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Samuele Trestini, Eleonora Chinchio

TeSAF Department, University of Padova

Simulation of a mutual fund to stabilise the income of farms belonging to a dairy cooperative

Keywords: Income Stabilisation Tool, dairy farms, risk assessment, mutual funds, cost index
JEL codes: G32, Q12, Q18

In the last years, the high volatility of the dairy market has exposed farmers to a strong income risk, which is expected to increase. In this context, with the reg. (EU) 1305/2013, European Union tried to encourage the adoption of risk management tools such as insurance, mutual funds and the Income Stabilisation Tool (IST). The IST is a mutual fund that compensates farmers for severe income losses, but nowadays it is still very little applied. The reform of reg. (EU) 1305/2013 by the so-called Omnibus Regulation, introduced relevant innovation allowing for sector-specific IST, a reduced threshold (20%) and the use of indexes. The simulation of a sector-specific IST under Omnibus Regulation is performed on 167 farms belonging to a dairy cooperative in Veneto Region (Italy).

1. Introduction

While price variation is both desirable and inevitable in all free markets to some degree (O'Connor *et al.*, 2015), exceptional price volatility in agricultural commodities and products represents an important risk factor for producers (Adinolfi *et al.*, 2011). During the last years, both political (e.g. changes in agricultural policies), economic (e.g. changes in supply and demand) and environmental factors (e.g. adverse weather conditions, plant and animal diseases) have put at serious risk market stability. Evidence shows that price volatility increased since 2005 and it is likely to remain a major concern in the coming decades, leading to a number of negative consequences (EPRS, 2016; Tangermann 2011).

Talking about the dairy sector in particular, price dynamics in the EU have been deeply affected by the changes of EU Common Agricultural Policy (CAP) that have occurred in recent years (O'Connor *et al.*, 2015). With the Luxembourg agreement in 2003, the focus was shifted from the maintenance of high and stable prices to a greater market orientation, through the reduction of market intervention prices and the introduction of income support via the Single Payment Scheme (SPS) (O'Connor *et al.*, 2015). This brought the EU

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dairy prices more in line with world prices (which were historically and significantly lower than EU prices), thus increasing price variability, reducing farmers' ability to invest in future production (Bergmann *et al.,* 2015; Bergmann *et al.,* 2016) and exposing them to the risk of failure (Meuwissen *et al.,* 2003; Capitanio, 2010; El Benni and Finger, 2013).

The increased market instability showed its first biggest effect with the 2009 crisis, when European milk prices had a substantial fall, dropping under the 0.30€/l (EPRS, 2016). To respond to this crisis, the Council and the European Parliament adopted the so-called "Milk package" with reg. (EU) 261/2012 and now integrated in the reg. (EU) 1308/2013. This plan includes different measures aimed to strengthen the bargaining power of agricultural producers and to prepare the sector to the new market environment. However, the package did not face the problem of price volatility (Pieri and Rama, 2016), for which it was necessary to implement appropriate risk management measures, as witnessed by the emergency of a new crisis in 2015. Consequently, with the reg. (EU) 1305/2013, risk management tools were introduced for the first time in the second pillar of the CAP, giving the possibility to EU Member States, or their regions, to include these measures in their Rural Development Programmes. Specifically, the aim was to:

1. help farmers to cover the premiums they pay for crop, animal and plant insurance (art. 37);
2. encourage the setting up of mutual funds (i.e. financial reserves based on the contributions of the participant, who chooses spontaneously to deal with and share the risk) (Borrelli *et al.*, 2013) used for compensating farmers experiencing serious production losses caused by adverse climatic events, the outbreak of animal or plant diseases, pest infestation or environmental incidents (art. 38);
3. help farmers in case of a severe drop of income through the Income Stabilisation Tool (IST) (art. 39).

