach considers individual indicators as substitutable thus a deficit in one dimension can be compensated by a surplus in another one.

This approach involves the use of linear functions such as the arithmetic mean. The non-compensatory approach is based on the assumption of non-substitutability of indicators that implies all the dimensions of the phenomenon must be balanced. In this case, unbalance-adjusted functions are generally applied to take into accountunbalances in terms of penalization.

4. THE THEORETICAL FRAMEWORK

The objective of this paper is to develop a composite indicator of well-being for the agricultural sector in Ita-

ly. The following paragraphs clarify the concept of agricultural well-being adopted for the construction of this indicator, the indicators selected for this purpose and, finally, the method applied for their aggregation.

4.1. The definition of agricultural well-being

The definition of agricultural well-being adopted in this work is based on the explored literature on composite indicators of well-being and sustainability. It refers to the health condition of the Italian agricultural sector measured as its capacity to survive crisis by diversifying farm income, intensifying trade, producing good quality products, using good quality inputs (water resources, soil etc.), regularly employing young people and well educated farmers. Furthermore, well-being in agriculture increases thanks to the availability of infrastructural services, enabling developing economic activities, the research that supports the agricultural activity's progress and the efficiency of public services which has positive effects on farm competitiveness.

4.2. The selection of indicators

In order to put into practice the above mentioned definition of agricultural well-being, objective aspects (economy, environmental conditions…) as well as subjective aspects of well-being (e.g.: positive judgement of future perspectives) have been taken into account. This led to a selection of 48 indicators[1] covering the following four dimensions: economic, social, environmental and institutional.

The economic dimension of well-being takes into account farm performances (e.g. value added) and factor productivity (e.g. capital productivity…) as well as other elements related to the farming activities, for example, the number of farms with quality products (e.g. DOP.). Factors linked to the regional context have been also taken into account in this dimension such as: the regional openness to international trade and the firm birth rate.

The environmental dimension includes indicators that focus on physical conditions of the environment (e.g.: regional areas under organic farming, extension of protected natural areas…), as well as the intensity of phytosanitary products' and fertilizers' uses. Subjective aspects are included in this dimension for example: citizens' concerns about landscape deterioration and biodiversity loss, and the level of satisfaction for the environmental conditions.

The social dimension of agricultural well-being is composed of indicators that are able to capture elements of the social structure where farmers operate such as: the rate of irregular employment in agriculture, the percentage of women agricultural workers, the number of farmers aged less than 44 and those who operate in disadvantaged rural areas. Subjective elements have also been considered such as: the level of generalized trust in people and the level of people's involvement in social activities (meetings with cultural and ecological associations…).

Finally, the institutional dimension is based on indicators taking into account the level of public support to farmers, the farmers' access to credit, as well as the amount of public expenditures in infrastructural services, agricultural research and technical assistance. Elements concerning the regional context are also included in this dimension such as: the level of accessibility to regional services and irregularities in electric power distribution. Individual indicators also capture subjective factors for example: the level of trust in Institutions and the political and civic participation.

The choice of indicators included in the composite index was limited by the data available in years 2013 and 2016 at regional level. Indeed, data used mainly derived from the database of the Italian National Institute of Statistics (ISTAT). It provides information on the Italian agricultural sector coming from official data (e.g.: national account data) and specific surveys (e.g. labor force survey; survey on aspects of daily life). Other data sources were also used (e.g.: farm accounting data network…).

4.3. The method

The method applied for building the composite indicator of well-being for the Italian agriculture is the Adjusted Mazziotta-Pareto (AMPI)[2]. It is a non-compensatory approach that is an extension of the Mazziotta-Pareto Index (MPI+/-).

The Mazziotta-Pareto Index (MPI) is based on a standardization of the individual indicators, at the reference time, that makes the indicators independent of the variability[3] allowing only relative comparisons over

[1] See Appendix.

[2] We used the software COMIC for the calculation of the composite indicator of agricultural well-being. COMIC was developed by the working group on the composite indicator of equitable and sustainable well-being within the Italian Institute of statistics. Its application requires the basic version of SAS System (ver. 9.1). The software allows the construction, analysis and validation of composite indicators.

[3] The normalized indicators have a mean of 100 and a standard deviation of 10.

time. The Adjusted Mazziotta-Pareto (AMPI) performs absolute comparison over time by re-scaling individual indicators in the range (70; 130) according to two goal posts, i.e., a minimum and a maximum value which represent the possible range of each indicator for all time periods and for all units (Mazziotta, 2016).

Given the matrix $X=\{x_{ij}\}$ with n rows (units) and m columns (indicators), we calculate the matrix R of normalized scores r_{ij} as follow:

$$r_{ij} = \begin{cases} \frac{(x_{ij} - \text{Min}_{x_j})}{\text{Max}_{x_j} - \text{Min}_{x_j}} * 60 + 70 \text{ , if the indicator's polarity is positive;} \\ \frac{\left(\text{Max}_{x_j} - x_{ij}\right)}{\text{Max}_{x_j} - \text{Min}_{x_j}} * 60 + 70, \text{if the indicator's polarity is negative;} \end{cases}$$

where x_{ij} is the value of the indicator j for the unit i and Min_{x_j} and Max_{x_j} are the "goalposts" for the indicator j. Denoting with Inf_{x_j} and Sup_{x_j} the overall minimum and maximum of the indicator j across all units and all years and with Ref_{x_j} the reference value for the indicator j, the "goalposts" are defined as:

$$\begin{cases} \text{Min}_{x_j} = \text{Ref}_{x_j} - \Delta \\ \text{Max}_{x_j} = \text{Ref}_{x_j} - \Delta \end{cases}$$

where: $\Delta=(\text{Sup}_{x_j}-\text{Inf}_{x_j})/2$

Values will fall approximately in the range (70; 130) while 100 represents the reference value (the Italian average in a given year). Denoting with , and respectively, the mean, the standard deviation and the coefficient of variation for the normalized values for the unit i, the generalized form of the Adjusted MPI is given by:

$$\text{AMPI}_i^{+/-} = \text{M}_{r_i} \pm (\text{S}_{r_i} * \text{cv}_i)$$

Where:

$$\text{cv}_i = \frac{\text{S}_{r_i}}{\text{M}_{r_i}}$$

The sign of the indicator depends on the nature of the phenomenon. The negative sign is applied if the composite indicator is positively related to the construct of well-being while the positive sign is used when the indicator is negatively related to the well-being (Mazziotta, Pareto, 2016).

The composite indicator is the arithmetic average to which a penalty is applied with the objective to penalize statistical units that show unbalanced distribution of values in each dimension and over time. Two components explain together the indicator's results: the first one captures the average effect (additive component); the second one is the penalty effect (due to unbalance). The penalty coefficient takes into account the horizontal variability of each indicator *j* per unit *i* by applying a penalty to units that show more unbalanced values than others.

4.4. Limitations of the method

A composite indicator is a measure, generally expressed in quantitative form and composed of several variables, capable of summarizing the trend of the phenomenon to which it refers. The composite indicator is not the phenomenon, but it represents and summarizes the behavior of the more complex phenomenon that we must monitor and evaluate. An example that gives the idea: the individual indicator is the finger reaching towards the sky … but the phenomenon is the star! (Terzi *et al.*, 2021). In general, when you decide to reduce the dimensions in space, you have few certainties: an approximation error is being made and the perfect composite index does not exist (Mazziotta, Pareto, 2020).

However, in the literature composite indices are widely used as they help to better read the complex reality and therefore to make relevant decisions for citizens. As mentioned, every composite indicator has strengths and weaknesses: the role of the researcher is to adapt the methodology to the phenomenon being measured.

The growing diffusion of AMPI method demonstrates that the methodology is robust and adaptable to many scientific contexts. As mentioned, AMPI is particularly recommended when the individual indicators are not substitutable and therefore it is essential that there is no compensation between them (De Muro *et al.*, 2011). The only precaution that must be kept under control is the choice of the base year if the data are in time series. Since the penalty occurs according to the variability with respect to the reference year, it seems desirable that the latter present a stable situation and that, therefore, is not subject to shocks that could affect the results of the entire time series. In the event that the base year is stable, it is easier to appreciate the trend of the composite index over time when the penalties due to the imbalances of the individual indicators are applied (Mazziotta, Pareto, 2016).

5. RESULTS

The results obtained for each dimension are reported in the following paragraphs together with the description of their aggregation in one composite indicator.

5.1. The economic dimension

In 2013, results for the economic dimension (Tab. 1) show how both northern and southern regions are in the top ten of the regional classification.

In particular, in the south, Apulia and Sicily occupy, respectively, the first and second positions, followed by Calabria in 4th position. In the north, Veneto (3rd), Emilia Romagna (5th) and Trentino-South Tirol (6th) have the highest positions.

This is according to the combined effect of four indicators which are the most influential: farms with owned land, trade openness, number of quality products and producers which assume values particularly high in the above mentioned areas. However, the northern regions show higher penalties than southern ones due to the unbalanced values of their individual indicators. This is because indicators belonging to the economic dimension reflect structural factors of regional economies (e.g.: extension of utilized agricultural area) as well as farm performances (e.g.: agricultural value added).

Furthermore, indicators are affected by the economic cycle and natural events (e.g.: climate change) that are responsible for the variability of regional position between 2013 and 2016. Indeed, in 2016, southern regions were getting worse with Apulia shifting to the second position, Sicily which moved into 5th position and Campania which moved from 7th to 9th. Analogously, in the north, Veneto moved to 6th position and Trentino-South Tirol to 13th. The only exception is Emilia Romagna which moved up 4 positions, upgrading from the 5th to 1st.

5.2. The environmental dimension

In 2013 the environmental dimension of agricultural well-being (Tab. 2) shows the best results in southern regions (Calabria 2nd, Apulia 3rd, Sicily 4th, Molise 5th, Basilicata 6th and Abruzzo 7th) while the worst ones are those attributable to northern territories (Lombardy 21st, Veneto 20th, Liguria 19th and Emilia Romagna 18th). This is ascribable to production varieties and methods applied but also to opinions about regional environmental conditions that are among the most influential indicators.

In particular, regional livestock numbers are responsible for positions occupied by northern regions. Live-

Tab. 1. Results for the economic dimension.

REGION	AMPI		RANK	
	2013	2016	2013	2016
Abruzzo	93.9	92.7	16	19
Basilicata	93.3	98.1	18	15
Calabria	104.2	108.6	4	3
Campania	103.1	103.7	7	9
Emilia-Romagna	103.7	112.3	5	1
Friuli-Venezia Giulia	91.6	94.9	19	18
Lazio	101.2	105.6	10	7
Liguria	95.0	100.2	14	14
Lombardy	101.9	105.0	9	8
Marche	93.7	95.1	17	17
Molise	91.1	92.6	20	20
Piedmont	97.6	102.6	13	11
Apulia	106.0	110.6	1	2
Sardinia	98.3	101.0	12	12
Sicily	105.5	106.5	2	5
Tuscany	102.4	107.2	8	4
Trentino-South Tyrol	103.5	100.8	6	13
Umbria	94.2	96.1	15	16
Aosta Valley	89.3	85.6	21	21
Veneto	105.2	106.4	3	6
ITALY	**100.0**	**102.6**	-	-

Source: Authors' elaboration on ISTAT and CREA data.

Tab. 2. Results for the environmental dimension.

REGION	AMPI		RANK	
	2013	2016	2013	2016
Abruzzo	102.2	99.9	7	5
Basilicata	102.6	101.3	6	4
Calabria	103.9	102.9	2	2
Campania	98.3	97.6	14	16
Emilia-Romagna	94.3	97.0	18	17
Friuli-Venezia Giulia	94.5	95.5	17	18
Lazio	97.3	97.6	16	15
Liguria	93.9	87.1	19	21
Lombardy	92.7	93.5	21	19
Marche	99.7	98.6	12	11
Molise	103.4	103.1	5	1
Piedmont	102.0	97.8	9	14
Apulia	103.9	102.9	3	3
Sardinia	98.3	98.6	13	10
Sicily	103.7	99.2	4	7
Tuscany	102.0	98.7	8	9
Trentino-South Tyrol	100.2	99.8	10	6
Umbria	98.2	98.1	15	13
Aosta Valley	105.0	98.4	1	12
Veneto	93.5	90.6	20	20
ITALY	**100.0**	**99.0**	-	-

Source: Authors' elaboration on ISTAT and CREA data.

stock productions are widespread in those territories thus negatively impacting on the environmental dimension of agricultural well-being. This is in addition to production methods which require more use of phytosanitary products per hectare of cultivated land in northern regions. Penalties show higher values in northern regions and, in particular, in Aosta Valley as a consequence of non-homogeneous values of their individual indicators.

On the opposite side, southern regions show a better score of subjective indicators related to the concerns for the loss of biodiversity and degradation of land. This suggests that an improved quality of life and a better conservation of natural resources are among the major advantages for farms which operate in these areas. An upgrade in the positions of southern regions is observed in 2016, with Molise shifting from 5th to 1st position, Basilicata moving from 6th to 4th and Sardinia from 13th to 10th mainly as result of a minor concerns for the loss of biodiversity.

5.3. The social dimension

In 2013, Tuscany occupied the first position in the regional classification related to the social dimensionof the agricultural well-being (Tab. 3), followed by Umbria and Lazio. In general, central regions show better results of the social dimension of the agricultural well-being. This is the consequence of the high number of farmers that operate in disadvantaged rural areas, thus contributing to their social and economic development, as well as the high percentage of people who believe their personal situation will improve in the next 5 years.

The indicator related to the percentage of farms with family labor also contributes to increase agricultural well-being in the above mentioned regions together with the high number of farmers aged less than 44 years. On the opposite side, the majority of southern regions (Calabria, Campania, Molise, Apulia and Sicily) show low values of the social dimension of agricultural well-being. Northern regions have medium values of well-being except for Trentino-South Tirol and Emilia Romagna that are in the 4th and 6th positions of the regional classification.

These results are confirmed in 2016, with central regions reporting the best results for the agricultural well-being while the southern ones showed a further worsening. Basilicata shifted from 7th to 9th position, Abruzzo lost 5 positions (from 5th to 10th) and Sardinia shifted from 8th to 14th position mainly due to the reduction in the number of farmers that operate in disadvantages rural areas.

Tab. 3. Results for the social dimension.

REGION	AMPI		RANK	
	2013	2016	2013	2016
Abruzzo	101.6	100.9	5	10
Basilicata	100.6	101.0	7	9
Calabria	96.5	94.6	17	19
Campania	94.3	97.4	19	17
Emilia-Romagna	100.9	99.9	6	12
Friuli-Venezia Giulia	97.0	99.5	16	13
Lazio	102.9	103.8	3	3
Liguria	99.1	102.3	11	5
Lombardy	99.9	98.4	10	16
Marche	98.5	102.1	14	7
Molise	98.2	101.4	15	8
Piedmont	99.1	100.5	12	11
Apulia	95.3	96.0	18	18
Sardinia	100.5	99.2	8	14
Sicily	92.7	90.6	20	20
Tuscany	109.0	108.0	1	1
Trentino-South Tyrol	102.6	103.6	4	4
Umbria	106.0	106.9	2	2
Aosta Valley	100.2	102.1	9	6
Veneto	98.8	99.1	13	15
ITALY	**100.0**	**99.9**	-	-

Source: Authors' elaboration on ISTAT and CREA data.

5.4. The Institutional dimension

The Institutional dimension of the agricultural well-being (Tab. 4) shows values particularly high in the northern regions where, in 2013, they led the regional classification with Piedmont occupying first position, followed by Lombardy (2nd) and Trentino-South Tirol (3rd).

This result is ascribable to the regional level of expenditure related to agricultural research and development as well as the expenditure related to infrastructural services provided to farmers that are the most influential indicators.

Furthermore, in southern regions the observed high level of agricultural public expenditure (e.g.: Sicily) is offset by a higher degree of technical problems that farmers have to cope with, for example: irregularities in electric power distribution and difficulties to reach some basic services, thus placing these regions at the bottom of the regional classification.

These positions are confirmed by 2016's results with few changes due to the economic cycle's effects and public expenditure dynamics at regional level (e.g.: commitments and co-financing mechanisms) which also reflect into penalties attributed to Italian regions.

Fig. 4. Results for the Institutional dimension.

REGION	AMPI		RANK	
	2013	2016	2013	2016
Abruzzo	96.7	94.1	14	14
Basilicata	90.8	92.2	17	16
Calabria	85.8	89.4	20	20
Campania	86.6	90.6	19	18
Emilia-Romagna	102.0	102.3	5	5
Friuli-Venezia Giulia	100.9	98.0	9	11
Lazio	99.6	101.5	10	6
Liguria	100.9	101.1	8	7
Lombardy	107.4	109.7	2	1
Marche	97.1	96.6	13	13
Molise	98.5	92.2	12	15
Piedmont	113.4	105.9	1	2
Apulia	90.0	90.4	18	19
Sardinia	101.4	104.1	7	4
Sicily	92.5	91.5	16	17
Tuscany	99.3	99.5	11	9
Trentino-South Tyrol	104.5	105.1	3	3
Umbria	96.5	97.4	15	12
Aosta Valley	104.0	98.5	4	10
Veneto	101.5	100.0	6	8
ITALY	**100.0**	**99.4**	-	-

Source: Authors' elaboration on ISTAT and CREA data.

5.5. The composite indicator of agricultural well-being for 2013 and 2016

By synthetizing the four dimensions (economic, environmental, social and institutional) we obtain the composite indicator of agricultural well-being for 2013 and 2016 (Tab. 5). Tuscany is in the first position of the regional classification in both years, followed by Trentino-South Tirol in 2013 and Emilia Romagna in 2016. In general, the composite indicator shows better performances in central and northern regions than southern ones, with the exception of Sardinia which held the 7th position in both years.

The presence of the same regions in the top ten of the regional classifications in 2013 and 2016 indicates that the agricultural well-being is stable and high in the above mentioned territories, despite climate change and other challenges affecting the primary sector. Furthermore, many elements contribute to this result, such as the social structure, the efficiency of local administration and the quality of regional expenditures. Theyimpact positively on the quality of farmers' life and the development of their activities.