The introduction of this last instrument is particularly interesting, because it focuses on farmer's income, combining all farm's insurable risks into a single contract (Pigeon *et al.*, 2012) and thus representing an overall coverage to all risks (Capitanio *et al.*, 2016). Specifically, the IST provides financial support to mutual funds that compensate farmers affected by a serious drop of income (i.e. income loss higher than 30% of the average annual income in the preceding three-years period or five-years period excluding the highest and lowest years), providing contributions to the administrative costs of setting up these mutual funds and to the amounts they pay to farmers. Payments by the mutual fund shall compensate for less than 70% of the income reduction. Mutual funds can profit for a public contribution limited to 65% of the cost of indemnities paid under IST rules. Income shall refer to the sum of revenues that the farmer receives from the market, including any form of public support, deducting input costs.

Despite the advantages related to the IST, which, being based on a mutual fund, permits to reduce typical insurance issues like moral hazard and adverse selection, it is actually little applied, such as mutual funds in general. Insurance schemes remain the most diffused risk management instruments, while IST has been actually activated by only two Member States (Italy, Hungary) and one region (Castilla y Léon in Spain) (EPRS, 2016). The major current limit of the IST is that it requires the precise measurement of farm incomes and costs, which are often unavailable because farmers have not the obligation to keep track of their entrances and losses. In addition to this, the fact that the detailed IST design is left to the Member States, sets some other important limits from the operational point of view, regarding mainly the absence of guidelines to define the reference income, the membership costs and trigger levels (Finco *et al.*, 2013; MIPAAF, 2015; Trestini *et al.*, 2017b). Lastly, it has been seen that in Europe mutual funds struggle to attract a sufficient number of participating farmers (EPRS, 2016).

From this picture clearly emerges that the IST is still an immature tool that needs to be improved. In September 2016, through the so-called Omnibus Regulation, the Commission proposed the introduction of a new sector-specific Income Stabilisation Tool (EC, 2016), characterized by a reduced threshold of income loss (20%) to access to the resources of the fund. This proposal followed Member States' requests for the dairy and meat sectors, which were affected by a severe crisis. In fact, it is well known that economic risks do not affect all the agriculture sectors in the same way (Vrolijk and Poppe, 2008; Enjolras *et al.*, 2014). The debate on the IST has continued in the early 2017, with a draft opinion of the Committee on Agriculture and Rural Development proposing the use of indexes to estimate the annual income loss. Its final goal is to achieve a sufficient degree of simplification (one of the main objective of the new CAP), in the hope that mutual funds will represent a safety net against market instability for farmers.

The Omnibus Regulation – reg. (EU) 2393/2017 –, which amends reg. (EU) 1305/2013, confirms the support of sector-specific IST (article 39a), the application of a threshold of at least 20% and the possibility to use indexes to calculate farms' annual loss of income. Moreover, public support has been increased to a maximum of 70%. Beside the administrative costs and the amounts paid by the mutual fund as financial compensations to farmers, the support can be addressed also to the initial capital stock of the mutual fund and to supplementing the annual payments into the fund.

The IST needs to be developed and tested, in order to become an effective risk management tool for farmers. During the last years, attempts were made to evaluate the IST potentiality. Finger and El Benni (2014b) focused on its feasibility on Swiss farms, while in Italy some preliminary studies were carried out by Dell'Aquila and Cimino (2012) and Finco *et al.* (2013). Capitanio *et al.* (2016) and Severini *et al.* (2018) debated issues about general strategies on IST implementation while the understanding of farm risk profile and resilience has been discussed by Trestini *et al.* (2017b). Furthermore, a hypothetical sector-specific IST has been discussed by Trestini *et al.* (2017a). Finally, concerning dairy farms, Trestini *et al.* (2018) presented some first attempts to estimate farms' risk profile and resilience to income drop.

The aim of this research is to simulate a mutual fund to stabilize the income of dairy farmers belonging to a cooperative, proposing a methodology using indexes for the calculation of the reference income, the level of indemnities paid to farmers and their annual payments to the fund. To our knowledge, this is the first study simulating the functioning of a sector-specific IST, able to support farmers and their associative forms to build a mutual fund under the current IST rules. Being dairy cooperatives a strong reality in Italy (they represent the 19% of turnover of milk sector and more than 60% of the three main PDO cheeses – MIPAAF, 2017), the result of this research could facilitate the application of this new instrument. This because farmers associated to cooperatives are already sharing mutual interest and cooperatives aggregate a relevant number of potential members.