This is why southern regions such as Sicily, Apulia and Calabria with good performances in more than one dimension of the agricultural well-being (economic and environmental) don't find good positions in the final classification.

6. DISCUSSION

The composite indicator for the Italian agricultural well-being allows us to understand trends in agricultural well-being at regional level, emphasizing its main determinants.

Results are comparable to those emerged in a study (Greco *et al.*, 2013) that assesses the multifunctionality[4] of agriculture in Italian regions by building a composite indicator of multifunctionality. Even if the latter measures a different concept than the indicator of well-being, the two indicators have some commonalities that are worth exploring in a comparative perspective.

Specifically, the composite indicator of multifunctionality is built on 5 pillars/dimensions such as: 1. Landscape conservation 2. Diversification of farm activities 3. Environment 4. Food quality 5. Land protection. Analogously, the composite indicator of agricultural well-being is based on 4 dimensions: economic, environmental, social and institutional. Some of them include and group individual indicators belonging to different pillars of the composite indicator of multifunctionality.

The composite indicator of multifunctionality uses the MPI (+) method (De Muro *et al.*, 2011) that is based on a penalized mean of standardized values. The composite indicator of agricultural well-being is based on the AMPI (+) which represents an extension of the MPI (+) method since it allows time comparisons.

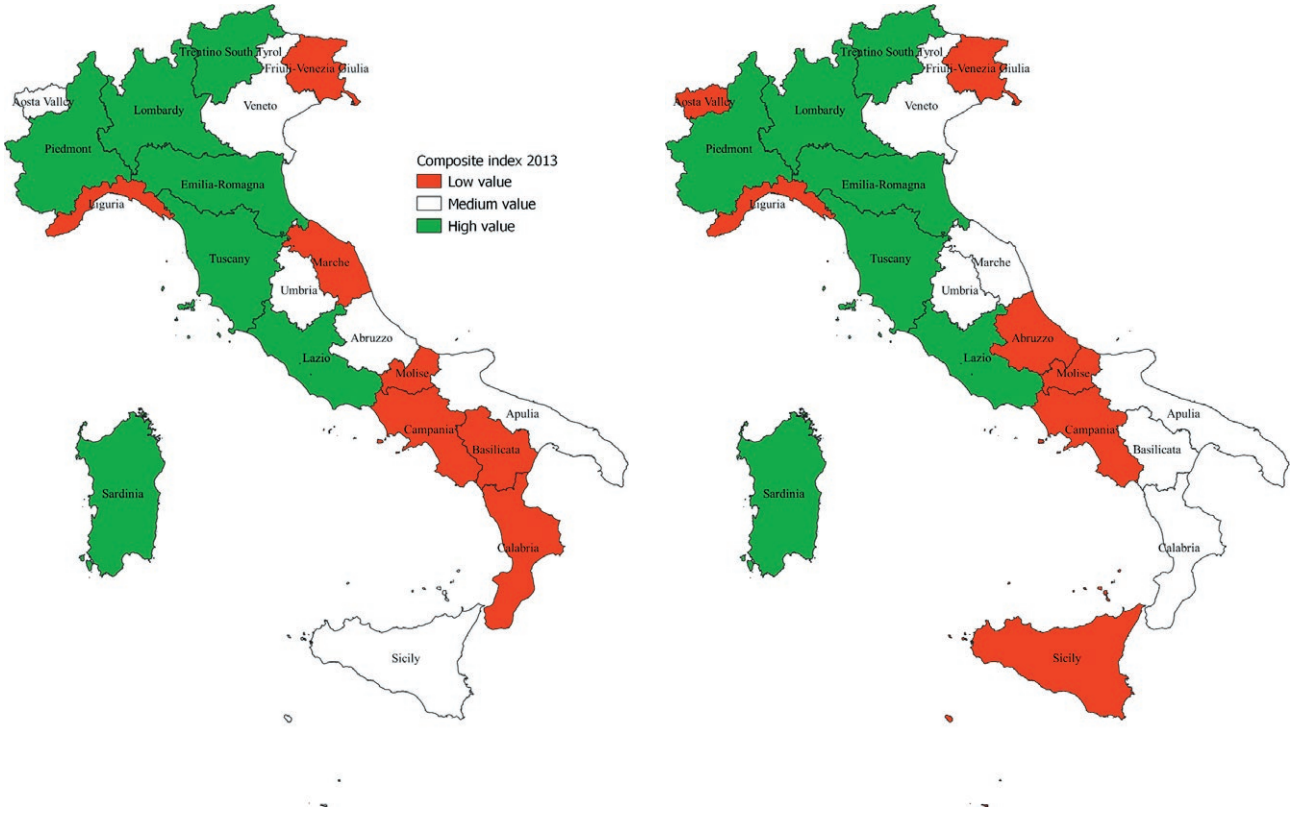
Results for the composite indicator of multifunctionality show that northern and central regions display better results that southern ones. Analogously happens for the composite indicator for agricultural well-being. This is attributable to the role of disadvantaged rural areas in northern and central regions that contribute to the development of farm activities' diversification for the composite indicator of multifuncitionality. The high number of farmers that operate in disadvantaged rural areas is responsible for the good performances of the composite indicator of agricultural well-being in northern and central regions.

[4] Multifunctional agriculture refers to the fact that "beyond its primary function of producing food and fibre, agricultural activity can also shape the landscape, provide environmental benefits such as land conservation, the sustainable management of renewable natural resources and the preservation of biodiversity, and contribute to the socio-economic viability of many rural areas" (OECD, 2001).

Fig. 5. The composite indicator of agricultural well-being.

REGION	AMPI		RANK		LEVEL	
	2013	2016	2013	2016	2013	2016
Abruzzo	98.5	96.8	11	18	Medium	Low
Basilicata	96.6	98.0	18	12	Low	Medium
Calabria	97.0	98.3	17	11	Low	Medium
Campania	95.2	97.1	20	15	Low	Low
Emilia-Romagna	100.1	102.5	6	2	High	High
Friuli-Venezia Giulia	95.9	97.0	19	17	Low	Low
Lazio	100.2	102	4	4	High	High
Liguria	97.2	97.3	16	14	Low	Low
Lombardy	100.2	101.3	5	6	High	High
Marche	97.2	98.0	15	13	Low	Medium
Molise	97.6	97.1	14	16	Low	Low
Piedmont	102.6	101.6	3	5	High	High
Apulia	98.4	99.4	12	9	Medium	Medium
Sardinia	99.6	100.7	7	7	High	High
Sicily	98.2	96.5	13	19	Medium	Low
Tuscany	103.0	103.2	1	1	High	High
Trentino South Tyrol	102.7	102.3	2	3	High	High
Umbria	98.5	99.5	10	8	Medium	Medium
Aosta Valley	99.2	95.8	9	20	Medium	Low
Veneto	99.5	98.7	8	10	Medium	Medium
ITALY	**100.0**	**100.2**	-	-	-	-

Source: Authors' elaboration on ISTAT and CREA data.



Furthermore, the composite indicator of multifunctionality shows better results in northern regions for the pillars related to farm activities' diversification. This is due to farms with activities such agritourism, production of renewable energy and other activities that assume values particularly high in the above mentioned areas. The same happens for the composite indicator of multifunctionality food quality's pillar due to the high number of quality products and producers operating in northern regions.

The composite indicator for agricultural well-being accounts for farm activities' diversification and food quality in the economic dimension. However, other elements are also taken into consideration in it such as: farm performances (e.g.: agricultural value added) and structural factors of regional economies (e.g.: extension of utilized agricultural area, trade openness). This is why the composite indicator of agricultural well-being shows that some southern regions as well as northern regions are in good positions in the regional classification for the economic dimension.

Furthermore, a part of southern regions hold higher positions for the pillar "landscape conservation" and "biodiversity protection" for the composite indicator of multifuctionality. These results are partially in line with those of the composite indicator of agricultural well-being that includes individual indicators for landscape conservation and biodiversity protection in the environmental dimension.

Indeed, results show that southern regions are at the top of the regional classification for this dimension of agricultural well-being. However, this is due to a better score displaying for subjective indicators such as the concerns for the loss of biodiversity and land degradation.

Subjective aspects have not been taken into account in the composite indicator of multifunctionality, representing the main difference between the two indicators. In addition the composite indicator of multifunctionality does not consider the institutional dimension, which is conversely included in the composite indicator of agricultural well-being. This dimension accounts for the efficiency of public administration and other elements able to impact on the development of farmers' activities at regional level. This offers a broader perspective of the well-being in agriculture from the farmers' point of view.

7. CONCLUSIONS

The experience of well-being indicators has been largely developed for many years starting from the definition of well-being in a broader sense as a multidimensional phenomenon which emphasizes the human/citizen perspective.

Recently, it has become a central topic for research institutions and national and international organizations due to the fact they are easy to understand and are a good communication tool, allowing aggregation of a huge amount of information in only one measure.

However, composite indicators may be incapable to reflect complexities of phenomena such as well-being. In this sense, the construction of a well-being indicator at sectorial level, is something new in the research arena that may help to complementthe multisectorial perspective offered by the traditional well-being measures.

The example of a composite indicator of well-being for the Italian agriculture, presented in this paper, allows stakeholders to focus on points of strengths and weaknesses of the agricultural sector.

Results for the composite indicator underline the presence of the same regions in the top ten of the regional classifications in 2013 and 2016. This indicates that the agricultural well-being is stable among regions and variabilities in their positions are mainly attributable to external factors affecting the primary sector (climate change, economic cycle…).

This is in line with the results of equitable and sustainable well-being indicators, published by the Italian National Institute of Statistics, that shows how southern regions are at the bottom of the regional classification for quality of life as a consequence of structural problems affecting those living in the south of Italy.

This indicator could be further refined by including new dimensions other than economic, social, environmental and institutional. It could be developed by taking into account subjective aspects of well-being such as: the satisfaction for the farming job, access to land and farm bureaucratic burden.

New indicators and dimensions should be able to capture elements of the agricultural well-being that have not been covered yet, and would provide deeper understanding of sector-related problems in order to intervene in an appropriate manner.

Sectorial indicators of well-being could assume a relevant role in the near future, considering the challenges that economic sectors are facing worldwide such as: climate change, pandemic crisis, depletion of natural resources. They may allow policy makers to find targeted solutions by taking into account needs, problems and perceptions of operators working in economic sectors, helping to improve public policies.

REFERENCES

Bacchini F., Baldazzi B., Morrone A., Savioli M., Sorvillo M. P., Tinto A. (2016). *Un framework integrato per la misurazione del benessere e la sostenibilità in Italia*. Working papers Urban@it, 2/2016.

Becker B. (1997). Sustainability assessment: a review of values, concepts, and methodological approaches. *Issues in agriculture*, 10. The World Bank, Washington D.C.

Binder C.R., Feola G., Steinberger J.K. (2010). Considering the Normative, Systematic and Procedural Dimensions in Indicator-Based Sustainability Assessments in Agriculture. *Environmental Impact Assessment Review*, 30(2): 71-81. https://doi.org/10.1016/j.eiar.2009.06.002

Comer S., Ekanem E., Muhammad S., Singh S. P., Tegegne F. (1999). Sustainable and conventional farmers: A comparison of socio-economic characteristics, attitude and beliefs. *Journal of Sustainable Agriculture,* 15(1): 29-45. https://doi.org/10.1300/J064v15n01_04

De Muro P., Mazziotta M., Pareto, A. (2011). Composite Indices of Development and Poverty: An Application to MDGs. *Social Indicators Research* 104: 1-18. https://doi.org/10.1007/s11205-010-9727-z

Greco M., Fusco D., Giordano P., Moretti V., Broccoli M. (2013). Misurare la multifunzionalità in agricoltura: proposta di un indice sintetico, *Agriregionieuropa*, 9(34).

Hamilton K. (1994). Green Adjustments to GDP. *Resources Policy*, 20(3): 155-168. https://doi.org/10.1016/0301-4207(94)90048-5

Hamilton K. (1996). Pollution and Pollution Abatement in the National Accounts. *Review of Income and Wealth,* 42(1): 13-33. https://doi.org/10.1111/j.1475-4991.1996.tb00143.x

Hayati D. (1995). *Factors influencing technical knowledge, sustainable agricultural knowledge and sustainability of farming system among wheat producers*, in Fars province, Iran M. Sc. Thesis presented in College of agriculture, Shiraz University Iran.

Hayati D., Ranjbar Z., Karami E. (2010). Measuring agricultural sustainability. *Biodiversity, Biofuels, Agroforestry and Conservation Agriculture*, 5: 73-100. https://doi.org/10.1007/978-90-481-9513-8_2

Herzog F., Gotsch N. (1998). Assessing the sustainability of smallholder tree crop production in the tropics: A methodological outline. *Journal of Sustainable Agriculture,* 11(4): 13-37. https://doi.org/10.1300/J064v11n04_04

Ikerd J.E. (1993). The need for a systems approach to sustainable agriculture. *Agriculture Ecosystems Environment*, 46(1/4): 147-160. https://doi:10.1016/0167-8809(93)90020-P

Ingels C., Campbell D., George M.R., Bradford E. (1997). *What is sustainable agriculture?* Available at: www.sarep.ucdavis.edu/concept.htm

ISTAT, 2018. *BES Report 2018: equitable and sustainable well-being in Italy*. ISTAT, Rome

Karami E. (1995). Agricultural extension: The question of sustainable development in Iran. *Journal of Sustainable Agriculture,* 5(1/2): 61-72. https://doi.org/10.1300/J064v05n01_05

Lebacq T., Baret P.V., Stilmant D. (2013). Sustainability indicators for livestock farming. A review. *Agronomy for sustainable development,* 33(2): 311-327. https://doi.org/10.1007/s13593-012-0121-x

Lockeretz W. (1988). Open questions in sustainable agriculture. *American Journal of Alternative Agriculture*, 3(04): 174-181.https://doi.org/10.1017/S0889189300002460

Lynam J.K., Herdt R.W. (1989). Sense and sustainability: sustainability as an objective in international agricultural research. *Agricultural Economics,* 3(4): 381-398. https://doi.org/10.1016/0169-5150(89)90010-8

Mazziotta M., Pareto A. (2016). On a Generalized Non-compensatory Composite indicator for Measuring Socioeconomic Phenomena. *Social Indicators Research*, 127(3): 983-1003. https://doi.org/10.1007/s11205-015-0998-2

Mazziotta M., Pareto A. (2018). Use and Misuse of PCA for Measuring Well-being. *Social Indicators Research*, 142(2): 451-476. https://doi.org/10.1007/s11205-018-1933-0

Mazziotta M., Pareto A. (2020). *Gli indici sintetici*. Torino, Giappichelli editore

Morris D. M. (1979). *Measuring the condition of the world's poor: the physical quality of life index*. New York, Pergamon Press.

Nambiar K.K.M., Gupta A.P., Qinglin F., Li S. (2001). Biophysical, chemical and socio-economic indicators for assessing agricultural sustainability in the Chinese coastal zone. *Agriculture, Ecosystems and Environment*, 87(2): 209-214. https://doi.org/10.1016/S0167-8809(01)00279-1

Neumayer E. (2004). *Sustainability and well-being indicators*. WIDER Research Papers, 2004/23. Available at: http://eprints.lse.ac.uk/30851/.

Nijkamp P., Vreeker R. (2000). Sustainability assessment of development scenarios: methodology and application to Thailand. *Ecological Economics,* 33(1): 7-27. https://doi.org/10.1016/S0921-8009(99)00135-4

OECD (1999). *Environmental indicators for agriculture. Issues and Design*. OECD Publishing, Paris.

OECD (2001). *Multifunctionality: Towards an Analytical Framework*. OECD Publishing, Paris, https://doi.org/10.1787/9789264192171-en.

OECD (2001). *Environmental indicators for agriculture: Methods and Results*. OECD Publishing, Paris.

Osberg L., Sharpe A. (2002). An Index of Economic Well-Being for Selected OECD Countries. *Review of Income and Wealth*, 48(3): 291-316. https://doi.org/10.1111/1475-4991.00056

Rasul G., Thapa G.B. (2004). Sustainability of ecological and conventional agricultural systems in Bangladesh: An assessment based on environmental, economic and social perspectives. *Agricultural Systems,* 79(3): 327-351. https://doi.org/10.1016/S0308-521X(03)00090-8

Rigby D., Woodhouse P., Young T., Burton M. (2001). Constructing a farm-level indicator of sustainable agricultural practice. *Ecological Economics,* 39(3): 463-478. https://doi.org/10.1016/S0921-8009(01)00245-2

Saltelli A. (2007). Composite Indicators between Analysis and Advocacy. *Social Indicators Research*, 81(1): 65-77. https://doi.org/10.1007/s11205-006-0024-9

Sands G.R., Podmore H. (2000). A generalized environmental sustainability index for agricultural systems. *Agriculture, Ecosystems and Environment,* 79(1): 29-41. https://doi.org/10.1016/S0167-8809(99)00147-4

Stiglitz J.E., Sen A., Fitoussi J.P. (2009). *Report by the Commission on the Measurement of Economic Performance and Social Progress.* Paris.

Tellarini V., Caporali F. (2000). An input/output methodology to evaluate farm as sustainable ecosystems: an application of indicators to farms in central Italy. *Agricultural ecosystems and environment*, 77(1/2): 11-123. https://doi.org/10.1016/S0167-8809(99)00097-3

Terzi S., Otoiu A., Grimaccia E., Mazziotta M., Pareto A. (2021). Open Issues in Composite Indicators. Roma TrE-Press. DOI: 10.13134/979-12-5977-001-1

United Nations Conference on Sustainable Development (2001). *Indicators of Sustainable Development: Guidelines and methodologies*. http://www.un.org/esa/sustdev/publications/indisd-mg2001.pdf

United Nations Development Programme (1998). *Human Development Report 1998.* Oxford University Press, New York.

United Nations Development Programme (2001). *Human Development Index* (HDI). http://hdr.undp.org/en/statistics/hdi/

Valkó G. (2016). *Developing the Indicator System of Sustainable Agriculture – Application of Composite Indicators Proceedings.* ICAS VII Seventh International Conference on Agricultural Statistics I Rome 24-26 October 2016. https.//doi:10.1481/icasVII.2016.b14

Van Cauwenbergh N., Biala K., Bielders C., Brouckaert V., Franchois L., Cidad V.G., Hermy M., Mathijs E., Muys B., Reijnders J., Sauvenier X., Valckx J., Vanclooster M., Der Veken B.V., Wauters E., Peeters A. (2007). SAFE: a hierarchical framework for assessing the sustainability of agricultural systems. *Agriculture, Ecosystems and Environment,* 120(2/4): 229-242. https://doi.org/10.1016/j.agee.2006.09.006

Webster P. (1999) The challenge of sustainability at the farm level: Presidential address. *Journal Agricultural Economics*, 50: 371-387. https.//doi:10.1111/j.1477-9552.1999.tb00888.x

World Commission on Environment and Development (1987). *Our Common Future*. United Nations, New York.

Zhen L., Routray J.K. (2003). Operational indicators for measuring agricultural sustainability in developing countries. *Environmental Management,* 32(1): 34-46. https://doi.org/10.1007/s00267-003-2881-1

APPENDIX

Economic Dimension			
	Yields	Polarity	
1		Agricultural value added per ha (crop -specialist holdings)	+
	Data source	Farm Accounting data network (Italy)	
	Livestock productivity	Polarity	
2		Agricultural value added per livestock unit (livestock-specialist holdings)	+
	Data source	Farm Accounting data network (Italy)	
	Labour productivity	Polarity	
3		Agricultural value added per work unit(LU)	+
	Data source	Farm Accounting data network (Italy)	
	Capital productivity	Polarity	
4		Agricultural value added/ Farm Net Capital	+
	Data source	Farm Accounting data network (Italy)	
	Agricultural value added	Polarity	
5		Agricultural value added at basic prices (mil. Euros)	+
	Data source	National account data (Italian National Institute of Statistics)	
	Openness to international trade index	Polarity	
6		(Import + Export) / Agricultural value added	+
	Data source	COMTRADE database and National account data (Italian National Institute of Statistics)	
	Farm birth rate	Polarity	
7		Number of new farms in a given yearas a percentage of the total number farms	+
	Data source	Infocamere, Firmregister	
	Agricultural workers' wages	Polarity	
8		Wagesin euros	+
	Data source	National account data (Italian National Institute of Statistics)	
	Quality products	Polarity	
8		Number of quality products	+
	Data source	Quality products' database (Italian National Institute of Statistics)	
	Farms with quality products	Polarity	
10		Number of farms with quality products	+
	Data source	Quality producers' database (Italian National Institute of Statistics)	
	Farms with own land	Polarity	
11		Number of farms with own land as a percentage of the total	+
	Data source	Survey on farm structure (Italian National Institute of Statistics)	
	Farms with other farming-related activities	Polarity	
12		Number of farms with other farming-related activitiesas a percentage of the total	+
	Data source	Survey on farm structure (Italian National Institute of Statistics)	
Environmental Dimension			
	Satisfaction for the environmental conditions	Polarity	
1		Percentage of people aged 14 and over very or quite satisfied of the environmental situation (air, water, noise) of the area where they live on total population aged 14 and over	+
	Data source	Survey on every-day life aspects (Italian National Institute of Statistics)	

	Energy from renewable sources	Polarity	
2		Percentage of energy consumptions coveredby renewable sources	+
	Data source	Terna	
	Fertilizer use	Polarity	
3		Quantity of fertilizers (Ton) / Utilized agricultural area (ha)	-
	Data source	Fertilizer database (Italian National Institute of Statistics)	
	Phytosanitary use	Polarity	
4		Quantity of phytosanitary products (Ton) / Utilized agricultural area (ha)	-
	Data source	Fertilizer database (Italian National Institute of Statistics)	
	Regional area under organic farming	Polarity	
5		Extension of agricultural areaunder organic farming (ha)	+
	Data source	SINAB	
	Livestock	Polarity	
6		Livestock units (LSU)	-
	Data source	Italian Farm structure Survey (Italian National Institute of Statistics)	
	Protected naturalareas	Polarity	
7		Percentage share of terrestrial protected natural areas included in Italian Official List of Protected Areas (Euap) and Natura 2000 Network	+
	Data source	Annex of environmental data, ISPRA	
	Utilizedagricultural area	Polarity	
8		Extension of utilized agricultural area (ha)	+
	Data source	Farm Accounting data network (Italy)	
	Farms with renewable energy production	Polarity	
9		Number of farms with renewable energy production as a percentage of the total number of farms	+
	Data source	Italian Farm structure Survey (Italian National Institute of Statistics)	
	Irrigated agricultural area	Polarity	
10		Irrigated agricultural area as a percentage of Irrigable agricultural area	+
	Data source	Italian Farm structure Survey (Italian National Institute of Statistics)	
	Impact of forest fires	Polarity	
11		Burnt forest area (wooded and non-wooded) per 1,000 sq.km	-
	Data source	Equitable and sustainable well-being indicators (Italian National Institute of Statistics)	
	Concern aboutlandscapedeterioration	Polarity	
12		Proportion of population reporting, among the environmental problems for which they express more concern, the decay of landscape due to overbuilding	-
	Data source	Equitable and sustainable well-being indicators, Italian National Institute of Statistics	
	Concern for biodiversity loss	Polarity	
13		Percentage of people aged 14 and over who believe that biodiversity loss is among the five most important environmental problems on total population aged 14 and over	-
	Data source	Equitable and sustainable well-being indicators, Italian National Institute of Statistics	
Social dimension			
	Farmers agedlessthan 44	Polarity	
1		Number of farmers aged less than 44	+
	Data source	Tax return data, (Italian Ministry of economics and finance)	
	Agricultural workers	Polarity	
2		Number of agricultural workers	+
	Data source	National account data, (Italian National Institute of Statistics)	

	Women farmers	Polarità	
3		Women farmers as a percentage of total number of farmers	+
	Data source	National account data, (Italian National Institute of Statistics)	
	Women agricultural workers	Polarity	
4		Women agricultural workers s as a percentage of total agricultural workers	+
	Data source	National account data, (Italian National Institute of Statistics)	
	Irregular employment rate in agriculture	Polarity	
5		Number of irregular agricultural workers as percentageof the total agricultural workers	-
	Data source	National account data, (Italian National Institute of Statistics)	
	Farmers in disadvantaged rural areas	Polarity	
6		Number of farmers in disadvantaged rural areas as a percentage of total number of farmers	+
	Data source	Data on workers in agriculture, (Italian National Institute of providence)	
	Agritourism	Polarity	
7		Number of agritourisms	+
	Data source	Italian Farm structure Survey, (Italian National Institute of Statistics)	
	Farms with family labor force	Polarity	
8		Number of farms with family labor force as a percentage of the total	+
	Data source	Italian Farm structure Survey, (Italian National Institute of Statistics)	
	Farmers with a degree or professional agricultural training	Polarity	
9		Number of farmers with a degree or professional agricultural training as a percentage of the total number of farmers	+
	Data source	Italian Farm structure Survey, (Italian National Institute of Statistics)	
	Positive jugement on future perspectives	Polarity	
10		Percentage of people aged 14 and over which believe their personal situation will improve in the next 5 years on total population aged 14 and over.	+
	Data source	Equitable and sustainable well-being (Italian National Institute of Statistics)	
	Generalized trust	Polarity	
11		Percentage of people aged 14 and over that feel that most people are worthy of trust on the total population aged 14 and over.	+
	Data source	Equitable and sustainable well-being (Italian National Institute of Statistics)	
	Social participation	Polarity	
12		People aged 14 and over that have performed at least one social participation activity in the last 12 months on total population aged 14 and over. The activities in question are: participation in meetings of associations (cultural/recreational, ecological, civil rights, peace); participation in meetings of trade union organizations, professional or trade associations; meetings of political parties and/or performance of free activities for a party; payment of a monthly or quarterly fee for a sports club	+
	Data source	Equitable and sustainable well-being (Italian National Institute of Statistics)	
Institutional dimension			
	Public expenditures in research and technical assistance	Polarity	
1		Amount of regional public expenditure in research and technical assistance (mil. euros)	+
	Data source	Agricultural public expenditure Database(Council for research in agriculture and economics)	

	Farm support	Polarity	
2		Amount offarm support as a percentage ofagricultural value added	+
	Data source	Agricultural public expenditure Database (Council for research in agriculture and economics), national account data (Italian Institute of Statistics)	
	Long-term loans for farm investments	Polarity	
3		Amount oflong-term loans for farm investments (mil. euros)	+
	Data sources	Bank of Italy	
	Public expenditures in infrastructural services for farmers	Polarità	
4		Amount of regional public expendituresin infrastructural services for farmers (mil. euros)	+
	Data source	Agricultural public expenditure Database on (Council for research in agriculture and economics)	
	Regional public expenditures	Polarity	
5		Amount of regional public expenditure (mil.euros)	+
	Data source	Agricultural public expenditure Database (Council for research in agriculture and economics)	
	Irregularities in electric power distribution	Polarity	
6	Unit	Frequency of accidental long lasting electric power cuts (cuts without notice longer than 3 minutes) (average number per consumer).	-
	Data source	Authority for Electricity gas and water system	
	Impact of knowledge workers on employment	Polarity	
7		Percentage of employees with tertiary education (ISCED 5-6-7-8) in scientific-technological occupations (ISCO 2-3) on total employees	+
	Data source	Labour force survey, (Italian National Institute of Statistics)	
	Trust in other institutions	Polarity	
8		Average score of trust in the police and the fire brigade (on a scale from 0 to 10) expressed by people aged 14 and over	+
	Data source	Survey on Aspects of daily life (Italian National Institute of Statistics)	
	Civic and politicalparticipation	Polarity	
9		People aged 14 and over who perform at least one of the activities of civic and political participation on total population aged 14 and over. The activities in question are: The activities in question are: to speak about politics at least once a week; to inform of the facts of Italian politics at least once a week; to attend online consultation or voting on social issues (civic) or political (e.g. urban planning, sign a petition) at least once in the 3 months prior to the interview, to read and to post opinions on social or political issues on the web at least once in the 3 months preceding the interview.	+
	Data source	Survey on Aspects of daily life (Italian National Institute of Statistics)	
	Trust in other institutions	Polarity	
10		Average score of trust in the police and the fire brigade (on a scale from 0 to 10) expressed by people aged 14 and over	+
	Data source	Survey on Aspects of daily life (Italian National Institute of Statistics)	
	Composite indicator of service accessibility	Polarity	
11		Percentage of households who find very difficult to reach some basic services (pharmacy, emergency room, post office, police, municipal offices, crèches, nursery, primary and secondary school, market and supermarket).	-
	Data source	Survey on Aspects of daily life (Italian National Institute of Statistics)	

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: Fabio Gaetano Santeramo, Ilaria Russo (2021) Aspetti comportamentali della partecipazione ai programmi di assicurazione agricola agevolata nell'Italia meridionale. *Italian Review of Agricultural Economics* 76(2): 73-91. DOI: 10.36253/rea-12186

Received: November 5, 2020

Revised: March 2, 2021

Accepted: June 7, 2021

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Aspetti comportamentali della partecipazione ai programmi di assicurazione agricola agevolata nell'Italia meridionale

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Abstract. The agricultural yield is affected by several risks, main of them are not controllable by humans. For this reason, the CAP has established several interventions to help guaranteeing a stable and appropriate income to farmers. One of the main policy interventions established in the current CAP that will be in place also in the future CAP, is the subsidized crop insurance. This tool did not spread in the Central and Southern Italy as much as in the Northern Italy. Several aspects should be considered to explain such a heterogenous uptake: among them, the behavioral aspects are likely to play a role. We investigate these aspects and conclude on variables that tend to affect farmers' choices on crop insurance, with specific reference to the behavioral aspects such as risk and ambiguity attitudes and temporal preferences.

Keywords: assicurazione, agricoltura, rischio, ambiguità, preferenze temporali.
JEL codes: D81, D91, G22, Q12, Q14, Q18.

1. INTRODUZIONE

L'assicurazione agevolata è uno strumento molto interessante e particolarmente utile in ambito agricolo, dato che consentirebbe agli imprenditori di proteggersi dalle fluttuazioni di reddito cui sono storicamente esposti, a causa della notevole esposizione e vulnerabilità del settore agricolo a diverse fonti di rischio (Moschini, Hennessy, 2001; Capitanio, 2010; Severini *et al.*, 2017) quali, ad esempio, i rischi di produzione, di mercato, finanziari, istituzionali e i rischi personali.

Proprio in virtù della numerosità delle fonti di rischio e della difficoltà (o, talvolta, impossibilità) di controllare i fattori su esse influenti, la gestione del rischio aziendale sta assumendo un ruolo sempre più importante nel settore agricolo, tanto da arrivare ad occupare un posto di riguardo anche nell'ambito della Politica Agricola Comune (Santeramo, 2018; Capitanio, De Pin, 2018; Meraner, Finger, 2019; Cordier, Santeramo, 2020). A livello europeo, infatti, vige il reg. (UE) 1305/2013, con il quale si prevedono sostegni economici per diversi strumenti di gestione del rischio, quali contributi finanziari per il pagamento dei premi delle assicurazioni, a favore dei fondi di mutualizzazione ed a sostegno dello strumento di stabilizzazione del reddito.

Nel presente lavoro ci si è soffermati sulle assicurazioni agevolate (art. 37 reg. (UE) 1305/2013), focalizzandosi, in particolare, sulle determinanti della partecipazione a tali programmi. L'interesse verso questo argomento è dovuto al fatto che, nonostante lo strumento appaia vantaggioso e dovrebbe essere ritenuto appetibile dagli agricoltori, in realtà non ha suscitato particolare interesse fra quest'ultimi e, di fatto, risulta essere poco diffuso[1], cosa particolarmente accentuata nel caso italiano[2]. Inoltre, esiste una sostanziale differenza tra Nord e Sud Italia (Santeramo *et al.*, 2016): il livello di adesione ai suddetti programmi di assicurazione agevolata delle aziende meridionali risulta essere notevolmente inferiore rispetto a quello delle aziende settentrionali[3]. Al fine di implementare questo strumento e di aumentarne la diffusione, per ottenere una più efficiente allocazione delle risorse economiche, appare interessante comprendere cosa vi sia alla base del comportamento degli agricoltori in tale ambito ed indagare l'eventuale presenza di fattori determinanti l'adesione o la mancata adesione ai programmi di assicurazione agevolata (Santeramo, 2018).

Nel presente lavoro è stata considerata la situazione del Sud Italia ed è stata data particolare attenzione alle variabili comportamentali (quali attitudine al rischio, attitudine all'ambiguità e preferenze temporali), alla percezione dei rischi (aziendali, avversità atmosferiche, cambiamenti climatici) ed alla quantità e tipologie di strumenti di gestione del rischio utilizzati. In letteratura, l'attitudine al rischio è indicata tra i principali motivi influenzanti l'adesione ai programmi assicurativi (Just *et al.*, 1999; Garrido, Zilberman, 2007, Hellerstein *et al.*, 2013), oltre che altre decisioni circa la gestione aziendale (Dessart *et al.,* 2019). I dati utilizzati sono stati raccolti nell'ambito del progetto "Indagine sulle assicurazioni in agricoltura nel Sud Italia", svolto nel 2018 in collaborazione tra ISMEA ed Università degli studi di Foggia e focalizzato sul tema della gestione del rischio nell'agricoltura del Mezzogiorno. Obiettivi del progetto sono stati l'individuazione, l'analisi e la valutazione dei motivi della scarsa adesione ai programmi di assicurazione agevolata nel Sud Italia, cercando di far emergere le criticità del sistema e le opportunità per promuovere tali programmi. I dati impiegati ai fini del presente articolo sono quelli rilevati attraverso la somministrazione di un questionario ad un ampio campione di agricoltori.

2. ASPETTI NORMATIVI LEGATI ALL'ASSICURAZIONE

Nel corso degli anni, gli aspetti normativi riguardanti la gestione del rischio in agricoltura hanno subito notevoli modifiche (Goodwin, 1993) e, ad oggi, occupano un ruolo di rilievo nelle politiche europee. Infatti, a livello europeo vige il reg. (UE) 1305/2013 (artt. 36, 37, 38 e 39), modificato dal reg. (UE) 2017/2393 ("*Omnibus*"), entrato in vigore il 13 Dicembre 2017. Gli strumenti per cui sono previsti i contributi finanziari (art. 36) sono: assicurazioni del raccolto, degli animali e delle piante (art. 37), fondi di mutualizzazione (art. 38) e strumento di stabilizzazione del reddito (art. 39). Per quanto riguarda le assicurazioni del raccolto, degli animali e delle piante (art. 37 reg. (UE) 1305/2013), il sostegno viene conferito per le polizze assicurative per perdite dovute ad avversità atmosferiche, epizoozie, fitopatie, infestazioni parassitarie, emergenze ambientali ed ai provvedimenti adottati per circoscrivere fitopatie ed infestazioni parassitarie che causino la distruzione di più del 30% della produzione media annua dell'agricoltore. Con il reg. (UE) 2017/2393, l'intensità dell'aiuto per le polizze assicurative è stata aumentata dal 65% al 70% del premio, mentre la soglia di danno è stata abbassata dal 30% al 20%.

A livello nazionale, il reg. (UE) 1305/2013 è stato recepito mediante la Circolare AGEA, prot. n. ACIU 2015-305 del 02-07-2015[4] ed il Piano Assicurativo Agricolo del Ministero delle politiche agricole alimentari e forestali. Nella Circolare AGEA sono riportati i rischi assicurabili, le fonti di finanziamento, le misure del contributo e i limiti contributivi previsti per gli incentivi assicurativi, nonché gli adempimenti e i requisiti per accedere agli incentivi assicurativi, le modalità di pre-

[1] Capitanio, De Pin (2018) riportano che la domanda di assicurazione agricola è ben al di sotto di quanto atteso. In Italia, la partecipazione ai programmi assicurativi da parte degli agricoltori è intorno al 15% (Santeramo, 2018). Wright, Hewitt (1994) e Enjolras *et al.* (2012) suggeriscono che anche la possibilità da parte degli agricoltori di poter usare diversi altri strumenti per la gestione del rischio aziendale – come diversificazione colturale, credito, mercati finanziari etc. – può contribuire al non considerare la possibilità di sottoscrivere polizze assicurative.