2. Methodology

2.1 The case study description

The case study we analyse is about one of the biggest cooperative in Veneto, with actually more than 350 members (10% of regional dairy farmers) providing the 11% of the regional production of milk. The cooperative produces different kind of dairy products, mainly PDO cheeses like Grana Padano and Piave.

The data collected from the cooperative database include: (i) the number of cows, (ii) the quantity of milk supplied to the cooperative and (iii) the annual price paid to farmers, related to each member, within nine years (2008-2016). To our purpose, we selected only the farms continuously active for the considered years, which were 172. These data allow to quantify farms' revenue. With the aim of quantifying income value and variation, section 2.3 proposes a methodology to model feed costs based on information extracted from Farm Accountancy Data Network (FADN), indexed on farm's characteristics and market prices.

2.2 Income definition

The first step to build a mutual fund according to reg. (EU) 1305/2013 is the definition of the reference income by which to evaluate the income variation. Regulation reports that reference income of a certain year can be (i) the average of the previous three years or (ii) the Olympic average of the previous five years. Here, we opted for the first option; this choice, allowing for the observation of two years more, is consistent with Finger and El Benni (2014a), who observed no significant differences between the two methods. In line with the US Dairy Margin Protection Program (Bozic *et al.*, 2012), our study adopted the Income Over Feed Costs (IOFC) as reference income. This index, that represents the milk margin above feed costs, is a good approximation of the farmer income, considering that feed cost alone accounts for more than 40% of revenues. Furthermore, the uncertainty in milk and feed prices represents a major source of business risk in dairy farm (Valvekar *et al.*, 2010).

Compared to income definition of reg. (EU) 1305/2013, public aids and costs different from feed were not included in the income calculation. Due to the stability over time of direct payments and costs different from feed, we expect that our approach may represent faithfully the functioning and the riskiness of a milk sector IST. Additionally, the inclusion of the other costs in the income calculation, may lead a higher number of farm to a negative reference income compare to IOFC, compromising the possibility to apply IST.

2.3 Estimation of feed costs

This section proposes a methodology to estimate feed costs for dairy farms belonging to the mutual fund. This approach aims at simplifying feed costs estimation in a way to improve fund's efficiency in estimating income variation reducing information asymmetry problems. Thus, the proposed approach is looking for a model able to explain feed costs considering data availability to the fund. Data to be considered should have the following characteristics:

- availability: to quantify income variation and the potential farms' compensations, data of a specific year need to be available when compensation are expected to be quantified and paid;
- independence: to avoid moral hazard, data in the model cannot be affected by farmers;
- representativeness: model should represent fund members.

Based on this, the model for feed cost has been estimated using FADN information in the period 2008-2015 and official commodity prices. Observed feed cost of a sample of farms located in the provinces where the dairy coop-

Tab. 1. Descriptive statistics of the FADN sample (n=498).

Variable name	Variables description	n.	Mean	St. Dev.
feed_cow	Feed expenditure per cow		1,469	473
milk_cow	Milk production per cow		70.0	21.1
province	Administrative province where each farm is located			
Belluno		23		
Padova		105		
Treviso		161		
Venice		39		
Vicenza		170		
year	Year of observation			
2008		97		
2009		95		
2010		58		
2011		58		
2012		61		
2013		56		
2014		38		
2015		35		

Source: own elaborations on FADN data.

erative operates has been explained on cows' productivity (FADN), feed prices (Bologna commodity exchange - AGER) and farms location (FADN). Bologna prices are assumed representative of Italian prices (Revoredo-Giha and Zuppiroli, 2013).