[2] Mahul, Stutley (2010); Enjolras *et al.*, (2012); Cioffi, Capitanio (2010), European Commission (2009).

[3] Nel 2010 il 78% del valore assicurato era nel Nord Italia, il 14% al Sud ed il restante 8% al Centro (Santeramo, 2018). Questo divario è ancor più accentuato considerando il 2016: l'85,5% del valore assicurato era concentrato nel Nord Italia, l'8,6% al Centro e solamente il 5,9% al Sud (Santeramo, 2019).

[4] Ove sono riportate modalità e condizioni per l'accesso ai contributi comunitari per le assicurazioni, con riferimento alle normative vigenti nell'ambito della misura 17.1 (Gestione del Rischio) del PSRN (Programma di Sviluppo Rurale Nazionale), come previsto dal reg. (UE) 1305/2013, e nell'ambito del programma nazionale di sostegno del settore vitivinicolo – reg. (UE) 1308/2013 cui si aggiungono le preesistenti misure del Fondo di solidarietà nazionale, istituito dal d.lgs. 102/2004, e modificato dal d.lgs. 82/2008. Il d.lgs.102/2004 ha anche segnato lo spostamento delle misure nazionali a favore di strumenti per la gestione del rischio *ex-ante* (Capitanio, De Pin, 2018; Santeramo, 2018; Santeramo, 2019).

sentazione della domanda di aiuto/sostegno e la descrizione del PAI (Piano assicurativo individuale). Nel Piano assicurativo agricolo nazionale (PAAN) del Ministero delle politiche agricole alimentari e forestali, aggiornato annualmente, sono definite le produzioni vegetali, le strutture aziendali, gli allevamenti zootecnici, i rischi, le garanzie assicurabili, nonché le possibili combinazioni di coperture assicurative che coprono la mancata resa[5]. Ivi si stabilisce, inoltre, che i dati relativi alle polizze integrative non agevolate debbano essere necessariamente trasmesse al sistema di gestione del rischio[6]. A seguito del d.lgs. n. 32 del 26 marzo 2018, a partire dal 2019 tale documento è stato sostituito dal Piano di gestione dei rischi in agricoltura (PGRA), nel quale sono inseriti anche i fondi di mutualizzazione e per la stabilizzazione del reddito.

3. QUADRO DI CONTESTO E LETTERATURA DI RIFERIMENTO

In Italia, sin dall'introduzione delle polizze agevolate, si è verificato uno sbilanciamento nelle adesioni, concentrate nelle regioni del Centro-Nord, sia per quanto riguarda i valori che le superfici che il numero di aziende assicurate (Rapporto ISMEA "La gestione del rischio nell'agricoltura del Mezzogiorno", 2018). Questa discrepanza nelle adesioni è andata accentuandosi nel corso degli anni, aggravandosi ulteriormente per via delle modifiche delle strutture dei costi aziendali seguite alla crisi del 2008-2009 che ha portato a dare priorità alle spese direttamente legate all'operatività delle imprese, in particolare nel Sud del Paese. Solo nel 2018 si è verificato un aumento rispetto all'anno precedente di circa il 30% nel numero di aziende assicurate al Sud (dato che si discosta dalla media nazionale del 7,6%), probabilmente da ascrivere al cambiamento normativo introdotto con il Piano Assicurativo Agricolo Nazionale 2018 (che estende la possibilità di agevolazione anche alle polizze che coprono da rischi meteo climatici associati a due soli eventi) e all'effetto positivo della revisione della PAC apportata con il Regolamento *Omnibus* (Capitanio, De Pin, 2018). Nel Centro-Nord sono diffuse anche le polizze collettive mediate da organismi, quali consorzi e cooperative di difesa, dimostrazione della solida tradizione associativa e più agevole operatività finanziaria di questi territori. Al contrario, i territori del Sud sono penalizzati dalla specificità degli orientamenti produttivi e dalla minor propensione all'innovazione. A ciò si aggiunge uno scarso livello di percezione del rischio: circa un terzo degli agricoltori non assicurati ritiene che la sua azienda non sia esposta a particolari rischi e tende a ricorrere con maggior frequenza rispetto agli assicurati a metodi "alternativi" di gestione del rischio (quali, principalmente, le tecniche agronomiche di prevenzione dei danni alle colture). Tra i principali motivi di rinuncia di adesione alle coperture assicurative figurano motivi economici nonché le esperienze negative avute in merito occasione di perizie e risarcimenti (che sottostimano le perdite di tipo qualitativo, causando disaffezione verso il sistema assicurativo). Va evidenziato che, nonostante la stragrande maggioranza degli imprenditori agricoli conosca le assicurazioni agricole, ancora in molti non sono al corrente dei contributi pubblici esistenti per le polizze agevolate (circa i tre quarti dei non assicurati intervistati). Tra questi, il 13%, alla luce del contributo pubblico, riconsidererebbe la possibilità di sottoscrivere polizze (cosa che consentirebbe al Sud di raggiungere un tasso di adesione in linea con quello del Nord Italia).

Risulta chiaro che il mercato assicurativo in Italia è ancora lontano dall'essere pienamente sviluppato. Bryan (2010), riporta che i mercati assicurativi sono ancora mercati incompleti, il che comporta un maggior peso delle fluttuazioni di reddito degli agricoltori con conseguente riduzione del loro benessere, particolarmente accentuata per i soggetti avversi al rischio. La volatilità di reddito, infatti, non consente agli agricoltori (soprattutto se avversi al rischio) di effettuare scelte serene ed intraprendere nuovi investimenti (Mishra, Sandretto, 2002; Vrolijk, Poppe, 2008; Severini *et al*., 2017), con ulteriori ripercussioni negative sulle loro possibilità di profitto. Inoltre, i cambiamenti climatici in atto inficiano ulteriormente sulla stabilità del reddito agricolo, inasprendo ancor di più questa situazione. Nello scenario presentato, si renderà, pertanto, sempre più necessario il ricorso a strumenti di gestione del rischio *ex-ante* (tra cui proprio le polizze assicurative) che consentano, almeno in parte, di stabilizzare il reddito. Svariate fon-

[5] Dette combinazioni si esplicano nei cosiddetti Pacchetti A, B e C. Il Pacchetto A (ovvero l'ex Multirischio) offre la copertura di tutte le avversità accessorie, di frequenza e catastrofali e, quindi, fornisce una copertura totale alle colture aziendali. Il Pacchetto B, invece, consiste nella copertura di almeno una avversità di frequenza e di tutte le avversità catastrofali. Il pacchetto C, infine, include almeno tre avversità di frequenza più, eventualmente, una o entrambe le avversità accessorie. I Pacchetti B e C rappresentano le ex garanzie Pluririschio. Esiste, inoltre, un'opzione D, che prevede polizze che coprono l'insieme delle avversità catastrofali; tuttavia, i dati relativi al 2015 evidenziano una scarsa diffusione di questo tipo di Pacchetto.

[6] Il Sistema di gestione del rischio (SGR), istituito con l'articolo 11 del d.m. n. 162 del 12/01/2015, è volto a garantire l'ottemperanzadel principio del "no double funding" (no doppio finanziamento) e la mancanza di sovra compensazioni e doppi finanziamenti tramite l'interscambio dei dati assicurativi riguardanti l'OCM ed il PSRN, grazie anche all'incrocio dei dati delle polizze/certificati e dei Piani assicurativi individuali (PAI). (Fonte: "Rapporto sulla gestione del rischio in Italia", ISMEA, Gennaio 2018).

ti (Severini *et al.*, 2017; OECD, 2009; Meuwissen *et al.*, 2008; Mishra, El-Osta, 2001) indicano che la stabilizzazione del reddito è un importante problema fronteggiato dagli agricoltori che, secondo alcuni autori (Pennings, Garcia, 2001; Garderbroek, 2006; Dessart *et al.*, 2019), sono avversi al rischio, seppur con molte differenze fra i vari Paesi Europei (Rieger *et al.*, 2014). L'intervento politico in tale settore è dunque giustificato dagli effetti secondari sul settore agroalimentare derivanti dallo scarso benessere degli agricoltori. Attualmente, tuttavia, i sussidi ai premi per le assicurazioni agricole hanno come risvolto una maggiore concentrazione dei finanziamenti nel Nord Italia (aumentando la differenza nell'entità di aiuti ricevuti tra le regioni), possono celare comportamenti opportunistici (ovvero selezione avversa e azzardo morale) e favorire strategie di ricerca di rendita, oltre ad una riduzione degli investimenti in altri tipi di strategie di gestione del rischio (Santeramo, 2018). Tuttavia, Garrido e Zilberman (2007) indicano che, senza sussidi, l'assicurazione agricola non sarebbe affatto attrattiva per gli agricoltori stessi e che minori sussidi sarebbero disincentivanti per via del minor ricavo atteso edella minore varianza. Santeramo (2018 e 2019) segnala l'insostenibilità economica di maggiori sussidi al settore assicurativo agricolo oltre che un possibile effetto distorsivo sulla quantità di rischi assunti dagli agricoltori. Capitanio e De Pin (2018) evidenziano, inoltre, l'inadeguatezza delle coperture attualmente offerte come causa della scarsa efficienza delle polizze assicurative sussidiate (soprattutto nel caso di specifiche colture e territori) e che molti viticoltori nella zona DOCG Conegliano – Valdobbiadene non si assicurano, nonostante l'elevato valore delle loro produzioni suggerirebbe un comportamento contrario (2018b). Garrido e Zilberman (2007) riportano, altresì, che gli agricoltori si assicurano principalmente per essere coperti da indennità occasionali e di maggior entità piuttosto che per avere un ritorno a fronte del premio assicurativo corrisposto.

Negli anni, diversi autori si sono impegnati nell'individuazione delle principali cause della disaffezione degli agricoltori verso il sistema assicurativo e della scarsa adesione a tali programmi. Capitanio e De Pin (2018b) evidenziano come gli agricoltori siano allontanati dal sistema a causa delle complicanze burocratiche e dalla mancata aderenza delle rese assicurabili e sottolineano la predilezione degli agricoltori per garanzie per le quali hanno un'elevata percezione del rischio. Gli stessi riportano anche che i tassi medi delle polizze sono più concentrati al Sud, cosa dovuta, fra l'altro, alla predilezione degli imprenditori meridionali a tutelare le produzioni a più elevato valore aggiunto. Come suggerito da Finger (2012) e Severini *et al.* (2017), gli strumenti a disposizione delle aziende per la gestione del rischio dovrebbero essere strutturati e diversificati con maggiore attenzione alle caratteristiche ed esigenze aziendali, data la diversità dei rischi affrontati e la conseguente differente variabilità di reddito. Inoltre, secondo gli stessi autori, i pagamenti diretti fungono da stabilizzatori del reddito e, pertanto, inducono ad intraprendere attività più rischiose e un minor ricorso alle strategie di gestione del rischio, comprese quelle finanziate dalla PAC stessa, generando, così, un'inefficienza. In aggiunta, Santeramo (2019) sottolinea l'importanza dell'esperienza, sia diretta che indiretta, nel campo assicurativo, con una maggior incidenza dell'esperienza diretta: chi si è assicurato tende ad assicurarsi nuovamente. Lo stesso autore suggerisce l'implementazione di misure *ad hoc* che spingano anche le piccole aziende mai assicuratesi verso la partecipazione ai programmi assicurativi, come ipotizzato anche da Was e Kobus (2018). Giampietri *et al.* (2020) si soffermano, invece, sul ruolo delle barriere percepite e della fiducia nei confronti degli intermediari sull'intenzione di adottare le polizze agevolate, evidenziando che l'esperienza pregressa con lo strumento assicurativo agevolato contribuisce ad abbassare il livello delle barriere percepite, facilitando la comprensione del funzionamento delle polizze e la riduzione dell'avversione circa l'adozione, ipotizzando anche che la fiducia negli intermediari finanziari potrebbe funzionare come sostituto della conoscenza del sistema assicurativo.

In questo lavoro, abbiamo utilizzato le variabili considerate in letteratura, con le limitazioni imposte dal dataset disponibile, per analizzare la realtà del Centro-Sud del Paese. In particolare i fattori raccomandati in letteratura considerati sono stati: caratteristiche aziendali e del conduttore dell'azienda, presenza di altre fonti di reddito, uso di strategie di gestione del rischio diverse dall'assicurazione. Inoltre, come accennato in precedenza, particolare attenzione è stata riservata a variabili ancora non molto analizzate nella letteratura riguardante il nostro territorio (il Sud Italia), ovvero le variabili comportamentali di attitudine al rischio ed all'ambiguità, le preferenze temporali, il numero di strategie di gestione del rischio aziendale utilizzate e la percezione dei rischi aziendali, delle avversità atmosferiche e dei cambiamenti climatici. Secondo la letteratura, infatti, tra i principali motivi che inducono ad assicurarsi c'è l'avversione al rischio, oltre ai benefici attesi positivi ed il fatto che gli imprenditori traggono guadagno dall'informazione asimmetrica (Just *et al.*, 1999; Garrido, Zilberman, 2007). L'ambiguità differisce dal rischio per il fatto che non sono note le probabilità che si verifichino i possibili eventi: per i soggetti avversi all'ambiguità assume una forte importanza l'effetto che le proprie scelte han-

no sugli eventi e spesso, tali soggetti tendono a preferire delle condizioni che comportano una minore utilità attesa, ma con probabilità di vincita note rispetto a situazioni con maggiore utilità attesa ma con sconosciute probabilità degli eventi. Questa situazione è indicata come Ellsberg paradox (1961), in quanto in contrasto con la teoria della massimizzazione dell'utilità soggettiva attesa (Subjective Expected Utility – SEU) di Savage (1972). Ellsberg (1961), inoltre, ha dimostrato che nel prendere le decisioni si tende a differenziare tra le situazioni rischiose ed ambigue. Secondo diversi studi, una gran parte della popolazione preferisce conoscere la probabilità degli eventi (Bryan, 2010).

Questi aspetti sono risultati influenti sulle scelte assicurative e imprenditoriali nei contesti analizzati in lavori precedenti: è riportato in letteratura che l'attitudine al rischio e la percezione dei rischi sono dei fattori con forte influenza sulle strategie di gestione del rischio e l'uso di specifici strumenti (Pennings, Garcia, 2004; Pennings, Wansink, 2004; Gardebroek, 2006; Just & Just, 2016, Iyer *et al.*, 2020), come nel caso dell'attitudine al rischio el'adozione dei contratti "*futures*" (Pennings, Leuthold, 2000). È notorio, inoltre, che la percezione dei rischi influenza le scelte imprenditoriali (van Raaij, 1981; Slovic *et al.*, 1982): Meraner e Finger (2019) riportano che ad una più elevata percezioni dei rischi corrisponde un maggior ricorso a strumenti di gestione del rischio, Capitanio e De Pin (2018b) suggeriscono che la percezione del rischio, mutata negli ultimi anni, è fra i presupposti più interessanti per lo sviluppo di un idoneo mercato assicurativo. Tuttavia, in letteratura, tale relazione empirica risulta ambigua (Meuwissen *et al.,* (2001); Flaten *et al.,* (2005); van Winsen *et al.,* (2016)), anche perché le passate esperienze di perdita influenzano la percezione soggettiva dei rischi da parte degli agricoltori (Menapace *et al.*, 2013). La percezione del rischio, infatti, è determinata dal rischio oggettivo cui è esposto il soggetto e la soggettiva interpretazione dei rischi: di conseguenza, la percezione del rischio deriva dalla combinazione della probabilità che si verifichi un evento incerto ed il suo conseguente impatto negativo (Slovic *et al.*, 1982; Meraner, Finger, 2019). Ne scaturisce che la percezione dei rischi è un fattore del tutto soggettivo che cambia fra i vari imprenditori ed anche per lo stesso imprenditore nel tempo.

Il metodo di rilevazione dell'attitudine al rischio è un argomento molto dibattuto in letteratura. Infatti, si riscontra una forte eterogeneità nelle preferenze verso il rischio in base alle metodologie utilizzate per elicitarle (Iyer *et al.*, 2020). In questo lavoro, il metodo utilizzato è basato sulla scelta di partecipare ad una lotteria, che permette di discriminare gli individui entro un range che spazia dalla forte avversione al rischio fino alla neutralità al rischio. Questa tipologia di indagine ha trovato ampia diffusione a partire dal 2010 fino a diventare il metodo più utilizzato nel periodo 2010-2017, poiché permette di superare i limiti imposti dai metodi utilizzati in precedenza, prevalentemente basati sull'osservazioni di dati comportamentali secondari (Iyer *et al.*, 2020).

4. DATI

I dati utilizzati ai fini del presente lavoro sono stati raccolti tramite la somministrazione di un questionario nell'ambito del progetto "Indagine sulle assicurazioni in agricoltura nel Sud Italia" svolto in collaborazione tra l'Istituto di Servizi per il Mercato Agricolo Alimentare (ISMEA) ed il Dipartimento SAFE dell'Università di Foggia[7]. Il progetto ha previsto, oltre alla somministrazione del suddetto questionario con metodologia CATI, ulteriori fasi, ovvero due *wave* di *focus group*[8], indagini *face-to-face*[9], redazione e stampa di un rapporto finale[10]. Il progetto si è focalizzato sul tema della gestione del rischio in agricoltura nel Sud Italia, soffermandosi sulle caratteristiche ed i comportamenti dei conduttori delle aziende, sia assicurate che non assicurate, sulla percezione dei rischi connessi all'attività agricola e sulla conoscenza degli strumenti di gestione del rischio e assicurativi. L'obiettivo dell'indagine svolta tramite il questionario è stato quello di individuare, analizzare e valutare i motivi della scarsa diffusione degli strumenti assicurativi agevolati in agricoltura, cercando di evidenziare le criticità del sistema e le opportunità per promuovere lo sviluppo di tale mercato nel Mezzogiorno di Italia.

4.1. Campionamento

Il questionario sopracitato è stato somministrato con tecnica CATI (*Computer-Assisted Telephone Interviewing*) tra aprile e luglio 2018 ad un ampio campione di aziende agricole del Sud Italia (oltre 2000), selezionate grazie ad uno schema di campionamento casuale stratificato territorialmente[11] ed in base all'orientamento pro-

[7] Dipartimento di Scienze Agrarie, degli Alimenti e dell'Ambiente, oggi Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria – DAFNE.

[8] Coinvolgendo agricoltori, responsabili dei centri di assistenza agricola e dei consorzi di difesa, rappresentanti di compagnie assicurative, associazioni dei produttori e periti.

[9] Con circa 60 interviste agli *stakeholder*.

[10] "La gestione del rischio nell'agricoltura del Mezzogiorno", dicembre 2018.

[11] In base alla distribuzione regionale delle aziende agricole italiane, pubblicata nell'indagine ISTAT infracensuaria SPA 2013 (Struttura e

duttivo dell'azienda (in proporzione all'incidenza della PPB)[12] in modo da essere il più possibile rappresentativo della reale situazione del momento. Sono state coinvolte aziende appartenenti alle otto regioni del Sud Italia e delle Isole (Abruzzo, Basilicata, Campania, Calabria, Molise, Puglia, Sardegna, Sicilia). Il campione è stato poi calibrato anche in base alle specificità del mercato assicurativo di ogni realtà esaminata[13]. In seguito, i suddetti campioni stratificati sono stati incrociati ponderalmente.

Per evitare problemi di *small sample*, è stato inserito un criterio per garantire una minima grandezza campionaria per settore produttivo regionale pari a 30 unità[14]. Infine, sono stati effettuati ulteriori assestamenti per raggiungere il tetto minimo di interviste previste dal progetto iniziale e per assicurare la copertura territoriale ed alcuni ulteriori aggiustamenti *in itinere* dovuti all'operatività della somministrazione. Il campione finale di aziende era costituito dal 69% di aziende non assicurate ed il restante 31% di aziende assicurate.

4.2. Questionario

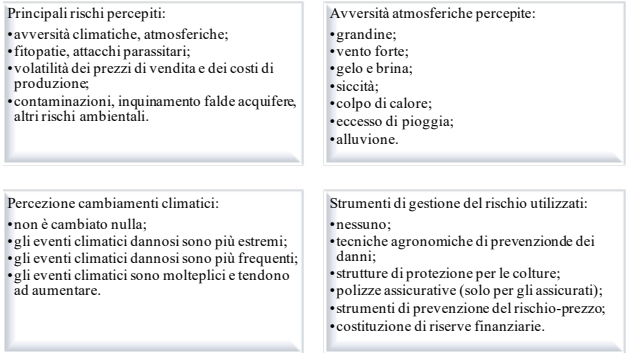
Il questionario precedentemente citato è strutturato in diverse sezioni e distinto per assicurati o ex assicurati e non assicurati. In particolare, il questionario siarticola in 6 sezioni per gli assicurati e 4 sezioni per i non assicurati, quali: «sezione anagrafica», «sezione percezione dei rischi e strumenti di prevenzione», «sezione polizze assicurative» (con domande distinte tra assicurati ed ex assicurati e non assicurati), «sezione strumenti innovativi» (solo per gli assicurati), «sezione suggerimenti e comportamenti futuri» (solo per gli assicurati) e «sezione attitudine al rischio». Criteri di inclusione sono stati un'estensione aziendale minima pari a 0,5 ettari ed un fatturato minimo di 5.000 € annui. Seguono maggiori specificazioni circa le sezioni riguardanti la raccolta dei dati principalmente analizzati nel presente lavoro (ovvero, sezioni «anagrafica», «percezione dei rischi e strumenti di prevenzione», «attitudine al rischio»).

La «sezione anagrafica» è volta all'acquisizione di informazioni circa l'azienda (irrigazione, diversificazione colturale, estensione in ettari, forma giuridica, produzione prevalente, utilizzo di marchi di qualità, classe di fatturato annuo), il suo conduttore (età, livello istruzione), la diversificazione del reddito con attività connesse o meno all'attività agricola e le eventuali attività connesse. Nella «sezione percezione dei rischi e strumenti di prevenzione» sono stati indagati i principali rischi connessi all'attività aziendale, le avversità atmosferiche e le fitopatie percepite come più rischiose, i principali strumenti di gestione del rischio adottati dall'azienda nei cinque anni precedenti l'intervista e l'effetto più recente dei cambiamenti climatici riscontrato con l'esperienza. Nello specifico, è stato chiesto agli intervistati di indicare un massimo di tre preferenze tra le opzioni proposte per ogni domanda (Fig. 1).

Infine, nella «sezione attitudine al rischio», sono state poste domande al fine di rilevare l'attitudine al rischio, all'ambiguità e le preferenze temporali degli agricoltori. Per testare l'attitudine al rischio si è chiesto ai soggetti di scegliere tra la riscossione di una somma sicura (via via decrescente, da 1000 € a 200 €) e la partecipazione ad una lotteria con il 50% di probabilità di vincere 2000 €, mentre per l'attitudine verso l'ambiguità si è posto il soggetto di fronte ad una scelta simile alla precedente, ma con una probabilità di vittoria ignota (Fig. 2). Per investigare le preferenze temporali, invece, è stato chiesto di scegliere inizialmente tra la riscossione di 1000 € sul momento o di una somma (progressivamente crescente, dai 1000 € ai 3000 €) dopo un anno e successivamente tra la riscossione di 1000 € dopo un anno o di una somma (gradualmente crescente, dai 1000 € ai 3000 €) dopo due anni (Fig. 3).

Lo scopo ultimo delle analisi è stato quello di avere un riscontro sugli eventuali fattori alla base delle deci-

Fig. 1. Opzioni di scelta per la rilevazione delle percezioni dei rischi aziendali, delle avversità atmosferiche e dei cambiamenti climatici e per la quantificazione delle strategie di gestione del rischio aziendale utilizzate nei cinque anni precedenti l'intervista.



Nota: in tutti questi casi, era consentito un massimo di tre risposte.
Fonte: elaborazioni personali su questionario somministrato.

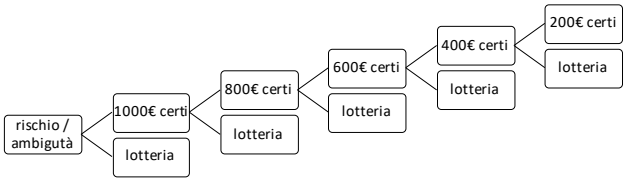
produzioni delle aziende agricole), ovvero la più recente al momento della definizione del disegno campionario.

[12] PPB: Produzione ai prezzi di base, calcolata dall'ISTAT nel 2015, in base alla disponibilità di dati assicurativi consolidati presenti nel sistema SGR/SIAN (Sistema di Gestione del Rischio – Sistema Informativo Agricolo Nazionale).

[13] Grazie ai dati del 2015 presenti nel Sistema di Gestione del Rischio – SGR/SIAN, considerando l'incidenza dei valori assicurati.

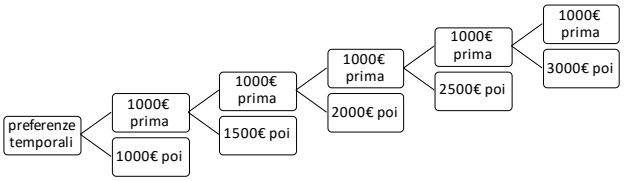
[14] Questo per assicurare la significatività statistica agli esiti delle interviste stesse. Il dato è stato azzerato se il numero di interviste assegnate dal modello risultava essere inferiore a 20, portato a 30 se era compreso tra 20 e 30 e conservato se maggiore di 30.

Fig. 2. Modalità per l'elicitazione delle informazioni relative all'atteggiamento verso rischio e ambiguità.



Nota: la figura mostra la modalità con cui sono state elicitate le preferenze degli intervistati circa l'attitudine al rischio ed all'ambiguità. Come è possibile osservare, in entrambi i casi, l'esperimento si interrompeva nel momento in cui l'intervistato sceglieva di partecipare alla lotteria rinunciando alla riscossione della somma sicura (via via decrescente). La differenza fra rischio e ambiguità sta nella strutturazione della lotteria. Nel primo caso (attitudine al rischio), la lotteria era costituita dal lancio di una moneta con vincita di 2000 € in caso uscisse testa (quindi, una lotteria con il 50% di possibilità di vittoria di 2000 €). Nel secondo caso (attitudine all'ambiguità), invece, la lotteria consisteva nell'estrazione di una pallina da un sacchetto contenente 10 palline bianche e nere, con vittoria di 2000 € in caso di estrazione di una pallina bianca, ma senza sapere in quale percentuale le palline bianche e nere fossero presenti nel sacchetto (quindi, una lotteria con ignota probabilità di vittoria di 2000 €).
Fonte: elaborazioni proprie su questionario somministrato.

Fig. 3. Modalità per l'elicitazione delle informazioni relative alle preferenze temporali.



Nota: la figura mostra la modalità con la quale sono state elicitate le preferenze temporali degli intervistati. A tal fine, i soggetti sono stati posti di fronte a due tipologie di scelta: in entrambi i casi si chiedeva di scegliere tra la ricezione di 1000 € in un momento più vicino nel tempo o la ricezione di una cifra via via crescente in un momento più lontano. Come è possibile osservare, in entrambi i casi, l'esperimento si interrompeva nel momento in cui l'intervistato sceglieva di aspettare il momento più lontano nel tempo, rinunciando alla riscossione dei 1000 € più immediati. La differenza fra l'impazienza di uno e due anni sta nelle tempistiche. Nel primo caso (impazienza di un anno), la scelta era fra la riscossione di 1000 € sul momento o la cifra man mano crescente dopo un anno, mentre, nel secondo caso (impazienza di due anni), la scelta era fra la riscossione di 1000 € dopo un anno o una cifra (via via crescente) dopo due anni.
Fonte: elaborazioni proprie su questionario somministrato.

sioni degli agricoltori nell'ambito della partecipazione a programmi di assicurazione agevolata. Sono stati, dunque, calcolati e definiti dei coefficienti per stimare il grado di avversione al rischio e ambiguità,di impazienza e di percezione del rischio, come di seguito riportato.

5. METODOLOGIA

Per valutare l'attitudine al rischio ed all'ambiguità, sono stati inizialmente definiti gli equivalenti certi (CE_r per il rischio, ovvero nel caso di lotteria con percentuale di vittoria nota pari al 50%, e CE_a per l'ambiguità, ovvero lotteria con percentuale di vittoria ignota), calcolati come la media tra la minima somma sicura accettata (m_{ssa}) e la massima rinuncia (M_r) per partecipare alla lotteria:

$$CE = \frac{m_{ssa} + M_r}{2} \quad (1)$$

Fanno eccezione, però, gli estremi, ovvero i casi in cui è stato scelto da subito di lanciare la moneta anziché accettare la somma sicura e quelli che, al contrario, hanno sempre preferito riscuotere la somma sicura. In questi due casi, non potendo calcolare l'equivalente certo come media (non conoscendo il valore della somma sicura che avrebbero accettato preferendola alla lotteria nel primo caso e, nel secondo caso, la cifra che li avrebbe spinti a partecipare alla lotteria.), si è deciso di rispettare la differenza di 200 € che si verificava per tutti gli altri casi. In entrambi i casi (CE_r e CE_a), l'equivalente certo rappresenta la cifra che rende l'individuo indifferente tra la partecipazione alla lotteria e la sicura riscossione di una determinata somma e, di conseguenza, la soglia che lo spinge a cambiare il suo comportamento. In base ai risultati ottenuti, è stato possibile definire l'attitudine degli intervistati nei confronti del rischio: è stato considerato avverso al rischio chiunque avesse un CE_r< di 1100 € (dunque, ≤ 900 €) e presumibilmente neutrale o propenso al rischio la restante parte (ovvero con un CE_r pari a 1100 €).

Successivamente, grazie agli equivalenti certi, sono stati calcolati i coefficienti di avversione al rischio (*r*) e di avversione all'ambiguità (*a*) con le seguenti formule (Sutter *et al.*, 2013; Coletta *et al.*, 2018):

$$r = 1 - \frac{CE_r}{\pi} \quad (2)$$

$$a = \frac{CE_r - CE_a}{CE_r + CE_a} \quad (3)$$

dove π rappresenta la massima riscossione sicura possibile, nonché l'utilità attesa (ovvero il valore atteso) della lotteria. In base ai coefficienti così computati, sono stati definiti avversi all'ambiguità gli aventi un coefficiente *a* maggiore di zero e propensi all'ambiguità quelli con coefficiente *a* minore di 0. Il coefficiente *r*, invece, è stato utilizzato ai fini della caratterizzazione del campione in merito al livello di avversione al rischio.

In seguito, sono state valutate le preferenze temporali degli intervistati. Sono, dunque, stati calcolati gli equivalenti futuri di un anno (fe_{1anno}) e due anni (fe_{2anni}) come media tra la massima rinuncia di riscossione futura (M_{rf}) per accettare 1000 € nel momento più vicino nel tempo e la più bassa cifra accettata dopo il maggior tempo (m_{af}) rinunciando ai 1000 € più immediati.

$$fe = \frac{M_{rf} + m_{af}}{2} \quad (4)$$

Anche in questo caso, come per il CE_r e per il CE_a, fanno eccezione i due casi estremi: infatti, non potendo fare una media, si è nuovamente deciso di rispettare l'andamento verificatosi in tutti gli altri casi (ovvero, una differenza di 500 € tra le osservazioni in sequenza). Sono stati, dunque, definiti impazienti tutti quelli con equivalente futuro maggiore di 750 € e sono stati calcolati i coefficienti di impazienza di un anno ($imp_{coeff1anno}$) e due anni ($imp_{coeff2anni}$) con le formule che seguono:

$$imp_{coeff_{1anno}} = \frac{fe_{1anno} - 750}{3250 - 750} \quad (5)$$

$$imp_{coeff_{2anni}} = \frac{fe_{2anni} - 750}{3250 - 750} \quad (6)$$

dove 750 e 3250 rappresentano il minimo ed il massimo equivalente futuro possibili.

In seguito sono state definite le variabili riguardanti la percezione dei rischi al fine di comprendere se e quanti rischi siano effettivamente percepiti degli agricoltori. Per rilevare l'eventuale presenza di una particolare sensibilità degli imprenditori verso tali eventi, si è posta attenzione sia alla percezione in sé di tali fattori, che alla quantità di rischi, avversità atmosferiche e cambiamenti climatici percepiti. Le variabili «percezione dei rischi» (da qui "PercRisk"), «percezione avversità atmosferiche» ("PercAvvAtm") e «percezione cambiamenti climatici» ("PercCambClim") mirano ad individuare se l'intervistato percepisce almeno una delle avversità proposte e possono assumere valore di 0 (in caso non ne percepisca nessuna) o di 1 (in caso abbia dichiarato di percepirne almeno una); mentre le variabili «numero di rischi percepiti» ("NumRiskPerc"), «numero avversità atmosferiche percepite» ("NumAvvAtmPerc") e «numero cambiamenti climatici percepiti» ("NumCambClimPerc") sono state ottenute come somma delle dummy delle singole opzioni proposte, possono assumere valori da 0 a 3 (a causa dell'impostazione del questionario, che consentiva di indicare al massimo tre delle opzioni proposte) e sono tanto maggiori quante più opzioni sono state indicate dall'intervistato. Analoghe considerazioni (con le opportune modificazioni circa l'oggetto delle variabili) sono state fatte per le variabili: «strategie di gestione del rischio» ("StratGestRisk") e «numero di strategie di gestione del rischio» ("NumStratGestRisk").

6. STATISTICHE DESCRITTIVE E ANALISI PRELIMINARI

Come riportato nella Tabella 1, il campione analizzato è costituito prevalentemente da aziende di piccole dimensioni, con un fatturato annuo inferiore ai 15000 €, che non utilizzano marchi di qualità, gestite quasi esclusivamente da conduttori di età superiore ai 40 anni, di sesso maschile, con livello di istruzione inferiore alla laurea. Il 43% del campione non attua strategie di diversificazione del reddito, mentre il 47% lo diversifica solo con attività connesse a quella agricola. Più della metà delle aziende considerate è dotata di impianti di irrigazione e poco meno della metà è in regime di monocoltura. In linea con la reale proporzione di aziende che hanno provato ad assicurarsi e mai assicuratesi, come previsto dalla strutturazione del campione, la maggior parte delle aziende intervistate non si è mai assicurata, mentre circa la metà della restante parte era ancora assicurata al momento dell'intervista. Il nostro campione è, dunque, in linea con quanto riportato in letteratura circa alcuni degli aspetti caratteristici delle aziende italiane, come l'essere di piccole dimensioni e la tendenza ad essere non assicurate, mentre si discosta circa la prevalenza di aziende non irrigue (Santeramo, 2018). Tuttavia, quest'ultimo dato non sorprende, in quanto il nostro campione è composto da aziende del Centro-Sud del Paese, notoriamente caratterizzato da minori disponibilità idriche che rendono pressoché indispensabile il ricorso all'irrigazione.

6.1. Variabili comportamentali e coefficienti corrispondenti

Come specificato nella Tabella 2a, circa i tre quarti del campione risultano essere avversi al rischio, solo il 9,6% avverso all'ambiguità ed il 9,8% propenso all'ambiguità, dunque la maggioranza dei soggetti coinvolti è neutrale all'ambiguità, diversamente da quanto presente in Bryan (2010), ossia che gli imprenditori agricoli sono prevalentemente avversi all'ambiguità. Circa la totalità del campione è impaziente sia nell'anno che nei due anni.

Nelle Tabelle 2b e 2c, invece, sono riportati gli andamenti dei coefficienti di avversione al rischio (*r*), all'ambiguità (*a*), e delle preferenze temporali. Poco più di un terzo del campione presenta il massimo valore di *r*, mentre un quarto il minimo (che è indice di neutralità o propensione al rischio, che, nel presente lavoro,

Tab. 1. Statistiche descrittive del campione.