Linear and log-linear functional forms have been both tested. Log-linear guarantees both higher R^2 and lower sum of squared for residuals. Log-linear function is also coherent with the shape of average cost, assuming a profit maximisation behaviour (Beattie and Taylor, 1993). The model can be represented as follows:

$$ln\ (feed\_cow_{it}) = \alpha + \beta_1 milk\_cow_{it} + \beta_2 milk\_cow_{it}^2 + \beta_3 province_i + \beta_4 prices_t + \varepsilon \qquad (1)$$

where:

- *feed_cow* is the feed expenditure per cow of the farm "*i*" in the year "*t*",
- *milk_cow* is the milk production per cow for the farm "*i*" in the year "*t*",

Tab. 2. Average commodity prices (*prices*) included in the model in the period 2008-2015 (€/ton).

Variable name	Variables description	Mean	St. Dev.
corn	national feed corn price	191.10	33.06
soybean	imported soybean non GMO price	371.72	50.69
alfalfa	local alfalfa price	216.99	17.44

Source: AGER.

- *province* is a set of dummy variables accounting for the administrative province where the farm "i" is located,
- *prices* is a set of average yearly prices for corn, soybean and alfalfa for the year "t" observed in Bologna commodity exchange.

Farms in the FADN dataset have been selected within the sample of Veneto in coherence with the dimension (between 3 and 300 milk cows) and the productivity (between 1.5 and 12.8 ton of milk per cow per year) of farms belonging to the dairy cooperative, and within the province covered by the cooperative members. Therefore, the final sample consists of 498 observations. Table 1 reports descriptive statistics of the sample and Table 2 reports prices in the period.

2.4 Farmers' income variation, indemnification and participation costs

Consistent with the choice of Finger and El Benni (2014b) and Trestini *et al.* (2018), we excluded farms that showed at least one negative reference income. The Regulation does not provide any specific rule for this case: e.g. also in the Canadian AgriStability Program (Kimura and Anton, 2011) farms with negative incomes are treated separately. Therefore, the final group consists of 167 farms.

Table 3 shows descriptive statistics of the farms (n=167). Looking at milk prices, it is particularly evident the effect of the two crisis (2009 and 2015-2016). Relatively higher prices compared to spot market are easily justified by the high share of milk devoted to the production of PDO cheeses.

Income variation is calculated for each farm as the difference among IOFC observed in each year and the reference income calculated over the previous three years. According to the methodology proposed by Trestini *et al.* (2018), each farms' reference income has been standardised on the number of cows observed in the current year. This allows to avoid a misleading estimation of the income variation due to a change in herd dimension.

Tab. 3. Average number of milk cows, milk production, milk revenues and prices paid by the cooperative (n=167).

Year	Milk cows (n.)	Milk per cow (100 L)	Farms revenues (000 €)	Milk price (€/100 L)
2008	37.8	69.3	100.8	38.5
2009	38.9	67.6	92.6	35.2
2010	39.1	71.4	116.2	41.7
2011	40.3	73.3	142.1	48.1
2012	41.0	75.4	136.4	44.1
2013	41.9	74.2	137.1	44.1
2014	42.2	77.9	139.6	42.5
2015	42.7	79.0	129.4	38.4
2016	42.7	79.8	127.1	37.3
Average	**40.7**	**74.4**	**124.6**	**41.1**

Source: own elaborations on dairy cooperative data.

According to the Omnibus Regulation, one farm can be indemnified by the fund when its income loss is greater than 20%, compared to its reference income. The fund pays the 70% of such income reduction.

By the simulation of income losses suffered by farmers in the period 2011-2016, the total amount of fund compensations to farms has been quantified. Except from functioning costs of the fund and considering the total requirement of the fund equal to the total entity of the indemnifications paid in the period, it is possible to quantify a hypothetical annual farmer participation cost, expressed as % on the reference IOFC or per revenue. Alternatively, it can be represented as flat fee expressed per farm or per cow or per kg of milk.