Variabile	Classe di appartenenza	Frequenza	%
Età conduttore	< 30 anni	39	*1,9*
	30-39 anni	149	*7,3*
	40-55 anni	667	*32,5*
	56-65 anni	567	*27,6*
	> 65 anni	632	*30,8*
Sesso conduttore	Uomo	1479	*71,8*
	Donna	580	*28,2*
Istruzione conduttore	Elementare	291	*14,2*
	Media inferiore	615	*30,0*
	Media superiore	828	*40,4*
	Laurea	308	*15,0*
	Post-laurea	6	*0,3*
Estensione azienda	< 5 ha	776	*38,1*
	Tra 5 e 10 ha	613	*30,1*
	> 10 fino a 30 ha	425	*20,9*
	> 30 fino a 50 ha	115	*5,7*
	> 50 fino a 100 ha	69	*3,4*
	> 100 ha	38	*1,9*
Fatturato aziendale annuo	< 15000 €	1292	*65,9*
	15000-50000 €	448	*22,9*
	50001-100000€	107	*5,5*
	100001-250000€	63	*3,2*
	250001-500000€	17	*0,9*
	> 500000€	33	*1,7*
Marchi di qualità	No	1289	*62,6*
	Si	771	*37,4*
Diversificazione reddito	No	870	*42,5*
	Solo con attività connesse	963	*47,0*
	Sia con attività connesse che non	187	*9,1*
	Solo con attività non connesse	29	*1,4*
Azienda irrigua	No	896	*43,5*
	Si	1164	*56,5*
Azienda monocolturale	No	1115	*54,1*
	Si	945	*45,9*
Azienda Ass/ exAss[1]	No	1423	*69,1*
	Si	637	*30,9*
Azienda assicurata[2]	No	308	*49,1*
	Si	319	*50,9*

Note: [1] azienda che ha provato l'assicurazione; assicurata o ex assicurata al momento dell'intervista. [2] azienda assicurata al momento dell'intervista, sottogruppo di "Azienda Ass/exAss".
Fonte: elaborazioni proprie su dati raccolti con il questionario.

Tab, 2a, Variabili comportamentali: avversi al rischio, avversi all'ambiguità e preferenze temporali.

Variabile	Frequenza	%
Avversione al rischio	1520	*74,9*
Avversione all'ambiguità	194	*9,6*
Impazienza 1 anno	1924	*94,8*
Impazienza 2 anni	1931	*95,2*

Fonte: elaborazioni proprie su dati raccolti con il questionario.

Tab. 2b. Variabili comportamentali: coefficienti di avversione al rischio, avversione all'ambiguità e preferenze temporali.

Coefficiente	Interpretazione	Frequenza	%
r	Non avversione[1]	509	*25,1*
	Media avversione[2]	821	*40,5*
	Forte avversione[3]	699	*34,5*
a	Forte propensione[4]	25	*1,2*
	Propensione[5]	174	*8,4*
	Neutralità[6]	1636	*80,6*
	Avversione[7]	142	*7,0*
	Forte avversione[8]	52	*2,6*
$imp_{coeff1anno}$	Non impazienza[9]	105	*5,2*
	Impazienza[10]	1043	*51,4*
	Forte impazienza[11]	881	*43,4*
$imp_{coeff2anni}$	Non impazienza[9]	98	*4,8*
	Impazienza[10]	903	*44,5*
	Forte impazienza[11]	1028	*50,7*

Note: [1] $r = -0,1$; [2] $-0,1 < r < 0,9$; [3] $r = 0,9$; [4] $a \leq -0,4$; [5] $-0,4 < a < 0$; [6] $a = 0$; [7] $0 > a > 0,4$; [8] $a > 0,4$; [9] $i = 0$; [10] $0 < i < 0,6$; [11] $i \geq 0,6$.
Fonte: elaborazioni proprie su dati raccolti con il questionario.

Tab. 2c. Variabili comportamentali.

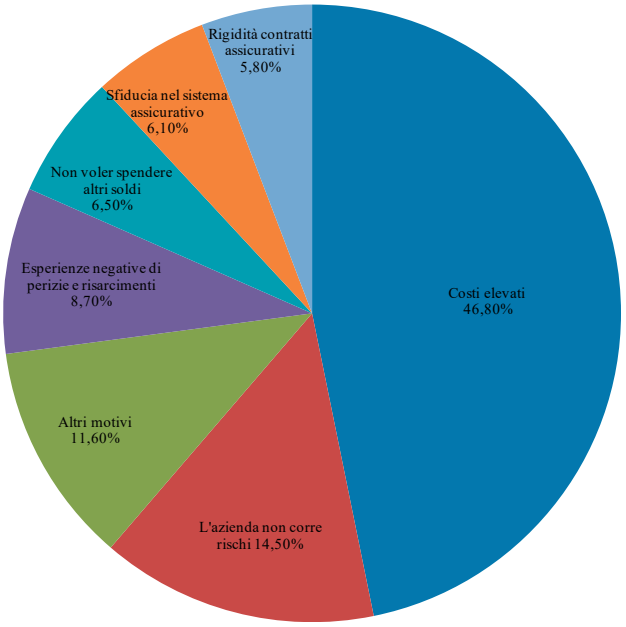
Variable	Mean	Std,Dev,	Min	Max
CE_r	565,75	403,1	100	1100
r	0,43	0,4	-0,1	0,9
CE_a	562,79	405,5	100	1100
a	0,01	0,2	-0,8	0,8
$fe_{1\ anno}$	2090,07	848,2	750	3250
$imp_{coeff\ 1\ anno}$	0,54	0,3	0	1
$fe_{2\ anni}$	2218,95	866,3	750	3250
$imp_{coeff\ 2\ anni}$	0,59	0,4	0	1

Nota: numero di osservazioni = 2029.
Fonte: elaborazioni proprie su dati raccolti con il questionario.

non è stato possibile discernere a causa della strutturazione delle interviste). I valori del coefficiente *a* indicano che l'81% del campione risulta neutrale all'ambiguità, l'1% fortemente propenso all'ambiguità ed il 2,6% fortemente avverso all'ambiguità. Infine, il 43% del campione presenta una forte impazienza di un anno, mentre una porzione maggiore ha una forte impazienza nei due anni.

Nonostante la maggioranza del campione presenti avversione al rischio, lo strumento assicurativo risulta essere poco utilizzato. Iyer *et al.* (2020) segnalano la necessità di considerare, ai fini della valutazione delle scelte degli agricoltori, anche l'eterogeneità del loro livello di avversione al rischio. Dunque, si potrebbe ipotizzare che ad assicurarsi siano solo gli individui con valori più elevati di avversione al rischio, come suggerito anche in letteratura da Meraner e Finger (2019) e Gardebroek (2006). Infatti, fra gli intervistati sono 637 quelli che hanno provato le assicurazioni agricole e 699 sono quelli con il valore massimo del coefficiente di avversione al rischio riscontrato. Inoltre, spesso non è sicuro che l'assicurazione copra i danni verificatisi e si potrebbe finire col non risultare idonei al risarcimento in fase di perizia. Ciò potrebbe essere considerato dagli imprenditori come un ulteriore rischio che rende il ricorso allo strumento assicurativo non vantaggioso. Una forte influenza su questo risultato potrebbe essere ascritta anche all'impazienza dei soggetti: la maggior parte di loro sono, infatti, impazienti o fortemente impazienti e, pertanto, non sono disposti ad aspettare i lunghi tempi burocratici richiesti per l'erogazione dei risarcimenti e dei contributi finanziari previsti per il premio assicurativo. Ciò risulta in accordo con quanto riscontrato da Capitanio e De Pin (2018b) circa l'effetto negativo delle tempistiche di erogazione dei contributi, soprattutto nel caso di piccole aziende non associate a consorzi di difesa (come quelle del Sud Italia). A supporto di quanto ipotizzato fin ora, circa il 9% di chi non si assicura più ha motivato la scelta con le esperienze negative avute in occasione di perizie e risarcimenti, circa il 6% con l'eccessiva rigidità dei contratti assicurativi in merito alle date di copertura e i rischi non percepiti, il 14,5% con l'assenza di rischi aziendali tali da ricorrere all'assicurazione, mentre la maggior parte degli intervistati (47%) ha indicato l'elevato costo dei contratti assicurativi come disincentivante, conformemente a quanto riportato da Garrido e Zilberman (2007), ossia che, in generale, le assicurazioni sono considerate uno strumento costoso, e a quanto descritto nel rapporto ISMEA 2018 «La gestione del rischio nell'agricoltura del Mezzogiorno» (Fig. 4).

Fig. 4. Percentuali motivi della disaffezione nei confronti del sistema assicurativo, aziende ex assicurate.



Fonte: adattamento su dati ISMEA.

6.2. Strumenti di gestione del rischio, percezione di rischi, avversità atmosferiche e cambiamenti climatici

Per quanto riguarda gli strumenti di gestione del rischio (Tab. 3), più di un terzo degli intervistati ha dichiarato di non usarne nessuno e meno dell'1% ne usa 3. Poco più di un quarto del campione non percepisce nessun rischio connesso all'attività agricola tra quelli proposti, mentre, tra quelli che ne percepiscono, la maggior parte ne ha indicato solo uno. Le avversità atmosferiche sono percepite da circa tre quarti del campione, di cui la maggior parte ne percepisce solo una. Quasi tutti gli intervistati hanno ammesso di percepire i cambiamenti climatici e, analogamente ai casi sopracitati, la maggioranza ne ha indicato solo uno.

Dunque, a fronte di un'alta percezione di rischi, avversità atmosferiche e cambiamenti climatici, non corrisponde un altrettanto alto ricorso a strategie di gestione del rischio: infatti, in media, circa il 10-11% del campione, pur percependo almeno uno di questi fattori che inficiano la produzione, non applica strategie di gestione del rischio. Questa situazione risulta ancor più evidente se rapportata alle assicurazioni agricole. In tal caso, solo meno di un terzo degli intervistati ha sperimentato lo strumento assicurativo e, tra questi, solo poco più della metà era ancora assicurata al momento dell'intervista (ne deriva che solo un sesto del campione complessivo era assicurato al momento dell'intervista). Stando ai dati raccolti, in media, tra coloro che percepiscono almeno un rischio circa il 69% non ha mai fatto ricorso allo strumento assicurativo e circa il 15% non se ne avvantaggia più. Analoghi riscontri si hanno considerando la percezione delle avversità atmosferiche e deicambiamenti climatici.

Tab. 3. Percezioni e gestione del rischio.

Variabile	Classe di appartenenza	Frequenza	%
sGdR[1]	Si	1307	*64,6*
nsGdR[2]	1	1007	*49,8*
	2	282	*13,9*
	3	18	*0,9*
pR[3]	Si	2039	*73,1*
nRp[4]	1	910	*32,6*
	2	730	*26,2*
	3	399	*14,3*
pAvvAtm[5]	Si	2016	*72,3*
nAvvAtmp[6]	1	1083	*38,9*
	2	716	*25,7*
	3	217	*7,8*
pCC[7]	Si	1667	*82,9*
nCCp[8]	1	1442	*71,7*
	2	210	*10,4*
	3	15	*0,8*

Note: [1] strategie gestione del rischio; [2] Numero di strategie gestione del rischio utilizzate nei cinque anni precedenti l'intervista; [3] Percezione rischi; [4] Numero di rischi percepiti; [5] Percezione avversità atmosferiche; [6] Numero di avversità atmosferiche percepite; [7] Percezione cambiamenti climatici; [8] Numero di cambiamenti climatici percepiti.
Fonte: elaborazioni proprie su dati raccolti con il questionario.

Tab. 4. Confronto assicurati/ex-assicurati e non assicurati.

Variabile	Ass/exAss[1]			MaiAss[2]		
	Classe di appartenenza	Frequenza	%	Classe di appartenenza	Frequenza	%
sGdR[3]	Si	465	*74,6*	Si	842	*60,1*
nsGdR[4]	1	300	*48,2*	1	707	*50,5*
	2	148	*23,8*	2	134	*9,6*
	3	17	*2,7*	3	1	*0,1*
pR[5]	Si	628	*98,6*	Si	1411	*99,2*
nRp[6]	1	259	*40,7*	1	651	*45,8*
	2	221	*34,7*	2	509	*35,8*
	3	148	*23,2*	3	251	*17,6*
pAvvAtm[7]	Si	625	*98,1*	Si	1391	*97,8*
nAvvAtmp[8]	1	297	*46,6*	1	786	*55,2*
	2	248	*38,9*	2	468	*32,9*
	3	80	*12,6*	3	137	*9,6*
pCC[9]	Si	516	*83,1*	Si	1151	*82,8*
nCCp[10]	1	443	*71,3*	1	999	*71,8*
	2	68	*11,0*	2	142	*10,2*
	3	5	*0,8*	3	10	*0,7*

Note: [1] azienda che ha provato l'assicurazione; assicurata o ex assicurata al momento dell'intervista; [2] azienda che non ha mai provato l'assicurazione; [3] strategie gestione del rischio; [4] Numero di strategie gestione del rischio utilizzate nei cinque anni precedenti l'intervista; [5] Percezione rischi; [6] Numero di rischi percepiti; [7] Percezione avversità atmosferiche; [8] Numero di avversità atmosferiche percepite; [9] Percezione cambiamenti climatici; [10] Numero di cambiamenti climatici percepiti.
Fonte: elaborazioni proprie su dati raccolti con il questionario.

6.3. Confronto tra assicurati / ex assicurati e mai assicurati rispetto al ricorso alle strategie di gestione del rischio

Tra gli assicurati/ex-assicurati (da ora "Ass/ExAss"), circa i tre quarti hanno dichiarato di aver utilizzato almeno una strategia di gestione del rischio (Tab. 4), valore superiore rispetto al 60% dei mai assicurati ("MaiAss"). Tra i MaiAss risulta inferiore anche il ricorso a più di una strategia di gestione del rischio, pari a meno del 10% a fronte del 26,5% registrato per gli Ass/ExAss.

In generale, non si rilevano differenze tra Ass/ExAsse MaiAss riguardo la percezione di almeno un rischio (individuato da quasi tutti in entrambi i casi). Lievemente differenti sono le percentuali di chi percepisce solo uno, due o tre rischi: un solo rischio è stato indicato dal 41% degli Ass/ExAss e dal 46% dei MaiAss, due rischi dal 35% degli Ass/ExAsse dal 36% dei MaiAsse tre rischi dal 23% degli Ass/ExAsse dal 18% MaiAss.

Analogamente, non c'è una sostanziale differenza tra Ass/ExAsse MaiAss riguardo la percezione di almeno un'avversità atmosferica (anche in questo caso, percepita da quasi tutti gli imprenditori). Tra i MaiAss, più della metà ha dichiarato di percepire solo un'avversità atmosferica, un terzo ne ha indicate due e solo il 10% ne ha indicate tre. Questi valori sono lievemente diversi nel caso degli Ass/ExAss: la percentuale di chi ha individuato solo un'avversità atmosferica è inferiore, mentre sono di più quelli che hanno indicato due o tre avversità.

Anche nel caso della percezione di almeno un cambiamento climatico, i sottocampioni Ass/ExAsse MaiAss registrano percentuali simili, corrispondenti alla stragrande maggioranza dei soggetti coinvolti. Per quanto riguarda il numero dei cambiamenti climatici percepiti, invece, i due sottocampioni risultano del tutto omogenei.

Nel complesso, dunque, si può ipotizzare una maggiore sensibilità o attenzione degli Ass/ExAss rispetto ai rischi ed alle avversità atmosferiche: infatti, tali soggetti percepiscono in media più rischi ed avversità rispetto ai MaiAss. Di conseguenza, il maggior livello di minaccia percepito potrebbe spingerli a comportarsi diversamente, cercando di attuare diverse strategie per gestire il rischio, compreso il ricorso all'assicurazione, avvalorando l'ipotesi che la percezione dei soggetti rispetto ai rischi ed alle avversità giochi un ruolo del tutto rilevante ai fini delle scelte imprenditoriali.

7. ANALISI ECONOMETRIA

L'analisi mira a comprendere come le caratteristiche aziendali e del conduttore dell'azienda[15], le variabili comportamentali[16], e la percezione dei rischi[17] siano correlate con l'adesione a programmi assicurativi agricoli e con il numero di strategie di gestione del rischioutilizzate dagli agricoltori nei cinque anni precedenti l'intervista ("NumStratGestRisk"). Sono stati esaminati sia il campione generale che i sottocampioni Ass/ExAss e MaiAss.

7.1. Adesione a programmi di assicurazione

La sottoscrizione di polizze assicurative (Tab. 5) risulta essere correlata positivamente con l'EstAz sia per quanto riguarda l'essersi assicurati in generale (Ass/exAss), sia l'essere assicurati al momento della partecipazione all'indagine (AzAss), come riportato anche da studi precedenti (Goodwin, 1993; Capitanio, 2010; Enjolras, Sentis, 2011; Enjolras *et al.*, 2012; Santeramo *et al.*, 2016; Santeramo, 2018 e 2019). È risaputo che l'estensione aziendale è collegata al livello dei rischi affrontati (con particolare riferimento al rischio di reddito-Barry *et al.*, 2001; Mishra, El-Osta, 2001; Vrolijk, 2006), oltre che alla sua efficienza e capacità di fronteggiare tali rischi. Secondo Severini *et al.* (2017), le aziende più grandi hanno maggiore efficienza (dovuta alla presenza di economie di scala) e maggior capacità di contrastare gli eventi estremi e in Italia, generalmente, sono le piccole aziende a non assicurarsi (in linea con quanto riscontrato nel nostro campione). Vrolijk *et al.* (2006) riportano che le aziende più grandi subiscono più importanti fluttuazioni di reddito, mentre, secondo Finger (2012) e Severini *et al.* (2017), il rischio di produzione e di reddito aziendale sono inferiori per le aziende di maggiori dimensioni. Quest'ultima relazione potrebbe sembrare in contrasto con la maggiore tendenza delle aziende più estese ad assicurarsi (dato che, in teoria, si assicurano le attività esposte a più rischi), a meno che non si consideri che l'assicurazione, in quanto uno dei molteplici strumenti di gestione del rischio utilizzati, è fra le cause della minore variabilità di reddito di tali aziende contribuendo al contenimento della vulnerabilità di questa tipologia di aziende agli eventi rischiosi[18]. Ne deriva che non ci si dovrebbe stupire se le aziende di maggiori dimensioni e con minore rischio di reddito si assicurano, poiché tale minore rischio potrebbe derivare proprio dalla scelta di assicurarsi.

L'essersi assicurati risulta essere negativamente correlato con la PercCambClime con l'età. Quest'ultimo risultato è in linea con quanto trovato da Foudi e Erdlenbruch (2012), ovvero che gli agricoltori più anziani sono meno propensi ad assicurarsi, diversamente da quanto riportato da Sherrick *et al.* (2004). Il fatto che la percezione dei cambiamenti climatici sia correlata negativamente con l'essersi mai assicurati appare controverso. È possibile che gli agricoltori non ritengano le polizze assicurative idonee a contrastare gli effetti dei cambiamenti climatici sulle produzioni e preferiscano optare per altri strumenti preventivi. In alternativa, gli agricoltori potrebbero non agire affatto con strumenti *ex-ante* per tutelarsi dai cambiamenti climatici, in quanto, a causa della loro natura spesso catastrofale, contano di ricevere indennizzi *ex-post*.

Viceversa, l'essersi assicurati è positivamente correlato con il FattAz (come in Capitanio, 2010; Enjolras *et al.*, 2012, nel caso italiano; e Santeramo *et al.*., 2016), con l'irrigazione (e.g. Santeramo, 2018 e 2019), con la DivColt, con la PercAvvAtm e con il NumStratGestRisk. Queste evidenze sono in accordo con quanto riscontrato da Enjolras e Sentis (2008), per quanto riguarda l'irrigazione e la diversificazione colturale, mentre risultano in contrasto con la maggior parte delle evidenze presenti in letteratura: infatti, Santeramo *et al.* (2016) riportano una correlazione negativa tra la sottoscrizione di polizze assicurative, diversificazione colturale ed area irrigata e si assume che irrigazione e diversificazione colturale siano considerate dagli agricoltori come sostitute dell'assicurazione. Analogamente, Foudi e Erdlenbruch (2012) suggeriscono che gli agricoltori potrebbero optare per l'irrigazione come una sorta di assicurazione personale per ridurre i rischi di produzione. Barnett e Coble (2009) e Severini *et al.* (2017) riportano che alla maggiore specializzazione aziendale corrisponde una maggiore esposizione a rischi di ricavo e di reddito, cosa che potrebbe suggerire che la diversificazione colturale, presentando

[15] Estensione aziendale (da ora "EstAz"), età del conduttore ("età"), sesso del conduttore ("sesso"), istruzione del conduttore ("istruzione"), fatturato annuo aziendale ("FattAz"), marchi di qualità ("marchi"), diversificazione colturale ("DivColt"), presenza di impianti di irrigazione in azienda ("irrigazione"), diversificazione del reddito ("DivRedd").

[16] Avversione al rischio, avversione all'ambiguità, impazienza di un anno, impazienza dei due anni (rispettivamente: "AvvRisk", "AvvAmb", "Imp1" e "Imp2").

[17] Numero di rischi percepiti ("NumRiskPerc"), percezione di avversità atmosferiche ("PercAvvAtm") e percezione di cambiamenti climatici ("PercCambClim").

[18] Ovvero, le aziende di maggiori dimensioni, avendo generalmente una maggiore disponibilità economica, sono più propense ad attuare strategie di gestione del rischio (tra cui anche l'assicurazione agricola) e ciò comporta una diminuzione del rischio di reddito. Dunque, non siamo in grado di discernere con certezza se sia la maggiore o minore variabilità di reddito delle aziende di maggiori dimensioni ad influenzare la scelta assicurativa o se, viceversa, sia l'assicurarsi ad influenzare la variabilità di reddito.

minori rischi, dovrebbe comportare un minor ricorso allo strumento assicurativo (fungendo, a sua volta, da strategia di gestione del rischio aziendale), come riscontrato in Was e Koble (2018). Capitanio (2010) riporta che la specializzazione produttiva impatta positivamente sull'adesione a programmi assicurativi agricoli, contrariamente alla diversificazione colturale. Ne deriva che la correlazione positiva da noi riscontrata tra l'essersi assicurati e la presenza di impianti di irrigazione in azienda e la diversificazione colturale potrebbe far ipotizzare che gli agricoltori più sensibili alle fluttuazioni di reddito vedano assicurazione, irrigazione e diversificazione colturale come strategie per mitigare il rischio di reddito e che le usino anche in simultanea per minimizzare il più possibile tale rischio.

La correlazione positiva tra l'assicurazione e la PercAvvAtm, invece, è in accordo con quanto riscontrato da Maraner e Finger (2019), riguardo la percezione del rischio di grandine. Circa la correlazione positiva tra l'assicurarsi ed il NumStratGestRisk, assumendo che all'aumentare dell'importanza attribuita alla gestione del rischio aumenti anche il numero di strategie di gestione del rischio utilizzate dagli imprenditori agricoli, questo risultato è in linea con quanto descritto da Sherrick *et al.* (2004), che riportano che gli assicurati sono caratterizzati da una maggior importanza attribuita alla gestione del rischio rispetto ai non assicurati. Inoltre, anche Giampietri *et al.* (2020) hanno riscontrato che chi attua anche altre strategie di gestione del rischio presenta una maggiore tendenza ad assicurarsi. Per quanto riguarda l'essere assicurati al momento dell'intervista, risulta essere positivamente correlato al sesso del conduttore (quindi se il conduttore è donna, è più probabile che l'azienda sia tuttora assicurata), alla seguenti variabili: DivRedd, Imp2, NumStratGestRisk e PercCambClim. I nostri risultati si discostano da quanto trovato da Foudi e Erdlenbruch (2012), secondo cui gli agricoltori uomini hanno maggiore probabilità di assicurarsi, e da quanto presente in Capitanio (2010), ovvero la non significatività statistica del legame fra l'adozione di polizze assicurative e la diversificazione del reddito con attività extra-aziendali.

Diversamente da quanto ci si sarebbe potuto aspettare e da quanto riportato nella bibliografia (Enjolras, Sentis, 2008; Giampietri *et al.*, 2020), le variabili comportamentali AvvRisked AvvAmb (e, in buona parte dei casi, anche le preferenze temporali), non risultano essere correlate alle scelte circa la sottoscrizione di polizze assicurative. Risultati analoghi ai nostri sono stati riscontrati da Was e Kobus (2018) nel caso della Polonia circa l'avversione al rischio. Inoltre, in linea con quanto ipotizzato da Goodwin (2001) e da Foudi ed Erdlenbruch (2012), solo una circoscritta porzione del campione di agricoltori (34,45%) risulta essere fortemente avverso al rischio, mentre circa un quarto (25,1%) risulta non avverso al rischio e la restante parte (40,45%) presenta un livello medio di avversione al rischio. Infine, a differenza da quanto atteso e riportato da Sherrick *et al.* (2004) e Giampietri *et al.* (2020), non si evince correlazione positiva tra sottoscrizione di polizze assicurative e NumRiskPerc.

7.2. Numero strategie gestione del rischio utilizzate (NumStratGestRisk)

Il NumStratGestRisk (Tab. 6) risulta essere lievemente correlato negativamente al sesso del conduttore nel sottocampione MaiAss e nel campione generale. Ciò significa che NumStratGestRisk è maggiore se il conduttore dell'azienda è un uomo piuttosto che donna. Nel campione generale e nel sottocampione MaiAss, il NumStratGestRisk è positivamente correlato con l'istruzione e con l'irrigazione, cose che non si verificano nel sottocampione Ass/ExAss. Anche il ricorso all'irrigazione può servire a gestire il rischio di produzione: dunque il fatto che sia usata in aggiunta alle altre strategie di gestione del rischio nel caso del sottocampione MaiAss, ma non in quello degli Ass/ExAss, può indicare che chi si assicura è meno attento all'uso di strumenti di gestione del rischio diversi dall'assicurazione e, di conseguenza, tende ad esporsi a maggiori rischi.

Solo nel sottocampione MaiAss è presente una correlazione negativa tra il NumStratGestRisk e l'uso di marchi di qualità. Sia nei due sottocampioni che nel campione generale, è presente una correlazione positiva tra il NumStratGestRisk, il FattAz, la DivRedd e la DivColt. La DivColt e la DivRedd possono essere altresì considerate come strategie di gestione del rischio aziendale. Dunque, le ultime due correlazioni possono far pensare che siano gli individui più sensibili alle fluttuazioni del reddito ad attuare sia più strategie di gestione del rischio che la diversificazione del reddito e/o colturale per proteggersi, appunto, da tali fluttuazioni. Inoltre, è anche presente una correlazione positiva tra il NumStratGestRisk, il NumRiskPerc (in accordo con quanto riscontrato da Maraner e Finger, 2019) e la PercCambClim. Non si evidenziano, diversamente da quanto presente in letteratura (Severini *et al.*, 2017), relazioni tra NumStratGestRisk e EstAz.

Contrariamente a quanto ci si potrebbe aspettare, nelle nostre analisi il NumStratGestRisk risulta essere negativamente correlato con l'AvvRisk, ovvero più gli agricoltori sono avversi al rischio, meno strategie utilizzano. Questa relazione è statisticamente significativa sia per il campione generale che per il sottocampione

Tab. 5. OLS - Assicurazione.

	Azienda Ass/exAss[1]			Azienda assicurata[2]		
	Ca[3]	Vc[4]	Fgrp[5]	Ca[3]	Vc[4]	Fgrp[5]
Estensione azienda	.032***	.028***	.030***	.034*	.038*	.036*
	(.011)	(.011)	(.011)	(.020)	(.020)	(.020)
Età conduttore	-.027**	-.026**	-.027**	-.019	-.012	-.001
	(.010)	(.011)	(.011)	(.021)	(.022)	(.021)
Sesso conduttore	.014	.003	.005	.108**	.080*	.086*
	(.023)	(.023)	(.023)	(.047)	(.048)	(.047)
Istruzione conduttore	-.010	-.007	-.009	.010	.012	.020
	(.012)	(.012)	(.012)	(.025)	(.026)	(.026)
Fatturato annuo aziendale	.088***	.091***	.074***	.024	.019	.005
	(.013)	(.013)	(.013)	(.020)	(.020)	(.021)
Marchi di qualità	.034	.031	.024	.056	.0547	.059
	(.021)	(.021)	(.022)	(.041)	(.042)	(.042)
Diversificazione reddito	-.007	-.010	-.024	.136***	.130***	.103***
	(.015)	(.015)	(.015)	(.027)	(.027)	(.028)
Azienda irrigua	.037*	.042**	.021	-.053	-.048	-.048
	(.021)	(.021)	(.021)	(.044)	(.045)	(.044)
Az. pluri-colturale	.070***	.069***	.053**	.046	.050	.031
	(.021)	(.021)	(.022)	(.044)	(.045)	(.045)
Avversione al rischio		.024	.027		-.033	-.017
		(.024)	(.024)		(.049)	(.048)
Avver. all'ambiguità		.006	.012		-.047	-.020
		(.035)	(.034)		(.070)	(.070)
Impazienza 1anno		-.025	-.029		-.083	-.080
		(.049)	(.048)		(.088)	(.087)
Impazienza 2anni		-.064	-.062		.329***	.261***
		(.051)	(.050)		(.092)	(.091)
nsGdR[6]			.128***			.137***
			(.016)			(.028)
nRp[7]			-8.07e-05			-.027
			(.014)			(.027)
pAvvAtm[8]			.134*			-.182
			(.078)			(.27)
pCC[9]			-.047*			.133**
			(.028)			(.058)
Constant	.241***	.301***	.147	.325***	.095	.109
	(.045)	(.071)	(.107)	(.092)	(.140)	(.315)
Observations	1,926	1,904	1,851	585	566	547
R-squared	.093	.095	.130	.076	.096	.150

Standard errors in parentheses ; *** p<0.01, ** p<0.05, * p<0.1.
Note: [1] azienda che ha provato l'assicurazione; assicurata o ex assicurata al momento dell'intervista; [2] azienda assicurata al momento dell'intervista, sottogruppo di "Azienda Ass/exAss"; [3] caratteristiche aziendali; [4] variabili comportamentali; [5] fattori gestione rischio e percezione; [6] numero di strategie gestione del rischio utilizzate nei cinque anni precedenti l'intervista; [7] numero di rischi percepiti; [8] percezione avversità atmosferiche; [9] percezione cambiamenti climatici.
Fonte: elaborazioni proprie su dati raccolti con il questionario.

MaiAss, mentre non lo è nel sottocampione Ass/ExAss. Ciò potrebbe essere ascritto al fatto che probabilmente gli agricoltori non considerano "sicuri" questi metodi, ma li ritengono in un certo qual modo rischiosi, oppure potrebbe dipendere dalla metodologia impiegata durante l'indagine per elicitare l'attitudine al rischio. Infatti, in

Tab. 6. OLS - Numero strategie di gestione del rischio (nsGdR) utilizzate nei cinque anni precedenti l'intervista

	Gen[1]			Ass/exAss[2]			MaiAss[3]		
	Ca[4]	Vc[5]	Vp[6]	Ca[4]	Vc[5]	Vp[6]	Ca[4]	Vc[5]	Vp[6]
Estensione azienda	-.003	-.001	-.0004	.004	.008	.006	-.016	-.016	-.014
	(.017)	(.017)	(.016)	(.031)	(.031)	(.031)	(.019)	(.019)	(.018)
Età conduttore	-.002	-.002	.005	-.023	-.027	-.006	.014	.016	.016
	(.016)	(.016)	(.016)	(.033)	(.034)	(.033)	(.018)	(.018)	(.017)
Sesso conduttore	-.075**	-.066*	-.045	-.113	-.080	-.069	-.065*	-.065*	-.039
	(.035)	(.035)	(.034)	(.072)	(.074)	(.073)	(.038)	(.038)	(.037)
Istruzione conduttore	.036*	.034*	.024	.027	.020	.024	.047**	.048**	.032
	(.018)	(.019)	(.018)	(.039)	(.040)	(.040)	(.020)	(.020)	(.019)
Fatturato annuo aziendale	.125***	.120***	.110***	.113***	.102***	.099***	.077***	.074***	.060**
	(.020)	(.020)	(.019)	(.032)	(.032)	(.032)	(.027)	(.027)	(.027)
Marchi di qualità	-.053	-.052	-.042	.038	.055	.059	-.108***	-.112***	-.098***
	(.033)	(.033)	(.032)	(.065)	(.066)	(.065)	(.037)	(.037)	(.036)
Diversificazione reddito	.105***	.106***	.096***	.112***	.117***	.111***	.107***	.107***	.094***
	(.023)	(.023)	(.022)	(.043)	(.043)	(.042)	(.026)	(.026)	(.025)
Az. irrigua	.126***	.118***	.109***	.095	.073	.074	.127***	.120***	.107***
	(.033)	(.033)	(.032)	(.069)	(.070)	(.069)	(.036)	(.036)	(.034)
Az. pluri-colturale	.165***	.165***	.134***	.127*	.116*	.094	.160***	.159***	.122***
	(.033)	(.033)	(.032)	(.069)	(.070)	(.069)	(.036)	(.036)	(.035)
AvvRis[7]		-.093**	-.088**		-.122	-.083		-.090**	-.096**
		(.037)	(.036)		(.076)	(.074)		(.041)	(.039)
AvvAmb[8]		-.081	-.061		-.139	-.117		-.058	-.036
		(.054)	(.052)		(.110)	(.108)		(.060)	(.057)
Imp1anno[9]		.026	.028		.114	.124		-.012	-.006
		(.076)	(.073)		(.138)	(.135)		(.089)	(.085)
Imp2anni[10]		.064	.020		.189	.133		.047	-.002
		(.078)	(.075)		(.143)	(.141)		(.091)	(.087)
nRp[11]			.168***			.127***			.180***
			(.020)			(.041)			(.023)
pAvvAt[12]			.140			.310			.044
			(.118)			(.368)			(.116)
pCC[13]			.365***			.377***			.355***
			(.0413)			(.088)			(.045)
Constant	.503***	.502***	-.181	.746***	.615***	-.266	.412***	.453***	-.104
	(.069)	(.110)	(.161)	(.143)	(.218)	(.437)	(.077)	(.124)	(.167)
Observations	1,897	1,880	1,851	577	560	550	1,320	1,320	1,301
R-squared	.091	.094	.174	.089	.093	.148	.065	.069	.165

Standard errors in parentheses ; *** p<0.01, ** p<0.05, * p<0.1.
Note: [1] campione complessivo; [2] sottocampione aziende che hanno provato l'assicurazione; assicurate o ex-assicurate al momento dell'intervista; [3] aziende che non hanno mai provato l'assicurazione; [4] caratteristiche aziendali; [5] variabili comportamentali; [6] variabili di percezione; [7] avversione al rischio; [8] avversione all'ambiguità; [9] impazienza un anno; [10] impazienza due anni; [11] numero di rischi percepiti; [12] percezione avversità atmosferiche; [13] percezione cambiamenti climatici.
Fonte: elaborazioni proprie su dati raccolti con il questionario.

tutti gli scenari proposti, la scelta si fondava sulla possibilità di vittoria di somme di denaro in ogni caso esigue, mentre nella realtà gli imprenditori sono chiamati ad amministrare ingenti somme di denaro e le loro scelte possono sfociare in altrettanto intense perdite economiche. Questa ipotesi è in linea con quanto affermato da Menapace *et al.* (2016) e Meraner e Finger (2019), secondo cui il metodo utilizzato per elicitare le attitudini ver-

so il rischio ha influenza sui risultati ottenuti. Si potrebbe anche ipotizzare che, in ambito imprenditoriale, gli agricoltori cambino i loro schemi decisionale, a favore di una maggior cautela. Se ciò fosse vero, con l'intervista sarebbe stato rilevato l'atteggiamento degli agricoltori verso rischio, ambiguità e tempo valido per le scelte della "vita di tutti i giorni", ma non nel caso delle decisioni imprenditoriali, che probabilmente sarebbe stato possibile captare con una diversa impostazione della lotteria.