3. Results

Table 4 reports the model estimates for equation (1) where variables have been included applying a stepwise regression method with forward selection. The model correctly describes the 43.7% of feed cost variation in the FADN sample with a significant effect associated to the average productivity of cows (*milk_cow*), *province* (reflecting the effect of different territories), and *prices* (incorporating the effect of price changes). *Milk_cow* shows a decreasing effect due to the negative coefficient of the square of the variable. Concerning commodity prices, only corn and soybean show a significant effect on *feed_*

Tab. 4. Model estimates – dependent variable: *ln (feed_cow).*

Variables	B	SE	t	p-val
constant	5.665	0.154	36.770	0.000
milk_cow	0.019	0.003	5.481	0.000
milk_cow^2	-6.2e-5	0.000	-2.505	0.013
province				
Treviso	0.145	0.032	4.516	0.000
Venice	-0.099	0.050	-1.980	0.048
Vicenza	0.084	0.032	2.626	0.009
prices				
corn	1.3e-3	0.000	3.167	0.002
soybean	7.7e-4	0.000	2.937	0.003
$R^2 = 0.437$				

Source: own estimations.

cow. The estimated coefficients are applied to calculate feed cost (*feed_cow*) of each farm belonging to the cooperative in different year: *milk_cow* is the average quantity of milk supplied by each farm to the cooperative; *province* is the province where the farm is located; *prices* are the average annual price, respectively for corn and soybean, that can be observed at the end of each year in the Bologna market. The calculated *feed_cow* multiplied by the number of cows in each farm in a specific year allows to estimate farms' annual feed cost.

Table 5 reports the farm's average feed costs and IOFCs among different years. Here, it is interesting to notice the high incidence of feed costs over milk revenues, which ranges from a minimum of 40.5% in 2011 to a maximum of 51.1% in 2019. Coherently to Valvekar *et al.* (2010), this justifies our choice to use the IOFC as indicator of farm income.

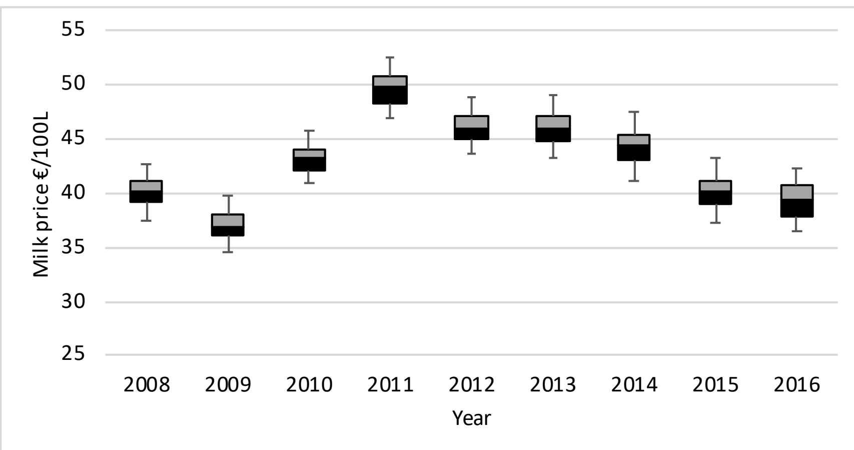
Considering that mean values represent only partially the distribution of individual economic results of the farms along the years, it is interesting to look at the dispersion around the mean of milk revenues, feed costs and IOFC. Milk prices (Fig. 1) clearly show the trend of dairy market in the last years. Values are characterized by a lower dispersion around the mean compared to other variables. In fact, the price paid to farmers by the cooperative is composed by two components: the basic price, that is paid per litre of milk and varies according to the year, and an additional price, based on milk quality parameters defined by the cooperative. While the basic price in a year is constant for all the farmers, the quality premium price is individual, and can

Tab. 5. Average feed costs, IOFC and incidence of feed costs over total milk revenues (n=167).

	Feed costs (€/100L)	IOFC (€/100L)	Feed costs/ Milk revenues (%)
2008	19.4	19.1	*50.4*
2009	18.0	17.2	*51.1*
2010	18.4	23.2	*44.2*
2011	19.5	28.6	*40.5*
2012	21.2	22.9	*48.0*
2013	21.0	23.1	*47.7*
2014	19.4	23.1	*45.6*
2015	18.1	20.3	*47.0*
2016	18.0	19.3	*48.2*
Average	**19.2**	**21.9**	***46.7***

Source: own elaborations.

Fig. 1. Milk prices over years for the sampled farms.

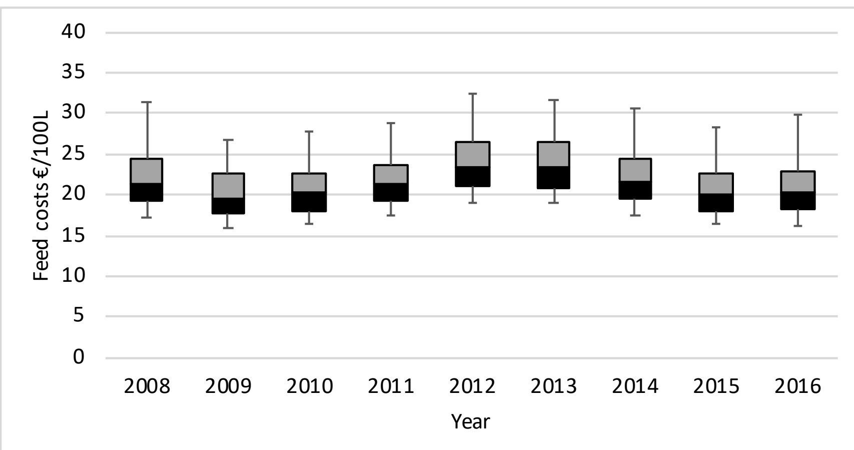


Source: own elaborations on dairy cooperative data.

represent an addition to the basic price, if the milk parameters considered are good, or a detraction, if they are not. Therefore, it is the price quality component that origins prices dispersion through farms in the same year. On the contrary, variability of feed costs is particularly high (Fig. 2), such as that of the IOFC (Fig. 3). Therefore, the variation of IOFC of a specific farm is the combination of two effects: i) milk and feed prices, mainly depending on market factors, out of the control of farmers, and ii) milk quality and cost efficiency, mainly under control of the farm.

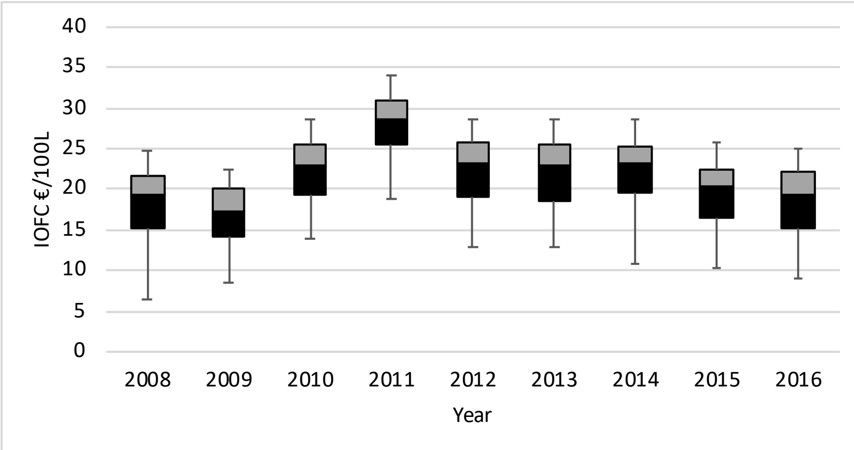
The simulation of the IST showed that the 62% of the sample would have received at least one indemnification during the period 2011-2016 and, between these, the 53% would have been compensated more than once. In Table 6, we can see that the percentage of farms that would have been compensated by the fund varies among the years with a greater incidence in 2013 (24%), 2015 (31%) and 2016 (26%). The IST allows supporting up to the 42% of farms in 2015, at the beginning of the sector crisis (70 farms within the 167). By the way, in the second year of the crisis (2016), only part of these farms could benefit from an additional support of the IST (24 over 51 farms) while 19 new farms would be supported for the first time. This happened because farms suffering a reduction of income lower than 20% experience a reduction of their reference income, reducing the probability of income support by the fund.

Fig. 2. Feed costs over years for the sampled farms.



Source: own elaborations.

Fig. 3. IOFC over years for the sampled farms.