8. CONSIDERAZIONI CONCLUSIVE

Il mercato assicurativo agricolo italiano è in costante evoluzione e sta assumendo un'importanza sempre maggiore, destinata ad aumentare ulteriormente a fronte dell'aumento dell'esposizione del settore agroalimentare a rischi di diversa natura e ai cambiamenti climatici in atto. La possibilità di ottenere sussidi per la sottoscrizione di polizze costituisce un'opportunità per gli imprenditori del settore. Nonostante ciò, lo strumento assicurativo agevolato è ancora limitatamente diffuso, soprattutto nel Mezzogiorno del Paese. Per questi motivi, vi è un crescente interesse nel comprendere quali fattori possano influenzare l'adesione ai programmi di assicurazione agricola agevolata ovvero la sottoscrizione di polizze assicurative agricole in generale.

I risultati permettono di avanzare alcune riflessioni: in primo luogo un'eventuale futura riprogettazione delle politiche a sostegno del settore assicurativo agricolo nel Sud Italia dovrebbe tenere in giusta considerazione le peculiarità delle aziende di minori dimensioni e con minor fatturato annuo – seppur in gran numero, nella maggior parte dei casi esse non hanno mai aderito ai programmi di polizze agevolate; in secondo luogo, la complessità della scelta di stipula o meno di un contratti assicurativo friziona la partecipazione e sembra auspicare il rafforzamento dell'intermediazione fra il tessuto imprenditoriale agricolo e l'offerta assicurativa; inoltre, considerata la scarsa tendenza associativa che caratterizza le imprese del Meridione, sarebbe utile promuovere la cooperazione (come suggerito dall'esperienza del Nord Italia), tramite la creazione di consorzi, associazioni dei produttori e simili, efficienti anche nella condivisione delle esperienze e informazioni sul funzionamento del sistema assicurativo; inoltre, il ricambio generazionale che si prospetta nel Mezzogiorno del Paese dovrebbe essere favorito, così da costituire un tessuto imprenditoriale maggiormente incline all'adozione di strumenti innovativi, quale, fra gli altri, lo strumento assicurativo.

Nel presente lavoro abbiamo esaminato anche l'influenza di alcune variabili comportamentali sulle scelte di gestione del rischio. I risultati evidenziati non sono completamente in linea con quanto sarebbe lecito attendersi in un mercato assicurativo perfettamente funzionante. Difatti, in diversi casi è stata verificata ritrosia all'adozione di strategie di gestione del rischio o alla stipula di contratti assicurativi. Tale risultato è in alcuni casi addirittura più evidente fra gli imprenditori agricoli che manifestano una maggiore avversione al rischio e alla mancanza di informazioni (e.g. ambiguità). Quindi, sebbene non direttamente conclusivi per possibili strategie di comunicazione e promozione dello strumento assicurativo, i risultati indicano in modo piuttosto evidente che il mercato assicurativo agevolato del Sud Italia non risponde ancora in modo efficiente, e che quindi sono necessari ulteriori sforzi comunicativi per trasferire al tessuto imprenditoriale non solo le specifiche del funzionamento dei contrattisti assicurativi, ma anche più ampie informazioni sui benefici derivanti da un sistema economico-finanziario più evoluto.

Le riforme dei prossimi mesi sono quindi un'opportunità piuttosto rara, se non unica, per ridisegnare il settore primario. Siamo nella giusta direzione? La conferma, nella PAC post-2020, dell'impianto dedicato alle politiche di gestione del rischio fa comprendere quanto sia importante continuare ad analizzare e comprendere le tematiche analizzate nel presente lavoro, e proporre nuovi strumenti dipolitica agraria, per un futuro divenuto ormai presente.

BIBLIOGRAFIA

Barnett B.J., Coble K.H. (2009). Are Our Agricultural Risk Management Tools Adequate for a New Era? *Choices,* 24(1): 36-39. Disponibile al sito: http://www.jstor.org/stable/choices.24.1.0036 (accesso: 06/10/2020).

Barry P.J., Escalante C.L., Bard S.K. (2001). Economic risk and the structural characteristics of farm businesses. *Agricultural Finance Review*. 61(1): 74-86. DOI: https://doi.org/10.1108/00214760180001117

Bryan G. (2010). *Ambiguity and insurance*. Unpublished manuscript. Disponibile al sito: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.185.2555&rep=rep1&type=pdf (accesso: 06/10/2020)

Capitanio F. (2010). *Quali le determinanti della domanda di assicurazioni agricole in Italia?* In: Boccaletti S. (eds), Cambiamenti nel sistema alimentare: nuovi problemi, strategie, politiche. XLVI Convegno SIDEA, Milano: Franco Angeli. Permalink: http://digital.casalini.it/9788856828849

Capitanio F., De Pin A. (2018). Measures of efficiency of agricultural insurance in Italy, economic evaluations. *Risks*, 6(4): 126. DOI: 10.3390/risks6040126

Capitanio F., De Pin A. (2018b). La gestione del rischio nella zona DOCG Conegliano-Valdobbiadene, valutazioni economiche. *Italian Review of Agricultural Economics*, 73(1): 37-61. DOI: 10.13128/REA-23578

Cioffi A., Capitanio F. (2010). *La gestione del rischio di impresa tra strumenti privati e sostegno pubblico*. Quaderni Gruppo 2013. Disponibile al sito: https://www.gruppo2013.it/wp-content/uploads/2009/03/CIOFFI-CAPITANIO-03.03.09.pdf (accesso: 04/10/2020)

Circolare AGEA Prot. N. ACIU.2015.305 del 02.07.2015, Modalità e condizioni per l'accesso ai contributi comunitari per le assicurazioni.

Coldiretti (2018). *Dove sta andando la PAC*. Disponibile al sito: https://agriregionieuropa.univpm.it/sites/are.econ.univpm.it/files/dove_va_la_pac.pdf (accesso: 11/03/2020)

Coletta A., Giampietri E., Santeramo F.G., Severini S., Trestini S. (2018). A preliminary test on risk and ambiguity attitudes, and time preferences in decisions under uncertainty: towards a better explanation of participation in crop insurance schemes. *Bio-based and Applied Economics*, 7(3): 265-277. DOI: 10.13128/bae-7679

Cordier J., Santeramo F. (2020). Mutual funds and the Income Stabilisation Tool in the EU: Retrospect and Prospects. *Euro Choices*, 19(1): 53-58. DOI: 10.1111/1746-692X.12210

Dessart F.J., Barreiro-Hurlé J., van Bavel R. (2019). Behavioural factors affecting the adoption of sustainable farming practices: a policy-oriented review. *European Review of Agricultural Economics*, 46(3): 417-471. DOI: 10.1093/erae/jbz019

Ellsberg D. (1961). Risk, ambiguity, and the Savage axioms. *The quarterly journal of economics*, 643-669. DOI: 10.2307/1884324

Enjolras G., Sentis P. (2008). *The Main Determinants of Insurance Purchase: An Empirical Study on Crop Insurance Policies in France* (No. 725-2016-49599). DOI: 10.22004/ag.econ.44395

Enjolras G., Sentis P. (2011). Crop insurance policies and purchases in France. *Agricultural Economics*, 42(4): 475-486. DOI: https://doi.org/10.1111/j.1574-0862.2011.00535.x

Enjolras G., Capitanio F., Adinolfi F. (2012). The demand for crop insurance: Combined approaches for France and Italy. *Agricultural economics review*, 13(389-2016-23488): 5-22. DOI: 10.22004/ag.econ.253490

European Commission (2009). Income Variability and Potential Cost of Income Insurance for EU. AGRI L.1/L.3/ D (2009). Brussels

Finger R. (2012). Effects of crop acreage and aggregation level on price-yield correlations. *Agricultural Finance Review*, 72(3): 436-455. DOI:https://doi.org/10.1108/00021461211277277

Flaten O., Lien G., Koesling M., Valle P.S., Ebbesvik M. (2005). Comparing risk perceptions and risk management in organic and conventional dairy farming: empirical results from Norway. *Livestock Production Science*, 95(1-2): 11-25. DOI: https://doi.org/10.1016/j.livprodsci.2004.10.014

Foudi S., Erdlenbruch K. (2012). The role of irrigation in farmers' risk management strategies in France. *European Review of Agricultural Economics*, 39(3): 439-457. DOI: https://doi.org/10.1093/erae/jbr024

Gardebroek C. (2006). Comparing risk attitudes of organic and non-organic farmers with a Bayesian random coefficient model. *European Review of Agricultural Economics*, 33(4): 485-510. DOI: https://doi.org/10.1093/erae/jbl029

Garrido A., Zilberman D. (2007). *Revisiting the demand of agricultural insurance: the case of Spain*. (No. 686-2016-47109). DOI: 10.22004/ag.econ.9266

Giampietri E., Yu X., Trestini S. (2020). The role of trust and perceived barriers on farmer's intention to adopt risk management tools. *Bio-based and Applied Economics*, 9(1): 1-24. DOI: 10.13128/bae-8416

Goodwin B.K. (1993). An empirical analysis of the demand for multiple peril crop insurance. *American journal of agricultural economics*, 75(2): 425-434. DOI: https://doi.org/10.2307/1242927

Goodwin B.K. (2001). Problems with market insurance in agriculture. *American Journal of Agricultural Economics*, 83(3): 643-649. DOI: 10.2307/1245093

Hellerstein D., Higgins N., Horowitz J. (2013). The predictive power of risk preference measures for farming decisions. *European Review of Agricultural Economics*, 40(5): 807-833. DOI: https://doi.org/10.1093/erae/jbs043

ISMEA (a cura di) (2018). *La gestione del rischio nell'agricoltura del Mezzogiorno*. Disponibile al sito: http://www.ismea.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/10534 (accesso: 06/03/2019).

ISMEA (a cura di) (2018). *Rapporto sulla gestione del rischio in Italia*. Disponibile al sito: http://www.ismea.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/10516 (accesso: 13/09/2020).

Iyer P., Bozzola M., Hirsch S., Meraner M., Finger R. (2020). Measuring farmer risk preferences in Europe: a systematic review. *Journal of Agricultural Economics*, 71(1): 3-26. DOI: https://doi.org/10.1111/1477-9552.12325

Just D.R., Just R.E. (2016). Empirical identification of behavioral choice models under risk. *American Jour-*

nal of Agricultural Economics, 98(4): 1181-1194. DOI:https://doi.org/10.1093/ajae/aaw019

Leg. Decree 102/2004 e successive modificazioni.

Leg. Decree 82/2008

Leg. Decree 32/2018

Mahul O., Stutley C.J. (2010). *Government support to agricultural insurance: challenges and options for developing countries*. The World Bank, Washington, DC, DOI: 10.1596/978-0-8213-8217-2

M.D. 162, 12 gennaio 2015

Just R.E., Calvin L., Quiggin J. (1999). Adverse selection in crop insurance: Actuarial and asymmetric information incentives. *American Journal of Agricultural Economics*, 81(4): 834-849. DOI: 10.2307/1244328

Menapace L., Colson G., Raffaelli R. (2013). Risk aversion, subjective beliefs, and farmer risk management strategies. *American Journal of Agricultural Economics*, 95(2): 384-389. DOI: https://doi.org/10.1093/ajae/aas107

Menapace L., Colson G., Raffaelli R. (2016). A comparison of hypothetical risk attitude elicitation instruments for explaining farmer crop insurance purchases. *European Review of Agricultural Economics*, 43(1): 113-135. DOI: https://doi.org/10.1093/erae/jbv013

Meraner M., Finger R. (2019). Risk perceptions, preferences and management strategies: evidence from a case study using German livestock farmers. *Journal of Risk Research,* 22(1): 110-135. DOI: https://doi.org/10.1080/13669877.2017.1351476

Meuwissen M.P., Huirne R.B.M., Hardaker J.B. (2001). Risk and risk management: an empirical analysis of Dutch livestock farmers. *Livestock production science*, 69(1): 43-53. DOI: https://doi.org/10.1016/S0301-6226(00)00247-5

Meuwissen M.P., VanAsseldonk M.A., Huirne R.B. (eds.). (2008). *Income stabilisation in European agriculture: design and economic impact of risk management tools*. Wageningen Academic Publishers, Wageningen, The Netherlands. DOI:https://doi.org/10.3920/978-90-8686-650-2

Mishra A.K., El-Osta H.S. (2001). A temporal comparison of sources of variability in farm householdincome. *Agricultural Finance Review*, 61(2): 181-198. DOI: https://doi.org/10.1108/00214820180001123

Mishra A.K., Sandretto C.L. (2002). Stability of farm income and the role of nonfarm income in US agriculture. *Applied Economic Perspectives and Policy*, 24(1): 208-221. DOI:10.1111/1058-7195.00014

Moschini G., Hennessy D.A. (2001). Uncertainty, risk aversion, and risk management for agricultural producers. *Handbook of agricultural economics*, 1: 87-153. North Holland.

Organisation for Economic Co-operation and Development. (2009). *Managing risk in agriculture: a holistic approach*. OECD publication, Paris.

Pennings J.M., Leuthold R.M. (2000). The role of farmers' behavioral attitudes and heterogeneity in futures contracts usage. *American journal of agricultural economics*, 82(4): 908-919. DOI:https://doi.org/10.1111/0002-9092.00090

Pennings J.M., Garcia P. (2001). Measuring producers' risk preferences: a global risk-attitude construct. *American journal of agricultural economics*, 83(4): 993-1009. DOI. https://doi.org/10.1111/0002-9092.00225

Pennings J.M., Garcia P. (2004). Hedging behavior in small and medium-sized enterprises: The role of unobserved heterogeneity. *Journal of Banking & Finance,* 28(5): 951-978. DOI: https://doi.org/10.1016/S0378-4266(03)00046-3

Pennings J.M., Wansink B. (2004). Channel contract behavior: The role of risk attitudes, risk perceptions, and channel members' market structures. *The journal of business,* 77(4): 697-724. DOI: https://doi.org/10.1086/422633

Piano assicurativo agricolo 2016 (Ministero delle politiche agricole alimentari e forestali, prot. n. 0028336 del 23/12/2015)

van Raaij W.F. (1981). Economic psychology. *Journal of Economic psychology*, 1(1): 1-24. DOI: https://doi.org/10.1016/0167-4870(81)90002-7

reg. (UE) 1305/2013.

reg. (UE) 1307/2013.

reg. (UE) 1308/2013.

reg. (UE) 2393/2017.

Rieger M.O., Wang M., Hens T. (2015). Risk preferences around the world. *Management Science*, 61(3): 637-648. DOI: https://doi.org/10.1287/mnsc.2013.1869

Santeramo F.G., Goodwin B.K., Adinolfi F., Capitanio F. (2016). Farmer participation, entry and exit decisions in the Italian crop insurance programme. *Journal of Agricultural Economics*, 67(3): 639-657. DOI: https://doi.org/10.1111/1477-9552.12155

Santeramo F.G. (2018). Imperfect information and participation in insurance markets: evidence from Italy. *Agricultural Finance Review*. DOI: https://doi.org/10.1108/AFR-06-2017-0053

Santeramo F.G., Di Gioia L. (2018). *La gestione del rischio in agricoltura. Assicurazioni, credito e strumenti finanziari per lo sviluppo rurale*. Edgricole – New Business Media.

Santeramo F.G. (2019). I learn, you learn, we gain experience in crop insurance markets. *Applied Economic Perspectives and Policy*, 41(2): 284-304.DOI: https://doi.org/10.1093/aepp/ppy012

Savage L.J. (1972). *The foundations of statistics*. Courier Corporation.

Severini S., Tantari A., Di Tommaso G. (2017). Effect of agricultural policy on income and revenue risks in Italian farms. *Agricultural Finance Review*. DOI: https://doi.org/10.1108/AFR-07-2016-0067

Sherrick B.J., Barry P.J., Ellinger P.N., Schnitkey G.D. (2004). Factors influencing farmers' crop insurance decisions. *American journal of agricultural economics*, 86(1): 103-114. DOI: https://doi.org/10.1111/j.0092-5853.2004.00565.x

Slovic P., Fischhoff B., Lichtenstein S. (1982). Why study risk perception?. *Risk analysis*, 2(2): 83-93. DOI:https://doi.org/10.1111/j.1539-6924.1982.tb01369.x

Sutter M., Kocher M.G., Glätzle-Rützler D., Trautmann S.T. (2013). Impatience and uncertainty: Experimental decisions predict adolescents' field behavior. *American Economic Review*, 103(1): 510-31. DOI: 10.1257/aer.103.1.510

Vrolijk H.C.J., de Bont K., Phimister E. (2006). *Income instability in Dutch agriculture: analyzing volatility of farm incomes with FADN data*. In International Conference for the 80th Anniversary of Farm Accountancy in Poland, Warsaw (Vol. 8). Disponibile al sito: https://www.researchgate.net/publication/303194794_Income_instability_in_Dutch_agriculture_analyzing_volatility_of_farm_incomes_with_FADN_data (accesso: 06/10/2020)

Vrolijk H.C.J., Poppe K.J. (2008). *Income volatility and income crises in the European Union*, in: Meuwissen M.P.M., van Asseldonk M.A.P.M., Huirne R.B.M. (edited by) (2008) Income stabilisation in European agriculture: design and economic impact of risk management tools. Wageningen Academic Publishers, Wageningen, The Netherlands. DOI:https://doi.org/10.3920/978-90-8686-650-2

Wąs A., Kobus P. (2018). Factors differentiating the level of crop insurance at Polish farms. *Agricultural Finance Review,* 78(2): 209-222. DOI: https://doi.org/10.1108/AFR-06-2017-0054

van Winsen F., de Mey Y., Lauwers L., Van Passel S., Vancauteren M., Wauters E. (2016). Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies. *Journal of Risk Research*, 19(1): 56-78. DOI: https://doi.org/10.1080/13669877.2014.940597

Wright B.D., Hewitt J.A. (1994). *All-risk crop insurance: lessons from theory and experience*. In Economics of agricultural crop insurance: theory and evidence (pp. 73-112). Springer, Dordrecht.

Finito di stampare da
Logo s.r.l. – Borgoricco (PD) – Italia

The Italian Review of Agricultural Economics is issued with the collaboration between CREA (Council for Agricultural Research and Economics) and SIDEA (Italian Association of Agricultural Economics).

REA is a scientific journal issued every four months and publishes articles of economics and policies relating to agriculture, forestry, environment, agro-food sector and rural sociology.

The articles undergo a double-blind peer review.

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