Source: own elaborations.

Tab. 6. Reference IOFCs, percentage of farms indemnified, indemnifications of the fund and incidence on the reference IOFCs (n=167)

Year	Ref. IOFC of the fund (000 €)	% farms indemnified (%)	Indemnifications paid by the fund (000 €)	Indemnifications	
				over ref. IOFC (%)	per farm (€)
2011	10,614	*1.2*	15	*0.14*	90
2012	12,515	*11.4*	139	*1.11*	832
2013	14,081	*24.0*	354	*2.52*	2,121
2014	14,402	*18.6*	274	*1.90*	1,640
2015	13,905	*30.5*	423	*3.04*	2,532
2016	13,557	*25.7*	427	*3.15*	2,559
Average	**13,179**	***18.6***	**272**	***2.06***	**1,629**

Source: own elaborations.

Considering the amount of the indemnifications, and thus the requirements of the fund, we hypothesize an annual participation fee for the farmer (excluding IST functioning costs). The IST applied to this dairy cooperative could work with an average contribution equal to 2.06% of their reference

IOFC (0.62% in presence of maximum public contribution). To have an idea of the amount of farm contribution, the fee for an average farm (42 milk cows in the period) equals to 1,629 €/year, corresponding to 39 €/milk cow, without accounting for public contributions. This contribution, based on the observed trend, should guarantee an amount of entrances to the fund that allows paying the indemnification. In fact, during the first four years of functioning of the fund, the percentage of the indemnification over reference IOFC is structurally below the average fee. This situation allows to the fund to overtake the above mentioned period of crisis (2015-2016) without the need to collect additional capital in the market or reduce farmers' indemnifications.

4. Conclusions

The research proposes, for the first time, the simulation of a sector-specific IST applied to milk sector within the context of a dairy cooperative. Results demonstrate the feasibility of such tool in terms of economic sustainability under the conditions defined by the Omnibus Regulation, also in the years of crisis for the milk sector. The participation cost seems to be affordable, with a value, on average, equals to 39 €/milk cow, without including public contribution (less than 12 € in the case of 70% public contribution). During the period of crisis, income losses do not involve all members systematically, although being diffused among farmers. The condition of financial sustainability for the fund lies on the creation of a capital stock able to support crises. In fact, it should be noted that in our case study the crisis would have had an impact to the fund only in the late part of the considered period, when the fund had created enough capital stock. Similarly, the present period, after a sector crisis, seems to be the right moment to setup a new fund: it can profit from a low reference income, that reduces the probability of a further income drop and farmers are particularly interested to adopt strategy to protect their income. The definition of a strategy to manage the bankrupt risk of the fund is crucial to guarantee its success and survival. In this sense, it is useful to remember the new possibility to profit from public contribution also to setup the initial stock of the fund. Furthermore, the research demonstrate that using indexes to quantify farms income drop, coherently with Omnibus Regulation, it is possible to guarantee the effectiveness of the IST by reducing both administrative costs and moral hazard. Additionally, the use of an index may support the improvement of farms' performances. In fact, indexed feed cost plays as a benchmark for the quantification of farms' income. It tends to overestimate costs for most cost-efficient farms, while underestimating costs for less-efficient ones. Being costs index linked on the whole behaviour of dairy farms, there is an incentive for a single farm to improve cost-efficiency to maximise its income. From an operational point of view, a public institution (e.g. ISMEA, CREA) may periodically provide an estimation of feed cost indexes or support funds in the application of a shared methodology. On the contrary, the cooperative could always decide to activate the fund privately, to help its members to overcome periods of economic difficulty and to improve its mutual effectiveness.

Further research may investigate about the more efficient method to apply farmers' fee, in particular looking to the effect on cost and benefit of the application of fees based on reference IOFC compared to fees expressed per litre of milk produced or per cow. Furthermore, even if cooperatives seem to be one of the best context where the high commitment towards a mutual interest can be associate to a high participation rate to the IST, sensitivity analysis should be performed to simulate the effect that a lower rate of participation could have on farmers' participation costs.

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